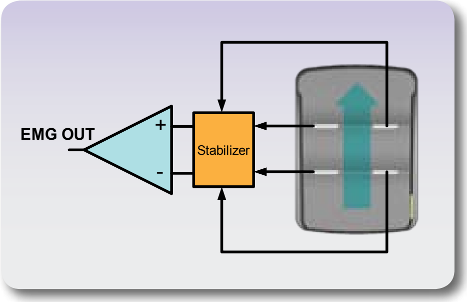
DELSYS®

Trigno Wireless- FAQ

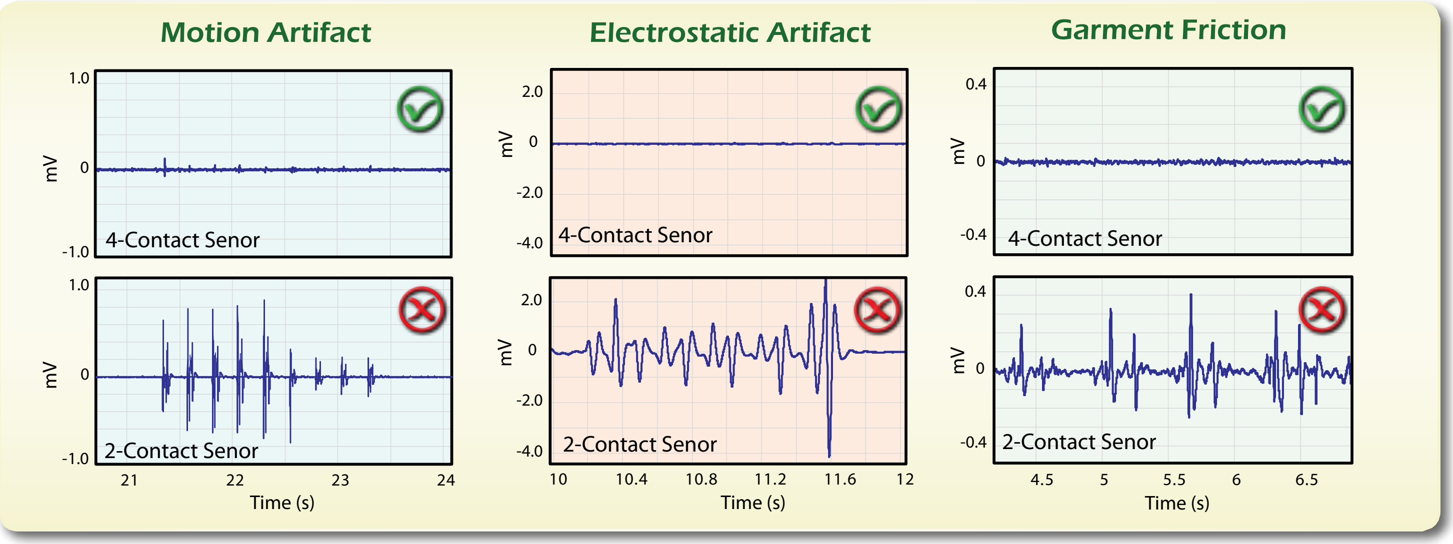
Q1. Why are there 4 bars on the bottom of the sensor?

A1. Our Patent-Pending approach uses two EMG inputs with proprietary stabilizing references.

Some commercial designs attempt to remove the reference contact by internalizing it within the circuit, or removing it altogether and performing a monopolar recording. These approaches are limited in their ability to cope with various disturbances that regularly affect the quality of EMG signals. For example, motion artifacts due to heel-strike, DC skin potential shifts during stretching and compression of tissue, and static-charge buildup of clothing are common events that can produce overwhelmingly large disturbances for EMG signals. "Reference-free" sensor designs have difficulty compensating for, and cancelling these disturbances because the reference point for the circuit is not in actual contact with the skin surface, and is thus removed both physically and electrically from these events.



