Trigno® Wireless Biofeedback System User's Guide

MAN-049-1-1

This product is protected by one or more of the following patents: 6480731, 6129666, 6238338, 2113193, 1070479, 6044293, 99309144.6, 6440067, 1290651, 1637076, 9351659, 9351660, 10004421, 2848195.

Important Information

The Trigno® Wireless Biofeedback System is an instrument consisting of the following key components:

- battery-powered wireless wearable biofeedback sensors
- a sensor recharge unit
- a base station receiver
- a commercial PC with USB communication or similar computing device
- software

Intended Use

The device enables researchers and clinicians to acquire electromyographic and related signals from participants for academic, clinical, and scientific study, education, fitness, and general wellness purposes. Outputs of the system are to be interpreted by qualified individuals educated in the understanding of physiological signals and human movement.

The device is intended for research use only, and not intended for diagnosing, treating, mitigating disease or direct patient therapy. Performing research on human participants usually requires oversight by an Institutional Review Board or equivalent body.

System Components

Trigno® Wireless Biofeedback System	**DS-T04**
Trigno® Avanti Sensor	SP-W11
Trigno® Centro Base Station	SP-W10
Trigno® Charge-16	SP-W09
Trigno® Lite USB Adapter	SP-W08
Trigno® Charge-4	SP-W07
Trigno® Power Supply	SC-P09
Trigno® 4-slot Adhesive Interfaces	SC-F03

Technical Service and Support

For information and assistance please visit our web site:

www.delsys.com

Or contact us:

E-mail: support@delsys.com

Telephone: (508) 545 8200

Symbols

Warning – immediate action must be taken to avoid undesirable consequences.

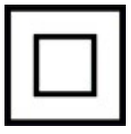
Important Note.

Consult accompanying User's Guide for detailed instructions.

Keep the device dry as the ingress of liquids into the device may compromise the safety features of the device.

Handle with care.

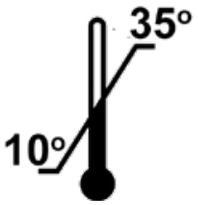
Sensitive electronic device. Avoid static discharges. Do not operate or store near strong electrostatic, electromagnetic, magnetic or radioactive fields. Interference from external sources may decrease the signal-to-noise ratio or result in corrupted data.



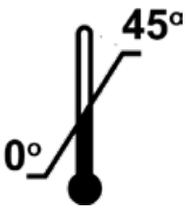
Trigno® Power Supply SC-P09 is Class II isolated equipment, certified to IEC 60601-1.

Trigno® Sensors and Trigno® Adhesive Skin Interfaces are Type BF Floating Applied Parts.

Single Use Only (applies to Trigno® Adhesive Skin Interfaces).

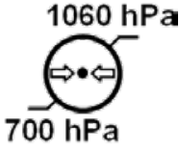


Operational Temperature Range: Trigno® Systems should be operated between 10 and 35 degrees Celsius due to the presence of internal lithium polymer rechargeable cells and heat dissipation considerations. Operating the system outside of this temperature range may compromise the longevity and safety features of the system.



Transport and Storage Temperature Range: Trigno® Systems should be stored/transported between 0 and 45 degrees Celsius. Storing the system outside of this temperature range for extended periods of time may compromise the integrity and the safety features of the device.

Do not transport, store, or operate Trigno® Systems for extended periods of time outside of 5% - 85% humidity range.



Do not operate, transport or store Trigno® Systems outside of a pressure range of 700 hPa and 1060 hPa.

Date of Manufacturing (appears on device)

Manufacturer:
Delsys Inc.
23 Strathmore Rd.
Natick, MA, 01760, USA

Made in the USA, Country of Origin USA

SN Serial Number (appears on device or package label)

Model Number (appears on device or package label)

REF Catalog Number (appears on device or package label)

LOT Batch Identifier (appears on device or package label)

UDI Unique Device Identifier (appears on device or package label)
DS-T04: 00851679007391

Dispose of the device according to local rules for electronic waste.

EC REP Authorized Representative:
CS Life Sciences Europe Ltd.
The Black Church
St. Mary's Place, Dublin 7
Dublin D07P4AX, Ireland

FC FCC ID: W4P-SP-W06 (Avanti Sensor)
FCC ID: W4P-SP-W10 (Centro Base Station)
Contains FCC ID: BL64 (Trigno® Lite USB Adapter)

IC: 8138A-DST03 (Avanti Sensor)
IC: 8138A-SPW10 (Centro Base Station)
Contains IC: 3147A-BL654 (Trigno® Lite USB Adapter)

R 211-190333 (Avanti Sensor)

Complies with Requirements put forth by the Medical Device Regulation EU 2017/745. Class I device, Annex VIII.

Complies with Requirements put forth by the United Kingdom Medical Devices Regulation 2002. Class I device, Annex IX of Directive 93/42.

Warnings

DO NOT USE on Participants with implanted electronic devices of any kind, including cardiac pacemakers or similar assistive devices, electronic infusion pumps, and implanted stimulators. Trigno® systems have not been tested with these devices and the wireless communication may interfere with implanted device function.

DO NOT USE on Participants with electronic wearable devices essential for well-being, therapy, or other medical needs that cannot be safely removed during operation of the Trigno® Wireless Biofeedback System. Trigno® systems have not been tested with these devices and the wireless communication may interfere with these other essential devices.

DO NOT USE in critical care applications or critical care environments as the device is not intended to be used in these conditions.

DO NOT USE on Participants while using high-frequency surgical equipment as this may result in burns at the site of the EMG sensor contacts and result in sensor damage.

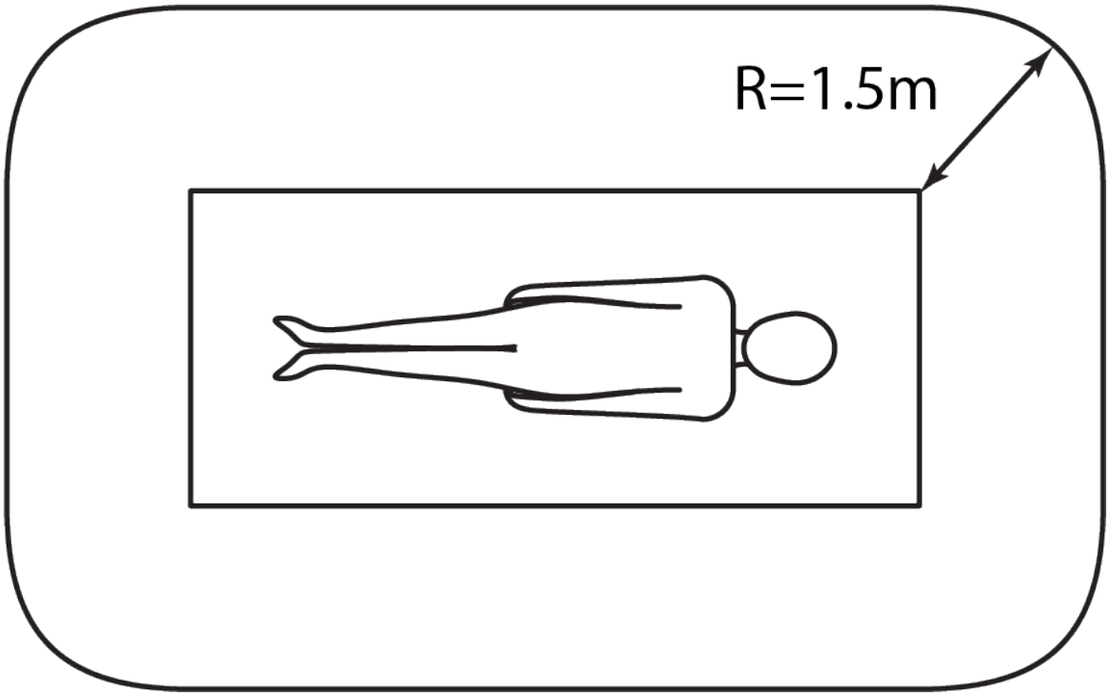
DO NOT USE on Participants in MRI machines or other environments with strong magnetic or electromagnetic fields as this may result in burns at the site of the sensor contacts and result in sensor damage.

DO NOT DAMAGE, CRUSH, BURN, FREEZE, OR OTHERWISE MISHANDLE THE DEVICE. Sensors contain a Lithium-Polymer battery. Recharge only with the approved power supply and recharger.

NO MODIFICATIONS of this equipment are allowed.

RISK OF ELECTRIC SHOCK HAZARD: Accessory equipment connected to the data ports must be certified according to the respective IEC standards; i.e., IEC 60950-1 or IEC 62368-1 for data processing equipment or IEC 60601-1 for electromedical equipment. All combinations of equipment must be installed in compliance with IEC 60601-1 systems requirements. Connecting additional equipment to the data ports results in configuration of a medical system; therefore, it must be ensured that the system complies with system requirements of IEC 60601-1-1.

IEC 60950-1 or IEC 62368-1 approved Information Technology Equipment must be placed outside the “patient environment.” The patient environment is defined as an area 1.5 m (4.92 feet) from the patient.



The other equipment shall be powered from a medical grade (IEC 60601-1 compliant) separating transformer if there is a need to remediate system leakage current.

Emissions from the Trigno® System may result in reciprocal interference with other devices in the environment. Research study coordinators must review and manage potential hazards with other equipment intended to be used in the environment.

Important Notes

- DO NOT USE on irritated skin or open wounds.
- DO NOT USE on Participants with allergies to silver.
- IMMEDIATELY DISCONTINUE DEVICE USE if skin irritation or discomfort occurs.
- IMMEDIATELY DISCONTINUE DEVICE USE if a change in the performance of the device is noted. Contact Delsys technical support for assistance.
- Device is not intended to be serviced by users or service personnel.
- Delsys Inc. guarantees the safety, reliability, and performance of the equipment only if assembly, modifications, and repairs are carried out by Delsys Factory Technicians; the electrical installation complies with the appropriate local building code requirements; and the equipment is used in accordance with these instructions for use.
- Use only with the Trigno® SC-P09 Power Supply.
- Disposal of the Trigno® Wireless Biofeedback System and its components is to be made in accordance with local electronic waste regulations or by returning the equipment to Delsys Inc. for processing.

- Report any serious incidents with the device to Delsys at 508 545 8200 or support@delsys.com.

- These devices comply with Part 15 of the FCC Rules and the Canadian Innovation, Science and Economic Development license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) these devices may not cause harmful interference and (2) these devices must accept any interference received, including interference that may cause undesired operation.

- Ces appareils sont conforme à des règlements Innovation, Sciences et Développement économique Canada exempts de licence standard RSS (s). Le fonctionnement est soumis aux deux conditions suivantes: (1) ces appareils ne doivent pas causer d'interférences nuisibles, et (2) ces appareils doivent accepter toute interférence reçue, y compris les interférences pouvant entraîner un fonctionnement indésirable.

- This Class B digital apparatus complies with Canadian ICES-003.

- Ces appareils numériqués de la classe B sont conformés à la norme NMB-003 du Canada.

- This product complies with FCC OET Bulletin 65 radiation exposure limits set forth for an uncontrolled environment.

- To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with instructions, may cause harmful interference to radio communications. There is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception (which can be determined by turning the equipment off and on), the user is encouraged to try and correct the interference via one or more of the following measures: (1) reorient or relocate the receiving antenna; (2) increase the separation between the equipment and the receiver; or (3) connect the equipment into an outlet on a separate circuit.

Pursuant to FCC 15.21 of the FCC rules, changes not expressly approved by Delsys Inc. could void the user's authority to operate the equipment.

These products comply with FCC & Industry Canada's RSS-102 radiation exposure limits set forth for an uncontrolled environment.

Ces produits sont conforme à la norme FCC et aux limites d'exposition au rayonnement RSS-102 d'Industrie Canada définies pour un environnement non contrôlé.

Windows PC Requirements

Windows 10/11
One USB 2.0 port or better
At least 3.0 GHz processor clock speed
At least 16 GB system memory
1680 x 1050 display resolution or better
At least 500 GB hard disk storage

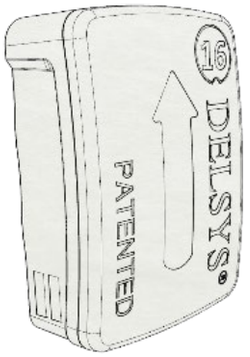
Trigno® System Overview

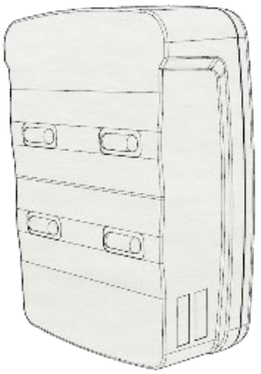
The Trigno® Wireless Biofeedback System is a device designed to make EMG (electromyographic) and biofeedback signal detection reliable and easy. The system transmits signals from Trigno® Avanti sensors to a receiving base station using a time-synchronized wireless protocol that removes data latency across sensors. The core architecture of the Trigno® System is designed to support high fidelity EMG signals, along with complementary biofeedback signals such as movement data, force signals, contact pressure events, and timing/synchronization information. For mobile biofeedback applications, Trigno® Avanti Sensors can also communicate with Bluetooth BLE 4.2 compliant host devices. The system is capable of integrating with 3rd party instruments through a variety of interfaces including analog signal acquisition, digital triggering, and software integrations through Trigno Discover® Software or the Trigno® API (Application Program Interface). Refer to the specific system component User Guides for operational details of these system elements.

