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HARDWARE USER MANUAL

Second Generation RibEye™ Model #60005
for the WorldSID 50th Male ATD

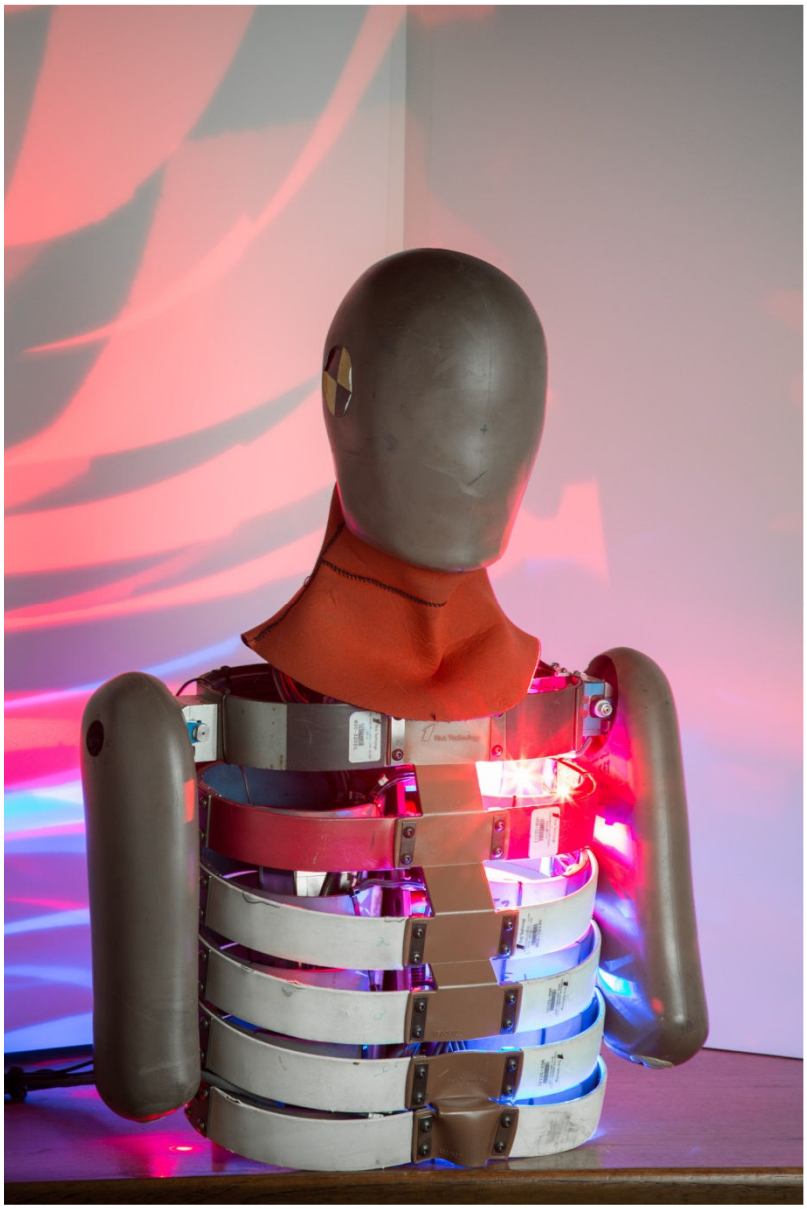

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Table of Contents

© 2023 Boxboro Systems LLC

Table of Contents, continued

List of Figures

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List of Figures, continued

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List of Tables

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HARDWARE USER MANUAL
Second Generation RibEye™ Model #60005
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1.0 WorldSID RibEye Description

The RibEye for the WorldSID anthropomorphic test device (ATD) provides X, Y, and Z position data for 18 light-emitting diodes (LEDs) mounted on the WorldSID ribs. Three LEDs are mounted on each of the six ribs. The RibEye for the WorldSID can be mounted on either side of the dummy to measure left-side or right-side impacts. Model #60005 is the Second Generation WorldSID RibEye. Appendix A provides the RibEye measurement range and other specifications. Up to 3 minutes of data can be collected at a 10-kHz sample rate. Data is stored in non-volatile memory that is retained after power is turned off. If external power is lost, the RibEye will operate on its battery. Communication to the RibEye is via Ethernet.

Two sets of three sensors monitor the LED positions. One of the six sensors is shown in Figure 1. The top set of sensors uses red optical filters and monitors the red LEDs mounted on the first three ribs: the shoulder rib, thoracic 1 rib, and thoracic 2 rib. The bottom set of sensors uses blue optical filters and monitors the blue LEDs mounted on the lower three ribs: the thoracic 3 rib, abdominal 1 rib, and abdominal 2 rib.

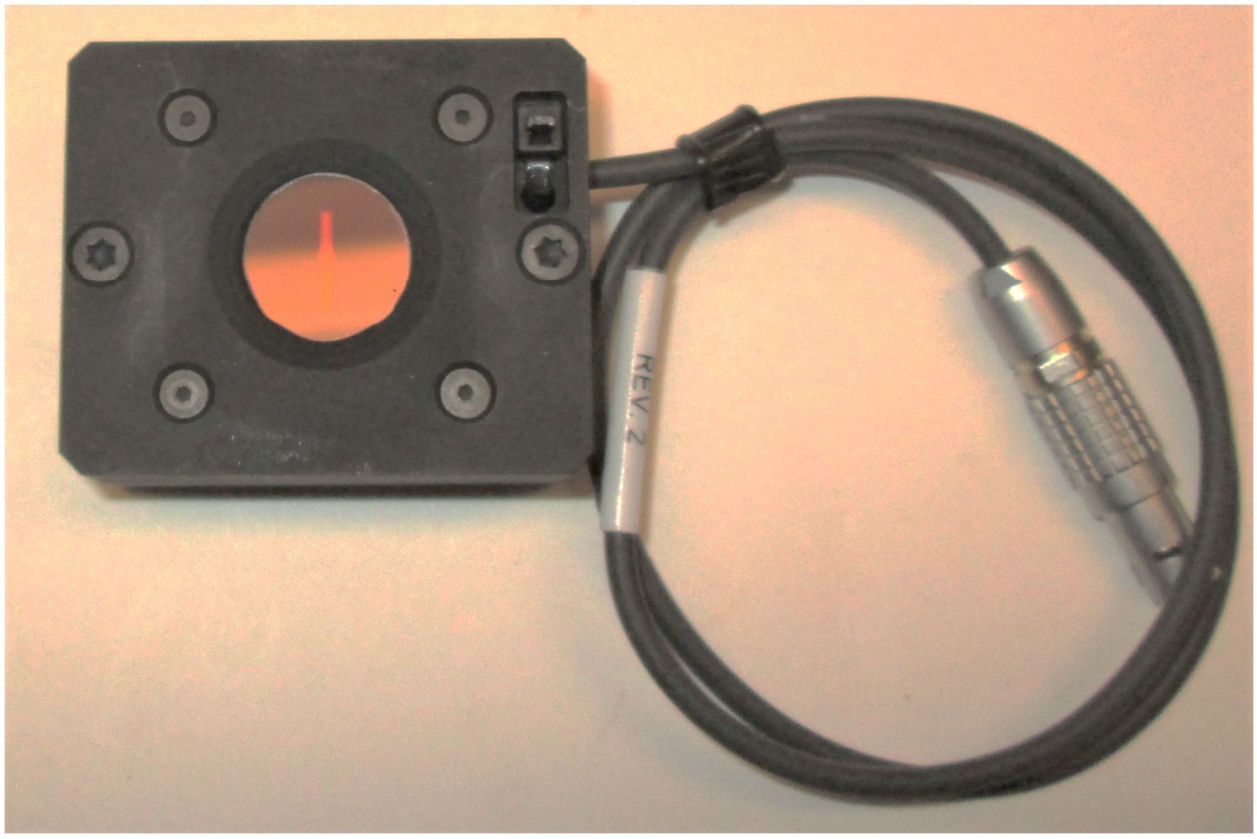

Figure 1. RibEye sensor, one of six

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Three RibEye LEDs are mounted on each rib. Figure 2 shows a RibEye LED assembly with the three LEDs. In each assembly, the center LED is mounted on the inner rib clamp. The forward and rearward LEDs are mounted to the rib damping material. The forward LED is closer to the front of the dummy, while the rearward LED is closer to the dummy's back. See Section 2.1, LED installation on the ribs.

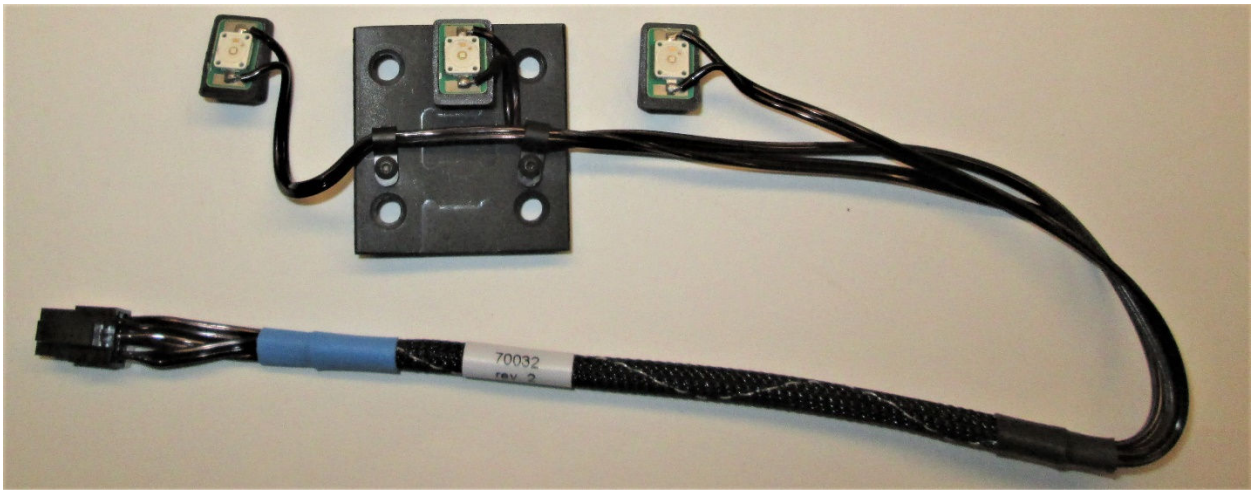

Figure 2. RibEye LED assembly, one of six

The RibEye controller and battery pack mount on the non-struck side of the dummy. Figures 3–6 show the following views of the controller:

- Figure 3 shows the controller as shipped, with connector covers installed at each end; also shown are the controller mounting plate and the controller mounting feet.
- Figure 4 shows the connectors for the sensors at one end of the controller.
- Figure 5 shows the connectors at the other end of the controller for the LED breakout cable, status cable, battery cable, and dummy exit cable.
- Figure 6 shows the battery pack and the adaptor for mounting the battery pack at the shoulder rib.

Figure 3. RibEye controller with connector end covers in place

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Figure 4. Controller sensor connectors

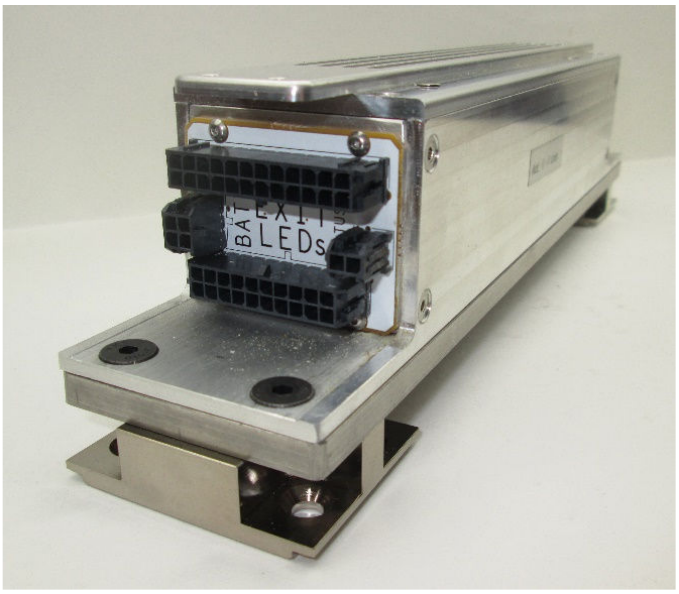

Figure 5. Controller connectors for LED breakout cable, status cable, battery cable, and dummy exit cable

Figure 6. Battery pack and the adaptor for mounting the battery pack at the shoulder rib

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2.0 RibEye Installation

This section explains how to mount the RibEye components into the WorldSID 50th Male ATD. The instructions cover the installation of the LEDs, sensors, controller, battery pack, ballast weights, as well as the cable routing. Some components are mounted before the ribs are assembled in the dummy, and others during or after rib assembly. Prior to the RibEye installation the thorax should be disconnected from the Pelvis, and the struck side ribs should be removed.

Order of assembly

1. Mount the LEDs on all of the struck-side ribs, as described in section 2.1.
2. Install a sensor base on the spine, install the rib, attach the sensor front piece to the base, and route the LED cable. These steps follow a prescribed order starting at the bottom rib (abdominal 2) and working upwards. The sensor bases are used to clamp the inner ribs to the spine (sections 2.2.1–2.2.3).
3. Install the controller mounting feet and the battery mount on the non-struck-side (sections 2.3.1).
4. Install the LED breakout cable, also on the non-struck side, and connect the six LED cables to the LED breakout cable (section 2.3.2).
5. Install the controller mounting plate and controller (section 2.3.3).
6. Connect the cables to the controller and install the battery (section 2.3.4).
7. Power up and test the RibEye before final assembly (section 2.3.5).
8. Attach the thorax to the pelvis with the tungsten triangular mass blocks on both sides of the thorax (section 2.4).
9. Install the shoulder pads (section 2.5).
10. Complete dummy assembly (neck, head, and arms) per the ATD Users Manual

2.1 LED installation on the ribs

NOTE: The LEDs must be mounted to the ribs before the ribs are installed in the dummy.

Table 1 summarizes the LED positions and mounting methods for all 18 LEDs. The following sections describe in detail how to mount the LED assemblies onto the ribs. The forward LEDs are closer to the front of the dummy and the rearward LEDs are closer to the dummy's back. The forward and rearward LEDs are mounted on the rib damping material with high-strength double-sided foam tape, 1/2-inch wide 3M VHB Tape 4952.

The center LEDs are mounted on the inner rib clamps. Figure 7 shows a picture of the LEDs mounted to the ribs.

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Table 1. Summary of LED positions and mounting methods

Rib number/type		Rearward LEDs	Center LEDs	Forward LEDs
Rib #1 (shoulder)	**Position**	Bottom edge of rib		
	Mounting	Snap LED assembly to angled block; mount angled block with VHB tape	LED assembly already glued to LED adaptor plate; screw LED adaptor plate to clamp plate	Snap LED assembly to angled block; mount angled block with VHB tape
Rib #2 (thoracic 1)	**Position**	Bottom edge of rib*		
	Mounting	Mount LED with VHB tape	LED assembly already mounted to clamp plate	Mount LED with VHB tape
Rib #3 (thoracic 2)	**Position**	Top edge of rib		
	Mounting	Snap LED assembly to angled block; mount angled block with VHB tape	LED assembly already glued to angled block; screw angled block into clamp plate	Snap LED assembly to angled block; mount angled block with VHB tape
Rib #4 (thoracic 3)	**Position**	Bottom edge of rib		
	Mounting	Snap LED assembly to angled block; mount angled block with VHB tape	LED assembly already glued to angled block; screw angled block into clamp plate	Snap LED assembly to angled block; mount angled block with VHB tape
Rib #5 (abdominal 1)	**Position**	Bottom edge of rib*		
	Mounting	Mount LED with VHB tape	LED assembly already mounted to clamp plate	Mount LED with VHB tape
Rib #6 (abdominal 2)	**Position**	Top edge of rib		
	Mounting	Snap LED assembly to angled block; mount angled block with VHB tape	LED assembly already glued to angled block; screw angled block into clamp plate	Snap LED assembly to angled block; mount angled block with VHB tape

***** Rib 2 (thoracic 1) and Rib 5 (abdominal 1) can alternatively be mounted at the center of the rib rather than the bottom.
If using this optional mounting, remove the center LED from the bottom of the rib clamp using heat to soften the epoxy, then re-epoxy the LED to the rib clamp's center indent.

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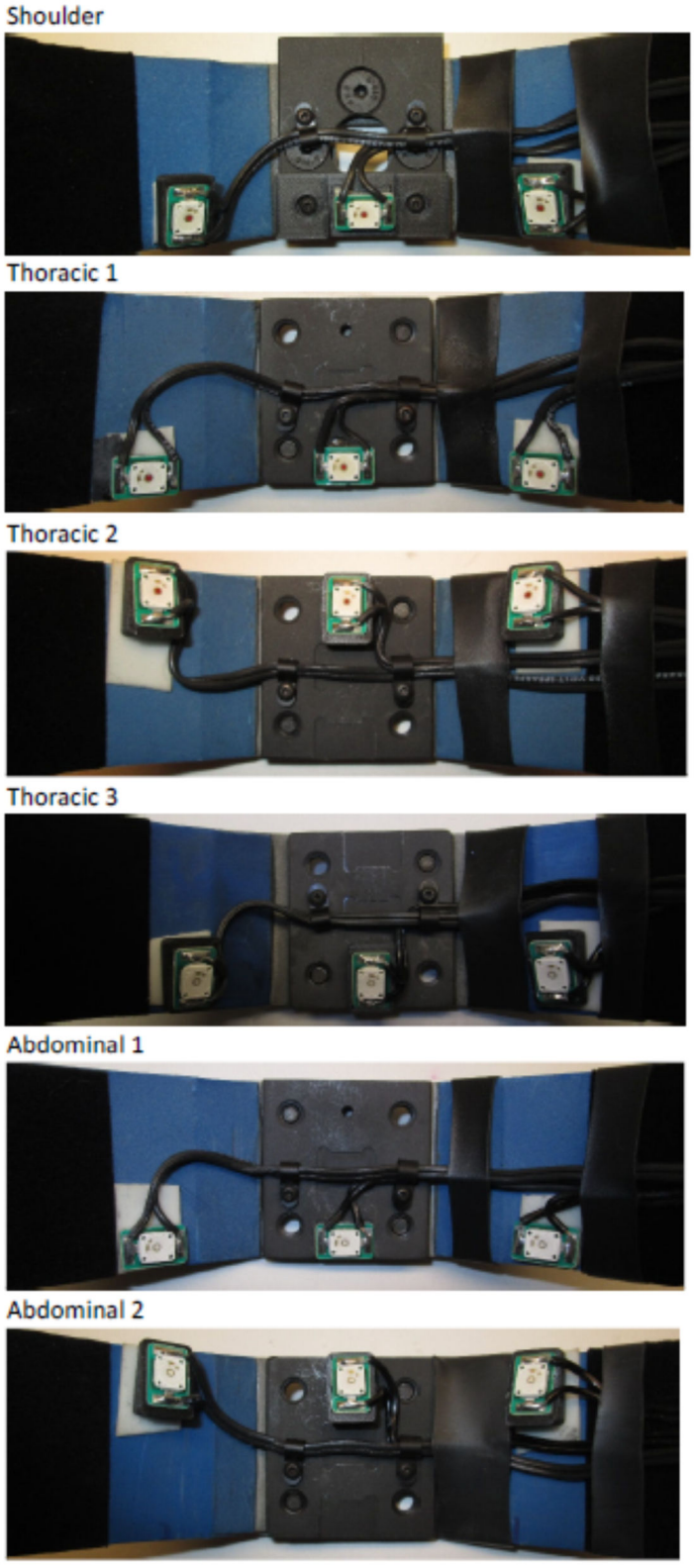

Figure 7. LED positions on each rib

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2.1.1 LED assemblies

Figure 8 shows a LED assembly, with its lead cable attached, and an angled mounting block. The LED is soldered onto a metal-clad printed circuit board. Figure 9 shows the LED assembly snapped into the angled mounting block. If the LED does not snap tightly into the angled block, it can be held in place with super-glue (cyanoacrylate) or epoxy. The RibEye is shipped with the LEDs snapped into the blocks. Center LEDs mounted on angled blocks (thoracic 2-3 and abdominal 1-2) are epoxied to the angled blocks.

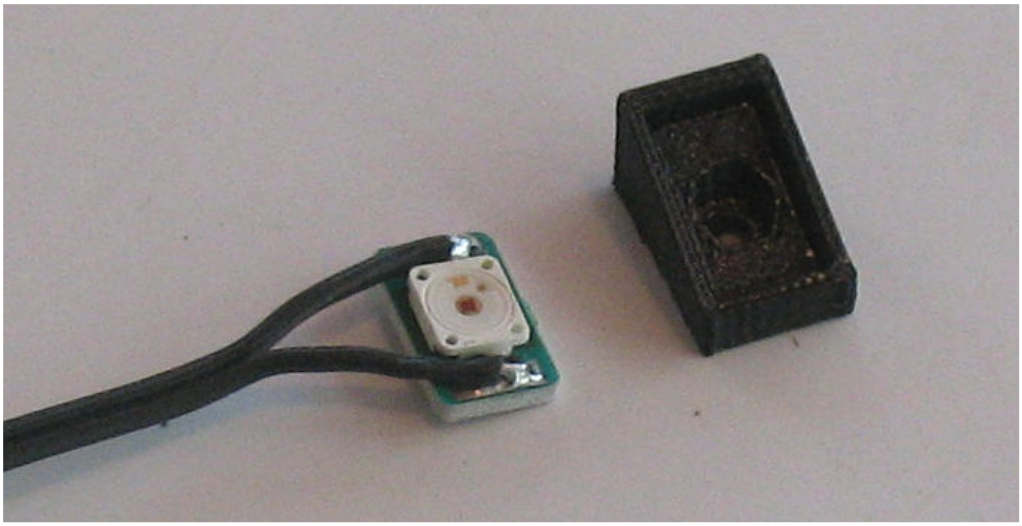

Figure 8. LED and angled mounting block

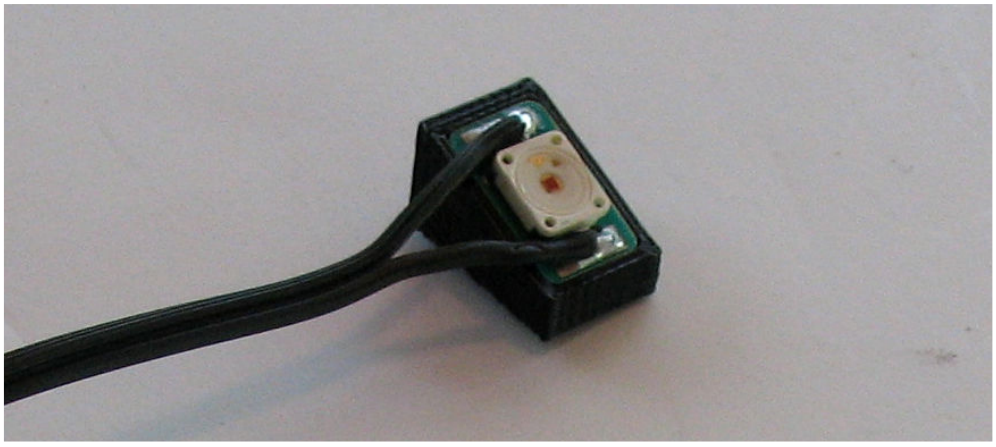

Figure 9. LED snapped into angled mounting block

The angled mounting blocks are used on four of the dummy's six ribs – the shoulder, thoracic 2, thoracic 3, and abdominal 2 ribs. On the shoulder and thoracic 3 ribs, the LEDs are mounted on the bottom edge of the ribs. On the thoracic 2 and abdominal 2 ribs, the LEDs are mounted on the top edge of the ribs.