In contrast, Trigno Wireless Sensors contain two patent-pending stabilizing references. This proprietary design allows the sensor to react instantaneously to disturbances detected on the surface of the skin, dramatically reducing the impact of these noise sources on the detected EMG signal quality. **The Trigno Sensor System is protected by US Patents 6480731, 6238338 and European Patent EP1070479**.

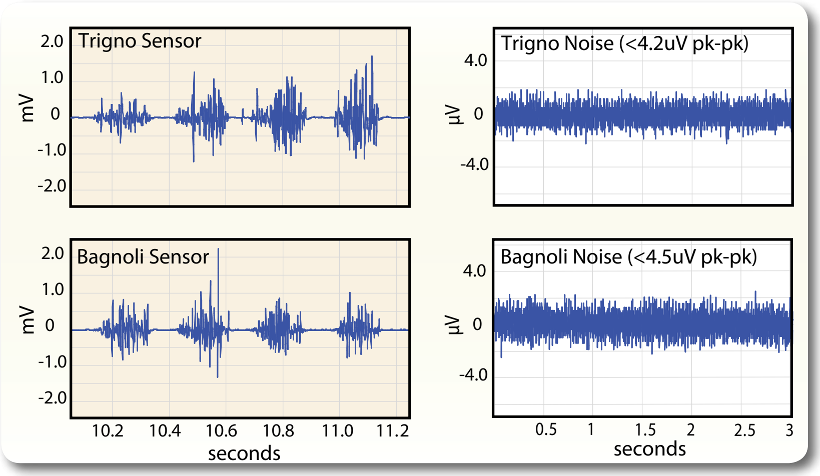


Q2. How do Trigno wireless sensors compare to Bagnoli tethered sensors?

A2. Trigno Wireless Sensors either match or improve upon the performance specifications of Bagnoli tethered sensors so that all Delsys systems share the same strict and discerning characteristics.

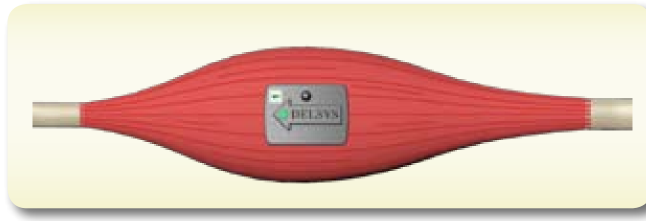
Specification	Bagnoli System	Trigno System
Baseline Noise	< 5uVpk-pk	< 4.5uV pk-pk
Bandwidth	20-450 Hz ±10%	20-450 Hz ±10%
|CMRR|	> 80 dB	> 80 dB
Resolution	153 nV/bit*	168 nV / bit
Range	16 bits *	16 bits
Sampling Rate	≥ 1000 sa/sec*	2000/4000 sa/sec

*when used with recommended A/D cards.



Q3. How do I orient the sensor on a muscle?

A3. The sensor works best when its arrow is aligned with the muscle fibers.



Trigno Sensors are designed with the same proven principles as our parallel bar sensors found in other Delsys systems. The arrow feature on the top of the sensor should be aligned parallel to the muscle fibers. In this fashion, the sensor contacts will intersect the muscle's action potentials with maximum sensitivity as these travel up and down the length of the muscle cell. The contacts of Trigno Sensors should be placed over the "belly" (i.e. centroid) of a muscle, avoiding the tendinous insertions. Results can be optimized by judicious placement, taking into consideration the anatomical particulars of the muscle being observed, and the impact of adjacent and overlying muscles. The sensor can be conveniently used as a probe to find the optimal location, and is simply affixed to the skin with our adhesive skin interfaces.

The sensor's area of observation is defined by the two active EMG contacts, and these should be placed over the intended recording site. The other two stabilizing contacts play an important role in obtaining a quality signal, but have no impact on the sensor's area of observation. **Note that Trigno Sensors have a fixed electrode contact area of 50mm² (5mm x 10mm), half the area of Bagnoli sensors (10mm x 10mm).**

Q4. How reliable is the RF communication?

A4. The antenna design, the communication protocol and the radio hardware have been optimized for trouble-free operation up to 40m in open office environments.