Trigno® Avanti Sensor

Trigno® Avanti sensors are equipped with the following capabilities:

- Configurable precision EMG sensor
- Built-in 9-axis inertial measurement unit (IMU)
- Dual-mode “BLE-Base” communication
- Onboard EMG signal calculations
- Onboard orientation calculation
- Software selectable operational modes
- Inter-sensor latency < 1 sample period
- Wireless transmission range 20+ m*
- Self-contained rechargeable battery
- Battery charge monitoring and status indicator
- Environmentally sealed enclosure
- Low power mode
- Auto shutoff
- Internal magnetic switch
- LED User Feedback





* *Transmission distance is determined by conditions of the environment which may be affected by RF path loss and interfering RF sources.*

Per IEC60601-1, Trigno® Avanti sensors are considered ‘floating applied parts’.

Onboard EMG Sensor

Trigno® Avanti sensors support a low noise, high fidelity sensing circuit for detecting EMG (electromyographic) biofeedback signals from the surface of the skin when muscles contract. Sensor bandwidth is selectable between 10-850Hz and 20-450Hz and the input range of the sensor can be selected between 22mV or 11mV depending on user needs.

Inertial Measurement Unit

Trigno® Avanti Sensors have a built-in nine DOF inertial measurement unit which can relay acceleration, rotation, and earth magnetic field (compass) information. Users can leverage this information to discern movement activity time-synchronized with the EMG signals. One of four ranges can be selected for each sensor to span ±2 g to ±16 g for accelerometer outputs and ±250°/s to ±2000°/s for gyroscope outputs. The sensor is capable of estimating orientation in 3D space from the nine channels of information.

Dual Mode “BLE-Base” Communication

Trigno® Avanti sensors are capable of communication with a PC-connected Base station using the custom Trigno® wireless communication protocol, or with Android devices using the Bluetooth Low Energy (BLE) industry standard protocol. Note that the information bandwidth when operating over Bluetooth is limited by the Bluetooth protocol and the host device capabilities.

Wireless Communication Distance

The Trigno® wireless communication scheme offers robust data transmission for up to 16 sensors with a nominal distance of 20 meters. Under optimal environmental

conditions (no RF path obstructions or interfering sources), this nominal distance can be notably superseded.

Data Synchronization

Data from each sensor and from each channel within a sensor are time synchronized over the Trigno® wireless communication protocol such that no time skew between data exists. A maximum of 32 sensors can stream data to a host base station at one time. These features are available only when communicating with a PC-connected Base Station; the Bluetooth/BLE protocol does not guarantee latency.

Rechargeable Battery

Sensors contain a sealed rechargeable lithium polymer battery for multiple hours of continuous use. Battery life can be extended when making use of low power modes. Actual duration will depend on the usage condition, which is expected to vary between 4 and 8 hours of performance. Charge status is conveniently reported through the software.

Sealed Enclosure

The environmentally sealed enclosure protects electronics from the ingress of liquids and other environmental elements and provides a high standard of user safety and durability.

Internal Magnetic Switch

Trigno® Avanti sensors are equipped with an internal magnetic switch which is used to turn the sensors “on” and perform RF pairing operations. To activate the internal magnetic switch, the sensor must be placed on the magnet lock label located on the Base Station charging cradle. The internal magnetic switch will only react when

sensors are undocked from the charger or when the software performs an RF pairing operation. Outside of these two qualifying conditions, exposure to any magnetic fields will be ignored by the sensor. The internal magnetic switch is a feature that removes the need for a mechanical button and improves sensor durability and performance.

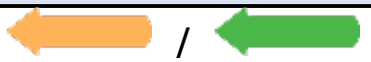
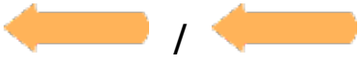
Sensor LED States

Trigno® Avanti sensors indicate their status through various LED arrow colors and blink patterns as indicated in the table below. Each of these states is described in subsequent sections of this User's Guide.

Common States

#	State	Color	Pattern	Arrow Display
1	Power Off	Off	None	
2	Power On/Activate	White/Green	Fade	
3	Charging	Orange	Solid	
4	Charge Complete	Green	Solid	
5	Identification Mode	White	Rapid flash	
6	Startup Scan	Orange/Cyan	Slow flash	
7	Power Up Error	Red	Slow flash	

Trigno® RF Mode

#	State	Color	Pattern	Arrow Display
8	Scan	Orange/Green	Slow flash	
9	Low Power Scan	Orange	Occasional flash	
10	Data Collection	Green	Slow flash	
11	Configuration Change	Green	Rapid flash (3x)	
12	Pairing	Orange	Solid	
13	Pairing Success	Green	Rapid flash (≥6x)	
14	Pairing Fail	Red	Double flash (≥3x)	

BLE Mode

#	State	Color	Pattern	Arrow Display
15	Advertise	Cyan	Slow flash	
16	Low Power Advertise	Cyan	Occasional flash	
17	Data Collection	Blue	Slow flash	
18	Idle	Magenta	Slow flash	

LED State Descriptions

1) **Power Off:** No LED arrow activity is present when the sensor is off.
2) **Power On/Activate:** When undocked, the sensor illuminates white for 6 seconds, during which time exposure to a magnetic field will turn the sensor on. Otherwise, the arrow fades to dark and the sensor turns off.
3) **Charging:** Sensor charging in the Trigno® Base Station is denoted by continuous orange LED arrow illumination.
4) **Charge Complete:** Once the sensor's internal battery has been fully charged, the LED arrow illuminates a continuous green.
5) **Identification Mode:** The arrow blinks white upon this software command so that it can be easily identified and located.
6) **Startup Scan:** Upon power-up, the sensor actively searches for a host to connect to, such as a PC Base Station or BLE tablet.
7) **Power Up Error:** Sensor fails self-check on power up.
8) **Scan:** Sensor was previously paired and is scanning for the active base station.
9) **Low Power Scan:** Sensor was previously paired and has been scanning for the active base station for more than 5 minutes.
10) **Data Collection:** Data from the sensor is streamed to a paired PC-connected base station.
11) **Configuration Change:** Sensor acknowledges a configuration change from the host base station.
12) **Pairing:** Sensor is performing a pair operation with the base host.
13) **Pairing Success:** Sensor successfully completes a pair operation with the Base Station host.

14) **Pairing Fail:** The pair operation did not complete successfully with the Base Station host.
15) **Advertise:** Sensor is broadcasting to connect with a BLE host.
16) **Low Power Advertise:** Sensor has been broadcasting to connect with a BLE host for more than 5 minutes.
17) **Data Collection:** Sensor is sampling and streaming data to a BLE host.
18) **Idle:** Sensor is waiting for a Bluetooth BLE command.

Trigno® Centro Base Station

The Trigno® Centro Base Station is a communicating unit for Trigno® Avanti sensors and is capable of securing a continuous synchronized data stream with up to 32 sensors. It can synchronously digitize up to six user-configurable analog signals as well as a microphone input. Four user-configurable digital I/O channels for event marking and device synchronization functions are available. Control of the Centro Base Station is managed by Trigno® Discover® software or the user-programmable Trigno® API over a USB port.

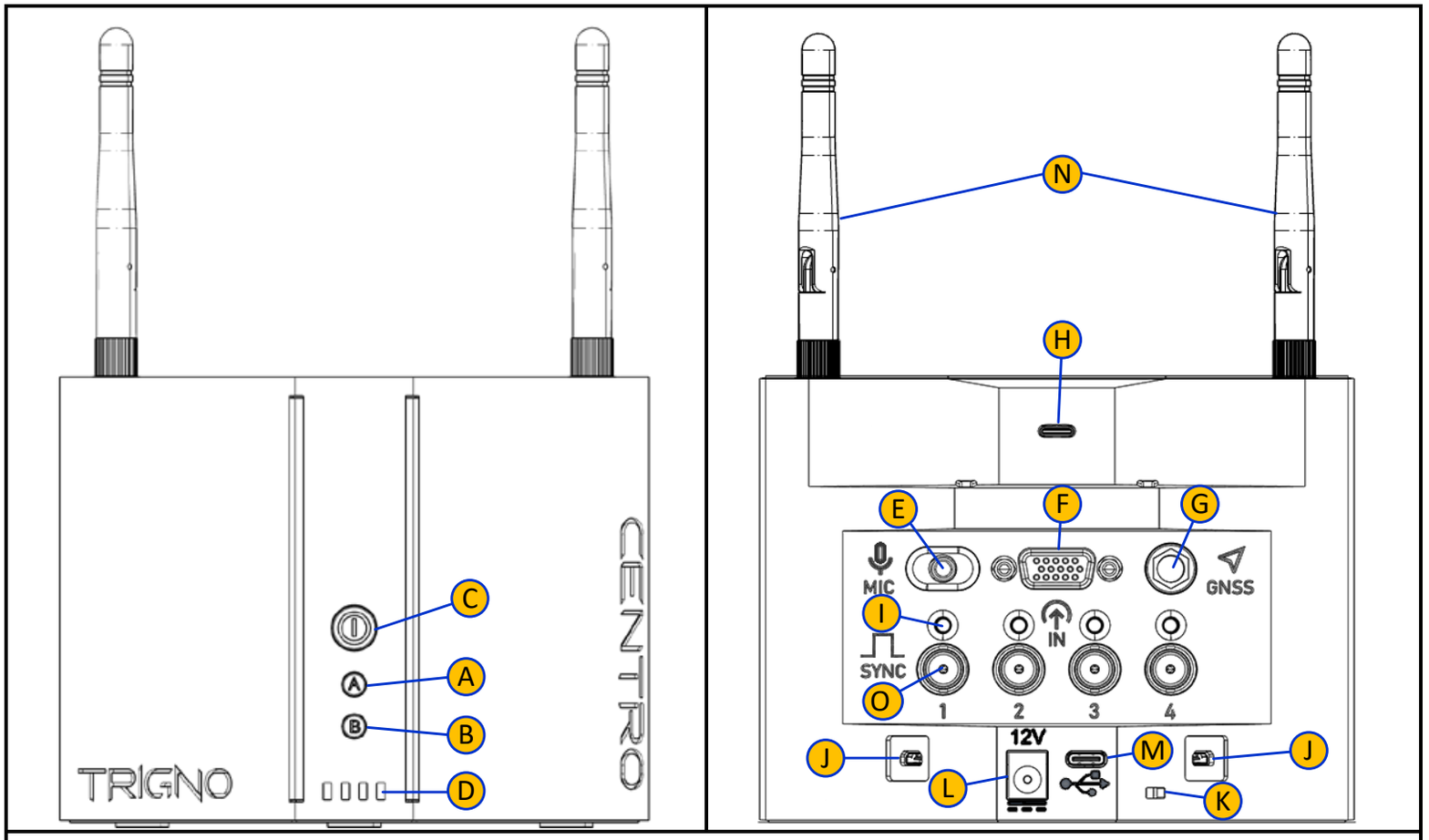


Figure 1: Front panel (left) and rear panel (right) of the Trigno® Centro unit.

Trigno® Centro Features

- Support for up to 32 Trigno® Avanti sensors
- (M) High speed USB communication with PC
- (N) Detachable antennas
- (L) Medical grade power supply (12VDC)
- (G) GNSS data timestamp capability (unused)
- (A) (B) Dedicated event marking buttons
- (H) (J) Expansion ports (unused)
- (K) Kensington® lock (NanoSaver™)

- Four configurable trigger channels
  - Data start/stop function
  - Event marker function
  - ±5V or ±3V logic or TTL
  - High impedance input or low impedance output function
  - Configurable rising or falling edge detection
  - (I) Pushbutton trigger bypass
  - (O) (D) BNC connectors with LED state feedback

- (F) Six user-configurable analog inputs
  - ±10V to ±100mV analog signal input ranges
  - 24-bit full scale analog signal resolution
  - 6-48 kSa/sec sampling, synchronized with sensors
  - (E) 3.5mm condensing mic input

32-Sensor Capability

The Trigno® Centro Base Station supports a high-speed wireless communication protocol that can support a maximum of 32 Trigno® Avanti sensors and maintain full time synchronization between them. The wireless communication operates in the 2.4 GHz band and creates frequency and spatial redundancy across the RF band and across the two antennas at the top of the unit.

Pushbutton Inputs (A) (B)

Two pushbuttons labelled “A” and “B” on the front panel of the Centro unit can be used to create data markers or trigger events during data streaming.

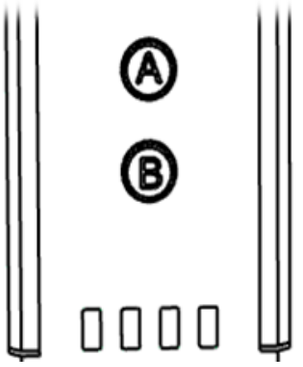


Figure 2: Pushbutton inputs.

Trigger Functions (D) (I) (O)

There are four BNC connectors on the back panel of the unit. These can be configured within the software to input trigger signals from other devices and start or stop sensor data streaming. Shunting the BNC or pressing the pushbutton will manually trigger the channel. Additionally, the channels can be configured as outputs so that Trigno® Centro can start or stop other devices. The trigger channels can be configured to operate with 3V logic, 5V logic, or TTL.