The center LED on the shoulder rib is epoxied on to a LED adaptor plate (#10089). The adaptor plate is attached to the shoulder inner rib clamp using two 2-56 x 1/4 button-head cap screws (BHCS).

The shoulder center LED assembly consisting of an inner rib clamp (#10086), LED adaptor plate, and pin for the shoulder pad (#W50-35047) are shown in Figure 10. A second inner rib clamp and pin for the shoulder pad are provided for the non-struck side.

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Also shown in Figure 10 are two plastic wire clamps that are bolted to the inner rib clamp plate with 2-56 x 1/4 BHCS. There are two sizes of plastic wire clamps. The smaller wire clamp (0.093-inch diameter) is sized for a single LED cable and is mounted on the left side of the inner rib clamp for the cable that goes to the rear LED. The larger wire clamp (0.125-inch diameter) holds two LED cables and is mounted on the right side of the rib clamp for the two cables that come from the controller, past the front LED. The description above is for Left-Side impact, directions are reversed for Right-Side impact

The cable clamps are from Micro Plastics Inc.:

- 22CC16A0093-B for the 0.093-inch-diameter clamp
- 22CC16A0125-B for the 0.125- inch-diameter clamp.

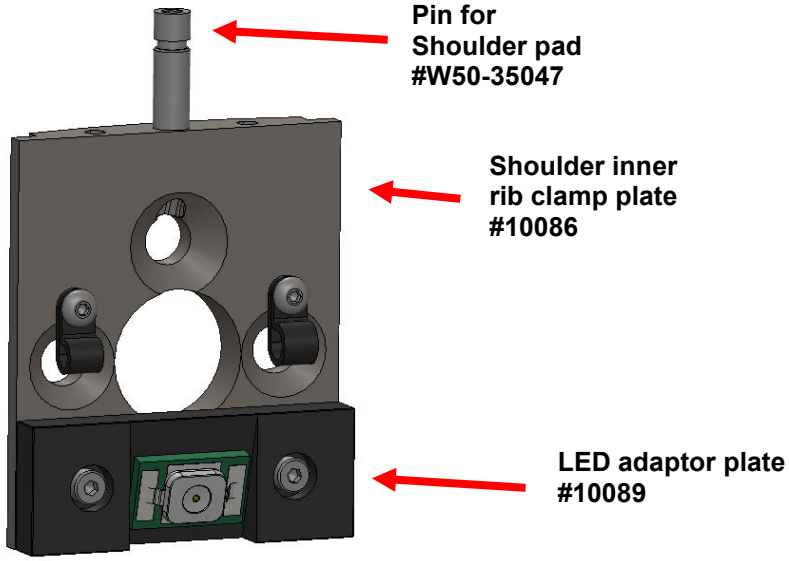

Figure 10. Shoulder center LED adaptor plate, inner rib clamp, pin for shoulder pad, and wire clamps

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The center LEDs on the thoracic and abdominal ribs are mounted to inner rib clamp plates #10085. A CAD drawing of an inner rib clamp plate is shown in Figure 11.

- Hole A is for installing the angled blocks, which are screwed to the clamp plates using a 1/4-inch long, 2-56 BHCS that engages in a captive 2-56 nut inside the angled blocks.
- The two B holes are for mounting the nylon wire clamps using 2-56 x 1/4 BHCS.

Recess C is for mounting the flat LED for thoracic 1 or abdominal 1 LEDs at the bottom edge of the rib clamp. Recess D is the alternative location for mounting the flat LED at the center of the rib clamp (see Table 1 footnote). The LEDs are epoxied into the recesses.

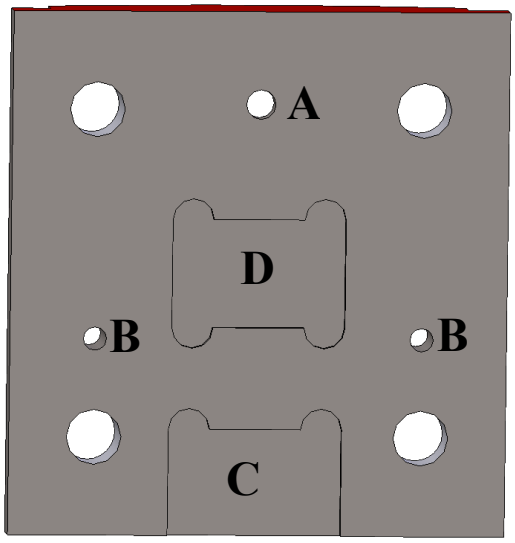

Figure 11. Inner rib clamp plate for thoracic and abdominal ribs

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Figure 12 shows the inner rib clamp plate for the thoracic 2, thoracic 3, and abdominal 2 ribs. Thoracic 2 and abdominal 2 have the LED and angled block mounted toward the top of the clamp plate as shown in Figure 12. Thoracic 3 has the LED and angled block mounted to the bottom of the clamp plate—the plate is rotated 180 degrees for the picture shown. For the thoracic 2, thoracic 3, and abdominal 2 angled blocks, there is a captive 2-56 nut installed in the angled block, and a 2-56 x1/4 BHCS screw holds the angled block to the inner rib clamp

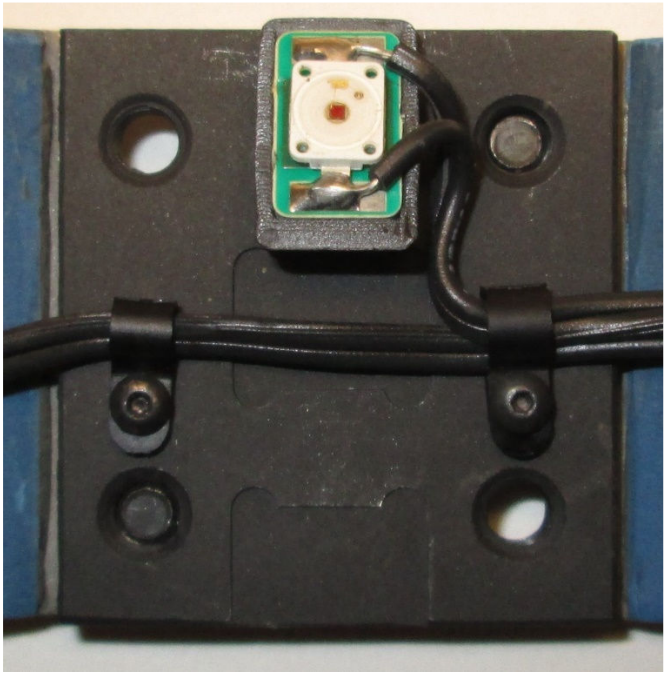

Figure 12. Thoracic 2, thoracic 3, and abdominal 2 inner rib clamp plate with LEDs and wire clamps installed

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There is one cable for each rib 3-LED set. Cables #70031 are for the upper three ribs and have red heat-shrink tubing near the connector. Cables #70032 are for the lower 3 ribs and have blue heat-shrink tubing near the connector. Figure 13 shows the #70031 and #70032 cables. The LED closest to the connector is mounted to the front of the rib, the center LED is mounted on the inner rib clamp, and the LED farthest from the connector is mounted on the rear side of the rib.

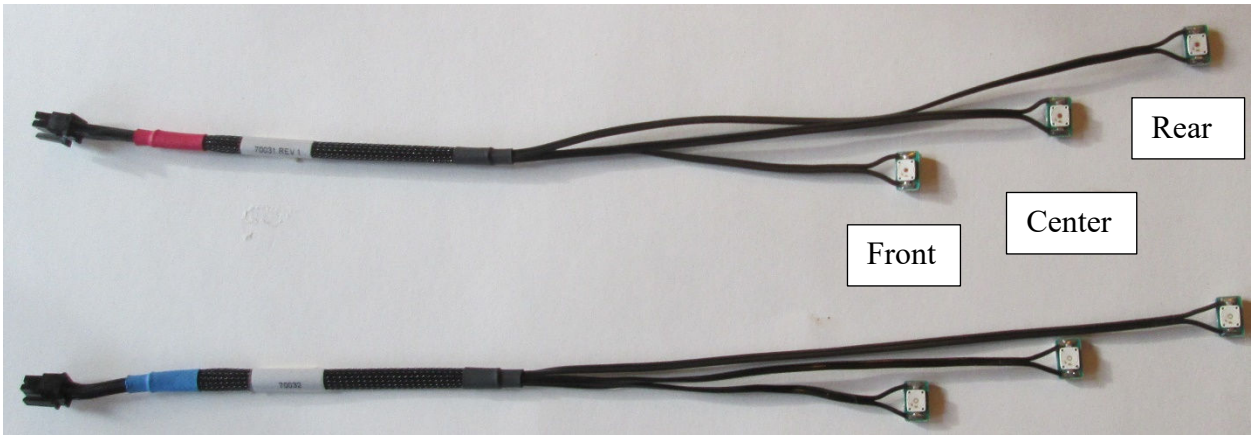

Figure 13. LED cables #70031 and #70032

The rearward and forward LEDs are typically mounted 35 mm from the center of the rib as shown in Figure 14. The 35-mm dimension is the straight-line distance to the edge of the angled block or 1 mm from the edge of the LED metal-clad printed circuit board.

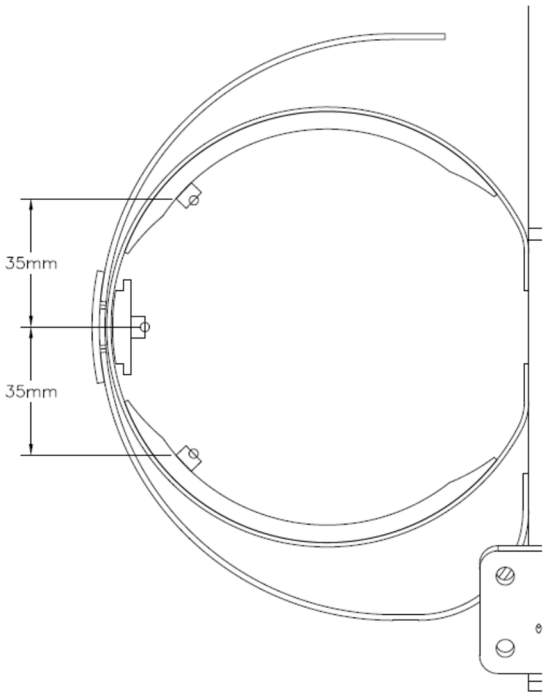

Figure 14. Rearward and forward LED locations

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To simplify the mounting of the front and rear LEDs, a LED placement fixture #70300 is available, shown in Figure 15. This fixture holds the rib in place and provides a guide for placing the VHB tape for the front and rear LEDs. Refer to the LED placement fixture instructions for using the fixture. The instructions are available on the RibEye tab of the Boxboro Systems web site (www.boxborosystems.com).

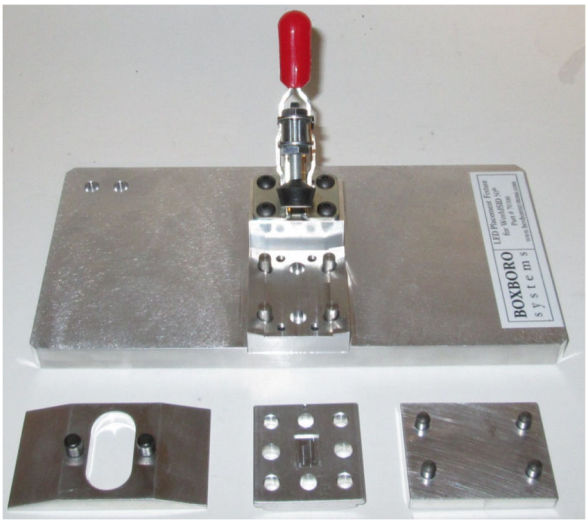

Figure 15. LED placement fixture #70300

On each rib, the rearward LEDs should be mounted first, then the center LEDs, and finally the forward LEDs. Before mounting the LEDs, remove grease and mold-release compound by wiping down the mounting area on the ribs and the back of the LEDs and mounting blocks, using isopropyl alcohol. When installing the foam tape, squeeze it onto the rib with at least 15 psi of force. When putting the LED assembly onto the foam tape, press it on with at least 15 psi of force; however, do *not* press on the soft silicone face of the LEDs.

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2.1.2 Mounting rearward LEDs on the ribs

The rearward LEDs should be mounted according to the following procedure:

Place a strip of double-stick tape on the rib at the rearward LED mounting location. Add a second piece of tape that will hold the LED cable in position. Place the LED on the first piece of tape and arrange the cable on the second piece of tape so that the cable avoids the spot where the center LED will be mounted (see Figure 16).

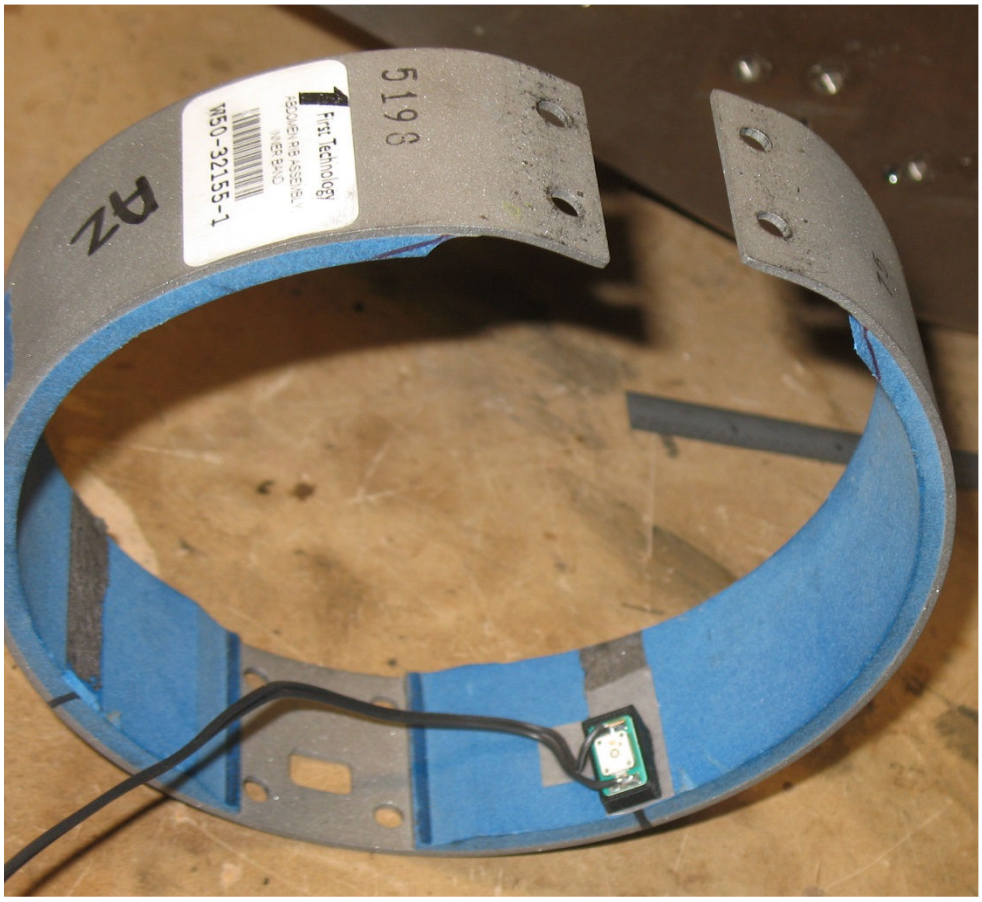

Figure 16. Rearward LED placed on double-stick tape (with cable arranged to avoid center LED position)

2.1.3 Mounting center and forward LEDs on the ribs

The next step is to install the center LEDs and route the cables. As noted earlier, the center LEDs are mounted on the inner rib clamp plates, which either have the LED mounted to them or have the LED/angled block screwed into them.

Temporarily install the inner rib clamp with LED assembly using one of the M5 x 12 button-head cap screws. Then place the double-stick tape for the forward LED and route the cables from the center and rearward LEDs as shown in Figure 7 above. Note how the LED cables are routed to avoid crossing in front of any LEDs.

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Place the forward LED in position on the double-stick tape. Slide a 1/4 to 3/8 inch wide band of 1.25 inch diameter heat-shrink tubing over the cables and rib and place it between the rear LED and the rib clamp to hold the bundle of wires in place as shown in Figure 7 above. The heat shrink tubing is Qualtek, 2:1 shrink ratio, 1-1/4 inches in diameter, part number Q2-Z-1 1/4-01-MS50FT, or equivalent.

NOTE: It is important to secure all the cables so that they do not block the light from the LEDs to the sensors during a test.

2.1.4 Install light-absorbing flock paper on the rib damping material

Measurement errors can result from light reflecting off the rib damping material. To prevent such errors, a material designed to absorb light can be applied on top of the damping material. We recommend Flock #55 adhesive-backed material from Edmund Optics. It is only 0.02 inch thick (0.5 mm), so it's very flexible and will not affect the performance of the ribs.

Two strips of flock paper are needed to cover the rib's inner surface from each outer LED (front and rear LEDs) to the rib-mounting end. The flock paper must be applied to the ribs after the LEDs are mounted, but before the LED cables are routed. After the flock paper is applied, the LED cables will lie on top of it.

You can order pre-cut strips of this flock paper from Boxboro Systems, or you can order sheets in various sizes from Edmund Optics in the US, Europe, and Asia. Pre-cut strips of the flock paper are supplied with new RibEyes.

2.1.4.1 Procedure for applying flock paper onto inner ribs

1. **Clean**. First clean the rib damping material by wiping it with isopropyl alcohol.

2. **Cut strips**. If you are not using our pre-cut strips, cut your flock paper into strips that are 50 mm wide and 120 mm long. Although the ribs are only 40 mm wide, it is much easier to use a wider strip and trim off the extra, versus lining up a 40-mm piece exactly along the edge of the rib later, when you stick it down (see Step 4).

3. **Test-fit**. Before you remove the flock paper's backing material, test-fit the length of your strips, starting at the outer LED, to make sure the flock paper does not extend beyond the damping material at the rib-mounting end. If the strips are longer than the damping material, cut them back.

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4. **Apply**. Remove the backing material from the flock-paper strip and stick it down, starting from one of the outer LEDs and applying the paper toward the rib-mounting end (Figure 17).

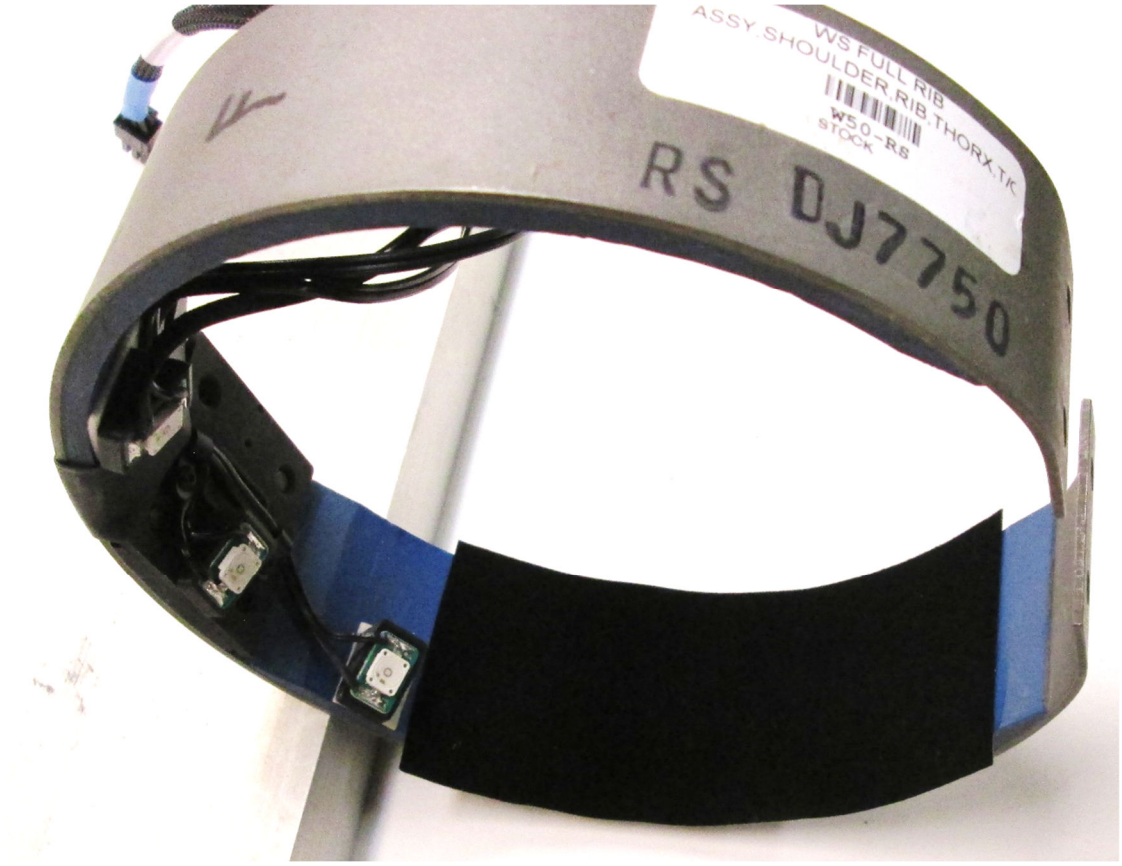

Figure 17. Flock paper applied from outer LED to rib-mounting end

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5. **Trim**. Using a ***very sharp*** blade – such as a single-edged razor blade or a utility knife – trim the excess flock paper from the edges of the rib (Figures 18–19).