Trigno sensors have been meticulously designed to ensure trouble-free operation for distances up to 40m and recording sessions as long as 8 hours. A custom RF protocol operating within the 2.4GHz spectrum has been developed to ensure no data latency between sensors and a high level of transmission robustness. Our approach has minimized the potential for interference from commercially available products that make use of WiFi, Bluetooth, Zigbee and similar RF communication schemes. None-the-less it is advisable to remove any unnecessary 2.4GHz sources from the recording environment when possible. The Trigno System has the ability to track all data packets that are sent from the sensor to the receiving Base Station, so that communication quality at any point in time is known to the system. Multiple sets of operating channels are accessible to the user so that communication quality can be maximized in any given environment.

Communication Test: 16 sensors @20m for 10 minutes

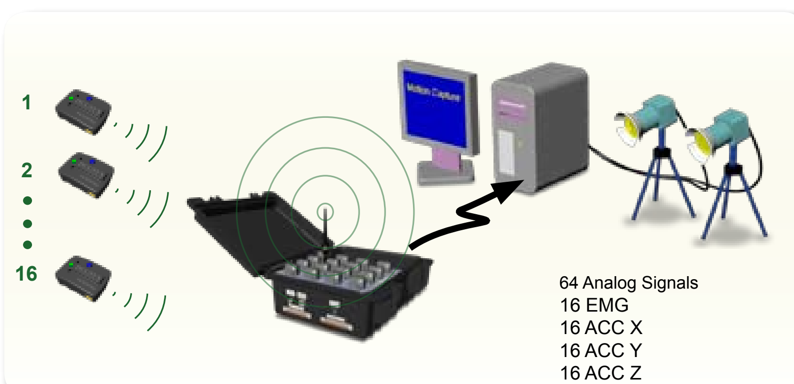
Sensor	Dropped Packets	Sensor	Dropped Packets	Sensor	Dropped Packets	Sensor	Dropped Packets
1	0	5	0	9	1	13	0
2	0	6	0	10	0	14	0
3	0	7	0	11	0	15	0
4	0	8	0	12	0	16	0

Total packets sent: 711,112. **Total dropped packets:** 1
Error Rate: < 0.0002 %

Q5. How do Trigno Sensors integrate with motion capture equipment?

A5. All data from Trigno Sensors are available as real-time analog output signals, which can be easily connected to any available data acquisition units.

The Trigno System Base Station provides easy access to all 64 available channels (16 EMG + 48 acceleration) through a standard 68-pin D-type connector, which can be easily terminated for varieties AD input connectors. If a data acquisition system is not available with the motion capture system, then Trigno Sensor data can be easily captured by EMGworks software and synchronised with motion capture data by using the system's triggers. Full trigger options are available; start input, stop input, start output and stop output.



Q6. How long can Trigno Sensors be continuously used for ?

A6. A fully charged sensor will stream data for an average of 7.5 hours.

Trigno Sensors contain smart charging capabilities to optimize the performance of the internal rechargeable battery. A depleted sensor can recharge in approximately 2 hours. Optimal battery performance is obtained if sensors are operated between 10 and 25 degrees Celsius. Battery longevity is rated at 80% of nominal after 300 charge-discharge cycles. As with all rechargeable technologies, capacities will decrease as the battery approaches its end-of-life.

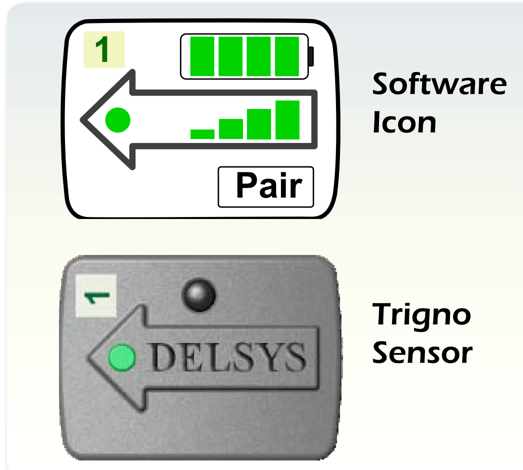
All materials in the sensor that come in contact with the skin are biocompatible and are approved for long-duration use. However, Delsys recommends removing and if necessary re-affixing sensors to the skin after 8 hours of use.

