# 2150EX Area Velocity Flow Module

This pocket guide is not intended to replace the instruction manual. Read the instruction manual thoroughly before operating the equipment.

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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 the full instruction manual.

If you have any questions regarding the equipment or its installation, contact Teledyne Isco or one of its representatives for assistance.

This manual applies Hazard Severity Levels to the safety alerts. Two levels used in this manual 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.**

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 I*

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.

**⚠ 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.**

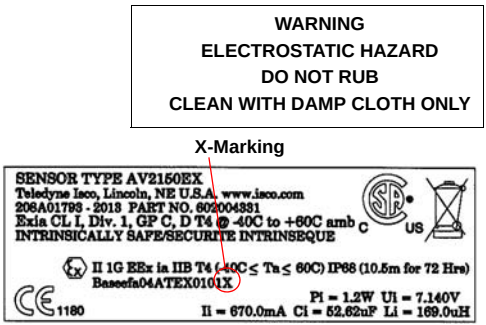
*Labeling*

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.

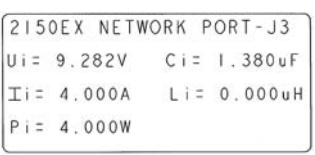

*Example of Safe and Hazardous Area Labeling on RS232EX Cable*

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.



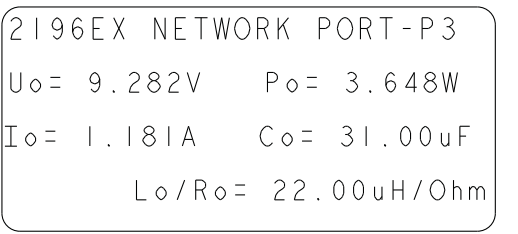

*AV2150EX Sensor cable labels*

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 previous figure 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.

# 2150EX Area Velocity Flow Module

## *Table of Contents*

## 3. Operation



## 4. Maintenance

# 2150EX Area Velocity Flow Module

## *Section 1 Introduction*

### 1.1 Overview

The 2150EX measures liquid level and average stream velocity, and calculates the flow rate and total flow.

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, appropriate for use in Hazardous Zones 0, 1, and 2.

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, analyze the data, and update the module's own software, all without entering the hazardous area.

The standard 2100 Series is designed to be modular. You can expand the system by stacking modules to meet your data collection needs. The 2150EX allows up to two 2150EX modules to be stacked on one 2196EX battery module.

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 have a locking mechanism that strongly secures the components and ensures a watertight seal.

## 1.2 Module Components

The 2150EX components are identified in Figures 1-1 through 1-5 and described in Tables 1-1 through 1-5.


*Figure 1-1 2150EX Top View*

| Table 1-1 2150EX Module Top VIew | | |
|---|---|---|
| **Item** | **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 in holder) | Insert into unused communication connector to terminate the network and protect it from moisture damage. When the communication connector is in use, stow the cap in its holder to protect its components. |
| 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 | Indicator illuminates when module communications are active. |


*Figure 1-2 2150EX Bottom View*

**Table 1-2 2150EX Module Bottom View**

| Item | Name | Description |
|---|---|---|
| 6 | Communication Connector (shown plugged) | Used to connect the module to the 2196EX battery module, or to another 2150EX module. When in use, stow the plug on its holder to protect the terminating components inside the plug. |
| 7 | Plug Holder | Used to store the Connector Plug. |


*Figure 1-3 2150EX Top Right View*

**Table 1-3 2150EX Top Right View**

| Item | 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. |
| 3 | Cap Holder | Used to store the connector cap. |
| 4 | AV Sensor Receptacle | Port used to attach the AV Sensor. |
| 5 | 2196EX | Contains rechargeable batteries, providing a source of power. |

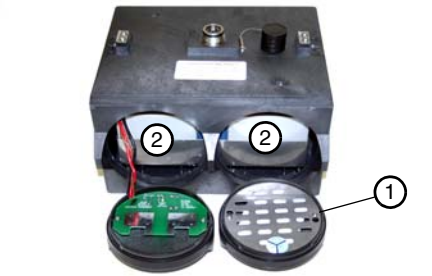



*Figure 1-4 2196EX Battery Components*

**Table 1-4 Battery Components**

| Item | Name | Description |
|---|---|---|
| 1 | Battery Door | The right door has one humidity indicator and bag of desiccant, while the left door houses the charging circuit board for the batteries.<br>The quarter-turn door seals the battery cavity. |
| 2 | Battery Cavity | The rechargeable batteries are integral to the module and not removable. |