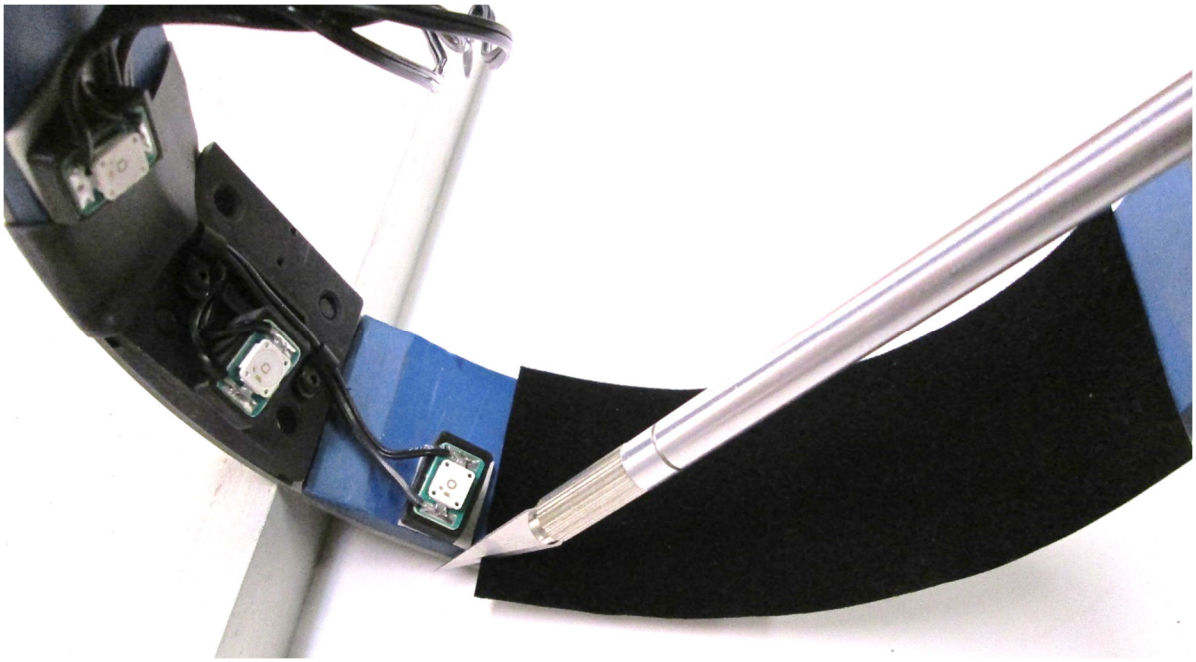

Figure 18. Excess flock paper being trimmed (view of inner rib)

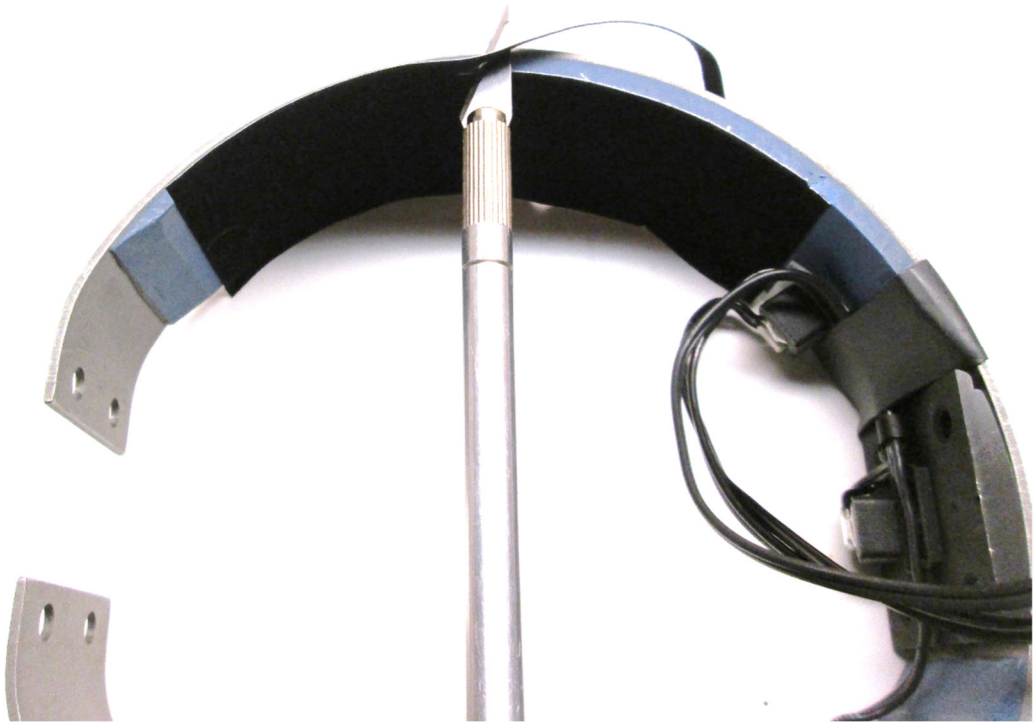

Figure 19. Excess flock paper being trimmed (view from edge of rib)

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6. **Repeat on other side**. Install the flock paper on the other side of the rib, so that the inner rib's forward and rearward sides are both covered.

7. **Route LED cables**. Route the LED cables on top of the flock paper on the forward side of the rib and secure them in place with three bands of heat-shrink tubing (Figure 20).

Figure 20. LED cables routed over flock paper

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2.2 Installation of ribs and sensor assemblies on the spine

NOTE: For customers who will be connecting the RibEye exit cable to Kistler NXT32 DAS systems mounted between the spine plates, you should attach the RibEye exit cable to the NXT32 now. The RibEye exit cable for the NXT32 system (cable #70115) connects to the last NXT32 in the chain. The last NXT32 is mounted at the top of the dummy's thorax between the spine plates.

To access the connector on the NXT32 interface module, remove the neck adaptor from the top of the thorax by removing the six M6 x 10 flat-head cap screws (three on each side) that hold the neck bracket to the spine plates. You can then plug in the Harwin connector end of the RibEye exit cable to the mating receptacle on the last NXT32 interface module. Replace the neck bracket with the six M6 x 10 screws.

2.2.1 Installation of sensor bases on spine with mounting screws

The RibEye's sensor assemblies take the place of the existing rib-to-spine clamps. Each sensor assembly contains a sensor front piece and a sensor base for mounting it to the spine. It is the sensor bases that act as the rib clamps.

The sensor bases are installed to the spine's existing rib-mounting holes using four special M5 x 10 flat-head cap screws that have precision-machined shoulders. Figure 21 shows the M5 x 10 shoulder screws. The shoulder screws ensure that the sensor bases are properly aligned to the spine.

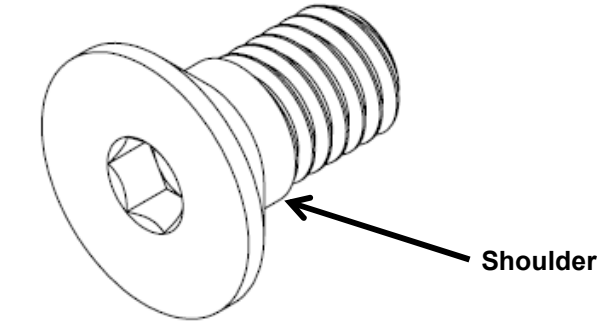

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Figure 21. M5 x 10 flat-head cap screw with precision-machined shoulder

The sensor bases have different angles depending on their mounting positions (Table 2).

Table 2. Sensor base part numbers and angles

Rib	Sensor Base Part Number	Base Angle, degrees
Shoulder	10071-11	11
Thoracic 1	10071-0	0 (flat)
Thoracic 2	10071-23	23
Thoracic 3	10071-20	20
Abdominal 1	10071-0	0 (flat)
Abdominal 2	10071-20	20

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The sensor bases have a label on the inside with the RibEye serial number (S/N), rib number, the rib name, and the screw installation order, as shown in Figure 22. To install the sensor bases, use four shoulder screws. Install the first screw in the upper-left hole (position 1) and tighten the screw loosely – "finger tight", so the base can still rotate about the screw. Next, install the second screw in the lower-right hole (position 2) and tighten the screw finger tight. Then put in screws in positions 3 (upper-right) and 4 (lower-left). Finally, tighten the screws in the order 1-2-3-4.

Figure 22. Sensor base with label

Figure 23 shows the sensor bases mounted to the spine.

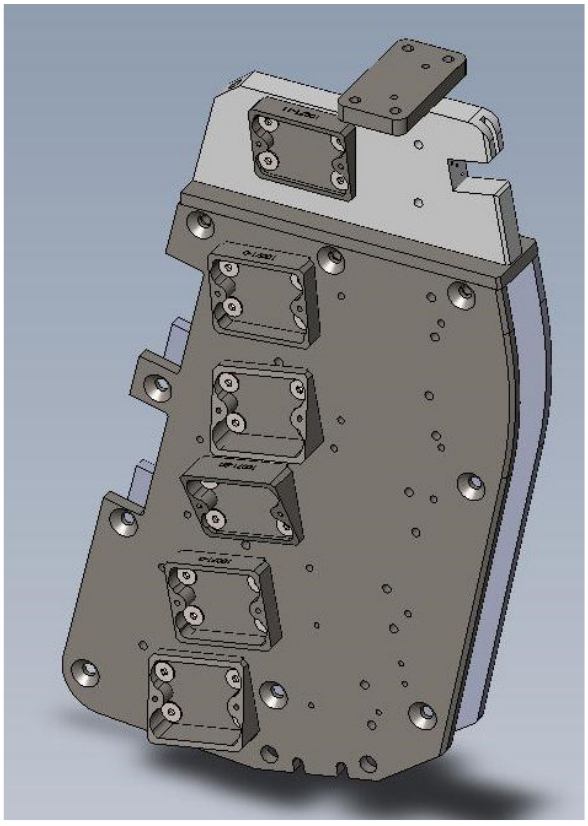

Figure 23. RibEye sensor bases mounted to spine
(ribs not shown)

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2.2.2 Mounting sensor front pieces to sensor bases

The sensor front piece containing the electronics and optics (Figure 24) is attached to the sensor base by two M3 x 16 flat-head cap screws. Torx head (T10) M3 x 16 flat-head cap screws are provided with the RibEye. The screws need only light tightening, to 5 inch-pounds (0.56 Newton-meters).

Although the sensor front pieces look identical, each piece is marked with the RibEye serial number (S/N) and the number of the rib that it must be mounted on. The sensor front piece must be installed on that rib. However, the sensor front pieces are not mounted to their bases until the ribs are in place inside the dummy (see section 2.2.3 below).

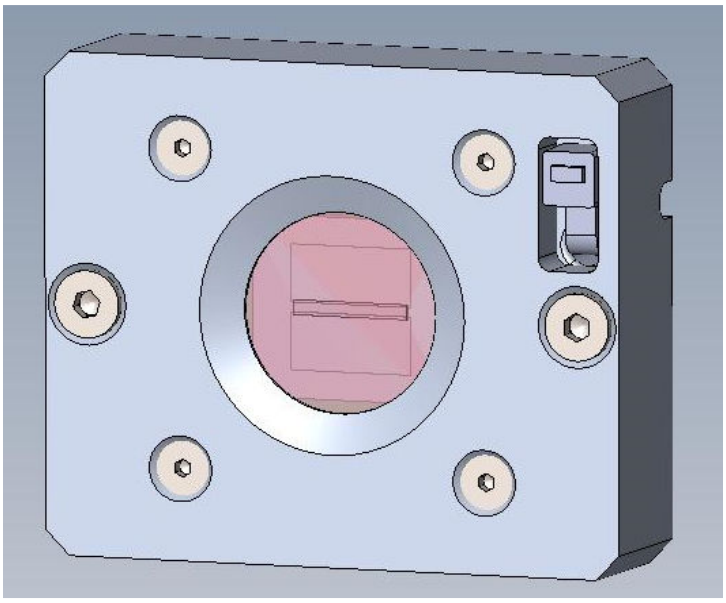

Figure 24. RibEye sensor front piece

WARNING:	**Never remove the sensor printed circuit board or loosen the circuit-board mounting nuts. Doing so will ruin the calibration of the RibEye.**

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Figure 25 shows the back side of the sensor front piece with the label showing the rib it must be installed on. Note that the sensor front pieces must be installed so that the cable is oriented to the rear of the dummy for left-side impact. For right side impact, the cable is oriented to the front of the dummy. The sensor has two alignment pins that fit into mating holes on the sensor bases.

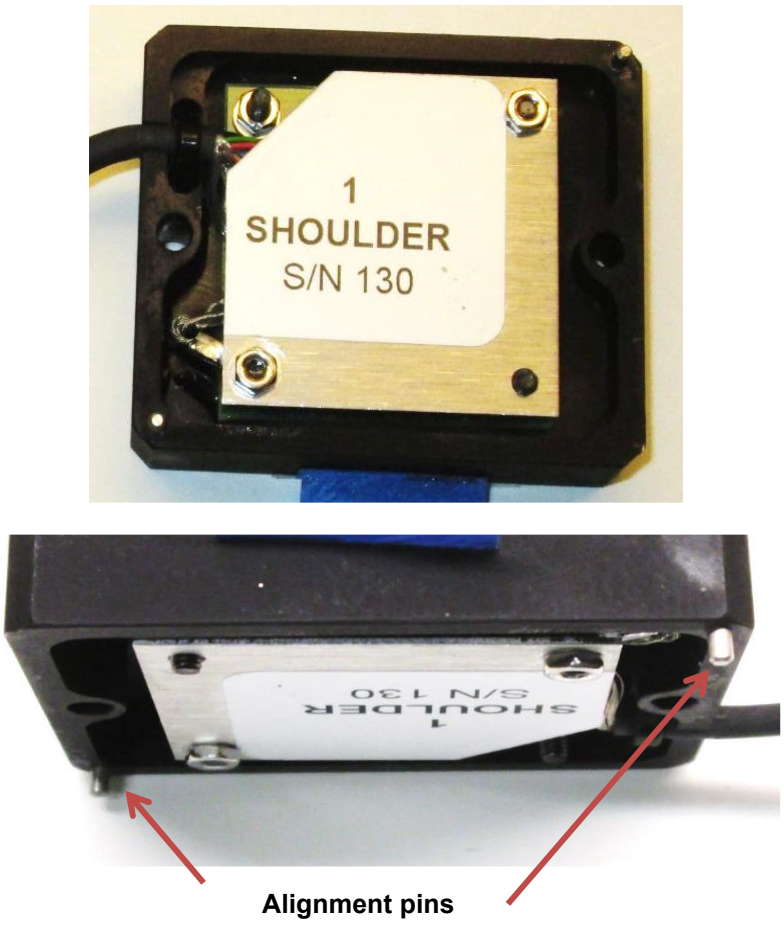

Figure 25. RibEye sensor label on back (top) and alignment pins (bottom)

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Figure 26 shows the spine with the entire sensor assemblies installed (bases and front pieces). However, the sensor front pieces are not mounted to their bases until the ribs are in place inside the dummy (section 2.2.3 below).

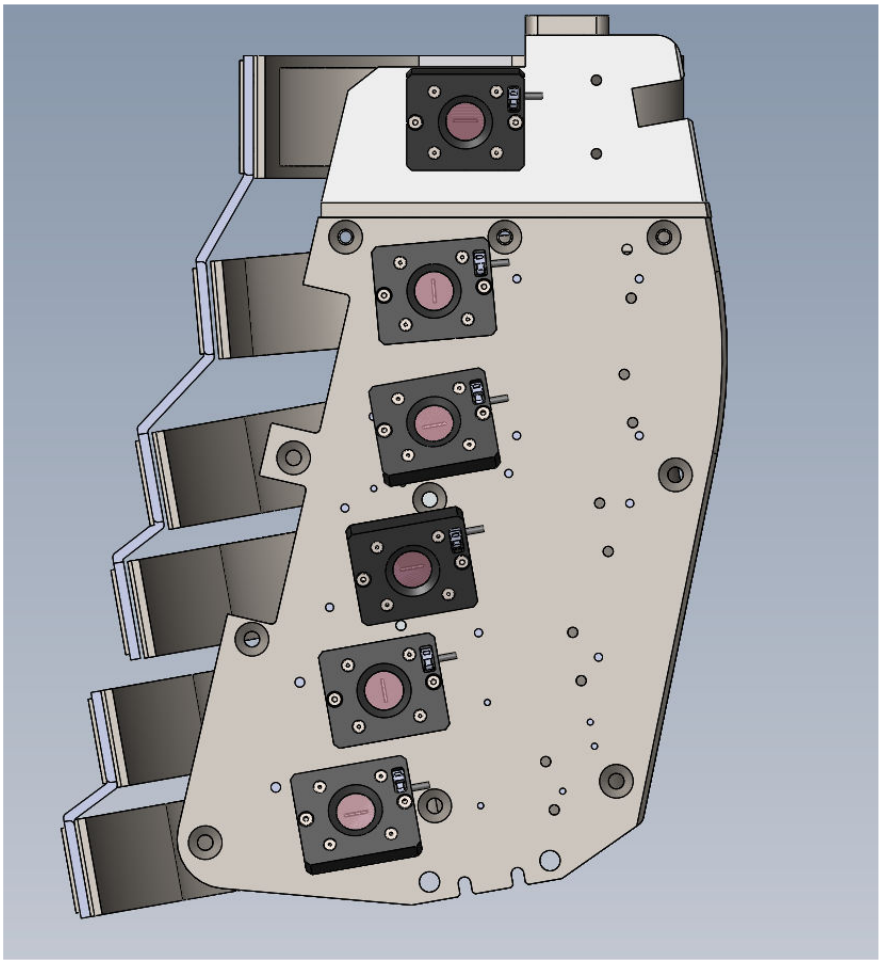

Figure 26. RibEye sensor assemblies mounted to spine
(ribs not shown)

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2.2.3 Installation of ribs on spine and routing LED cables

Install the ribs on the spine, starting with the bottom rib (abdominal 2) and working up, in the following order:

- Install outer rib.
- Install inner rib to spine using sensor base and shoulder screws.
- Connect the outer rib to the inner rib using the clamp plates and bolts supplied with the dummy.
- Attach sensor front piece to base.
- Route cable up to shoulder. Attach cable to next sensor cable using a nylon zip tie at the point where the cable exits the sensor.
- Route LED cables as follows:
    - Abdominal 2 through thoracic 2: LED cable exits TOP of rib
    - Thoracic 1 and shoulder rib: LED cable exits BOTTOM of rib
    - Cables go over the front of the dummy to its non-struck side.

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Figure 27 shows the bottom 3 ribs installed. Sensors are installed on the abdominal 1 and 2 ribs, and the thoracic 3 rib is installed with the sensor base ready for mounting the sensor front piece on thoracic three. Note that the painters tape that is shipped covering the sensor glass is left on during installation to prevent getting smudges on the lenses.

The sensor cables are routed upwards to the next sensor and zip-tied to the sensor cable close to the sensor. Assure that the cables are tight and can not move up (away from the spine) and block or reflect light into the sensors.

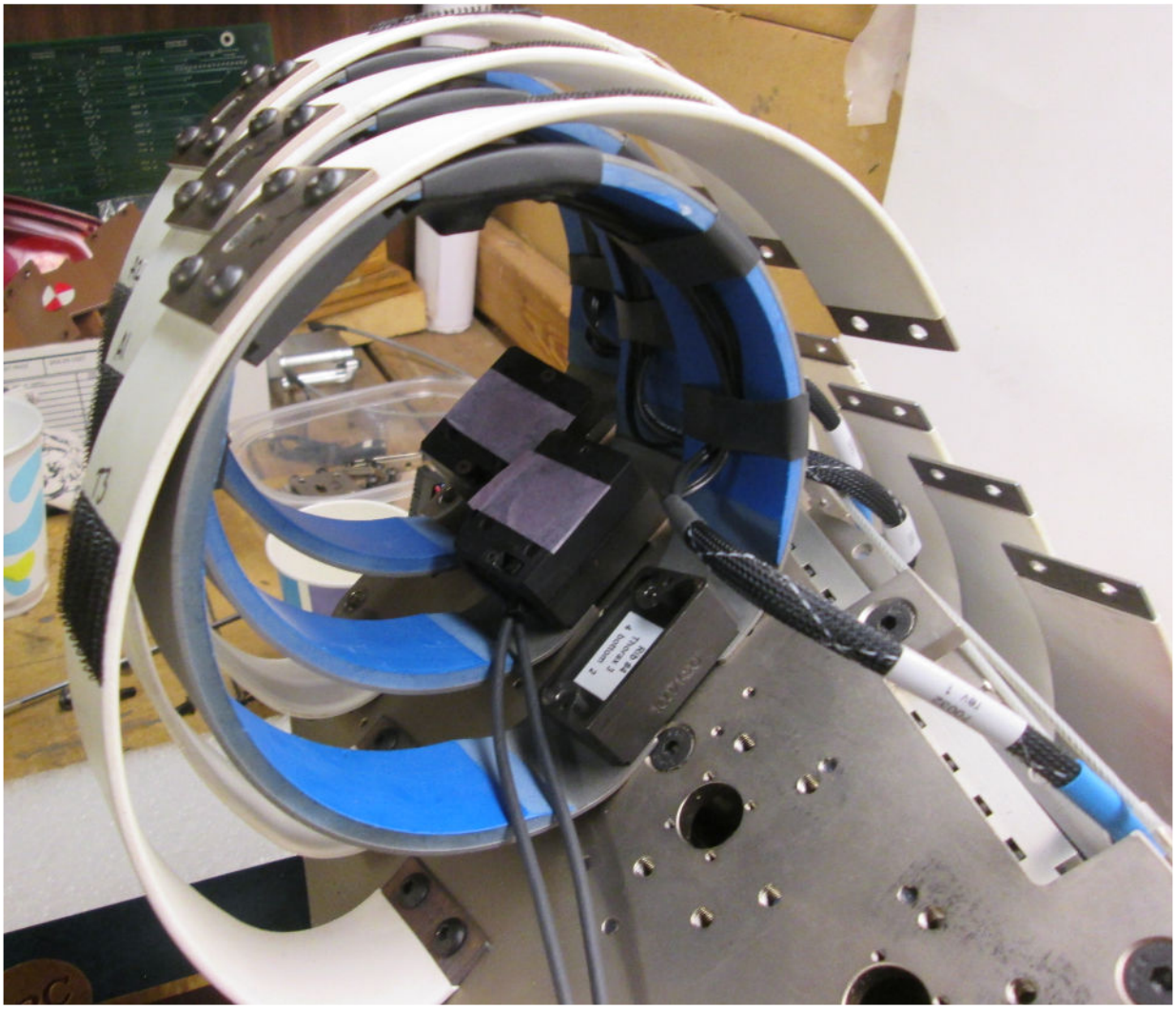

Figure 27. Lower three ribs – abdominal 2, abdominal 1, and thoracic 3 – and RibEye sensor assemblies mounted to spine

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The upper three ribs installed are shown in Figure 28. The dummy shown has a temperature sensor on the thoracic 1 rib, and its cable is routed to join the sensor cable bundle. The sensor cable bundle is routed to the non-struck side under the neck bracket as shown.

