



Trigno™ Wireless System User's Guide



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TRIGNO™ Wireless System

User's Guide

**October 2009 Edition
PM-W01**

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MAN-012-1-2

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Important Information

Intended Use

The Trigno™ Wireless EMG Systems are designed for research, investigational and scholarship purposes only. Delsys' products are not intended for measurement purposes or for use in the treatment and diagnosis of humans.

Rx ONLY

Contraindications



DO NOT USE on Patients with implanted electronic devices of any kind, including cardiac pace-makers or similar assistive devices, electronic infusion pumps, and implanted stimulators.



DO NOT USE on irritated skin or open wounds.



DO NOT USE on Patients with allergies to Silver.

Technical Service and Support

For information and assistance visit our web site at:

www.delsys.com

Contact us at:

E-mail: support@delsys.com

tel: (617) 236 0599

Warnings and Precautions



Consult all accompanying documents for precautionary statements and other important information.



Consult accompanying user's guide for detailed instructions.



Keep the device dry. The presence of liquids 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.



Connect only to Delsys-approved devices.



Connecting a patient to high-frequency surgical equipment while using Delsys EMG systems may result in burns at the site of the EMG sensor contacts.



Immediately discontinue device use if skin irritation or discomfort occurs.



Immediately discontinue device use if a change in the device's performance is noted. Contact Delsys technical support for assistance.



Delsys Inc. guarantees the safety, reliability, and performance of the equipment only if assembly, modifications and repairs are carried out by authorized technicians; the electrical installation complies with the appropriate requirements; and the equipment is used in accordance with the instructions for use.



Device contains a Lithium-Polymer battery. Do not damage, crush, burn, freeze or otherwise mishandle the device. Recharge only with the approved power supply and recharger.



Trigno Systems should be stored and operated between 5 and 50 degrees Celsius due to the presence of an internal Lithium Polymer rechargeable cell. Storing or operating the device, and consequently the cell, outside of this temperature range may compromise the integrity and the safety features of the cell.



Device Information



Complies with Requirements put forth by the Medical Device Directive 93/42/EEC. Class I device, Annex VII.



Type BF device (IEC 60601-1).



Isolated device, (Class II, IEC 60601-1)



Do not dispose this product with house waste. Contact Delsys Inc. for instructions on responsibly disposing this device. This product should not be mixed with other commercial wastes.



Date of Manufacturing (appears on device)



Serial Number (appears on device)



EMERGO EUROPE
Molenstraat 15
2513 BH, The Hague
The Netherlands

Authorized Representative



DELSYS INC.
650 Beacon St.
Boston MA 02215
USA

Manufacturer

FCC ID: W4P-SP-W02 (Trigno Base Station)

FCC ID: W4P-SP-W01 (Trigno Sensor)

IC: 8138A-DST01 (Trigno System)



This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference. and (2) this device must accept any interference received, including interference that may cause undesired operation.

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

Operation is subject to the following two conditions: (1) This device may not cause harmful interference. and (2) this device must accept any interference received, including interference that may cause undesired operation.



Changes not expressly approved by Delsys Inc. could void the User's authority to operate the equipment



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 the 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 to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into outlet on a separate circuit.

Disclaimer

DELSYS INC. makes no warranties, express or implied, as to the quality and performance of this product including but not limited to, any implied warranty of applicability for other than research uses by qualified individuals. DELSYS INC. shall not be liable to any person for any medical expenses or any direct or consequential damages resulting from any defect, failure or malfunction, whether a claim for such damages is based upon theory of warranty, contract, tort or otherwise. No representative, agent, or licensed practitioner is authorized to waive this disclaimer. DELSYS INC. makes no diagnosis or prescription by virtue of anything about this product.

Limited Warranty

The Trigno™ Wireless EMG Systems are warranted against failure of materials and workmanship for a period of 1 year from the date of delivery, provided that the product is given proper care and has not been subject to abuse during this period. This warranty is in lieu of all other warranties expressed or implied. Operation of this device outside specifications determined by DELSYS INC. or use with any other input devices other than DELSYS INC. sensors constitute an invalidation of this limited warranty. This warranty is not transferable.

Trigno™ Wireless EMG System Overview

The Trigno™ Wireless EMG System is a high-performing device unparalleled in its sophistication, its reliability and its ease-of-use. Each EMG sensor has a built-in triaxial accelerometer, a guaranteed transmission range of 40 m and a rechargeable battery lasting a minimum of 7 hours. The system is capable of streaming data to EMGworks Acquisition and Analysis software and of generating 16 EMG and 48 accelerometer analog channels for integration with motion capture and other 3rd party data acquisition systems. Full triggering features further expand the possibility for integration with additional measurement technologies.

Wireless EMG Sensor

Each Trigno Sensor is equipped with the following features:

- transmission range of 40m
- inter-sensor latency < 500us
- self-contained rechargeable battery
- EMG signal bandwidth 20- 450 Hz
- EMG signal sampling rate up to 4000 samples/sec
- EMG baseline noise of 3uV pk-pk
- CMRR > 80dB
- 16-bit EMG signal resolution
- integrated triaxial accelerometer
- software selectable accelerometer sensitivity of $\pm 1.5g$ or $\pm 6g$
- LED User feedback
- battery charge monitoring and status indicator
- environmentally sealed device
- proven parallel bar electrode technology
- contoured sensor-skin interface for maximum signal stability
- auto shutoff

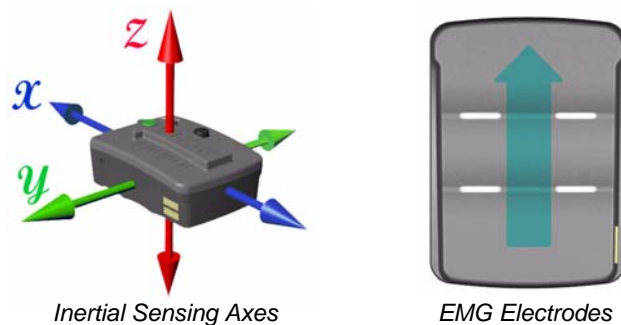


Figure 1. Trigno wireless 4-channel sensor.

