

# 2150EX Area Velocity Flow Module

## Installation and Operation Guide



Part #69-2003-347 of Assembly #60-2004-347  
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Revision BB, November 2014





## Foreword

This instruction manual is designed to help you gain a thorough understanding of the operation of the equipment. Teledyne Isco recommends that you read this manual completely before placing the equipment in service.

Although Teledyne Isco designs reliability into all equipment, there is always the possibility of a malfunction. This manual may help in diagnosing and repairing the malfunction.

If a problem persists, call or e-mail Teledyne Isco technical support for assistance. Simple difficulties can often be diagnosed over the phone. For faster service, please have your serial number ready.

If it is necessary to return the equipment to the factory for service, please follow the shipping instructions provided by technical support, including the use of the **Return Merchandise Authorization (RMA)** specified. **Be sure to include a note describing the malfunction.** This will aid in the prompt repair and return of the equipment.

Teledyne Isco welcomes suggestions that would improve the information presented in this manual or enhance the operation of the equipment itself.

**Teledyne Isco is continually improving its products and reserves the right to change product specifications, replacement parts, schematics, and instructions without notice.**

## Contact Information

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*General Warnings*

Before installing, operating, or maintaining this equipment, you should read this entire manual. While specific hazards may vary according to location and application, it is still helpful to read this safety section (which is specific to the 2150EX) and the general safety information contained in Appendix E. If you have any questions regarding the equipment or its installation, contact Teledyne Isco or one of its representatives for assistance.

This manual has been created in compliance with general requirements for equipment installed in potentially explosive atmospheres (refer to Clause 28 of EN 50014:1997).

 **WARNING**

**Avoid hazardous practices! If you use this instrument in any way not specified in this manual, the protection provided by the instrument may be impaired; this will increase your risk of injury.**

 **WARNING**

**Intrinsic safety is dependent on proper installation in accordance with IEC 60079-14 and IEC 60079-17 International Standards, or ATEX Group II, Category 1G requirements of the authority that has jurisdiction for the installation of equipment in hazardous areas at your specific installation site. Installation should be performed only by trained and qualified personnel.**

*Hazard Severity Levels*

This manual applies *Hazard Severity Levels* to the safety alerts. These three levels are described in the sample alerts below.

 **CAUTION**

Cautions identify a potential hazard, which if not avoided, may result in minor or moderate injury. This category can also warn you of unsafe practices, or conditions that may cause property damage.

 **WARNING**









**Warnings identify a potentially hazardous condition, which if not avoided, could result in death or serious injury.**

 **DANGER**

**DANGER – limited to the most extreme situations to identify an imminent hazard, which if not avoided, will result in death or serious injury.**

*Hazard Symbols*

The equipment and this manual use symbols to warn of hazards. The symbols are explained below.

<b>Hazard Symbols</b>	
<b>Warnings and Cautions</b>	
	The exclamation point within the triangle is a warning sign alerting you of important instructions in the instrument's manual.
	The lightning flash and arrowhead within the triangle is a warning sign alerting you of "dangerous voltage" inside the product.
<b>Symboles de sécurité</b>	
	Ce symbole signale l'existence d'instructions importantes relatives au produit dans ce manuel.
	Ce symbole signale la présence d'un danger d'électocution.
<b>Warnungen und Vorsichtshinweise</b>	
	Das Ausrufezeichen in Dreieck ist ein Warnzeichen, das Sie darauf aufmerksam macht, daß wichtige Anleitungen zu diesem Handbuch gehören.
	Der gepfeilte Blitz im Dreieck ist ein Warnzeichen, das Sie vor "gefährlichen Spannungen" im Inneren des Produkts warnt.
<b>Advertencias y Precauciones</b>	
	Esta señal le advierte sobre la importancia de las instrucciones del manual que acompañan a este producto.
	Esta señal alerta sobre la presencia de alto voltaje en el interior del producto.

*2150EX Safety  
Information*

The intrinsically safe 2150EX is intended for use in potentially explosive atmospheres, and complies with ATEX Directive 94/9/EC. The 2150EX is Group II, Category 1G equipment for use in gas hazard zones 0, 1, and 2 (European standards), or Class I, Division 1 (North American standards). Class I, Div 1 is classified by European standards as Zones 0 and 1.

*Class I*

Locations where flammable gases or vapors may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. Equipment approved for these locations has been evaluated for maximum explosion pressure, maximum safe clearance between parts of a clamped joint in an enclosure, and the minimum ignition temperature of the atmosphere mixture.

*Class I, Division 1*

These are locations in which:

1. ignitable concentrations of flammable gases or vapors can exist under normal operating conditions; or
2. ignitable concentrations of such gases or vapors may exist frequently because of repair, maintenance operations, or leakage; or
3. breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors, and may also cause simultaneous failure of electric equipment.



*2150EX Module Connected to  
2196EX Battery Module and AV2150EX Sensor*

*Designed for safety*

Installation should be completed with adherence to local requirements for ATEX Group II, Category 1G or 2G equipment as appropriate, and should be done by trained and qualified personnel.

The purpose of intrinsic safety is to limit the energy available to a given circuit or device to a level where electrical discharge (sparking) cannot ignite the hazardous (flammable or explosive) atmosphere. With no spark ignition possible, safe operation of the equipment in areas with hazardous atmospheres is possible.

The durable 2150EX, 2196EX, and 2194EX enclosures are made with ABS plastic embedded with conductive carbon fiber, giving the units low surface resistance to minimize electrostatic energy.

The 2150EX system has been designed so that it does not cause physical injury or other harm due to contact. It does not produce excessive surface temperature or dangerous radiation. When used properly, it does not present any non-electrical dangers.

*Labels*

Read all labels carefully before installing the equipment!

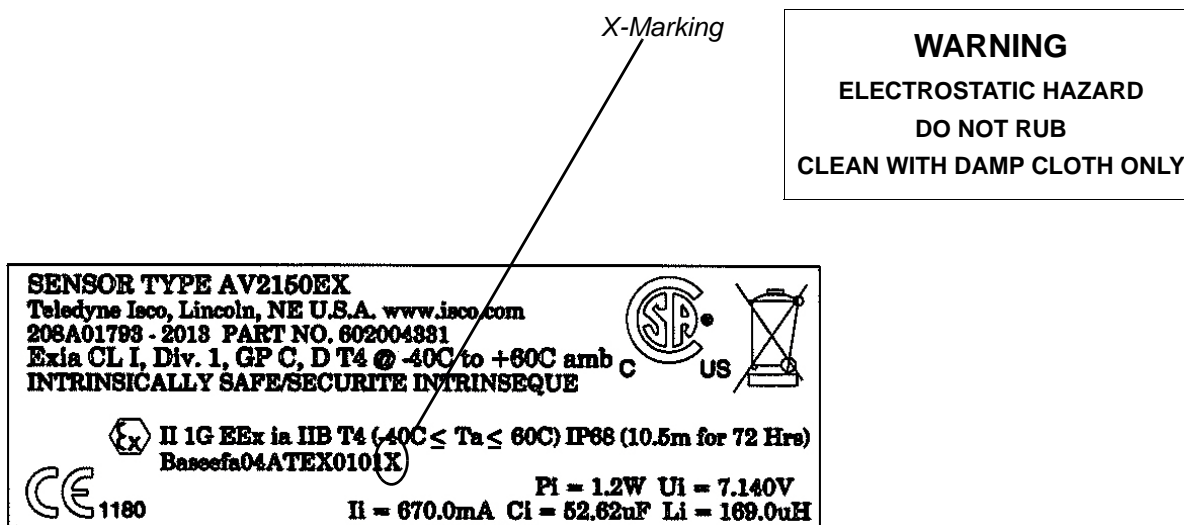
The 2150EX and its components are clearly labeled with color and/or text so you know what can be located in a safe or hazardous area (see figure below). For example, on the label shown below, light blue is used to indicate the intrinsically safe end and yellow to indicate the non-protected end of the cable and connector.



*Example of Safe and Hazardous Area Labeling on RS232EX Cable*

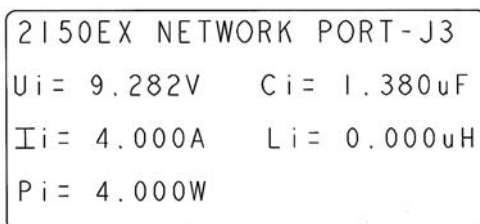
Some system components have an X marking, as shown in the example on the following page. The X marking indicates that there are special conditions that must be met to ensure intrinsic safety. In the case of the sensor cable, there is a danger of static electricity. The cable is labeled with a warning telling you that you should not rub the sensor with a dry cloth, as this might generate static electricity.





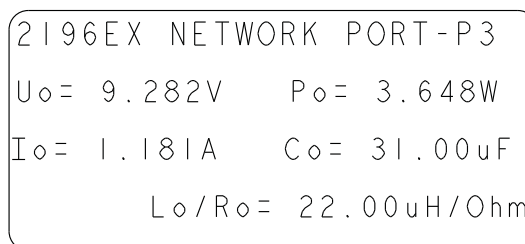
*AV2150EX Sensor Cable Labels*

Where applicable, the labels contain other information, such as voltage, serial number identification, etc. For example, the label shown below indicates the maximum input voltage ( $U_i$ ), input current ( $I_i$ ), and input power ( $P_i$ ) that can be applied to the 2150EX network port without invalidating intrinsic safety. It also shows the internal capacitance ( $C_i$ ), and internal inductance ( $L_i$ ) that must be allowed by any power source.



*Example of 2150EX Label*

When you compare the 2150EX label in the figure above with the 2196EX label in the figure below, you can see they provide a helpful reference so you can make sure your connections are safe.



*Example of 2196EX Label*

For example, the 2150EX network port cannot have an input voltage greater than 9.282V. When you look at the label on the power source, you can see that the maximum output voltage is 9.282V. From this you know that you can safely connect the two, and will not be providing too much voltage to the 2150EX unit.

 **Note**

This information is not intended to fully explain entity parameters. Other publications should be referenced for more detailed explanations.

*Installation*

Installation of the 2150EX system is described in this manual. Typical round-pipe installations are shown in Figures 2-1 and 2-2, and Appendix E provides information on general safety procedures for work in manholes and sewers.

When the equipment is installed in accordance with the instructions in this manual, it will not be subjected to dangerous mechanical or thermal stresses. It should not be installed where it may be attacked by existing or foreseeable aggressive substances that could damage the module enclosures. The enclosures are made of Acrylonitrile Butadiene Styrene (ABS) plastic. Substances that may cause damage include organic solvents (ketones and esters, aromatic and chlorinated hydrocarbons), alcohols, hydrocarbons, fuels, and UV radiation.

*Repair and Maintenance*

Refer to Section 5 of this manual for instructions regarding periodic maintenance of the 2150EX and its components.

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The internal components of the 2150EX System are not user-serviceable. The case is completely sealed to protect the internal components. If you think your module requires repair, contact Teledyne Isco's Technical Service Department.

Rapidly failing desiccant may indicate a crack.

 **WARNING**

**Any cracks in the module case will impair the safety protection. If this occurs, return the unit to Teledyne Isco for a replacement.**

Components of the AV2150EX Sensor are encapsulated in plastic resin and are not user-serviceable. If any part of the AV Sensor fails, it must be replaced.

# 2150EX Area Velocity Flow System

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# 2150EX Area Velocity Flow System

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## *Section 1 Introduction*

### 1.1 Product Description

The 2150EX Area Velocity Flow Module is part of Isco's 2100 Series. The 2100 Series measures parameters of open channel flow streams.

The intrinsically safe 2150EX is intended for use in potentially explosive atmospheres, and complies with ATEX Directive 94/9/EC. The 2150EX is Group II, Category 1G or 2G equipment as appropriate for use in Hazardous Zones 0, 1, and 2.

The purpose of intrinsic safety is to limit the energy available to a given circuit or device to a level where electrical discharge (sparking) cannot ignite the hazardous (flammable or explosive) atmosphere. With no spark ignition possible, safe operation of the equipment in areas with potentially explosive atmospheres is possible.

The standard 2100 Series is designed to be modular so that you can expand the system by stacking modules to meet your data collection needs. The 2150EX incorporates this modularity, allowing up to two 2150EX modules to be stacked on one 2196EX battery module.

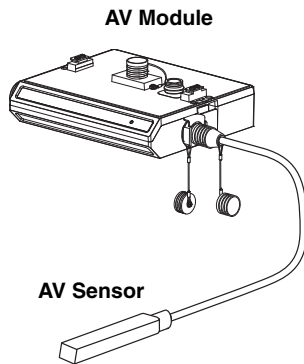
The 2150EX is paired with Isco's *Flowlink* software. With this full-featured application software, you can quickly set up the module, retrieve measurement data, manage the sites, and analyze the data, and update the module's own software, all without entering the hazardous area.

The module's data storage memory is quite flexible, able to store the measurements in intervals from 15 seconds to 24 hours. The module can also be configured for variable rate data storage. Variable rates allow you to store data at a different interval when a programmed condition occurs.

The module's program and collected data are stored in *flash* memory for security. Flash memory retains data without the concern of power failures or aging backup batteries. Its capacity is more than sufficient for most applications. The data storage memory can hold approximately 79,000 readings – the equivalent of nine months of level and velocity data when stored at fifteen minute intervals. The flash memory also stores sensor level adjustment information. A separate flash memory device inside the module stores the operating firmware.

The rugged 2150EX components are rated NEMA 4X, 6P (IP68). The permanently sealed enclosures are designed to meet the environmental demands of many sewer flow monitoring applications. All connections between sensors and communication cables "lock" in place. Each locking mechanism strongly secures the components and ensures a watertight seal.

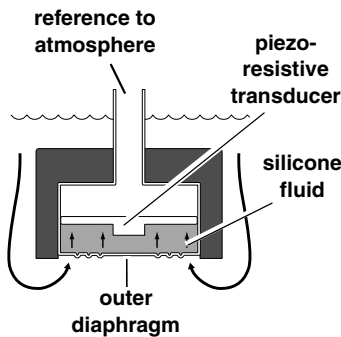
### 1.1.1 2150EX Area Velocity Flow System Overview



The 2150EX measures liquid level and average stream velocity, and calculates the flow rate and total flow. The liquid level and velocity measurements are read from an attached Area Velocity (AV) Sensor that is placed in the flow stream. Flow rate calculations are performed internally using the measured parameters from the AV Sensor. Additionally, the 2150EX can measure its input voltage.

The 2150EX is designed to provide durable operation with only a minimal amount of routine maintenance, all of which may be performed in the field, while keeping in mind restrictions for potentially explosive atmospheres. Typically, the 2150EX and its AV2150EX Sensor will only require that you keep the stream free from excessive debris, and replace or recharge spent desiccant and batteries. Sections 1.1.2 through 1.1.6 describe the 2150EX and sensor in greater detail.

### 1.1.2 Level

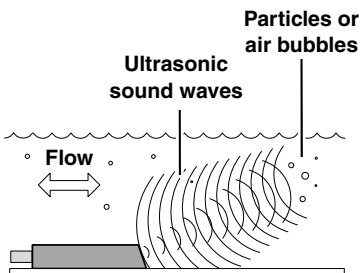


The AV Sensor's internal differential pressure transducer measures the liquid level. The transducer is a small piezo-resistive chip that detects the difference of the pressures felt on the inner and outer face.

The stainless steel outer diaphragm is exposed to the flow stream through the ports under the AV Sensor. The pressure felt on the outer diaphragm is transferred to the outer face of the transducer through a silicone fluid medium. The outer diaphragm and fluid isolate the sensitive transducer from direct exposure to the stream. The inner face of the transducer is exposed, or referenced, to the atmosphere through the internal vent tube that runs the full length of the AV Sensor's cable.

The difference between the pressures exerted on the transducer is the hydrostatic pressure. Hydrostatic pressure is proportional to the level of the stream. The Isco AV2150EX sensor uses state of the art techniques to ensure accuracy throughout the environmental operating range. At the factory each sensor is measured at scores of pressure and temperature levels to precisely characterize the unique transducer. These calibration results are digitally stored within the sensor's flash memory. During readings the sensor's microcontroller applies the known correction factor to produce highly accurate level readings.

### 1.1.3 Velocity



The AV Sensor measures average velocity by using ultrasonic sound waves and the Doppler effect. The Doppler effect states that the frequency of a sound wave (or other wave) passed from one body to another is relative to both their motions. As the two approach each other, the frequency increases; as they move apart, the frequency decreases.

The AV Sensor contains a pair of ultrasonic transducers. One transducer transmits the ultrasonic sound wave. As the transmitted wave travels through the stream, particles and bubbles carried by the stream reflect the sound wave back towards the AV Sensor. The second transducer receives the reflected wave.



Circuits internal to the module compare the frequencies of the sound waves and extract the difference. An increase or decrease in the frequency of the reflected wave indicates forward or reverse flow. The degree of change is proportional to the velocity of the flow stream.

#### 1.1.4 Flow Rate

Using measurements from the AV Sensor, the 2150EX can calculate the flow rate. Many different flow rate conversion methods are supported:

- Area Velocity
- Data Points
- Manning Formula
- Two-term Polynomial Equations
- Flumes
- Weirs

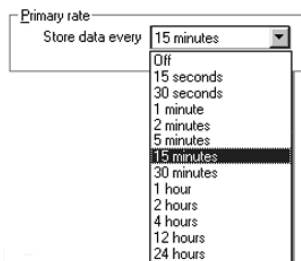
Often the 2150EX is chosen for applications where a primary device is not available, nor is it practical to install a primary device. Therefore, area velocity is usually the conversion method of choice.

The 2150EX is capable of calculating and storing any two conversion methods simultaneously. This feature is useful when it is necessary to validate a flow conversion method. For example, the flow rate at a new site programmed for area velocity conversion can be directly compared to the flow rate calculated using a Manning formula.

#### 1.1.5 Total Flow

The 2150EX can calculate and report the total flow. You can set up the system to monitor *net*, *positive*, or *negative* total flow from either of the calculated flow rates.

#### 1.1.6 Data Storage



Time Resolution

Through Flowlink, you configure which type of data is logged and the storage rate. For each measurement, the *Data Storage Setup* window lets you turn the primary rate off, or select a rate from 15 seconds to once every 24 hours. If the primary rate is turned off, the 2150EX will not store the measurement (unless a secondary rate is selected). However, the 2150EX will still take readings if that measurement type is necessary for a calculation.

Secondary rates are used to log data at a different rate when a user-defined condition exists. For example, a secondary rate can be used to increase the level and velocity data storage rate when level is greater than or equal to a point of interest. Secondary rates give you the best resolution of data, but only when it is needed. Until the condition is met, the module will conserve power and memory by storing the data at the primary storage rate. Like the primary rate, you can turn the secondary rate off, or select a storage rate of 15 seconds to every 24 hours.

The time resolution of each measurement is one second. That is, readings are taken at the same time as the time stamp, not collected and averaged over a period of time before the stamp.

Rollover Memory

Whether the measurements are stored at the primary or secondary rate, they are stored in a *rollover* type of memory. When full, the module overwrites the oldest data with the newest readings.

## 1.2 Identifying Module Components

The various components of the 2150EX are shown in Figures 1-1 through 1-4. Items referenced in the figures are described in Tables 1-1 through 1-4.

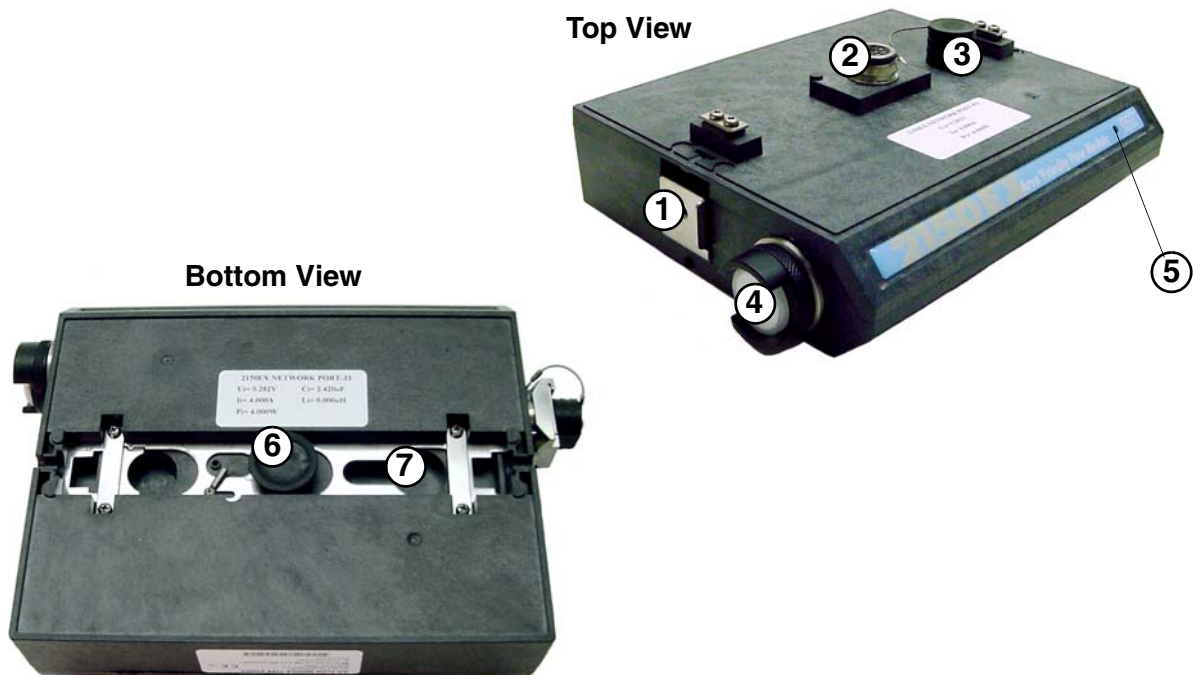


Figure 1-1 2150EX - Top and Bottom Views

Table 1-1 2150EX Area Velocity Flow Module - Top and Bottom Views		
Item No. Fig. 2-1	Name	Description
1	Latch	Latches the module in place. A latch release is located on the right side of the module.
2	Communication Connector (shown uncapped)	Upper communication port; used to connect to another module, or to a PC running Flowlink software.
3	Connector Cap (shown on holder)	Insert into unused communication connector to terminate the network and protect it from moisture damage. When the communication connector is in use, the cap must be stowed on its holder to protect the terminating components inside the cap.
4	Desiccant Cartridge and Hydrophobic Filter	The cartridge holds desiccant that dries the reference air. The filter prevents moisture from entering the reference line.
5	Communication Indicator	Illuminates when module communications are active.
6	Communication Connector (shown plugged)	Used to connect the module to the 2196EX battery module, or to another 2150EX module. When the communication connector is in use, the plug must be stowed in its holder to protect the terminating components inside the cap.
7	Plug Holder	Used to store the Connector Plug.



Figure 1-2 2150EX Connected to 2196EX- Top Right View

Table 1-2 2150EX Area Velocity Flow Module - Top Right View		
Item No. Fig. 2-2	Name	Description
1	Carrying Handle	Used to lift and carry the unit.
2	Communication Connector (shown capped)	Upper communication port, used to connect to another module or to a PC running Flowlink software.
3	Cap Holder	Used to store the connector cap.
4	AV Sensor Receptacle	Port used to attach the AV Sensor. Insert the protective cap when not in use.
5	2196EX	Contains rechargeable batteries, providing a source of power for the 2150EX.



Figure 1-3 Components – AV2150EX Area Velocity Sensor

<b>Table 1-3 Components – AV2150EX Area Velocity Sensor</b>		
<b>Item No. Fig. 1-3</b>	<b>Name</b>	<b>Description</b>
1	Connector Cap	Protects the connector. When the connector is not in use, this cap must be in place to prevent damage to the connector pins and reference air tubing.
2	Connector	Attaches to the AV Sensor receptacle on the 2150EX Module.
3	AV Sensor Body	The AV Sensor Body is placed in the flow stream to measure level and velocity.
4	Cable	10.0 m (32.8 ft) cable containing the reference air tubing and conductors to transfer level data, velocity data, and AV Sensor power.

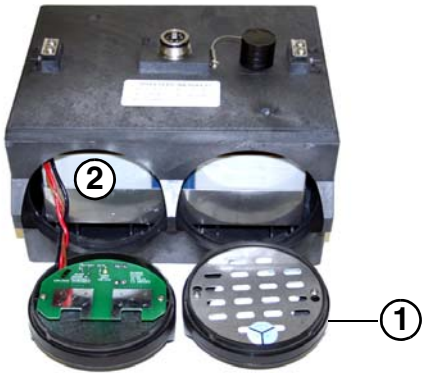


Figure 1-4 2196EX Battery module components

Table 1-4 2196EX Battery Module Components		
Item No. Fig. 1-4	Name	Description
1	Battery Door	The quarter-turn door seals the battery cavity. The right door has one humidity indicator and bag of desiccant, while the left door houses the charging circuit board for the batteries.
2	Battery Cavity	The batteries are integral to the module and not removable.

### 1.3 Technical Specifications

This section lists technical information about the 2150EX Area Velocity Flow Module and its related components.

- Table 1-5 lists the technical specifications for the 2150EX.
- Table 1-6 lists the technical specifications for the 2196EX Zone 1 battery module.
- Figure 1-5 is a specification drawing, providing the dimensions of a 2150EX mounted on a 2196EX.
- Table 1-7 lists the technical specifications for the 2194EX network interface module.
- Table 1-8 lists the technical specifications for the AV2150EX Area Velocity Sensor.
- Figure 1-6 and Table 1-9 list information about the 2150EX's communication connector.