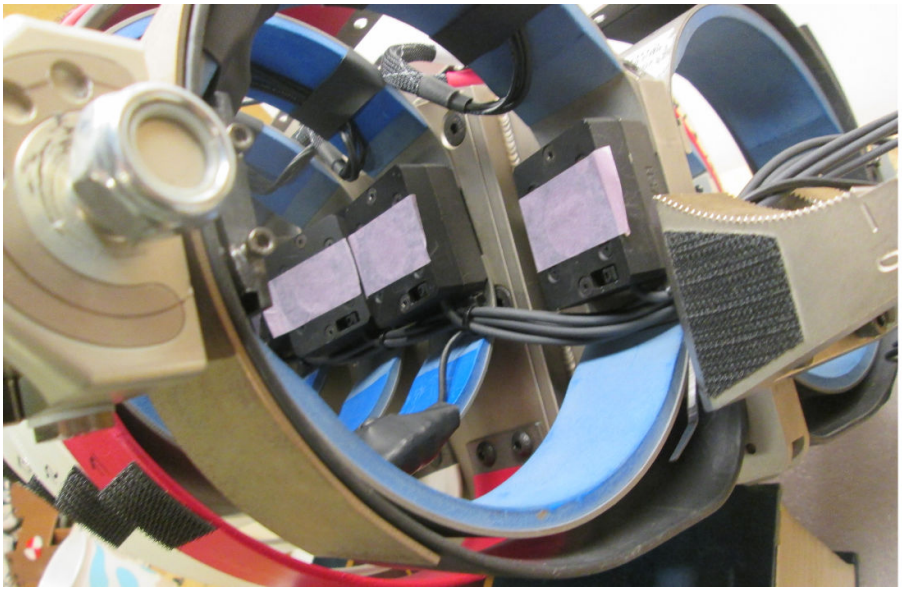

Figure 28. Upper three ribs – thoracic 2, thoracic 1, and shoulder – and RibEye sensor assemblies mounted to spine

For right-side impact configuration, the sensor cables exit the sensors toward the front of the dummy, and are routed similarly to the left-side impact described earlier. Above the shoulder, the sensor cables go over the top of the shoulder rib to the non-struck side (Figure 29).

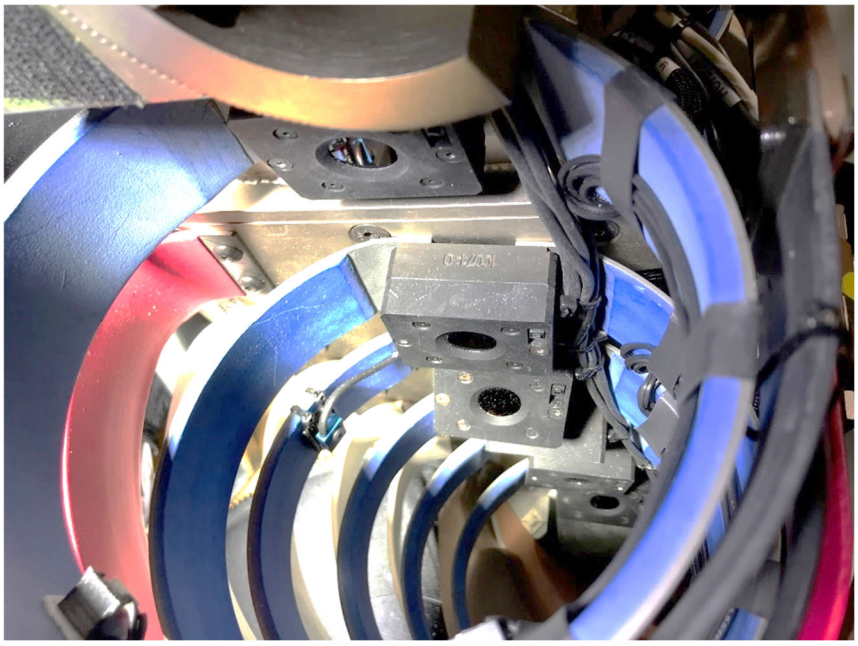

Figure 29. Right-side impact sensor cable routing

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Figure 30 shows the LED cables exiting the ribs over the top of ribs abdominal 2 and 1 and thoracic 3 and 2. The LED cables exit bottom of the thoracic 1 rib and the shoulder rib. Note that the outer ribs on the struck side are removed for clarity. Figure 31 also shows the LED cables routed over the sensor connector blocks, with all outer ribs installed.

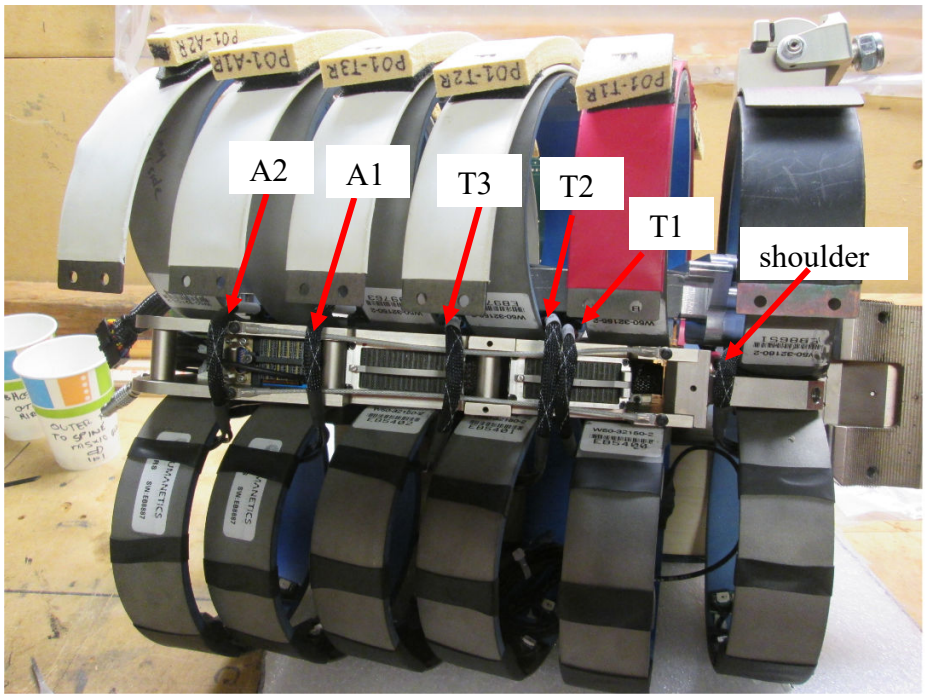

Figure 30. LED cables exiting the top of ribs abdominal 2 through thoracic 2 and the bottom of thoracic 1 and abdominal 1 (outer ribs removed for clarity)

Figure 31. LED routed to non-struck side

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2.3 Installing components and quick-testing RibEye operation

This section describes mounting and connecting the LED breakout cable, the controller, the battery base, and the shoulder inner rib clamp on the non-struck side, then connecting the sensor cables to the controller, installing the battery, and verifying RibEye operation.

2.3.1 Mount the controller feet, battery base, and shoulder inner rib clamp

The controller and controller mounting plate attaches to two controller feet (#10081) that take the place of the rib clamps on the non-struck side of the thoracic 1 rib and the abdominal 2 rib (Figures 32 and 33). The feet are installed by removing the four rib clamp bolts, removing the rib clamp plates, and then installing the feet using four M5 x 10 flat-head cap screws, which are provided with the RibEye.

The RibEye battery mounts to a battery base (#60413) that replaces the shoulder rib clamps on the non-struck side as shown in Figure 34. The battery base is installed by removing the four rib clamp bolts, removing the rib clamp plates, and then installing the battery base using four M5 x 10 flat-head cap screws, which are provided with the RibEye.

Replace the shoulder inner rib clamp (W50-32171) with the #10086 inner rib clamp and shoulder foam pin (W50-35047) (see Figure 35).

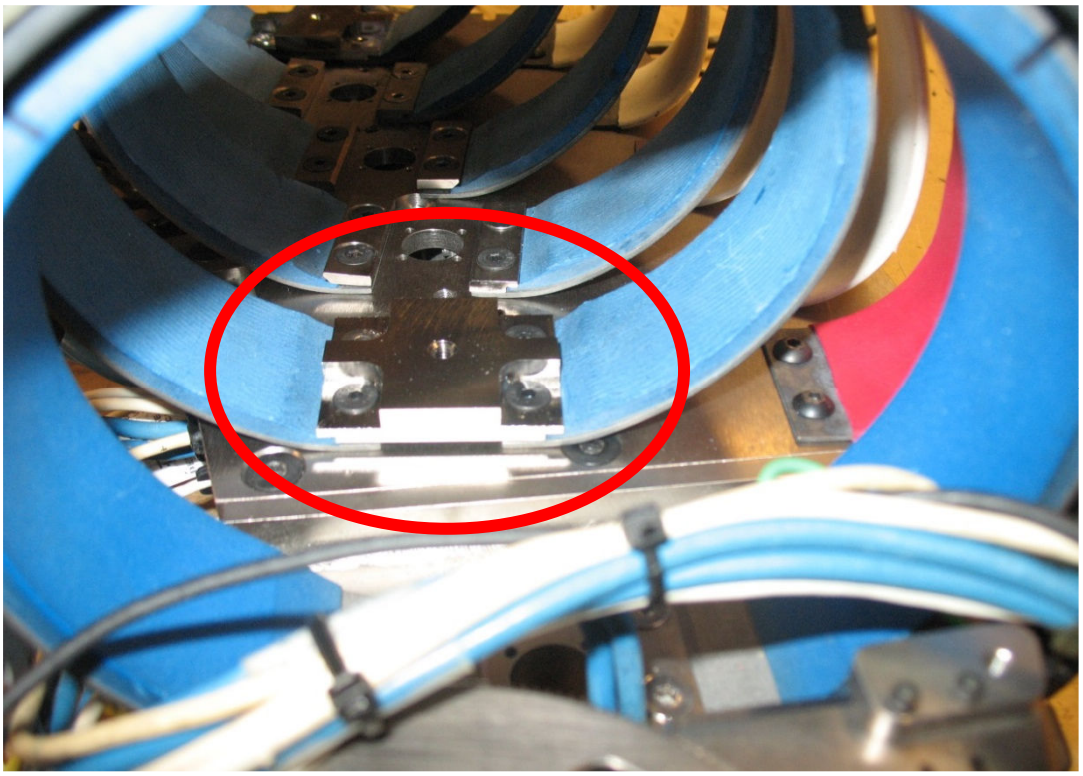

Figure 32. Controller foot installed on thoracic 1 rib

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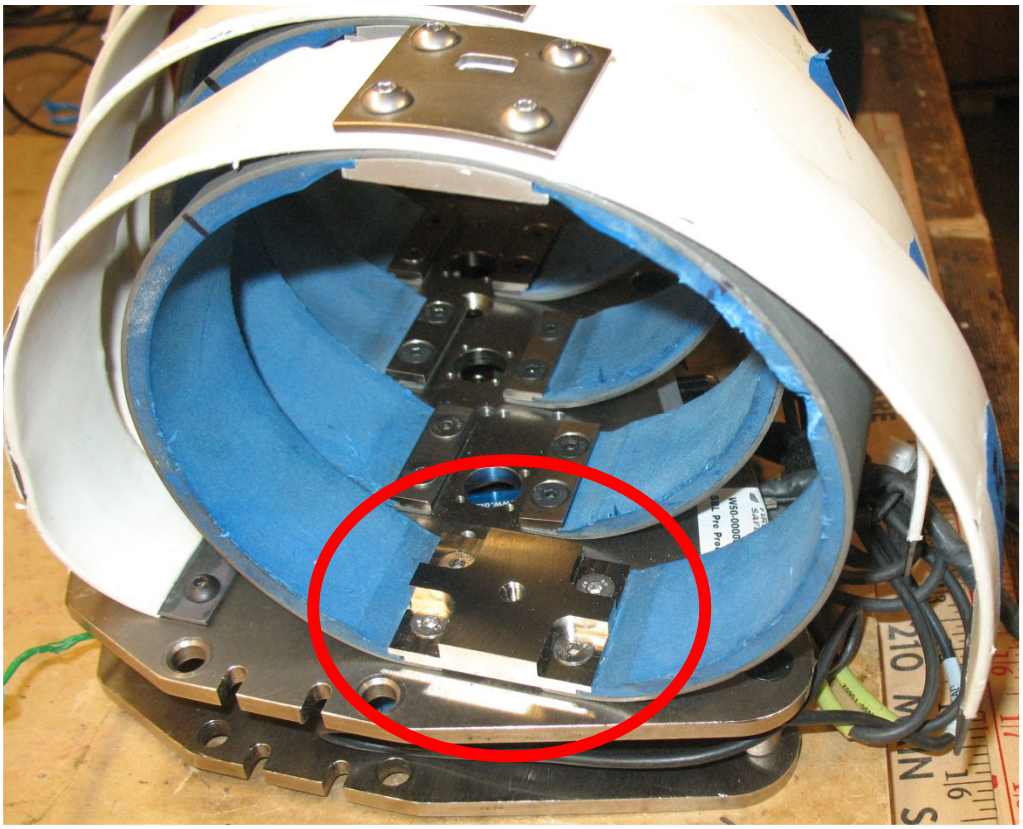

Figure 33. Controller foot installed on abdominal 2 rib

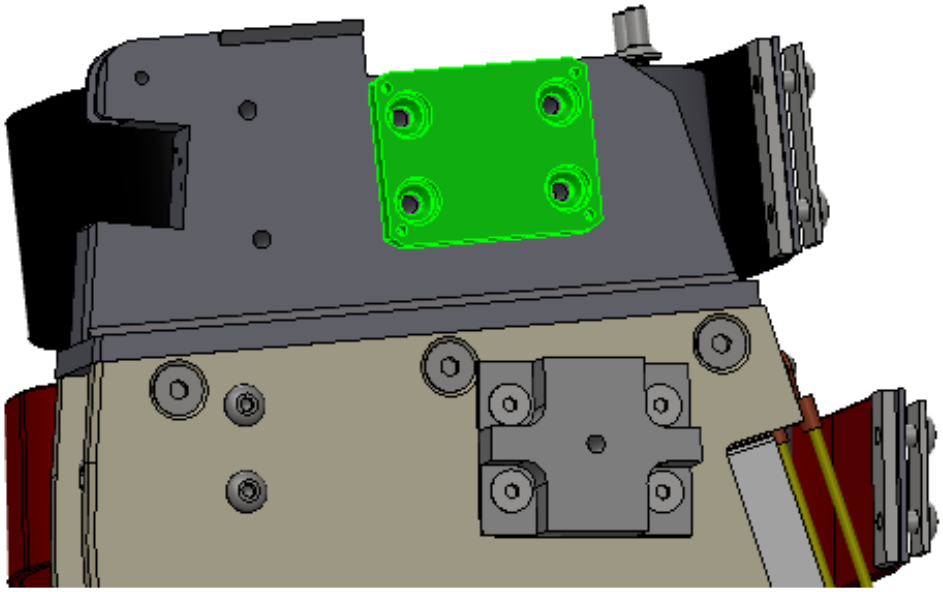

Figure 34. Battery base (highlighted in green) installed on shoulder rib (ribs hidden)

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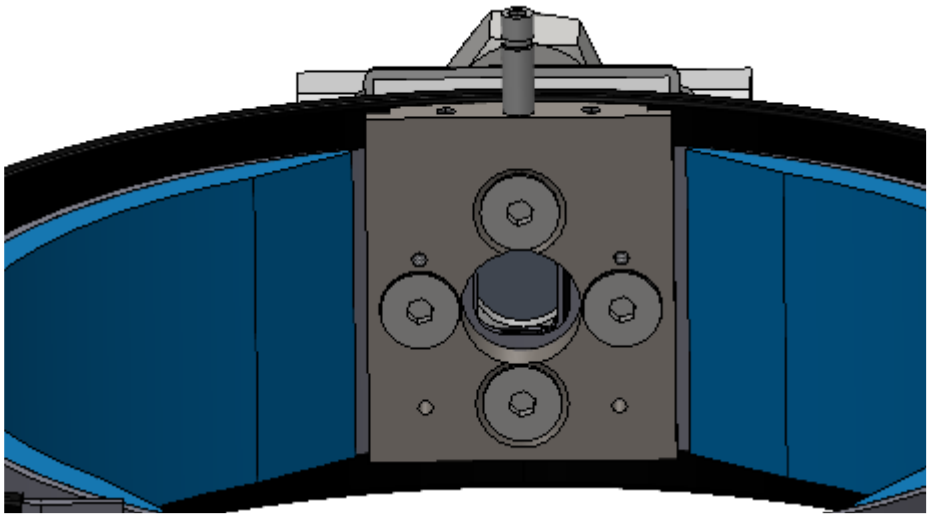

Figure 35. Shoulder inner rib clamp and shoulder foam pin installed

2.3.2 Install the LED breakout cable

The LED cables plug into a #70030 breakout cable shown in Figure 36. The LED cables from each rib plug into the connectors numbered 1 through 6, where connector 1 is for the shoulder rib and connector 6 is for the abdominal 2 rib.

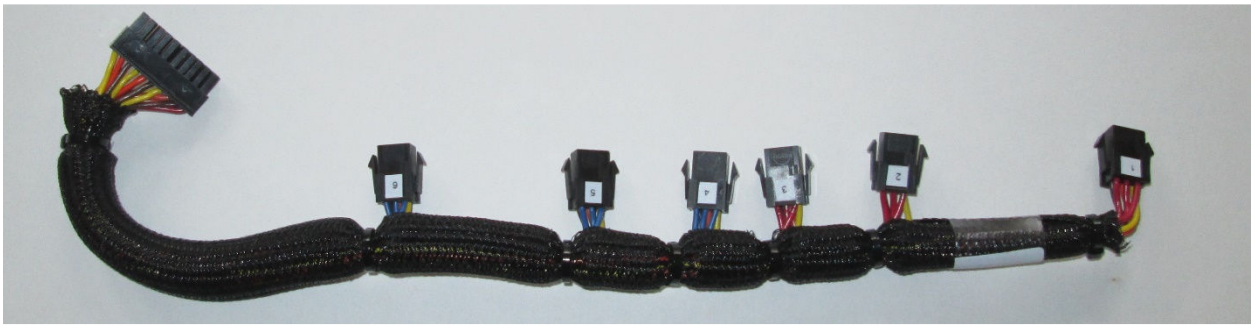

Figure 36. #70030 breakout cable

The breakout cable mounts to the inner ribs 30-35 mm from the spine ends of the ribs toward the rear of the dummy as shown in Figure 37. The shoulder LED connector (#1) lies just above, toward the shoulder of the thoracic 1 controller foot. The remaining connectors lie between the thoracic 1 and abdominal 2 controller feet as shown in Figures 37 and 38. Hold down the breakout cable to the inner ribs using nylon zip-ties.

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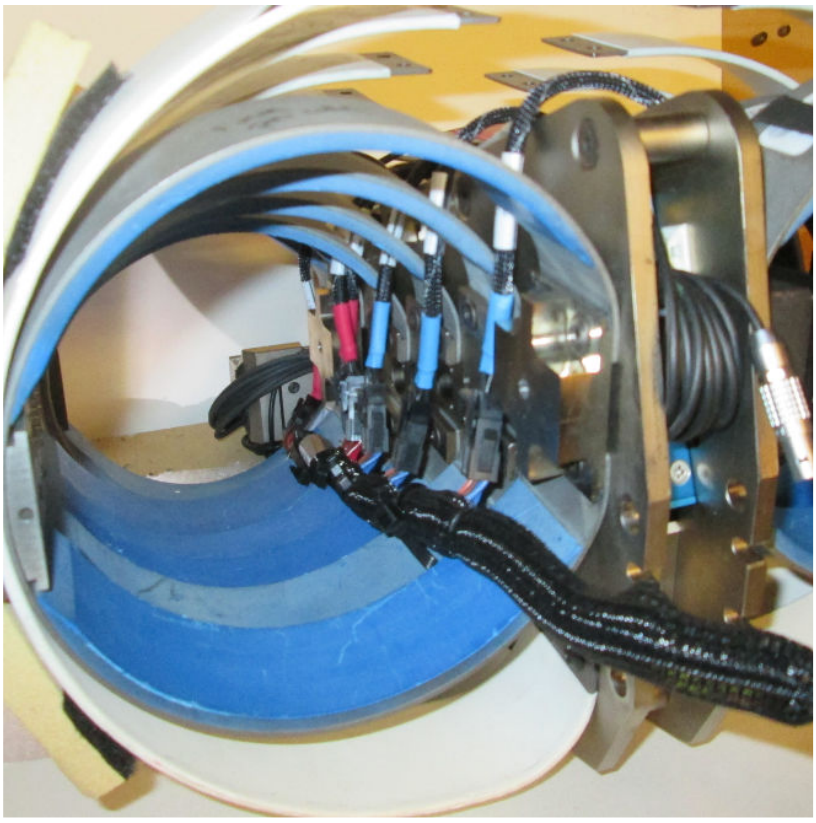

Figure 37. LED breakout cable – view from pelvis with LED cables plugged in

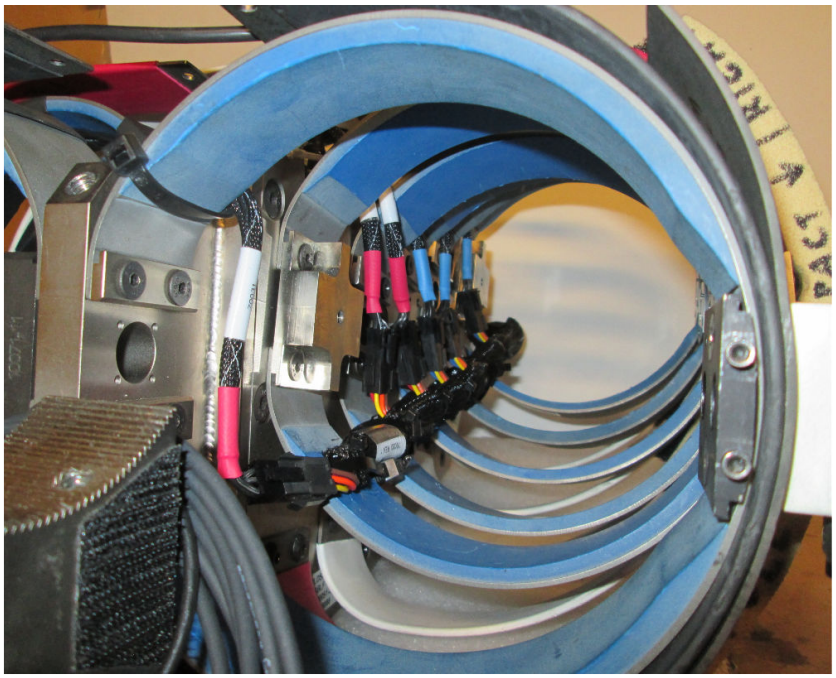

Figure 38. LED breakout cable – view from head with LED cables plugged in

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2.3.3 Install the controller mounting plate and controller

The controller mounting plate (#60408) attaches to the controller feet using two M5 x 16 flat-head cap screws as shown in Figure 39.