Sensor LED Indicator Status

Status	LED Behavior	LED
Data Streaming	Flashing green, 1 Hz	● ●
Scanning	Alternating green/amber flash, 1Hz	● ●
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 up	○
Sensor Off	LED off	○

Base Station



Figure 2. Trigno Base Station.

1 Wireless Sensor	5 Analog Output Connectors
2 Base Station	6 Trigger Port
3 USB Port	7 Antenna
4 Power Jack/Power Supply	8 EMGworks Software

Each Base Station is equipped with the following features:

- recharging cradle for 16 sensors
- high speed USB communication with PC
- 64-channel analog output connector (16 EMG, 48 ACC)
- $\pm 5V$ analog output range
- detachable antenna
- full trigger capability (Start/Stop, Input/Output)
- communication & power feedback LEDs
- convenient carry case design

Power Supply

Trigno Systems are equipped with an isolated medical grade power supply. The green power LED on the base station will illuminate when power is connected to the Base Station. The power supply is provided with interchangeable country-specific plug adapters. The power supply can be conveniently stored in the Base Station storage space when the system is not in use.



Figure 3. Trigno SC-P05 International Medical Power Supply



Trigno System are specifically designed and approved to function only with the Power Supply provided. Power Supply substitutions constitute a violation of the medical safety approvals and will void the warranty.



If using a mains-powered PC then an additional isolation transformer is required for medical compliance to IEC60601-1. Refer to Appendix I for further details. No PC isolation is required for operation on a battery-powered laptop.

Getting Started with the Trigno™ System

Powering the Base Station



Connect the Trigno power supply to the circular DC jack located on the side of the Base Station. Energize the power supply by connecting it to a Mains outlet or to an isolation transformer. Ensure that the PC to be used with the Base Station is connected to the same isolation transformer. Please refer to Appendix I for clarification on using an Isolation Transformer. The power LED on the Base Station will illuminate anytime power is applied. Ensure that the Base Station antenna is securely attached to the antenna connector.

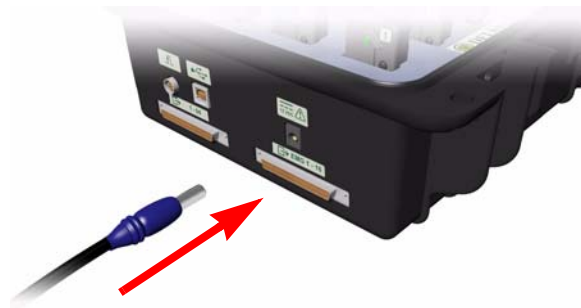


Figure 4. Connecting the Trigno Base Station power supply.

Connecting the Base Station



The Trigno Base Station communicates with a PC through the USB link. It is important to install the EMGworks software prior to connecting the Base Station to the PC. If this is not done, the “Found New Hardware” dialog will appear, and Windows will prompt for a driver location. Cancel this dialog and refer to the Software Installation Guide provided with the CD. Once the software is correctly installed, the PC will automatically detect the Trigno Base Station when it is connected to the USB port.

Charging the Sensors

Before using the system, the sensors should be fully charged by placing them in the Base Station cradle slots. Ensure the Base Station is powered and that the green power LED is illuminated. When charging, the sensor LEDs will illuminate to an amber color. Once the sensor battery is fully charged the sensor LED will turn green. A blinking LED indicates an incomplete charge. Remove

the sensor from the device and let it stand for 5 minutes. Cycle power on the Base Station and re-dock the sensor to restart the charge cycle. A complete charge cycle from a fully depleted sensor takes approximately 2.5 hours.



Do not force the sensors into the recharging cradles of the Base Station. The sensors are keyed so that they can only be inserted in one orientation. Check the sensor orientation and check for obstructions in the cradle if physical resistance is met while cradling the sensors.



Recharge only with the approved power supply (SC-P05) originally included with the system. Charging with any other power supply may damage the device and will void the warranty.

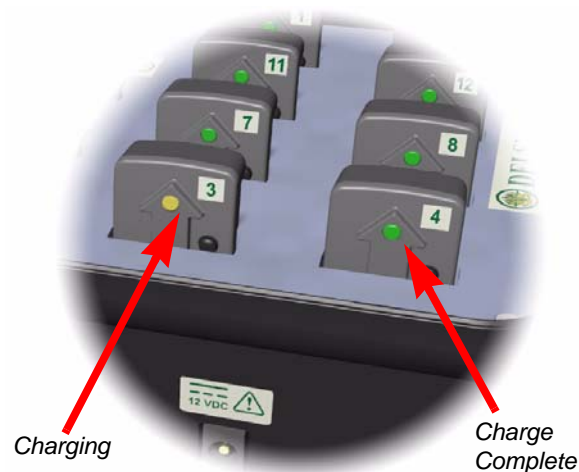


Figure 5. Sensor LED feedback for battery charging status.

Tuning the Sensors ON

Trigno Sensors are turned on by depressing the rubber button for approximately one second. The green LED on the sensor will immediately begin to flash, and begin searching for a Base Station that has been properly paired and is within its range. If no Base Station is found, the LED will alternate between amber and green, indicating that it does not have an established communication link. As soon a link is established with the Base Station, the sensor LED

will flash green approximately once per second, indicating that data are streaming.



Figure 6. Turning the Trigno Sensor "ON".

Turning the Sensors Off

There are several mechanisms for turn turning the Trigno sensors off, described as follows:

- Send an "off" command via software
- Dock the sensor in an active cradle
- 5 minute time-out if no base is linked
- Hold sensor button for approx. 20 sec.

Using EMGworks with the Trigno™ System

Software Installation

The Trigno EMG system is controlled by a PC via the USB port and thus requires specialized software. The system is shipped with a Delsys Software CD containing EMGworks Signal Acquisition and Analysis Software, which includes the Trigno Analog Output software for use with 3rd party data acquisition systems.



Refer to the Software Installation Guide provided with the CD to install the EMGworks package.