*Figure 1-5 AV2150EX Area Velocity Sensor*

**Table 1-5 AV2150EX Sensor**

| Item | Name | Description |
|---|---|---|
| 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 | This 10 m or 25 m cable contains the reference air tubing and conductors. |

# 1.3 Specifications

| Table 1-6 Specifications 2150EX | |
|---|---|
| Weight<br>2150EX only<br>w/ 2196EX | <br>3.0 kg<br>7.49 kg |
| Material | Molded ABS, SST |
| Surface Resistivity | < IE9 OHM/SQ |
| Enclosure | NEMA 4X, 6P IP68 |
| Surface Temperature | Maximum 135 °C / 275 °F; N. American/European classification of T4 |
| Power | 7.0 to 9.1 VDC, 120 mA typical at 8 VDC, 1 mA standby |
| Battery Life w/ 2196 EX | (using 2-minute measurement interval) 6.5 weeks (typical) |
| Temperature | -40° to 60°C<br>operating and storage |
| Operating Atmospheric Pressure | 80 to 110 kPa<br>(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 |

| Table 1-6 Specifications 2150EX (Continued) | |
|---|---|
| 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-<br>co, 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 |

| Table 1-6 Specifications 2150EX (Continued) | |
|---|---|
| Data Storage Memory | Non-volatile flash; retains stored data during program updates<br>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). |
| 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 |
| Data Retrieval | Serial connection to IBM PC or compatible computer with Isco Flowlink Software Version 4.16 or greater |
| Baud Rate | 38,400 |

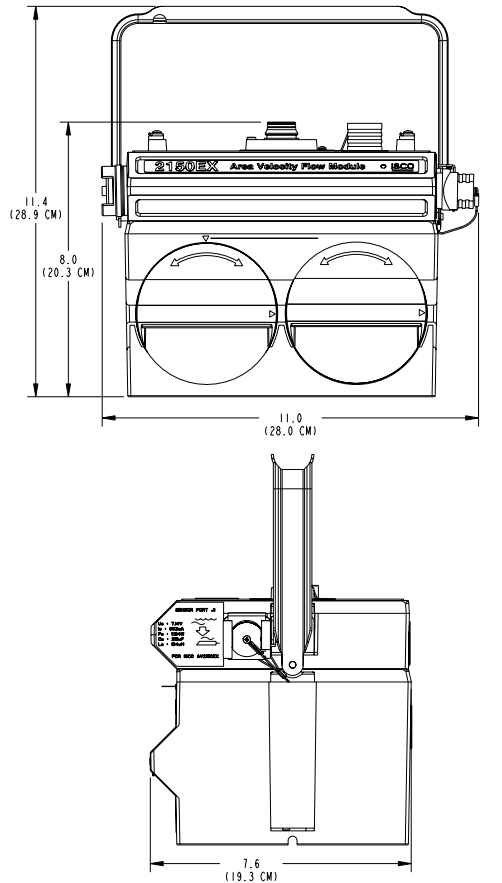



*Figure 1-6 Specification drawing: 2150EX mounted on a 2196EX*

| Table 1-7 Specifications 2196EX Battery Module | |
|---|---|
| Size (H×W×D): | 14.94 x 23.12 x 19.3 cm |
| Weight | 5.77 kg |
| Enclosure | NEMA 4X, 6P IP68 |
| Temperature | -20 °C to 60 °C<br>Operating and Storage |
| Operating Atmospheric Pressure | 80 to 110 kPa<br>(0.8 to 1.1 bar) |
| Power Output:<br><br>Charger Input: | Nominal: 8 VDC<br>Maximum: 9.28 VDC<br>Nominal: 13.5 to 14.7 volts<br>Maximum: 20 volts, 2.0A |

| Table 1-8 Specifications AV2150EX Area Velocity Sensor | |
|---|---|
| Size (H×W×D): | 1.9 x3.3 x15.2 cm |
| Cable Length x diameter | 10 m x 0.9 cm or<br>25 m x 0.9 cm |
| Weight | 1.02 kg (includes cable) |
| Materials | Sensor - Epoxy, stainless steel;<br>Cable - Polyvinyl chloride (PVC), stainless steel |
| Operating Atmospheric Pressure | 80 to 110 kPa<br>(0.8 to 1.1 bar) |