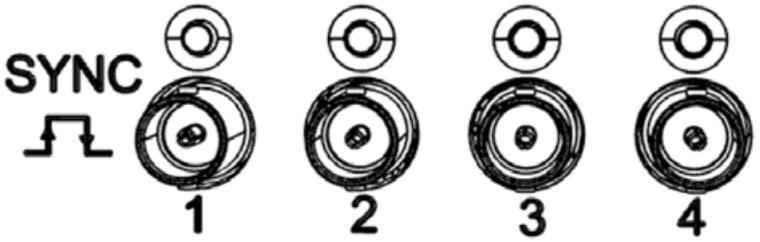


Figure 3: Configurable BNC trigger channels with pushbutton activators.

Options for a sync output pulse can be configured to create a continuous signal input for other devices. The clock pulse is synchronized to the wireless sensors' data frames, ranges between 500 µs and 1 second, and has a settable phase shift. Refer to the Trigger Configuration section for additional details on these features.

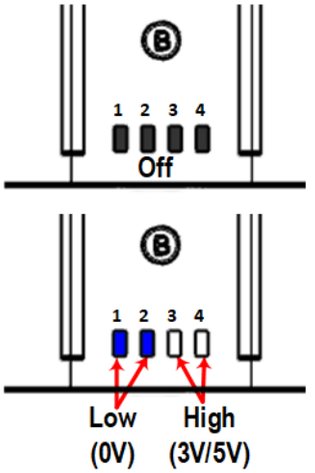


Figure 4: Trigger states.

Trigger Signal Feedback (D)

Four LEDs on the front panel relay the voltage states of the four BNC Trigger channels. A low state (0V) is shown as blue and a high state (3V or 5V) is shown as white. LEDs that are off indicate that no trigger function has been configured.

Microphone Input (E)

The back panel of the unit has a 3.5mm jack that can input a PC-style condenser microphone to sample voice and sound in a time-synchronized way with wireless sensor data. Operating the microphone input suspends operation of the 6 analog input channels available on the DSUB-15 connector. Microphone data are sampled at 48,000 samples/sec with 24 bits of resolution.

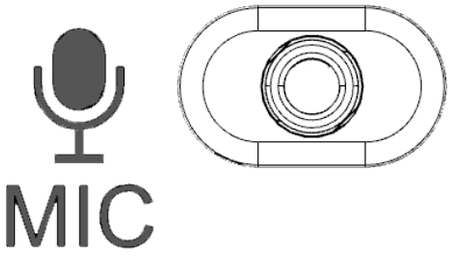


Figure 5: 3.5mm condensing microphone.

Analog Signal Inputs (F)

Ch.¤	Pin¤	¤	Ch.¤	Pin¤
+IN1¤	5¤	¤	-IN1¤	10¤
+IN2¤	15¤	¤	-IN2¤	14¤
+IN3¤	7¤	¤	-IN3¤	2¤
+IN4¤	1¤	¤	-IN4¤	6¤
+IN5¤	9¤	¤	-IN5¤	4¤
+IN6¤	8¤	¤	-IN6¤	3¤
Trigger¤	11¤	¤	GND¤	13¤
NOT·CONNECTED¤				12¤

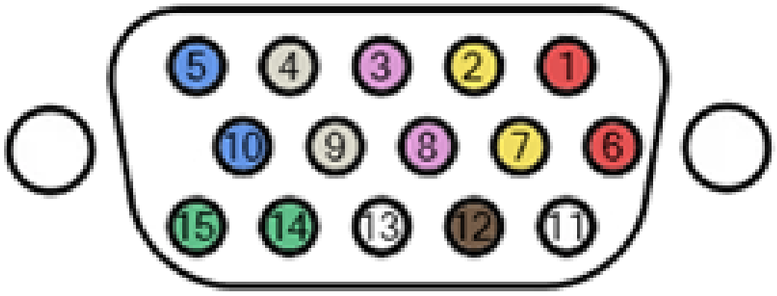


Figure 6: DSUB 15F Analog signal connections.

The Centro unit can sample analog signals at an aggregate rate of 48,000 samples per second, time synchronized with the wireless sensor data. This data rate can be directed to one channel or split between a maximum of 6. The Centro unit supports 4 input ranges, spanning ±10V to ±0.1V which can be selected to maximize the signal to noise ratio for a given input and can be configured as differential or single ended signals accessed via the DSUB-15 connector. A configurable trigger channel is included on the connector to facilitate multi-signal connections for a wide array of applications.

Power & USB Connection L A

The Centro unit is supplied with the universal SC-P09 medical grade 12-volt power supply which connects to the device with the 2.1mm barrel jack on the rear panel. In addition to the Centro base station, this power supply is also used for the Charge-4 and Charge-16 recharge units.

The Centro base station communicates with a PC over the USB-C connector located on the rear panel next to the power supply jack.

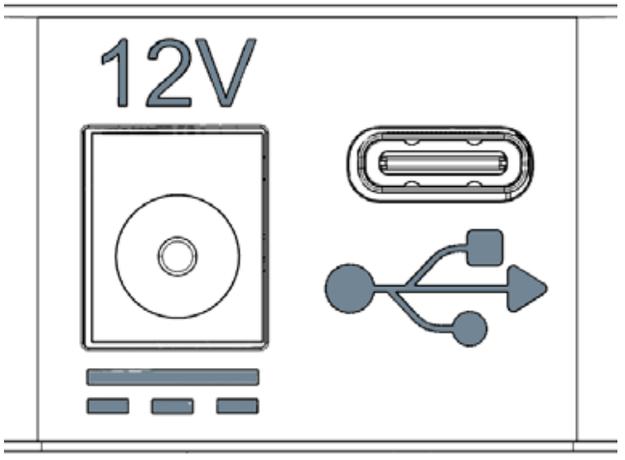


Figure 7: Power and USB-C jacks.

Power Button C

Tapping the power button will begin the Centro boot process which takes approximately 45 seconds. Holding the button down for 3 seconds or more will power the device off. Holding the button down for 12 seconds or more will initiate a forced reset of the device.

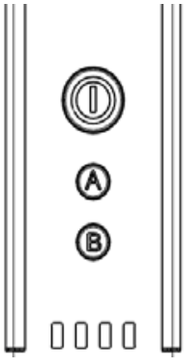
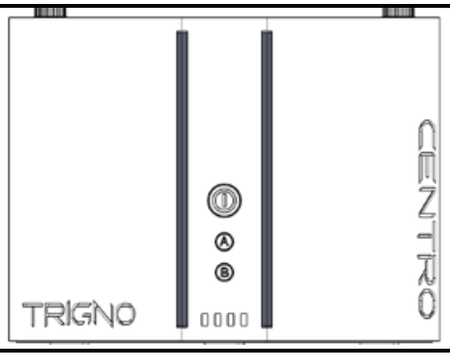
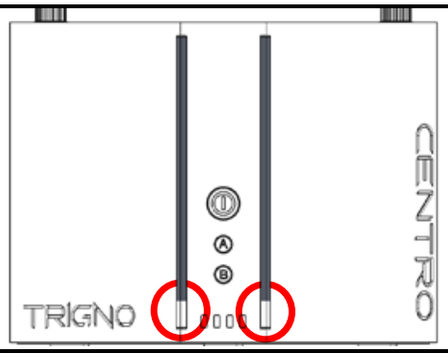


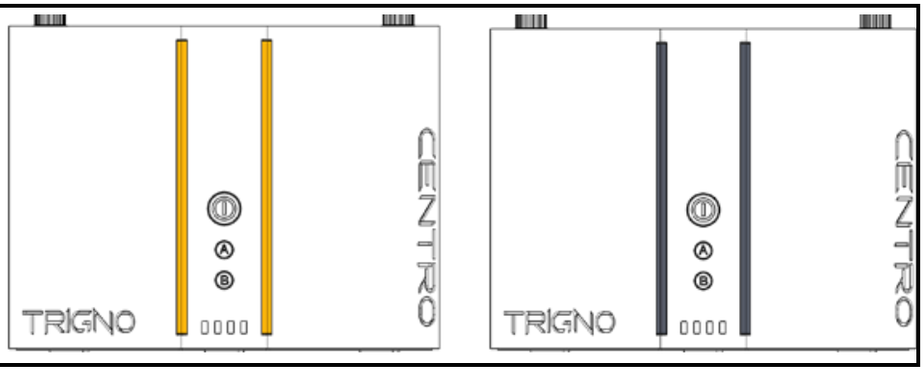
Figure 8: Power Button.

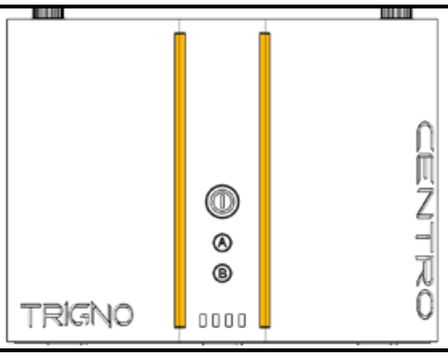
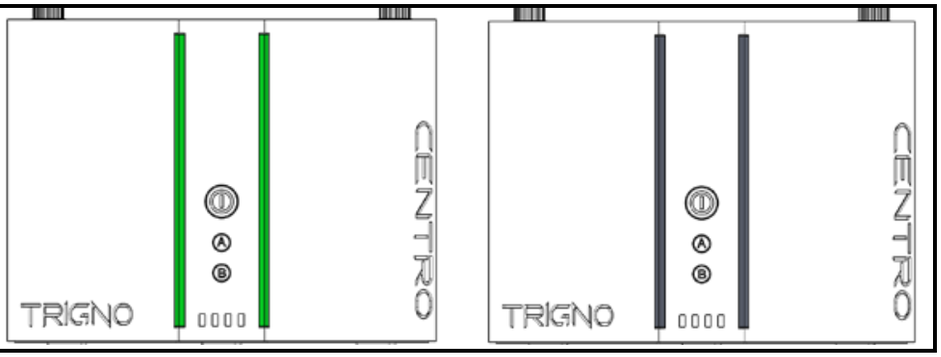
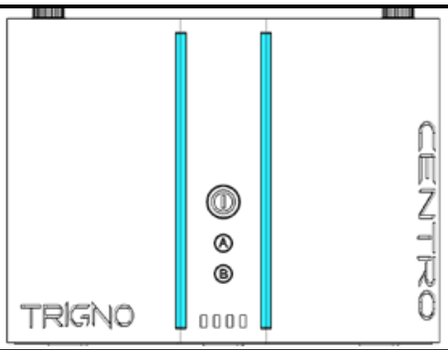
Trigno® Centro LED States

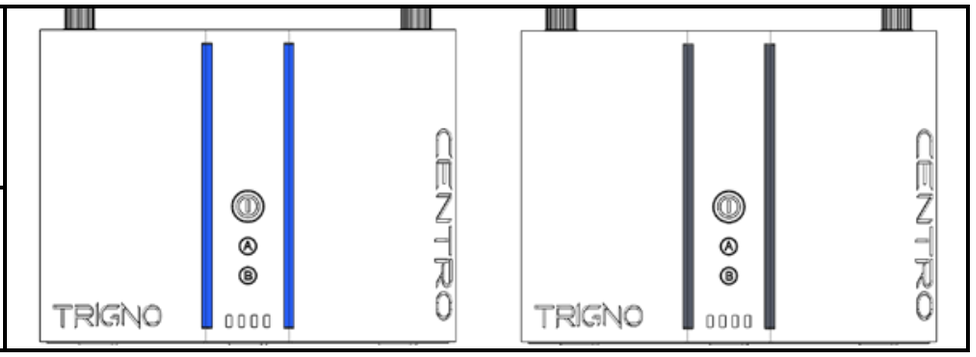
The Trigno® Centro's two long front panel LEDs indicate the device's operational modes, which are described below:

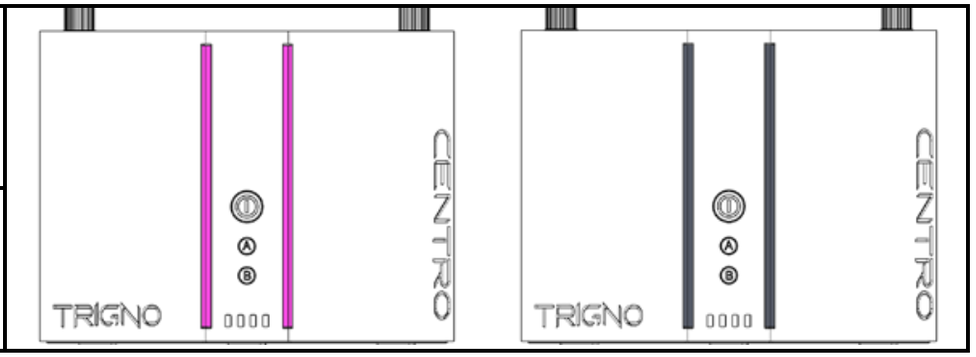
Mode: Off **Color:** Off **Pattern:** Off	
Power is unplugged from the device.	

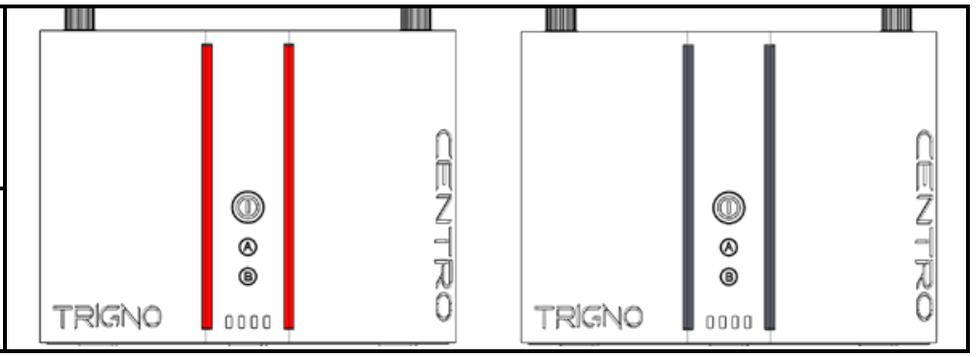
Mode: Standby Power **Color:** White **Pattern:** Solid (footer)	
Power is connected but the device is dormant.	

