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HARDWARE USER'S MANUAL

RibEye™ Multi-Point Deflection Measurement System:

3-Axis Version for Ballistics Testing

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RibEye™ Multi-Point Deflection Measurement System: 3-Axis Version for Ballistics Testing

1.0 Overview

The RibEye measurement system, as designed for the three-rib ballistics test fixture, has the following components:

- The RibEye controller/sensor (Figure 1), located in the spine of the anthropomorphic test dummy.
- Three light-emitting diodes (LEDs), mounted on the ribs. The LEDs (Figure 2) are designed to be mounted in the order shown in the photo; that is, the top LED goes on the top rib, etc. Figure 2 shows the two different styles of LEDs that can be used for the three-rib fixture. The top picture shows the original LED cases mounted on a calibration bar. The bottom picture shows the newer style of LEDs for the three-rib test fixture.

  DANGER: *The LEDs are very bright when driven at full power. DO NOT LOOK DIRECTLY AT THE LEDs.*
- The interface box (Figure 3), also called the trunk box because it is usually placed in the trunk of a vehicle.

Figure 1A. RibEye controller/sensor rear view

Figure 1B. RibEye controller/sensor front view

Figure 2A. Original LED cases mounted on a calibration bar

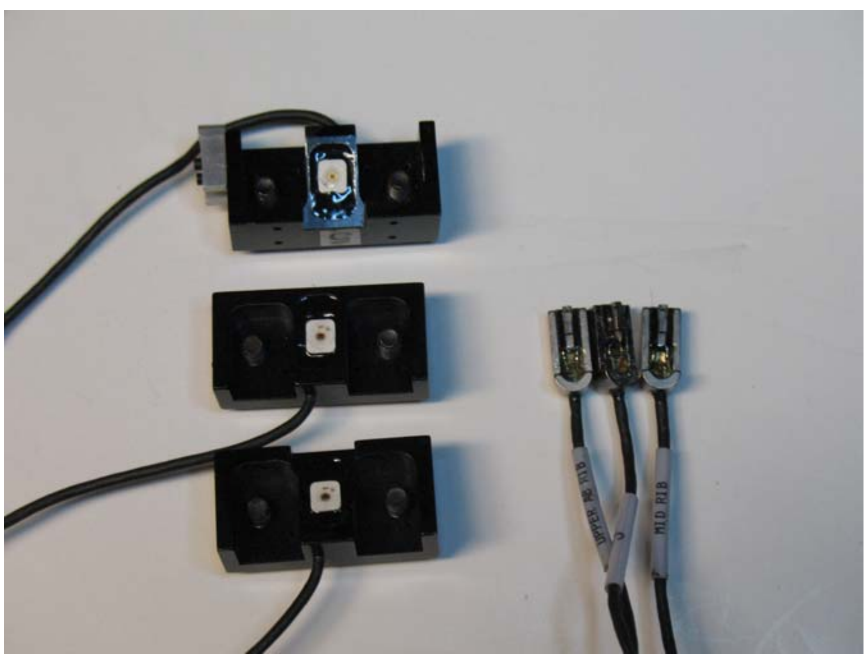

Figure 2B. Newer style LEDs for three-rib fixture

Figure 3. RibEye interface (trunk) box

The RibEye components are interconnected as shown in Figure 4. Power and communications cables are provided for connecting the controller/sensor to the interface box in the trunk. The interface box has sockets for Ethernet connection, power input, and data acquisition system (DAS) connection/trigger input. Mating connectors and pigtail cables are provided for the power input and DAS/trigger connectors. The power cable should be connected to a good quality DC power source. The DAS/trigger cable is used to provide a trigger input to the RibEye, as well as armed and trigger output signals from the RibEye.

2.0 Mounting the RibEye

2.1 Controller/sensor mounting

Please refer to the Humanetics Innovative Solutions documentation for instructions on how to mount the RibEye to the three-rib fixture.

2.2 LED mounting

The LEDs mount to the center of the inside of the ribs using two screws for each rib. The LED wires should be routed along the ribs and tied down with black nylon zip-ties. This will prevent the cables from crossing the path between the LEDs and the sensor heads. If the light from a LED to a sensor head is blocked, the position reading will be invalid.

Referring back to Figure 2, the LEDs are shown in the order that they are mounted, with the top LED in the pictures attaching to the top rib. Note that the LEDs for Ribs 1 and 3 are angled so that they will be aimed toward the sensor heads, providing the maximum amount of light to the sensors.