The controller mounts to the controller mounting plate using four M5 x 10 flat-head cap screws, as shown in Figure 40 (circled in red). Prior to mounting the controller, remove the two controller end covers by removing the four M3 x 6 socket-head cap screws.

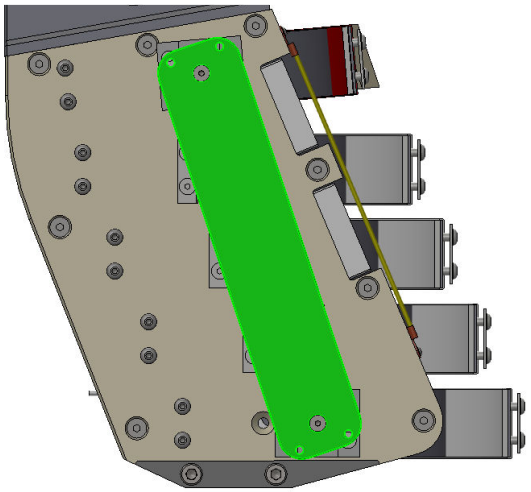

Figure 39. Controller mounting plate (in green) bolted to the controller feet

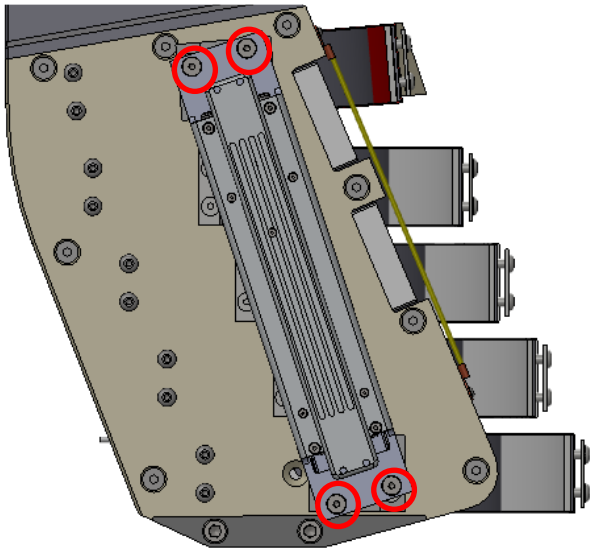

Figure 40. Controller attached to controller mounting plate (ribs hidden)

2.3.4 Connect cables to controller and install battery

The sensor cables plug into the sensor jacks on the top of the controller (refer back to Figure 4). The cables are marked 70051-1 through 70051-6. The jacks are marked 1 through 6, where 1 is the shoulder sensor and 6 is the abdominal 2 sensor. After the sensor cables are plugged in, install the connector cover on the sensor end of the controller with two M3 x 6 socket-head cap screws.

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Next install the battery to the battery mount using four M3 x 8 socket-head cap screws as shown in Figure 41. Orient the battery so the cables exit toward the controller. The battery cables should run down the rearward side of the controller toward the pelvis. After the battery is installed, tie any extra sensor cable to the shoulder rib.

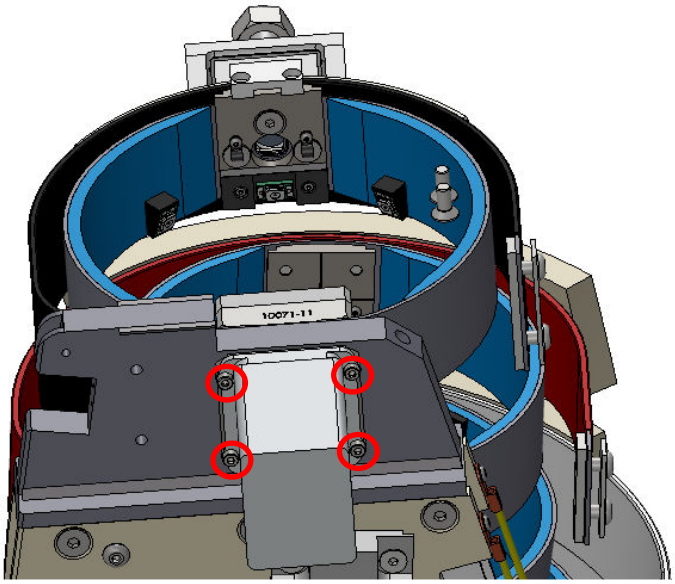

Figure 41. Battery box attached to battery mount at shoulder (shoulder rib not shown)

At the bottom end of the controller the connector panel has jacks for:

- LED breakout cable – marked “LEDs”
- Status LED – marked “STATUS”
- Battery power/communication cable – marked “BATT”
- Dummy exit cable – marked “EXIT”

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The bottom connector panel is shown in Figure 42 (and above in Figure 5). For all of the jacks, the locking tab is toward the center of the connector panel.

- First plug in the LED breakout cable into the LEDs jack
- Second plug in the battery power/communication cable into the BATT jack
- Then plug in the LED status cable into the STATUS jack
- Finally plug in the dummy exit cable to the EXIT jack.

After the cables are plugged in, re-install the connector cover using the two M3 x 6 socket-head cap screws, then secure the cables with zip ties.

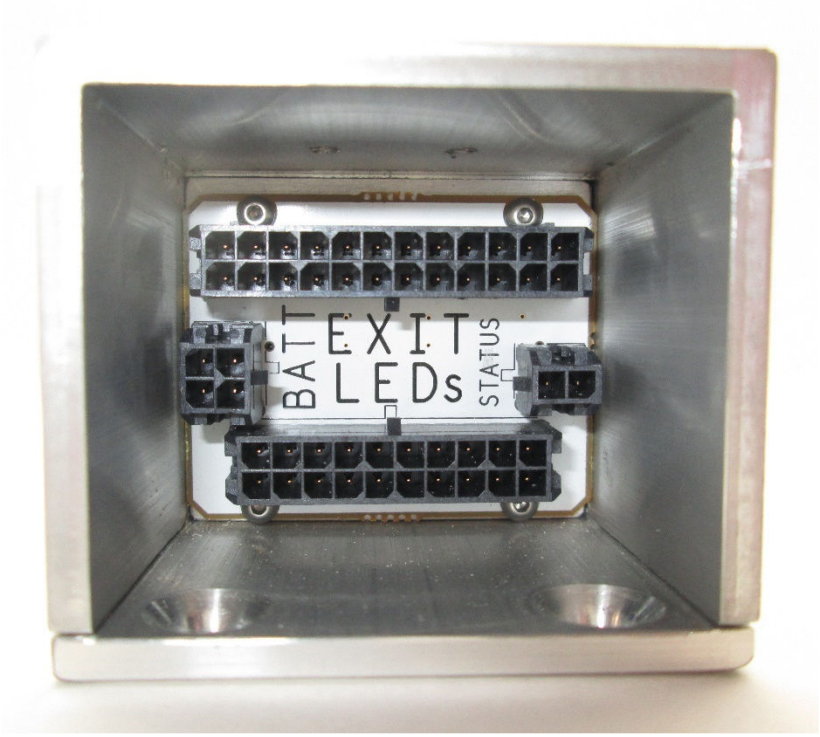

Figure 42. Connector panel at bottom of controller

The status LED cable is routed to the outside of the dummy. It has a LED on it that flashes at different rates so you can see that the RibEye is working and what state it is in (see Section 3.3).

The battery charger cable should be routed to wherever it is convenient for you to plug in the charger.

All of the external connections to the WorldSID RibEye controller – power, trigger, and Ethernet - are in the exit cable. Boxboro Systems provides several cable options to connect the WorldSID RibEye controller to the customer's equipment to get power, trigger, and Ethernet connections. Refer to Appendix B for a list of the cable options and drawings for connecting to various DAS systems.

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2.3.5 Verify operation via quick test prior to completing ATD assembly

At this point the RibEye can be tested to verify proper operation prior to finishing the dummy assembly.

Plug the exit cable assembly into your DAS (see Appendix B for cable assemblies) and power up the RibEye. When the RibEye powers up you should see the status LED flash slowly. The LEDs on the ribs will turn on in the following order, for about 1 second per set (Table 3).

Table 3. LED flash order on power-up

Time	Rib and Position	
	Upper Rib Set (Red)	**Lower Rib Set (Blue)**
1	Shoulder rear	Thoracic 3 rear
2	Shoulder middle	Thoracic 3 middle
3	Shoulder front	Thoracic 3 front
4	Thoracic 1 rear	Abdominal 1 rear
5	Thoracic 1 middle	Abdominal 1 middle
6	Thoracic 1 front	Abdominal 1 front
7	Thoracic 2 rear	Abdominal 2 rear
8	Thoracic 2 middle	Abdominal 2 middle
9	Thoracic 2 front	Abdominal 2 front

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If you haven't already done so, remove tape covering the sensor lenses. Then power up and connect to the RibEye, using the RibEye 7.1 (or later) software (refer to the RibEye Software Manual 7.0). Click on the "Show Current XYZ's" button to display the current positions of all of the LEDs. There should be no error codes (see Section 3.5). The reported positions should be within a few millimeters of the positions shown in Table 4.

Table 4. Nominal LED positions

LED #	Rib#	Position	X	Y	Z
1	1	Rear	–51	–84	–53
2	1	Middle	–14	–95	–56
3	1	Front	19	–84	–58
4	2	Rear	–36	–101	16
5	2	Middle	2	–110	16
6	2	Front	40	–101	16
7	3	Rear	–29	–98	41
8	3	Middle	7	–106	44
9	3	Front	43	–98	48
10	4	Rear	–54	–97	–36
11	4	Middle	–18	–105	–35
12	4	Front	16	–96	–35
13	5	Rear	–36	–100	16
14	5	Middle	2	–110	17
15	5	Front	39	–100	16
16	6	Rear	–15	–95	36
17	6	Middle	21	–105	35
18	6	Front	56	–96	35

After the quick test, you should power down the RibEye and complete the ATD assembly.

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2.4 Install mass blocks at bottom of thorax

There are two tungsten mass blocks (part #60416) that are installed when connecting the thorax to the pelvis. The mass blocks are shown in Figure 43 highlighted in green. Each mass block is held in by two M8 x 1.25 x 30 socket-head cap screws that go through the mass block and the spine plate and into the threaded holes in the lumbar mounting wedge.

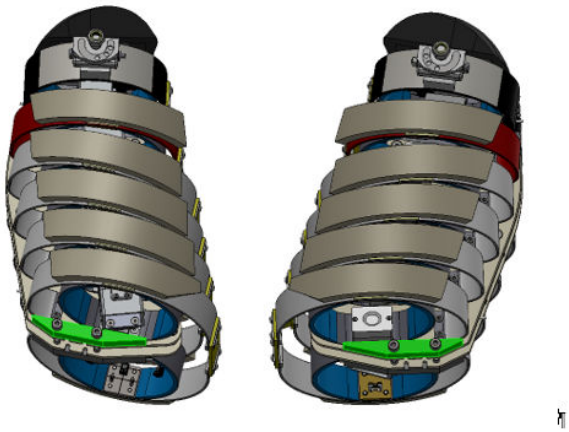

Figure 43. Mass blocks #60416 installed at bottom of thorax

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2.5 Install shoulder pads

Top and bottom views of the shoulder pad assembly are shown in Figure 44. The shoulder pad assembly consists of a left pad and right pad and two brackets. The hat shaped bracket is to the front of the dummy. The short rectangular bracket is to the rear of the dummy on the struck side. Left side impact positions are shown. For right-side impact, switch the rectangular bracket to the right side pad.

The shoulder rib clamps have posts sticking up vertically from the rib clamps (shown in Figure 10 and Figure 35). The shoulder pads have a molded-in receivers for the posts at the outboard edge. Drop the shoulder pad over the post so it engages with the receiver molded into the pad.

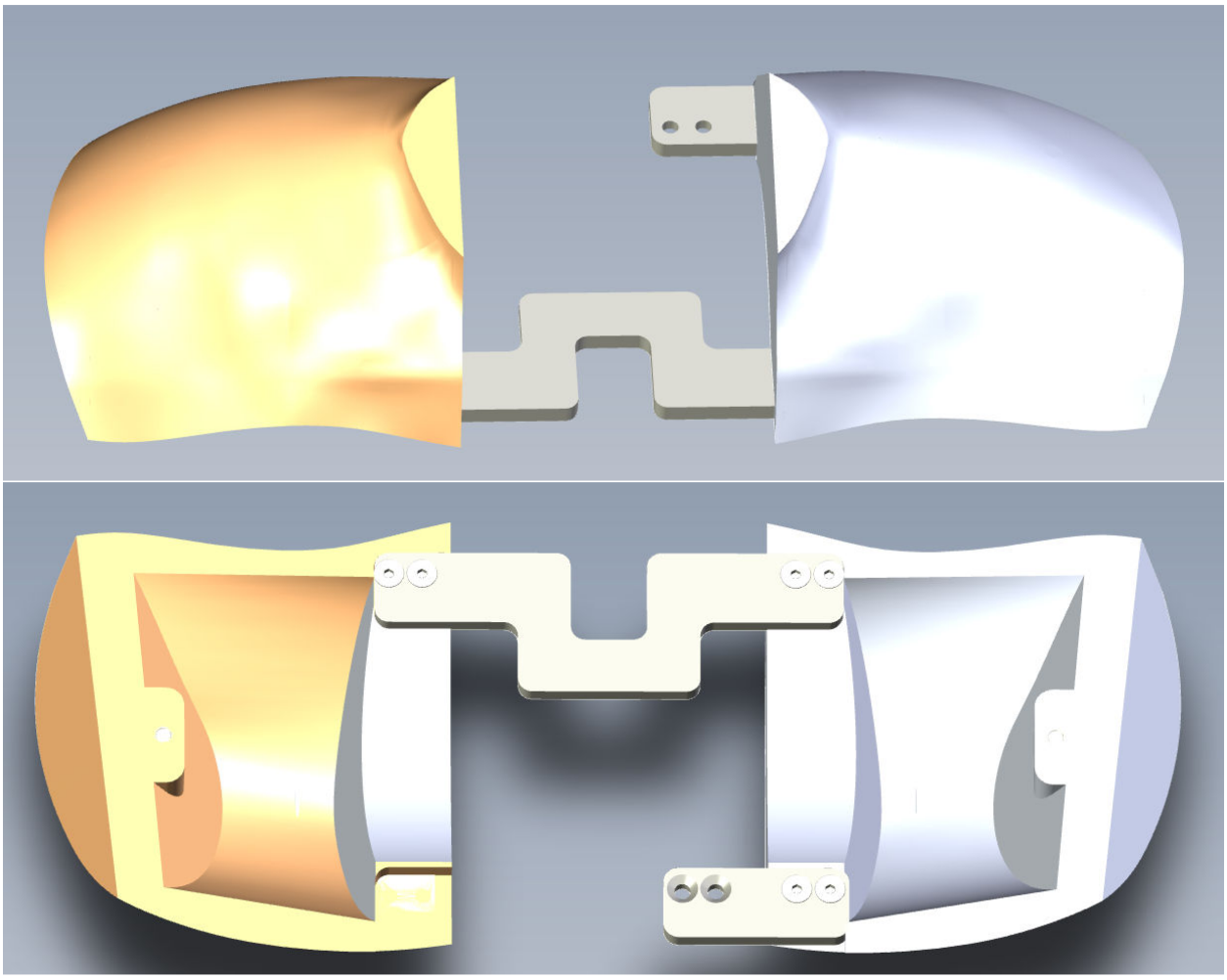

Figure 44. Top and bottom views of the shoulder pad assembly

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3.0 RibEye Operation

3.1 Introduction

This section describes the operation, the coordinate system, and the connections used in the RibEye. The WorldSID RibEye can be mounted on either side of the dummy to measure left-side or right-side impact. If the RibEye will be used for right-side impacts, it must be calibrated for the right side. When ordering your RibEye, please specify left-side, right-side, or both-side impacts.

Please refer to the RibEye Software User Manual 7.0 (or later) for software details and instructions on how to change the RibEye network's IP address. The manual is included on the USB thumb drive shipped with the RibEye and can also be downloaded from our website, www.boxborosystems.com.

The RibEye is not designed to be left powered on and running for an hour or more. The system generates a lot of heat and has no active cooling device, so if it overheats, the RibEye will shut itself down to cool off.

If your test is delayed for any reason, or if your plans change, please turn off the RibEye as soon as possible to avoid overheating and shutdown.

WARNING: The RibEye can be permanently damaged if left powered on and running for an hour or more.

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3.2 Data coordinate system

As noted earlier, two sets of three sensors each monitor the LED positions. The top set of sensors monitors the red LEDs mounted on the first three ribs (shoulder, thoracic 1, and thoracic 2). The bottom set of sensors monitors the blue LEDs mounted on the lower three ribs (thoracic 3, abdominal 1, and abdominal 2).

Position data from each sensor set is reported with respect to a coordinate system that has its origin in the center (middle) sensor of each set (Figure 45). For both upper and lower rib sets, the origin of the coordinate system is 21 mm from the face of the spine plate in the Y direction.

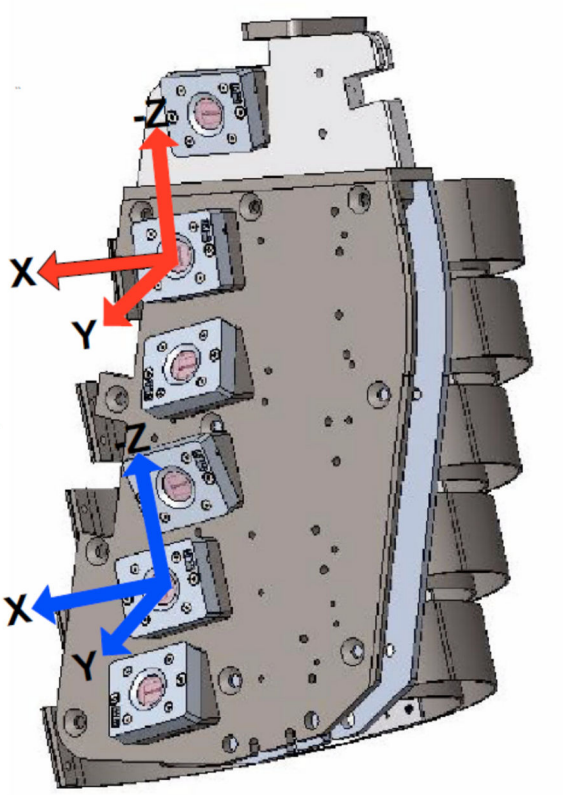

Figure 45. RibEye coordinate system

For the top three ribs –

- The center of the coordinate system is the center of the inside face of the lens in the sensor mounted on the thoracic 1 rib. (Note that the inside face is 2 mm from the outside face.) The X-axis is parallel to the rib, the Y-axis is perpendicular to the spine plate, and the Z-axis is perpendicular to the rib.
- The shoulder rib center in the X direction is 19.86 mm to the rear of the thoracic 1 rib.
- The thoracic 2 rib center in the X direction is 4.72 mm to the front of the thoracic 1 rib.

For the lower three ribs –

- The center of the coordinate system is the center of the inside face of the lens in the sensor mounted on the abdominal 1 rib. The X, Y, and Z axes are the same as for the upper sensor set (X parallel to the rib, Y perpendicular to the spine plate, and Z perpendicular to the rib).
- The thoracic 3 rib center in the X direction is 20 mm to the rear of the abdominal 1 rib
- The abdominal 2 rib center in the X direction is 20 mm to the front of the abdominal 1 rib.

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For R&D testing, the LEDs can be placed anywhere within the RibEye's measurement range (see Appendix A-1). For example, a user could place nine LEDs on a single rib to show the shape of the rib.

3.3 Status indicator

The status light flashes at varying rates to indicate that the RibEye is operating and what it is doing:

- 0.5 Hz = idle with data in memory
- 1.0 Hz = idle with memory erased
- 2.0 Hz = acquiring data
- 10 Hz = erasing flash memory or downloading data

3.4 Ethernet link and activity lights

There are two lights on the side of the controller; the Ethernet link light, and the Ethernet activity light.

3.5 Batteries and charger

The backup battery for the RibEye is mounted on the shoulder rib. A picture of the battery pack assembly was shown previously in Figure 6. Figure 46 shows the battery pack and the battery shoulder rib adaptor installed in the dummy on the non-struck side.

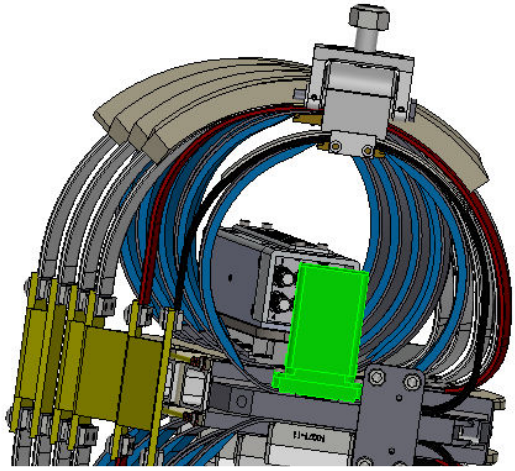

Figure 46. Battery pack and adaptor (shown in green)

The RibEye battery pack consists of 12 AAA NiMH batteries. There are two cables coming out of the battery pack:

1. Power/communications cable with a 4 pole Microfit connector that plugs into the bottom connector panel on the controller.
2. A 2.5 mm coaxial charger jack for plugging in the Cell-Con battery charger.

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The RibEye batteries are turned on ***only*** when the RibEye is armed or storing collected data to flash memory. They will provide a minimum of 20 minutes of run-time. The batteries are being charged ***only*** when the charger is plugged in. The RibEye software will display the battery charge level and voltage. Refer to the RibEye Software Manual for more information on the battery status display. The RibEye battery pack has a self-resetting polymer fuse on its power input. If this fuse ever opens, it can take up to 4 hours to self-reset.