| Table 1-8 Specifications AV2150EX Area Velocity Sensor | |
|---|---|
| Operating Temperature | -40° to 60°C *(applies to flow media when the sensor is immersed)* |
| **Typical Long-Term Stability** | |
| Method | Submerged pressure transducer mounted in the flow stream |
| Transducer Type | Differential linear integrated circuit pressure transducer |
| Range | 0.010 to 3.05 m |
| Maximum Allowable Level | 10.5 m |
| Level Compensation | 0 to 50 °C |
| **Velocity Measurement** | |
| Method | Doppler Ultrasonic |
| Typical Minimum Depth | 25 mm |
| Range | -1.5 to +6.1 m/s |
| Frequency | 500kHz |

| Table 1-9 Specifications 2194EX Interface Module | |
|---|---|
| Size (H×W×D) | 7.37 x 28.7 x 19.05 cm |
| Weight | 9 kg |
| Enclosure | NEMA 4X, 6P IP68 |
| Temperature | -20 to 60 °C (operating)<br>-40 to 60 °C (storage) |
| Operating Atmospheric Pressure | 80 to 110 kPa<br>(0.8 to 1.1 bar) |
| Power | 9 to 26.5 VDC<br>(nominal 12 or 24 VDC)<br>150 mA typical @ 12 VDC<br>Output 8.8 VDC, nominal<br>Number of 2150EX flow modules powered:<br>with 75m interface cable: 2<br>with 150m interface cable: 1 |
| Communication | Side connector: Isco EX node network compatible explosion protected devices<br>Top & Bottom connectors: Isco node network / PC compatible |

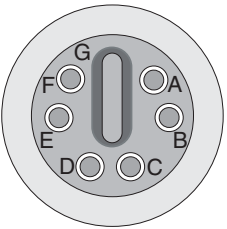



*Figure 1-7 2150EX Communication Connector Pins*

**Table 1-10 Communication Connector**

| 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 |

# 2150EX Area Velocity Flow Module

## *Section 2 Installation*

## 2.1 Preparation

A 2150EX flow system may be a portable installation, powered by a 2196EX battery module, or a permanent installation, powered from the safe area by the 2194EX network interface module.

**☑ *Note***

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.

### 2.1.1 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 work site. 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, such as manholes, pipelines, digesters, and storage tanks. These spaces may become hazardous environments that can prove fatal for those unprepared. Read the Safety section at the front of this manual, and the general safety information in the full instruction manual.

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.

### 2.1.2 Site Location

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.

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.

#### 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, inverts, 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.

### 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.

When you install the AV Sensor in a primary device, a Level-to-Flow conversion method should be used.

## 2.1.3 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. Avoid continual exposure to UV light or periodic submersion in order to extend the life of the components.

Typically, the 2150EX is suspended inside a manhole, near the opening. This protects it from the elements, minimizes the chance of submersion, and allows it to be easily retrieved without entering the manhole.

## 2.2 Site Examples

Figures 2-1, 2-2, and 2-3 illustrate typical round-pipe sites. Figures 2-1 and 2-2 represent **portable installations**; Figure 2-3 represents a **permanent installation**.

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, it is attached to a **2196EX battery module**, which supplies power to the module.

As described in Section 2.7, the **EX network cable** connects to the top of the 2150EX stack and extends to the interface of the safe and hazardous areas.

Also described in Section 2.7, 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 2.7, 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 a network interface cable, usually through conduit, to the **2194EX network module**, located in the safe area, which serves as both the power supply and network connection.

The **AV2150EX sensor cable** must be routed carefully without kinks, coils, or sharp bends, and may not be looped. Any excess cable must be kept out of the channel to prevent debris from collecting. Refer to 2.5 Connecting the AV2150EX Sensor - Secure the Cable section for additional details.

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.

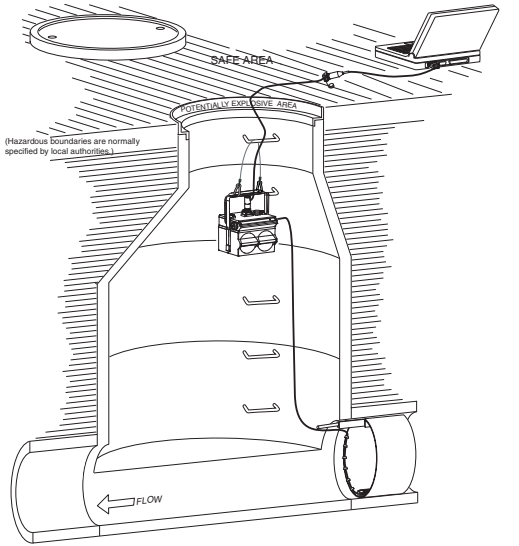



*Figure 2-1 Typical round-pipe installation connected to a laptop computer*

Figure 2-1 shows a 2150EX area velocity flow module connected to either a 2196EX battery module. The AV2150EX sensor is mounted in the pipe, inside a mounting ring. A computer running Flowlink is in the safe area, and is connected to the 2150EX using an EX network cable and an RS232EX isolator cable.