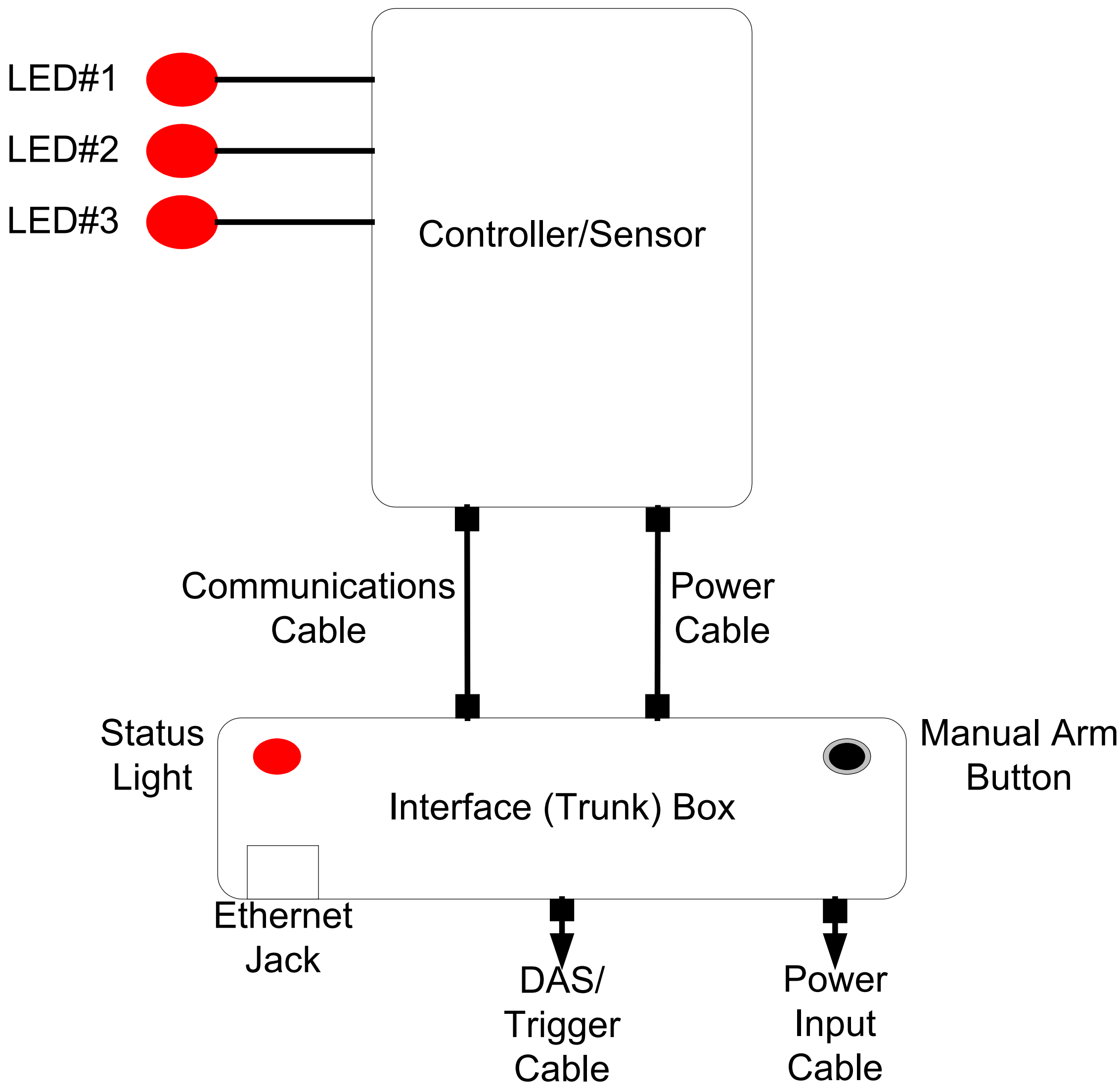

Figure 4. RibEye connections

Figure 5 shows the radiation pattern of the LEDs. Note that the brightest light is directly in front of the LED (on axis), and the brightness gets lower at larger angles. The RibEye controller continuously adjusts how hard it drives the LEDs to get a good signal from the sensors.

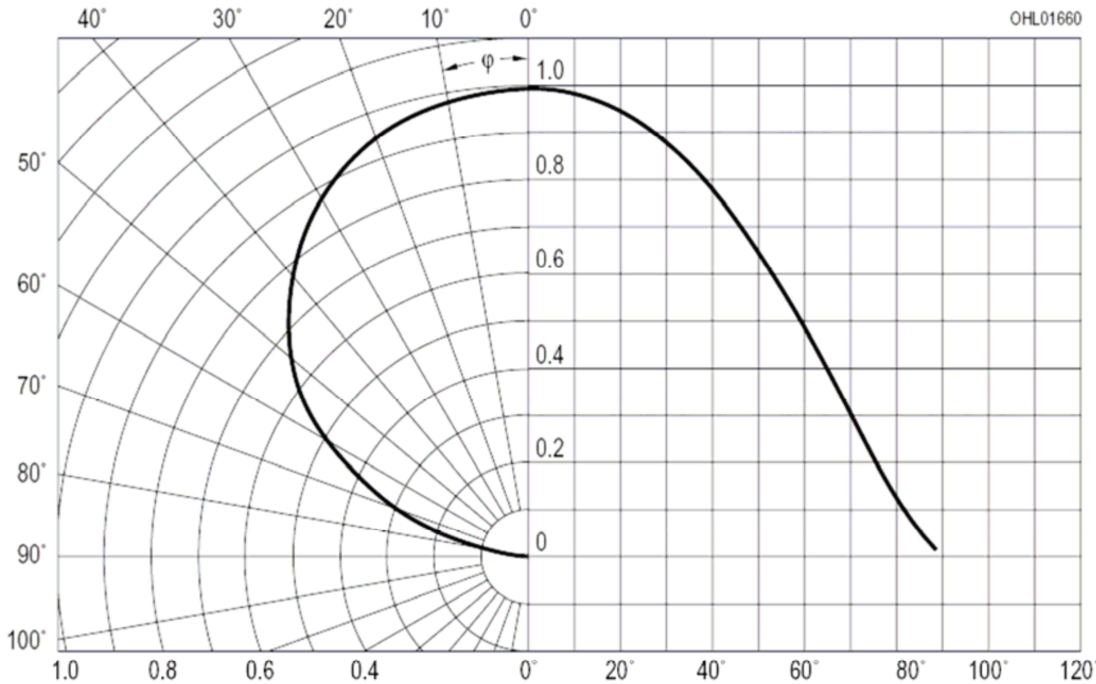

Figure 5. LED radiation pattern

The RibEye uses different calibration curves to process the LED data, depending on which rib (the Z-axis location) that the LED is mounted on. To obtain the guaranteed accuracy, the LEDs must be mounted on the ribs specified (default locations) as described above. Also as noted earlier, make sure that the wires cannot move between the LEDs and the controller, blocking the light.