Hardware Configuration

Start the EMGworks application and define a **Hardware Configuration** for the Trigno system. Refer to the EMGworks User's Guide for a detailed explanation of this process. Please note the following particulars relating to the Trigno Systems:

Number of Channels: Trigno Systems have a maximum of 64 channels. Each Sensor has 1 EMG channel and an X, Y and Z channel of inertial information.

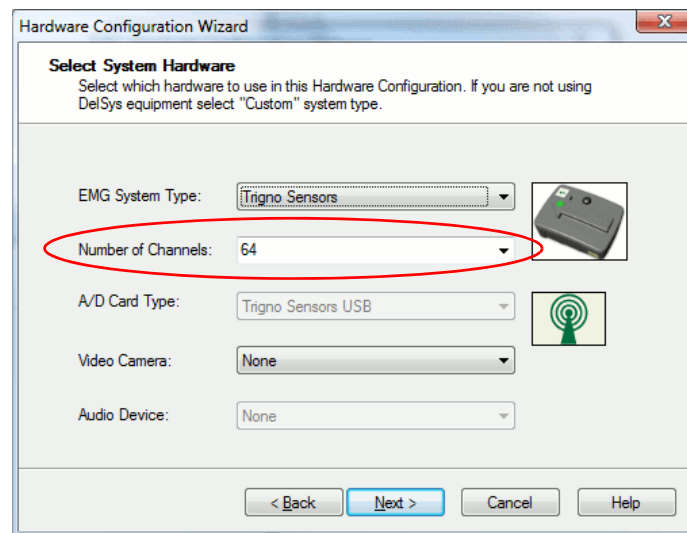


Figure 7. Hardware Configuration Wizard- selecting the number of channels.

Channel Properties: Channel gains for Trigno Sensor cannot be changed by the user. These are optimized for hardware design and pre-populated in the hardware configuration. It is possible to run a calibration on the inertial channels to express these data in meaningful units.

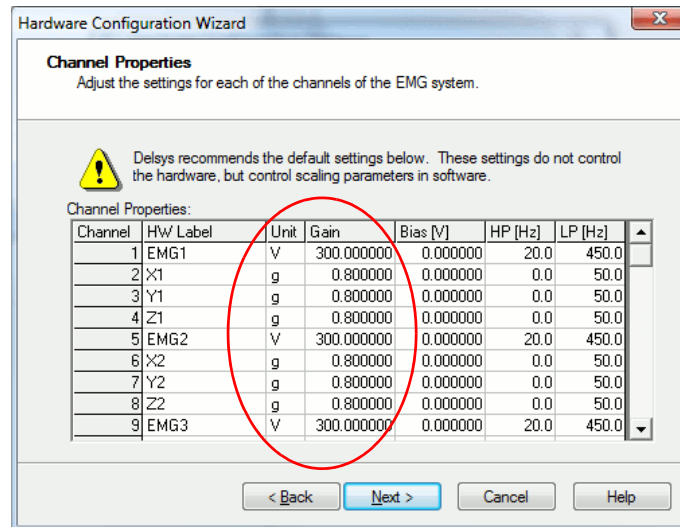


Figure 8. Hardware Configuration Wizard- defining the system gains.

Test Configuration

Once you have defined a **Hardware Configuration** for the Trigno System, proceed to define a **Test** so that data can be acquired. Refer to the EMGworks User's Guide for a detailed explanation of this process. Please note the following particulars relating to the Trigno Systems and EMGworks **Test Configurations**:

Sampling Rate

Trigno Sensors have 2 available sampling rates for EMG and Accelerometer data. EMG data can be sampled at either 2000 or 4000 samples/second. Correspondingly, each of the inertial sensing axes will be sampled at either 148.1 samples/sec or 296.3 samples/sec. These sampling rates are tightly integrated with the wireless communication protocol and cannot be changed.

Channel Selection

Trigno Systems make available a total of 64 channels of information. Subsets of this 64-channel set can be easily enabled and disabled by using the following features:

EMG only: Enables the 16 EMG channels and disables all 48 inertial channels.

ACC only: Enables 48 accelerometer channels and disables the 16 EMG channels.

Disable All: Disables all channels.

Enable by Sensor: Enables and disables sensor by number.

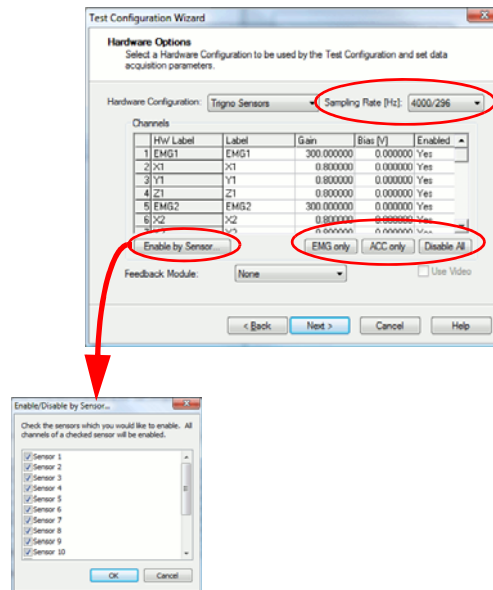


Figure 9. EMGworks Test Configuration Wizard

Biosignal Calibration

The Test Configuration Wizard will also permit a calibration for the inertial channels active in the test. The calibration will appropriately scale the accelerometer information and relate that to gravitational units in the plots ($1g = 9.8m/s^2$). The simplest method for calibrating the accelerometer channels is to perform a 90 degree rotation along 1 axis of the sensor so as to induce a 1 g

positional offset on the channel being calibrated. Data from each of these positions are sampled by clicking the “Snapshot” buttons for “Position 1” and “Position 2” options.