The charger for the RibEye battery pack is a Cell-Con Model 452115-01071-3311. A LED on the charger indicates its current mode, as shown in Table 5. Figure 47 shows the charger and the battery cable charger receptacle. Please refer to the Cell-Con manual, which is supplied with the charger, for information on safety, operation, maintenance, etc. Note that the charger should be plugged into the RibEye battery *before* it is plugged into a power outlet.

Table 5. Cell-Con battery charger modes

LED Color	Mode
Orange	Battery not connected
Orange	Battery initialization and analysis (up to 15 seconds)
Red	Fast charge
Green with intermittent orange flash	Top-off charge
Green	Trickle charge
Alternating Red-Green	Error

Figure 47. RibEye battery pack Cell-Con charger and battery cable charger receptacle

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3.5.1 Batteries and external power supply

The emergency battery and the external power supply are connected via diodes as shown in Figure 48.

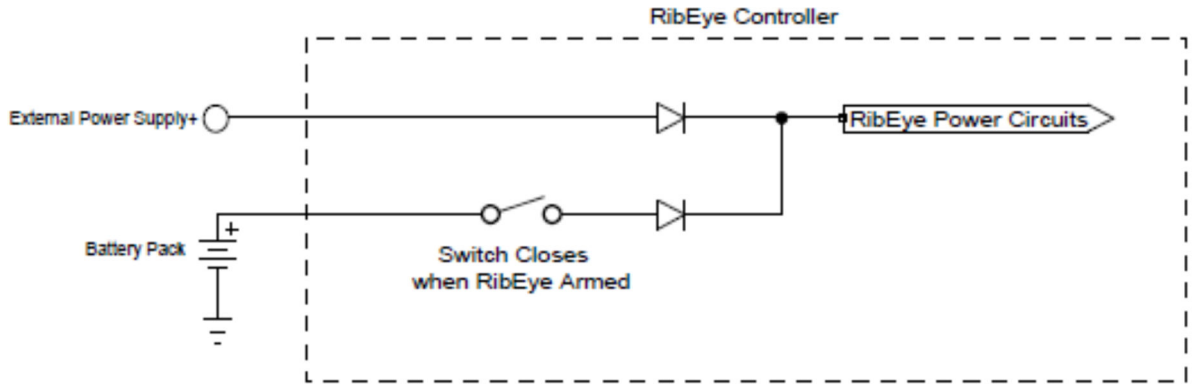

Figure 48. Battery pack and external power connection

The battery switch closes when the RibEye is armed, and the RibEye's internal power circuits will be fed from either the battery or the external power supply, depending on which has a higher voltage.

A freshly fully charged battery will be at approximately17 Volts DC. The external power supply voltage can range from 12 to 60 Volts DC to operate the RibEye.

However, if the external power supply voltage is lower than the battery voltage, the battery will supply power to operate the RibEye, and it will need to be recharged after the test.

If the external power supply voltage is greater than the battery voltage, the RibEye will be powered by the external power supply, and the battery will not be discharged unless the external power supply cable is disconnected or damaged. If disconnection or cable damage happens during a test, the battery will disconnect after data collection is completed, and the RibEye will shut off. In order to download the collected data, the external power must be reconnected to wake the RibEye.

We recommend using an external power supply that has a voltage greater than the battery voltage, so that the battery is not discharged during a test. This will extend the life of the battery. The battery manufacturer, Panasonic, says that the batteries can take over 500 charge/discharge cycles before they start to lose capacity.

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3.6 Error codes

If the RibEye cannot calculate a LED position, the software will insert error codes in the data. If an error code occurs, data from all three axes, X, Y, and Z, will be forced to the same error code.

Usually error codes occur when the light from a LED is blocked and cannot reach one of the sensors. Typically, this results when a loose cable gets between the LED and the sensor. Also, if the center rib on either set of three ribs compresses significantly more than the upper or lower ribs of the set, it can block the light from the upper or lower rib LEDs to one of the sensors. Too much ambient light can also cause the RibEye to generate error codes.

If an error code occurs, you must discount the data for a few milliseconds before and after the drop-out in the plots. Before and after the light is completely blocked, the obstacle partially blocks light, which confuses the sensor and causes bad data to be reported. That's why a few milliseconds of data must be discounted before and after the blockage and drop-out.

NOTE: The error codes can get masked by filtering the data. Therefore, we strongly recommend reviewing and saving a copy of the unfiltered data so that the error codes are preserved.

The error codes for each sensor set are as follows:

1. The top sensor is blocked or sees too much ambient light
2. The bottom sensor is blocked or sees too much ambient light
3. Both top and bottom sensors are blocked or see too much ambient light
4. The middle sensor is blocked or sees too much ambient light
5. The middle and top sensors are blocked or see too much ambient light
6. The middle and bottom sensors are blocked or see too much ambient light
7. All three sensors are blocked or see too much ambient light
8. A divide-by-zero condition occurred in the data processing
9. Out of range error.

The out-of-range error, code 9, occurs when the data from the sensor goes beyond the end of a calibration curve, indicating that the LED moved significantly out of the RibEye's guaranteed range.

If the data on a channel jumps from good data to an error code of 7 in one sample, it usually indicates an electrical problem in the LED wiring, such as an open circuit or a short circuit.

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To verify that a LED has moved out of range, create X-Y or Z-Y plots of the RibEye's absolute data and overlay the range limits on the plot. An example is shown below in Figure 49. RibEye software will generate X-Y and Y-Z plots with the RibEye range overlaid.

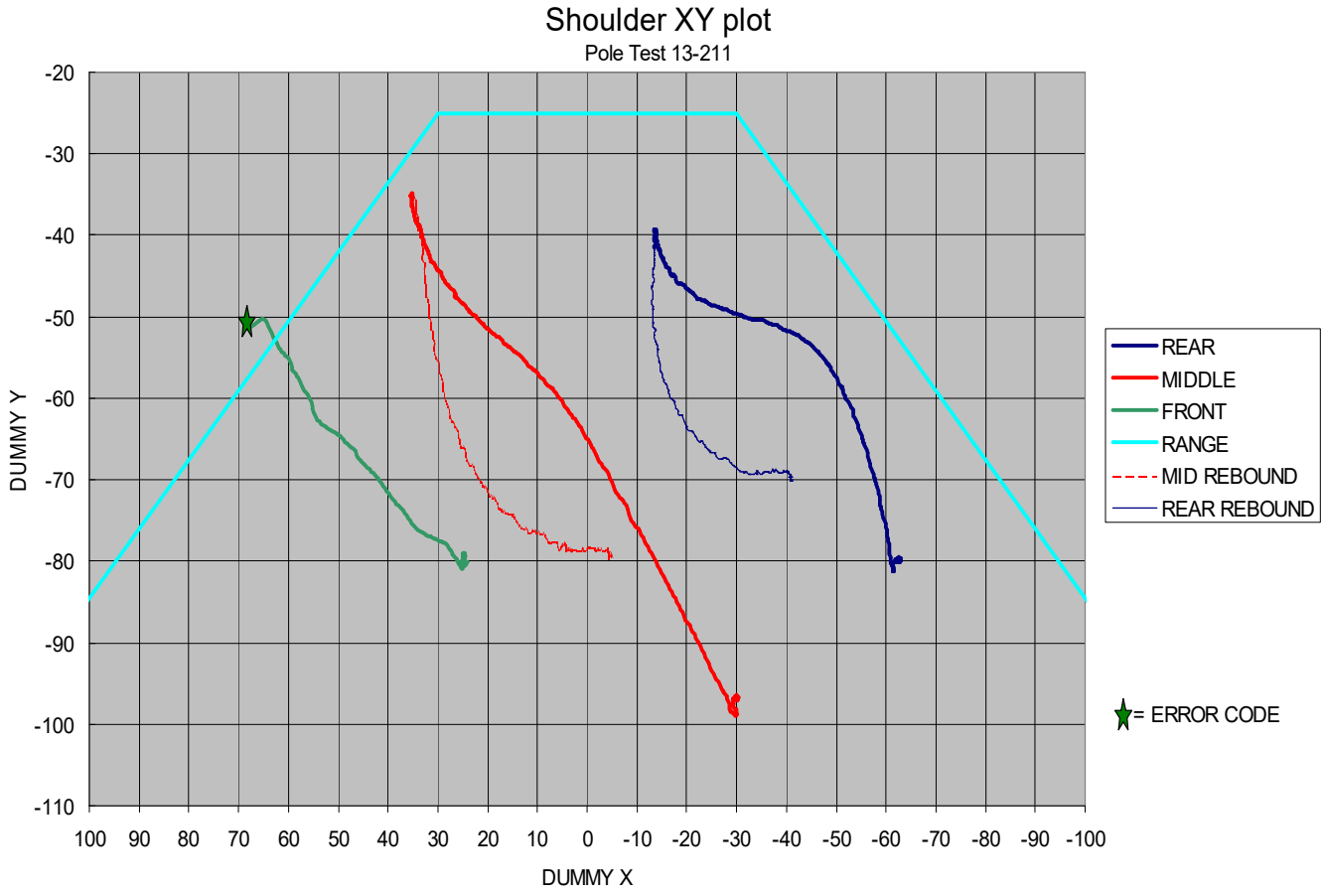

Figure 49. Plot overlay verifying whether LED moved out of range

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4.0 RibEye Maintenance

The only maintenance required for the RibEye is to keep the sensor lenses clean.

A dirty camera lens will create a fuzzy photo, and smudged eyeglasses will distort vision. The same holds true for RibEye: If the lenses are not clean, the data will be less accurate.

Make sure that the lenses are clean before each and every test.

If the lenses need to be cleaned, follow this procedure:

1. Blow dust off the lenses with clean, dry air.
2. If there is grease or dirt on the lenses, clean them with eyeglass or camera-lens cleaning solution and lens cleaning paper or a lens cleaning cloth. You can also use isopropyl alcohol.
3. Make sure there is no residue from the cleaning solution remaining on the lens.

WARNING: DO NOT USE cotton-tipped swabs like Q-Tips. They leave fibers on the lens.

Note: If you can't get enough light into the thorax to see the lenses well, you can arm the RibEye to turn on the LEDs.

DANGER: Never look directly at the LEDs, they are very bright.

Also clean the inside of the dummy to remove all loose debris such as dirt, pieces of foam, and zip-tie ends. Any objects, even very small, that are flying around inside the dummy during a test can interfere with the light from the LEDs to the sensors, causing spikes in the data.

WARNING: Never remove the sensor printed circuit board or loosen the circuit-board mounting nuts. Doing so will ruin the calibration of the RibEye.

4.1 Dummy maintenance for RibEye

The inside of the thorax must be kept clean. Dirt and other particles can fly through the field of view between the LEDs and the sensors during a test, causing data spikes and anomalies. We recommend vacuuming or blowing out the thorax to remove any loose particles.

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Appendix A. RibEye specifications

A-1. Measurement accuracy and range

The RibEye meets the requirements of SAE J211/1 (August 2022) as a combined sensor and data acquisition system. It also meets the ISO 6487-2000 specifications.

Figure A1 shows the RibEye measurement range in the X-Y plane for all six ribs. The plot also shows the LED positions.

Figure A2 shows the RibEye measurement range in the Y-Z plane for the upper set of three ribs (shoulder, thoracic 1, and thoracic 2). The plot also shows the LED positions for all of the upper three rib LEDs.

Figure A3 shows the RibEye measurement range in the Y-Z plane for the lower set of three ribs (thoracic 2, abdominal 1, and abdominal 2). The plot also shows the LED positions for each of the lower three rib LEDs.

The maximum error for the Y and Z data is less than 1 mm, and the maximum X error is less than 1.5 mm.

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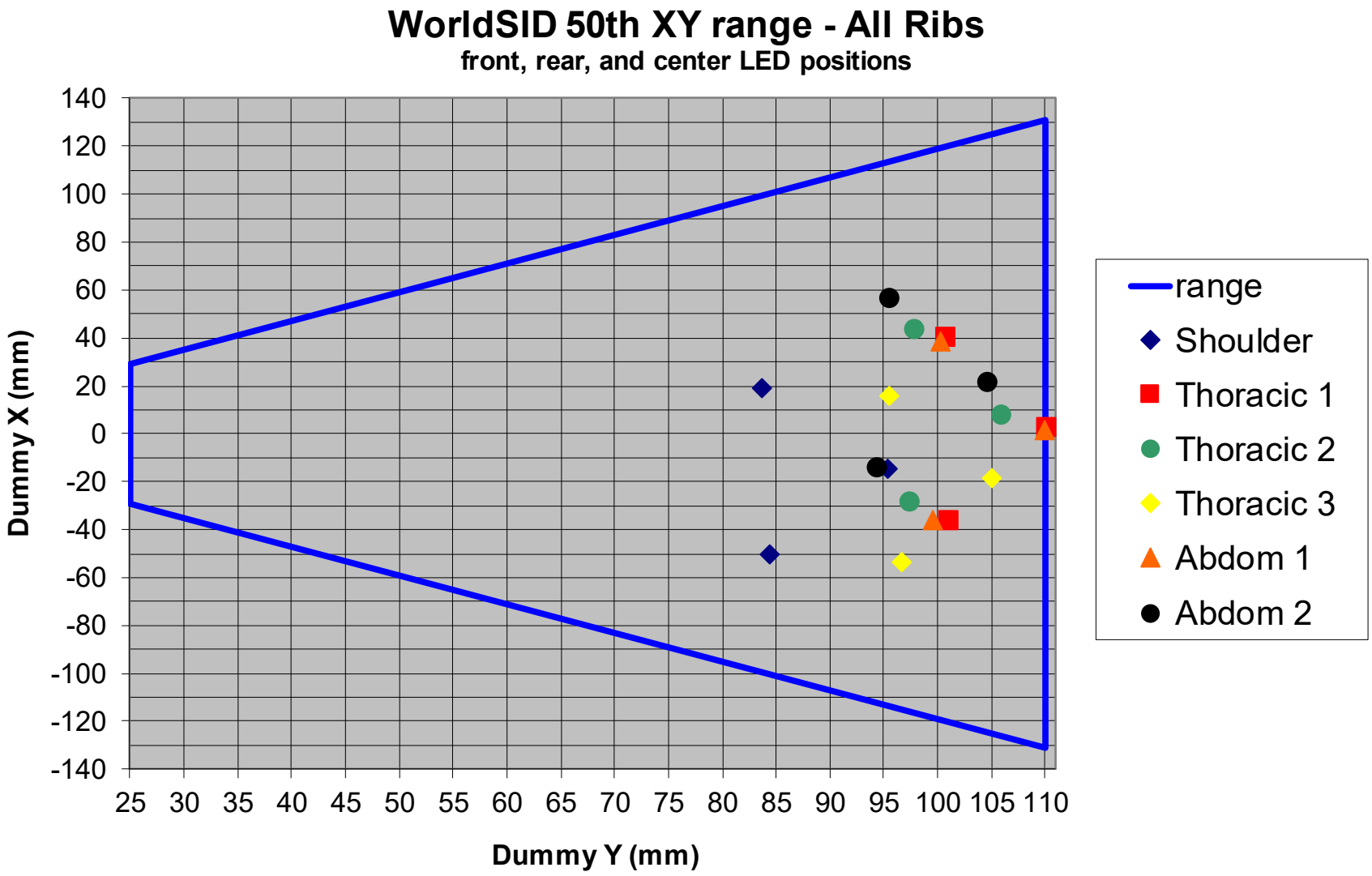

Figure A1. RibEye measurement range in X-Y plane – all ribs

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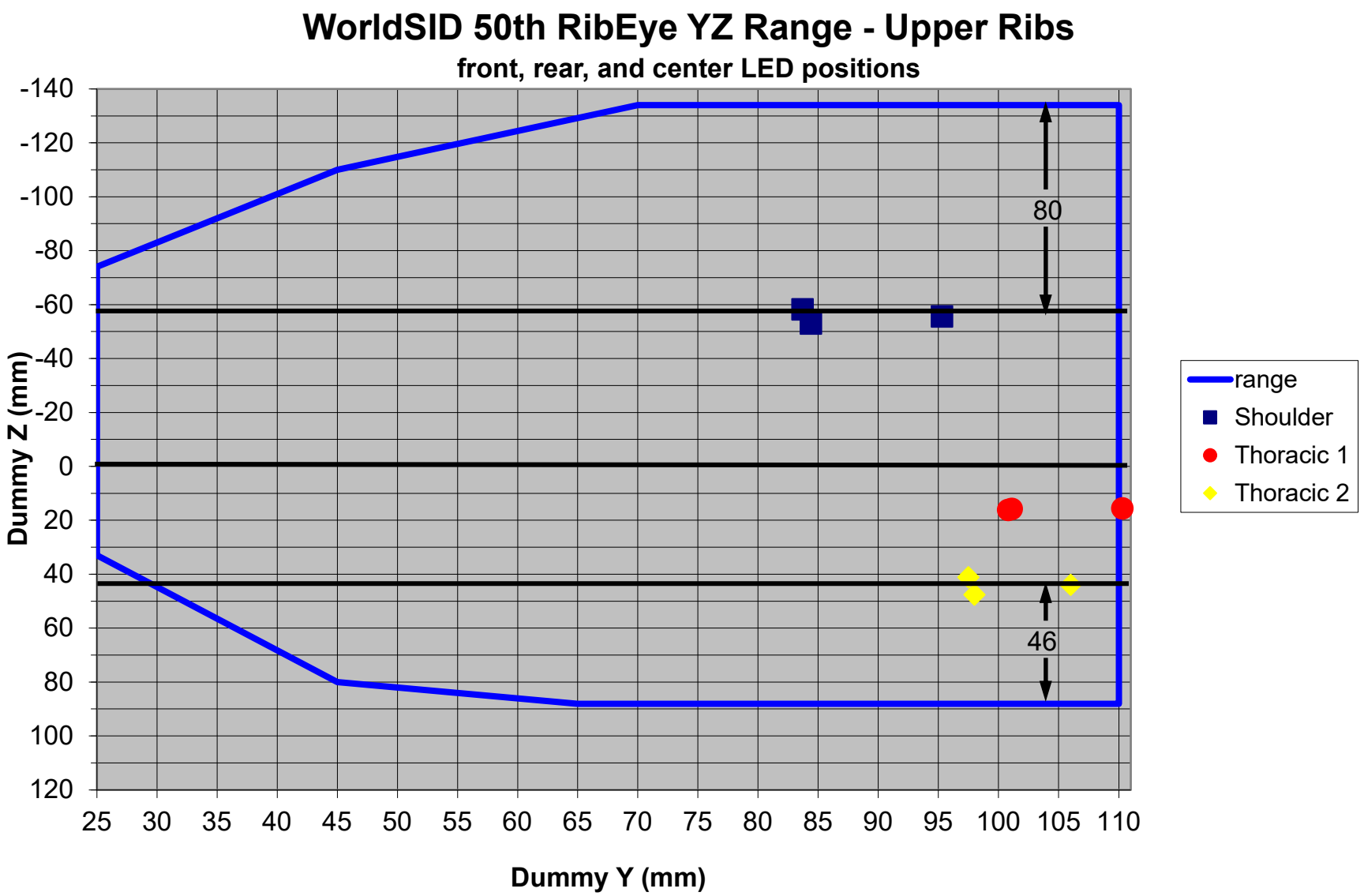

Figure A2. RibEye measurement range in Y-Z plane – upper three ribs

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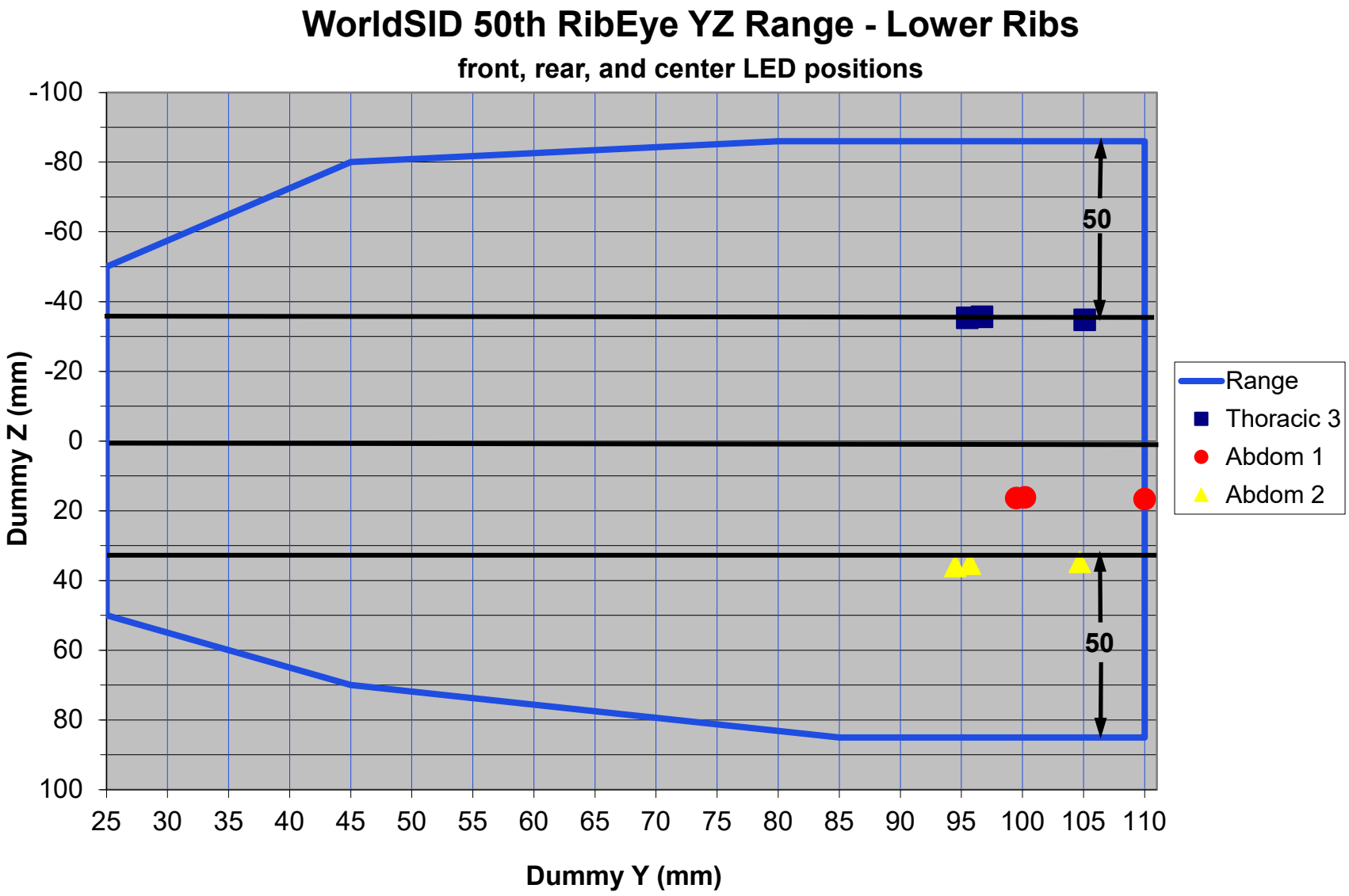

Figure A3. RibEye measurement range in Y-Z plane – lower three ribs

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A-2. Power requirements

The RibEye model #60005 can be powered by a high-quality DC voltage source from 12 to 60 Volts. At idle, the RibEye draws 15 Watts. When collecting data, it draws 25 Watts typically and up to 40 Watts maximum if all LEDs are out of range and driven to full power.