2.3 Interface box mounting

The interface box, or trunk box, is intended to be mounted outside the three-rib fixture near the DAS and the power source. Four holes are provided on the base of the box for mounting. The interface box can be mounted in any orientation, but we recommend that it be mounted such that the side of the box with all of the connectors is easily accessible.

The communications and power cables from the spine box are connected to jacks on the interface box. An Ethernet cable is used to connect the interface box to a router/hub or directly to a laptop PC. Jacks are provided for incoming power and DAS/trigger connections.

3.0 Operating the RibEye

The RibEye operates as a stand-alone smart sensor that collects and stores data. In this stand-alone mode, a PC program is used to control the RibEye and download data. In addition to controlling the RibEye with the PC program, the interface box has a status light and a manual “Arm” button. The status light will blink at different rates depending on the state of the RibEye:

- 0.5 Hz = idle with data in memory
- 1.0 Hz = idle with memory erased
- 2.0 Hz = acquiring data
- 5.0 Hz = storing data in flash memory
- 10 Hz = erasing flash memory, downloading data, or powering up.

The Arm button can be used to manually arm the RibEye when it is idle and the memory is erased. You must hold the Arm button for at least 3 seconds to arm the RibEye.

3.1 RibEye IP address

The RibEye ships from the factory with its IP address set to 192.168.0.240. This IP address can be changed to work with your local area network (LAN). You can also communicate with the RibEye directly using a PC, without connecting to a LAN. To directly connect a PC to the RibEye, your PC must be set up with a fixed IP address on the same subnet as the RibEye. Please refer to the RibEye Software User’s Manual for instructions on how to change the RibEye IP address. If you are using a PC with the Windows 7 operating system, follow the instructions in the software manual’s Appendix C.

3.2 Powering up the RibEye

When the RibEye is powered up, it takes about 18 seconds to complete booting. While it is booting, it will turn on each of the LEDs in sequence, starting with LED #1. When booting is completed, the “Status” light will flash slowly, on for 1-2 seconds and off for 1-2 second (0.5-1.0 flashes per second).

DANGER: *The LEDs are very bright when driven at full power. Do not look directly at the LEDs during full power operation.*

3.3 Ambient light cancellation

To compensate for ambient light conditions, the RibEye takes an additional sensor reading during each collection cycle with none of the LEDs turned on. If there is very bright ambient light (much greater than normal room lighting), the difference between the reading with the LED being turned on and the ambient reading may not be enough for an accurate position calculation, and the data will display error code values. The RibEye PC software allows you to view plots of the ambient light data collected.

4.0 RibEye Software

Instructions for installing and operating the RibEye PC software can be found in the RibEye Software User’s Manual. The software manual can be found on the disk shipped with the RibEye or on the Boxboro Systems website at http://www.boxborosystems.com/servicepage.html. Updates to the RibEye PC software can be downloaded from the website as they become available.

5.0 RibEye Maintenance

The RibEye lenses must be kept very clean for accurate measurements. Dust and smudges from fingers will affect the RibEye's accuracy detrimentally.

Follow this procedure for cleaning the lenses:

1. Blow the lenses off with canned compressed air (*not* shop air) to remove any grit
2. Wipe the lenses with a *dry*, clean, lint-free cloth, or wipe the lenses with a clean, lint-free cloth and lens-cleaning solution or alcohol

There are ***NO*** user-serviceable parts in the RibEye.

Appendix A. RibEye specifications

Measurement accuracy and range

The measurement accuracy is +/– 1 mm over the measurement range, which is a volume defined in Figures A1 and A2 for *each* LED**.**

