



Trigno[®] Wireless Biofeedback System

— Avanti Analog Input Adapter

User's Guide

**Download EMGworks[®] at
www.delsys.com/emgworks**

Copyright © 2019 by Delsys Incorporated

MAN-021-2-0

MP1289A

August 2019



No part of this document may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language in any form by any means without the written permission of Delsys Inc.

Important Information.....	3
Intended Use	3
Contraindications	3
Technical Service and Support	3
Warnings and Precautions	4
Device Information.....	5
Windows PC Requirements	6
Android Device Requirements.....	6
Trigno System Overview	7
Trigno Analog Adapter Features.....	7
Robust +/-5V Input Signal	8
Industry Standard Connectors	8
Pushbutton Event Marker	8
Dual Mode “BLE-Base” Communication	8
Wireless Communication	8
Data Synchronization	8
Rechargeable Battery.....	8
Sealed Enclosure	9
Internal Magnetic Switch	9
Sensor LED Feedback States	9
Getting Started with the Analog Input Adapter	11
Configuring the Trigno Analog Input Adapter	11
Using the Analog Outputs (if Equipped)	11
Analog Input Adapter Connections	12
Single Channel BNC Connection (DC-X06).....	12
Quad Channel BNC Connection (DC-X07).....	13
Biodex Isokinetic Device Connection (DC-X05)	13
Event Marker Button (DC-X08)	13
Maintenance and Care.....	14
Trigno Sensors	14
Specifications.....	15
Physical Specifications.....	15
Electrical Specifications	15
Analog Input Measurement Data Modes	16

Important Information

Intended Use

The Trigno Analog Adapters are components of the Trigno® Wireless Biofeedback System used view +/-5V output signals. This system is a battery-powered biofeedback device that enables researchers and clinicians to acquire EMG and related signals from subjects for biofeedback and research purposes. The System is intended for relaxation training and muscle reeducation. Interpretation of the EMG and supporting signals by a qualified individual is required.

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.



DO NOT USE in critical care applications.

Technical Service and Support

For information and assistance please visit our web site at:
www.delsys.com

Contact us at:

E-mail: support@delsys.com

Telephone: (508) 545 8200

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 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.



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.



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



Trigno Systems should be stored and operated between 5 and 45 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)



Type BF Equipment.



Date of Manufacturing (appears on device)



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



Serial Number (appears on device)



Dispose the device according to local rules for electronic waste.



Authorized Representative:
EMERGO EUROPE
Prinsessegracht 20, 2514 AP The Hague
The Netherlands

Trigno Wireless Biofeedback System

Sensor Model: SP-W06-025 (“Trigno Avanti Analog Input Adapter”)

System Model: DS-T03

FCCID: W4P-SP-W06 (Sensor)

FCCID: W4P-SP-W02 (Base Station)

IC: 8138A-DST03 (System)

[R] 211-190332 (DS-T03)

[R] 211-190333 (SP-W06)



This device complies with Part 15 of the FCC Rules and Industry Canada’s RSS-210 License Exempt Standards. 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 Class B digital apparatus complies with Canadian ICES-003.

Cet appareil est conforme à des règlements d'Industrie Canada exempts de licence standard RSS (s). Son fonctionnement est soumis aux deux conditions suivantes: (1) Ce dispositif ne doit pas causer d'interférences nuisibles, et (2) cet appareil doit accepter toute interférence reçue, y compris les interférences pouvant entraîner un fonctionnement indésirable.

Cet appareil numérisé de la classe B est conforme 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 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.



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.



Please refer to the main Trigno System User Guide for additional information.