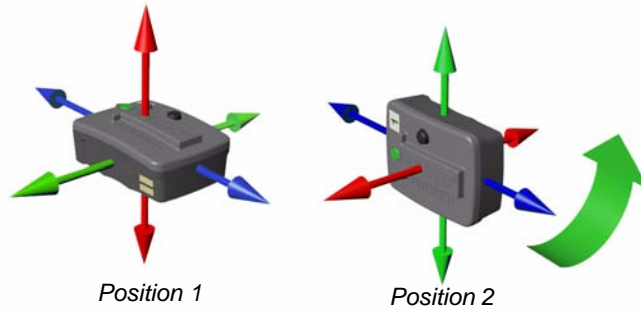
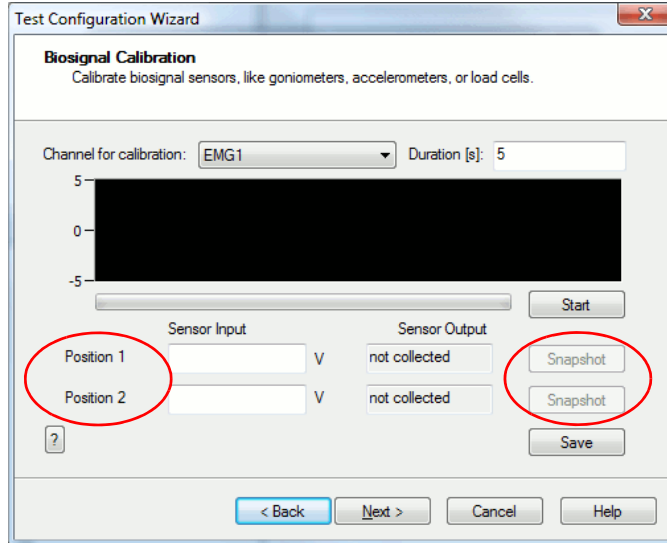


Figure 10. Rotating the sensor 90 degrees to calibrate the inertial axes.



Please refer to the EMGworks User's Guide for a detailed explanation of the Test Configuration Wizard.

Configuring Trigno Sensors

Trigno sensor status and configuration information is accessed in the “Tools” menu under “Trigno Sensors Configuration”.

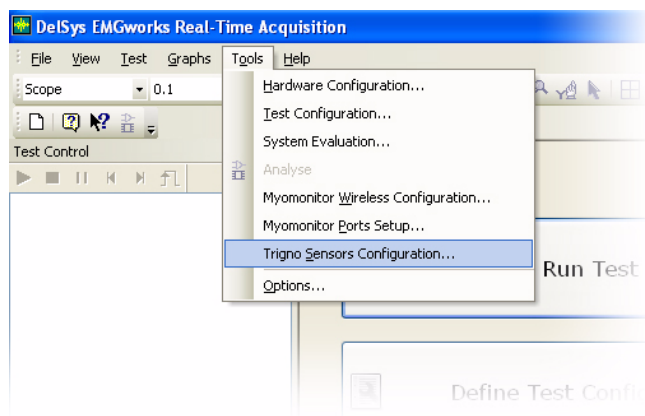


Figure 11. Accessing the Trigno Sensors Configuration window.

Trigno System Information

The Information tab in the window relays data pertaining to the system settings:

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”). These should only be changed if wireless communication is poor for the default set “A”. Poor communication occurs if nearby sources are interfering with the operating frequencies, or if there is significant path loss on the operating frequencies.

Accelerometer Sensitivity:

Trigno sensors have a high sensitivity setting of ± 1.5 g and a low sensitivity range of ± 6 g. All sensors and all axes share the same sensitivity setting.

Firmware Version:

Delsys may occasionally release firmware upgrades to improve and evolve the functionality of Trigno Systems. The current firmware version is shown here.

Serial Address:

Each Trigno Base Station has a unique serial address which is shown here.

Launch Test Panel:

Places the Trigno Base Station in a test mode for verifying the analog output connections. Each of the 64 analog output channels is configured to produce a unique sinusoid which can be verified by properly sampling these channels with a third party data acquisition system. Refer to the “Using Analog Outputs” section of this guide.

Refresh 

This button refreshes the status information.

Copy

Copies the data the in the Information tab to the clipboard.

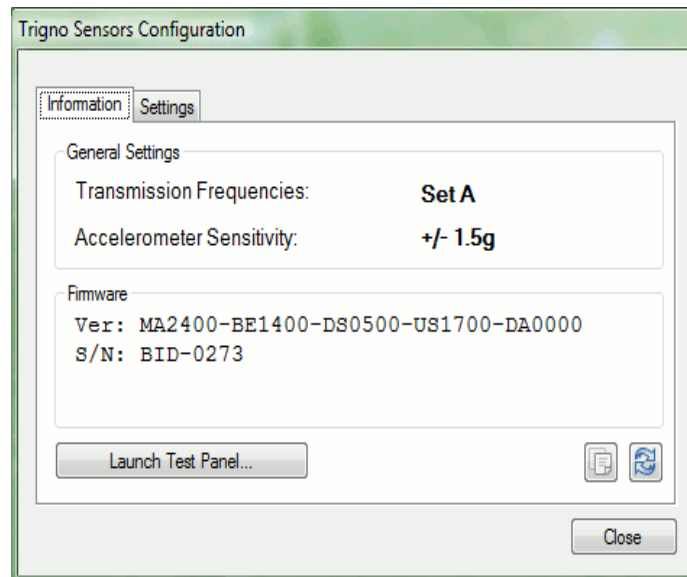


Figure 12. Trigno Wireless System information.

Trigno System Settings

The Settings tab in the Trigno Configuration window allows several system parameters to be modified as needed.