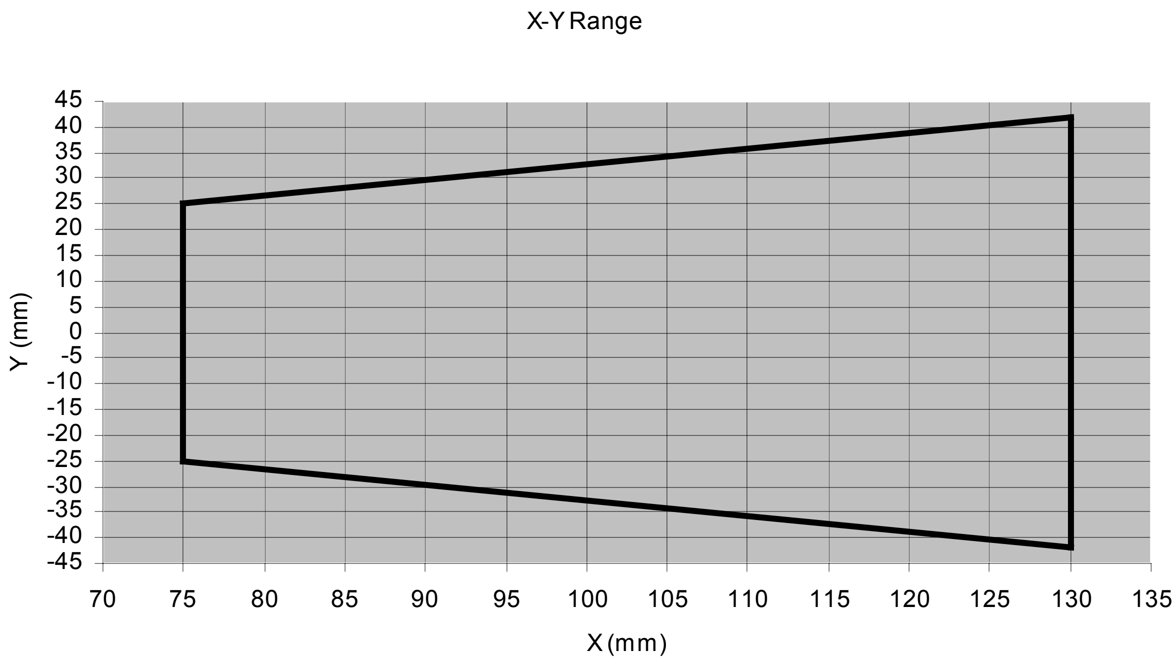

Figure A1. RibEye measurement range in X-Y plane

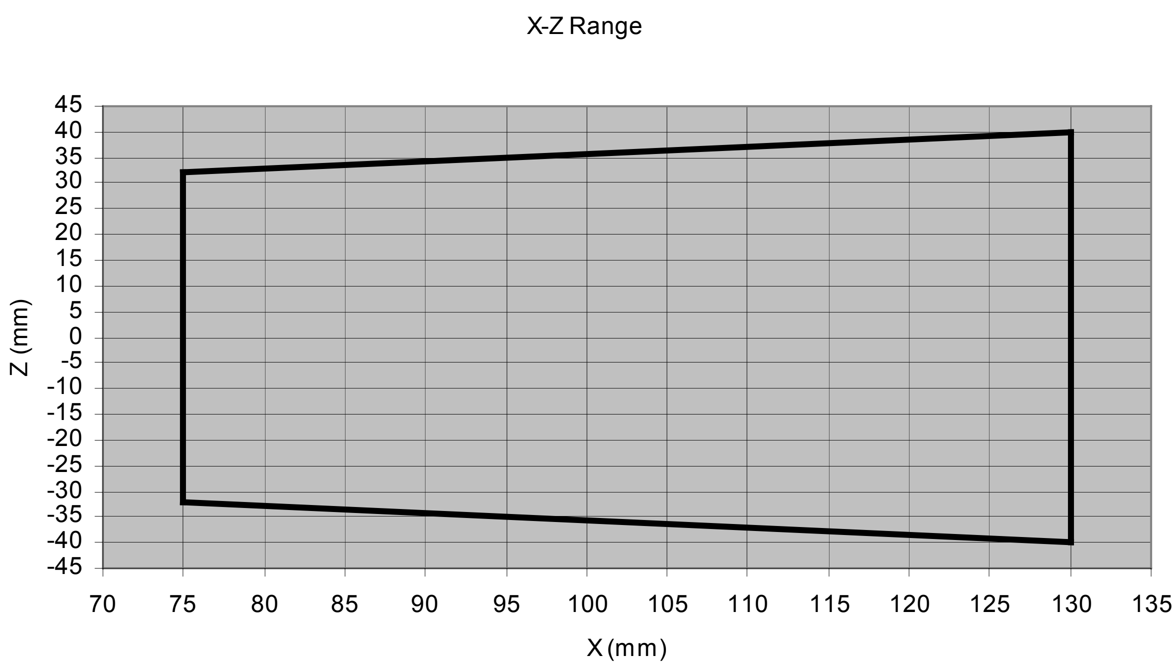

Figure A2. RibEye measurement range in X-Z plane

Power requirements

The RibEye can be powered by a good quality DC voltage source of 12 to 36 Volts. Note that the input power cable is terminated at the user end in pigtails. The red wire is connected to the DC power supply's positive power connection. The black wire is for the DC power supply's negative (ground) connection. The power cable shield should be tied to either the DAS common ground point or the DC power supply's negative (ground) connection, or neither or both, depending on the configuration of your DC power grounding scheme. We recommend that you try the various shield connection options and see which one is best for minimizing noise in the RibEye data.

The trunk box has an internal self-resetting polymer fuse. It can take up to ½ hour to reset after an overload.

The power draw depends on the RibEye's operating conditions, as shown in Table A1.

Table A1. RibEye power requirements

Operating Conditions	Interface Box	Controller + LEDs	Total
	Watts		
On/idling	3.3	2	5.3
Collecting data (typical)	3.3	5	8.3
Maximum*	3.3	9	12.3

* When all LEDs are out of view of both sensors and driven to full power.

Data acquisition and storage

Sample rate: 20,000 samples per second per LED

Acquisition time: 30,000 milliseconds (30 seconds) in D-RAM, 2 seconds in flash

Data is collected to RAM memory and stored post-test in flash memory.

Appendix B. Trigger inputs and armed output circuits

The DAS/trigger interface connector on the RibEye's interface box is an 8-pin Lemo connector. A mating cable, terminated in a pigtail, is supplied with the RibEye. At this time, 7 of the connector's 8 pins can be used for triggering and status. The trigger output is programmed to go low when the center LED has moved approximately 2 mm toward the sensors.

Table B1 lists the pinouts, pigtail color code, and signal function. Refer to "Signal Specifications" below to find the maximum voltages applied to these connections.

Table B1. Control signals

Pin #	Color Code	Function
1	white	switch trigger in
2	brown	5 Volts through 1k resistor for pull-up
3	blue	ground
4	green	differential trigger in +
5	orange	differential trigger in –
6	yellow	+5 Volts (50 milliamp maximum)
7	black	armed output
8	red	trigger output

Figures B1–B4 show how to connect trigger switches, active TTL level trigger sources, and differential trigger sources. Where a trigger switch is shown, you can use the same configuration for open collector transistor output trigger sources. If you want to use a photo-interrupter type trigger source, you can power it from the 5-Volt supply on pin 6.