Windows PC Requirements

- EMGworks 4.7 or later
- Windows 7, 8.1, 10
- One USB 2.0 port
- At least 2.0 GHz processor clock speed
- At least 2 GB system memory
- 1280x1024 (SXGA) display resolution or better
- 50 GB hard disk storage (minimum)

Android Device Requirements

- Android V 7 (Nougat) operating system or later
- BLE 4.2 support
- RAM 1GB minimum
- Storage 8 GB minimum
- Screen Resolution 2048x1536 (recommended)
- Recommended Tablet:

Samsung Galaxy Tab S2
8" screen, 32 GB, WI-FI
(SM-T713NZKEXAR)

or

Samsung Galaxy Tab S5e
10.5" AMOLED screen, 64 GB Storage
Android 9.0 (Pie), WiFi & Bluetooth v.5.0

Trigno System Overview

The Trigno® Analog Input Adapter is a component of the Trigno Wireless Biofeedback System, a device designed to make EMG (electromyographic) and biofeedback signal detection reliable and easy. The system transmits signals from the Trigno sensors to a receiving base station using a time-synchronized wireless protocol which minimizes 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 and triggering information. For mobile biofeedback applications, Trigno Sensors can communicate with Bluetooth BLE 4.2 compliant host devices. The system is also capable of integrating with 3rd party lab equipment through a variety of interfaces which include analog signal generation, triggering scenarios and digital integration through the Trigno SDK (Software Development Kit) and the Trigno API (Application Program Interface). **Refer to the Trigno System User Guide for System information and operational details.**

Trigno Analog Adapter Features

The Trigno Analog Adapters are capable of sampling up to 4 channels of +/-5V analog signals from 3rd party devices. The adapter is terminated in a 9-Pin DSUB female connector and can be fitted with up to 4 BNC connectors.

- Configurable bandwidth DC-100 Hz or DC-1000 Hz
- Max input range of +/-5V
- Up to 4 independent channels
- 16 bits of resolution
- software selectable operational modes
- inter-sensor latency < 1 sample period
- wireless transmission range 20+m¹
- self-contained rechargeable battery
- battery charge monitoring and status indicator
- environmentally sealed enclosure
- low power mode
- auto shutoff
- internal magnetic switch
- LED User Feedback
- Industry Standard DSUB-9 connector
- Optional Industry Standard BNC connectors
- Optional push-button attachment for event triggering



1. Communication distance is dependent on the RF operating environment.

Robust +/-5V Input Signal

The analog input adapter can accept 4 voltage signals in the +/-5V range and sample these to a resolution of 16 bits alongside other data from Trigno sensors. The adapter has a selectable filter of DC-100 Hz or DC-1000 Hz, depending on the configured mode that the adapter is operated in (see mode selection tables in the appendices).

Industry Standard Connectors

To facilitate connections to signals from 3rd party devices, the analog input adapter terminates in a 9-pin female DSUB connector. Mating components are available to support BNC connections or direct connections to isokinetic devices.

Pushbutton Event Marker

An optional pushbutton attachment to analog input adapter is available and can be used to manually denote events during biofeedback sessions. Events are marked as high-to-low signal transitions and are time synchronized with all other signal data from the Trigno System.

Dual Mode “BLE-Base” Communication

Trigno sensors are capable of communication with a PC-connected Base station using the Trigno custom 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

The Trigno wireless communication scheme offers robust data transmission for up to 16 Trigno sensors operating in full bandwidth mode, with a nominal distance of 20m. 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 so no time skew between data exists. A maximum of 16 sensors can stream data to a host base station at one time. These features are available only when communicating with the PC-connected Base Station; the Bluetooth/BLE protocol does not guarantee latency.

Rechargeable Battery

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

Sealed Enclosure

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

Internal Magnetic Switch

The Trigno sensors are equipped with an internal magnetic switch which is used to turn the sensors “on” and to 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 the sensors are undocked from the charger or when the software is performing an RF pairing operation. Exposure to any magnetic fields outside of these 2 qualifying conditions will be ignored by the sensor. The internal magnetic switch is a feature which removes the need for a mechanical button and improves sensor durability and performance. Common household magnets can be used to perform these functions as well.

Sensor LED Feedback 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 Guide.



