Mode: Booting **Color:** Orange **Pattern:** Flash (3x/sec) Flash (1x/sec)	
Device is initializing on power up.	

Mode: Idle **Color:** Orange **Pattern:** Solid Device is ready to start data streaming.	
Mode: Data Streaming **Color:** Green **Pattern:** Flash (1x/sec) Data from sensors are streaming to the device.	
Mode: Pairing **Color:** Cyan **Pattern:** Solid Device is actively pairing with a sensor.	

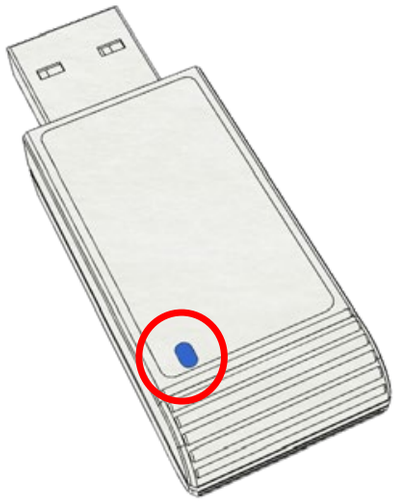
Mode:	File Transfer
Color:	Blue
Pattern:	Flash (2x/sec)
Files are transferring between PC and device over USB.	

Mode:	Firmware Update
Color:	Magenta
Pattern:	Flash (~2x/sec)
Firmware is updating on sensors or base station.	

Mode:	Internal Error
Color:	Red
Pattern:	Flash (~3x/sec)
Device experienced an internal communication error.	

Trigno® Lite USB Adapter

For cost-effective, portable, or space-constrained needs, the Trigno® Lite USB Adapter offers an alternative path to the Centro Base unit for wireless communication, allowing up to four sensors to communicate with a PC/laptop over a USB 2.0 compliant port. The Trigno® Lite adapter supports all the Avanti sensors available in the Centro unit.



State		LED Pattern
1	Standby	Solid
2	Connected	Flash (1x/sec)
3	Streaming	Flash (4x/sec)
4	Pairing	Flash (10x/sec)
5	FW Update	Breathing (1x/sec)

Figure 9: Trigno® Lite USB Adapter.

Charge-16 Station

A 16-sensor recharge station is available for the purpose of sensor recharging and turning sensors on during undocking. The device is powered by the SC-P09 medical grade power supply and has a build-in magnet for sensor turn-on. Sensors display orange when charging and green when fully charged. The green LED on the charger illuminates when it is ready for use.

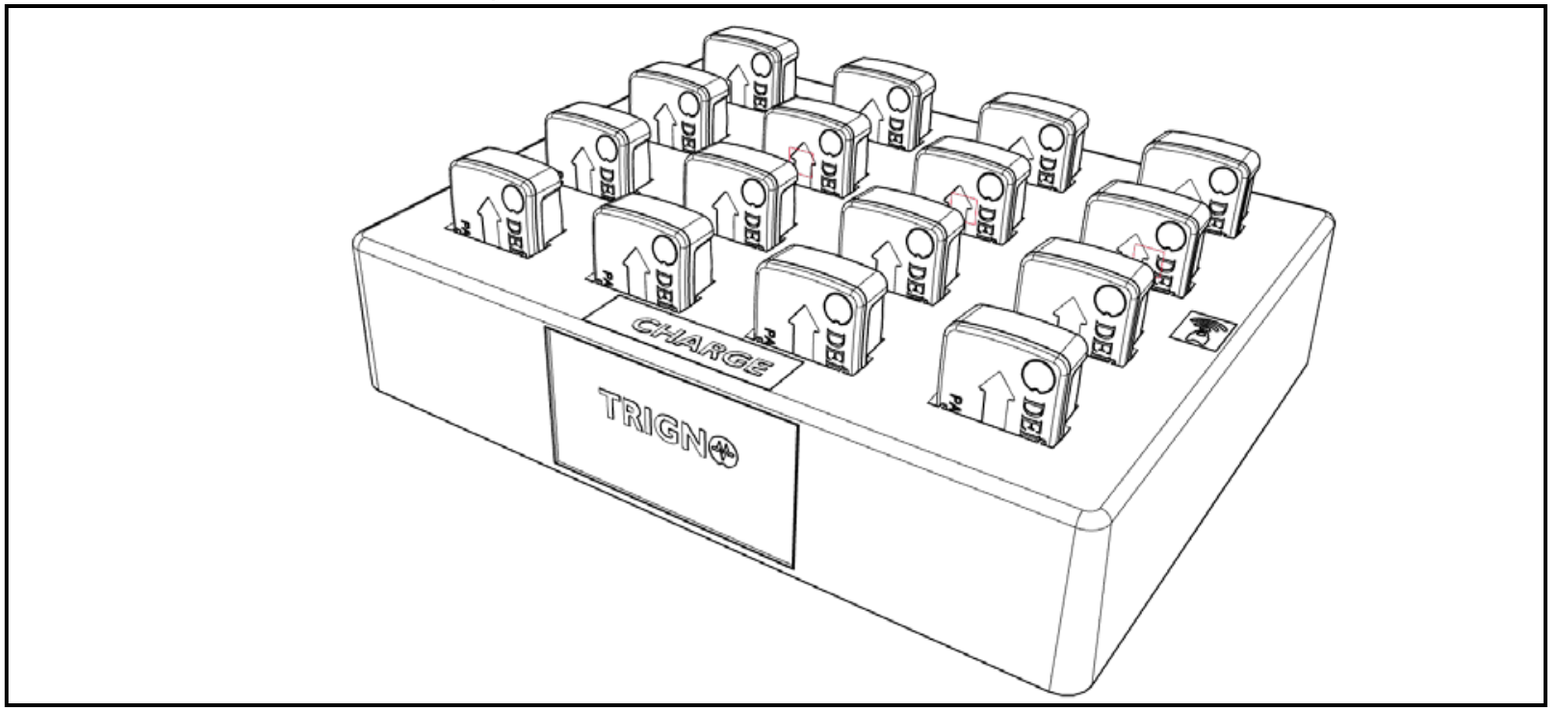


Figure 10: Trigno® System "Charge-16" Station for sensor recharging. No wireless or digital communication is available on the Charge-16 component of the system.

Charge-4 Station

A compact 4-sensor recharge station is available for the purpose of sensor recharging. Charge operation is identical to that of the Charge 16 unit using the same SC-P09 power supply. The green LED on the charger illuminates when it is ready for use.

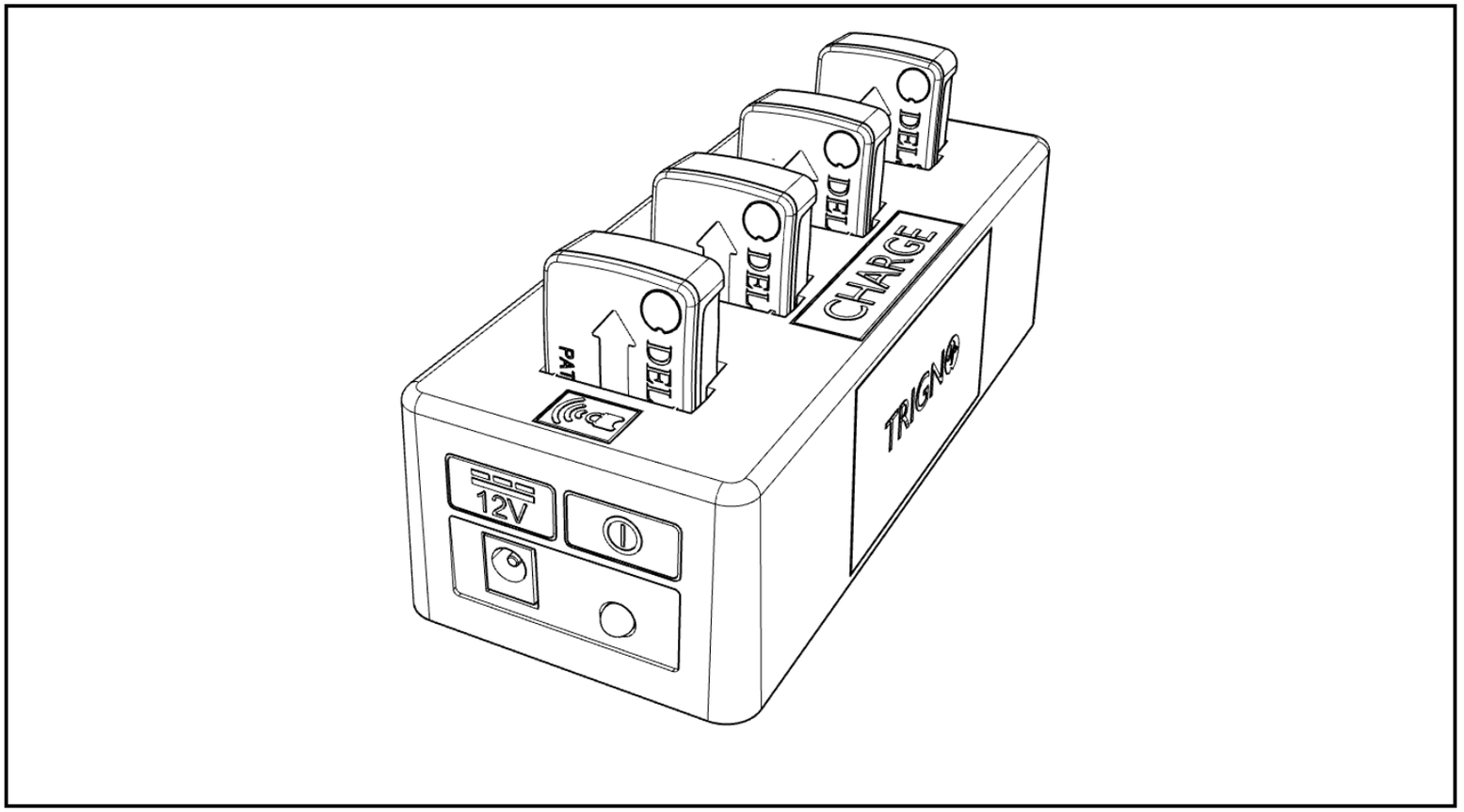


Figure 11: Trigno® System "Charge-4" Station for sensor recharging and sensor turn on by way of undocking.

Getting Started with the Trigno® System

Initializing the Centro Base Station

Trigno® Systems are equipped with a universal medical power supply and are provided with country-specific power cables. Connect the Trigno® SC-P09 power supply to the circular DC jack located on the back of the Centro Base Station. Energize the power supply by connecting it to a mains outlet or to an isolation transformer. The device will enter standby mode, indicated by the white LEDs at the bottom of the front panel.

Trigno® Systems are specifically designed and approved to function only with the SC-P09 Trigno® medical power supply provided. Power supply substitutions constitute a violation of the medical safety approvals and will void the warranty.

To fully power down the Centro Unit, the SC-P09 power supply must be disconnected from the Mains 120/240 VAC outlet.

Connect the USB cable to the jack on the back panel of the Centro Base Station and to the PC. Initiate the Centro boot process by pressing the power button on the front panel. The device LEDs will blink white during boot up and glow orange once completed. Initiate the Trigno Discover® software to connect and configure the unit. Refer to the Trigno Discover® User Guide for installation operational details.

Initializing the Trigno® Lite USB Adapter

The Trigno® Lite USB Adapter is an alternative component of the Trigno® System which can be used to communicate with Trigno® Sensors in place of the Trigno® Centro Base Station. The USB Adapter connects directly to the USB port of the PC and communicates with the Trigno® Sensors in the same way as the Centro Base Station, offering the same sensor configuration options. The Trigno® Lite USB adapter is limited to a maximum of 4 simultaneous sensor connections and does not offer the triggering or analog signal input functionality available on the Centro unit.

Charging the Sensors

All sensors are fitted with a sealed lithium polymer cell and are charged with the Trigno® Charge-4 unit or the Trigno® Charge-16 unit powered by the SC-P09 Trigno® medical grade power supply. A full charge will generally require three hours or less to complete, depending on the battery age, usage history, and particular charge conditions. The sensor arrow will glow orange during charging and illuminate green upon charge completion.

Sensor batteries will self-discharge with time and will degrade if left uncharged for extended periods of time. It is therefore recommended to charge the sensors at least once a month, or to actively store them in the powered charger when not in use.