When the batteries are fully charged, the backup battery pack can power the RibEye while collecting data for at least 20 minutes. After running the RibEye on batteries for 20 minutes, it will take about 2 hours to fully recharge the batteries.

The RibEye controller has a self-resetting polymer fuse on its power input. If this fuse ever opens, it can take up to 4 hours to self-reset.

There is no active cooling in the RibEye, so it should not be left powered on for more than 1 hour, or it will overheat and shut itself down to cool off.

A-3. Data acquisition and storage

Data is collected to RAM random-access memory and simultaneously in flash memory.

Sample rate: 10,000 samples per second per LED (10 kHz)

Modes: Linear or circular buffer

Total acquisition time: 3 minutes

Data storage: 3 minutes

A-4. Ethernet communication

Communication between the RibEye and the PC software is via 10/100 MBS Ethernet. The IP address can be set by the user. (Factory default = 192.168.0.240)

Please refer to the RibEye Software User Manual 7.0 for software details and instructions on how to change the RibEye network's IP address. The software manual is included on the USB thumb drive shipped with the RibEye and can also be downloaded from our website, www.boxborosystems.com.

The RibEye communicates with the PC software using port 3000. An open protocol is used to send commands to the RibEye and to receive data. See the RibEye Communications Protocol document on our website for more information.

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A-5. Trigger circuits

The trigger circuit can be configured for a variety of options including a high-impedance input or a lower impedance, optically isolated input. Please contact Boxboro Systems for your requirements. Appendix B shows standard cable assemblies available for connecting to typical DAS systems.

Figure A4 shows the generic trigger circuits inside the RibEye controller.

Figure A5 shows the trigger input configured for connection to an external DTS Distributor using Boxboro Systems cable #70110 and extension cable #70200.

Figure A6 shows the trigger input configured for a Kistler NXT32-supplied trigger using cable #70115 or Kistler KiDau/KiHub or Kistler DTI Hub using Boxboro Systems cable #70125.

Figure A7 shows the trigger input configured for generic pigtail cable assembles using Boxboro Systems exit cable #70120 and breakout cable #70201.

Figure A8 shows a trigger switch wiring example for the generic pigtail assemblies.

Figure A9 shows the trigger wiring to a Kyowa DIS-61A.

A-6. Armed-out circuit

Boxboro Systems exit cable #70120 and breakout cable #70201 have an “Armed-out” signal that turns on when the RibEye is armed and turns off when the RibEye has completed storing the data for the test in flash memory.

Figure A10 shows the armed-out circuit.

Figure A11 shows an example of how to wire an indicator light to the armed-out circuit.

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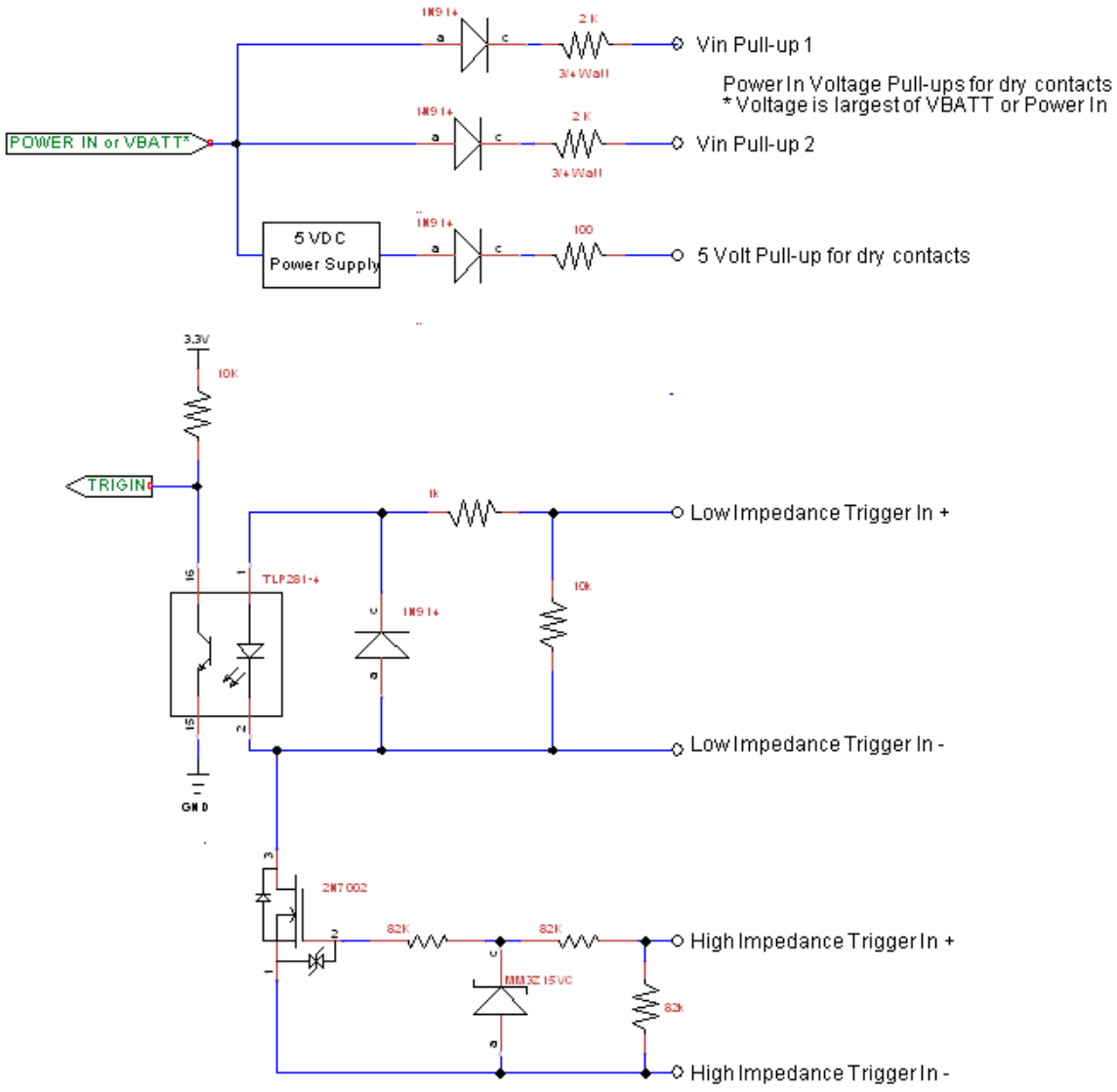

Figure A4. Trigger input circuits

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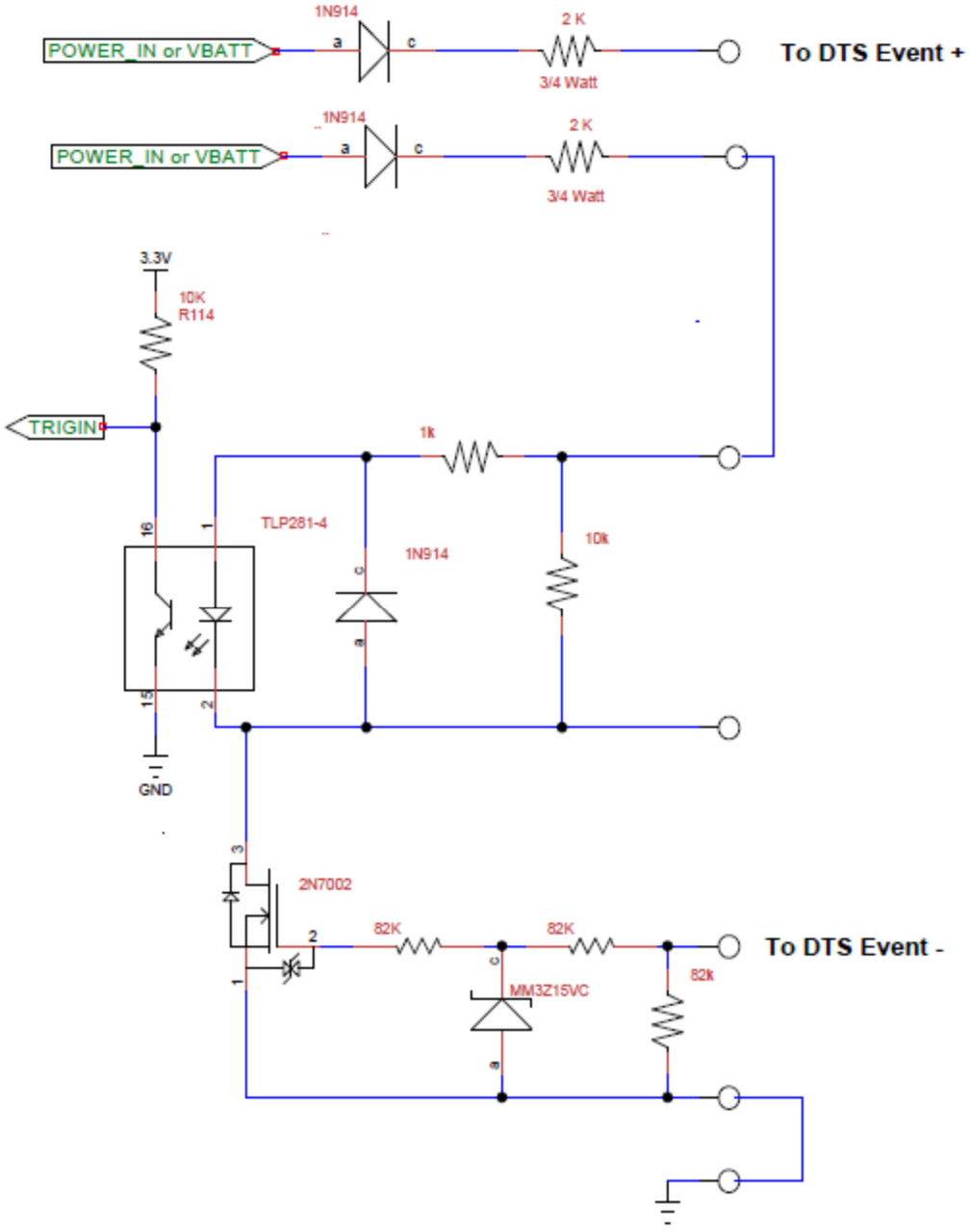

Figure A5. Trigger input configured for DTS MDB-supplied trigger
(Note: Power-in and ground are supplied from the DTS MDB)

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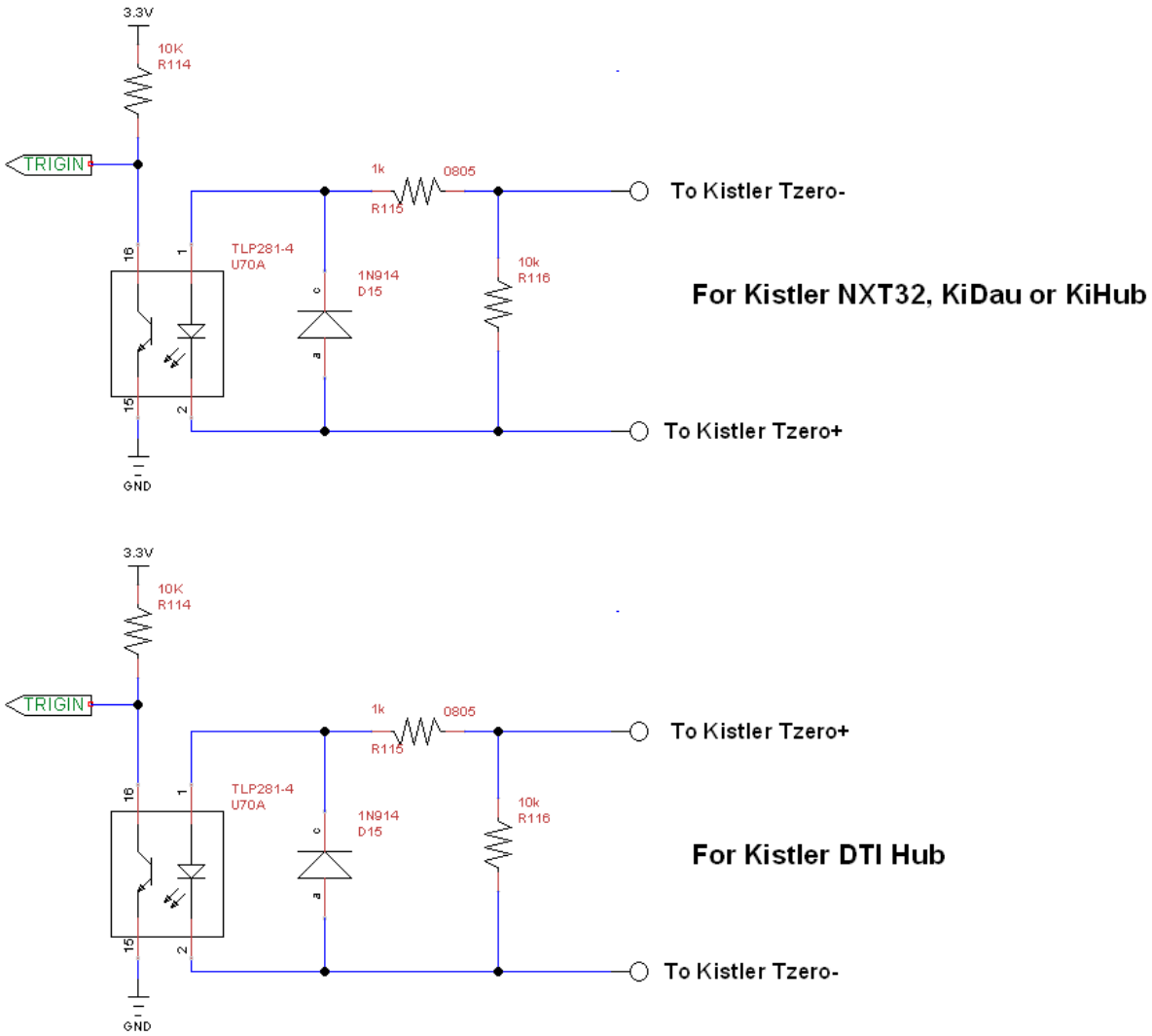

Figure A6. Trigger input configured for Kistler NXT32, KiDau, or KiHub (upper drawing) or Kistler DTI Hub (lower drawing)

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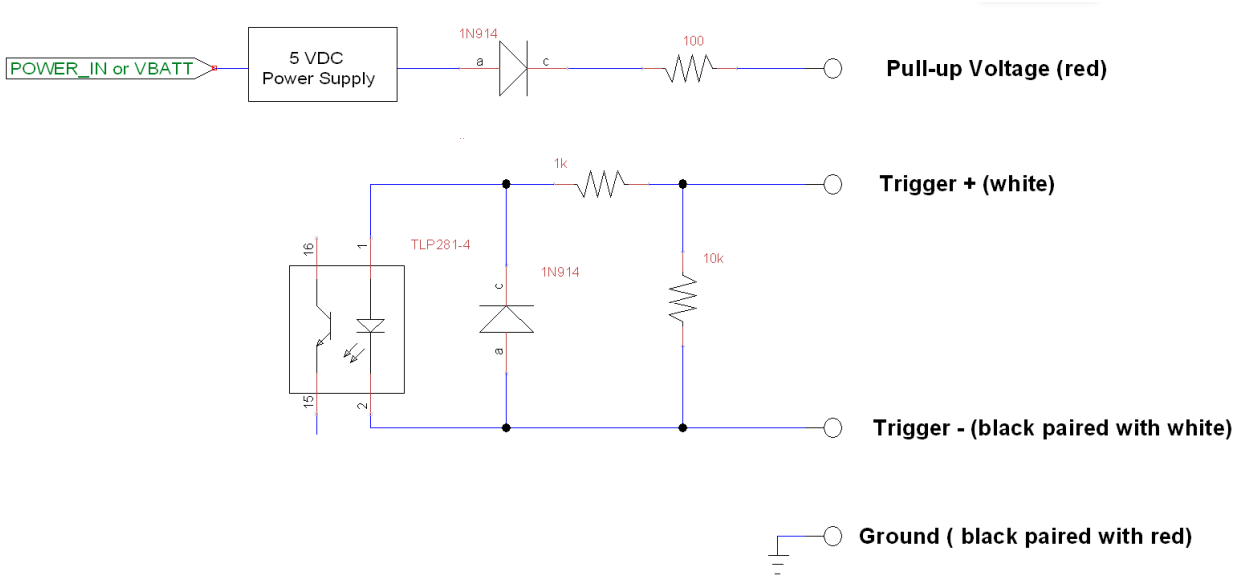

Figure A7. Trigger input configured for generic pigtail cable assemblies

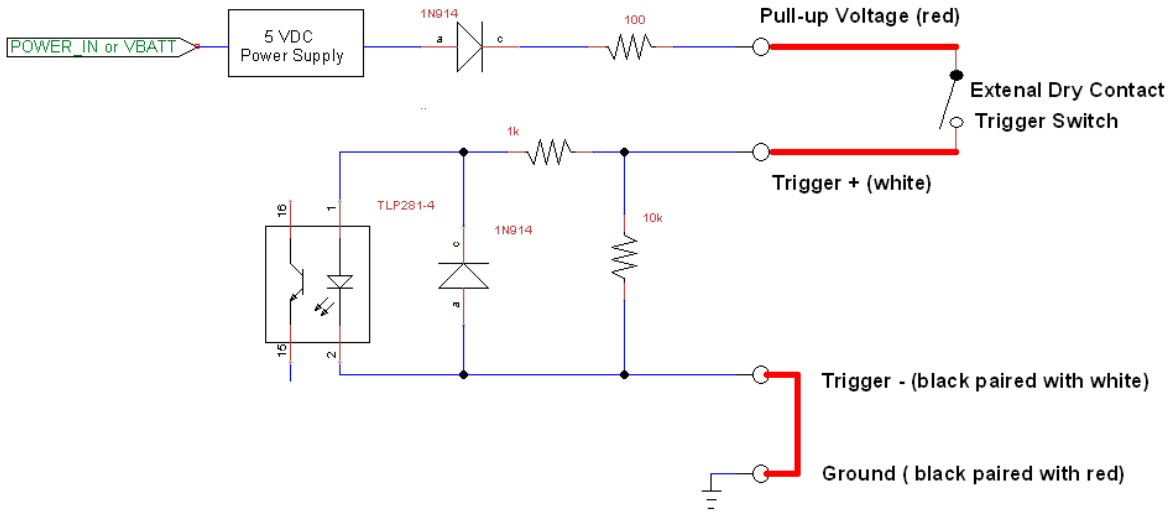

Figure A8. Trigger switch wiring example for generic pigtail cable assemblies

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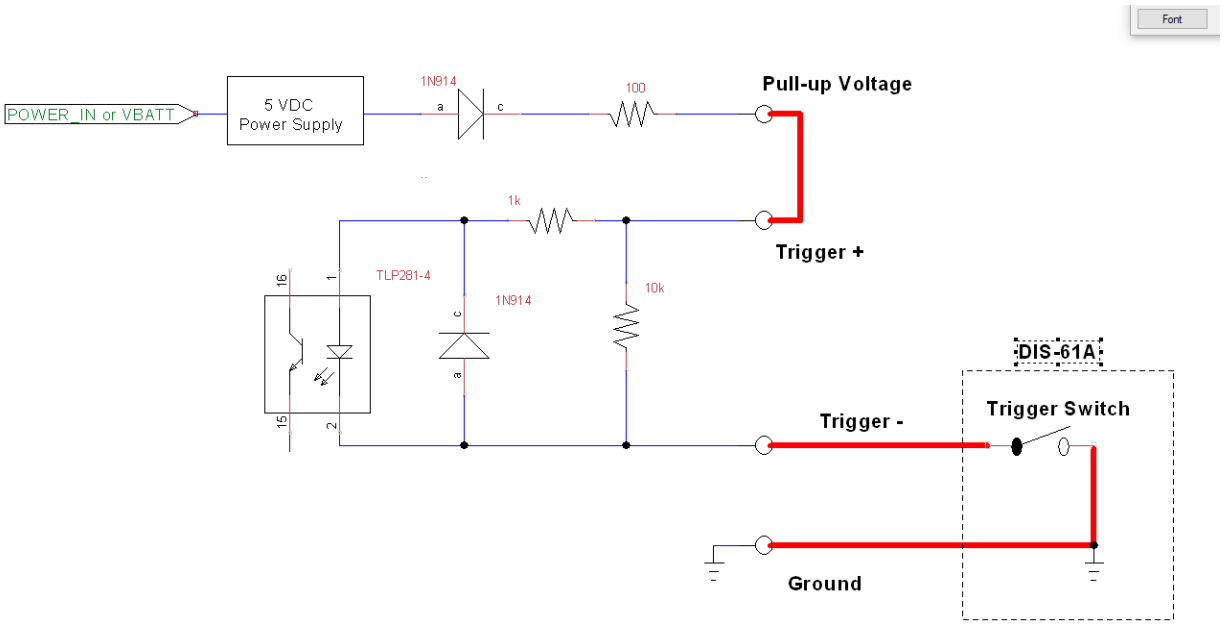

Figure A9. Trigger switch wiring for Kyowa DIS-61A interface

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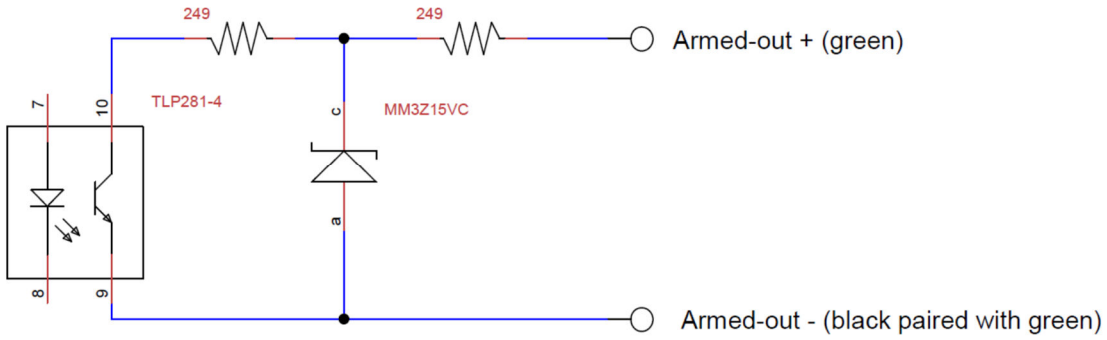

Figure A10. Armed-out circuit for generic pigtail cable assemblies
(Note: The opto-isolated output transistor turns on
when the RibEye is armed and collecting or storing data)

WARNING: The maximum current through the circuit must be less than 20 milliamps.