	State	Color	Pattern	Arrow Display
	Common States			
1	Power Off	Off	none	
2	Power On/Activate	White/Green	fade	 / 
3	Charging	Amber	solid	
4	Charge Complete	Green	solid	
5	Identification Mode	White	rapid flash	 /  / 
6	Scan (Startup)	Amber/Cyan	slow flash	 / 
7	Power Up Error	Red	slow flash	 / 
	Trigno RF Mode			
8	Scan (Base)	Amber/Green	Slow flash	 / 
9	Low Power Scan (Base)	Amber	Occasional Flash	 / 
10	Data Collection (Base)	Green	slow flash	 / 
11	Configuration Change (Base)	Green	rapid flash (3x)	 /  / 
12	Pairing (Base)	Amber	solid	
13	Pairing Success (Base)	Green	rapid flash (≥6x)	 /  / 
14	Pairing Fail (Base)	Red	double flash(≥3x)	 /  / 
	BLE Mode			
15	Advertise (BLE)	Cyan	Slow flash	 / 
16	Low Power Advertise (BLE)	Cyan	occasional flash	 / 
17	Data Collection (BLE)	Blue	slow flash	
18	Idle (BLE)	Magenta	slow flash	

Table 1: Sensor LED functions.

LED State Descriptions

- 1) **Power Off:** No LED arrow activity is present when the sensor is off.
- 2) **Power On:** When undocked, the sensor illuminates white and fades to black. A magnetic field will turn the sensor on within 6 seconds, otherwise the arrow fades to dark and sensor turns off.
- 3) **Charging:** Sensor Charging in the Trigno Base Station is denoted by continuous amber LED arrow illumination
- 4) **Charge Complete:** Once the internal sensor battery has been fully recharged, the LED arrow illuminates to continuous green.
- 5) **Identification Mode:** The arrows blink 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 (PC Base Station or BLE tablet).
- 7) **Power Up Error:** Sensor fails self-check on power up
- 8) **Scan (Base):** Sensor was previously paired and is scanning for the active base station.
- 9) **Low Power Scan (Base):** Sensor was previously paired and has been scanning for the active base station for more than 5 minutes.
- 10) **Data Collection (Base):** Data from sensor are streaming to a paired PC-connected base station.
- 11) **Configuration Change (Base):** Sensor acknowledges change in configuration sensor from host base station.
- 12) **Pairing (Base):** Sensor is performing a pair operation with the base host.
- 13) **Pairing Success (Base):** Sensor successfully completes a pair operation with the Base Station host.
- 14) **Pairing Fail (Base):** The pair operation did not complete successfully with the Base Station host.
- 15) **Advertise (BLE):** Sensor is broadcasting to connect with a BLE host.
- 16) **Low Power Advertise (BLE):** Sensor is broadcasting to connect with a BLE host for more than 5 minutes.
- 17) **Data Collection (BLE):** Sensor is sampling and streaming data to BLE host.
- 18) **Idle (BLE):** Sensor is waiting for a Bluetooth BLE command.

Getting Started with the Analog Input Adapter



Please refer to the Trigno System User guide for key operational details regarding the base station, sensor charging, and initiating the sensor.

Configuring the Trigno Analog Input Adapter

Once paired to the system, the analog input adapter can be configured in the following ways:

Input Sensing Characteristics			
Input Range ¹	+/-5 Volts		
Frequency Considerations			
Bandwidth ¹	DC-100 Hz	or	DC-1000 Hz
Filter	Butterworth, 2 pole	or	Bessel, 2 pole
Sampling Considerations ³	Single data slot modes		Multi-data slot modes

¹Take care to ensure that voltage inputs do not exceed +/-5V in amplitude.

²Accuracy of voltage signal representation is dependent on the series output impedance of the device to which the adapter is connected. A series output impedance of 50 ohms or less is recommended. Signal amplitude and offset is derated by the following equation as a function of source output impedance:

$$V_{in} = \frac{37.4k\Omega + R_s}{37.4k\Omega} (V_{sw} - 1.267) + 1.267$$

³Refer to mode tables in the appendix for additional details on sampling options.

Using the Analog Outputs (if Equipped)

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 and range cover the +/-5V range. Analog outputs are engaged through software and are only available for specific sensor sampling configurations as stated below:

	Sampling Rate	Data Type	Bandwidth
Ch. x.1	1926 sa/sec	EMG	20-450 Hz

Table 2: Analog Output signal details. Note that sampling rates are approximate; please refer to specification table for precise sampling periods.