**Table 1-5 Technical Specifications – 2150EX**

Material	ABS plastic, stainless steel	
Weight 2150EX only with 2196EX module	3.00 kg 7.49 kg	6.6 lb 16.5 lb
Enclosure (self-certified)	Molded ABS (Carbon Filled) NEMA 4X, 6P	IP 68
Surface Resistivity	< IE9 OHM/SQ	
Power	7.0 to 9.1 VDC, 120 mA typical at 8 VDC, 1 mA standby	
Battery Life with 2196 EX module	(using 2-minute measurement interval) 6.5 weeks (typical)	
Temperature Operating and Storage	-40° to 60°C	-40° to 140°F
Surface Temperature	Maximum 135 °C / 275 °F; N. American/European classification of T4	
Operating Atmospheric Pressure	80 to 110 kPa (0.8 to 1.1 bar)	
Program Memory	Non-volatile, programmable flash; can be updated using PC without opening enclosure or entering hazardous area; retains user program after updating	
Flow Rate Conversions	Up to 2 independent level-to-area and/or level-to-flow rate conversions	
Level-to-Area Conversions		
Channel Shapes	Round, U-shaped, rectangular, trapezoidal, elliptical, with silt correction	
Data Points	Up to 50 level-area points	
Level-to-Flow Rate Conversions		
Weirs	V-notch, rectangular, Cipolletti, Isco Flow Metering Inserts, Thel-Mar	
Flumes	Parshall, Palmer-Bowlus, Leopold-Lagco, trapezoidal, H, HS, HL	
Manning Formula	Round, U-shaped, rectangular, trapezoidal	
Data Points	Up to 50 level-flow rate points	
Equation	2-term polynomial	
Total Flow Calculations	Up to 2 independent, net, positive or negative, based on either flow rate conversion	
Data Storage Memory	Non-volatile flash; retains stored data during program updates	
Capacity	395,000 bytes (up to 79,000 readings, equal to over 270 days of level and velocity readings at 15 minute intervals, plus total flow and input voltage readings at 24 hour intervals). Bytes per reading is 5.	
Data Types	Level, velocity, flow rate 1, flow rate 2, total flow 1, total flow 2, input voltage	
Storage Mode	Rollover with variable rate data storage based on level, velocity, flow rate 1, flow rate 2, total flow 1, total flow 2, or input voltage	
Storage Interval	15 or 30 seconds; 1, 2, 5, 15 or 30 minutes; or 1, 2, 4, 12 or 24 hours	
Setup and Data Retrieval	Serial connection to IBM PC or compatible computer with Isco Flowlink <i>Software Version 4.16 or greater</i>	
Baud Rate	38,400	

Table 1-6 Technical Specifications - 2196EX Battery Module (Zones 1 and 2)		
Size (HxWxD)	14.94 x 23.12 x 19.3 cm	5.88 x 9.13 x 7.6 in.
Weight	5.77 kg	12.71 lb
Enclosure (self-certified)	NEMA 4X, 6P	IP 68
Operating and Storage Temperature	-20 °C to 60 °C	-4 °F to 140 °F
Operating Atmospheric Pressure	80 to 110 kPa (0.8 to 1.1 bar)	
Power	Output	Nominal: 8 VDC Maximum: 9.28 VDC
	Charger Input	Nominal: 13.5 to 14.7 volts Absolute Maximum: 20 volts, 2.0A
<p><b>NOTE:</b>                      The serial tag of the 2196EX Module contains important X marking, indicating special safety conditions that must be observed. See <i>Important Information Regarding "X" Marking</i> on page 2-12.</p>		

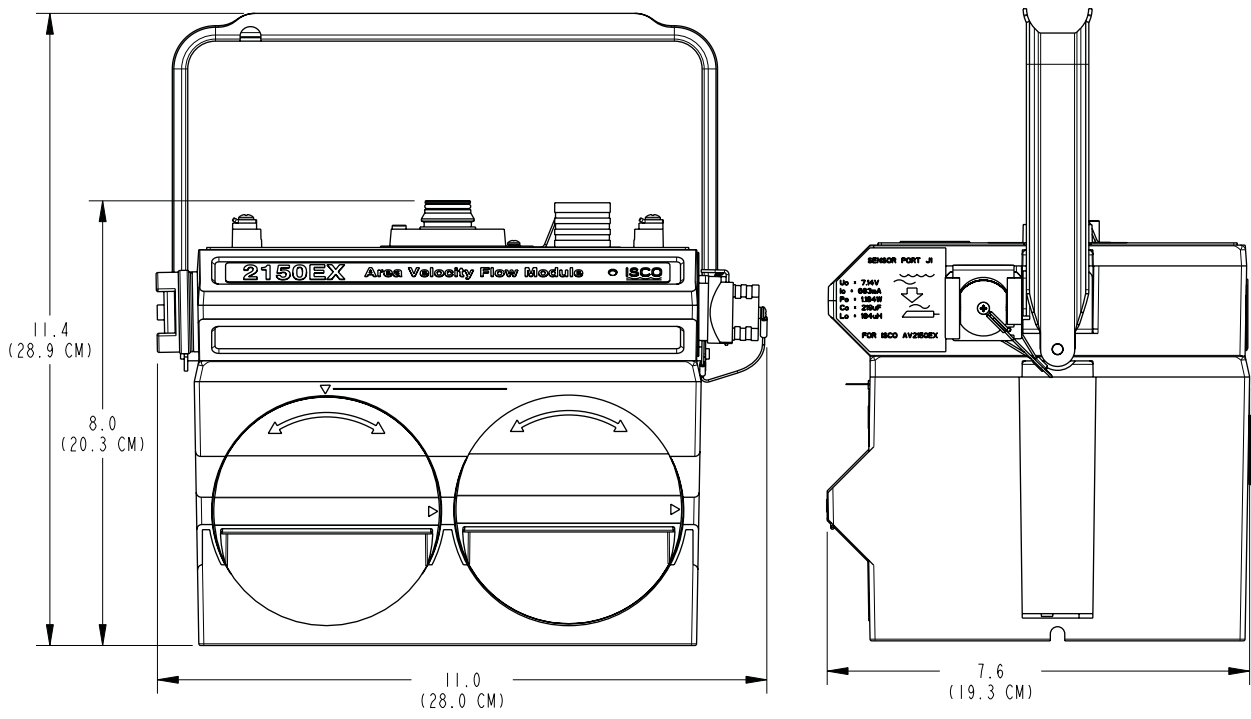


Figure 1-5 Specification drawing: 2150EX mounted on a 2196EX



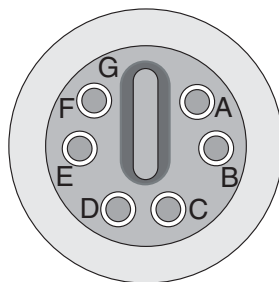


**Table 1-8 Specifications – AV2150EX Area Velocity Sensor  
(Zones 0, 1, and 2)**

Materials	
Sensor	Epoxy, stainless steel
Cable	Polyvinyl chloride (PVC), stainless steel
Size (H×W×D)	1.9 × 3.3 × 15.2 cm      0.75 × 1.31 × 6.00 in.
Cable Length	10.0 m      32.8 ft.
Cable Diameter	0.9 cm      0.37 in.
Weight (including cable)	1.02 kg      2.24 lbs
Typical Long-Term Stability	
Method	Submerged pressure transducer mounted in the flow stream
Transducer Type	Differential linear integrated circuit pressure transducer
Range <sup>1</sup>	0.010 to 3.05 m      0.033 to 10 ft.
Maximum Allowable Level	10.5 m      34 ft.
Accuracy <sup>2</sup>	±0.003 m      ±0.010 ft
Long Term Stability	±0.007 m/yr      ±0.023 ft/yr
Operating Temperature Range	-10° to 60°C      -14° to 140°F (applies to flow media when the sensor is immersed)
Temperature Compensation	0° to 50°C      32° to 122°F
Velocity Measurement	
Method	Doppler Ultrasonic
Frequency	500 kHz
Transmission Angle	20° from horizontal
Typical Minimum Depth for Velocity Measurement	25 mm      0.08 ft.
Range	-1.5 to +6.1 m/s      -5 to +20 ft./s
Accuracy <sup>3</sup>	Velocity      Error -1.5 to +1.5 m/s (-5 to +5 ft./s)      ±0.03 m/s (±0.1 ft./s) 1.5 to 6.1 m/s (5 to 20 ft./s)      ±2% of reading
Operating Temperature	-40° to 60°C      -40° to 140°F
Operating Atmospheric Pressure	80 to 110 kPa (0.8 to 1.1 bar)
Temperature Measurement	
Accuracy	± 2°C

NOTES:

1. Actual vertical distance between the area velocity sensor and the liquid surface
2. Maximum non-linearity, hysteresis, and temperature error from actual liquid level
3. In water with a uniform velocity profile and a speed of sound of 1480 m/s (4850 ft./s)
4. The serial tag of the AV2150EX sensor contains important X marking, indicating special safety conditions that must be observed. See *Important Information Regarding "X" Marking* on page 2-26 for more information.



Communications Port

Figure 1-6 2150EX Area Velocity Flow System Communication Connector Pins

Table 1-9 Communication Connector Pins		
Pin	Name	Description
A	NETA	Network differential transceiver Data A
B	NETB	Network differential transceiver Data B
C	VIN+	Positive power supply voltage input (+8 VDC nominal)
D	VIN-	Negative power supply voltage input (0 VDC nominal)
E	RCVUP	PC data receiver RS232 compatible input
F	XMTUP	PC data transmit RS232 compatible output
G	Key	Aligns connector pins

 **CAUTION**

The connector of the interrogator cable and protective cap both have an alignment key to ensure proper connection. Observe proper alignment and NEVER reverse the connector.

# 2150EX Area Velocity Flow System

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## *Section 2 Preparation and Installation*

### **2.1 Unpacking Instructions**

When the system arrives, inspect the outside packing for any damage. Then carefully inspect the contents for damage. If there is damage, contact the delivery company and Teledyne Isco (or its agent) immediately.

 <b>WARNING</b>
--

**If there is any evidence that any items may have been damaged in shipping, do not attempt to install the unit. Please contact Teledyne Isco (or its agent) for advice.**

**Teledyne Isco**  
Customer Service Dept.  
P.O. Box 82531  
Lincoln, NE 68501 USA

Phone:(800) 228-4373  
Outside USA & Canada  
call:  
(402) 464-0231

FAX: (402) 465-3022

E-mail:  
IscoInfo@teledyne.com

When you unpack the system, check the items against the packing list. If any parts are missing, contact the delivery company and Teledyne Isco's Customer Service Department. When you report missing part(s), please indicate them by part number. In addition to the main packing list, there may be other packing lists for various sub-components.

It is recommended that you retain the shipping cartons as they can be used to ship the unit in the event that it is necessary to transport the system.

Please complete the registration card and return it to Teledyne Isco.

## 2.2 Preparation

A 2150EX flow system may be a portable installation, powered by a 2196EX battery module (described in Section 2.4), or a permanent installation, powered from the safe area by the 2194EX network interface module (described in Section 2.5).

While a 2150EX system with proper installation and operation meets ATEX requirements for use in defined hazardous locations, these requirements must also be observed with regard to associated tools and equipment at the site.

 **WARNING**

**Intrinsic safety is dependent on proper installation in accordance with IEC 60079-14 and IEC 60079-17 International Standards, or ATEX Group II, Category 1G or 2G requirements of the authority that has jurisdiction for the installation of equipment in hazardous areas at your specific installation site. Installation should be performed only by trained and qualified personnel.**

### 2.2.1 Safety

 **WARNING**

**Avoid hazardous practices! If you use these instruments in any way not specified in this manual, the protection provided by the instruments may be impaired; this will increase your risk of injury.**

 **WARNING**

**The installation and use of this product may subject you to hazardous working conditions that can cause you serious or fatal injuries. Take any necessary precautions before entering a worksite. Install and operate this product in accordance with all applicable safety and health regulations, and local ordinances.**

 **WARNING**

**Manually ensure that all equipment is electrostatically grounded at the installation site before any portion enters the hazardous area.**

The 2150EX module components are often installed in confined spaces. Some examples of confined spaces include manholes, pipelines, digesters, and storage tanks. These spaces may become hazardous environments that can prove fatal for those unprepared. In the United States, these spaces are governed by OSHA 1910.146 and require a permit before entering.

Read the Safety section at the front of this manual, and the general safety information in Appendix D.

### 2.2.2 Locating the Site

The 2150EX is designed to measure flow in open channels with or without a primary device. A primary device is a hydraulic structure, such as a weir or a flume that modifies a channel so there is a known relationship between the liquid level and the flow rate. Although the 2150EX supports flow rate conversion in channels with a primary device, its level and velocity measurement capabilities are best suited for channels *without* a primary device.

 **Note**

Primary devices limit the usefulness of the AV Sensor's readings. In most cases, levels and velocities near these structures do not represent what normally occurs in the channel. If you must use area velocity flow conversion, or if your interest is the stream's velocity, do not install the AV Sensor near a primary device. Move the AV Sensor away to where the flow is unaffected by the primary device.

### 2.2.3 Channels Without a Primary Device

When the AV Sensor is installed without a primary device, find a section of channel with a minimum of disturbances to the flow. Avoid areas with elbows, outfalls, inverters, junctions, etc. that create turbulence near the AV Sensor. The AV Sensor should be located away from these disturbances to a point where the flow has stabilized. For best results, install the AV Sensor where the flow is most uniform. Uniform flow is a condition where the water surface is parallel to the bottom of the channel.

### 2.2.4 Channels With a Primary Device

If the AV Sensor is installed in a primary device, its location depends on the type of primary device. Most primary devices have a specific place for the head (level) measurement sensor. For more details about the location of the head measuring point, refer to the *Isco Open Channel Flow Measurement Handbook*, or to information provided by the manufacturer of the primary device.

 **Note**

When you install the AV Sensor for use within a primary device, a Level-to-Flow conversion method should be used. (See Programming, Section 3.)

### 2.2.5 2150EX and AV Sensor Mounting Considerations

Ideal sites are easily accessible for service and data collection, while still providing protection for the 2150EX module devices. The 2150EX module devices are rated NEMA 4X, 6P, and constructed of materials that can withstand harsh environments. However, continual exposure to UV light, or periodic submersion should be avoided to extend the life of the components.

Typically, the 2150EX is suspended inside a manhole. Suspending the 2150EX near the opening will protect it from the elements, minimize the chance of submersion, and allow it to be easily retrieved without entering the manhole.

## 2.3 Site Examples

Figures 2-1, 2-2, and 2-3 illustrate typical round-pipe sites. Key items are called out in the illustration and explained below.

Figures 2-1 and 2-2 represent **portable installations**. For details about portable installations, see Section 2.4.

Figure 2-3 represents a **permanent installation**. For details about permanent installations, see Section 2.5.

The **computer running Flowlink** (Figures 2-1 and 2-3) or the **2101 Field Wizard module** (Figure 2-2) should be located outside the potentially explosive atmosphere. The computer and modules communicate with the 2150EX module.

The **2150EX area velocity flow module** measures and stores the stream data. In portable installations (Figures 2-1 and 2-2), it is attached to a **2196EX battery module**, which supplies power to the module.

As described in Section 2.6.1, the **EX network cable** connects to the top of a module and provides a bridge between hazardous zones or to the safe area.

As described in Section 2.6.2, an **RS232EX isolator cable** connects the computer and the site. The cable supports the data transfers between the two, and is connected to an EX Network Cable connected to the top of the 2150EX module.

As described in Section 2.6.3, an **RS485EX isolator cable** connects the site with a Field Wizard or other network device. The cable supports the data transfers between the two, and is connected to an EX Network Cable, connected to the top of the 2150EX module.

In permanent installations (Figure 2-3), the 2150EX is connected via network interface cable CA75EX-CTL (75m) or CA150EX-CTL (150m), usually through conduit, to the **2194EX network module**, located in the safe area, which serves as both power supply and network or PC connection.

The **AV2150EX sensor cable** must be routed carefully without kinks, coils, or sharp bends, and secured in place without overtightening the plastic ties. Any excess cable must be kept out of the channel to prevent accumulation of debris.

The **Mounting Ring** holds the AV2150EX sensor in place.

The **Ground Lug Kit** provides a means to electrostatically earth ground the mounting ring.

The **AV2150EX sensor** is positioned in the flow stream to measure liquid level and velocity.

 <b>Note</b>
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For a complete listing of part numbers and ordering information, see Appendix B *Accessories*.

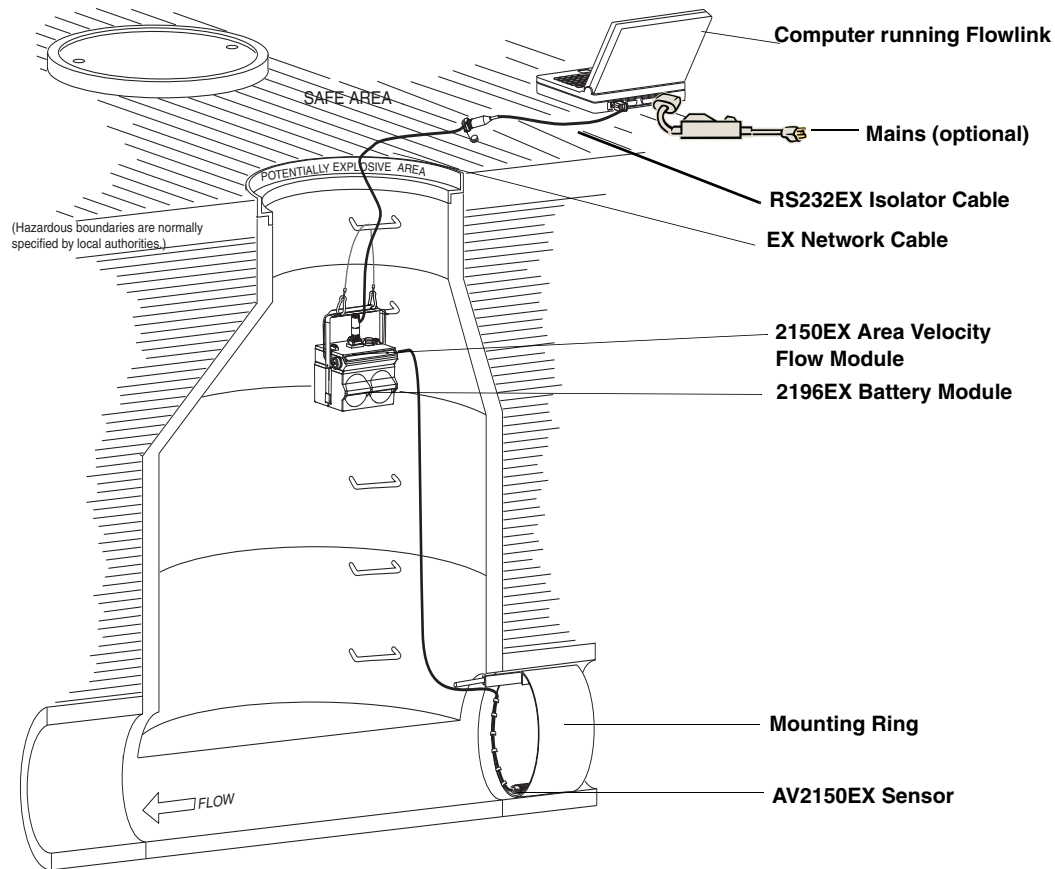


Figure 2-1 Typical Round-pipe Installation Connected to a Laptop Computer (Portable Installation, see section 2.4)

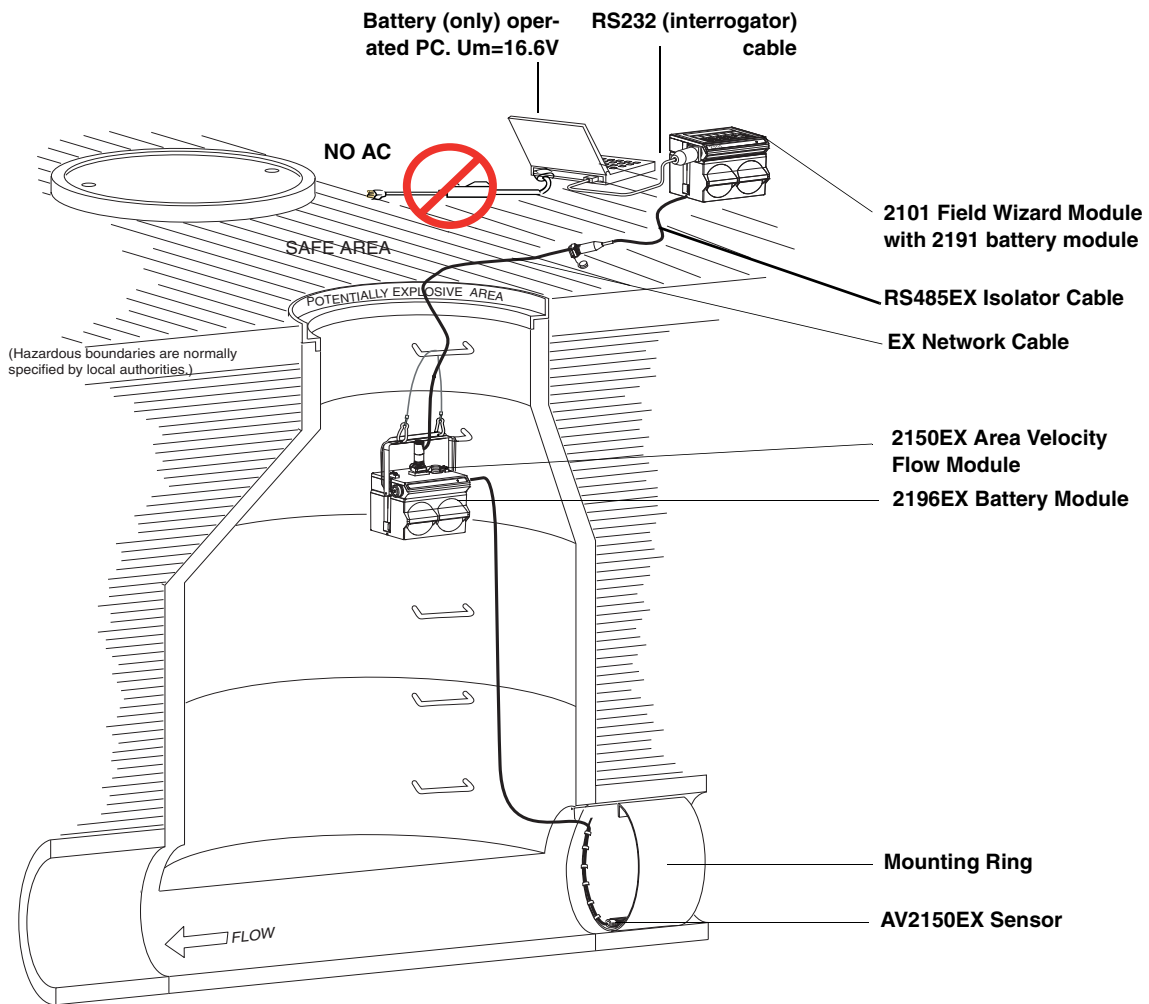


Figure 2-2 Typical Round-pipe Installation Connected to a 2101 Field Wizard (Portable Installation, see section 2.4)



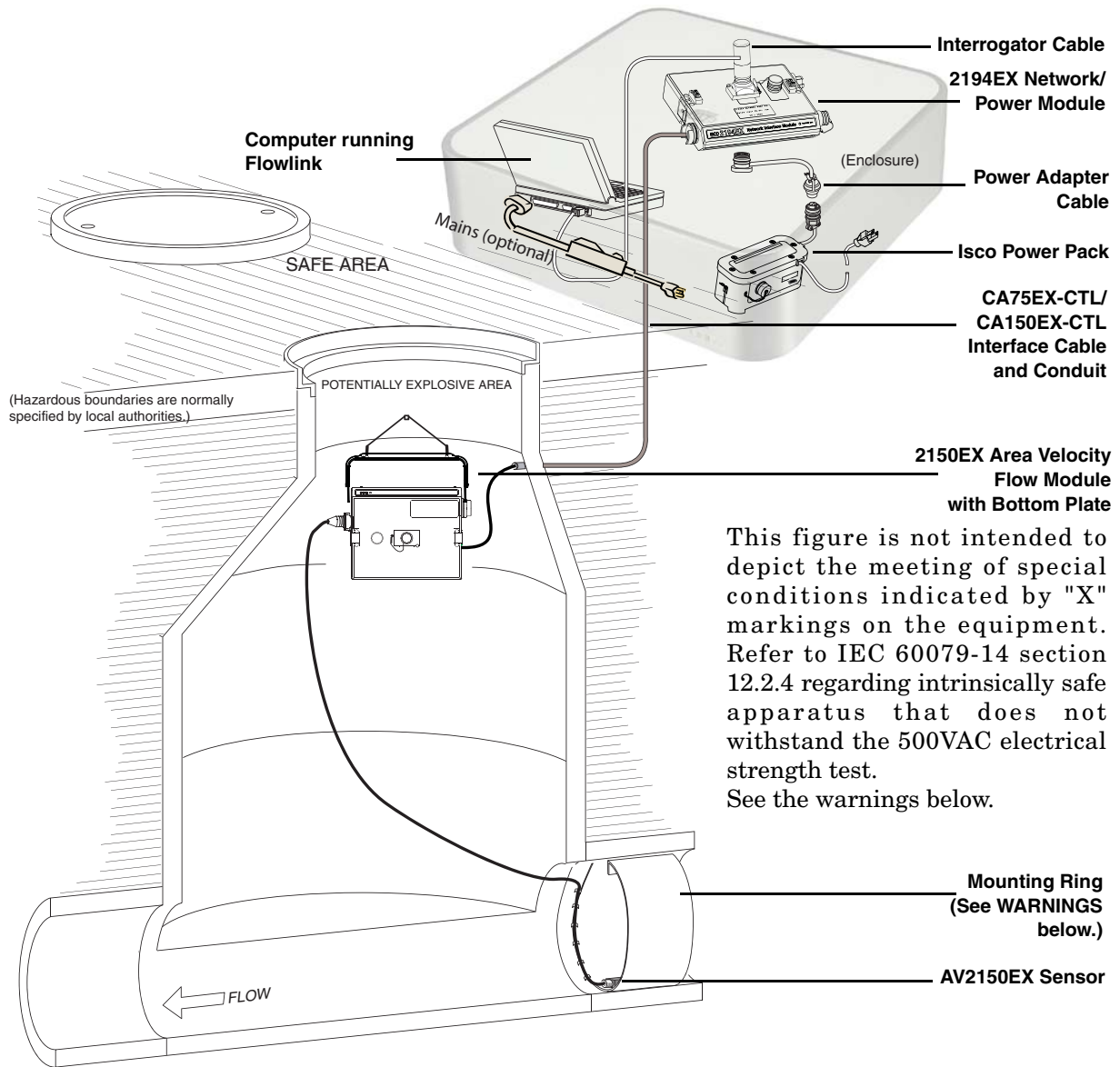


Figure 2-3 Typical Round-pipe Installation Connected to a 2194EX Module and Laptop  
(Permanent Installation, see Section 2.5)

**WARNING**

Due to the creation of a permanent grounding point between the sensor's transducer cover and the mounting ring when the sensor is installed, the 2150EX system can not withstand the 500 VAC test according to EN60079-11:2007 clause 6.3.12. Refer to IEC 60079-14, section 12.2.4, regarding earthing of intrinsically safe circuits.

**WARNING**

The sensor mounting ring is a potential isolated charge carrier. Your installation MUST satisfy earthing requirements. Refer to IEC 60079-14 section 12.2.4 and IEC 60079-11 and the Teledyne Isco accessory Ground Lug Kit.

## 2.4 Portable Installations

For portable installations, the 2150EX module is stacked with a 2196EX battery module. It communicates with a computer or 2100 Series network device via an EX Network Cable (for potentially explosive atmospheres) and an EX Isolator Cable.

The 2196EX is a rechargeable module for use in gas hazard zones 1 and 2, or as an Associated Apparatus for zone 0. For detailed information about the 2196EX, turn to section 2.4.4.

### 2.4.1 Installation Example

The following steps may be used as a guide to install a basic, portable 2150EX system, including the 2150EX module, the battery module, and an AV2150EX sensor.

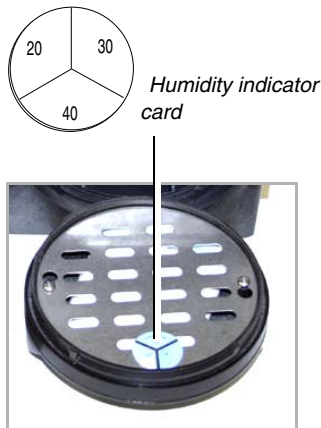
1. Inspect 2150EX module desiccant (2.4.2).
2. Inspect the 2196EX desiccant (2.4.2).
3. Assemble the system.
  - a. Install the 2150EX module (2.4.3 and Figure 2-4).
  - b. Attach the AV2150EX sensor cable to the 2150EX module (2.7).
4. Install the AV2150EX sensor in the flow stream (2.7.1).
5. Connect the RS232EX cable and connect to the site with *Flowlink* software (2.6).
  - a. Create the site by Quick Connecting to the stack.
  - b. Set up the site and module settings.
6. Disconnect from the site and replace all protective caps.

### 2.4.2 Inspecting the Desiccant

A desiccant cartridge is inserted into the side of the 2150EX Module. The cartridge is filled with silica gel beads that will indicate when they are saturated. When dry, the beads are blue or yellow. As the desiccant becomes saturated, the humidity levels will increase and the beads turn pink or green. If the entire length of the desiccant cartridge turns pink or green, the reference air is no longer adequately protected and the desiccant must be replaced. Refer to Section 5.3 for replacement instructions.

 <b>CAUTION</b>
--

Operating the 2150EX and sensor with saturated desiccant can cause many problems such as unstable level readings and permanent internal damage. It is important that the equipment is serviced often enough to prevent the entire desiccant cartridge from becoming saturated.



A small bag of desiccant is mounted inside the right door of the 2196EX. A humidity indicator card is attached above each desiccant bag. The humidity indicators have regions that display 20, 30, and 40 percent humidity levels. Ideally, each region should be completely blue. As the desiccant bag becomes saturated, the humidity levels will increase, and the regions turn pink. When the 40 percent region turns pink, the battery module is no longer adequately protected, and the desiccant must be replaced. Refer to Section 5.3 for replacement instructions.

### 2.4.3 Assembling the System

The 2100 Series System is modular; you build the system by connecting modules together. The instructions in this section describe how to connect a 2150EX module to a 2196EX battery module in its most basic configuration — by stacking the two modules. The battery module must be at the bottom of the stack.

You can use multiple modules in a stack to increase the site's functions. A maximum of two 2150EX modules may be powered by one battery module, to avoid overloading the batteries.

#### Connection options

Keep in mind that stacking is not the only way to connect modules. The modules may be placed in remote locations and still operate as a single site. If you would like to use remote modules for your application, please consult with the factory or your representative to realize the full potential of your system.

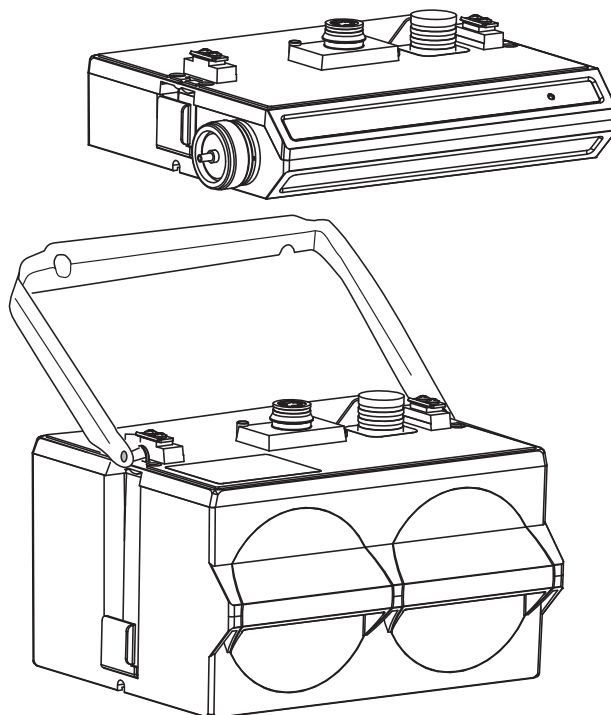


Figure 2-4 Assembling a basic portable system

Connecting the Modules

To connect the 2150EX and 2196EX modules, refer to the following instructions and Figure 2-4.

1. On the top of the battery module, remove the cap and stow it on the holder. This exposes the communication connector.
2. Prepare the battery module's communication connector:
  - a. Inspect the connector. It should be clean and dry. Damaged O-rings must be replaced. Spare O-rings (P/N 202-1006-69) are supplied in the 2150EX maintenance kit (refer to Appendix B Accessories).
  - b. Coat the O-ring's sealing surface with a *silicone* lubricant. (A small quantity of lubricant is supplied in the maintenance kit.)

 **CAUTION**

Do not use petroleum-based lubricants. Petroleum-based lubricants will cause the O-ring to swell and eventually deteriorate. Aerosol silicone lubricant sprays often use petroleum based propellants. If you are using an aerosol spray, allow a few minutes for the propellant to evaporate before proceeding.