Figures B1–B4 also show the input circuitry in the interface box. Note that the differential receiver connected to pins 4 and 5 is enabled when a differential trigger is selected.

Figure B5 shows the armed output circuitry that you can use to monitor the state of the RibEye.

Figure B6 shows the trigger output circuitry that you can use to monitor the state of the RibEye.

WARNING: *DO NOT EXCEED THE MAXIMUM RATINGS LISTED BELOW.*

Signal Specifications:

Differential trigger inputs (pins 4, 5)

- Maximum differential input voltage: +/– 12 Volts DC (VDC)
- Minimum differential input voltage: +/– 0.2 VDC
- Common mode input voltage +/– 12 VDC

Switch trigger input (pin 1 with respect to pin 3, ground)

- Maximum input voltage = 5.0 VDC
- Minimum "on" voltage = 3.3 VDC

- Maximum “off” voltage = 0.4 VDC
- Current limited by 1k resistor

Additional 5 Volts for external power (pin 6)

- Output voltage 4.75 to 5.25 Volts
- Limit external loads to 50 milliamp maximum
- Short circuit will cause resettable fuse to trip

Armed output (pin 7)

- Output voltage 4.75 to 5.25 Volts at 0.5 ma max when armed
- Output voltage 0.5 Volts when disarmed

Trigger output (pin 8)

- Output voltage 4.75 to 5.25 Volts at 0.5 milliamp max when idle or armed
- Output voltage 0.5 Volts when triggered, until data acquisition is done