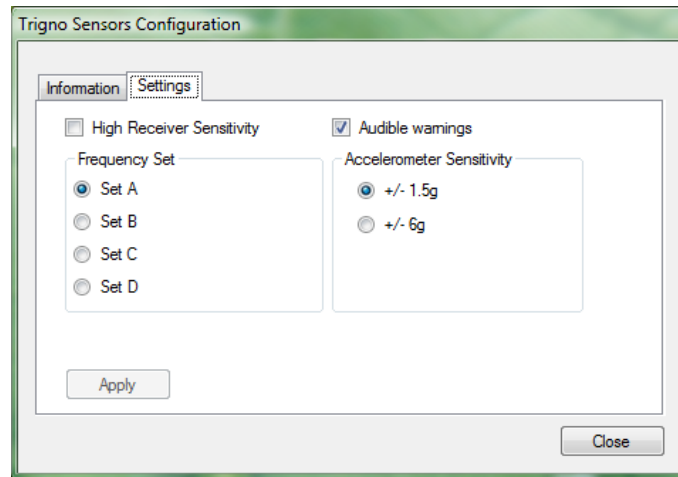


Figure 13. Configuring Trigno Sensor Settings

Frequency Set

Use this setting to change the frequencies being used for wireless communication. The default set is “A”. The frequency set should only be changed if nearby sources are interfering with Trigno communications or the particular operating environment is causing significant path loss on the current frequency set. Note that changing the communication frequency set will require sensor re-pairing (see section on **Trigno Sensor Status**). Frequencies within the sets are defined by the system and cannot be changed by the User.

Accelerometer Sensitivity

Trigno sensors have 2 sensitivity ranges for their triaxial accelerometers: a high sensitive range of $\pm 1.5g$ for looking at fine movement details, and a low sensitivity range of $\pm 6g$ for use during dynamic, ballistic or high-impact motions. All sensors and all axis share the same sensitivity setting.

Audible Warnings

This option will generate an audible “ping” along with a small message, whenever a sensor falls out of range or it’s battery is excessively low.

Trigno Sensor Status Console

A Status console for Trigno Sensors will always operate in the Windows Task Bar when the Trigno System is running. This Status console is available when operating EMGworks and when operating the Trigno system in Analog Output mode. The console tracks all Trigno sensors in the system in real-time, relaying their on/off state, their battery charge level and their communication quality in the network. Additionally, this console can send an “off” command to all sensors, and hosts the sensor pairing function.

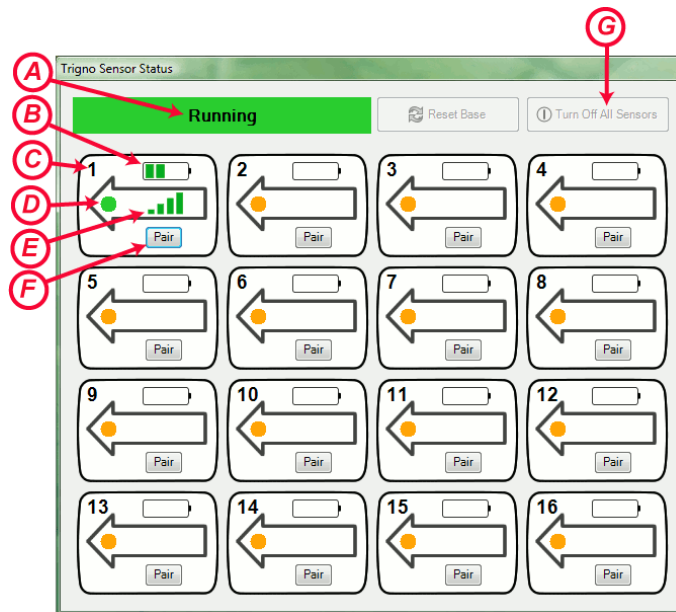


Figure 14. The Trigno Sensor Status Console offers real-time sensor feedback. A) data acquisition status, B) battery charge, C) sensor id, D) communication link, E) signal strength, F) sensor pairing, G) off command.

Using the Wireless EMG Sensors

Orienting the EMG Sensors on the Skin

Trigno EMG Sensors are fitted with 4 silver bar contacts for detecting the EMG signal at the skin surface. It is crucial that the orientation of these bars be perpendicular to the muscle fibers for maximum signal detection. The top of the sensor is shaped with an arrow to aid in the determination of this orientation. The arrow should be placed parallel to the muscle fibers underneath the sensor. The sensor should also be placed in the center of the muscle belly away from tendons and the edge of the muscle. The sensor is easily attached to the skin using the Delsys Adhesive Sensor Interface.

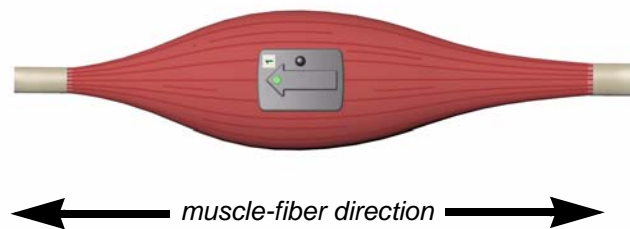


Figure 15. EMG Sensors must be properly oriented with the muscle fibers. Align the sensor's arrow with the direction of the underlying muscle fibers.

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 dry dermis and any skin oils. Wiping the skin prior to sensor application is critical. 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 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 System are supplied with specially-designed adhesive interfaces to simplify sensor attachment. These interfaces are cut from double-sided medical grade adhesive approved for dermatological applications. Usage of the interface promotes a

high quality electrical 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 dry completely before applying the interfaces.



Adhesive Sensor Interfaces are for single use only.



Immediately discontinue use if skin irritation or discomfort occurs. All Adhesive Sensor Interfaces and Reference Electrodes are for single use only. Discard after using. Reseal storage bag to maintain freshness.

Sensor Pairing

Trigno sensors communicate with a custom wireless protocol that links each sensor to a unique Base Station. This linking process is known as sensor “pairing”, and is initiated through the “Pair” command accessible from the Sensor Status Console on the PC software. There are 2 steps involved in the pairing process:

1. Initiate sensor pairing on the Base Station by clicking the “Pair” button of the desired sensor.
2. Complete the pairing process by depressing the desired sensor button for a minimum of 3 seconds. Successful pairing will result in 3 green LED flashes on the sensor, and a confirmational message on the Sensor Status Console.