3. Place the carrying handle on the battery module. (If you are stacking two 2150EX modules on top of the 2196EX, position the handle between the 2150EX modules.)
4. Unlock the 2150EX module's latch by pressing in on the latch release (right side).
5. Underneath the 2150EX, remove the cap from the lower communication connector and stow it in the holder.
6. Lock the latch. Locking the latch correctly seats and aligns the lower cap in its holder.
7. Position the 2150EX over the 2196EX battery module. Align the connectors and lower the 2150EX onto the 2196EX.
8. Unlock the 2150EX module's latch by pressing in on the latch release (right side).
9. Firmly press the modules together and lock the 2150EX module's latch (left side).

The communications indicator will blink during the start-up routine to indicate the 2150EX is operating.

 **Note**

Unused communication ports on the top and bottom of the stack must be capped. The connector caps terminate the communication lines and protect the pins.

#### 2.4.4 Zone 1 Battery Module

The Model 2196EX is a rechargeable battery module for zones 1 and 2 that offers indication of declining voltage prior to power interruption, with two batteries permanently contained in an IP68 enclosure. The 2196EX is also rated as an Associated Apparatus for zone 0 installations of the 2150EX, using an EX network cable for the interface. See Figure 2-6 for X marking and port labeling. The 2196EX may be safely connected to or disconnected from a 2150EX flow module within a hazardous area.

#### Note

The 2196EX is for use in gas hazard zones 1 and 2. It is not approved for use in zone 0 installations, in accordance with IEC 60079-14.

The 2196EX module has no port or latches on the bottom of the case; therefore, it can only be installed on the bottom of a module stack. One 2196EX module can power one or two 2150EX flow modules with sensors attached.

The 2196EX uses two fully rechargeable, non-replaceable lead-acid batteries.

Never operate or store the 2196EX at temperatures above 140 °F (60 °C). Operate the 2196EX below 86 °F (30 °C) for maximum service life. For prolonged shelf life, the 2196EX should be stored at 50 °F (10 °C) or lower in a fully charged state.

#### *Battery protection*

The system protects the lead-acid batteries from damage due to deep discharge by first indicating low voltage through Flowlink software, and then by shutting off when the voltage becomes critically low.

As the 2196EX output voltage decreases to a value near the 7-volt shut-off threshold, Flowlink software will issue a low-voltage warning (Figure 2-5).

**Neither of these protective functions should become necessary on a regular basis. Cycle life is improved by regularly re-charging the batteries *before* a drop in voltage is indicated.**

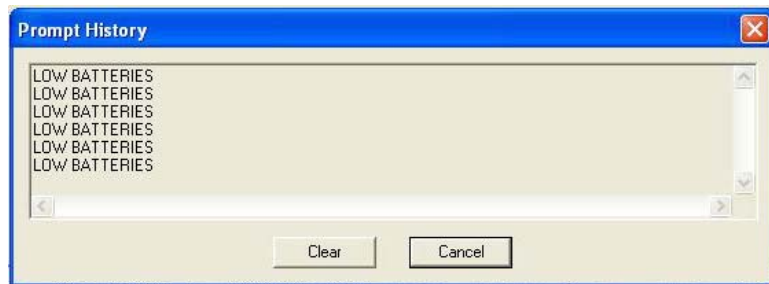


Figure 2-5 Flowlink low-voltage warning

The output voltage may also be tested with a voltmeter at the top 'P3' port connector on pins c (+) and d (-), and will range between 7V and 9V.



2196EX port connector


*Important Information  
 Regarding "X" Marking*

Read all labels carefully before installing the equipment!

The 2150EX and associated equipment are clearly labeled with color and/or text so you know what can be located in a safe or hazardous area (see figure below).

The ATEX labeling on the serial tag of the 2196EX module shows a number ending in "X." The X marking indicates that there are special conditions that must be met to ensure safety, as explained beginning on page *viii* in the front of this manual.

In the case of the 2196EX, the module must be protected from mechanical damage when installed and during transit.

 **WARNING**

**Ensure that the 2196EX module case is never subjected to physical impact with enough force to cause cracking during transport, installation, operation, or storage. Damage to the case can compromise the unit's safety.**

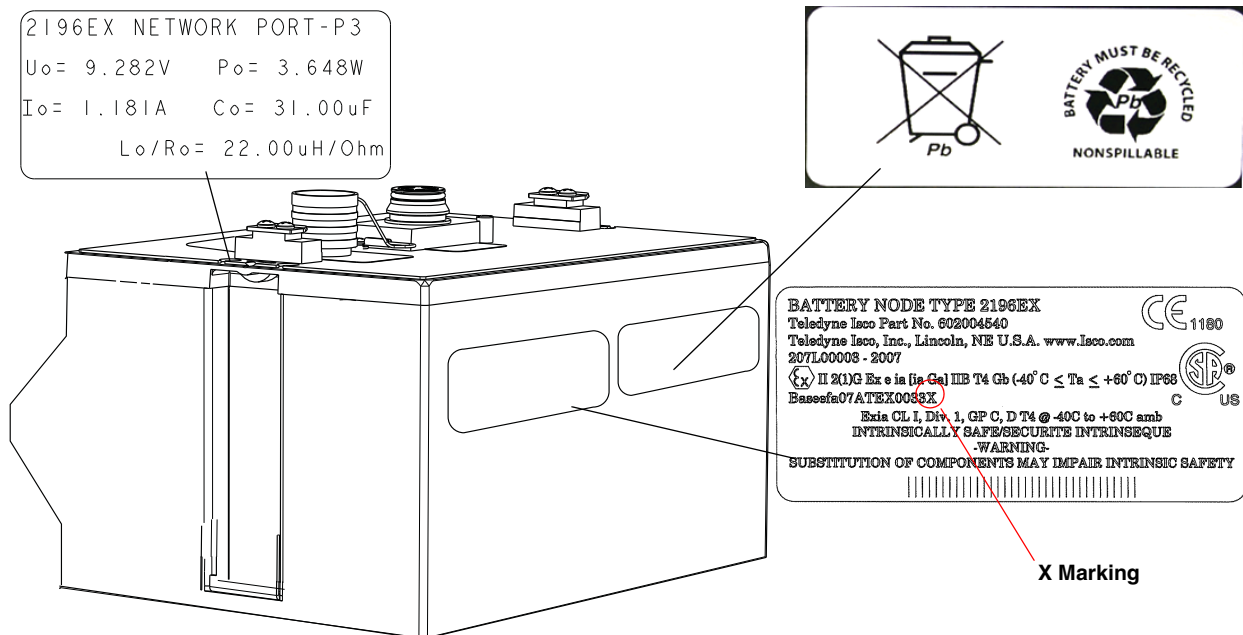


Figure 2-6 2196EX battery module and labeling

#### 2.4.5 Charging the Zone 1 Battery Module

The 2196EX module requires a lead-acid battery charger with a maximum rating of 20 volts, 2 amps. The module is fused for protection against excessive current (see Figure 2-8).

 **WARNING**

**Do not charge the 2196EX in a potentially explosive environment. Charge only in a safe area.**

 **WARNING**

**When charging the 2196EX, observe maximum voltage ratings of  $U_m = 250V$  and  $U_n = 20V$ . The charger output must not exceed 20 volts or 2 amperes as labeled.**

 **WARNING**

A 2196EX module kept in storage for extended periods should be recharged approximately every six to nine months. The battery voltage should never be allowed to fall below 10.5 volts (when measured at battery volts (TP1)) as seen in Figures 2-7 and 2-8) before recharging. Deep discharge of the lead-acid batteries can lead to permanent loss of capacity.

 **Note**

During the charging process, the 2196EX case must remain open, exposing the desiccant to the atmosphere. Teledyne Isco recommends storing the desiccant in an airtight container while charging the batteries. Check the humidity indicator on the inside of the door whenever it is opened and ensure that only dry desiccant is installed when re-sealing the case.

The charging terminals are located on the circuit board mounted on the inside of the left compartment door (Figures 2-7 and 2-8, + and -).

 **CAUTION**

The circuit board is permanently connected to the interior of the module.

During charging, the yellow LED on the circuit board remains on to indicate charge voltage in correct polarity. The replaceable 2A fuse on the back side of the board protects against excessive current.

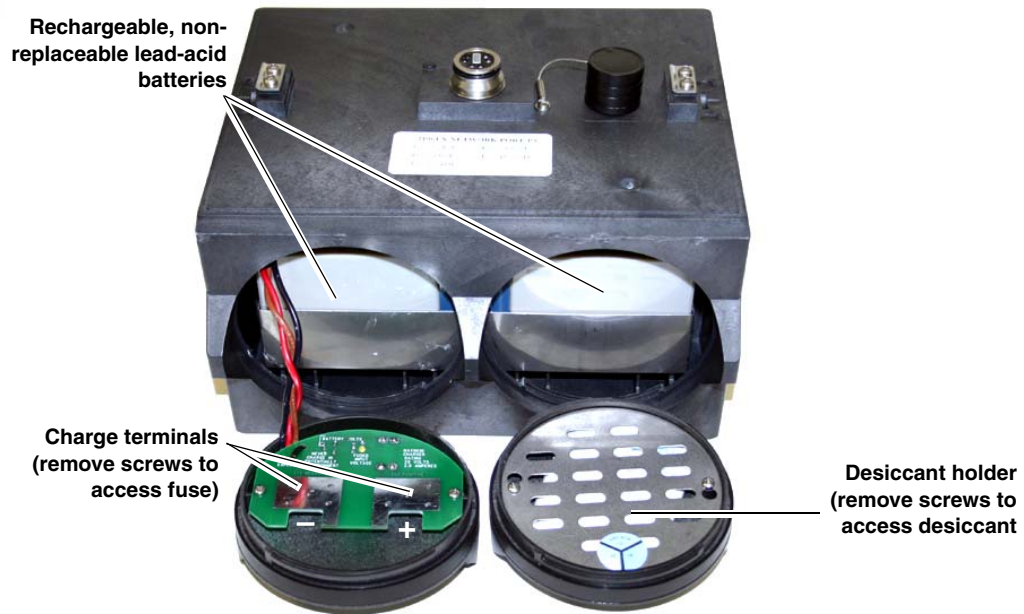
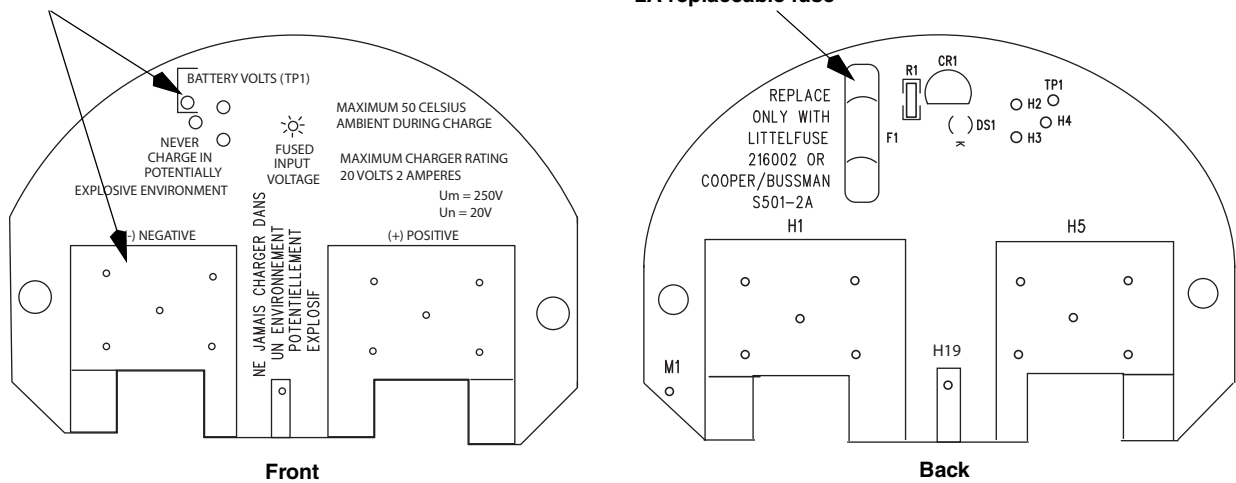


Figure 2-7 Location of 2196EX charging terminals

Measure the 12V battery voltage between Test Point 1 and H5 (negative terminal).



The charge terminals are large plated pads marked (-) NEGATIVE and (+) POSITIVE and are suitable for alligator-style charger clips.

Figure 2-8 Detailed view of charging circuit board



 **Note**

There is a 60K ohm resistor in series with the voltage sensing circuit. The voltage reading measured on the circuit board may have slight variance, depending on the voltmeter used.

*Fuse replacement*

To access the 2A charge fuse (F1), remove the two mounting screws holding the circuit board inside the compartment lid. Replace the fuse with the specified Littelfuse 216002 or Cooper/Bussman S501 only (part #411-9922-60).

*Charger options*

**See Appendix B for a complete listing of part numbers and ordering information.**

1. The 2-Amp charger (part #68-2000-044) includes a connect cable ending in alligator clips, indicator lights for maximum output and float voltage, and protection against reverse polarity. It can charge the 2196EX in about 6 hours. The charger is user-switched for 120/240VAC, 50/60Hz applications.
2. The Isco Model 965 five-station battery charger has five 2-pin amphenol connector ports on the front. The 965 provides greater charging voltage, and can therefore charge to a higher capacity than the other chargers offered. However, because of this, the module should not remain connected to it beyond the charging period. The charger is user-switched for 120/240VAC, 50/60Hz applications.

 **CAUTION**

The module should not remain connected to the Isco Model 965 charger after the Battery Voltage measured at TP1 reaches 13.8 volts. Over time, overcharging can decrease the water content of the batteries' electrolyte, causing premature aging.

3. The Isco Model 963 desktop charger has a single, 2-pin amphenol connector port. The charger is user-switched for 120/240VAC, 50/60Hz applications.  
The 963 is a float mode charger, using a lower voltage, which reduces the risk of overcharging. It can fully charge the module in 16-24 hours maximum.

*Charging connections*

1. Teledyne Isco offers the CB edge adaptor cable (60-2004-547) for use with chargers 2 & 3 (Figure 2-9). Simply push the 2-pin amphenol connector into the connector port on your Isco charger, and the card edge connector onto the circuit board.  
Polarity is observed by the design, as the cable can only fit onto the installed board in one direction.

Part #60-2004-547

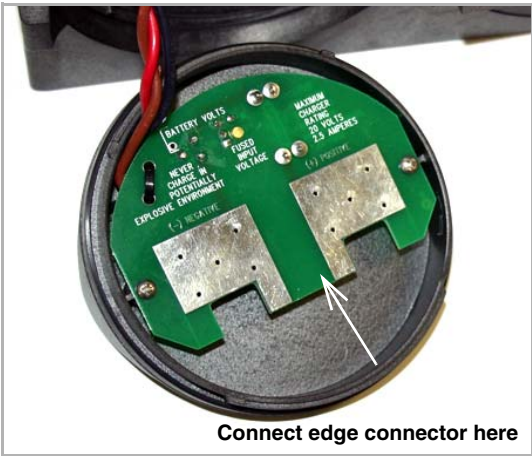


Figure 2-9 2196EX charging adaptor cable

## 2.5 Permanent Installations

For permanent installations, the 2150EX can be powered from a safe area by an associated apparatus, the 2194EX module. The 2194EX also serves as a network interface, with network and RS232 communication via the top connector. The 2194EX requires 12 or 24 volts DC, and may be powered by an Isco 910/920 series power pack, 934 NiCad battery, or 940 series lead acid battery using power adapter cable 69-2004-451. For details about these power supplies, see Isco's Power Products Guide (60-9003-092).

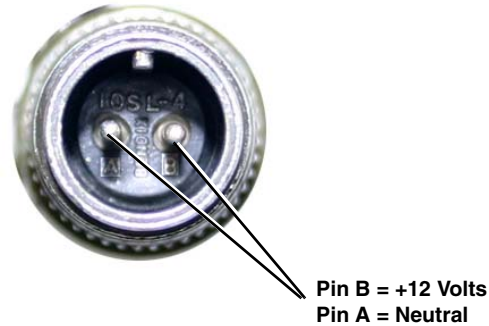
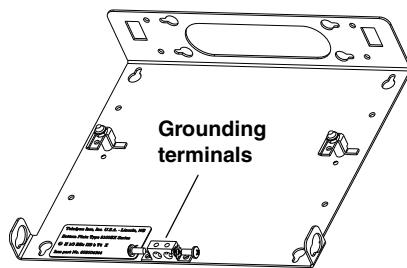


Figure 2-10 Amphenol connector pins for 12V adapter cable 69-2004-451

### Note

Isco AC power supplies do not provide galvanic isolation in accordance with IEC 60079-14 for Zone 0 installations.



EX Bottom Plate 60-2004-344

### Important Information Regarding "X" Marking

Make sure the 2150EX is secured so that it will not accidentally fall or be swept away by flooding. Mount the 2150EX onto the EX bottom plate (60-2004-344) for suspension over the flow stream. Use the notched holes in the plate to insert fasteners to secure the module to a wall, or attach a carrying handle and suspension handle (60-2004-377 and 60-2004-386), which can be secured to a ladder rung. The EX bottom plate has stainless steel ground terminals for attaching bonding conductors in permanent installations where circulating current presents a hazard.

The ATEX labeling on the serial tag of the 2194EX module shows a number ending in "X". The X marking indicates that there are special conditions that must be met to ensure intrinsic safety, as explained on page *viii* in the front of this manual.

In the case of the 2194EX, this associated apparatus does not provide the galvanic isolation required for zone 0 installations in accordance with IEC 60079-14 (refer to IEC 60079-14 sections dealing with earthing of intrinsically safe circuits and installations for zone 0) when powered by an Isco AC power source.

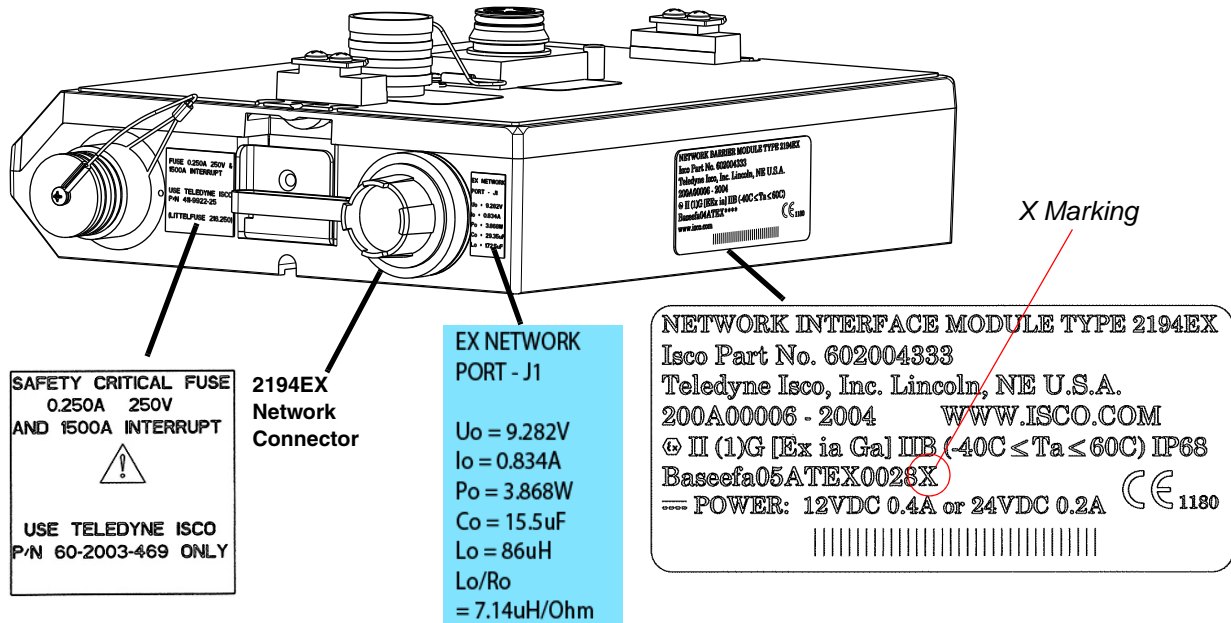


Figure 2-11 2194EX labels and cable connector

### 2.5.1 Installation Example

The following steps may be used as a summary guide to install a basic, permanent 2150EX system, including the 2150EX module, the 2194EX power module, and an AV2150EX sensor. The setup will look similar to Figure 2-3.

1. Inspect 2150EX and 2194EX module desiccant (2.4.2).
2. Install the interface cable.
3. Assemble the system.
  - a. Install the 2150EX module.
  - b. Install the 2194EX module in the safe area.
  - c. Attach the AV2150EX sensor cable to the 2150EX module (2.7).
4. Install the AV2150EX sensor in the flow stream (2.7.1).
5. Connect the interface cable between the 2150EX and 2194EX.
6. Connect the interrogation cable to the 2194EX and connect to the site with *Flowlink* software.
  - a. Create the site by Quick Connecting to the modules.
  - b. Set up the site and module settings.
  - c. Disconnect from the site and replace all protective caps.

### 2.5.2 Interface Cable

Connection to the 2194EX module requires a network interface cable. The cable's molded connector plug will connect to the bottom communication port of the 2150EX module. The other end will enter the safe area, usually via conduit.

Two interface cable assemblies are available from Teledyne Isco: The CA75EX-CTL, 75 meter (60-2004-337) provides the maximum length for powering two 2150EX modules with sensors. The CA150EX-CTL, 150 meter (60-2004-338) provides the maximum length for powering one 2150EX module with sensor. Maximum length may require reduced-power program settings. Contact the factory for custom-ordered lengths less than standard. Install the interface cables without coiling and cut to the appropriate practical length. Wire the interface cable to the 2194EX using the Network Interface Connector Wiring Kit (60-2004-468), referring to Figures 2-11 through 2-15. Always comply with the clearly labeled entity parameters for hazardous location installations.

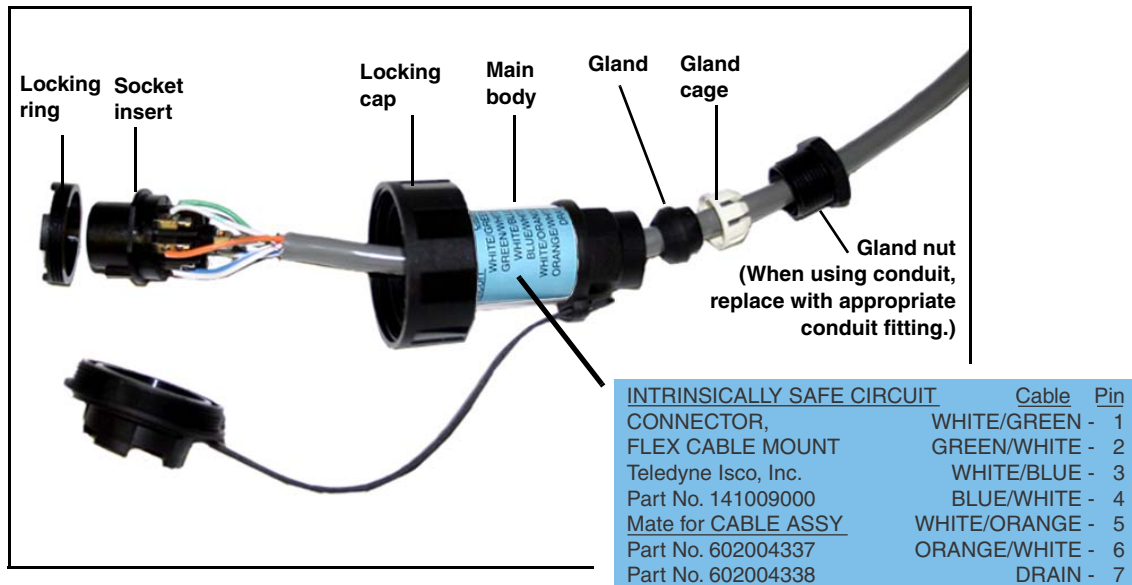



Figure 2-12 Network cable connector and wiring

Observe intrinsic safety requirements regarding proximity to external sources of potential electric or magnetic interference. Refer to IEC 10079-14 Section 12.2.2.5 on installation of cables and wiring.

 <b>WARNING</b>
<p><b>Do not coil the interface cable; this will form an inductor and create a hazard. The cable should be kept as short as is practical.</b></p>

**Teledyne Isco strongly recommends that you route the interface cable through conduit between the safe and hazardous areas.** Two different sizes of conduit fittings are provided with the connector wiring kit (Figure 2-13).



Figure 2-13 Network cable conduit fittings

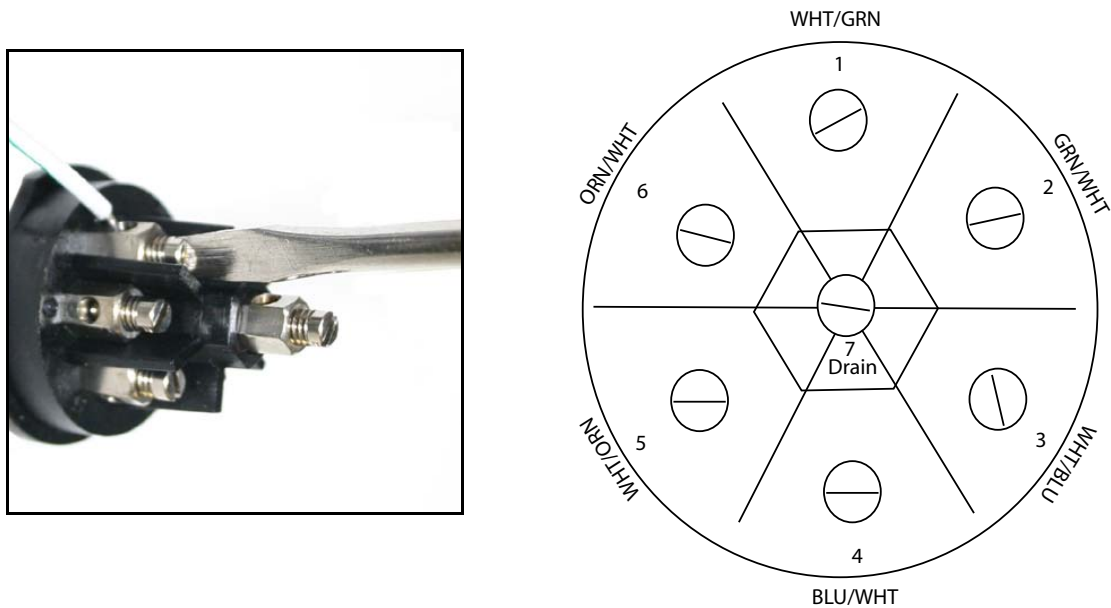


Figure 2-14 Wiring the socket insert

**Note**

To disassemble the network cable connector for wiring, turn the cap over and use as a key to unscrew the locking ring (Figure 2-15).

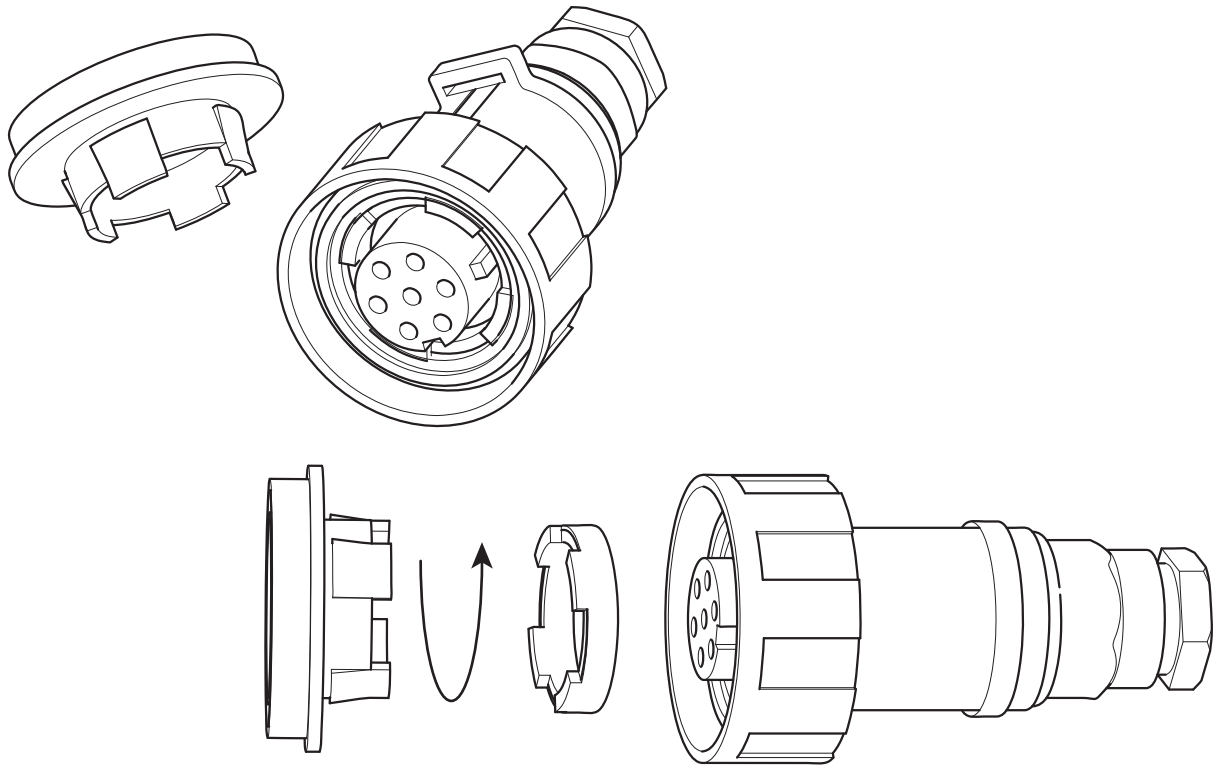


Figure 2-15 Disassembling network cable connector

## 2.6 Network Communication

To connect the 2150EX for network communication, one or two of three different cables are required, depending on the type of communication, whether the installation is portable or permanent, and whether or not the flow module installation is in a hazardous area. When the communication connector is not in use, it should always be capped to prevent corrosion and improve communications. When the communication connector is in use, store the cap on the holder next to the connector.