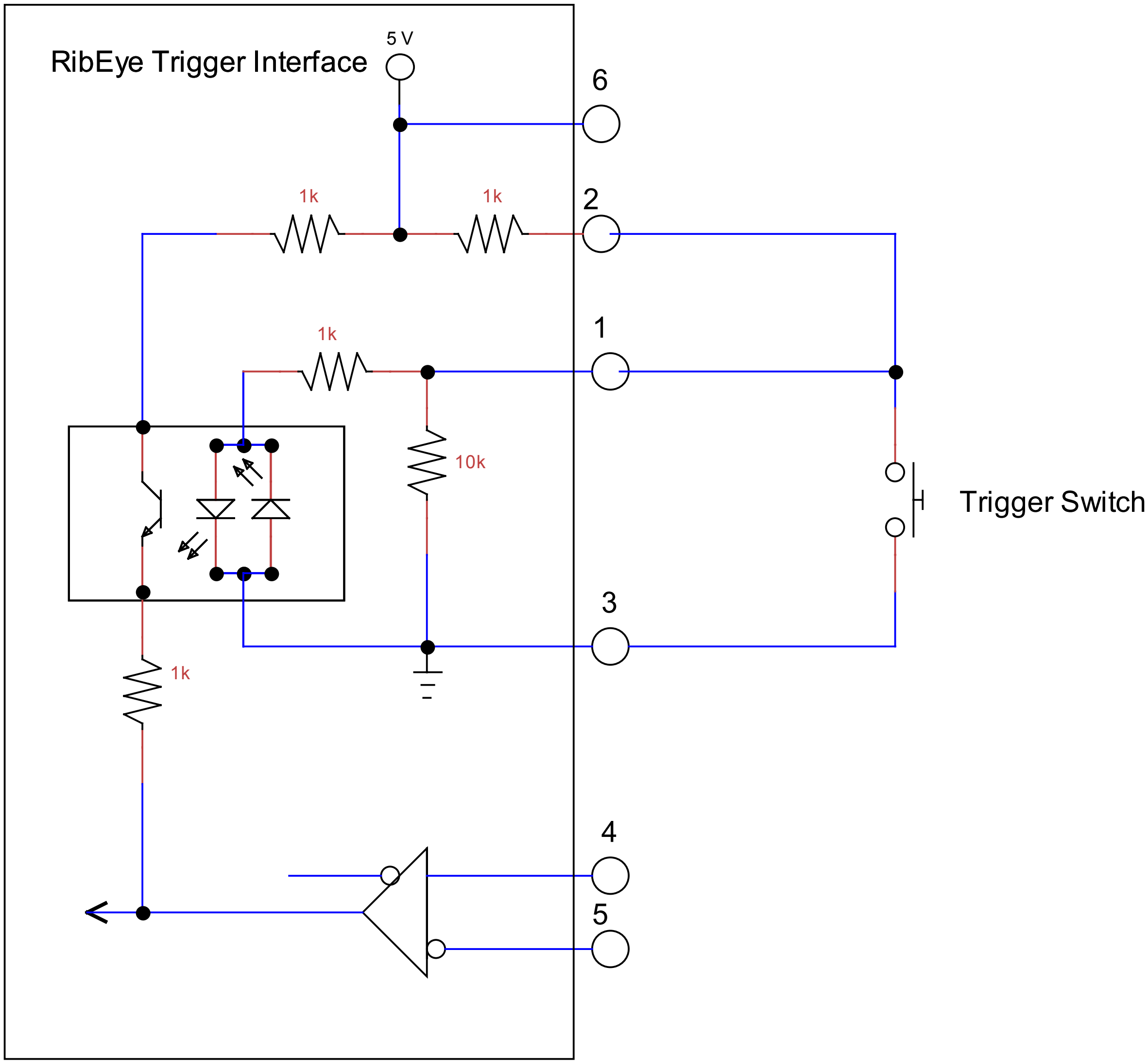

Figure B1. Trigger switch connection

For this connection, if the switch closes at the start of the event, select—

SWITCH OR TTL, FALLING EDGE TRIGGER

If the switch opens at the start of the event, select—

SWITCH OR TTL, RISING EDGE TRIGGER

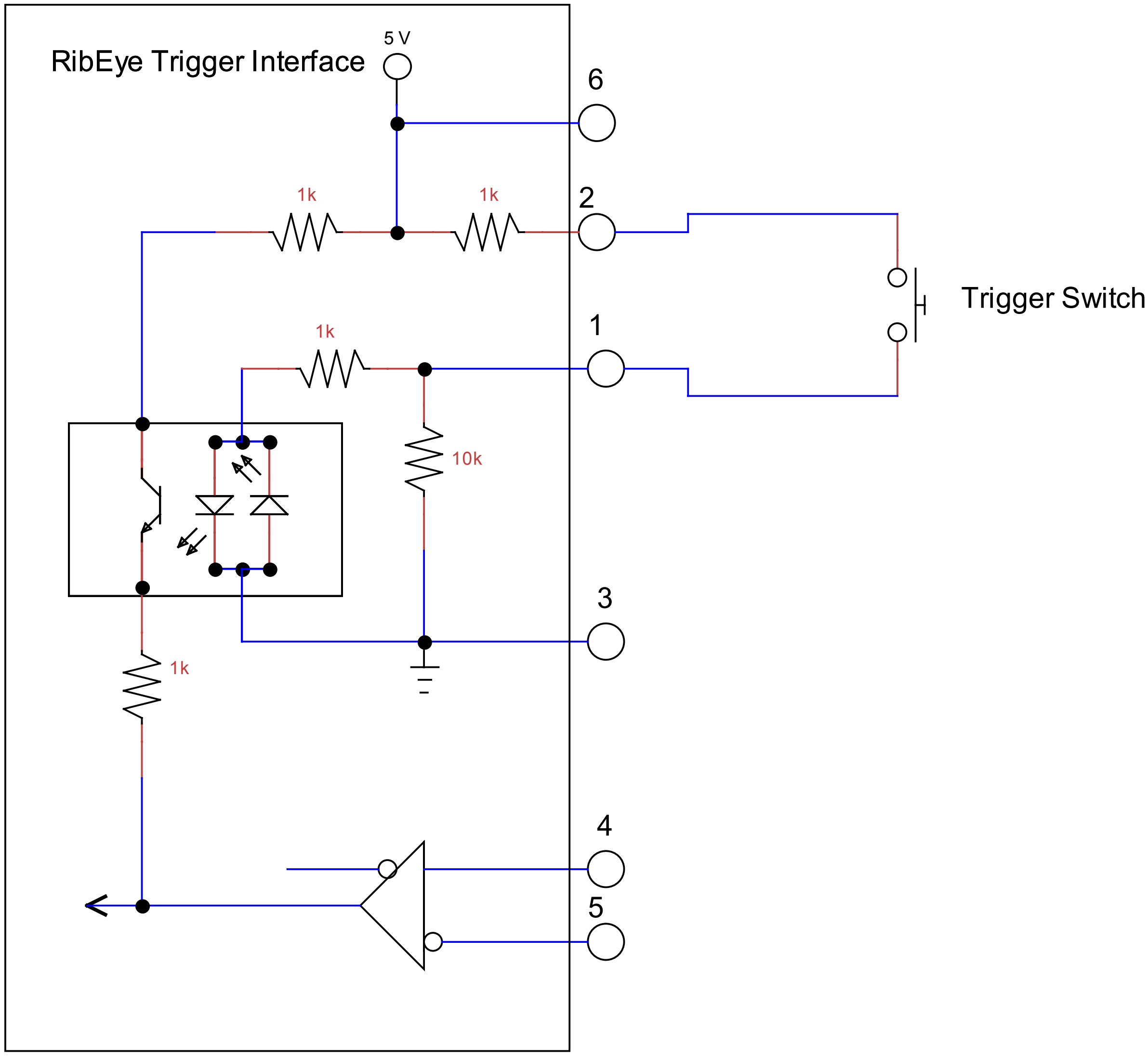

Figure B2. Alternate trigger switch connection

For this connection, if the switch closes at the start of the event, select—

SWITCH OR TTL, RISING EDGE TRIGGER

If the switch opens at the start of the event, select—

SWITCH OR TTL, FALLING EDGE TRIGGER