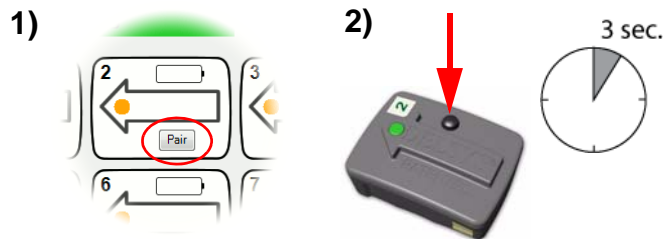


Figure 16. Sensor Pairing: 1) Initiate the process from the Status Console. 2) Complete the process by depressing the sensor button for 3 sec.

Trigno systems are shipped with all sensors appropriately paired. Sensor pairing is typically needed if sensors are being replaced within the network group, when the communication frequency sets are changed, and after a firmware upgrade is performed.

Using the Analog Outputs

The Trigno System provides simultaneous analog signal reconstruction of data being detected by all active sensors. These signals are made available on the 68-pin connectors located on the Base Station. EMG signals at these outputs are amplified by a factor of 1000, with full dynamic range of $\pm 5V$. Similarly accelerometer signals are presented with a nominal full range of $\pm 5V$. These must be calibrated according to their selected operational range ($\pm 1.5g$, $\pm 6g$). Note that these signals exhibit a fixed 48ms delay from the time the sensor detects the event to the time the analog signal is reproduced.



Figure 17. Analog Output connections.

Analog Output Connectors

Channels 1 - 16, EMG Signals



The pinout of this connector replicates the pinout of the Bagnoli desktop EMG systems to facilitate connectivity between shared equipment. Only EMG signals are provided on this connector. Note that this pinout is also compatible to that of National Instruments data acquisition modules.

Channels 1-64, all Signals



This connector makes available all 64 analog output channels in the 68-pin connector. This connector is compatible with some 80-channel data acquisition modules from National Instruments.

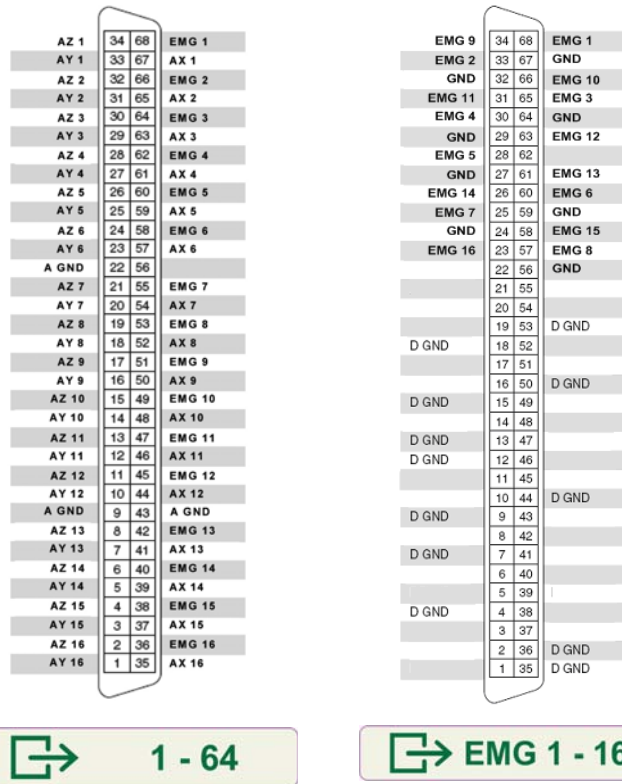


Figure 18. Pinouts of the Analog Output connectors.

Screw Terminal Connections

Many data acquisition systems are equipped with screw-type wire terminations. In these cases Delsys can supply a cable assembly that mates with the Trigno Analog Output connectors and breaks out the individual channels onto single conductors. Please contact Delsys for details regarding this particular wire assembly or other connectivity needs. Please refer to Appendix II for further details regarding the DC-A22 Unterminated Output Cable.



Figure 19. DC-A22 Unterminated Output Cable.

Analog Output Software

Included with the Delsys software package is the Trigno Analog Output software, which operates on a PC independently from EMGworks Data Acquisition and Analysis software. The Trigno Analog Output Software is designed to configure and control the Trigno System so that it becomes a full analog instrument. In this scenario, all data acquisition is performed by sampling the analog channels with 3rd party acquisition systems, often found with Motion Capture Systems. The Trigno Analog Output software presents information in that is identical to the Trigno Sensor Status console with the following exceptions:

- the wireless sensor configuration window is accessible from the “configure” button.
- an Analog Output “Test Panel” can be launched from the Sensor Configure dialog which can be used to debug connectivity problems.
- “Start” and “Stop” controls are available primarily to define the Start and Stop trigger events, if these are being used. All settings are locked once the “Start” button is depressed, and can only be changed after the “Stop” button is pressed.



Figure 20. Trigno Analog Output software.

Test Panel

The Test Panel is used to verify the analog signal connections with the data acquisition module by outputting predefined and unique signals on each channel. The test signals are sinusoidal in nature and defined by an amplitude, a frequency and an offset. The expected outputs for each analog channels are listed in the Test Panel window once the option is selected.

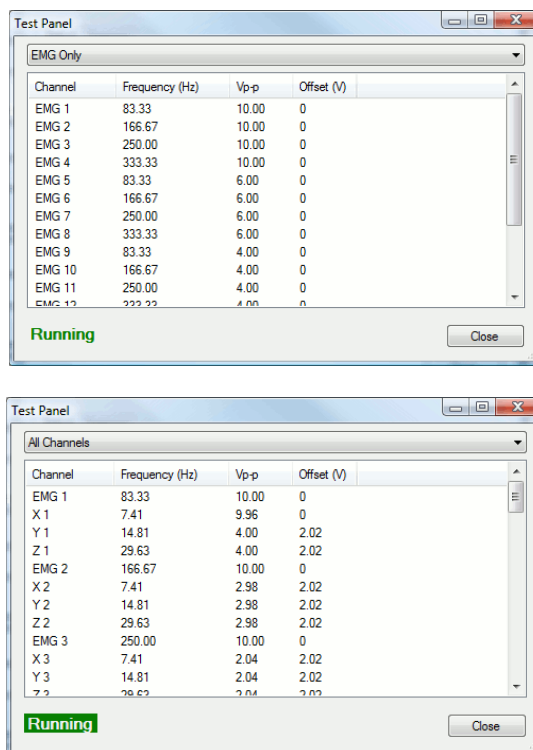


Figure 21. The Test Panel Signals.