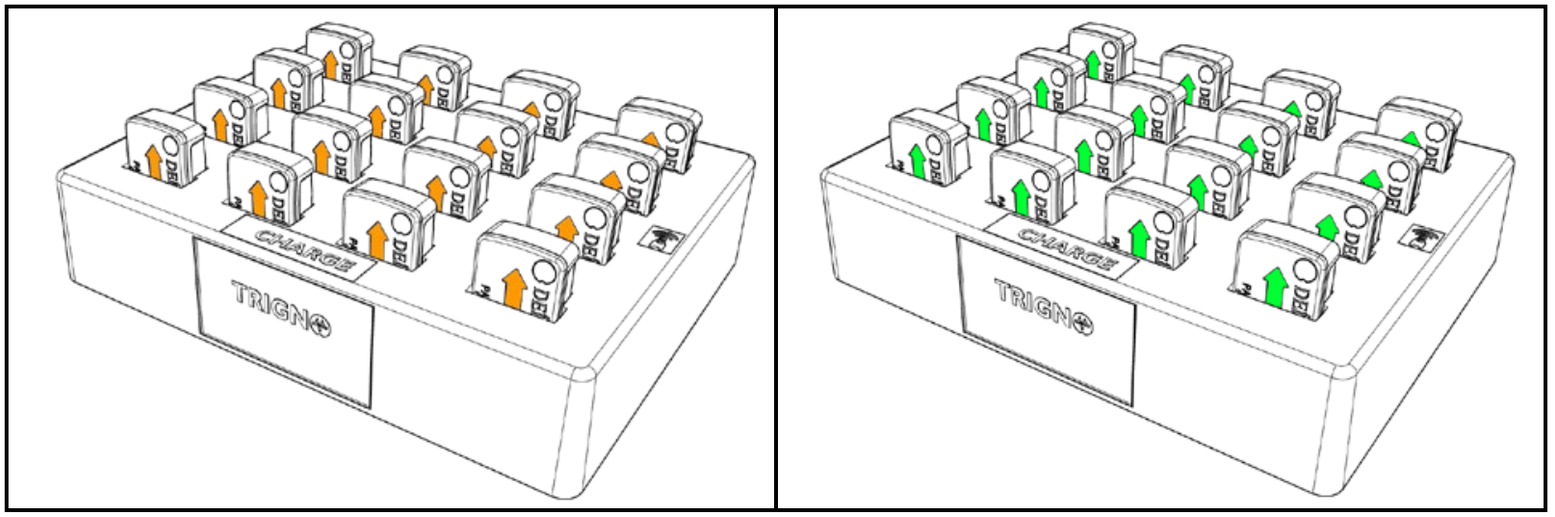


Figure 12: Docking a sensor in the charge cradle (left). When docked, sensors will turn off and begin battery charging indicated by an orange LED indicator. Once fully charged, the sensor LED indicator shows green (right).

Trigno® Systems are specifically designed and approved to function only with the SC-P09 Trigno® medical power supply provided. Power supply substitutions constitute a violation of the medical safety approvals and will void the warranty.

To fully power down the charger, the SC-P09 power supply must be disconnected from the Mains 120/240 VAC outlet.

Turning the Sensor ON

Trigno® Avanti sensors are automatically turned on when they are removed from a powered charging dock. The sensors must have been docked for a minimum of 3 seconds to initiate the power up sequence upon undocking. Once undocked, the arrow illuminates to white and the sensor must be exposed to the cradle magnet to complete the power up sequence. The arrow will fade to black within 6 seconds and the sensor will turn off if not tapped on the cradle magnet within this time. See below for a pictorial representation of the power-on sequence.

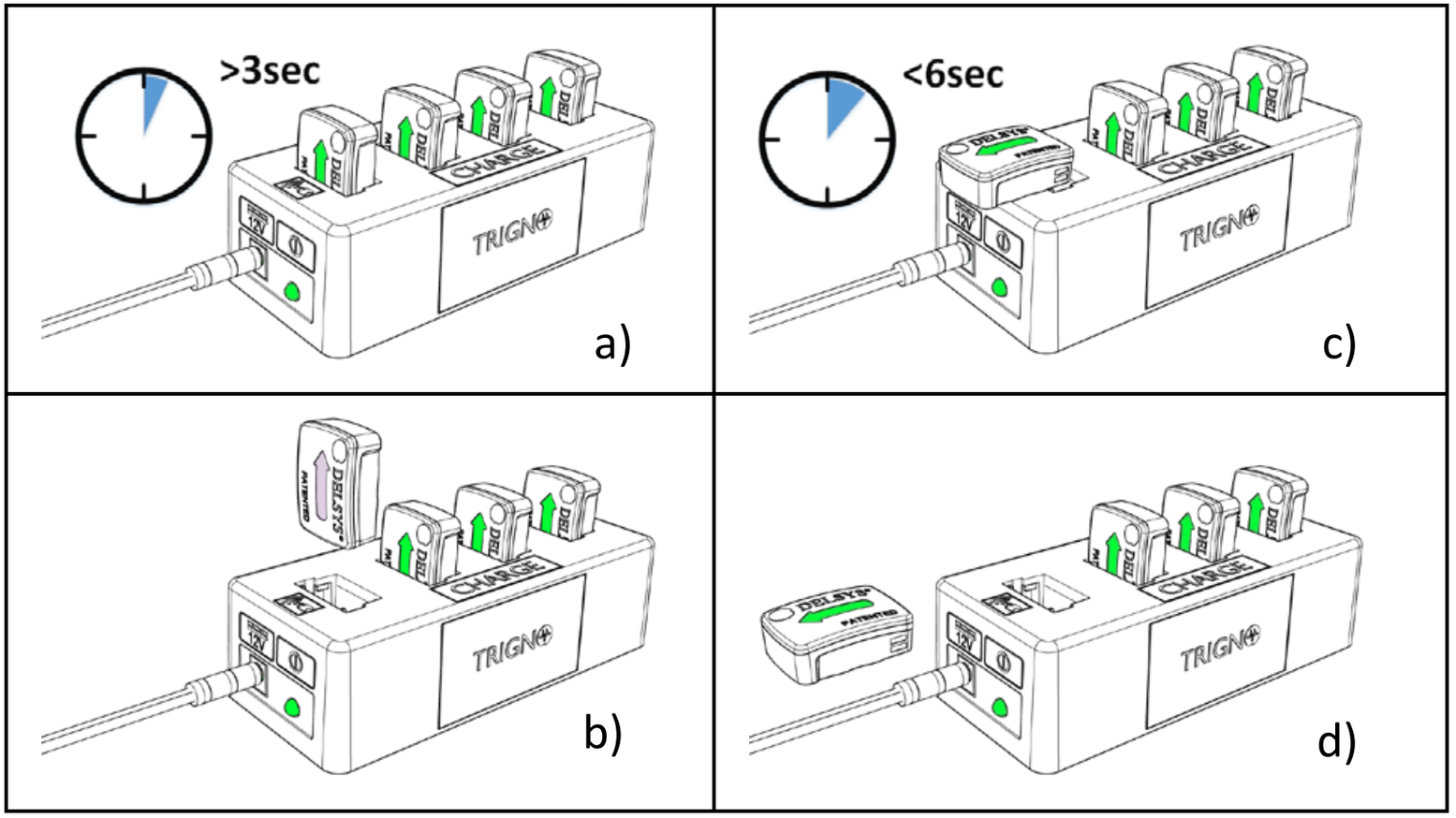


Figure 13: To turn sensors on: a) dock for 3 seconds or more, b) remove from cradle, c) tap sensor on magnet within 6 seconds to complete power-up (d).

Turning the Sensors OFF

There are three mechanisms that will turn the sensors off:

a) Dock Sensors in Charger: docking the sensors in the charge cradle will automatically turn the wireless communication system of the sensor off and engage the battery charging circuit.

b) Undock Sensors, No Magnet: Undocking the sensors to initiate the power up sequence and allowing the 6-second magnetic activation window to lapse will turn off the sensors. Unplugging the base station will turn off all docked sensors.

c) Software Issued Command: Sensors that are paired with the base station and communicating with the host software application can be turned off by way of an "off" command sent from the software application. Please refer to the software User's Guide for more information.

Battery Performance

Battery performance and longevity is subject to a myriad of factors, which include charge/discharge conditions, usage scenarios, number of cycles, environmental temperature factors, and cell manufacturing parameters which are subject to statistical variations. Typical industry expectations assume an 80% charge capacity derating after 2-years or 300 charge/discharge cycles. Sensors are equipped with battery charge monitoring and automatic sensor turn off when charge is depleted to reduce the occurrence of deep discharge which is damaging to the longevity of batteries. Batteries exhibit self-discharge behavior, so that extended periods of time without a charge will cause the battery to deeply discharge and accelerate degradation. To avoid this, it is recommended to charge the sensors at least once a month, or to actively store them in the powered charger when not in use.

Storing the sensors at temperatures outside the 0-45°C range will degrade and possibly damage the battery.

Startup Scan Mode

Once the sensors turn on and complete the activation process, the LED will alternate between orange and cyan, indicating that the sensor is looking for a connection to the host. The host can either be the Centro Base Station or Trigno® Lite USB adapter, or a Bluetooth enabled Android device. Once a connection to a host is made, the system will store this selection so that an immediate re-connection to this host is made on future power cycles as soon as the host is available. Refer to subsequent sections for information on how to pair a sensor to the Trigno® Centro Base Station, the Trigno® Lite USB Adapter or to an Android device.

Acquiring Data with the System

PC Software Installation

Trigno Discover® software for Microsoft Windows can be downloaded from the Delsys website (www.delsys.com). Acquiring data with a PC requires the Trigno® Centro Base Station or the Trigno® Lite USB Adapter to be connected via the USB port. The Trigno® System uses a custom RF protocol to guarantee high data bandwidth across a maximum of 32 sensors with no inter-sensor latency. Refer to the Trigno Discover® Software User Guide and related help information for a detailed explanation of software functions. Data collection and sensor configuration is initiated through the software.

Pairing the Sensors

Sensors require pairing with the Centro Base Station or Trigno® Lite USB Adapter in order to be configured and to stream data to the PC. The pairing process associates the unique ID of the sensor to the unique ID of the base station receiver to establish a wireless data link. Pairing information is retained after the base station receiver and sensors are powered off. Pairing is initiated through the software pairing command and completed by activating the internal magnetic switch in the sensor. The magnetic switch in the sensor is activated by placing the sensor over the built-in magnet of the charger indicated by the lock

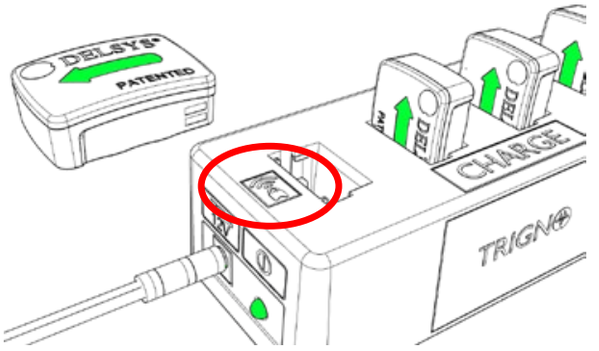


Figure 14: Paring a sensor with the magnet.

symbol. Note that common household magnets can also be used for pairing operations.

Configuring the Trigno® Sensors

Once paired to the system, EMG data and IMU data from the sensor can be configured through software in the following ways:

Electromyographic (EMG) Sensing Ranges	
Input Range[1]	11 mV, 22 mV
Bandwidth[1]	20-450 Hz, 10-850 Hz
RMS Window (optional)[4]	100 ms
Inertial Measurement Unit (IMU) Ranges	
Accelerometer[2]	±2 g, ±4 g, ±8 g, ±16 g
Accelerometer Bandwidth[2]	24-470 Hz
Gyroscope[2]	±250 dps, ±500 dps, ±1000 dps, ±2000 dps
Gyroscope Bandwidth[2]	24 Hz – 360 Hz
Orientation Bandwidth[3]	10 Hz

[1]EMG range, bandwidth selection and sampling rate are configured by the software. Please refer to the specifications section for additional details.
[2]Accelerometer and gyroscope range, bandwidth and sampling rate are configured by the software. Please refer to specifications section for additional details
[3]Note that the orientation is calculated on-board with a data fusion algorithm.
[4]An onboard RMS calculation can be invoked to reduce data transmission rates and maximize bandwidth resources.

Inertial Measurement Unit (IMU)

Trigno® Sensors are fitted with an internal Inertial Measurement Unit (IMU) that outputs three degree-of-freedom (DOF) acceleration data as well as three DOF rotational data. Orientation of the axes is denoted in the figure below. Data can be used to provide movement biofeedback of the sensor in physical space. Additionally, an onboard magnetometer provides compass heading information to the IMU. When engaged in orientation mode, the magnetometer data are fused with the accelerometer and gyroscope data to estimate the orientation of the sensor in space. This output is expressed as Euler angles or Quaternions.