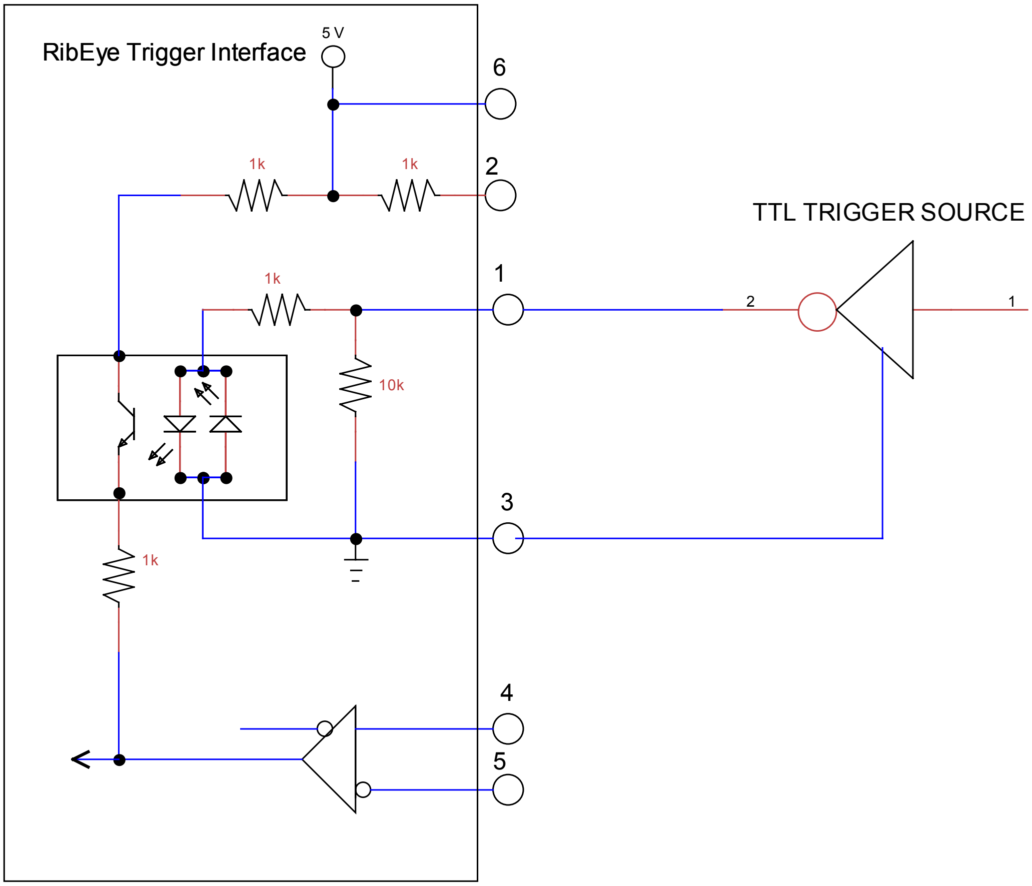

Figure B3. TTL trigger source connection

For this connection, if the input at pin 1 goes from 0 Volts to 5 Volts at the start of the event, select—

SWITCH OR TTL, RISING EDGE TRIGGER

If the input at pin 1 goes from 5 Volts to 0 Volts at the start of the event, select—

SWITCH OR TTL, FALLING EDGE TRIGGER

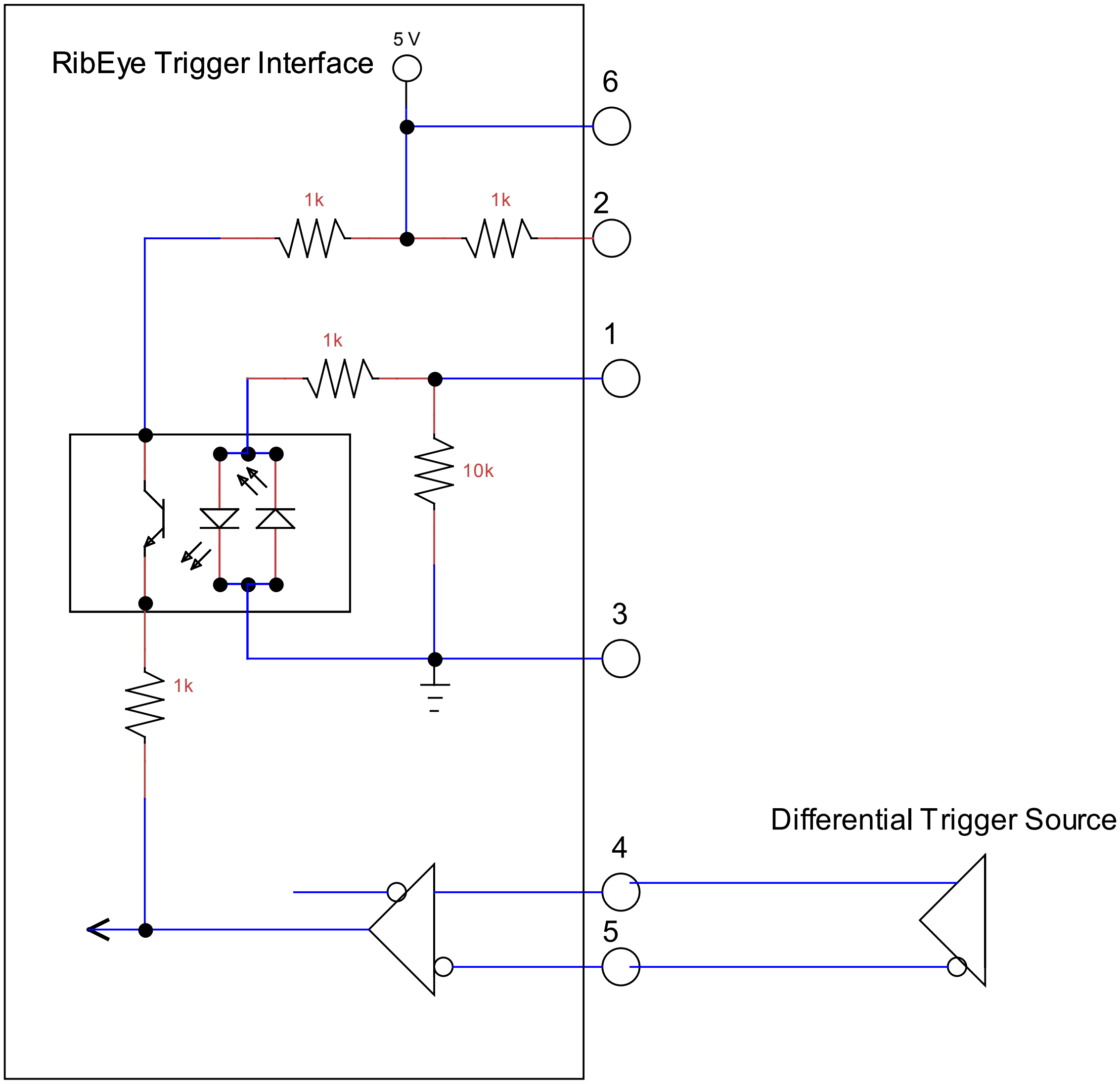

Figure B4. Differential trigger source connection

In this configuration, if the differential driver transitions from HIGH (pin 4 voltage > pin 5 voltage) to LOW (pin 4 voltage < pin 5 voltage) at the start of the event, select—