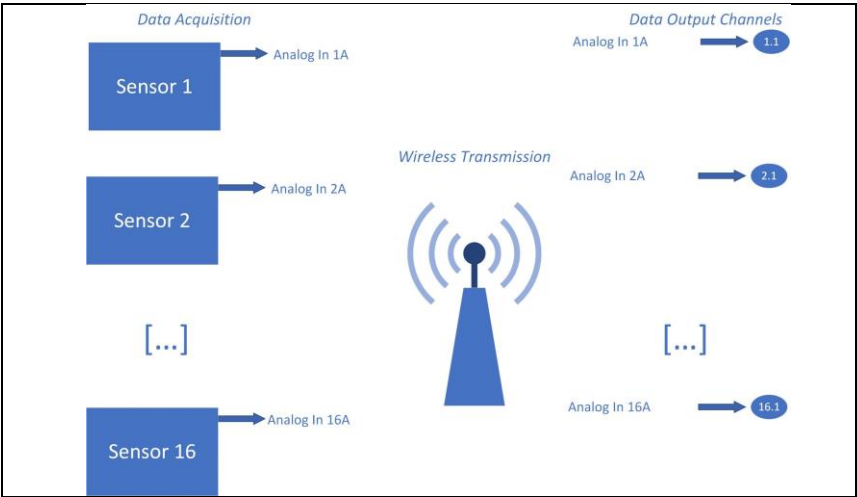


Figure 1: Analog Output Data Flowchart

Refer to the Trigno System User Guide for more information on Analog Output Operation.

Analog Input Adapter Connections

Users can interface with the analog adapter according to the signal map below, using commonly found catalog 9-Pin D-SUB male mating connectors with female thumb-screw sockets. The recommended mating connector with jack screws is Norcomp 172-009-102R031 along with matching plastic hood, Norcomp 970-009-010R011. Standard 9-pin DSUB alternative connectors are acceptable.

Adapter Channel	DSUB Pin	
A	6	
B	9	
C	7	
D	8	
Common	1,2,3,4,5	

Figure 2: Trigno Avanti Analog Input Adapter. DSUB connector makes ground and 4 channel inputs available for sampling +/-5V signals. Bandwidth setting of DC-100 Hz is recommended for single BW data slot operation and DC-1000 Hz will require multi-slot acquisition.

Single Channel BNC Connection (DC-X06)

The single channel BNC connector makes available channels “A” from the adapter to an industry standard female BNC connector. The remaining 3 channels are unaccusable when using this attachment. Single data slot modes can support both bandwidth options of DC-100 Hz and DC-1000 Hz.

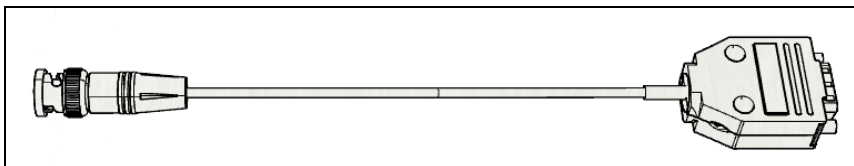


Figure 3: The Single Channel BNC attachment.

Quad Channel BNC Connection (DC-X07)

The quad channel BNC attachment maps channels “A” through “D” to industry standard female BNC connectors. Single data slot modes can support the low bandwidth options of DC-100 Hz, while multi-data slot modes support the high bandwidth option of DC-1000 Hz.

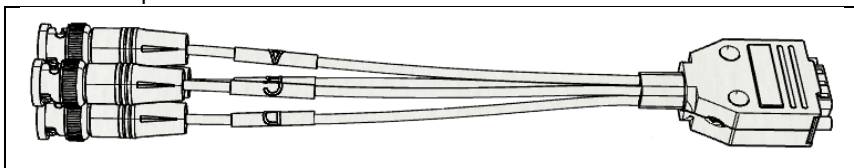


Figure 4: The Quad Channel BNC attachment.

Biodex Isokinetic Device Connection (DC-X05)

A conversion cable for Biodex Isokinetic devices is available that maps the 9-pin DSUB connection of Analog Input Adapter to the 15-pin DSUB connector of the Analog Output port of Biodex Isokinetic devices.