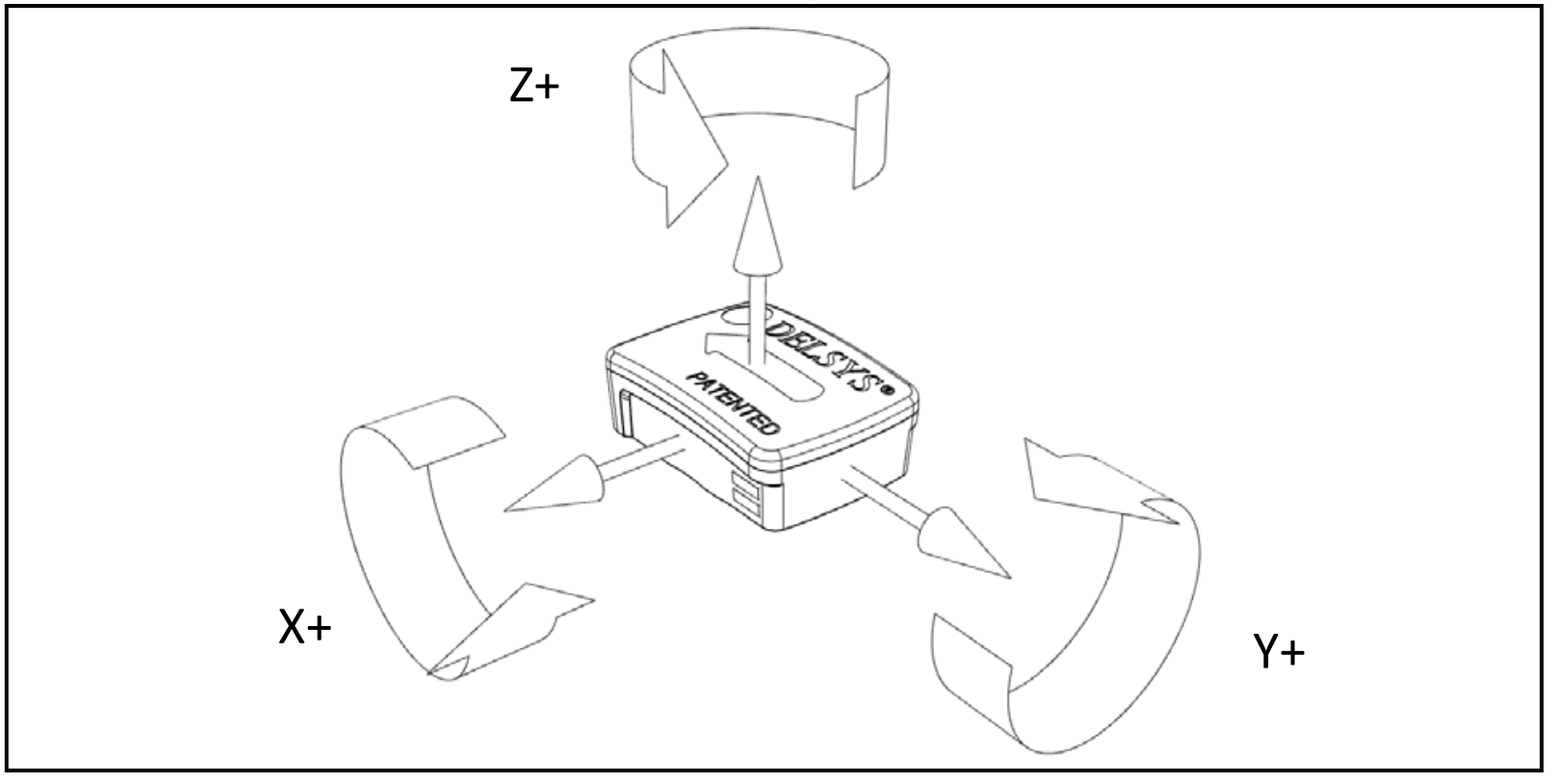


Figure 15: Trigno® Sensors are fitted with an internal Inertial Measurement Unit (IMU) that will output 3 DOF acceleration data as well as 3 DOF rotational data as oriented in the figure. An onboard magnetometer measures compass heading and is used to calculate orientation along with the accelerometer and gyroscope data.

Sensor Data Throughput

The Trigno® RF protocol is designed to support an aggregate data network of 1.1Mbits/sec. This bandwidth can be shared across 32 Avanti sensors, allocating 35.5kbits/sec to each sensor. Alternate bandwidth distribution scenarios are possible; for example, allocating the maximum data rate of 142kbits/sec to all sensors would support up to 8 sensors at these rates.

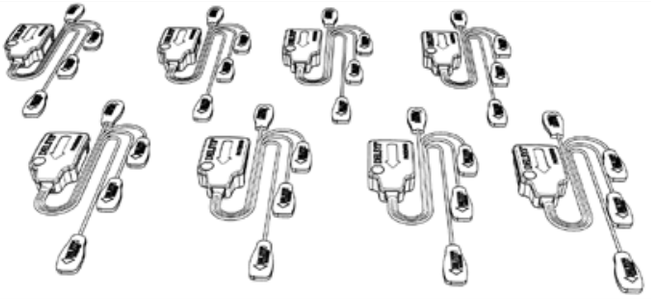
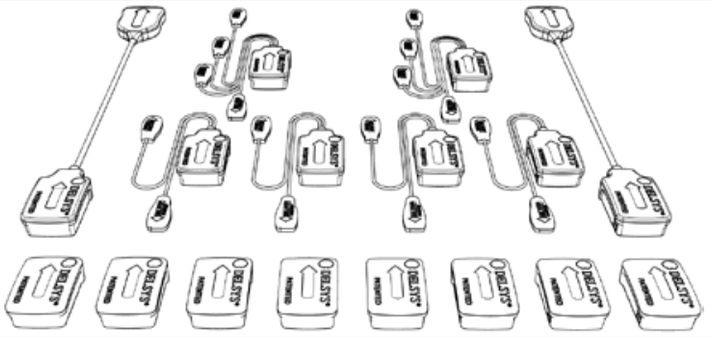
	Maximum Sensor Count Number of Sensors: 32 Sensor Data Rate: 35.5 kbits/sec Inter Sensor Latency: 0ms
	Maximum Sensor Data Rate Number of Sensors: 8 Sensor Data Rate: 142 kbits/sec Inter Sensor Latency: 0ms
	Combination (example) Number of Sensors: 16 Sensor Data Rate: 35.5 - 142 kbits/sec Inter Sensor Latency: 0ms

Figure 16: Sensor Network Configuration options: the Trigno® system can support a variety of time synchronized sensor arrangements and sampling rates ranging from 35.5 kbits/sec to 142 kbits/sec per sensor, corresponding to sampling rates as low as 74 sa/sec up to 8000 sa/sec.

Data bandwidth is determined by the various sensor options. The system is designed to be highly adaptable so that it can be optimized for many different specific needs.

Sensor data rates are automatically determined by the system based on the options set for each paired sensor. Depending on the sensor type, users can configure individual channels within a sensor which may include channel sampling rate, channel bandwidth, channel sensitivity and range, in addition to usage of the onboard IMU and similar choices for the 3 accelerometer axis, the 3 gyroscope axis or the orientation mode. The maximum number of supported sensors for a given setup will be determined by the configuration options of each sensor and the proportion of allocated system bandwidth to support the requested configuration.

Note that the Trigno® Lite USB Adapter is limited to a maximum of 4 wireless sensor connections.

Configuring Wireless Communication

Transmission Frequencies

Wireless communication occurs on varieties of frequencies throughout the acceptable 2.4 GHz spectrum. Four frequency sets are available (“A”, “B”, “C”, and “D”) so that accommodations for RF crowding or RF noises can be made in a given environment.

Frequency Set A: Creates an allowance from 2416-2451 MHz for standard 802.11 (WiFi) channels 5, 6, & 7.

Frequency Set B: Creates an allowance from 2421 – 2441, 2443-2483 MHz for standard 802.11(WiFi) channels 5, 9, 10, 11, 12, 13, & 14.

Frequency Set C: Creates an allowance from 2400-2446 MHz for standard 802.11 (WiFi) channels 1, 2, 3, 4, & 5.

Frequency Set D: Creates an allowance from 2409-2461 MHz for standard 802.11 (WiFi) channels 3, 4, 5, 6, 7, & 8.

Changing the communication frequency of the system requires all sensors to be re-paired to the base station for proper operation. The factory default setting is set to frequency set A.

Bluetooth Operation

Trigno® Avanti Sensors can communicate using the Bluetooth Low Energy (BLE) communication protocol as an alternative to the PC-connected Base Station or Lite adapter. This feature is only available for OEM applications and requires a software app that can directly manage a BLE connection. Upon power up, the sensors will scan for BLE devices. Sensors are paired on a “first come, first serve” basis. Since previously paired sensors will attempt to connect to their prior hosts, be sure to turn off all Centro Base Stations and Trigno® Lite USB Adapters in the environment in order to avoid conflict with previously connected hosts. Note that sensors can only communicate with one host at a time. BLE performance will depend on individual sensor configurations and the host capabilities. OEM developers are responsible for testing the performance of specific configurations and for complying with all regulatory requirements pertinent to their intended application.

Configuring Sync Triggers on the Centro Base Unit

Trigger Inputs

An input trigger signal from a 3rd party device can be connected to any one of the industry-standard BNC connectors on the rear panel of the Trigno® Centro unit. Using the Trigno Discover® Software, the selected BNC connector can be configured to support 3.3V logic or 5.0V logic and once armed can be configured to act on a signal's rising edge or falling edge.

Start Trigger Input

A BNC configured as a start signal input will commence data acquisition and storage at the instance the signal edge is detected. Only one BNC can be configured as a start input at any time.

Figure 17: Start Trigger Input data sample timing for rising or falling signal edges.

Stop Trigger Input

A BNC configured as a stop signal input will immediately stop data acquisition at the instance the signal edge is detected. Only one BNC can be configured as a stop input at any time.

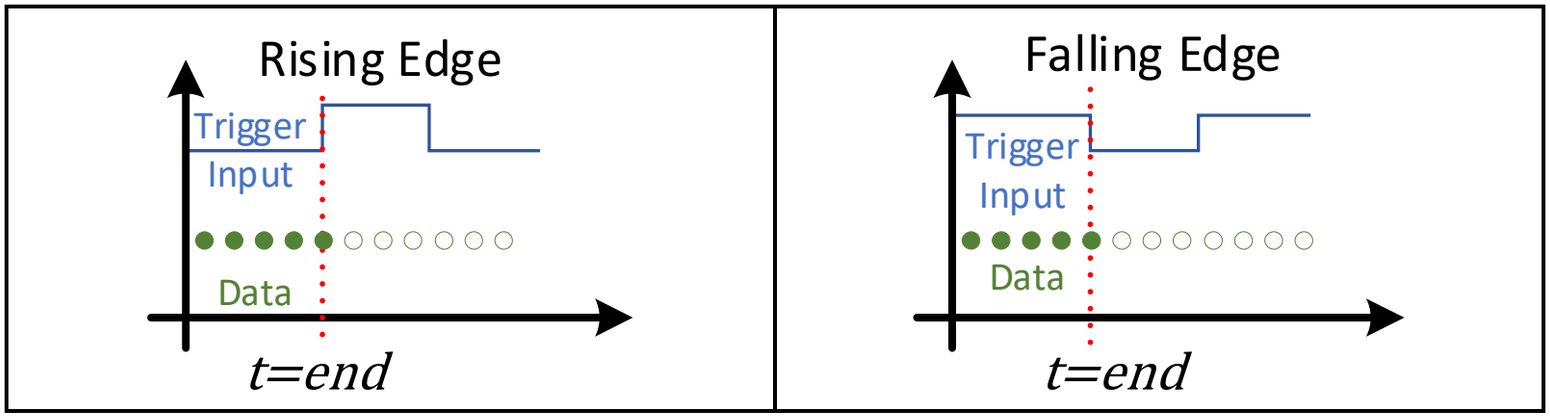


Figure 18: Stop Trigger Input data sample timing for rising or falling signal edges.

Single Input Start/Stop Trigger

A single BNC can be configured as a combined start and stop trigger input. In this configuration the first pulse received initiates data collection and the second received pulse stops data collection. As with other trigger configurations, options for voltage levels and edge definition of rising or falling apply. Once a trigger BNC input is configured in this way no other input BNCs can be configured. Consecutive triggers must be separated by at least 2 seconds.

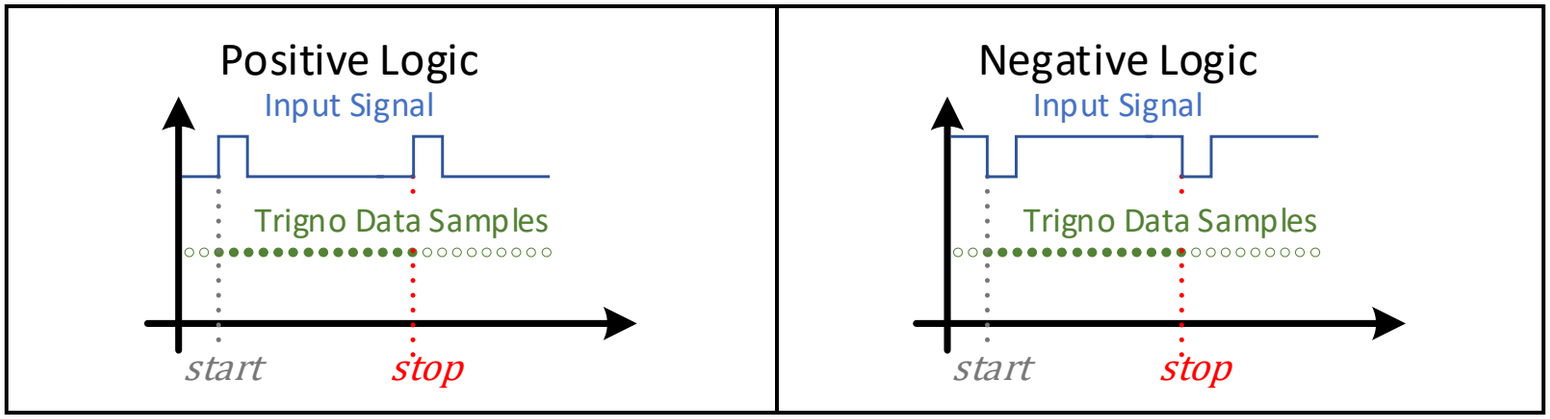


Figure 19: Single input start/stop trigger.