Note that the analog outputs are generally always active, whenever data are transmitting from the sensors. The Trigno Analog Output software is used to provide full control over the Trigno Base Station and its features outside of EMGworks.

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.
- The sensors can be cleaned and sterilized with a damp cloth and mild detergent, or with 70% isopropyl alcohol swabs. Ensure that the sensor contacts remain clean at all times for proper operation.
- While the sensors are sealed and are water-resistant, these should never be completely submerged in any liquid. They are designed to be used on damp skin surfaces and in the presence of sweat without compromise to safety, sensor integrity or operation.
- The sensor contacts are made of pure silver and are quite soft. Care should be taken to preserve the integrity of these contacts. Do not scrape or dent these contacts.
- Handle the sensors with care: do not drop them on the ground or step on them.



Do not submerge the sensors in any liquid under any circumstance.



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

Trigno Base Station

The Trigno System is designed to provide years of reliable service when proper care is followed. While the Base Station enclosure is made of durable plastic, the following points should be kept in mind during its use and handling:

- The device and its accessories should be visually inspected before every use to ensure that no mechanical deterioration has occurred.
- The Base Station can be easily cleaned with a 70% solution of isopropyl alcohol if necessary. **DO NOT EXPOSE THE BASE STATION TO ANY LIQUID. IT IS NOT A SEALED DEVICE.**

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- The units are not shockproof and should not be dropped or be subjected to excessive forces or accelerations.



The recharging Base Station is not water-resistant. Under no circumstance should this unit be exposed to water or any other type of liquids.

Specifications

Trigno Sensors

GENERAL SPECIFICATIONS	
Typical Operating Range ⁽¹⁾	40 m
Transmission Source	2.4 GHz, 1 mW
Power Consumption	<60 mW
Case Dimension	27 x 37 x 15 mm
Case Material	medical-grade polycarbonate
Full-charge Operation Time ^(2,3)	8 hours
Recharge Time	<2.5 hours
Mass	< 15g
Auto Shut-down timer	300 seconds
Temperature Range ⁽⁴⁾	5 - 50 degrees Celsius

- (1) Range is characterized in open office environments. Interfering RF sources in the 2.4GHz spectrum, as well as absorptive objects occluding the RF communication path may degrade transmission distance. Stated range can be exceeded under favorable RF conditions.
- (2) Battery duration is a function of charge and discharge conditions. Optimal battery performance is obtained when the device is operated at room temperature. Note that the stated Operation Time reflects the expected performance of a fully charged new battery used in a sensor that is transmitting data. Operation Time is expected to decrease as a function of charge cycles, and when the sensor is searching for a network.
- (3) 80% of original battery capacity is maintained after 300 discharge/recharge cycles. This value represents a typical expectation under ideal conditions. Actual performance will vary depending on usage conditions.
- (4) Operation beyond these temperature limits may damage the rechargeable battery.

EMG SENSOR SPECIFICATIONS	
Range ⁽¹⁾	11 mV (r.t.i.)
Resolution (EMG Signal) ⁽²⁾	168 nV/bit
Bandwidth (EMG Signal) ⁽³⁾	20±5 Hz, >40 dB/dec 450±50 Hz, >80 dB/dec
Passband Ripple ⁽³⁾	<2%
Overall Channel Noise ⁽⁴⁾	<0.75uV
CMRR	>80 dB
Sampling Rate ⁽⁵⁾	2000 samples/sec 4000 samples/sec
Number of Contacts	4
Contact Dimension	5 x 1 mm.
Contact Material ⁽⁶⁾	99.9% Silver

- (1) Range is specified for the input of the EMG sensor and is samples with 16 bits
- (2) Resolution is specified for the input of the sensor.
- (3) Filter is designed as a maximally flat Butterworth to preserve EMG signal amplitude and phase linearity.
- (4) Input-referred noise is calculated as a root mean square over a 5 second window sampled at 2kHz.
- (5) EMG signal sampling rates are intrinsic to the sensor and cannot be changed beyond the two stated rates, which are software selectable.
- (6) Sensor skin contacts are made from pure silver and should not be used if allergic reactions to silver are expected or found to occur.

ACCELEROMETER SPECIFICATIONS	
Number of Axis	3
Range ^(1,2)	±1.5g ±6g
Resolution ⁽²⁾	0.016 ± 0.001 g/bit 0.063 ± 0.005 g/bit
Offset Error ⁽³⁾	±0.2g
Bandwidth	DC - 50±5 Hz, 20dB/dec
Sampling Rate ⁽⁴⁾	148.1 / 296.3 samples sec

- (1) Accelerometer range is software selectable.
- (2) Accelerometer output is sampled with 8 bits over full range (±2g, ±7g). Readings exceeding the nominal range of ±1.5g and ±6g may be non-linear and are not guaranteed.
- (3) Offset errors can nulled in software by using a calibration routine that references the normal gravitation force.
- (4) Accelerometer sampling rates are intrinsic to the sensor and cannot be changed beyond the two stated rates, which are software selectable.

Trigno Recharging Base Station

GENERAL SPECIFICATIONS	
Typical Operating Range	40 m ⁽¹⁾
Transmission Source	2.4 GHz, 1 mW
Power Consumption	<10W
Sensor Recharge Time	< 2.5 hours
USB type	USB 2.0 compliant, high speed
Temperature Range	5 - 50 degrees Celsius
Maximum number of Sensors	16
Inter-sensor delay	<500 us
Dimensions	276 x 241 x 127 mm

- (1) Range is characterized in normal office environments. Interfering RF sources in the 2.4GHz spectrum, as well as absorptive objects occluding the RF communication path may degrade transmission distance. Stated range can be exceeded under favorable RF conditions.