### **Note**

Caps **PUSH ON** and **PULL OFF**. Do not rotate the caps to remove them from the connectors.

### 2.6.1 EX Network Cable

The EX Network cable (2m P/N 60-2004-335, 8m P/N 60-2004-336) connects to the top of a module and provides a bridge between hazardous zones or to the safe area.





Figure 2-16 EX Network Cable for Connection to an Isolator Cable

To connect the EX Network and RS232EX isolator cables:

1. Remove the protective cap from the communication connector on the top of the 2150EX module.
2. Store the protective cap in the holder next to the connector.
3. Push the 6-pin end of the EX Network cable onto the communication connector on the top of the 2150EX module.  
**Use care, so you do not misalign the pins and cause any short circuits.**
4. Route the cable as shown in Figure 2-1, so the other end of the EX Network cable is at the interface of the safe and hazardous areas.
5. Attach the hazardous area end of the RS232EX isolator cable to the EX Network cable coming from the 2150EX. Use care, so you do not misalign the pins and cause any short circuits! Attach the other end of the RS232EX cable to the appropriate port on your computer.

**Note**

You can safely connect and disconnect the RS232EX cable from the EX Network cable without removing the 2150EX module or the EX Network cable from the potentially explosive atmosphere.

### 2.6.2 Connecting to a Computer for Interrogation

The 2150EX module can be connected to a computer located in a safe area, using Isco's Flowlink software (see Figure 2-1). In order for the 2150EX to communicate with a computer, the two must be connected by an Isco RS232EX Isolator Cable (P/N 60-2004-339). The hazardous area end, labeled with proper entity parameters, connects to the EX Network cable. This enables you to update the 2150EX's software without entering the potentially explosive atmosphere.



Observe intrinsic safety requirements regarding proximity to external sources of potential electric or magnetic interference. Refer to IEC 10079-14 section 12.2.2.5 on installation of cables and wiring.

If the 2150EX and AV2150EX sensor are *not* located in a potentially explosive atmosphere, the RS232EX isolator cable can be connected directly to the top of the 2150EX.

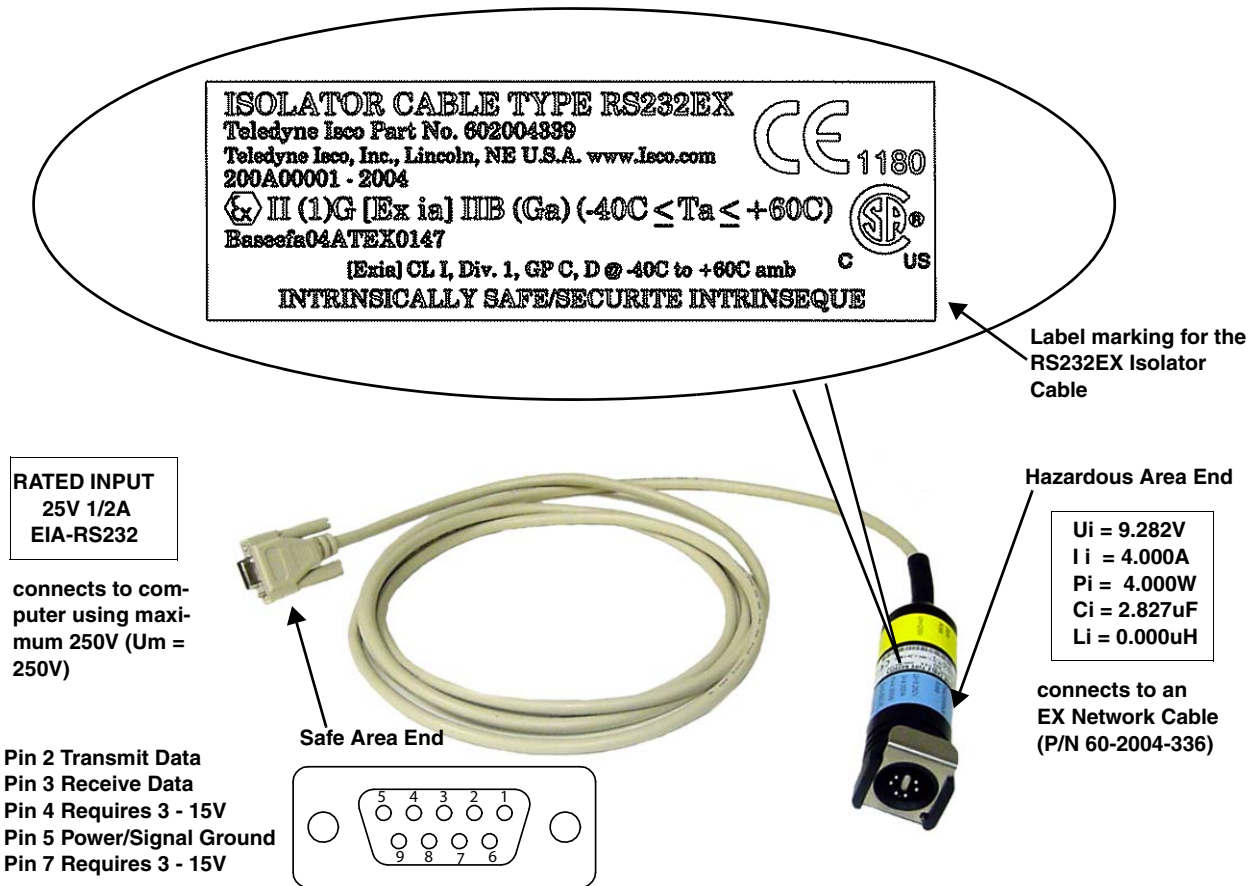


Figure 2-17 RS232EX Isolator Cable for Connection to a Computer

### 2.6.3 Connecting to a 2100 Series Network Device

The 2150EX can be connected to a 2100 Series network device located in a safe area (with the exception of the 2102 Wireless module). In order for the 2150EX to communicate with a 2100 Series network device other than the 2194EX, the two must be connected by an Isco RS485EX Isolator Cable (P/N 60-2004-340). The hazardous area end, labeled with proper entity parameters, connects to the EX Network cable.

Observe intrinsic safety requirements regarding proximity to external sources of potential electric or magnetic interference. Refer to IEC 10079-14 section 12.2.2.5 on installation of cables and wiring.

If the 2150EX and AV2150EX sensor are *not* located in a potentially explosive atmosphere, the RS485EX isolator cable can be connected directly to the top of the 2150EX.

A site example using the Field Wizard is shown in Figure 2-2.

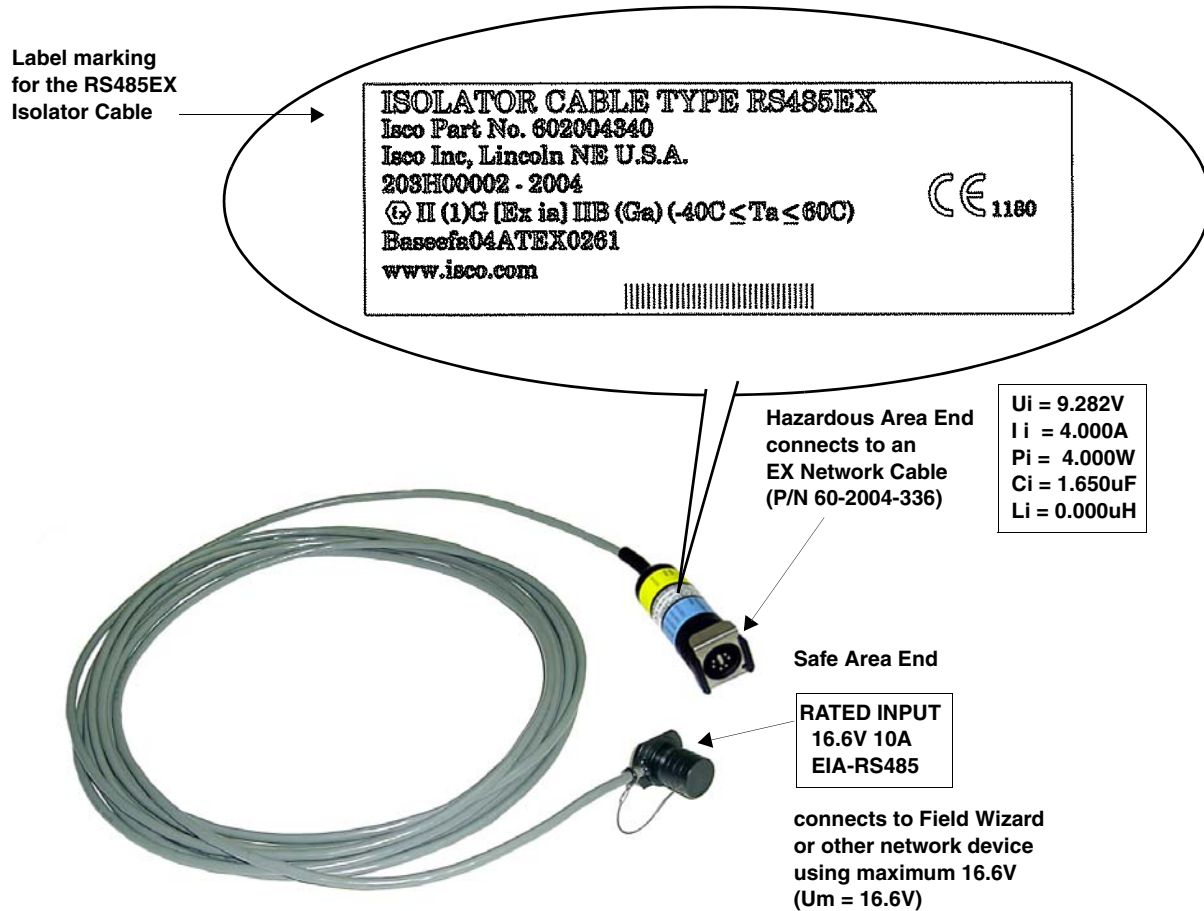


Figure 2-18 RS485EX Isolator Cable for Connection to a 2100 Series Network Device

To connect the EX Network and RS485EX isolator cables:

1. Remove the protective cap from the communication connector on the top of the 2150EX module.
2. Store the protective cap in the holder next to the connector.
3. Push the 6-pin end of the EX Network cable onto the communication connector on the top of the 2150EX module. Use care, so you do not misalign the pins and cause any short circuits!
4. Route the cable as shown in Figure 2-2, so the other end of the EX Network cable is at the interface of the safe and hazardous areas.
5. Attach the hazardous area end (with yellow/blue label) of the RS485EX cable to the EX Network cable coming from the 2150EX. Use care, so you do not misalign the pins and cause any short circuits! Attach the other end of the RS485EX cable to the communication connector on the power supply for the Field Wizard or other network device.

 **WARNING**

The RS485EX cable maximum  $U_m = 16.6V$ . As displayed in Figure 2-2, if the RS232 cable is used to connect a laptop computer to the Field Wizard or other Isco network device, **NEVER** use mains power to power the laptop; use battery power only.

 **Note**

You can safely connect and disconnect the RS485EX cable from the EX Network cable without removing the 2150EX module from the potentially explosive atmosphere.

**2.6.4 RS232 Communication Cable**

In a permanent installation, the 2194EX serves as the network communication isolator, with RS232 or RS485 communication via the top connector.



*Figure 2-19 RS232 communication cable*

The 9-pin connector of Isco's RS232 communication cable (60-2004-046) connects to a computer's serial port, and the push-on end connects to the top of the 2194EX.

## 2.7 Connecting the AV2150EX Sensor

The AV2150EX sensor cable attaches to the sensor receptacle on the 2150EX module.

To connect the AV Sensor (refer to Figure 2-20):

1. Remove the protective caps:
  - a. On the 2150EX, push down on the sensor release while pulling the protective cap from the receptacle.
  - b. On the AV Sensor cable, pull the cap from the end of its connector.
2. Prepare the AV Sensor connector:
  - a. Inspect the connector. It should be clean and dry. Damaged O-rings must be replaced. Spare O-rings (P/N 202-1006-69) are supplied in the 2150EX maintenance kit (60-2059-001).
  - b. Coat the O-ring's sealing surface with a *silicone* lubricant.

### CAUTION

Do not use petroleum-based lubricants. Petroleum-based lubricants will cause the O-ring to swell and eventually deteriorate. Aerosol silicone lubricant sprays often use petroleum based propellants. If you are using an aerosol spray, allow a few minutes for the propellant to evaporate before proceeding.

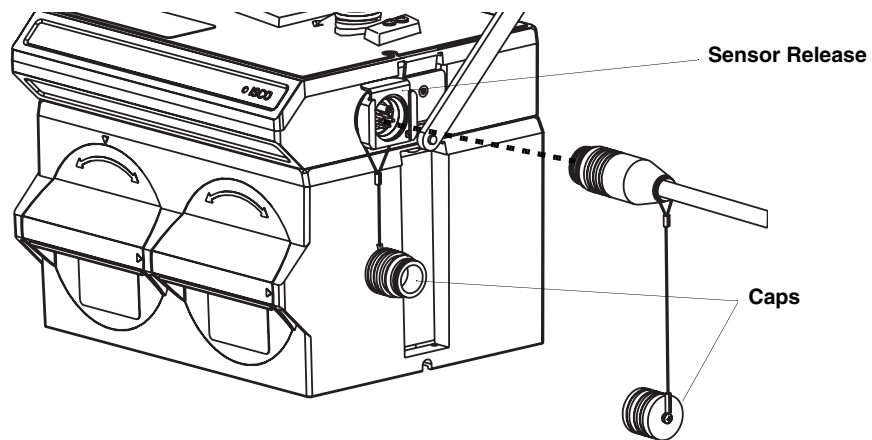


Figure 2-20 Connecting the AV Sensor

3. Align and insert the connector. The sensor release will *click* when the sensor connector is fully seated.
4. Connect the two caps together.

### *Important Information Regarding "X" Marking*

The ATEX labeling on the sensor's serial tag shows a number ending in "X". The X marking indicates that there are special conditions that must be met to ensure safety, as explained on page *viii* in the front of this manual.

In the case of the AV2150EX, the sensor is labeled and X-marked for special usage conditions in order to prevent static electricity. Avoid conditions that may generate a static charge, such as rubbing the AV2150EX with static producing cloth.

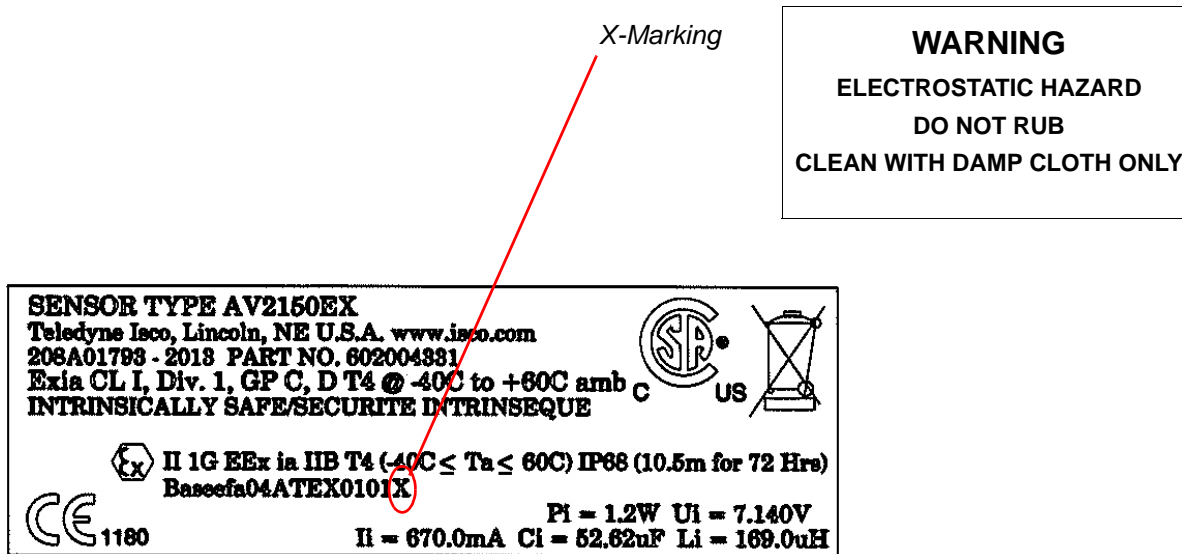
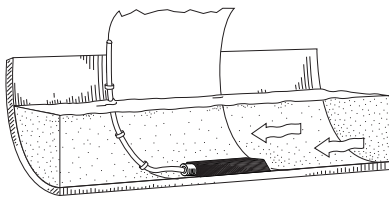


Figure 2-21 AV2150EX Sensor Cable Labels

### 2.7.1 Positioning the AV Sensor



Ideal Conditions - Uniform Flow

Sensor installation is discussed in Section 2.8 of this manual. Consult your Isco Mounting Rings instruction manual for detailed hardware information. This section explains how to position the AV Sensor in flow streams.

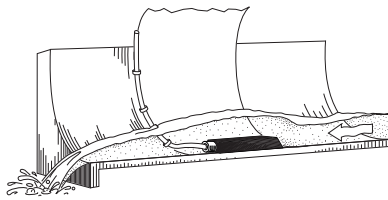
Several factors concerning the AV Sensor's installation may affect your system's performance. Review the following to understand how to obtain the best results:

**Uniform flow** - The AV Sensor provides the best results in flow streams with uniform flow. An example of uniform flow is shown in the margin.

**Avoid poor channel conditions** - Poor channel conditions may cause incorrect or erratic readings. Areas to avoid are:

- outfalls or channel intersections
- flow streams at very low levels with high flow rates
- turbulence
- channel sections that are apt to collect debris or silt
- depths that consistently run below 2.54 cm (1 inch).

Install the AV Sensor in streams where the liquid covers the sensor. The AV Sensor can detect levels above approximately 1.0 cm (0.4 inch) and typically can measure velocities in streams as low as 2.54 cm (1 inch). Streams that run consistently below 2.54 cm are not a good application for the 2150EX.



Poor Conditions

The example at left shows an illustration of these poor conditions. The outfall is drawing down the liquid level and the AV Sensor is disturbing the flow. In this example, the AV Sensor should be moved forward to avoid the drawdown near the outfall.

**Offsets** - You can install the AV Sensor above the bottom of the flow stream or along the side of the channel, as long as it will be continually submerged. The 2150EX can be adjusted to measure level with the AV Sensor at nearly any depth. The AV Sensor cannot, of course, measure a liquid level that falls below its position in the flow stream.

Installing the AV Sensor above the bottom has advantages:

- It avoids heavy concentrations of silt, sand, or other solids.
- It aids installation in narrow or hard-to-reach locations.
- It maximizes level resolution over a specific level range.
- It can avoid obstructions in the flow stream.

When the AV Sensor is installed above the bottom of the channel, a *Zero Level Offset* must be entered in the program settings (see Section 3.3.2).

**Liquid properties** - Velocity measurements depend on the presence of some particles in the stream such as suspended solids or air bubbles. If the stream lacks particles it may be necessary to aerate the water upstream from the sensor.

**Handle with care** - Abusive handling will damage the AV Sensor. Although the AV Sensor will survive normal handling and installation, treat the sensor with reasonable care. The internal components cannot be repaired.

**Secure the cable** - Secure the sensor cable in place to prevent lost equipment if excessive flow dislodges the sensor and its mounting. Any excess cable must be kept out of the channel to prevent accumulation of debris.

 **CAUTION**

The vent tube inside the sensor cable must remain open. Do not kink the cable or overtighten the plastic ties while securing the cable.

 **WARNING**

**Do not coil the sensor cable. This will form an inductor and create a hazard.**

## 2.8 Mounting Rings

**Consult your Isco Mounting Rings instruction manual for detailed hardware information.**

The following sections describe sensor installation using the two options available for mounting the AV sensor in pipes or round-bottomed flow streams. For pipes up to 15" (38 cm) in diameter, **stainless steel self-expanding mounting rings (Spring Rings)** are available. For pipes larger than 15" in diameter, Teledyne Isco offers the **Scissors Rings (Universal Mounting Rings)**. Area velocity sensors can also be installed using primary measuring devices.

 **WARNING**

**Due to the creation of a permanent grounding point between the sensor's transducer cover and the mounting ring when the sensor is installed, the 2150EX system can not withstand the 500 VAC test according to EN60079-11:2007 clause 6.3.12. Refer to IEC 60079-14, section 12.2.4, regarding earthing of intrinsically safe circuits.**

 **WARNING**

**The sensor mounting ring is a potential isolated charge carrier. Your installation MUST satisfy earthing requirements. Refer to IEC 60079-14 section 12.2.4 and IEC 60079-11 and the Teledyne Isco accessory Ground Lug Kit.**

### 2.8.1 Spring Rings

To install a spring ring, compress the ring, slip it inside the pipe, and then allow it to spring out to contact the inside diameter of the pipe. The inherent outward spring force of the ring firmly secures it in place. A typical self-expanding mounting ring (with a probe mounted on it) is shown in Figure 2-22.

These mounting rings are available for use in pipes with inside diameters of 15.2 cm (6"), 20.3 cm (8"), 25.4 cm (10"), 30.5 cm (12"), and 38.1 cm (15"). The Isco part numbers for the various size mounting rings available are listed in Appendix B. These part numbers include not only the ring, but also the miscellaneous hardware necessary to mount the sensor on the ring.

Isco spring rings have mounting holes for installing a stainless steel grounding block for the attachment of bonding conductors. Ground lag kit #60-2007-476 ordered separately.

 **CAUTION**

Always wear leather gloves when handling the rings (either type). The metal is finished, but there is still a possibility of cutting your hands on the edges.

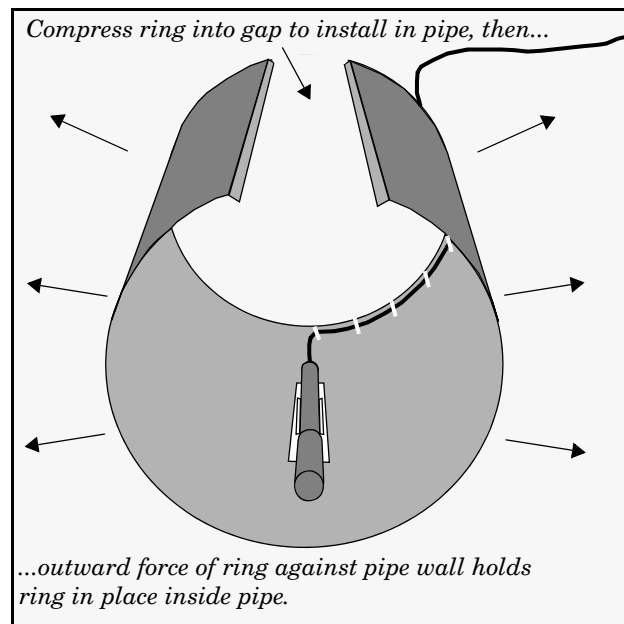


Figure 2-22 Sensor Installed on a Spring Ring

*Attaching the Sensor to the Ring*

Attach the AV sensor to the ring either by using two 4-40 countersink screws or by snapping the optional probe carrier to the ring. This second method of attaching the sensor allows for easy removal in case service is needed later.

**CAUTION**

Make sure the slots on the AV sensor carrier are completely pressed into the tabs on the ring. This is particularly important where there is any possibility of reverse flows, or where flows are of high velocity. If the AV sensor is not fully pressed into the mounting ring tabs, it might come loose in the stream, and could possibly be damaged or lost.

Make sure the sensor cable is securely fastened along the back (downstream) edge of the ring. Otherwise, the sensor may provide **inaccurate level readings** under conditions of high velocity.

To complete the sensor-spring ring assembly procedure, attach the sensor cable to the downstream edge of the ring. Follow the cable routing shown in Figure 2-22. Other routing directions may affect measurement accuracy. The cable can actually create a stilling well downstream from the sensor, causing the level to read low. Use the self-locking plastic ties supplied with the ring. Install the ring in the pipe by compressing it. Press inward on both sides and slide the ring into the pipe.

Route the sensor cable out of the stream and secure it in position by placing the ties through the holes in the mounting ring and then locking them around the cable, as shown in figure 2-22.



 **CAUTION**

Do not overtighten the plastic cable ties; they should be tightened just enough to secure the cable in place, without greatly indenting the cable. Overtightening the plastic ties may collapse the reference tube in the cable, blocking it.

The spring ring may need anchoring. Under conditions of high velocity (greater than 1.5 meters per second or 5 feet per second), the ring may not have sufficient outward spring force to maintain a tight fit inside the pipe. The ring may start to lift off the bottom of the pipe, or may even be carried downstream.

This problem is more prevalent in the larger diameter pipes and in pipes with smooth inside surfaces, such as plastic pipes. If any of these conditions are present, or if movement of the mounting ring is detected or suspected, you must anchor the ring in place. You can do this by setting screws through the ring into the pipe, or by other appropriate means. If there is a problem with the smaller diameter rings, it may be sufficient to simply increase the outward spring force of the ring by bending it into a less round configuration.

### 2.8.2 Scissors Mounting Ring

For pipes larger than 15" in diameter, Teledyne Isco offers the adjustable Scissors Ring (also known as the Universal Mounting Ring). This device consists of two or more metal strips that lock together with tabs to form a single assembly. There is a base section where the sensors are mounted, two or more extension sections (usually), and a scissors section at the top that expands the entire assembly and tightens it inside the pipe. The scissors section contains a long bolt that increases the length of the section as it is tightened.

The assembled scissors rings fit pipe diameters from 16" to 80". Secure the unit in place by tightening the scissors mechanism with a  $\frac{5}{8}$ " socket wrench or other suitable tool. Ring sections are .040" thick half-hard 301 stainless steel sheet. All other parts are also stainless steel, except for the plastic cable ties in the hardware kit.

Each extension, 1, 2, 3, and 4, adds 9.0", 21.5", 31.5", or 41.5", respectively, to the circumference of the ring. Used alone, the base section fits a pipe that is approximately 16" to 19" in diameter. The 9.0" (smallest) extensions can be used to take up or remove slack, to bring the scissors mechanism into a position where it can be effectively tightened.

 **Note**

The hardware kit includes flat head bolts and nuts. Teledyne Isco strongly recommends bolting the assembled scissors ring together before installation, using the holes provided for that purpose. Bolting the tongue sections together can greatly increase safety and prevent the assembly from being torn apart.

**Do not overtighten the mechanism.** It is designed to flex somewhat to provide a positive lock, once moderately tightened.

For installations in larger channels and/or high flow, extensions 2, 3, and 4 have slots for attaching the ring to the channel wall using appropriate anchoring hardware.

**WARNING**

Avoid prolonged use of excessive force when adjusting the equipment. This can create hot surfaces from the friction of screw or lever mechanisms, resulting in a potential ignition hazard if surface temperatures exceed the equipment's 135°C rating.

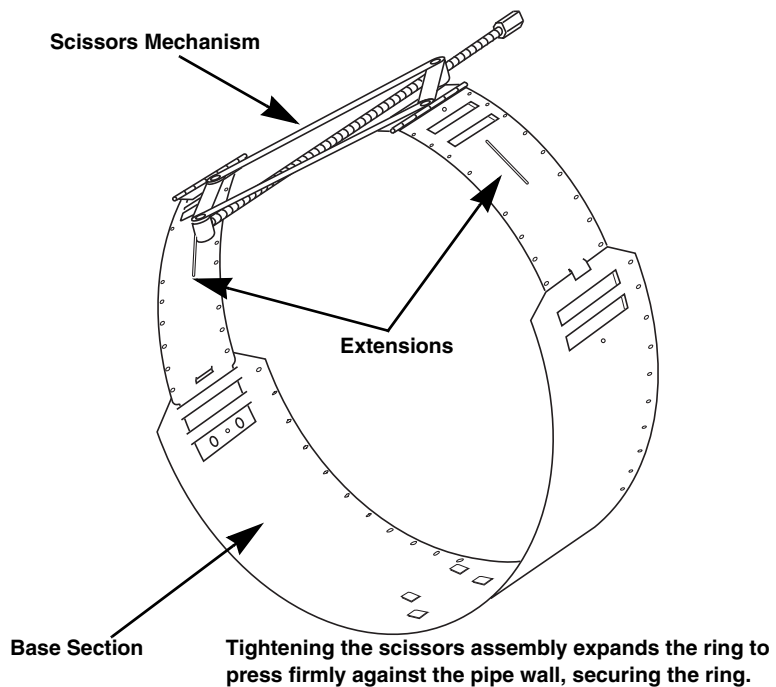


Figure 2-23 Scissors Ring adjustment

To prevent debris from catching on the probe cable, it is important to attach the cable to the mounting ring so it offers as little resistance to the flow as possible. Attach the sensor cable to the downstream edge of the ring, using the self-locking plastic ties supplied with the ring. Place the ties through the holes in the mounting ring and then lock them around the cable.

**CAUTION**

Do not overtighten the plastic cable ties; they should be tightened just enough to secure the cable in place, without greatly indenting the cable. Overtightening the plastic ties may collapse the reference tube in the cable, blocking it.