Windowed Trigger

A BNC can be configured to control data acquisition from a windowed signal, with the leading edge starting data acquisition and the trailing edge stopping acquisition. The window width of the signal determines the duration of the data collection. As with other trigger options, 3.3V/5.0V voltage levels and positive/negative configurations are available. Once a windowed trigger input is defined, no other trigger pathways can be configured as inputs.

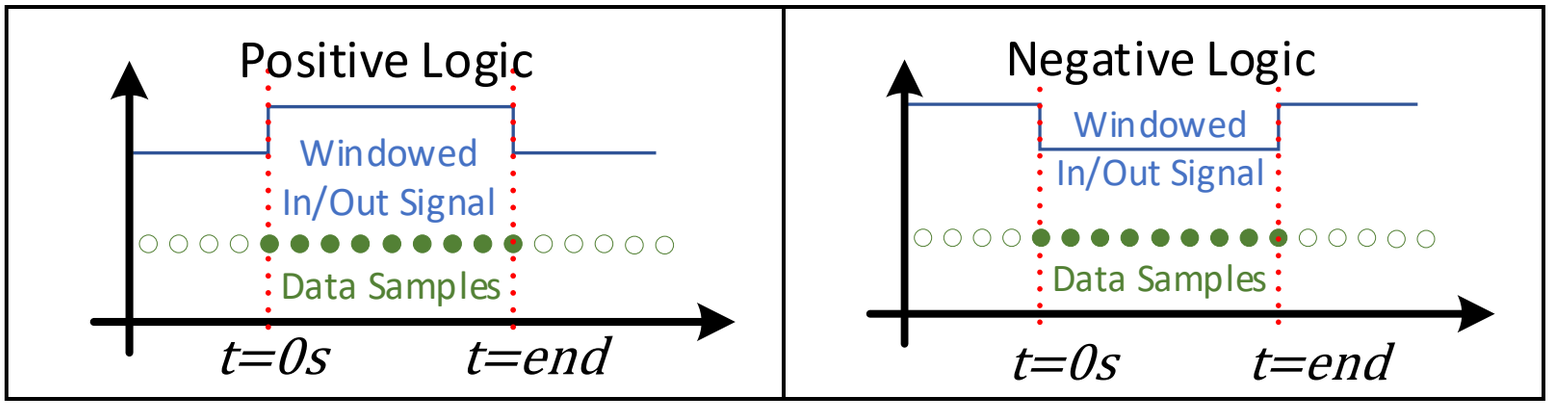


Figure 20: Windowed Trigger Input defining data acquisition duration by window width.

Trigger Input Manual Override

For any Trigger BNC configured as an input, a signal can be generated manually by pushing the tactile button switch associated with the corresponding BNC on the back panel. Depressing the button generates a rising edge signal and releasing the button generates a falling edge signal. This can be easily used to test trigger input configurations and manually trigger the system as an alternative to an electrical signal pulse.

Trigger Outputs

An output trigger signal for 3rd party devices can be connected to any one of the BNC connectors on the rear panel of the Trigno® Centro unit. Using the Trigno® Discover Software, the selected BNC connector can be configured to support 3.3V logic or 5.0V logic and once armed can be configured to generate a rising edge or a falling edge signal at the moment of data acquisition start or data acquisition stop.

Start Trigger Output

A BNC configured as a start signal output will generate a signal edge at the moment the first data sample is captured. Only one BNC can be configured as a start output at any time. The Start Output pulse duration is 10ms.

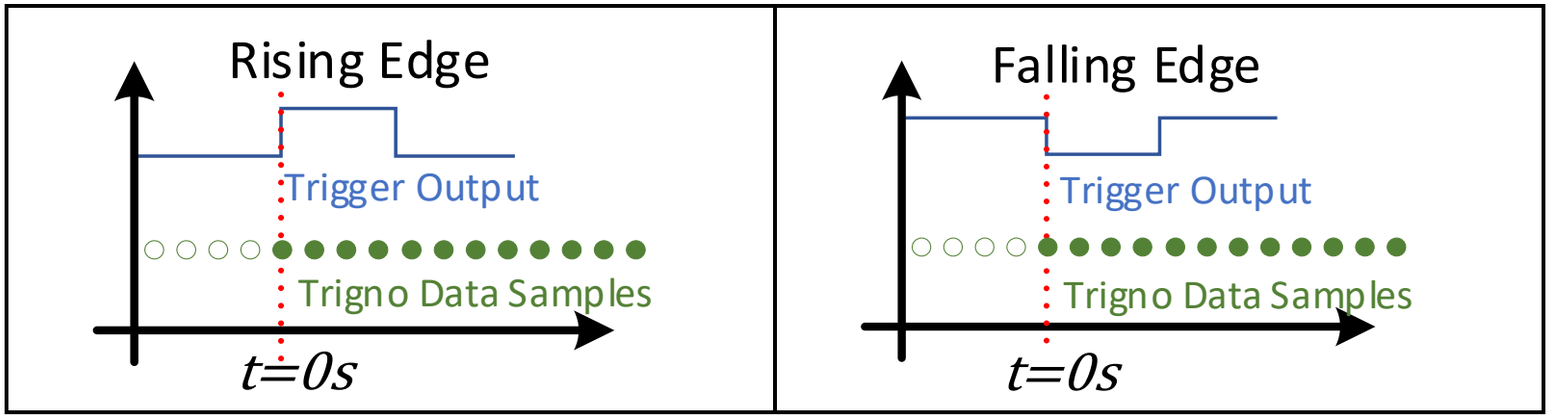


Figure 21: Start Trigger output signal timing for rising or falling signal edges.

Stop Trigger Output

A BNC configured as a stop signal output will generate a signal edge at the same time the last data sample is acquired. Only one BNC can be configured as a stop output at any time. The Stop Output pulse duration is 100us when triggered by a software event and 10ms when triggered by a stop input signal.

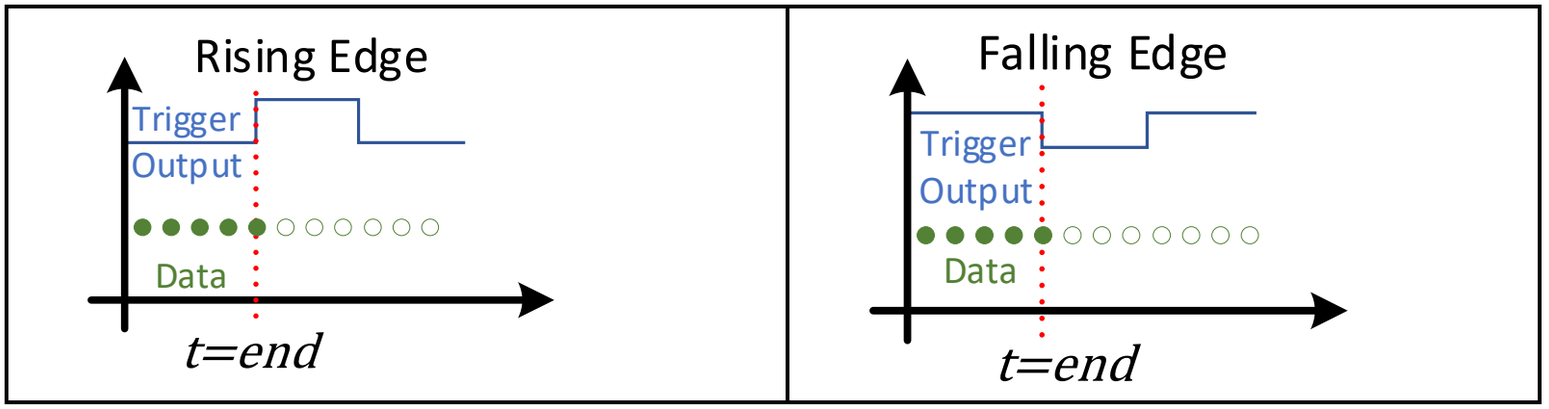


Figure 22: Stop Trigger output signal timing for rising or falling signal edges.

Configuring Analog Inputs on the Centro Base Unit

The Trigno® Centro unit supports up to 6 analog inputs which are sampled in synchrony with Trigno® Sensor data. The aggregate analog input sampling rate is 48,000 samples/sec with a max resolution depth of 24 bits. The aggregate data rate is divided amongst the configured channels according to the table below. Note that the signal sampling system introduces a fixed filter delay depending on the selected sampling rate.

Configured Channels	Sampling Rate per channel	Filter Delay
1	48,000 sa/sec	0.708 ms
1,2	24,000 sa/sec	1.417 ms
1,2,3,4	12,000 sa/sec	2.833 ms
1,2,3,4,5,6	6,000 sa/sec	5.667 ms

Table 1: Sampling rates and filter delays as a function of number of input channels enabled.

The voltage input range of each channel can be tuned to maximize bit resolution and SNR based on the expected signal amplitude range.

		Sampling Rate			
		48 kSa/sec	**24 kSa/sec**	**12 kSa/sec**	**6 kSa/sec**
Dynamic Range	**± 10 V**	288uV	213uV	151uV	107uV
	± 5 V	144uV	107uV	76uV	54uV
	± 1 V	19uV	14uV	10uV	7uV
	± 0.1 V	6uV	4uV	3uV	2uV

Table 2: Analog channel input range and typical noise floor (RMS) vs sampling rate.

Differential and Single Ended Analog Input Configurations

The data acquisition channels are sampled differentially, so each channel has an inverting (negative) input and a non-inverting (positive) input. Single-ended connections are typical and require all the inverting inputs to be connected to ground. Shielding is recommended and should be connected to the ground pin of the analog input connector. For differential signal configurations, individual shielding of each channel pair is recommended.

Differential Setup

Pin	CH+	CH-	Pin
5	+IN1	-IN1	10
15	+IN2	-IN2	14
7	+IN3	-IN3	2
1	+IN4	-IN4	6
9	+IN5	-IN5	4
8	+IN6	-IN6	3
11	TRIG	GND	13

Single Ended Setup

Pin	CH+	CH-	Pin
5	+IN1	GND	10
15	+IN2	GND	14
7	+IN3	GND	2
1	+IN4	GND	6
9	+IN5	GND	4
8	+IN6	GND	3
11	TRIG	GND	13

Table 3: Differential analog input connections (left side); Single ended analog input connections (right side). Note pin 12 is not connected (NC).

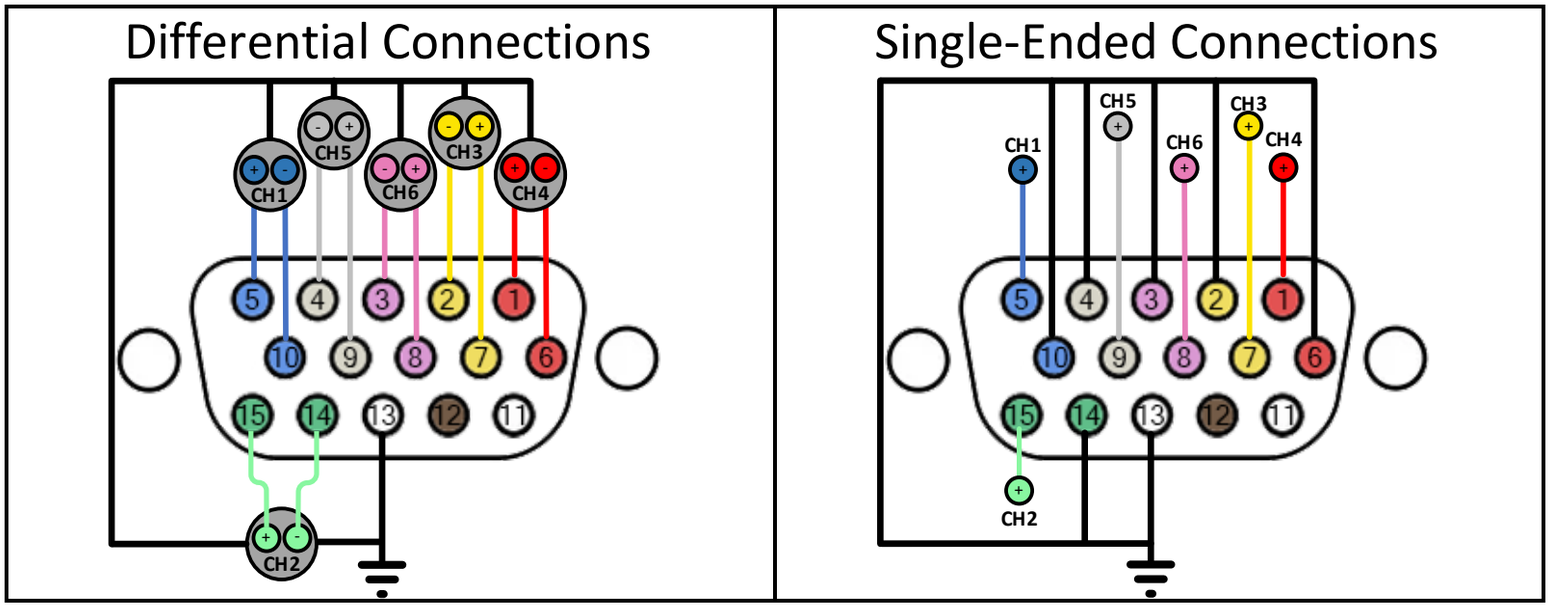


Figure 23: Connecting the Analog Inputs in a differential configuration (left) and single ended configuration (right).