Q7. What kind of status information do Trigno Sensors give the User?

A7. Battery status, communication quality, recharge state along with other details are made available in Trigno software as well as from the sensor's onboard LED.

Trigno software displays status information on all 16 sensors in with easy-to-understand graphics. Each sensor is labelled and shows its network status, battery charge and communication quality. The LED on the sensor will also show whether the sensor is on or off and its network status, along with many other conditions.

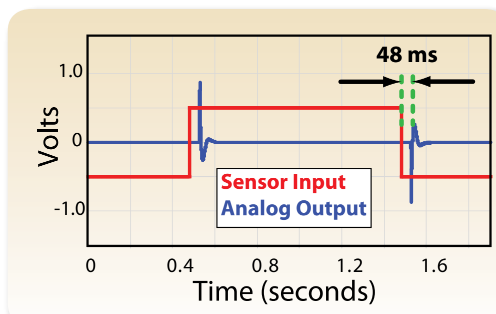
State	LED Behavior
Data Streaming	Flashing green, 1 Hz
Scanning	Alternating green/amber flash, 1 Hz
Pairing Successful	Rapid green flashing 3x, button depressed
Pairing Unsuccessful	Rapid red flashing, 3x, button depressed
Mode Switch	Rapid green flashing, 3x
Firmware Update	Rapid green flashing, 3x
Battery Charging	Solid amber, in cradle
Charging Complete	Solid green, in cradle
Charging Error	LED off, sensor in cradle, cradle powered
Sensor Off	LED off



Q8. What delays exist in Trigno Systems?

A8. Maximum Inter-sensor latencies are < 500us, while overall analog outputs are fixed at 48 ms.

The two delay parameters of concern in wireless EMG systems are: a) the maximum delay between any two sensors (inter-sensor latency), and b) the overall transmission delay from sensor input to analog output (group delay). All Trigno sensors have a **guaranteed inter-sensor latency less than 500us** (1 sample period) and a **fixed group delay of 48 ms** from sensor input to analog output which can easily synchronized with motion capture data.



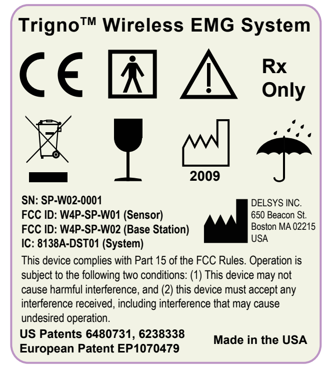
Q9. How are the sensors turned off?

A9. Sensors are turned off through software commands, by depressing the sensor button, and through various automatic internal protocols.

Sensors can be manually turned off by sending a software command, or by depressing the rubber button for 20 seconds. Additionally, the sensors are immediately turned off whenever they are placed in the recharging cradles. If the sensors are out of range and cannot receive a software command, they will automatically turn off after 5 minutes. Sensors will also monitor the battery voltage internally and automatically turn themselves off prior to entering a state of deep discharge. This extends battery lifetime and ensures optimal sensor performance. The user is alerted to a low battery condition prior to automatic shutoff.

Q10. What approvals and certifications does the Trigno System have?

A10. The Trigno System satisfies medical device and RF communication requirements for North America, Europe, Australia and most Asian countries.



- FDA-registered (USA)
- FCC ID (USA)
- CE (Europe MDD 93/42/EEC)
- IEC601-1 (General Requirements for Medical Devices)
- IEC601-1-2 (EMC Compatibility Requirements for Medical Devices)
- IC (Canada)
- UL recognized internal battery

Q11. What amplification do Trigno Sensors have?