DIFFERENTIAL, FALLING EDGE TRIGGER

If the differential driver transitions from LOW (pin 4 voltage < pin 5 voltage) to HIGH (pin 4 voltage > pin 5 voltage) at the start of the event, select—

DIFFERENTIAL, RISING EDGE TRIGGER

Note that when differential triggering is selected, the output of the differential receiver can be monitored at pin 10.

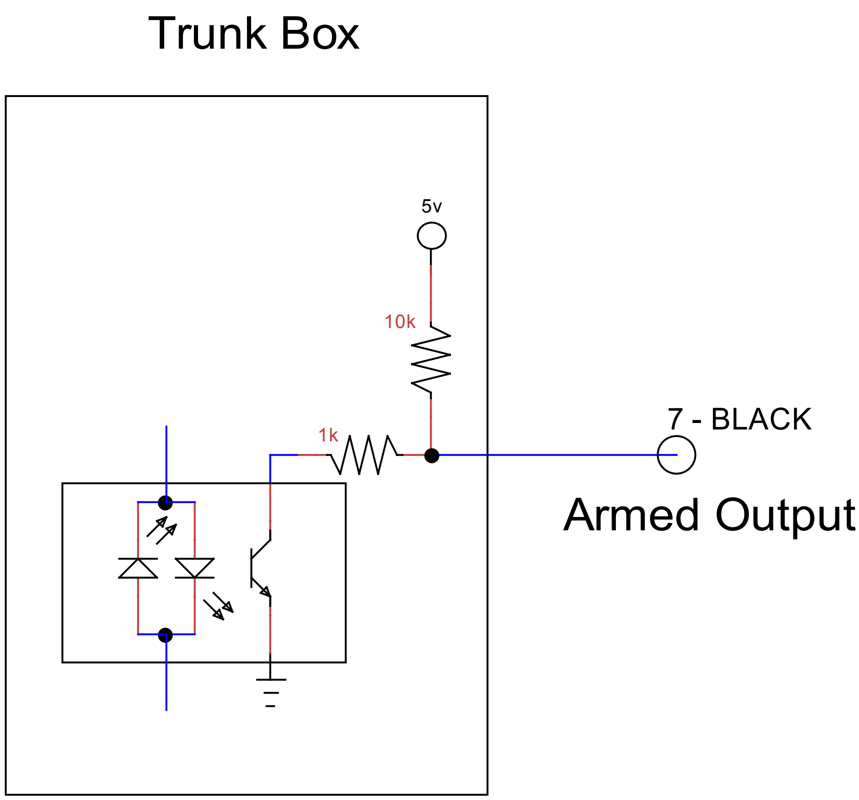

Figure B5. Armed output circuit

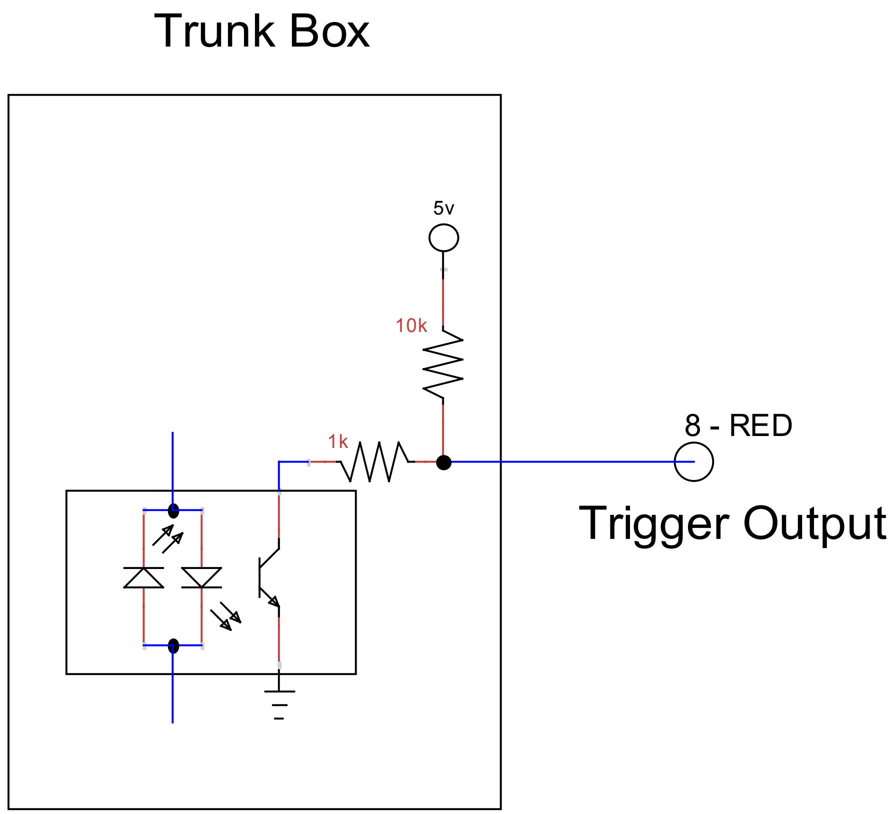

Figure B6. Trigger output circuit