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ANALOG OUTPUT SPECIFICATIONS	
Number of outputs	16 EMG, 48 Accelerometer
Signal group delay ⁽¹⁾	48 ms
EMG Signal Range	±5 V
Effective EMG Signal Gain ⁽²⁾	909 V/V
Accelerometer Signal Range	±5 V
Nominal Accelerometer Signal Gain ⁽³⁾	2.42 V/g @ ±1.5g range 0.62 V/g @ ± 6 g range
Channel Offset	±100 mV (max)
Baseline Noise	0.5mV RMS
Passband Ripple ⁽⁴⁾	<2% with Sin(X)/X correction
Connector Type	SCSI-68, Type II

- (1) Delay from sensor event to analog output is fixed for all channels, and referenced as a "group delay".
- (2) This parameter relates the detected voltage input at the sensor to the reproduced voltage at the EMG channel output.
- (3) This parameter relates the nominal uncalibrated voltage differential for an inertial displacement of 1 g.
- (4) Sin(X)/X correction is applied to each channel for cancelling the distorting effects of the DAC sampling process.

Appendix I

Mains Isolation

The Trigno Base Station is provided with Medical Grade isolated power supply which is compliant with IEC60601 series of harmonized standards for Medical Devices. However, full compliance with IEC60601-1 Basic Safety for Medical Devices requires that the PC operating the software be isolated as well. This stems from the basic requirement to have all patients electrically isolated from equipment within their reach, and since the PC running the Trigno Software is conceivably within their reach, it too must be isolated.



Delsys does not supply isolation transformers for Personal Computers and their peripherals.



Delsys recommends model IS1000HG manufactured by Tripp Lite (www.tripplie.com) for this task. This device is a medical grade isolation transformer capable of delivering up to 1000 W. A smaller similar version for 500W is also available (IS500HG).

Similar products compliant with IEC60601-1 are acceptable.

Appendix II

DC-A22 Underterminated Output Cable

The DC-A22 Underterminated Output Cable provides access to all 64 analog output channels from the Trigno System on discrete wires for data acquisition systems with screw-type terminations.

The DC-A22 cable connects directly to the output connector labeled "1-64" on the Trigno System and terminates in 67 signal conductors with pre-stripped ends (64 analog output signals and 3 GND conductors).

Each conductor employs a unique color scheme to identify its signal. The conductor jacket is the primary color, and it is marked with a secondary color. An example of the coloring scheme is shown in Figure 22 below.

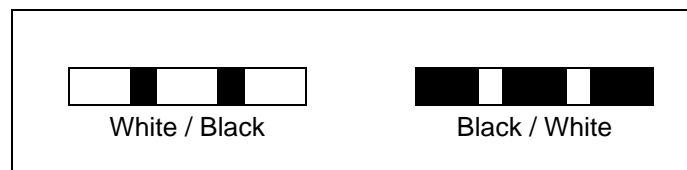


Figure 22. Wire color scheme example.

Installation

Refer to Figure 23 for installing the DC-A22 cable. Please observe the following points:

- Connect the GND wires to the data acquisition system ground for analog inputs. It is recommended to twist all three wires together and connect these to a common ground point on the measurement system to avoid the risk of creating ground loops.
- Ensure that any unused conductors are not exposed and will not come into contact with each other or any other signal or voltage potential. This can be done by clipping the bare ends of the conductors or using heat shrink tubing or electrical tape to enclose the bare ends.

DC-A22 Conductor Assignments

Trigno Output	Trigno Pin	Conductor Color Primary / Secondary
EMG 1	68	Violet / Orange
AX 1	67	Blue / Orange
AY 1	33	Orange / Blue
AZ 1	34	Orange / Violet
EMG 2	66	Green / Orange
AX 2	65	Yellow / Orange
AY 2	31	Orange / Yellow
AZ 2	32	Orange / Green
EMG 3	64	Gray / Pink
AX 3	63	Violet / Pink
AY 3	29	Pink / Violet
AZ 3	30	Pink / Gray
EMG 4	62	Blue / Pink
AX 4	61	Green / Pink
AY 4	27	Pink / Green
AZ 4	28	Pink / Blue
EMG 5	60	Yellow / Pink
AX 5	59	Orange / Pink
AY 5	25	Pink / Orange
AZ 5	26	Pink / Yellow
EMG 6	58	Gray / Brown
AX 6	57	Violet / Brown
AY 6	23	Brown / Violet
AZ 6	24	Brown / Gray
EMG 7	55	Green / Brown
AX 7	54	Yellow / Brown
AY 7	20	Brown / Yellow
AZ 7	21	Brown / Green
EMG 8	53	Orange / Brown
AX 8	52	Pink / Brown
AY 8	18	Brown / Pink
AZ 8	19	Brown / Orange
EMG 9	51	Gray / Tan
AX 9	50	Violet / Tan
AY 9	16	Tan / Violet
AZ 9	17	Tan / Gray
EMG 10	49	Blue / Tan
AX 10	48	Green / Tan
AY 10	14	Tan / Green
AZ 10	15	Tan / Blue
EMG 11	47	Yellow / Tan
AX 11	46	Orange / Tan
AY 11	12	Tan / Orange
AZ 11	13	Tan / Yellow
EMG 12	45	Pink / Tan
AX 12	44	Brown / Tan
AY 12	10	Tan / Brown
AZ 12	11	Tan / Pink
EMG 13	42	Violet / White
AX 13	41	Blue / White
AY 13	7	White / Blue
AZ 13	8	White / Violet
EMG 14	40	Green / White
AX 14	39	Yellow / White
AY 14	5	White / Yellow
AZ 14	6	White / Green
EMG 15	38	Orange / White
AX 15	37	Pink / White
AY 15	3	White / Pink
AZ 15	4	White / Orange
EMG 16	36	Brown / White
AX 16	35	Tan / White
AY 16	1	White / Tan
AZ 16	2	White / Brown
GND	9	White / Gray
GND	22	Brown / Blue
GND	43	Gray / White
NC	56	Blue / Brown

Figure 23. DC-A22 Conductor Assignments