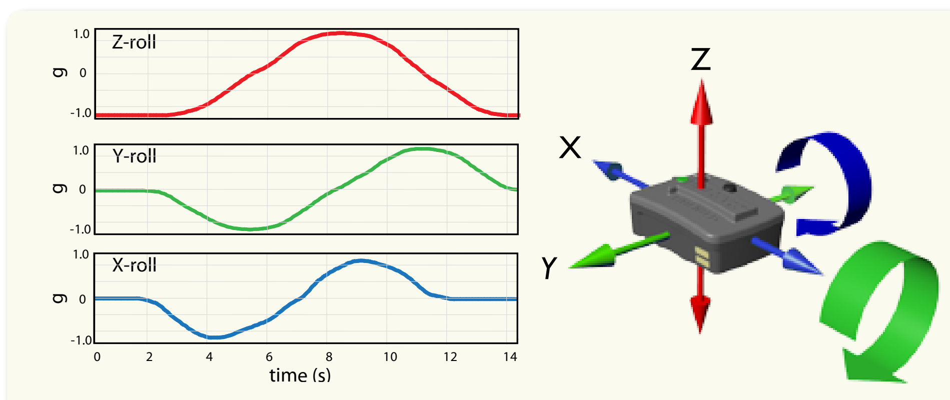
A11. EMG analog output channels have a gain of 1000 V/V while ACC analog output channels have a nominal gain of 0.8 V/g

Trigno analog output channels are expressed in a +/-5 V range. Converting the measured voltage output of an EMG channel to the original amplitude on the skin requires a simple division of 1000 V/V. Converting the measured voltage output of an Accelerometer (ACC) channel to the original detected acceleration requires a division 0.8 V/g. An accurate accelerometer scaling factor can be obtained by performing a calibration (see Q12 below). Note that data are automatically scaled when using Trigno with EMGworks software.

Q12. How is the internal accelerometer oriented and what is their range?

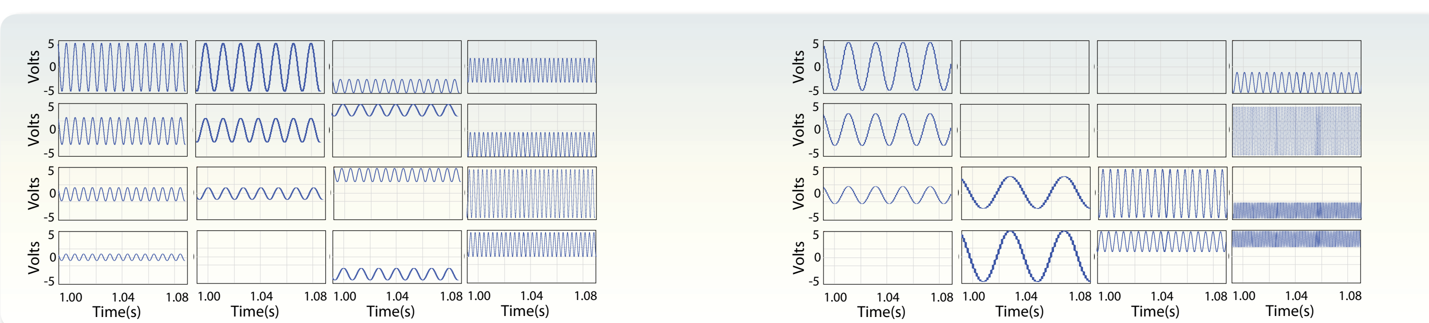
A12. The "X" axis is parallel to the sensor arrow, while the "Y" axis is perpendicular to and coplanar with the arrow.

The accelerometer is judiciously mounted in the sensor so that the inertial behavior of the sensor is intuitive. Accelerometer calibration is easily performed by carefully orienting the sensor with respect to the earth's gravitational field. This process creates a selective displacement of 1 g (i.e. 9.8m/s^2), which conveniently allows the software to scale the sensor outputs accordingly. Accelerometers have a range of ±1.5 or ±6 g, selectable by software.



Q13. How can I test the analog output connections to my data acquisition system?

A13. Trigno Systems can be placed into a test mode where 64 predetermined, unique sinusoidal signals are outputted to the data acquisition system.



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