The scissors mechanism has stainless steel ground terminals mounted on the hinged bracket for the attachment of bonding conductors.

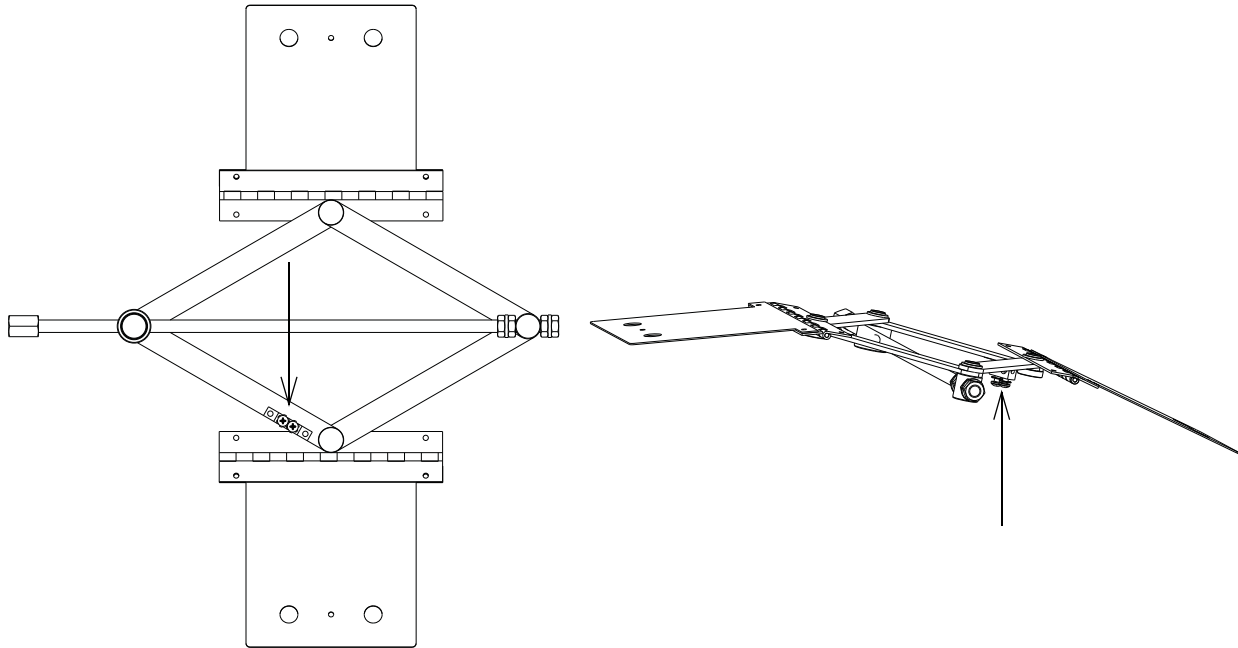


Figure 2-24 Scissors mechanism ground terminals

### 2.8.3 Completing the AV Sensor Installation

The AV sensor installation is finished by securing any excess sensor cable using cable clamps or other means.

The reference tube inside the cable can be restricted or blocked if the cable is kinked, sharply bent, coiled, or otherwise pinched. The sensor cable should be handled and mounted with care. Also, if there is any appreciable distance between the point where the sensor cable leaves the mounting apparatus and the location of the flow meter, *be sure* to attach the cable to the flow stream wall to prevent it from vibrating, moving around, tangling, or possibly collecting debris.

**⚠ WARNING**

**Do not coil the sensor cable. This will form an inductor and create hazard.**

 **CAUTION**

Under no circumstances should you leave any extra length of sensor cable dangling freely in the flow stream where it could trap debris or become tangled.

Use gloves and eye protection when assembling and installing the rings in a pipe. Though deburred, the edges of the stainless steel can cut if improperly handled. *Please read the information on how best to install this device.*

Observe general safety procedures when entering any manhole. See “General Safety Procedures” in the back of the manual for more information on general hazards and necessary precautions.

## 2.9 Final Installation Check

The system should be secured at the site. This prevents damage caused by accidental falls and from being swept away if the channel is flooded. In manholes, the module is often secured to a ladder rung. Teledyne Isco’s Customer Service Department or your local representative can assist you with installation options.

As you complete the installation, the following should be checked before leaving the site unattended:

1. The module should be positioned where it will be protected from submersion. Should the module become submerged, level readings may drift and the hydrophobic filter will seal to protect the reference air line.

 **Note**

To protect the 2150EX AV Flow module and sensor, the hydrophobic filter seals off the reference air line when it is exposed to excessive moisture. When sealed, the filter prevents irreparable damage, yet may cause the level readings to drift. This single-use filter must be replaced once it becomes sealed.

2. Make sure all of the protective caps are in place. An unused upper communication connection must be capped to prevent damage and terminate the communication line. If the communication connector is in use, its cap should be properly stowed. Like the module and sensor connections, the protective caps and their O-rings should be cleaned and coated with a silicone lubricant. Damaged O-rings must be replaced (P/N 202-1006-69).
3. Carefully route cables. Protect them from traffic in the area. Avoid leaving excess AV Sensor cable in the flow stream where it may collect debris.

### 2.9.1 Program the Module

After you have installed the AV Sensor in the flow stream, the flow stream properties must be defined. To do this, connect to the 2150EX with *Flowlink* software and define the stream properties in the 2150EX module’s program settings. These ensure that the system correctly reads the liquid level and converts the measured level to flow rate.

**Note**

The 2150EX requires Flowlink 4.1 or later. If you require two minute data storage intervals, you will need version 4.16 or later.

Refer to Section 3 and define the following properties:

- **Level** - Enter a liquid level measurement to adjust the level readings from the AV Sensor.
- **Zero Level Offset** – If the AV Sensor is not installed in the bottom-center of the channel, an offset distance must be entered.
- **Set Flow Rate to zero if no velocity data checkbox** - Determines how the 2150EX reports flow rates if stream velocity data is not available.
- **Flow Conversion** – The 2150EX can store flow rate readings. To correctly convert the measured level and velocity readings to a flow rate, the flow conversion method and channel properties should be defined.
- **Silt Level** – (*Area Velocity Flow Conversion Only*) The 2150EX can compensate for a build up of silt around the AV Sensor.

These five settings should be considered a minimum requirement. Other settings, such as *Data Storage Rates*, *Site Name*, and *Module Names*, also may be set using Flowlink.

## 2.10 System Power

Table 2-1 lists the maximum voltages for all Isco 2100 instrumentation. Regardless of the capabilities of other components, **never** attempt to connect a module or cable to a system using a power source that exceeds its stated operating range.

Table 2-1 Voltage Specifications for 2100 System Components			
Module or Cable	Earlier Voltage Range	Current Voltage Range	Date of Change
2160	N/A	7-16.6 VDC	N/A
2150	7-16.6 VDC	7-26 VDC	March 2005
2110	7-16.6 VDC		N/A
2101			
2103			
2102	10.2-16.6 VDC		
2108	7-26 VDC		
2105			
RS-232 DB9 Cable (part #60-2004-046)	7-16.6 VDC	7-26 VDC	January 2009
RS-232 USB Cable (part #60-2004-507)	7-26 VDC		N/A
Sampler Interface Cable (part #60-2004-260)	12VDC (from sampler)		N/A (Cable is powered from sampler.)

 **WARNING**

Injury and/or equipment damage can result from connecting modules or cables to a power source exceeding the specified operating voltage range. Check labeling on all modules and cables for voltage ranges.

 **Note**

All connected system components should share a common supply ground.

# 2150EX Area Velocity Flow System

## Section 3 Programming

### 3.1 Overview

#### *Flowlink Help*

This section describes how to set up the operation of a 2150EX Area Velocity Flow Module using Isco's Flowlink software.

Detailed Flowlink instructions are beyond the scope of this manual. Flowlink's operating instructions are available in a Windows Help format. You can access the help topics for an active window by clicking on its *Help* button or by pressing F1 on your computer's keyboard. You can also access Help topics from a Contents and Index window (HELP>CONTENTS AND INDEX from the Flowlink menu).

### 3.2 Flowlink Connections

To allow interrogation of data using a computer connected to your 2150EX, you need to make the necessary connections to allow your computer to communicate with the site. Figure 3-1 shows a connection using Isco's RS232EX Isolator Cable, P/N 60-2004-339 and EX Network Cable (P/N 60-2004-336). Note that the computer must be positioned in a safe area. Use care in connecting cables so you do not misalign the pins and cause a short circuit.

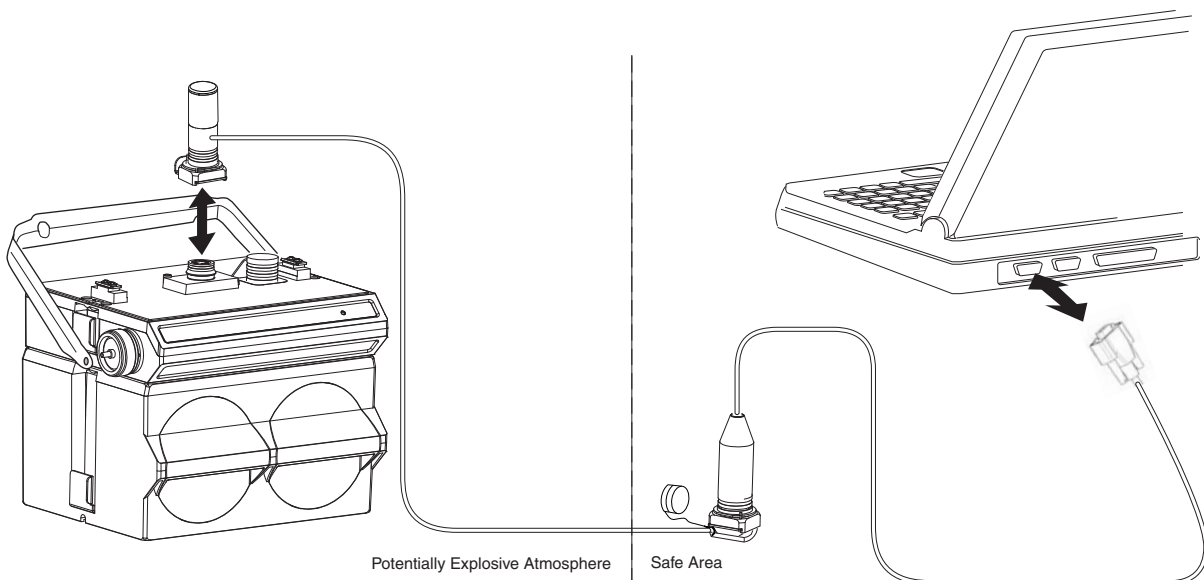


Figure 3-1 Connection to a Laptop, Using Cables P/N 60-2004-336 and 60-2004-339

An easy way to begin Flowlink communications with the site is to *Quick Connect*. As a default Flowlink setting, the Quick Connect dialog box opens when you start Flowlink. Click on the large *2100 Instruments* button to connect. Flowlink will read the 2100 system information and try to match it with an existing site in the open database. If Flowlink cannot find a match for the connected site, it creates a new site in the database.

### 3.2.1 Site Configuration Stability

During the connection process, Flowlink checks the stability of the site's configuration. If there are conflicts with the site configuration, Flowlink presents the *Network Resolution* window.

There are two common causes of site configuration conflicts. One cause is a Module Name conflict, which may occur when two or more modules at a site use the same module name. The second cause is a Site Name conflict, which occurs when a module added to the site indicates that it belongs to a different site.

The Network Resolution window lets you choose how the modules should be configured and which Site Name should be retained. To resolve the conflicts, select the actions that should be taken and click the OK button. Be aware that some actions will delete all data in the module.

## 3.3 Program Settings

### *Essential Settings*

While connected, Flowlink displays the *Site View* window. This window contains all of the program settings that control the site's operation. The settings are grouped, or categorized, using five tabs: Measurements, Site Info, Modules, Data Storage, and a variable tab used to set up the various measurement types.

Some program settings are essential to the operation of an 2150EX and its attached AV2150EX Sensor. Five program settings should always be verified when setting up a new site:

- **Level** - Enter a liquid level measurement to adjust the level readings from the AV Sensor (3.3.1).
- **Zero Level Offset** – If the AV Sensor is not installed in the bottom-center of the channel, the distance the AV Sensor is offset must be entered (3.3.2).
- **Set Flow Rate to zero if no velocity data checkbox** - Determines how the 2150EX reports flow rates if stream velocity data is not available (3.3.3).
- **Flow Conversion** – The 2150EX can calculate flow rate readings. To correctly convert the measured level and velocity readings to a flow rate, the flow conversion method and channel properties should be defined (3.3.4).
- **Silt Level** – The 2150EX can compensate for a build up of silt around the sensor (3.3.5).

These five program settings directly affect the data collection. Incorrect settings may introduce errors in the measured data, many of which may prove to be difficult to correct afterwards.



- Data Storage Settings* You should also check the Data Storage Rates while you are reviewing the program settings. You can view the storage rates on the Data Storage tab to ensure that pertinent types of data are being stored, and that the rates will provide a sufficient amount of data for your application. Refer to section 3.3.6 for instructions on how to modify the data storage rates.
- General Settings* Once the site’s configuration has been resolved, the Site and Module Names may be changed to help you better manage the sites and data collection. Giving sites descriptive names such as “12th and Main Streets” can help you easily recognize the measurement locations, instead of generic terms such as “Site 1.” Site and Module Names are discussed in sections 3.3.7 and 3.3.8.
- Changing a Setting* After modifying a setting as described in sections 3.3.2 through 3.3.8, click on the APPLY button (or press F9 on your keyboard). Flowlink sends the change to the module and updates the site’s settings in its Flowlink database.

**3.3.1 Level**

*Measurement Location* A measurement of the actual liquid level must be taken to adjust the level readings. The value of this measured depth should be entered on the *Level* measurement tab in Flowlink. The location of your measurements can affect the flow conversion results. An understanding of how the AV Sensor measures level and velocity will help you determine where the measurements should be taken.

The AV Sensor transmits an ultrasonic sound wave. It propagates from the front of the sensor in a cone-shaped pattern. From within this cone, the AV Sensor measures the stream velocity. Therefore, it is best to measure level from a point inside the cone. Since this cone cannot be seen, a general rule is to measure in front of the sensor along the channel centerline at a distance equal to the liquid depth. For example, if the stream is one foot deep, take the level and channel dimension measurements one foot upstream from the sensor. If the flow at this point is turbulent, consider relocating the sensor.

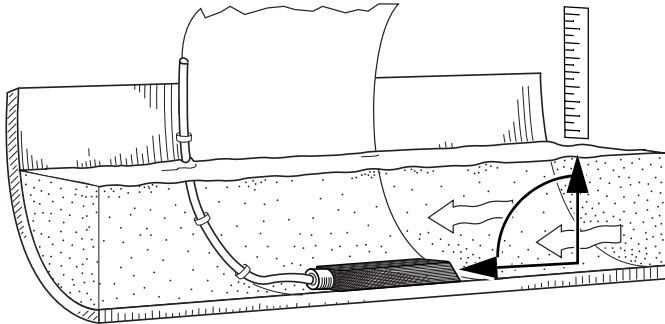
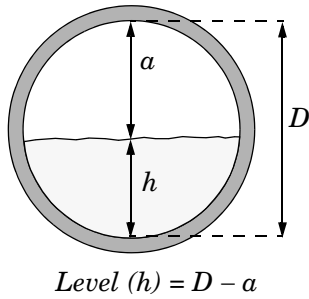


Figure 3-2 Preferred Measurement Location

Do not measure the level and channel dimensions right at the sensor, as the sensor and the mounting ring may cause a slight “jump” or localized rise in the level. At very low levels and high velocities, this jump in the liquid surface may become quite significant.



In round pipes it is possible to measure the level without disturbing the stream surface. This method is preferred. Refer to the diagram in the margin. First measure the inside diameter of the pipe ( $D$ ). Then measure the airspace ( $a$ ) from the liquid surface to the peak of the inside diameter. Average this measurement if the surface is not calm. The level measurement that you enter ( $h$ ) is calculated by subtracting the distance above the liquid ( $a$ ) from the diameter ( $D$ ). If difficult channel conditions keep you from making the measurements as described above, another site should be considered.

### 3.3.2 Zero Level Offset

AV Sensors are sometimes offset in the channel to avoid heavy concentrations of silt, or to maximize the level resolution over a specific range. When the AV Sensor is offset, an offset distance must be entered on the *Velocity* measurement tab in Flowlink.

Refer to Figure 3-3. Enter a value for the vertical distance the sensor is installed above the true zero level of the stream. For example, if the sensor is mounted on the side of the pipe two inches higher than the true zero level (the bottom center of the pipe), the Zero Level Offset is two inches. If the sensor is mounted at the bottom of the channel, enter zero.

**Note**

Do not confuse the circumferential distance between true zero and the location of the AV Sensor with the vertical distance (height). If you install the AV Sensor at the true zero level of the pipe or channel, you would enter "0" for the offset (ignoring the thickness of the mounting ring).

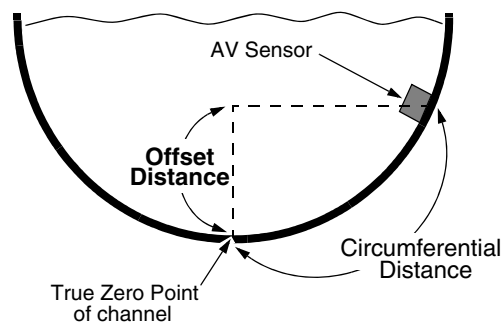


Figure 3-3 Zero Level Offset Measurement

### 3.3.3 No Velocity Data and Flow Rates

Occasionally velocity readings are lost because either a flow stream does not contain enough reflective particles, or the sensor is covered with silt. These lost velocity readings are logged as a “No Data Code.” If the 2150EX is set up to use area velocity flow conversion, it is then unable to calculate the flow rate. You can control how the Flow Rate readings will be reported during these conditions with the “Set flow rate to zero if no velocity data” checkbox, found on Flowlink’s *Velocity* measurement tab.

- Checked, the 2150EX stores the flow rate as 0.0 when velocity data is not available.
- Unchecked, the 2150EX will use the last valid velocity measurement in the flow rate calculation.

<input checked="" type="checkbox"/> <b>Note</b>
---

Measuring velocity becomes extremely difficult at low liquid levels. When the level falls below one inch, the module no longer measures the velocity. Instead, velocity is interpolated based on measurements that occurred between one and seven inches of liquid.

#### *Prevent Velocity Signal Interference*

If the AV Sensors of a multiple module site are placed near each other it is important that each sensor receives its own transmitted signal. To prevent this sort of interference, you can synchronize the modules so that only one module may take a velocity measurement at any given moment.

To synchronize the velocity measurements of a multiple module site, check the *Prevent interference* box found on the *Velocity* measurement tab. You may leave this box unchecked for single module sites or multiple module sites measuring velocities of separate channels.

### 3.3.4 Flow Conversion

The 2150EX is capable of determining flow rates using either area velocity conversion or level-to-flow rate conversion. Table 3-1 lists the available flow conversion methods.

The 2150EX is capable of calculating and storing any two conversion methods simultaneously. Flow conversions are defined on the *Flow Rate* and *Flow Rate 2* measurement tabs in Flowlink. To do this, select the *Conversion Type* that matches your application, then enter the required parameters in the fields to the right of the selected conversion type.

**Table 3-1 Flow Conversion Methods**

Conversion Type		Device, Formula, or Table	Size or Parameters
<b>Area Velocity</b>	<b>Channel Shape</b>	Area × Velocity	Round Pipe, U-Channel, Rectangular, Trapezoidal, Elliptical
	<b>Level-to-area Data Points</b>	User-developed Table	3 to 50 data points
<b>Level to Flow</b>	<b>Weir</b>	V-Notch Weir	22.5, 30, 45, 60, 90, 120 degrees
		Rectangular Weir with end contractions	Crest Length
		Rectangular Weir without end contractions	Crest Length
		Thel-Mar	6, 8, 10, 12-14, 15-16 inches
		Cipoletti Weir	Crest Length
	<b>Flume</b>	Parshall Flume	1, 2, 3, 6, 9 inches 1, 1.5, 2, 3, 4, 5, 6, 8, 10, 12 feet
		Palmer-Bowlus Flume	4, 6, 8, 10, 12, 15, 18, 21, 24, 27, 30, 48 inches
		Leopold-Lagco	4, 6, 8, 10, 12, 15, 18, 21, 24, 30 inches
		"HS" Flume	0.4, 0.6, 0.8, 1.0 feet
		"H" Flume	0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4.5 feet
		"HL" Flume	4.0 feet
		Trapezoidal Flume	Large 60-degree V Extra Large 60-degree V 2-inch, 45-degree WSC 12-inch, 45-degree SRCRC
	<b>Flow Metering Insert</b>	V-notch	6, 8, 10, 12 inches
		Round Orifice	6, 8, 10, 12 inches
	<b>Manning Formula</b>	Round Pipe	Slope, Roughness, Diameter
		U-Channel Pipe	Slope, Roughness, Width
		Rectangular Pipe	Slope, Roughness, Width
		Trapezoidal	Slope, Roughness, Bottom Width, Top Width
	<b>Equation</b>	Flow = 0.00*(Head <sup>0.00</sup> ) + 0.00*(Head <sup>0.00</sup> )	
	<b>Level-to-Flow Rate Data Points</b>	User-developed tables for level-to-flow rate	3 to 50 data points

If the selected flow conversion requires channel dimensions, actual channel measurements should be taken. Channel measurements are preferred over nominal values. Significant errors may be introduced if your measurements are inaccurate. The example below illustrates the importance of accurate measurements.

**Example:**

Nominal Pipe Diameter: 10 inches  
Actual Pipe Diameter: 10.25 inches  
Level Measured Near Outfall: 2.75 inches  
Correct Level Measurement: 3 inches

During programming, you enter 10 inches for the round pipe diameter - from the pipe manufacturer's specification. You also enter the 2.75 inch level measurement taken behind the sensor near an outfall. Although each setting has only a 0.25 inch error, the cumulative flow measurement error may exceed 14%!

Refer to the information in Section 3.3.1 to determine where to measure the channel dimensions.

### 3.3.5 Silt Level

Silting in the flow stream will alter your channel dimensions, affecting the flow rate conversion. To compensate for a buildup of silt, a *Silt Level* value can be entered on the *Flow Rate* measurement tab in Flowlink. Silt level compensation is only available when using Area Velocity flow conversion.

### 3.3.6 Data Storage Rates

The data storage function of a 2150EX can record level, velocity, flow rate, total flow, and input voltage readings. The interval at which the 2150EX stores the readings is called the *Data Storage Rate*. The 2150EX is shipped with default storage rates of 15 minutes for the level, velocity, and flow rate, and 1 hour for total flow and input voltage readings.

You can modify the data storage rates to log readings at a faster or slower rate. Keep in mind that although the 2150EX can store data as fast as 1 reading every 15 seconds, faster storage rates will shorten battery life, increase memory usage, and lengthen *Retrieve Data* (interrogation) times.

You can also create conditional data storage rates. The 2150EX can log data at a secondary rate when user-defined conditions have been met. For example, a 2150EX can store level readings at a primary rate of 15 minutes, and a secondary rate of 1 minute when the level reading is greater than or equal to 1 foot. Secondary rates allow you to collect detailed data when defined events of interest occur, while reducing power and memory consumption when detailed readings are not needed.

To modify the Data Storage Rates, first click on the *Set Up Data Storage...* button on a measurement tab. Then enter the Primary and Secondary Rate settings on the *Data Storage Setup* window. Repeat this for each measurement type.

### 3.3.7 Site Name

The module is shipped with a default name so that it can immediately begin to communicate with Flowlink. You can change the site name to a more descriptive name on the *Site Info* tab in Flowlink. Keep in mind that the name must be unique among the other site names in the open Flowlink database.

Site names can be up to 20 characters long. Any character may be used in the name except:

/	forward slash	\	back slash
:	colon	*	asterisk
?	question mark	"	double-quote
<	left angle bracket	>	right angle bracket
	bar	&	ampersand

### 3.3.8 Module Name

The module is shipped with a default name so that it can immediately begin to communicate with Flowlink. You can change a Module Name to a more descriptive name on the *Modules* tab in Flowlink. Keep in mind that the name must be unique among the other module names connected at that site.

Module names can be up to 20 characters long. Any character may be used in the name, except for those noted in *Site Name*, section 3.3.7.

# 2150EX Area Velocity Flow System

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## *Section 4 Modbus Protocol*

Sections 4.1 through 4.5 give an overview of the basic capabilities and operation of Modbus protocol as it applies to Isco 2100 Series flow modules.

For a Glossary of Terms and Common Acronyms, see sections 4.4 and 4.5.

### **4.1 Introduction**

Modbus is a simple command/response mechanism to read from and write to specific memory locations called *registers*. A register is a holding place for a piece of digital information within the equipment. There are three standard protocols for Modbus: Modbus RTU, Modbus TCP/IP, and Modbus ASCII. The Isco 2100 Series devices use Modbus ASCII protocol, the method discussed in this manual. Modbus ASCII has more liberal communication timing requirements. Modbus communication for the Isco 2100 Series provides a standard protocol that can be used to retrieve real-time data from a single module or stack of modules at a site, or multiple sites, over a wide area. The data can be sent to a central computer for display, data collection, or process control.

Modbus implementation is independent of Flowlink and cannot alter the Flowlink-programmed configuration of the module. Modbus cannot be used to retrieve historical data from a module's memory.

Due to the wide variety of configurations that can be made with Modbus, it is impossible to cover every usable application. This section will discuss the overall capabilities and operation of Modbus.

### **4.2 Operation**

There are many standard, third party Modbus drivers and OPC servers that may be used to link a remote Modbus device, such as a 2100 Series module, to SCADA or process control software, such as Wonderware™ or Intellution™. The OPC server communicates with the remote instrumentation and accesses registers. The definition of what information is contained and where (the register number, or address) is decided by the manufacturer (Teledyne Isco).

In a 2100 module, the registers hold, but are not limited to, the current real-time value of the meter's level, velocity, flow, input voltage, temperature, and total flow readings, stored in specified register locations.

By accessing these registers you can obtain the current value of whatever parameter you desire. The reading(s) can then be displayed or stored wherever you designate as a destination; for example, a process control computer.

 **Note**

Level, flow, velocity, and temperature data is stored in metric units only.

Not all registers are limited to read-only data storage. You can also use some registers for control purposes. For example, by writing a “1” value to register 24 (“Identify Module” register), you will tell a 2100 module to light the LED on the front of the module.

**4.2.1 Establishing Communication**

There are several different communications protocols supported in the 2100 series that require auto-baud rate detection. Because of this, each time a modbus connection is made, the module uses a polling mechanism to repeatedly send a command until a response is received. It may take up to 20 command retries before the module has identified the baud rate and a response is received.

**4.2.2 Module Addressing**

When connecting to a site via a Modbus OPC server, you use a dedicated line of communication to that module or stack from the OPC server, which can be a dedicated communications cable (direct connection) or a dedicated phone number (modem).

When you are using a direct connection, you are dedicating a specified COM port on the computer, and that COM port determines the site to which you are connecting.

When you are using a modem, the dedicated line is defined by the site's phone number.

If you connect more than one 2100 Series module at a site, the Modbus OPC server, while using the shared communication line for all of the modules within the network, must have some way to differentiate between the modules. When sending a command to a specific module, the command has an address field. This allows the server software to talk to, as well as control, the specified module, while ignoring other modules in the same stack or site.

Each module capable of Modbus Protocol communication will automatically create its own specific ASCII address within the site, using:

- The model numbers of the modules
- The user-defined module names



### 4.3 Configurations

A variety of configurations can be made with Modbus, either through direct connection or through a modem.

In the example shown in Figure 4-1, you are direct-connecting a server PC to two individual 2100 sites through Modbus, using the COM ports on the OPC Server, which are directly connected to the remote sites.

Connection to the module is made through the RS-232 communication port on the top of the module.

In Figure 4-1, the OPC Server PC must have two COM ports. Modbus requires one COM port each, for direct connection of each 2150.

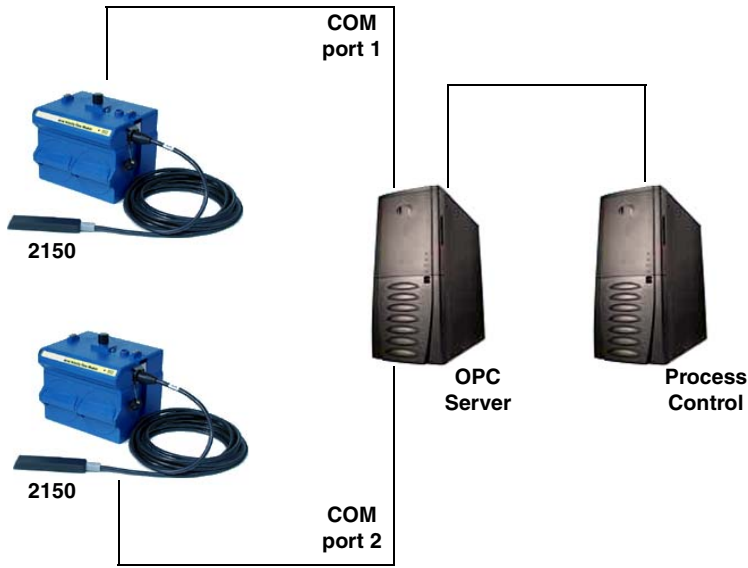


Figure 4-1 Configuration example

The operation sequence for the example above can be summarized in the following steps:

2150:

1. 2150s take readings from probes.
2. 2150s store readings (level, velocity, flow rate, etc.) in their specified registers.