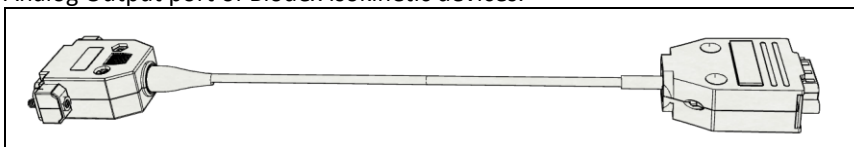


Figure 5: The analog signal connector for Biodex Isokinetic devices.

Event Marker Button (DC-X08)

A push-button attachment is available that can be used to manually toggle a signal line from a voltage “high” to a voltage “low” signal to mark events.

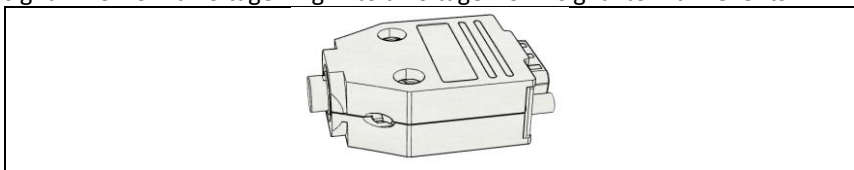


Figure 6: Event Marker Button attachment.

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 with 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.
- Do not pull, kink or twist cables as damage may occur.



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.



Do not pull the cable as this will result in damage.



Do not exceed voltages of +/-5 Volts as damage may occur.



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

Specifications

Physical Specifications








Dimension (Body)	27 x 46 x 13 mm
Cable Length SP-W06-025	127mm (5 inch)
Mass	25g
Temperature Range ⁽¹⁾	5 - 45 degrees Celsius

1) Exposure beyond these temperature limits may damage the rechargeable battery.

Electrical Specifications

RF Frequency Band	2400-2483 MHz (ISM band)
EMG Signal Input Range	11mV / 22mV r.t.i.
EMG Signal Bandwidth	20-450 Hz / 10-850 Hz
Accelerometer Range	±2g, ±4g, ±8g, ±16g
Accelerometer Bandwidth	24 Hz – 473Hz (configurable in software)
Gyroscope Range	±250 dps, ±500 dps. ±1000dps, ±2000dps
Gyroscope Bandwidth	24Hz – 361 Hz (configurable in software)
Magnetometer Range	±4900 uT
Magnetometer Bandwidth	50 Hz
Inter-Sensor Delay	< 1 sample period (Base Station only)
Intra-Channel Delay	< 1-2 sample period

Analog Input Measurement Data Modes

	Configuration ID	# Data Slots ¹	# Analog Input Channels	Analog Input Sampling Period ² (ms)	Analog Input Sampling Rate ² (sa/sec)	Analog Input Bandwidth ³ (Hz)	Analog Input Input Range ⁴ (V)	Analog Input Resolution Depth ⁵ (bits)
	1	1	4	1.93	519	DC-100	+/- 5	16
	2	2	4	0.9	1111	DC-100	+/- 5	16
	3	4	4	0.45	2222	DC-100 DC-1000	+/- 5	16
	4	1	1	0.52	2222	DC-100 DC-1000	+/- 5	16
	5	2	1	0.225	4444	DC-100 DC-1000	+/- 5	16
 	6	1	1	27 / 52	1926	DC-100	+/- 5	16

- 1)
- The Trigno System is designed with 16 data slots for wireless transmission. Sensors can occupy up to 4 slots depending on the sampling rate settings.
- 2)
- Sampling period is the precise time elapse between samples in milliseconds. The sampling rate is a rounded expression of 1/"sampling period" expressed as samples/second (sa/sec).
- 3)
- Analog Input Sensor Butterworth filter bandwidth (0-100Hz): 2 pole low pass corner in Hz.
- 4)
- Analog Input Sensor Bessel filter bandwidth (0-1000Hz): 2 pole low pass corner in Hz.
- 5)
- Analog signal input range of sensor in Volts.
- 6)
- Sensor resolution depth across input range.



Denotes Analog Input Voltage signal detection.



Denote analog output supported mode.

This page intentionally left blank.

This page intentionally left blank.