Analog Input Connector Trigger

For increased accessibility, a trigger signal connection is available on pin 11 of the DSUB-15 connector supporting the analog input signals. Configuration of the trigger channel matches configuration options of the BNC trigger channels.

Using the Wireless EMG Sensors

Orienting the EMG Sensors on the Skin

Trigno® EMG Sensors employ four silver bar contacts for detecting EMG signals at the skin surface. For maximum signal amplitude, it is important to orient these bars perpendicular to the muscle fiber direction. The top of the sensor is shaped with an arrow to aid in the determination of this orientation. Place the arrow parallel to the muscle fibers underneath the sensor. Place the sensor over the center of the muscle to maximize signal capture. Avoid placement near tendinous insertions and muscle boundaries. The sensor is easily attached to the skin using the Delsys Adhesive Sensor Interface.

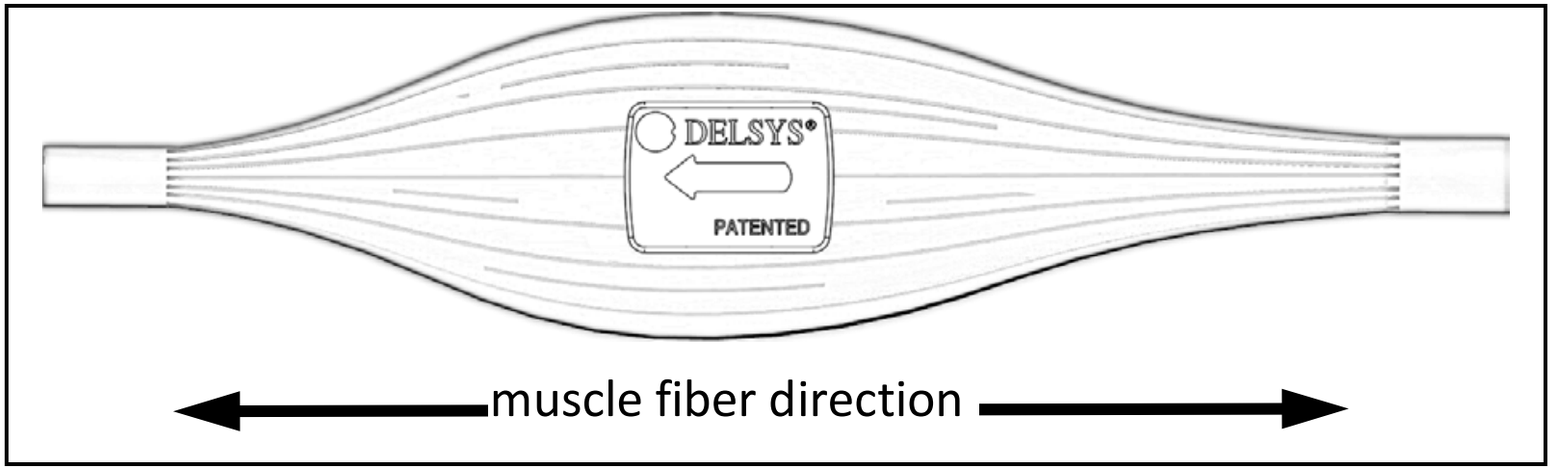


Figure 24: EMG Sensors must be properly oriented with the muscle fibers. Align the sensor's arrow with the direction of the underlying muscle fibers.

Cleaning the Sensor Site

Prior to affixing the EMG sensor on the surface of the skin, the sensor site must be properly cleaned to remove loose, dry dermis and skin oils. Wiping the skin prior to sensor application helps ensure a high-quality signal. If excessive hair is present, it will also be necessary to shave the site. In cases where the skin is excessively dry, it may be useful to dislodge dry skin cells by dabbing the site with medical tape. The dry cells will attach to the tape's adhesive when it is removed. Be sure to wipe with isopropyl alcohol to remove any adhesive residue that may remain.

Applying the Trigno® Adhesive Skin Interfaces

Trigno® Systems are supplied with specially designed adhesive interfaces to simplify sensor attachment. These interfaces are manufactured from medical grade adhesive approved for dermatological applications. Usage of the interface promotes a high-quality, stable connection between the sensor bars and the skin, minimizing motion artifacts and the ill-effects of line interference. To ensure a strong bond with the skin, it is advised to remove excessive hair and wipe the skin area and the EMG Sensor with isopropyl alcohol to remove oils and surface residues. Allow the skin to completely dry before applying the interfaces.

1) Wipe the silver bars and sensor surface with isopropyl alcohol and allow to dry.
2) Remove an adhesive interface from the paper carrier and apply it to the sensor, taking care to align the silver bars through the openings of the interface. Sensors can be prepared in this way prior to usage.

3) After the skin site has been prepared, remove the liner from the adhesive interface already affixed to the sensor to expose the second adhesive surface of the interface.
4) Affix the sensor to the desired location.
5) Once sensor usage is completed, remove the sensor from the skin by gently pulling the tab of the adhesive interface.
6) Remove and discard the adhesive interface from the sensor and clean the sensor using an isopropyl alcohol wipe.

Adhesive Sensor Interfaces are for single use only. Discard after using. Reseal storage bag to maintain freshness.

Immediately discontinue use if skin irritation or discomfort occurs. Participants with sensitive skin may experience temporary redness and irritation.

Do not use on Participants with allergies to silver.

Do not apply over open wounds or irritated skin.

Per IEC60601-1, Trigno® Adhesive Interfaces are considered Type BF ‘floating applied parts’.

Maintenance and Care

Trigno® Sensors

Trigno® sensors are encased in a sealed polycarbonate enclosure. The following points should be kept in mind when handling the sensors.

All sensors should be visually inspected before each use to ensure that no mechanical deterioration has occurred. Do not use damaged sensors as this may create unsafe operating conditions.

Sensors must only be cleaned with isopropyl alcohol. Ensure that the sensor contacts remain clean at all times for proper operation.

Do not clean sensors with abrasive, corrosive, or dissolving agents as this can permanently damage the sensors and compromise the integrity of the exterior enclosure.

The sensor contacts are made of pure silver. Take care to preserve the integrity of these contacts. Do not scrape or dent these contacts.

Sensors should never be completely submerged in any liquid.

Handle the sensors with care. Hard impacts such as dropping sensors on hard surfaces may damage the internal IMU and integrated circuits.

The sensors contain sensitive electronic circuitry. Static discharges and intense electromagnetic fields should be avoided to prevent the risk of irreparable damage to the sensors.

Trigno® System Components

While the Base Station, Charge units, and USB adapter enclosures are made of durable materials, the following points should be kept in mind during use and handling of these items:

All system components should be visually inspected before every use to ensure that no mechanical deterioration has occurred. Do not use any device that has been damaged as this may create unsafe operating conditions.

Clean only with isopropyl alcohol swabs; other cleaning agents may compromise the plastic material.

Trigno® system components should only be powered with the supplied Trigno® System power supply. Using an unapproved power supply may cause damage and may negate the safety features of the system.

The units should not be dropped or subjected to excessive forces of impacts or accelerations.

Do not submerge or expose Trigno® System components to liquids as ingress may cause damage and compromise safety features of the design.

Reference Specifications

Trigno® Avanti Sensor

Physical Specifications	
Dimensions	27 x 37 x 13 mm
Mass	14 g
Operating Temperature Range(1)	10 - 35 deg Celsius
Enclosure Material	medical grade polycarbonate
Contact Material(2)	99.9% silver
EMG Contact Dimensions	5x1 mm
Wireless Communication Specifications	
RF Protocol	Proprietary, BLE 4.2
RF Frequency Band	2400-2483 MHz (ISM band)
Inter-Sensor Delay	< 1 sample period
Intra-Channel Delay	< 1-2 sample period
Max number of sensors	32
EMG Sensing Specifications	
EMG Signal Input Range(3)	11mV / 22mV r.t.i.
EMG Signal Bandwidth(3)	20-450 Hz / 10-850 Hz
EMG Sampling Rate(3,4)	1259 – 4444 samples/sec
EMG Signal Resolution	16 bit
EMG RMS Signal Window(5)	100 ms
EMG RMS Signal Update Rate(4)	148 samples/sec
EMG RMS Sampling Rate	2000 sa/sec

IMU Sensing Specifications (3 DoF)	
Accelerometer Range	±2g, ±4g, ±8g, ±16g
Accelerometer Bandwidth	24 Hz – 473 Hz
Accelerometer Sampling Rate	74Hz – 963 Hz
Accelerometer Resolution	16 bits
Gyroscope Range	±250 deg/s, ±500 deg/s ±1000 deg/s ±2000 deg/s
Gyroscope Bandwidth	24 Hz – 360 Hz
Gyroscope Sampling Rate	74 Hz – 741 Hz
Gyroscope Resolution	16 bits
Calculated Orientation Signal	quaternions
Orientation Signal Resolution	16 – 32 bits
Orientation Signal Update Rate	74- 222 samples/sec

1) *Exposure beyond these temperature limits may damage the rechargeable battery, or compromise performance of the sensor.*
2) *Sensor skin contacts are made from pure silver and should not be used if allergic reactions to silver are expected or found to occur.*
3) *Selectable via software.*
4) *Precise sampling rates for a given configuration are stored in the file header. Actual sampling rates are multiples of 1/(0.0135 s). Inversely, sampling periods are defined as (0.0135 s)/n, where 17≤n≤59 for raw EMG channels, n=2 for RMS channels, 1≤n≤13 for ACC channels, and 1≤n≤10 for GYRO channels.*
5) *RMS window is the period of raw signal that is captured and processed to produce a singular RMS value.*

Trigno® Centro Base Station

Physical Specifications	
Dimensions	138 mm x 111 mm x 107 mm
Mass	700g
Operating Temperature Range[(1)]	10 - 35 deg Celsius
Enclosure Material	Medical grade polycarbonate
Data Transfer Connector	USB-C
Trigger Connectors	BNC
Antenna Connectors	SMA-RP
Analog Input Connector	DSUB-15 HD socket
Power Connector	2.1mm power jack
Specified Antenna	TE Connectivity Linx: ANT-2.4-LCW-RPS
Microphone Connector	3.5mm
Recommended Microphone	Rode: Lavalier GO
Wireless Communication Specifications	
RF Protocol	Proprietary
RF Frequency Band	2400-2483 MHz (ISM band)
Inter-Sensor Delay	< 1 sample period
Intra-Channel Delay	< 1-2 sample period
Max number of sensors	32

Electrical Specifications	
Voltage Input	12 VDC
Current Rating (average)	400 mA
Power Supply Model	SC-P09
Data Transfer	USB 2.0 or higher
Trigger Input Signal Range	0-3.3 V, 0-5.0V
Trigger Output Signal Range	0-3.3 V, 0-5.0V
Trigger Output Drive	50 mA max
5V Trigger Rising Edge Threshold	3.5V (max),
5V Trigger Falling Edge Threshold	1.5V (min)
3.3V Trigger Rising Edge Threshold	2.0 V (max)
3.3V Trigger Falling Edge Threshold	0.8V (max)
Analog Signal Input Ranges	±10V, ±5V, ±1V, ±0.1V,
Analog Signal Sampling Rates (F_{sample})	6,000 sa/sec 12,000 sa/sec 24,000 sa/sec 48,000 sa/sec
Microphone Sampling Rate	48,000 sa/sec
Effective Bandwidth	DC-0.425*(F_{sample})
Analog Signal Resolution	24 bits
Full Range Gain Error	<-40dB
Channel Crosstalk	< -90 dB

DC Offset (r.t.i)	<10 mV @ ±10V <5 mV @ ±5.0V <1 mV @ ±1.0V <0.5 mV @ ±0.1V
Noise Baseline (r.t.i.)	<300 uVrms @±10V <150 uVrms @±5.0V <20 uVrms @±1.0V <10 uVrms @±0.1V

Trigno® Lite USB Adapter

Physical Specifications	
Dimensions	50 mm x 10 mm x 18 mm
Operating Temperature Range(1)	10 - 35 deg Celsius
Enclosure Material	polycarbonate
Data Transfer Connector	USB-A
Wireless Communication Specifications	
RF Protocol	Proprietary
RF Frequency Band	2400-2483 MHz (ISM band)
Inter-Sensor Delay	< 1 sample period
Intra-Channel Delay	< 1-2 sample period
Max number of sensors	4
Electrical Specifications	
Input Voltage	5 VDC
Data Transfer	USB 2.0 or higher

Trigno® Charge-4/16

Physical Specifications	
Charge-4 Dimensions	150 mm x 43 mm x 65mm
Charge-16 Dimensions	200 mm x 153 mm x 44 mm
Charge-4 mass	300 g
Charge-16 mass	150 g
Operating Temperature Range(1)	10 - 35 deg Celsius
Enclosure Material	medical grade polycarbonate
Number of sensors	4, 16
Electrical Specifications	
Charge-4 /16 Input Voltage	12 Vdc
Charge 4 Current	300 mA
Charge-16 Current	1200 mA
Overcurrent cutout per sensor	100mA

Trigno® SC-P09 Power Supply

Physical Specifications	
Dimensions	46 x 98 x 31 mm
Mass	200 g
Input Connector	IEC 320
Output Connector	IEC C8
Electrical Specifications	
Input Voltage	100-240Vac
Output Voltage	12Vdc
Input Frequency	50 – 60 Hz
Input Current (max)	0.5-1.0A
Max Current Output	2 A
Certifications	
Medical	IEC 60601-1
Compliance	UL/cUL, TUV
EMI/EMC	CE, FCC
Restrictions	RoHS