Process Control:

3. The user requests data through Process Control.
4. Process Control asks the OPC server to gather information.
5. OPC connects to the 2150 stack through the cable (direct connection), takes register data from the specified 2150, and populates the OPC server's holding index.
6. Process Control takes data from the OPC server's holding index and gives data to the user.

Note that Process Control can be either manual or automated in this example, and that the OPC server and Process Control may be located physically on the same computer.

#### 4.4 Glossary of Terms

**ASCII** – Short for American Standard Code for Information Interchange, ASCII is a code that represents English characters with numbers. Most computers represent text with ASCII code, making it possible for one computer or device to share data with another.

2100 modules support Modbus ASCII protocol.

**Dedicated Line** – A telecommunications path reserved for communication between two specified points and not shared among multiple points.

**Modbus Protocol** – Modbus Protocol is a messaging structure used to establish master-slave/client server communications between intelligent devices. Modbus is a simple command/response mechanism to read from and write to registers.

**OPC** – OPC (OLE for Process Control) means open connectivity via open (free for use) standards. It is a series of software standards specifications that fill a need in automation (like printer drivers did for Windows), acting as a translator for data transmission and process control.

The specification defines a standard set of objects, interfaces, and methods for use in process control and manufacturing automation applications to facilitate interoperability. There are hundreds of OPC Data Access servers and clients.

**Registers** – Registers are locations in memory that have specific data stored for retrieval or are used for control functions. A register is a holding place for a piece of digital information within the equipment. The definition of what is contained and where (the registry number, or address) is decided by the manufacturer (in this case Teledyne Isco).

**SCADA** – SCADA (Supervisory Control And Data Acquisition) is a computer system for gathering and analyzing real-time data. SCADA systems are used to monitor and control plant operation, or equipment in industries such as telecommunications, water and waste control, energy, oil and gas refining, and transportation.

The SCADA system transfers the information (for example, where a leak has occurred in a pipeline), back to a central site, alerting the home station of the leak, performing necessary analysis and control (such as determining if the leak is critical), and displaying the information in a logical and organized manner.

SCADA systems can be relatively simple, such as one that monitors the environmental conditions of a small office building, or very complex, such as a system that monitors all the activity in a nuclear power plant or a municipal water system.

#### 4.5 Common Acronyms

**ASCII** – American Standard Code for Information Interchange  
**DCS** – Distributed Control Systems  
**MTU** – Master Terminal Unit  
**OPC** – Object Linking and Embedding (OLE) for Process Control  
**PLC** – Programmable Logic Controller  
**RTU** – Remote Terminal Unit  
**SCADA** – Supervisory Control And Data Acquisition  
**TCP/IP** – Transmission Control Protocol/Internet Protocol

#### 4.6 Register Specifications

All numbers in the Modbus registers are stored most significant byte first. If the polling device has a byte ordering of least significant byte first (an Intel-based PC, for example), the bytes will need to be reversed after they are received.

The Modbus ASCII address is used to index the data by modules. Modbus ASCII address 1 contains information related to the site. The first register contains a 16-bit integer count of the number of modules that have data to report. The maximum number of modules that can be supported is 4.

Modbus ASCII addresses 2 through the number of the module in the stack (N) minus 1 contain data from the individual modules.

The Modbus ASCII addresses will be sorted by the model number, and then by module name, which is entered by the user through Flowlink. This allows the user to control the ordering of the addresses and easily predict what data will be in specific registers.

Every measured parameter has a corresponding status and measurement time that are updated with each measurement.

The maximum number of supported measurements from all modules in the system is 28.

The Modbus registers are assigned within 30 seconds after the 2100 module is powered up. To conserve power for the users who do not use Modbus communications, no Modbus registers will be updated with sensor readings until a Modbus master communicates with the 2100 module.



# 2150EX Area Velocity Flow System

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## Section 5 Maintenance

### 5.1 Maintenance Overview

This section explains the maintenance requirements of the 2150EX Area Velocity Flow Module, 2196EX Battery Module, and the AV2150EX Sensor.

The 2150EX System is designed to perform reliably in adverse conditions with a minimal amount of routine service requirements. To keep your system working properly, the following should be checked at regular intervals:

- Desiccant (section 5.3)
- Channel conditions (section 5.4)

Maintenance intervals are affected by many variables; for example, the Data Storage Rate will affect the battery life. Humidity levels obviously affect the service life of the desiccant, and the amount of debris in the stream can drastically alter the channel conditions.

As a guide, a basic system installed in an environment with moderate humidity levels and an AV Sensor installed in a channel relatively free from debris and silt, the maintenance interval should not exceed three months. A basic system is defined as:

- a 2150EX Module and AV Sensor,
- recording readings at the default intervals of 15 minutes.

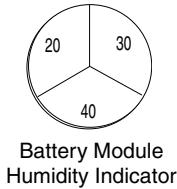
*Experience* is often the best tool to use when establishing minimum maintenance intervals for your system. Until you have gained an understanding of the 2150EX Module's operation under differing environmental conditions, a weekly maintenance interval is recommended.

### 5.2 Maintenance Kits

**Teledyne Isco**  
Customer Service Dept.  
P.O. Box 82531  
Lincoln, NE 68501 USA  
Phone: (800) 228-4373  
(402) 464-0231  
FAX: (402) 465-3022  
E-mail:  
IscoInfo@teledyne.com

Many of the parts called out in the Installation and Maintenance sections of this manual are available in maintenance kits. Kit number 60-2059-001, which supports the 2150EX Module, contains O-rings for the connectors and desiccant cartridge, a hydrophobic filter, and a one-pound container of indicating silica gel desiccant. You can order the kits by calling Teledyne Isco's Customer Service Department.

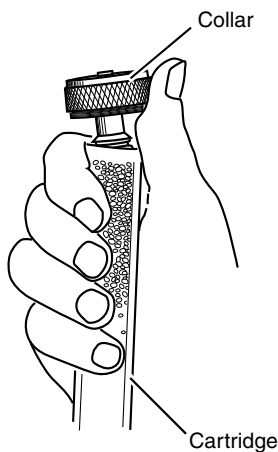
## 5.3 Desiccant



The 2150EX System devices use desiccant to protect the internal components from moisture damage. In the 2150EX, a desiccant cartridge is used to dry the reference air for the sensor. This prevents moisture from plugging the reference line, which would cause the sensor to report erroneous level readings. The cartridge is filled with indicating silica gel, which is blue or yellow when dry. As the desiccant becomes saturated, the color changes from blue to pink, or from yellow to green. Replace the desiccant before the entire length of the cartridge turns pink or green.

The 2196EX battery module uses a desiccant bag to keep the interior of the case dry. The bag is located inside the right battery door. Attached to the inside face of the cap is a humidity indicator. Humidity indicators have regions that display 20, 30, and 40 percent humidity levels. Ideally, each region should be completely blue. As the desiccant becomes saturated, the humidity levels will increase and the regions turn pink. When the 40 percent region begins to turn pink, the components are no longer adequately protected and the desiccant must be replaced.

### 5.3.1 Replacing the Desiccant: AV Module



The desiccant is contained in a cartridge located on the left side of the 2150EX. To remove the cartridge, unscrew the collar and slide the cartridge out of the 2150EX. The opaque tube reveals the silica gel desiccant inside.

#### CAUTION

To prevent static electricity, do not replace silica in potentially explosive atmospheres. Empty and fill the desiccant cartridge in a safe area.

To replace the silica gel desiccant:

1. Hold the cartridge upright with the collar at the top.
2. As shown to the left, push the collar off the cartridge.
3. Empty the saturated silica gel beads or granules.
4. Fill the tube with new (P/N 099-0011-03) or reactivated (see section 5.3.3) silica gel desiccant.
5. Press the collar onto the tube.
6. Slide the cartridge into the 2150EX Module. Tighten the collar to seal the cartridge in place.

### 5.3.2 Replacing the Desiccant: Battery Module

A bag of desiccant is located inside each of the battery caps behind a retaining plate. To replace the desiccant:

1. Loosen the two mounting screws that secure the metal retaining plate.
2. Rotate the retaining plate until it is free from the mounting screws.
3. Remove the spent desiccant bag from the cap and replace it with a new (P/N 099-0002-33) or reactivated (see section 5.3.3) bag.
4. Replace the retaining plate and secure it with the screws.

### 5.3.3 Reactivating the Desiccant

Silica gel beads, granules, and bags of desiccant can be reactivated.

 **CAUTION**

Desiccant may produce irritating fumes when heated. Observe the following precautions:

- Use a vented oven in a well-ventilated room.
- Do not remain in the room while the regeneration is taking place.
- Use the recommended temperature. Avoid heating the desiccant at higher than recommended temperatures.

Irritating fumes can come from the desiccant during reactivation, and you should use caution. Material Safety Data Sheets are in the back of this manual.

The desiccant's ability to remove moisture may lessen with each saturation/reactivation cycle, resulting in a need for more frequent service. After several cycles, the desiccant may no longer be effective as it saturates too quickly. At this point, replace the desiccant.

#### *Silica gel*

To reactivate the silica gel desiccant, pour the spent desiccant into a heat resistant container. Never heat the cartridge assembly; it will melt. Heat the silica gel in a *vented convection oven* at 100° to 175°C (212° to 350°F) for two to three hours, or until the blue or yellow color returns. Allow the desiccant to cool and store it in an airtight container until ready for use.

#### *Desiccant bags*

Bagged desiccant will often include reactivation or recharging instructions on the bag's labeling. Always follow the instructions printed on the bag. If the instructions are not available, the bags may be heated in a *vented convection oven* at 120°C (245°F) for sixteen hours.

## 5.4 Channel Conditions

Because the sensor body offers a streamlined profile to the flow, solid materials rarely collect on the sensor. However, clean the channel upstream and downstream from the sensor periodically. This maintains the hydrostatic conditions on which the level-to-area conversion is based.

## 5.5 Other Maintenance

Other maintenance may be performed on the modules and sensor “as needed.” Sections 5.5.1 through 5.5.3 describe these activities.

### 5.5.1 Hydrophobic Filter



209-0093-93

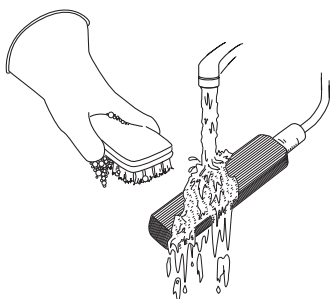
If the 2150EX is in a humid location or submerged, a hydrophobic filter prevents water from entering the desiccant cartridge and reference line. Any amount of water will plug the filter and it must be rinsed with clean water and allowed to dry, or replaced so that the reference line can be reliably ventilated. *Drifting level readings are often an indication that the hydrophobic filter may be plugged.*

Remove the hydrophobic filter with a  $\frac{5}{8}$ " or 16mm socket. Gently screw in the replacement filter (Isco part #209-0093-93).

If the hydrophobic filter frequently requires replacement, consider relocating the modules so that they are better protected.

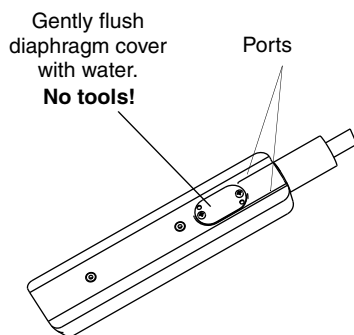
### 5.5.2 Cleaning

The 2150EX enclosure may be cleaned with mild detergent and warm water. Before cleaning the module, make sure all protective connector caps are in place.



The cable and outer surfaces of the AV Sensor may also be cleaned with mild detergent and warm water.

If the flow stream carries a great deal of debris, beware of organic materials that may collect beneath the AV Sensor. This material swells as it becomes saturated with water and may exert pressure on the outer diaphragm. This can damage the transducer and permanently disable the AV Sensor. Keeping the ports clean not only prevents damage, but assures you that the AV Sensor will respond to the hydrostatic pressure above instead of the pressure created by swollen material.



If the ports become blocked:

1. Remove the sensor from its mounting ring, plate, or carrier.
2. Scrape any accumulated solids off the exterior of the sensor. Use a brush and flowing water.
3. Remove debris that has accumulated in the ports.
4. The outer diaphragm is behind the small round cover on the bottom of the sensor. It should be visible through the two small openings at the center of the cover. Gently flush the cover and holes with water to remove debris.

### CAUTION

Avoid using tools near the cover openings. The transducer is extremely sensitive to pressure applied to its exposed surface. Direct or indirect contact with the outer diaphragm may permanently damage the AV Sensor.



### 5.5.3 Sensor Cable Inspection

Erroneous level or velocity readings may not always indicate a fault inside the AV Sensor body. A damaged cable can affect the operation of the sensor, particularly if the reference air tube inside the cable is collapsed or blocked. Damaged cables cannot be spliced or repaired.

If the AV Sensor cable is damaged, you must replace the entire assembly, as the sensor body and cable are a factory-sealed unit. Keep the connector clean and dry and install the cable so that it is not at risk of damage resulting from other activity taking place in the area. The connector can be replaced in some instances, depending on the condition of the cable.

In temporary installations, do not leave cables lying around where they may be stepped on or run over by heavy equipment. Do not leave extra cable loose in the flow stream where it can trap debris.

In permanent installations, cables repeatedly subjected to abuse will fail and should be installed in conduit for protection. The conduit must be large enough to pass the connector through, as you cannot remove or replace it.

## 5.6 How to Obtain Service

**Teledyne Isco**  
Technical Service Dept.  
P.O. Box 82531  
Lincoln, NE 68501 USA

Phone: (800) 228-4373  
(402) 464-0231  
FAX: (402) 465-3085

E-mail:  
IscoService@teledyne.com

The internal components of the 2150EX System are not user-serviceable. The case is completely sealed to protect the internal components. To repair the unit, the case must be broken open and replaced. If you think your module requires repair, contact Teledyne Isco's Technical Service Department.

The pressure transducer, the ultrasonic transducers, cable connections, and the electronic components of the AV Sensor are encapsulated in plastic resin and are not user-serviceable. If any part of the AV Sensor fails, it must be replaced.

Corresponding with a Teledyne Isco Technical Service Representative can often resolve the problem without the need to return the item. If the difficulty cannot be resolved you will be issued a Return Authorization Number (RAN) and information on returning it to the factory.

### 5.6.1 Diagnostics

As a troubleshooting aid, many module functions can generate a diagnostic file. With the assistance of a Teledyne Isco Technical Service Representative, the diagnostic files can often be used to isolate a problem.

To view a diagnostic file, connect to the site with Flowlink. View the measurement tab of the suspect function and click on the *Diagnostics...* button. The module then generates the file and sends it to Flowlink where it is displayed as a text report.

Flowlink can also collect all of the diagnostic files while retrieving data. The last available diagnostic files are always kept in Flowlink's database where they can be viewed "off-line" at a later time. To enable Flowlink to automatically collect all diagnostic files while retrieving the data, open the *Utilities>Options* from the menu and check the *Retrieve data gets text reports* box on the 2100 tab.



# 2150EX Area Velocity Flow System

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## *Appendix A Replacement Parts*

### **A.1 Replacement Parts Diagrams and Listings**

Replacement parts for the 2150EX, the Area Velocity Sensor, the 2196EX battery module, and the 2194EX interface module are called out in the diagrams in this appendix. Refer to the parts lists to determine the part number and description for a specific item.

Replacement parts can be purchased by contacting Teledyne Isco's Customer Service Department.

#### **Teledyne Isco**

Customer Service Department  
P.O. Box 82531  
Lincoln, NE 68501 USA

Phone: (800) 228-4373

(402) 464-0231

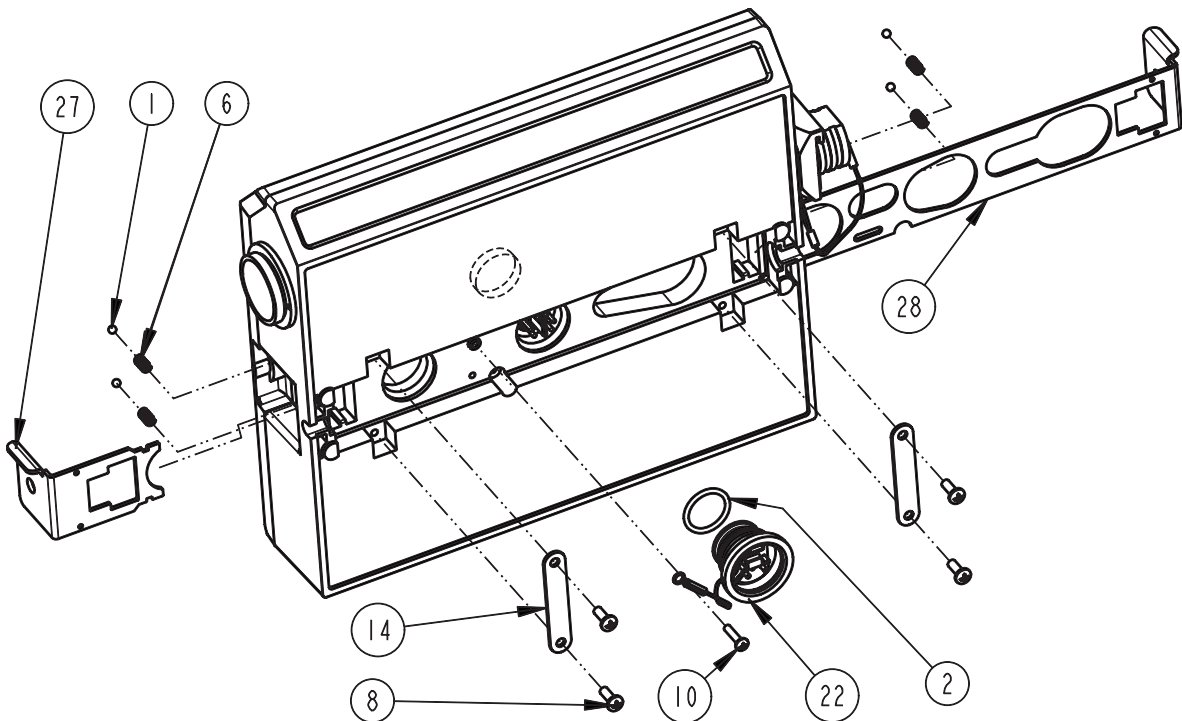
FAX: (402) 465-3022

E-mail: [IscoInfo@teledyne.com](mailto:IscoInfo@teledyne.com)



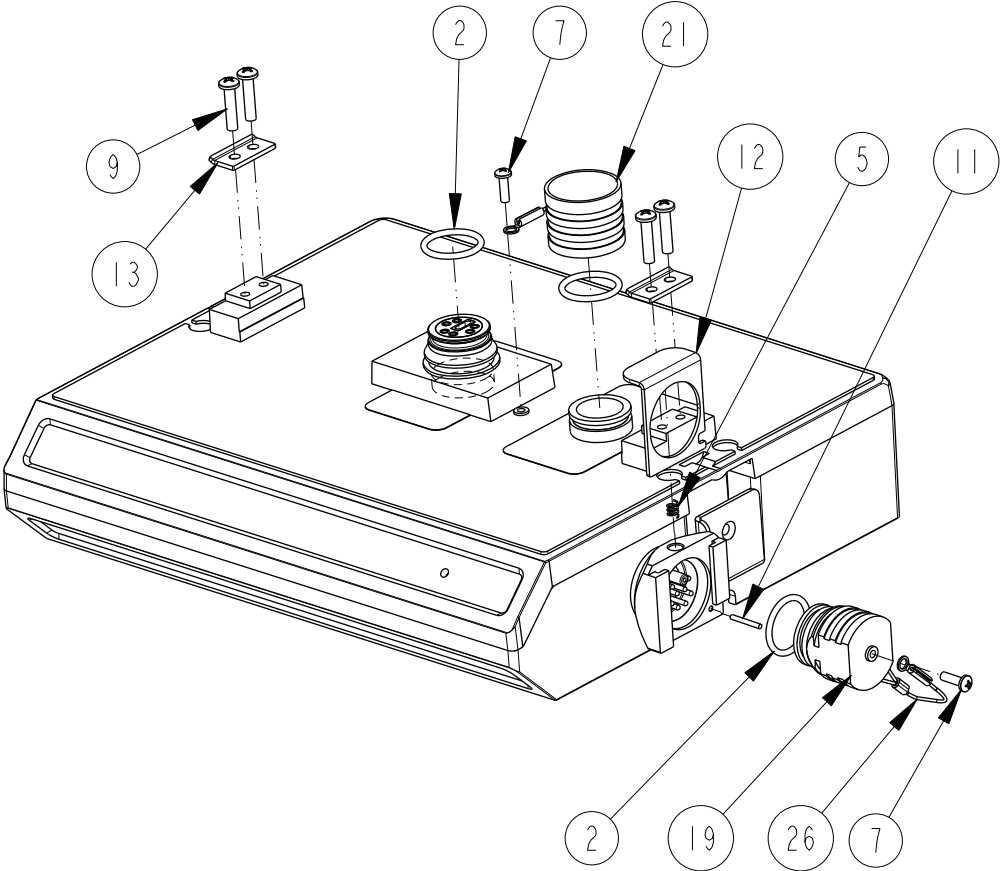
**WARNING**

**Substitution of components may impair intrinsic safety.**



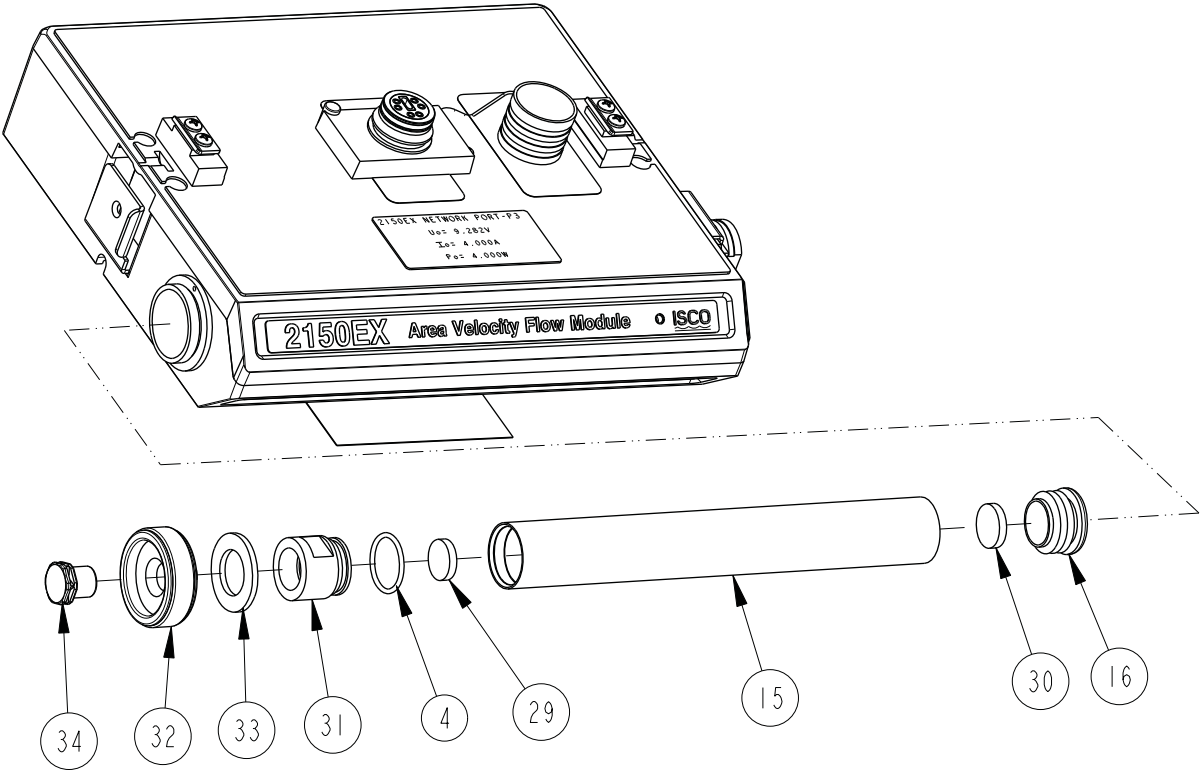
Document controlled for third party certification  
**DO NOT CHANGE**  
 without written approval of the Isco Product Compliance Engineer  
 P/C Engr: *Larry Sedlak* larry sedlak 2008.11.06 09:40:48 -06'00'

<b>TELEDYNE ISCO, INC.</b>			D
THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI/ASME Y14.5M-1994	CREATED	MM	03255
	DRAWN	MM	03255
	APPROVED	BLE	03255
REPLACEMENT PARTS LIST, 2150EX VELOCITY MODULE			
DRAWING NO. 602002330			SHEET 1 OF 5



2150EX Area Velocity Flow System  
Appendix A Replacement Parts

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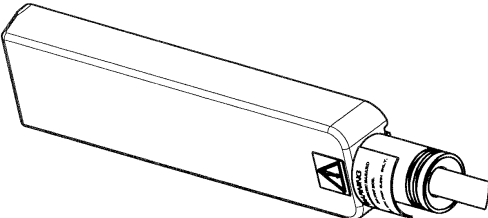


<b>REPLACEMENT PARTS LIST</b>		602002330
<b>TELEDYNE ISCO, INC.</b>		SHEET: 4 OF 5
ITEM NO.	PART NUMBER	DESCRIPTION
1	201900102	BALL, .125 DIAMETER, 316 SST
2	202100669	O RING, .669 ID, .079 CROSS SECTION, BUNA-N RUBBER
4	202500017	O RING, .676 ID, .070 CROSS SECTION, BUNA-N RUBBER
5	203011105	COMPRESSION SPRING, .026 DIA WIRE, .31 FREE LENGTH
6	203011602	COMPRESSION SPRING, .022 DIA WIRE, .31 FREE LENGTH
7	231310140	SCREW, SELF TAP, #4 X 3/8, PAN HEAD, PHILLIPS, SST
8	231311206	SCREW, SELF TAP, #6 X 3/8, PAN HEAD, PHILLIPS, SST
9	231514920	SCREW, SELF TAP, 6-19 X 5/8, TORX, PAN HEAD, SST
10	231611108	SCREW, SELF TAP, #4 X 1/2, PAN HEAD, PHILLIPS, SST
11	236410408	PIN, SPRING, 1/16 X 1/2 LONG, SST
12	602003018	CONNECTOR CLIP
13	602003019	NODE CLIP
14	602003022	LATCH HOLD
15	602005046	DESICCANT TUBE MODIFICATION, EX
16	602003074	DESSICANT CAP ASSEMBLY
19	602003355	PLUG, VELOCITY NODE SENSOR, EX
21	602004286	CAP ASSEMBLY, MALE CONNECTOR
22	602004287	PLUG ASSEMBLY, FEMALE CONNECTOR (Includes item 2)
23	602004355	PLUG ASSEMBLY, VELOCITY NODE SENSOR, EX (Includes items 2, 7, 19, & 26)
24	602004385	DESICCANT ASSEMBLY EX (Includes items 4, 15, 16, 17, 25, 29 & 30)
26	692003172	CABLE, FEMALE PROBE PLUG
NOTE: 1. For current prices and quotations on parts, contact Isco Service Department. 2. This list is subject to change without notice.		