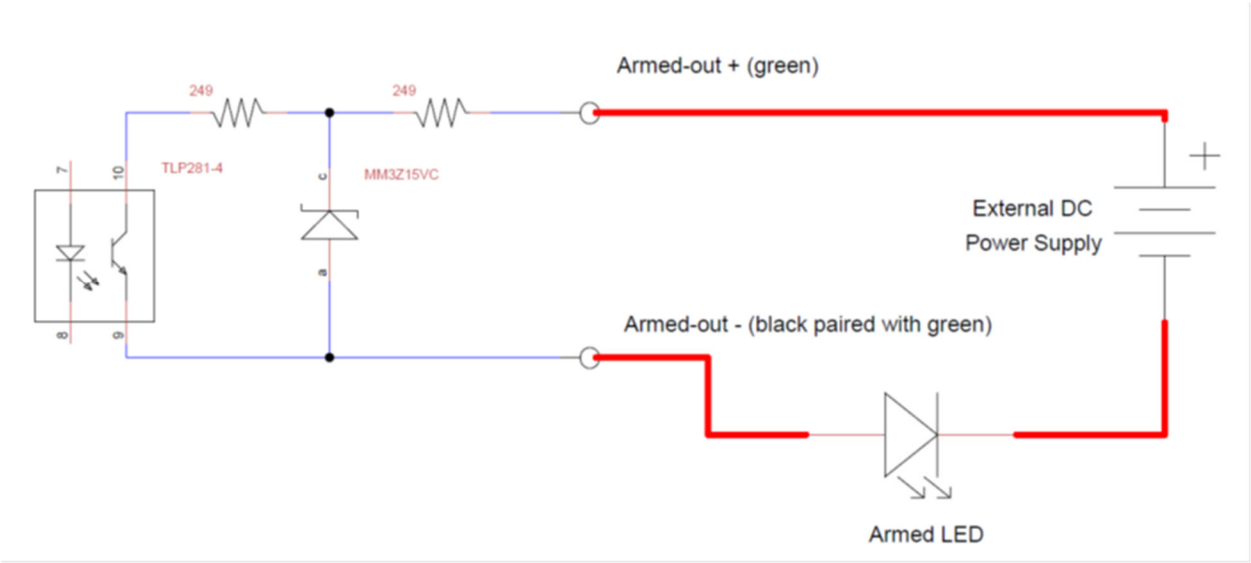

Figure A11. Example of armed-out indicator light wiring for generic pigtail cable assemblies

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Appendix B. Cable assemblies for connection to various DAS systems

Boxboro Systems provides several cable options to connect the WorldSID RibEye controller to the customer's equipment to get power, trigger, and Ethernet connections. You must specify the cable option you need when ordering the RibEye.

For customers with DTS TDAS G5 or Slice in-dummy DAS with external DTS Distributor (see Figure B1)

Exit cable #70110 connects to the RibEye controller at one end and to an extension cable #70200 at the other end. This cable set uses the RibEye high-impedance trigger input compatible with the DTS trigger output. With this cable the RibEye software trigger setting should be set to "Rising Edge"

Note: A DTS DBX cable to system port (DDX) – DTS cable #10700-00053 – can be used instead of the #70200 extension cable.

For customers with Kistler NXT32 in-dummy DAS (see Figure B2)

Exit cable #70115 connects to the RibEye controller at one end and at the other end, to the last NXT32 module in the chain of modules in the dummy. This cable uses the RibEye opto-isolated trigger input compatible with the Kistler CrashLink trigger. With this cable the RibEye software trigger setting should be set to "Rising Edge"

For customers with other types of internal or external DAS (see Figure B3)

Exit cable #70120 connects to the RibEye controller at one end and to a breakout cable #70201 at the other end. The breakout cable is terminated in pigtails for power, opto-isolated trigger, and an armed output. The Ethernet connection is a standard RJ45 plug for connecting to an Ethernet hub/switch. With this cable the RibEye software trigger setting depends on how the external switch is configured. If the external trigger switch is wired as shown in Figure A8, where the switch closes upon a trigger, RibEye software trigger setting should be set to "Rising Edge". If the switch opens when a trigger occurs, set the software trigger setting to "Falling Edge".

For customers with Kyowa DAS with external DIS-61A Junction Unit (see Figure B4)

Exit cable #70120 connects the RibEye controller at one end to a #70209 extension cable at the other end. The extension cable plugs into a Kyowa DIS-61A Junction unit, and has pigtails for an external power connection. With this cable the RibEye software trigger setting should be set to "Rising Edge"

For customers with Kistler External KiHub or KiDau (see Figure B5)

Exit cable #70125 connects the RibEye controller at one end to extension cable #70208 at the other end. The #70208 cable plugs into a KiHub or KiDau.. With this cable the RibEye software trigger setting should be set to "Rising Edge"

For customers with Kistler External DTI Hub (see Figure B6)

Exit cable #70125 connects the RibEye controller at one end to extension cable #70218 at the other end. The #70218 cable plugs into a DTI Hub. With this cable the RibEye software trigger setting should be set to "Rising Edge"

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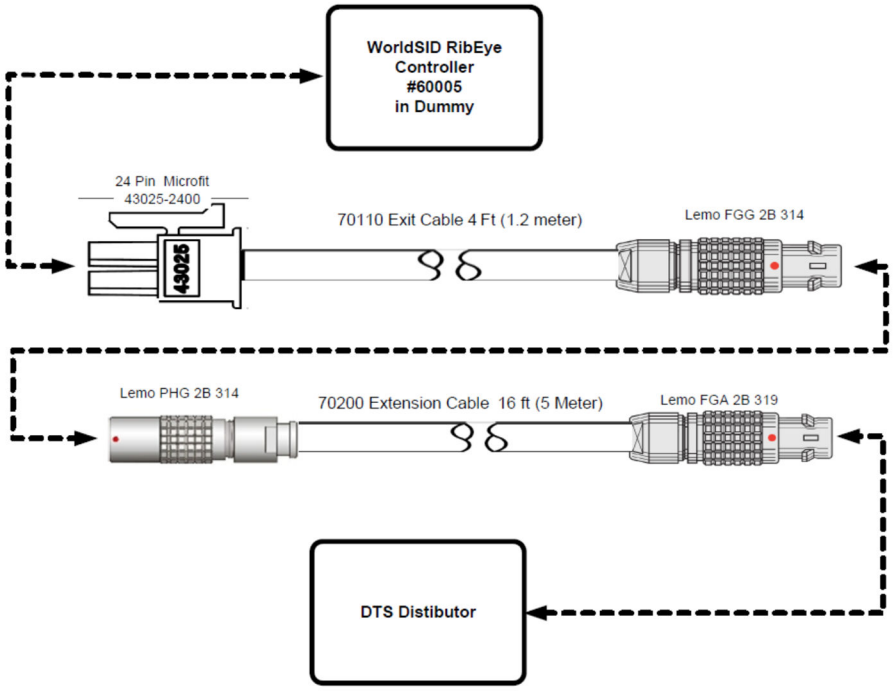

Figure B1. Cable option for DTS DAS – exit cable #70110 and extension cable #70200

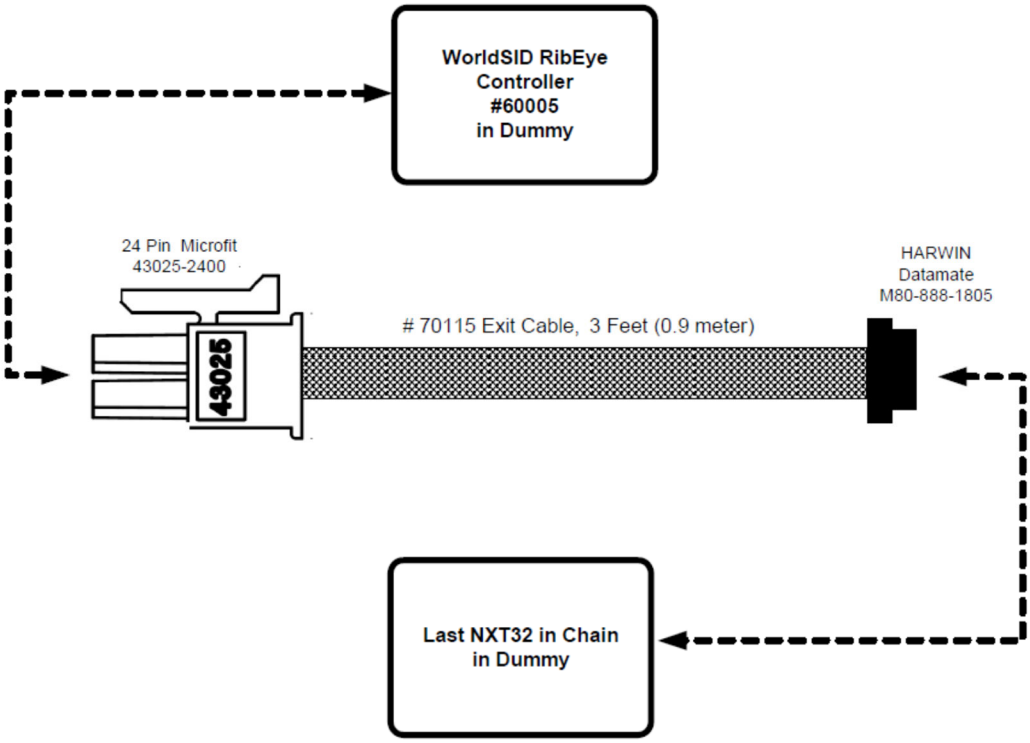

Figure B2. Cable option for Kistler NXT32 DAS – exit cable #70115

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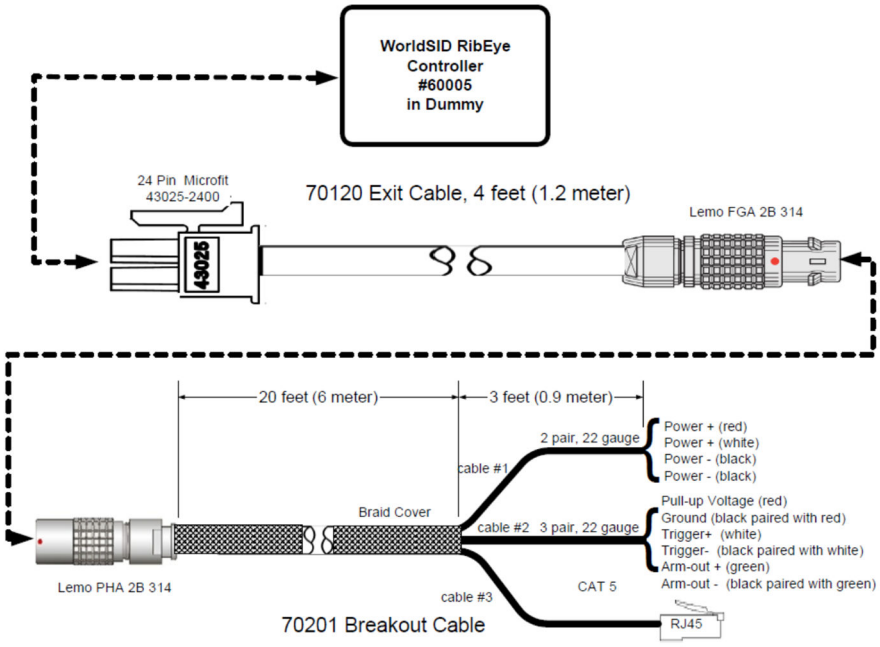

Figure B3. Cable option for generic DAS with exit and breakout cables – exit cable #70120 and breakout cable #70201 with opto-isolated trigger input and armed output

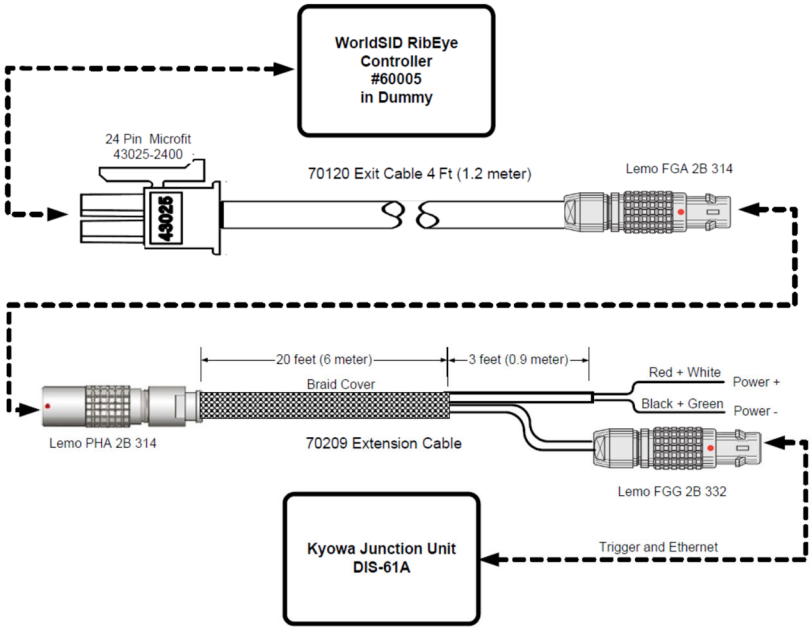

Figure B4. Cable option for Kyowa DAS – exit cable #70120 and extension cable #70209

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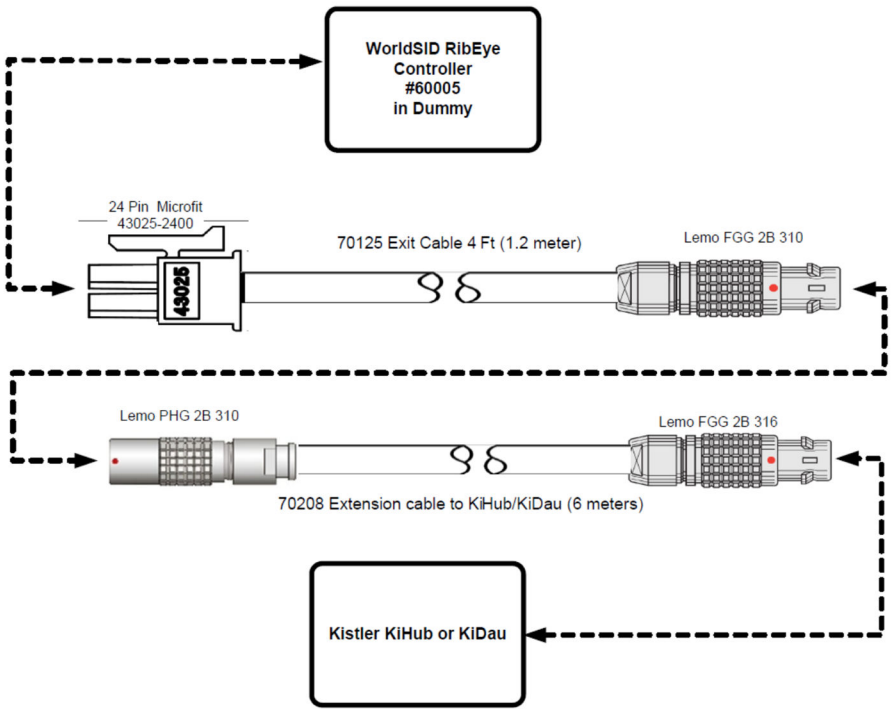

Figure B5. Cable option for Kistler KiHub/KiDau DAS – exit cable #70125 and extension cable #70208

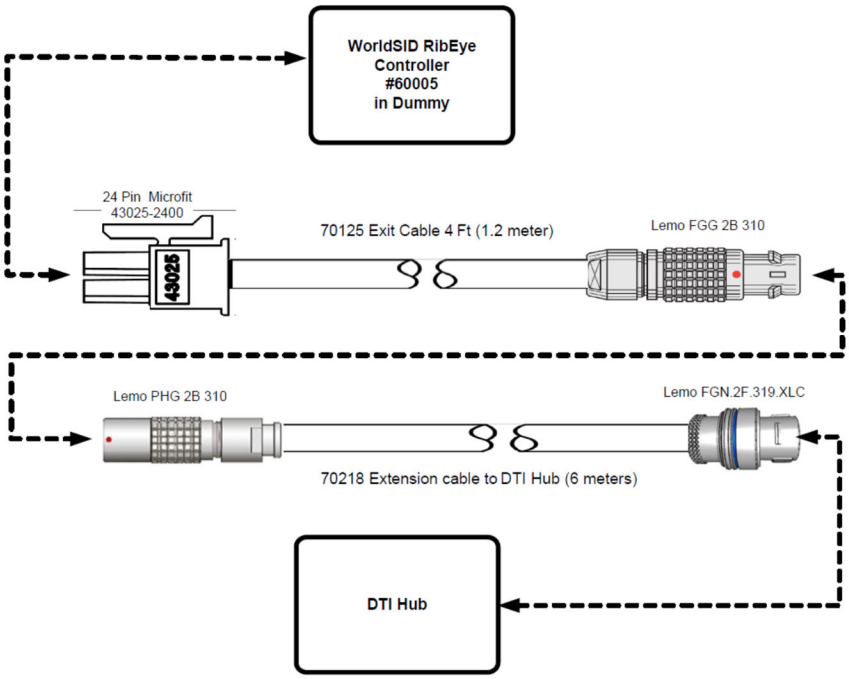

Figure B6. Cable option for Kistler DTI DAS HUB – exit cable #70125 and extension cable #70218

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Appendix C. RibEye cable connector details

This section describes the connector wiring for the various RibEye cables to facilitate field-repair of damaged cables. All Molex Microfit 3.0 connectors are crimp types. We recommend using a Molex crimp tool designed for the Microfit 3 series. The current production hand crimp tool is Molex part #638190000.

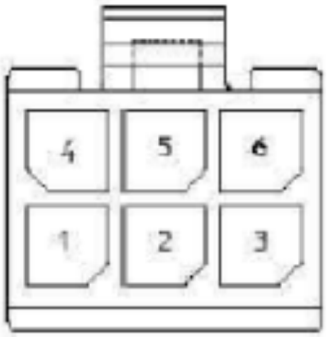
C-1. LED cables

Table C1. LED cables #70031 and #70032

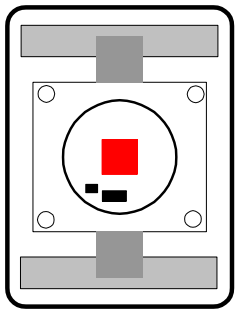
Microfit connector	43025-0600
Microfit crimp terminals	43030-0009 20-24 gauge

RibEye Name	Microfit 43025-0600
rear LED cathode	1
middle LED cathode	2
front LED cathode	3
rear LED anode	4
middle LED anode	5
front LED anode	6

View from mating side



Anode



Cathode

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C-2. LED breakout cable #70030

This cable has six 6-pole LED connectors that mate with #70031 and #70032 LED cables and a 20-pole connector that plugs into the controller “LED” Socket.

Table C2. Breakout cable LED connector (6)

Microfit connector s	43020-0600
Microfit crimp terminals	43031-0009 20-24 gauge

RibEye Name	Microfit 43020-0600	RibEye Name	Microfit 43020-0600
rear LED cathode	1	rear LED anode	4
middle LED cathode	2	middle LED anode	5
front LED cathode	3	front LED anode	6

View from mating side

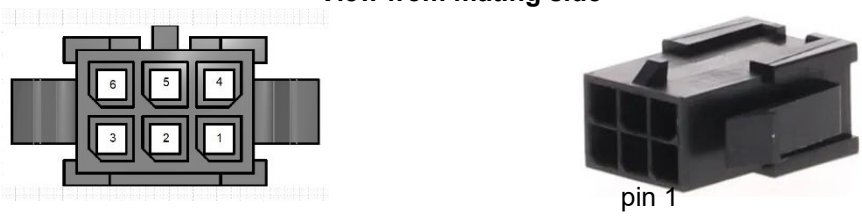

Table C3. Breakout controller connector

Microfit connectors	43025-2000
Microfit crimp terminals	43030-0009 20-24 gauge

RibEye Name	Microfit 43025-2000	RibEye Name	Microfit 43025-2000
shoulder rear	1	thorax 3 rear	11
shoulder middle	2	thorax 3 middle	12
shoulder front	3	thorax 3 front	13
thorax 1 rear	4	abdomen 1 rear	14
thorax 1 middle	5	abdomen 1 middle	15
thorax 1 front	6	abdomen 1 front	16
thorax 2 rear	7	abdomen 2 rear	17
thorax 2 middle	8	abdomen 2 middle	18
thorax 2 front	9	abdomen 2 front	19
GND - cathodes	10	GND - cathodes	20

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C-3. Exit cable connector

The exit cable connector is defined below.

Table C4. Exit cable controller connector

Microfit connector s	43025-2400
Microfit crimp terminals	43031-0009 20-24 gauge

RibEye Name	Microfit 43025-2400	RibEye Name	Microfit 43025-2400
Ethernet Rx+	1	Ethernet Rx-	13
Ethernet Tx+	2	Ethernet Tx-	14
GND	3	GND	15
Vin Pullup 2	4	reserved for future use	16
5 V pullup	5	armed out -	17
reserved for future use	6	reserved for future use	18
reserved for future use	7	armed out+	19
Vin Pullup 1	8	GND	20
Lo I Opto Trig in +	9	LO I Opto Trig in -	21
Hi I Trig in +	10	HI I Trig in -	22
GND	11	GND	23
+Vin	12	+Vin	24

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C-4. Sensor cable connector

The sensor cables are hard-wired to the sensors. A 7-pin Lemo 0B is used at the controller end of the cable.

Table C5. Sensor cable #70051

Name	Wire Color	Lemo FGG.0B.307.CLAD31
common	blue	1
out B	orange	2
out A	brown	3
-5 V	green	4
+5 V	red	5
control	yellow	6
ground	black	7
shield	shield	no connect

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Appendix D. Manual Revisions

Changes since January 2023 version:

- Added Section 3.5.1, Batteries and external power supply
- Fixed Figure A4, Trigger circuits, to show 5V pullup and added notes on Vin Pullup in the figure
- Fixed Figure A7 for 5V pullup voltage
- Fixed Figure A8 for 5V pullup voltage
- Added Figure A9, Kyowa DIS-61A interface

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