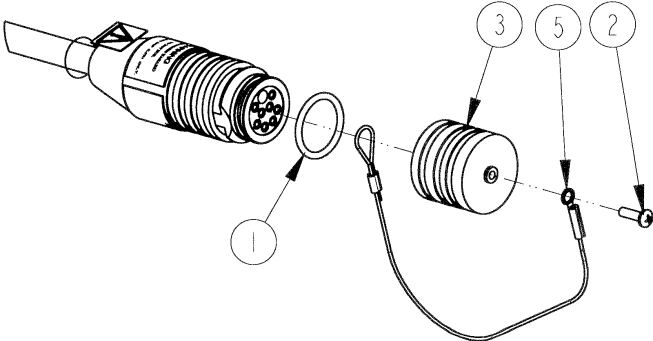




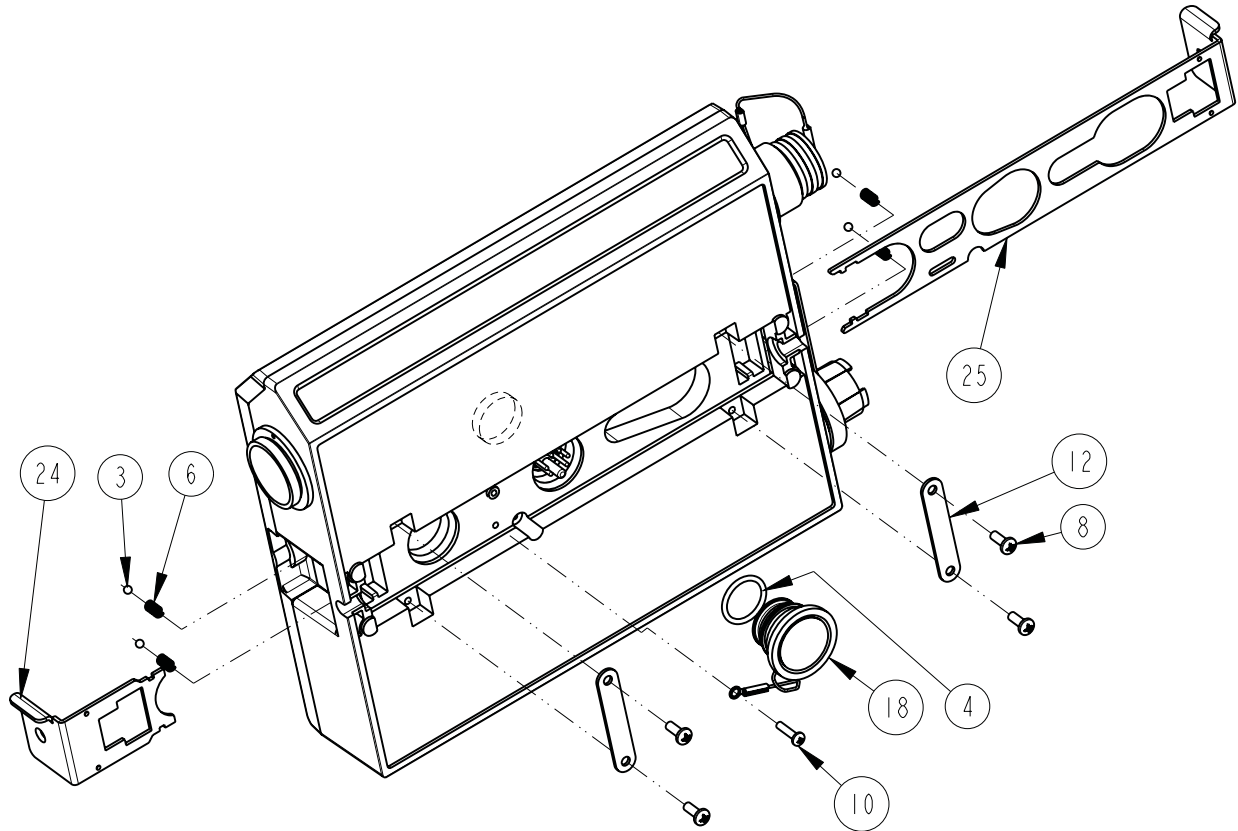
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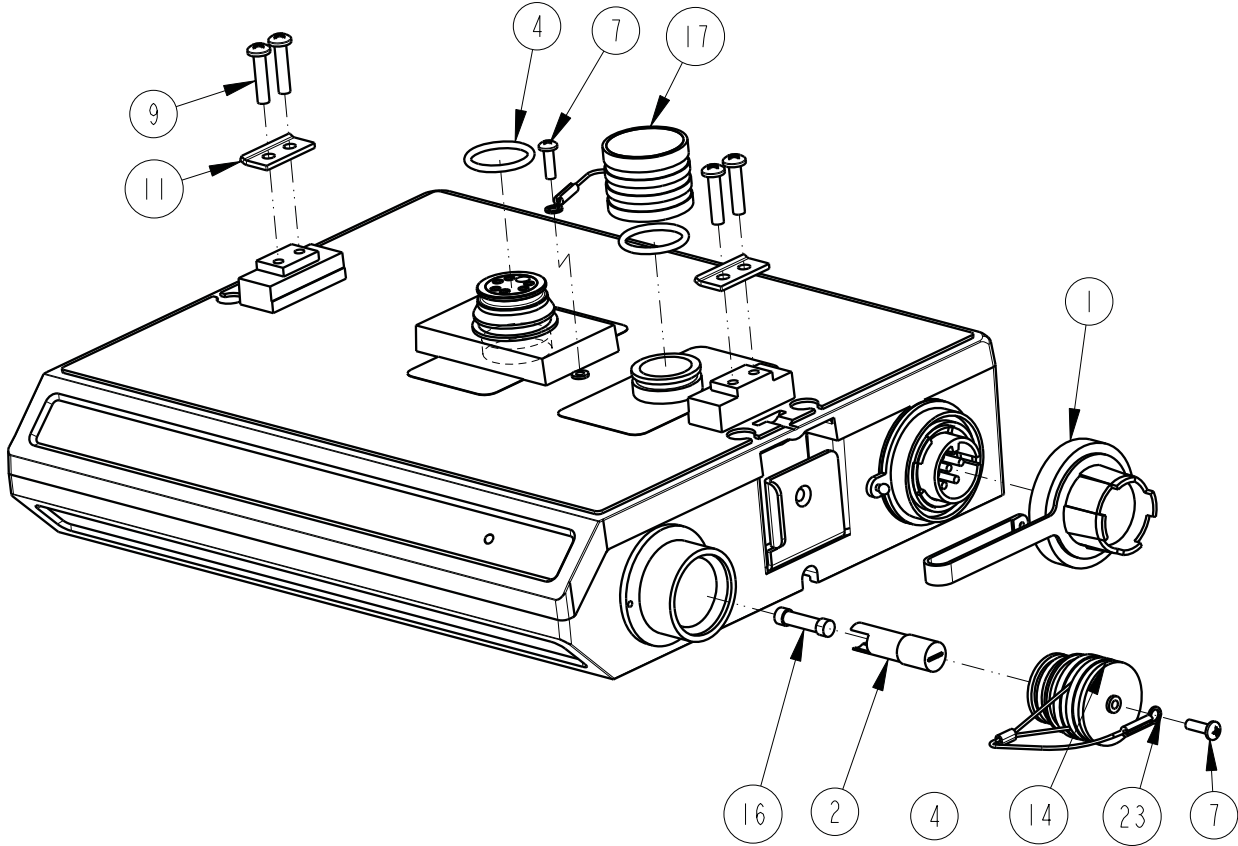




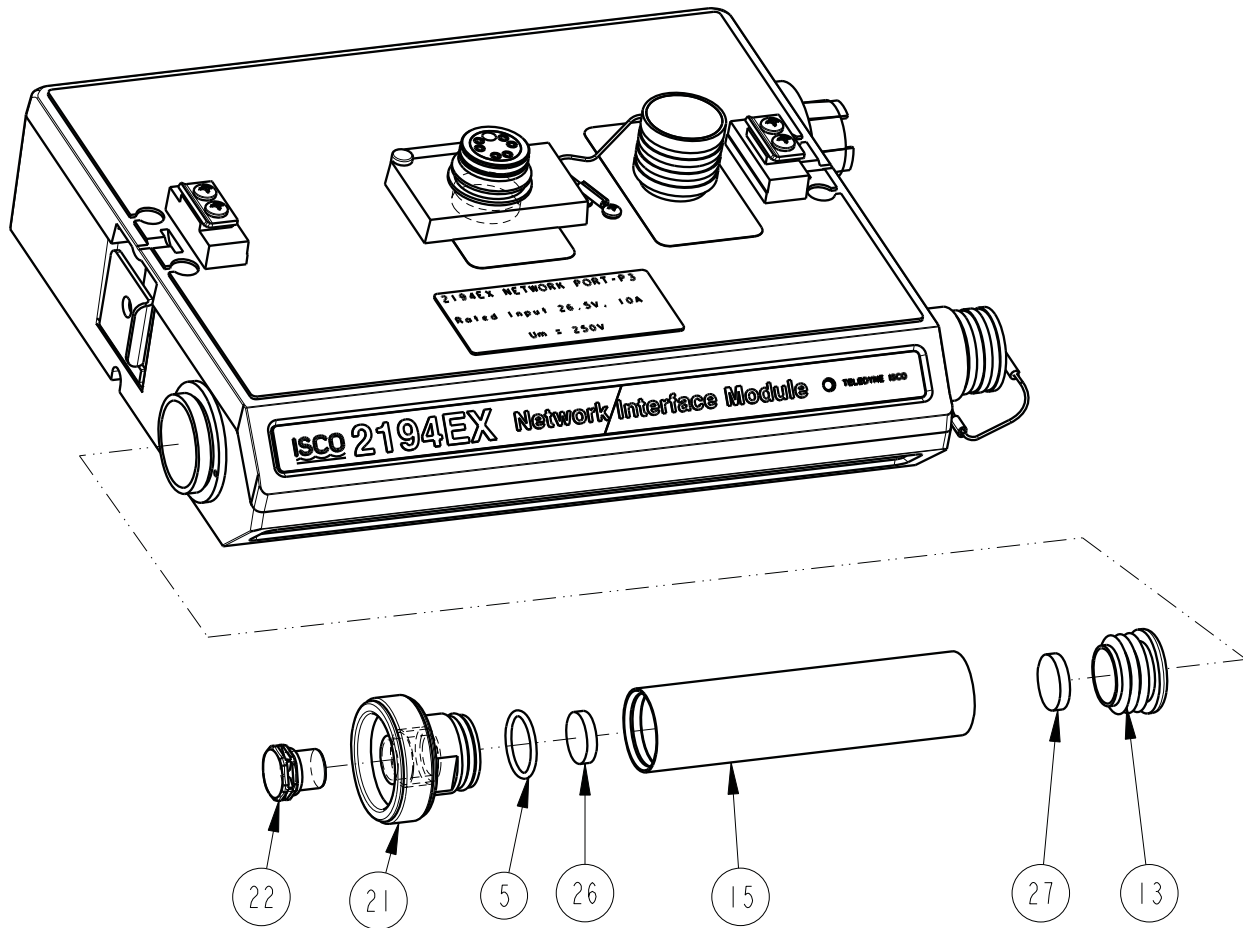


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THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI/ASME Y14.5M-1994	CREATED	MM	05095		SHEET 1 OF 5
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REPLACEMENT PARTS LIST, 2194EX MODULE					



<b>TELEDYNE ISCO, INC.</b>			B
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REPLACEMENT PARTS LIST, 2194EX MODULE			DRAWING NO. 602002336 SHEET 2 OF 5



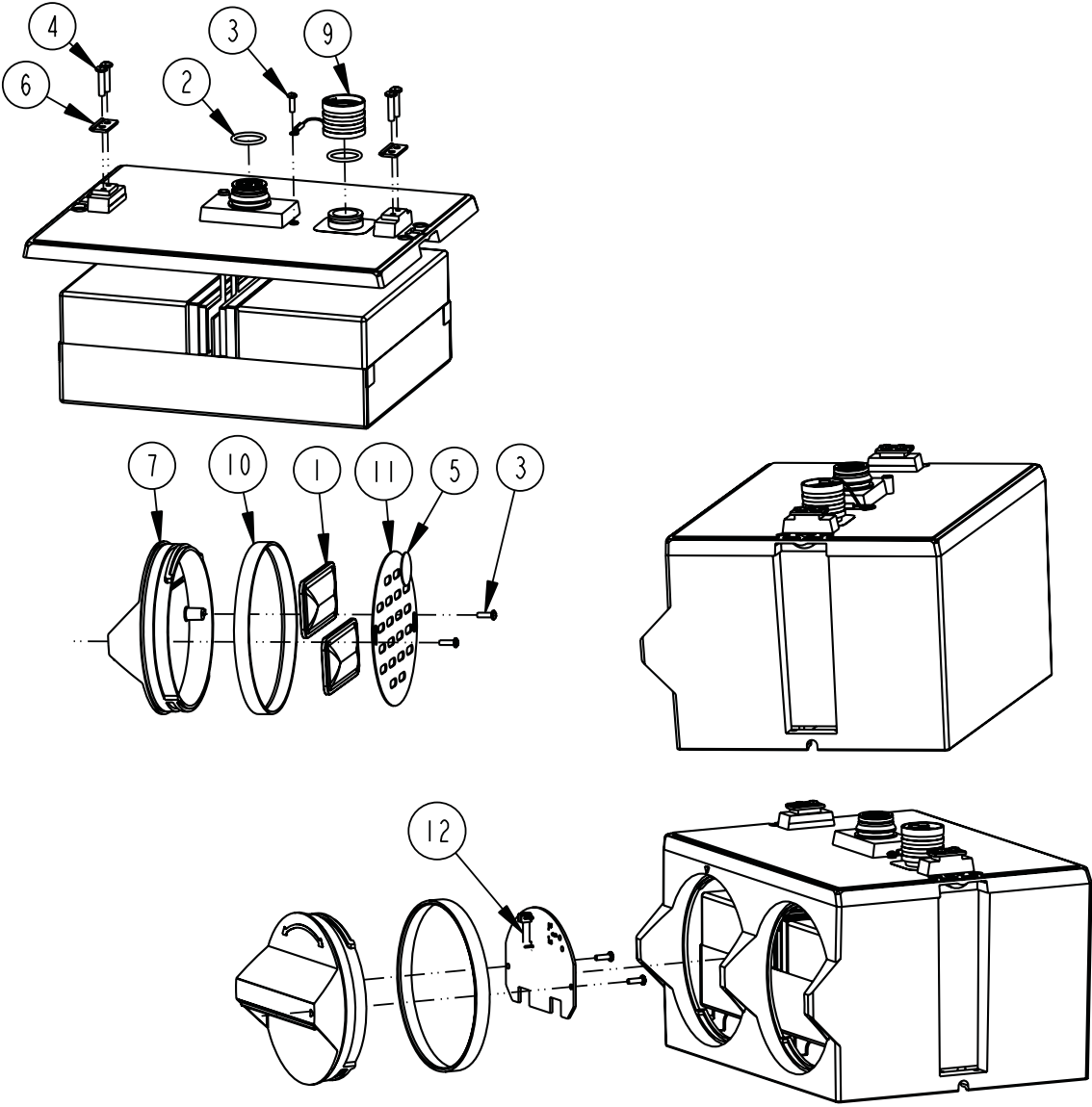
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REPLACEMENT PARTS LIST, 2194EX MODULE		DRAWING NO. 602002336 SHEET 3 OF 5

<b>REPLACEMENT PARTS LIST</b>		
<b>TELEDYNE ISCO, INC.</b>		
		602002336
		SHEET: 4 OF 5
		REV: B      090710
ITEM NO.	PART NUMBER	DESCRIPTION
1	109030733	SEALING CAP, PANEL MOUNT CONNECTOR
2	142110403	FUSE HOLDER, PANEL MOUNT, 5X20MM FUSES
3	201900102	BALL, .125 DIAMETER, 316 SST
4	202100669	O RING, .669 ID, .079 CROSS SECTION, BUNA-N RUBBER
5	202500017	O RING, .676 ID, .070 CROSS SECTION, BUNA-N RUBBER
6	203011602	COMPRESSION SPRING, .022 DIA WIRE, .31 FREE LENGTH
7	231310140	SCREW, SELF TAP, #4 X 3/8, PAN HEAD, PHILLIPS, SST
8	231311206	SCREW, SELF TAP, #6 X 3/8, PAN HEAD, PHILLIPS, SST
9	231514920	SCREW, SELF TAP, 6-19 X 5/8, TORX, PAN HEAD, SST
10	231611108	SCREW, SELF TAP, #4 X 1/2, PAN HEAD, PHILLIPS, SST
11	602003019	NODE CLIP
12	602003022	LATCH HOLD
13	602003074	CAP PLUG MODIFICATION, DISICCANT
14	602003076	PLUG, FEMALE PROBE
15	602003086	DESICCANT TUBE, 4.1 LONG
16	602003469	FUSE SELECTED FOR RESISTANCE TOLERANCE
17	602004012	CAP ASSEMBLY, MALE CONNECTOR
18	602004013	PLUG ASSEMBLY FEMALE CONNECTOR ( Includes item 4 )
19	602004033	PLUG ASSEMBLY FEMALE PROBE ( Includes items 4, 7, 14, & 23 )
20	602004060	DESICCANT ASSEMBLY, SHORT ( Includes items 5, 13, 15, 21, 22, 26 & 27 )
21	602004265	DESICCANT CAP ASSEMBLY
22	209009393	SCREW-IN FILTER
23	692003172	CABLE, FEMALE PROBE PLUG
24	692003189	SMALL LATCH
25	692003190	LARGE LATCH
26	692203300	FRIT .620 DIA
NOTE: 1. For current prices and quotations on parts, contact Isco Service Department. 2. This list is subject to change without notice.		





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DRAWING NO.  
602002540 A  
SHEET 1 OF 2

REPLACEMENT PARTS LIST,  
2196EX NODE ASSEMBLY





# 2150EX Area Velocity Flow System

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## *Appendix B Accessories*

### **B.1 How to Order**

Accessories can be purchased by contacting Teledyne Isco's Customer Service Department.

**Teledyne Isco**  
Customer Service Dept.  
P.O. Box 82531  
Lincoln, NE 68501 USA

Phone: (800) 228-4373  
(402) 464-0231  
FAX: (402) 465-3022

E-mail: [IscoInfo@teledyne.com](mailto:IscoInfo@teledyne.com)

### **B.2 General Accessories**

AV2150EX Sensor (8m Cable) . . . . .	60-2004-331
Av2150EX Sensor (25m Cable) . . . . .	60-2004-334
RS232EX Isolator Cable . . . . .	60-2004-339
RS485EX Isolator Cable . . . . .	60-2004-340
NET2EX Two Meter EX Network Cable . . . . .	60-2004-335
NET8EX Eight Meter EX Network Cable . . . . .	60-2004-336
Flowlink software. . . . .	Call Factory
Instruction Manual . . . . .	69-2003-347
Isco Open Channel Flow Measurement Handbook . . . . .	60-3003-041
Power Adapter Cable . . . . .	69-2004-451
2100EX Bottom Plate . . . . .	60-2004-344
Carrying Handle . . . . .	60-2004-377
Suspension Harness. . . . .	60-2004-386
2196EX Battery Module . . . . .	60-2004-540
2A Battery Charger with indicator lights . . . . . (for use with 2196EX)	68-2000-044
CB edge connector cable . . . . . (for use with 2196EX with 965 or 963)	60-2004-547
965 Five-Station Battery Charger . . . . . (US line cord; for use with 2196EX)	68-3000-965
965 Five-Station Battery Charger . . . . . (EU line cord; for use with 2196EX)	69-3000-966
963 Lead-Acid Battery Charger . . . . . (for use with 2196EX)	68-3004-198

2A charge fuse (F1) . . . . .	411-9922-60
<i>(for use with 2196EX)</i>	
2194EX Network Interface Module . . . . .	60-2004-333
2194EX Interface Fuse, Select . . . . .	60-2003-469
CA75EX-CTL 75m Interface Cable . . . . .	60-2004-337
CA150EX-CTL 150m Interface Cable . . . . .	60-2004-338
2194EX Connector wiring interface kit . . . . .	60-2004-468
2150EX Maintenance Kit . . . . .	60-2059-001

### B.3 AV Sensor Mounting Accessories

The AV2150EX Area Velocity Sensor can be installed using Isco's installation systems listed below. A Low Profile Carrier is optional when attaching the sensor to any system listed below.

Low Profile Carrier	
<i>(attaches the AV sensor to a ring or plate)</i> . . . . .	60-3204-029
Ground Lug Kit . . . . .	60-2007-476
<i>(recommended for spring mounting rings)</i>	

#### Spring Rings *(Each ring includes plastic ties and a manual)*

15.2 cm (6") Diameter . . . . .	68-3200-007
20.3 cm (8") Diameter . . . . .	68-3200-008
25.4 cm (10") Diameter . . . . .	68-3200-009
30.5 cm (12") Diameter . . . . .	68-3200-010
38.1 cm (15") Diameter . . . . .	68-3200-011

#### Scissors Rings *(Each scissors ring includes a base section, scissors mechanism, extensions, plastic ties, and a manual)*

40.6-61 cm (16-24") Pipe . . . . .	68-3000-042
66-96.5 cm (26-38") Pipe . . . . .	68-3000-043
96.5-111.7 cm (38-44") Pipe . . . . .	68-3000-044
111.7-121.9 cm (44-48") Pipe . . . . .	68-3000-045
152.4 cm (60") Pipe . . . . .	68-3000-046
182.9 cm (72") Pipe . . . . .	68-3000-047
40.6-152.4 cm (16-60") Pipe . . . . .	68-3000-048

Base Section <i>(with plastic ties and manual)</i> . . . . .	60-3004-169
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Sensor Mounting Plate <i>(With plastic ties &amp; instructions)</i> . .	68-3000-051
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# 2150EX Area Velocity Flow System

## Appendix C General Safety Procedures

The intrinsically safe 2150EX is intended for use in potentially explosive atmospheres, and complies with ATEX Directive 94/9/EC. The 2150EX is Group II, Category 1G or 2G equipment for use in gas hazard zones 0, 1, and 2. For safety information specific to the 2150EX, refer to the Safety Information section at the front of this manual.

The safety of the personnel who use the 2150EX is a critical consideration. The following general safety procedures, applicable to working in and around manholes and sewers, are those used by Black & Veatch, a respected consulting firm, and are published here by permission.

Field personnel must keep safety uppermost in their minds at all times. When working above ground, rules of common sense and safety prevail. However, when entering manholes, strict safety procedures must be observed. Failure to do so could jeopardize not only your own life, but also the lives of other crew members.

### CAUTION

Before you install any flow logger, you must take the proper safety precautions. The following discussion of safety procedures offers only general guidelines. Each situation in which you install a flow logger varies. You must take into account the individual circumstances of each installation.

Additional safety considerations, other than those discussed here, may be required. Check applicable guidelines, codes, and regulations of federal, state, city, and county agencies.

### C.1 Hazards

There are many hazards connected with entering manholes. Some of the most common hazards are:

- *Adverse Atmosphere*—The manhole may contain flammable or poisonous gases or the atmosphere may be deficient in oxygen. Forced ventilation may be necessary.
- *Deteriorated Rungs*—Manhole steps may be corroded and not strong enough to support a man. It may be difficult to inspect the rungs because of poor lighting.
- *Traffic*—Whenever manholes are located in the traveled way, barricades and warning devices are essential to direct traffic away from an open manhole.
- *Falling Objects*—Items placed near the manhole opening may fall and injure a worker in the manhole. All loose items should be kept away from the manhole opening.

This applies to hand tools as well as stones, gravel and other objects.

- *Sharp Edges*—Sharp edges of items in or near a manhole may cause cuts or bruises.
- *Lifting Injuries*—Unless proper tools are used to remove manhole covers, back injuries or injuries to hands or feet may result.

## C.2 Planning

Advance planning should include arrangements for test equipment, tools, ventilating equipment, protective clothing, traffic warning devices, ladders, safety harness, and adequate number of personnel. Hasty actions may result in serious injuries. Time spent in the manhole should be kept to a minimum.

## C.3 Adverse Atmospheres

[Refer to the table of Hazardous Gases at the end of this Appendix.] Before workers enter a manhole, tests should be made for explosive atmosphere, presence of hydrogen sulfide, and oxygen deficiency. Combustible or toxic vapors may be heavier than air, so the tests on the atmosphere must be run at least  $\frac{3}{4}$  of the way down the manhole.

Whenever adverse atmosphere is encountered, forced ventilation must be used to create safe conditions. After the ventilating equipment has been operated for a few minutes, the atmosphere in the manhole should be retested before anyone enters the manhole.

When explosive conditions are encountered, the ventilating blower should be placed upwind to prevent igniting any gas that is emerging from the opening. When a gasoline engine blower is used, it must be located so that exhaust fumes cannot enter the manhole.

If testing equipment is not available, the manhole should be assumed to contain an unsafe atmosphere and forced ventilation must be provided. It should never be assumed that a manhole is safe just because there is no odor or the manhole has been entered previously.

## C.4 Entering Manholes

Since the top of the manhole is usually flush with the surrounding surface, there may not be anything for the person who is entering the manhole to grab on to steady himself. Persons who are entering manholes should not be permitted to carry anything in their hands as they enter the manhole, to ensure that their hands will be free to hold on or grab if they slip. A good method for entering a manhole is to sit on the surface facing the manhole steps or ladder, with the feet in the hole and the arms straddling the opening for support. As the body slides forward and downward, the feet can engage a rung, and the back can rest against the opposite side of the opening. If there is any doubt about the soundness of the manhole steps, a portable ladder should be used.



A person should never enter a manhole unless he is wearing personal safety equipment, including a safety harness and a hard hat. Two persons should be stationed at the surface continuously while anyone is working inside a manhole, to lift him out if he is overcome or injured. One man cannot lift an unconscious man out of a manhole.

The persons stationed at the surface should also function as guards to keep people and vehicles away from the manhole opening. To avoid a serious injury, a person should not be lifted out of manhole by his arm unless it is a dire emergency.

When more than one person must enter a manhole, the first person should reach the bottom and step off the ladder before the next one starts down. When two men climb at the same time, the upper one can cause the lower one to fall by slipping or stepping on his fingers.

#### **C.4.1 Traffic Protection**

In addition to traffic cones, markers, warning signs, and barricades, a vehicle or a heavy piece of equipment should be placed between the working area and oncoming traffic. Flashing warning signals should be used to alert drivers and pedestrians. Orange safety vests should be worn by personnel stationed at the surface when the manhole is located in a vehicular traffic area.

#### **C.4.2 Removing the Covers**

Manhole covers should be removed with a properly designed hook. Use of a pick ax, screwdriver, or small pry bar may result in injury. A suitable tool can be made from  $\frac{3}{4}$ -inch round or hex stock. Two inches of one end should be bent at a right angle and the other end should be formed into a D-handle wide enough to accommodate both hands. Even with this tool, care must be exercised to prevent the cover from being dropped on the toes. The 2-inch projection should be inserted into one of the holes in the cover, the handle grasped with both hands, and the cover lifted by straightening the legs which have been slightly bent at the knees.

#### **C.4.3 Other Precautions**

Other precautions which should be taken when entering a manhole are:

- Wear a hard hat.
- Wear coveralls or removable outer garment that can be readily removed when the work is completed.
- Wear boots or nonsparking safety shoes.
- Wear rubberized or waterproof gloves.
- Wear a safety harness with a stout rope attached.
- Do not smoke.
- Avoid touching yourself above the collar until you have cleaned your hands.

#### C.4.4 Emergencies

Every member of the crew should be instructed on procedures to be followed in cases of an emergency. It is the duty of each crew chief to have a list of emergency phone numbers, including the nearest hospital and ambulance service, police precinct, fire station, and rescue or general emergency number.

#### C.4.5 Field Equipment

The following equipment should be available for use:

Blowers  
Gloves  
Breathing apparatus  
Hard Hats  
Coveralls  
Harnesses  
First aid kits  
Manhole irons  
Emergency flashers  
Pick axes  
Flashlight  
Rain slickers  
Mirror  
Ropes  
Gas detectors  
Safety vests  
Gas masks  
Traffic cones  
Waders

#### C.5 Lethal Atmospheres in Sewers

The following is an article written by Dr. Richard D. Pomeroy, and published in the October 1980 issue of "Deeds & Data" of the WPCF. Dr. Pomeroy is particularly well known for his studies, over a period of nearly 50 years, in the field of the control of hydrogen sulfide and other odors in sewers and treatment plants. He has personally worked in a great many functioning sewers. In the earlier years he did so, he admits, with little knowledge of the grave hazards to which he exposed himself.

"It is gratifying that the subject of hazards to people working in sewers is receiving much more attention than in past years, and good safety procedures are prescribed in various publications on this subject. It is essential that people know and use correct procedures.

"It is less important to know just what the hazardous components of sewer atmospheres are, as safety precautions should in general be broadly applicable, but there should be a reasonable understanding of this subject. It is disturbing to see statements in print that do not reflect true conditions.

"One of the most common errors is the assumption that people have died from a lack of oxygen. The human body is able to function very well with substantially reduced oxygen concentrations. No one worries about going to Santa Fe, New Mexico, (elev. 2,100 meters), where the partial pressure of oxygen is equal to 16.2% (a normal atmosphere is about 21%) oxygen. "When first going there, a person may experience a little 'shortness of breath' following exercise.

"People in good health are not afraid to drive over the high passes in the Rocky Mountains. At Loveland Pass, oxygen pressure is 13.2% of a normal atmosphere. At the top of Mt.

Whitney, oxygen is equal to 12.2%. Many hikers go there, and to higher peaks as well. After adequate acclimation, they may climb to the top of Mt. Everest, where oxygen is equal to only 6.7%.

“The lowest oxygen concentrations that I have observed in a sewer atmosphere was 13 percent. It was in a sealed chamber, near sea level, upstream from an inverted siphon on a metropolitan trunk. A man would be foolish to enter the chamber. Without ventilation, he might die, but not from lack of oxygen.

“It seems unlikely that anyone has ever died in a sewer from suffocation, that is, a lack of oxygen. Deaths have often been attributed to ‘asphyxiation.’ This is a word which, according to the dictionary, is used to mean death from an atmosphere that does not support life. The word has sometimes been misinterpreted as meaning suffocation, which is only one kind of asphyxiation.

“In nearly all cases of death in sewers, the real killer is hydrogen sulfide. It is important that this fact be recognized. Many cities diligently test for explosive gases, which is very important, and they may measure the oxygen concentration which usually is unimportant, but they rarely measure H<sub>2</sub>S. Death has occurred where it is unlikely that there was any measurable reduction in the oxygen concentration. Waste water containing 2 mg per liter of dissolved sulfide, and at a pH of 7.0, can produce, in a chamber with high turbulence, a concentration of 300 PPM H<sub>2</sub>S, in the air. This is considered to be a lethal concentration. Many people have died from H<sub>2</sub>S, not only in sewers and industries, but also from swamps and from hot springs. In one resort area, at least five persons died from H<sub>2</sub>S poisoning before the people were ready to admit that H<sub>2</sub>S is not a therapeutic agent. Hardly a year passes in the US. without a sewer fatality from H<sub>2</sub>S as well as deaths elsewhere in the world.

“The presence of H<sub>2</sub>S in a sewer atmosphere is easily determined. A bellows-and-ampoule type of tester is very satisfactory for the purpose, even though it is only crudely quantitative. When using a tester of this type, do not bring the air to the ampoule by way of a tube, as this may change the H<sub>2</sub>S concentration. Hang the ampoule in the air to be tested, with a suction tube to the bulb or bellows.

“Lead acetate paper is very useful as a qualitative indicator. It cannot be used to estimate the amount of sulfide, but it will quickly turn black in an atmosphere containing only a tenth of a lethal concentration.

“Electrodes or other similar electrical indicating devices for H<sub>2</sub>S in air have been marketed. Some of them are known to be unreliable, and we know of none that have proved dependable. Do not use one unless you check it at frequent intervals against air containing known H<sub>2</sub>S concentra-

tions. A supposed safety device that is unreliable is worse than none at all.

“Remember that the nose fails, too, when it comes to sensing dangerous concentrations of H<sub>2</sub>S.

“Various other toxic gases have been mentioned in some publications. It is unlikely that any person has been asphyxiated in a sewer by any of those other gases, except possibly chlorine. The vapor of gasoline and other hydrocarbons is sometimes present in amounts that could cause discomfort and illness, but under that condition, the explosion hazard would be far more serious. The explosimeter tests, as well as the sense of smell, would warn of the danger. Pipelines in chemical plants might contain any number of harmful vapors. They, too, are sensed by smell and explosimeter tests if they get into the public sewer. Such occurrences are rare.

“The attempt to instill a sense of urgency about real hazards is diluted if a man is told to give attention to a long list of things that in fact are irrelevant.

“Be very careful to avoid high H<sub>2</sub>S concentrations, flammable atmospheres, and hazards of physical injuries. Remember that much H<sub>2</sub>S may be released by the stirring up of sludge in the bottom of a structure. Obey your senses in respect to irritating gases, such as chlorine (unconsciousness comes suddenly from breathing too much). Be cautious about strange odors. Do not determine percent oxygen in the air. There is a danger that the result will influence a man's thinking about the seriousness of the real hazards. Most important, use ample ventilation, and do not enter a potentially hazardous structure except in a good safety harness with two men at the top who can lift you out.”

**Table C-1 Hazardous Gases**

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air = 1	Physiological Effect*	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air.) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Ammonia	NH <sub>3</sub>	Irritant and poisonous. Colorless with characteristic odor.	0.60	Causes throat and eye irritation at 0.05%, coughing at 0.17%. Short exposure at 0.5% to 1% fatal.	300 to 500	85	16 to 25	Near top. Concentrates in closed upper spaces	Sewers, chemical feed rooms	Detectable odor at low concentrations
Benzene	C <sub>6</sub> H <sub>6</sub>	Irritant, colorless anesthetic	2.77	Slight symptoms after several hours exposure at 0.16% to 0.32%. 2% rapidly fatal.	3,000 to 5,000	25	1.3 to 7.1	At bottom	Industrial wastes, varnish, solvents	Combustible gas indicator
Carbon Bisulfide	CS <sub>2</sub>	Nearly odorless when pure, colorless, anesthetic. Poisonous.	2.64	Very poisonous, irritating, vomiting, convulsions, psychic disturbance.	—	15	1.3 to 44.0	At bottom	An insecticide	Combustible gas indicator
Carbon Dioxide	CO <sub>2</sub>	Asphyxiant, Colorless, odorless. When breathed in large quantities, may cause acid taste. Non-flammable. Not generally present in dangerous amounts unless an oxygen deficiency exists.	1.53	Cannot be endured at 10% more than a few minutes, even if subject is at rest and oxygen content is normal. Acts on respiratory nerves.	40,000 to 60,000	5,000	— to —	At bottom; when heated may stratify at points above bottom.	Products of combustion, sewer gas, sludge. Also issues from carbonaceous strata.	Oxygen deficiency indicator
Carbon Monoxide	CO	Chemical asphyxiant. Colorless, odorless, tasteless. Flammable. Poisonous.	0.97	Combines with hemoglobin of blood. Unconsciousness in 30 min. at 0.2% to 0.25%. Fatal in 4 hours at 0.1%. Headache in few hours at 0.02%.	400	50	12.5 to 74.0	Near top, especially if present with illuminating gas.	Manufactured gas, flue gas, products of combustion, motor exhausts. Fires of almost any kind.	CO ampoules
Carbon Tetra-Chloride	CCl <sub>4</sub>	Heavy, ethereal odor.	5.3	Intestinal upset, loss of consciousness, possible renal damage, respiratory failure.	1,000 to 1,500	100	— to —	At bottom.	Industrial wastes, solvent, cleaning	Detectable odor at low concentrations
Chlorine	Cl <sub>2</sub>	Irritant. Yellow-green color. Choking odor detectable in very low concentrations. Non-flammable.	2.49	Irritates respiratory tract. Kills most animals in a very short time at 0.1%.	4	1	— to —	At bottom.	Chlorine cylinder and feed line leaks	Detectable odor at low concentrations
Formaldehyde	CH <sub>2</sub> O	Colorless, pungent suffocating odor.	1.07	Irritating to the nose.	—	10	7.0 to 73.0	Near bottom	Incomplete combustion of organics. Common air pollutant, fungicide.	Detectable odor
Gasoline	C <sub>8</sub> H <sub>12</sub> to C <sub>9</sub> H <sub>20</sub>	Volatile solvent. Colorless. Odor noticeable at 0.03%. Flammable.	3.0 to 4.0	Anesthetic effects when inhaled. Rapidly fatal at 2.4%. Dangerous for short exposure at 1.1 to 2.2%.	4,000 to 7,000	1,000	1.3 to 6.0	At bottom	Service stations, garages, storage tanks, houses.	1. Combustible gas indicator. 2. Oxygen deficiency indicator.**
Hydrogen	H <sub>2</sub>	Simple asphyxiant. Colorless, odorless, tasteless. Flammable	0.07	Acts mechanically to deprive tissues of oxygen. Does not support life.	—	—	4.0 to 74.0	At top	Manufactured gas, sludge digestion tank gas, electrolysis of water. Rarely from rock strata.	Combustible gas indicator
Hydrogen Cyanide	HCN	Faint odor of bitter almonds. Colorless gas	0.93	Slight symptoms appear upon exposure to 0.002% to 0.004%. 0.3% rapidly fatal.	—	10	6.0 to 40.0	Near top	Insecticide and rodenticide	Detector tube

**Table C-1 Hazardous Gases (Continued)**

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air = 1	Physiological Effect*	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air.) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Hydrogen Sulfide	H <sub>2</sub> S	Irritant and poisonous volatile compound. Rotten egg odor in small concentrations. Exposure for 2 to 15 min. at 0.01% impairs sense of smell. Odor not evident at high concentrations. Colorless. Flammable.	1.19	Impairs sense of smell, rapidly as concentration increases. Death in few minutes at 0.2%. Exposure to 0.07 to 0.1% rapidly causes acute poisoning. Paralyzes respiratory center.	200 to 300	20	4.3 to 45.0	Near bottom, but may be above bottom if air is heated and highly humid.	Coal gas, petroleum, sewer gas. Fumes from blasting under some conditions. Sludge gas.	1. H <sub>2</sub> S Ampoule. 2. 5% by weight lead acetate solution.
Methane	CH <sub>4</sub>	Simple asphyxiant. Colorless, odorless, tasteless, flammable.	0.55	Acts mechanically to deprive tissues of oxygen. Does not support life.	Probably no limit, provided oxygen percent-age is sufficient for life.	—	5.0 to 15.0	At top, increasing to certain depth.	Natural gas, sludge gas, manufactured gas, sewer gas. Strata of sedimentary origin. In swamps or marshes.	1. Combustible gas indicator 2. Oxygen deficiency indicator.
Nitrogen	N <sub>2</sub>	Simple asphyxiant. Colorless, tasteless. Non-flammable. Principal constituent of air. (about 79%).	0.97	Physiologically inert.	—	—	—	Near top, but may be found near bottom.	Sewer gas, sludge gas. Also issues from some rock strata.	Oxygen deficiency indicator
Nitrogen Oxides	NO	Colorless	1.04	60 to 150 ppm cause irritation and coughing.	50	10	—	Near bottom	Industrial wastes. Common air pollutant.	NO <sub>2</sub> detector tube
	N <sub>2</sub> O	Colorless, sweet odor.	1.53	Asphyxiant.	—	—	—			
	NO <sub>2</sub>	Reddish-brown. Irritating odor. Deadly poison	1.58	100 ppm dangerous. 200 ppm fatal.	—	—	—			
Oxygen	O <sub>2</sub>	Colorless, odorless, tasteless. Supports combustion.	1.11	Normal air contains 20.8% of O <sub>2</sub> . Man can tolerate down to 12%. Minimum safe 8 hour exposure, 14 to 16%. Below 10%, dangerous to life. Below 5 to 7% probably fatal.	—	—	—	Variable at different levels.	Oxygen depletion from poor ventilation and absorption, or chemical consumption of oxygen.	Oxygen deficiency indicator
Ozone	O <sub>3</sub>	Irritant and poisonous. Strong electrical odor. Strong oxidizer. Colorless. At 1 ppm, strong sulfur-like odor.	1.66	Max. naturally occurring level is 0.04 ppm. 0.05 ppm causes irritation of eyes and nose. 1 to 10 ppm causes headache, nausea; can cause coma. Symptoms similar to radiation damage.	0.08	0.04	—	Near bottom	Where ozone is used for disinfection	Detectable odor at 0.015 ppm
Sludge Gas	—***	Mostly a simple asphyxiant. May be practically odorless, tasteless.	Variable	Will not support life.	No data. Would vary widely with composition.		5.3 to 19.3	Near top of structure	From digestion of sludge	See components
Sulfur Dioxide	SO <sub>2</sub>	Colorless, pungent odor. Suffocating, corrosive, poisonous, non-flammable.	2.26	Inflammation of the eyes. 400 to 500 ppm immediately fatal.	50 to 100	10	—	At bottom, can combine with water to form sulfurous acid.	Industrial waste, combustion, common air pollutant.	Detectable taste and odor at low concentration
Toluene	C <sub>6</sub> H <sub>12</sub> to C <sub>9</sub> H <sub>20</sub>	Colorless, benzene-like odor.	3.14	At 200-500 ppm, headache, nausea, bad taste, lassitude.	200	100	1.27 to 7.0	At bottom	Solvent	Combustible gas indicator
Turpentine	C <sub>10</sub> H <sub>16</sub>	Colorless, Characteristic odor.	4.84	Eye irritation. Headache, dizziness, nausea, irritation of the kidneys.	—	100	—	At bottom.	Solvent, used in paint	1. Detectable odor at low concentrations. 2. Combustible gas indicator.
Xylene	C <sub>8</sub> H <sub>10</sub>	Colorless, flammable	3.66	Narcotic in high concentrations. less toxic than benzene.	—	100	1.1 to 7.0	At bottom	Solvent	Combustible gas indicator

\* Percentages shown represent volume of gas in air.

\*\* For concentration over 0.3%.

\*\*\*Mostly methane and carbon dioxide with small amounts of hydrogen, nitrogen, hydrogen sulfide, and oxygen; occasionally traces of carbon monoxide.

# 2150EX Area Velocity Flow System

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## *Appendix D Material Safety Data*

This appendix contains the manufacturer's Material Safety Data Sheet (MSDS) for the desiccant used in Teledyne Isco 2100 modules.

Teledyne Isco does not guarantee the accuracy of this data. Specific questions regarding the use and handling of the product should be directed to the manufacturer listed on the MSDS.

MATERIAL SAFETY DATA SHEET



sSORB®



Health	1
Fire	0
Reactivity	0
Personal Protection	E

**Section 1: CHEMICAL PRODUCT & COMPANY IDENTIFICATION**

<b>Product Name:</b> sSORB®	<b>Supplier:</b> Interra Global Corporation
<b>Chemical Name:</b> Yellow Indicating Silica Gel	800 Busse Hwy, Suite 101
<b>Synonyms:</b> Orange Indicating Silica Gel	Park Ridge, IL 60068
	USA
<b>Emergency Assistance</b>	
USA	+ 1.847.292.8600 Telephone: + 1.847.292.8600
Outside USA	+ 1.847.292.8600 Fax: + 1.847.292.8601

**Section 2: COMPOSITION & INFORMATION ON INGREDIENTS**

<b>CAS Numbers:</b> 1343-98-2, 77-09-8
<b>Molecular Formula:</b> SiO <sub>2</sub> · nH <sub>2</sub> O + C <sub>20</sub> H <sub>14</sub> O <sub>4</sub>

**Section 3: HAZARDS IDENTIFICATION**

<b>Potential Health Effects</b>
<b>Inhalation:</b> May cause dryness and irritation to mucous membranes, nose and throat. Symptoms may include coughing, sore throat, and wheezing.
<b>Ingestion:</b> No adverse effects expected.
<b>Skin Contact:</b> May cause irritation with dryness and abrasion.
<b>Eye Contact:</b> May cause irritation, redness and pain.
<b>Chronic Exposure:</b> Repeated exposure may cause symptoms similar to those listed for acute effects. Synthetic amorphous silica does not produce silicosis.

**Section 4: FIRST AID MEASURES**

<b>Eye Contact:</b> Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention if irritation occurs.
<b>Skin Contact:</b> Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops.
<b>Ingestion:</b> Give several glasses of water to drink to dilute. If large amounts were swallowed, get medical advice.
<b>Inhalation:</b> If inhaled, remove to fresh air. If breathing is difficult, get medical attention.

**Section 5: FIRE & EXPLOSION DATA**

<b>Fire:</b> Not considered to be a fire hazard.
<b>Explosion:</b> Not considered to be an explosion hazard.
<b>Fire Fighting Media and Instructions:</b> Use any means suitable for extinguishing surrounding fire.
<b>Special Remarks:</b> Use protective clothing and breathing equipment appropriate for surrounding fire.



## MATERIAL SAFETY DATA SHEET

### Section 6: ACCIDENTAL RELEASE MEASURES

**Small Spill:** Use appropriate tools to put the spilled solid in a convenient waste disposal container. Use respiratory protection and eye protection.

**Large Spill:** Use a shovel to put the material into a convenient waste disposal container. Vacuuming or wet sweeping may be used to avoid dust dispersal. Use respiratory protection and eye protection.

### Section 7: HANDLING & STORAGE

**Storage:** Keep container tightly closed. Suitable for any general chemical storage area. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

### Section 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

**Engineering Controls:** Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

**Personal Protection:** Safety glasses. Lab coat. Respirator (NIOSH Approved). Gloves.

### Section 9: PHYSICAL & CHEMICAL PROPERTIES

<b>Physical state:</b>	Solid	<b>Boiling Point:</b>	2230C (4046F)
<b>Color:</b>	Yellow/Orange-Dry:Green-Saturatec	<b>Melting Point:</b>	1610C (2930F)
<b>Odor:</b>	Odorless	<b>Vapor Pressure:</b>	Not applicable.
<b>Solubility:</b>	Insoluble	<b>Vapor Density:</b>	Not applicable.
<b>Specific Gravity:</b>	2.1 (Water=1)	<b>Evaporation Rate:</b>	Not available.
<b>pH :</b>	3 - 8 (in 5% slurry)	<b>% Volatiles by volume @ 21C (70F):</b>	0

### Section 10: STABILITY & REACTIVITY

**Stability:** The product is stable.

**Hazardous Decomposition Products:** Oxides of carbon and silicon may be formed when heated.

**Hazardous Polymerization:** Will not occur.

**Incompatibility with powerfull oxiders:** Reacts with hydrogen flouoride, fluorine, oxygen difluoride, chlorine trifluoride, strong acids, strong bases, and oxidizers.

**Conditions to Avoid:** Moisture, extreme heat, and incompatibles.

### Section 11: TOXICOLOGICAL INFORMATION

**Routes of Entry:** Absorbed through skin. Eye contact. Inhalation. Ingestion.

**Toxicity to Animals:**

**LD50:** Not available.

**LC50:** Not available.

### Section 12: ECOLOGICAL INFORMATION

**Ecotoxicity:** This material is not expected to be toxic to aquatic life.

### Section 13: DISPOSAL CONSIDERATIONS

**Waste Disposal:** Waste must be disposed of in accordance with federal, state and local environmental control regulations.

### Section 14: TRANSPORT INFORMATION

**DOT Classification:** Not a DOT controlled material (United States).

**Identification:** Not applicable.

**MATERIAL SAFETY DATA SHEET**

Section 15: OTHER REGULATORY INFORMATION	
<b>HMIS (U.S.A.):</b>	
Health Hazard:	1
Fire Hazard:	0
Reactivity:	0
Personal Protection:	E
<b>National Fire Protection Association (U.S.A.):</b>	
Health:	1
Flammability:	0
Reactivity:	0

Section 16: OTHER INFORMATION	
<b>References:</b>	Not available.
<b>Other Special Considerations:</b>	Not available.
<b>Created:</b>	04/03/2009 11:20 AM
<b>Last Updated:</b>	08/20/2012 12:15 PM
<p>The purpose of this Safety Data Sheet is to describe the products in terms of their safety requirements. The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Interra Global Corporation be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Interra Global Corporation has been advised of the possibility of such damages.</p>	

# 2150EX Area Velocity Flow System

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# DECLARATION OF CONFORMITY



Application of Council Directive: 2004/108/EC-The EMC Directive  
2006/95/EC- The Low Voltage Directive  
94/9/EC - The ATEX Directive  
2012/19/EC - The WEEE Directive

Manufacturer's Name: Teledyne Isco

Manufacturer's Address: 4700 Superior, Lincoln, Nebraska 68504 USA  
Mailing Address: P.O. Box 82531, Lincoln, NE 68501

Equipment Type/Environment: Laboratory Equipment for Light Industrial/Commercial Environments:  
The device is a water flow monitoring instrument consisting of a flow monitoring electronic circuit board assembly housed inside a plastic enclosure that is attachable to an encapsulated sensing circuit board assembly with cable and connector. The device is intended for indoor/outdoor operation in ambient temperature range of -40 to +60 C.

Trade Name/Model No: 2150EX Flow Module and AV2150 EX Sensors

Year of Issue: 2004

Review of Harmonized Standards: 2013

Provisions of the Directive fulfilled by the Equipment: (2150EX) Group II Category 1G Ex ia IIB T4 Ga(-40C ≤ Ta ≤ +60C)  
(AV2150EX) Group II Category 1G EEx ia IIB T4 (-40C ≤ Ta ≤ +60C)

Notified Body for EC-Type Examination: Baseefa 1180 Buxton UK

EC-type Examination Certificate: Area Velocity Flow Module Type 2150EX: Baseefa04ATEX0083  
Type AV2150EX Sensors (10m & <25m length): Baseefa04ATEX0101X

Notified Body for Production: Baseefa 1180 Buxton UK

Harmonized Standards used: 2150EX EN60079-0:2012, EN60079-11:2012, EN60079-26:2007

Other Standards and Specifications used: AV2150EX 50014:1997 + Amd 1&2, EN50020:2002, EN50284:1999 A review against EN 60079-0:2012 and EN60079-11:2012 shows non-compliance only with mechanical deformation requirements and higher impact levels of 7J but is considered not applicable because the environment of use for the sensor will be under water.

\*EN 61326-1:2006 - EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

EN60529:1992 - Degrees of Protection Provided by Enclosure; Certified as IP-68 by submersion in water at (2150EX) 1.8meters for 24 hours and (AV2150EX) 10.5meters for 72Hrs.

\*Within EN61326-1:2006, tests conducted with a 2150EX and sensor using standards EN55011:2009, EN61000-4-3:2010, EN61000-4-4:2010, and EN61000-4-6:2008 showed performance criteria "A". EN61000-4-2:2009 tests showed Performance Criteria "B"

I, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of December 18, 20 13.

USA Representative :

Vikas V. Padhye Ph, D.  
Vice President and Product General Manager  
Teledyne Isco  
4700 Superior Street  
Lincoln, Nebraska 68504  
Phone: (402) - 464- 0231  
FAX: (402) - 465- 3799





# DECLARATION OF CONFORMITY



Application of Council Directive: 2004/108/EC-The EMC Directive  
2006/95/EC- The Low Voltage Directive  
94/9/EC - The ATEX Directive

Manufacturer's Name: Teledyne Isco, Inc.  
Manufacturer's Address: 4700 Superior, Lincoln, Nebraska 68504 USA  
Mailing Address: P.O. Box 82531, Lincoln, NE 68501

Equipment Type/Environment: Laboratory Equipment for Light Industrial/Commercial Environments:  
The device is an instrument interface for restricting power and communications network energy through cables connecting to flow monitoring instruments and consists of several circuit board assemblies inside a plastic enclosure fitted with input and output network connectors. The device is intended for operation in ambient temperature range of -40 to +60 C.

Trade Name/Model No: **2194EX Network Interface Module**

Year of Issue: 2005  
Review of Harmonized Standards: 2008, 2011

Provisions of the Directive fulfilled by the Equipment: Group II (1)G [Ex ia Ga] IIB (-40C ≤ Ta ≤ +60C) IP68  
(submerged under 1.83 meters for 24hrs with no ingress of water)

Notified Body for EC-Type Examination: Baseefa 1180 Buxton UK

EC-type Examination Certificate: Network Interface Module Type 2194EX: Baseefa05ATEX0028X

Notified Body for Production: Baseefa 1180 Buxton UK  
EN60079-0:2009, EN60079-11:2007 and EN60079-26:2007

Harmonized Safety Standards: \*EN 61326-1998 - EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use  
Other Standards and Specifications used: EN60529:1992 - Degrees of Protection Provided by Enclosure; IP-68

\*Surge on I/O not conducted because test is irrelevant. (Surge coupled into I/O is not possible from any source in EX environment.)

I, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of January 24, 2011.

USA Representative:

William Foster  
Vice President of Engineering  
Teledyne Isco Inc.  
4700 Superior Street  
Lincoln, Nebraska 68504  
Phone: (402)-464-0231  
FAX: (402)-465-3799



60-2002-335  
Rev C





# DECLARATION OF CONFORMITY



Application of Council Directive: 2004/108/EC-The EMC Directive  
2006/95/EC- The Low Voltage Directive  
94/9/EC - The ATEX Directive

Manufacturer's Name: Teledyne Isco, Inc.  
Manufacturer's Address: 4700 Superior, Lincoln, Nebraska 68504 USA  
Mailing Address: P.O. Box 82531, Lincoln, NE 68501

Equipment Type/Environment: Laboratory Equipment for Light Industrial/Commercial Environments:  
The device supplies power to water flow monitoring instruments. It consists of lead acid batteries and a circuit board assembly housed inside a plastic enclosure. The device is intended for indoor/outdoor operation in ambient temperature range of -40 to +60 C.

Trade Name/Model No: **2196EX Battery Node**

Year of Issue: 2007  
Review of Harmonized Standards: 2008, 2011

Provisions of the Directive fulfilled by the Equipment: Group II Category 2(1)G Ex e ia [ia Ga] IIB T4 Gb (-40C ≤ Ta ≤ +60C)IP68 (submerged under 1.83 meters for 24hrs with no ingress of water)

Notified Body for EC-Type Examination: Baseefa 1180 Buxton UK

EC-type Examination Certificate: 2196EX Battery Pack Node: Baseefa07ATEX0033X

Baseefa 1180 Buxton UK

Notified Body for Production:

EN60079-0:2009, EN60079-7:2007, EN60079-11:2007

Harmonized Safety Standards:

Other Standards and Specifications used: \*EN 61326-1998 - EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

EN60529:1992 - Degrees of Protection Provided by Enclosure; IP-68

\*Within EN61326-1998, tests conducted with a 2150EX and sensor using standards EN55011, EN61000-4-2, and EN61000-4-3. EN61000-4-3 showed performance criteria "A". EN61000-4-2 tests showed Performance Criteria "B" when used with a Type 2150EX node and AV2150EX sensor.

I, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of February 17, 2011.

USA Representative:

William Foster  
Vice President of Engineering  
Teledyne Isco Inc.  
4700 Superior Street  
Lincoln, Nebraska 68504  
Phone: (402)-464-0231  
FAX: (402)-465-3799



60-2002-541  
Rev C



# DECLARATION OF CONFORMITY



Application of Council Directive: 2004/108/EC-The EMC Directive  
2006/95/EC- The Low Voltage Directive  
94/9 EC - The ATEX Directive

Manufacturer's Name: Teledyne Isco, Inc.  
Manufacturer's Address: 4700 Superior, Lincoln, Nebraska 68504 USA  
Mailing Address: P.O. Box 82531, Lincoln, NE 68501

Equipment Type/Environment: Laboratory Equipment for Light Industrial/Commercial Environments:  
The devices are communication cables connecting to a water flow monitoring instrument. The devices are intended for indoor/outdoor operation in ambient temperature range of -40 to +60 C.

Trade Name/Model No: **RS232EX and RS485EX Isolator Cable**  
Year of Issue: 2004  
Review of Harmonized Standards: 2008, 2011

Provisions of the Directive fulfilled by the Equipment: Group II Category (1)G [Ex ia] IIB (Ga) (-40C ≤ Ta ≤ +60C)

Notified Body for EC-Type Examination: Baseefa 1180 Buxton UK

EC-type Examination Certificate: Isolator Cable Type RS232EX: Baseefa04ATEX0147  
Isolator Cable Type RS485EX: Baseefa04ATEX0261  
Baseefa 1180 Buxton UK

Notified Body for Production: EN60079-0:2009, EN60079-11:2007

Harmonized Safety Standards: \*EN 61326-1998 - EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

Other Standards and Specifications used: EN60529:1992 - Degrees of Protection Provided by Enclosure; Self Certified as IP-68 by submersion in water at 3meters for 24Hrs. (excluding 9 pin D connector).

\*Within EN61326-1998, tests conducted with a 2150EX and sensor using standards EN55011, EN61000-4-3, EN61000-4-4, and EN61000-4-6 showed performance criteria "A". EN61000-4-2 tests showed Performance Criteria "B"

I, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of May 31, 2011.

USA Representative:

William Foster  
Vice President of Engineering  
Teledyne Isco Inc.  
4700 Superior Street  
Lincoln, Nebraska 68504



60-2002-084  
Rev E



# Replacement Policy

Although some repairs to the Teledyne Isco 2151, 2151P, 2150EX, and 2194EX modules can be made without opening the unit (such as problems with the battery component or firmware), there are some repairs that would require opening the unit. However, the Teledyne Isco 2151, 2151P, and 2150EX modules cannot be opened for repair without voiding their intrinsically safe certification. Therefore, Teledyne Isco offers a prorated replacement cost during the first four years of ownership of the unit.

The first year is covered by Teledyne Isco's One Year Limited Factory Service Warranty, which will repair or replace your 2151, 2151P, or 2150EX module free of charge during the first year, provided it meets the terms of the warranty.

For succeeding years of ownership, if failure is due to faulty parts or workmanship, repairs that can be made without opening the unit will be done at the prevailing technical service rate. If repair would require opening the unit, Teledyne Isco will replace the unit according to the prorated costs listed below:

- Year 2: replaced at 25% of current list price
- Year 3: replaced at 50% of current list price
- Year 4: replaced at 75% of current list price
- Year 5 and after: replaced at 100% of current list price

If you have any questions regarding replacement of your unit, please contact Teledyne Isco.



## Teledyne Isco One Year Limited Factory Service Warranty\*

This warranty exclusively covers Teledyne Isco instruments, providing a one-year limited warranty covering parts and labor.

Any instrument that fails during the warranty period due to faulty parts or workmanship will be repaired at the factory at no charge to the customer. Teledyne Isco's exclusive liability is limited to repair or replacement of defective instruments. Teledyne Isco is not liable for consequential damages.

Teledyne Isco will pay surface transportation charges both ways within the 48 contiguous United States if the instrument proves to be defective within 30 days of shipment. Throughout the remainder of the warranty period, the customer will pay to return the instrument to Teledyne Isco, and Teledyne Isco will pay surface transportation to return the repaired instrument to the customer. Teledyne Isco will not pay air freight or customer's packing and crating charges. This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

The warranty for any instrument is the one in effect on date of shipment. The warranty period begins on the shipping date, unless Teledyne Isco agrees in writing to a different date.

Excluded from this warranty are normal wear; expendable items such as pH sensors, charts, ribbon, lamps, tubing, and glassware; fittings and wetted parts of valves; and damage due to corrosion, misuse, accident, or lack of proper maintenance. This warranty does not cover products not sold under the Teledyne Isco trademark or for which any other warranty is specifically stated.

No item may be returned for warranty service without a return authorization number issued by Teledyne Isco.

**This warranty is expressly in lieu of all other warranties and obligations and Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.**

The warrantor is Teledyne Isco, 4700 Superior, Lincoln, NE 68504, U.S.A.

**\* This warranty applies to the USA and countries where Teledyne Isco does not have an authorized dealer. Customers in countries outside the USA, where Teledyne Isco has an authorized dealer, should contact their Teledyne Isco dealer for warranty service.**

Before returning any instrument for repair, please call, fax, or e-mail the Teledyne Isco Service Department for instructions. Many problems can often be diagnosed and corrected over the phone, or by e-mail, without returning the instrument to the factory.

Instruments needing factory repair should be packed carefully, and shipped to the attention of the service department. Small, non-fragile items can be sent by insured parcel post. **PLEASE BE SURE TO ENCLOSE A NOTE EXPLAINING THE PROBLEM.**

**Shipping Address:** Teledyne Isco - Attention Repair Service  
4700 Superior Street  
Lincoln, NE 68504 USA

**Mailing Address:** Teledyne Isco  
PO Box 82531  
Lincoln, NE 68501 USA

**Phone:** Repair service: (800) 775-2965 (lab instruments)  
(866) 298-6174 (samplers & flow meters)  
Sales & General Information: (800) 228-4373 (USA & Canada)

**Fax:** (402) 465-3001

**Email:** IscoService@teledyne.com



October 11, 2013 P/N 60-1002-040 Rev H





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