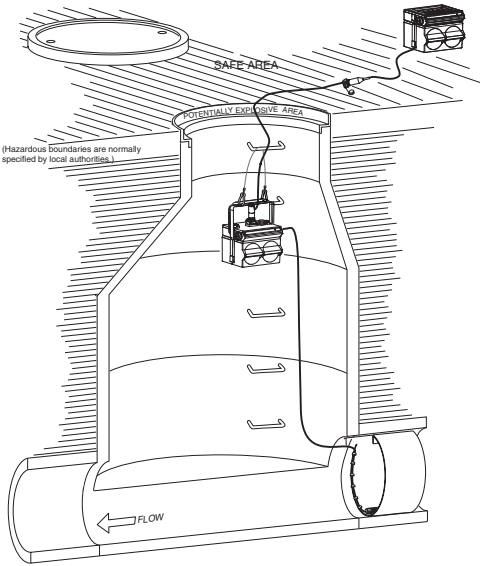



*Figure 2-2 Typical round-pipe installation connected to a 2101 Field Wizard*

Figure 2-2 shows a 2150EX area velocity flow module connected to either a 2196EX battery module. The AV2150EX sensor is mounted in the pipe, inside a mounting ring. A 2101 Field Wizard module is in the safe area, and is connected to the 2150EX using an EX network cable and an RS485EX isolator cable.

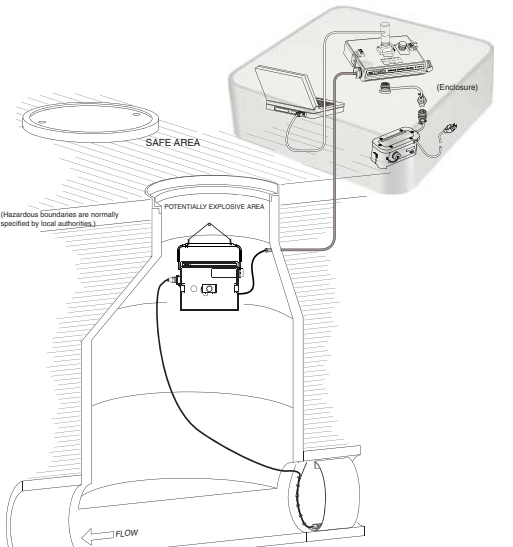



*Figure 2-3 Typical round-pipe installation connected to a 2194EX and laptop*

Figure 2-3 shows a 2150EX area velocity flow module mounted on an EX bottom plate. In an equipment box in the safe area is a 2194EX network/power module, connected to the 2150EX by an EX interface cable run through conduit. An Isco power pack is connected to the 2194EX. A computer running Flowlink is also connected to the 2194EX, using an interrogator cable. The AV2150EX sensor is mounted in the pipe, inside a mounting ring.

**☑ Note**

In Figures 2-1, 2-2, and 2-3 the safe area is the area which is both above ground and outside of the manhole. The potentially explosive area is generally the area inside the manhole. Note that the hazardous boundaries are normally specified by local authorities, and may differ from those shown in these illustrations.

**⚠ 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 EN50020:2002 clause 6.4.12. 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.**

## 2.3 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.

**☑ 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 following sections provide general information for installing a basic, portable 2150EX system:

1. Inspect the desiccant (2.3.1)
2. Assemble the system (2.3.2)
3. Connect the AV2150EX sensor (2.5)
4. Position the AV2150EX sensor (2.5.1)
5. Set up network communication (2.7)

Section 4 *Maintenance* contains details about the maintenance of the 2196EX battery module.

The 2196EX uses two fully rechargeable, nonreplaceable lead-acid batteries. Refer to Section 4.3 for information on charging its batteries.

### 2.3.1 Inspect the Desiccant

The 2150EX System devices use desiccant to protect the internal components from moisture damage.

A desiccant cartridge inserted into the side of the 2150EX is used to dry the reference air for the sensor. This prevents moisture from

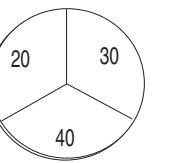
plugging the reference line, which would cause the sensor to report erroneous level readings.

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.

**⚠ CAUTION**

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

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, with regions that display 20, 30, and 40 percent humidity levels. Ideally, each region should be 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 or reactivated.



Battery Module Humidity Indicator

Refer to Section 4.3 for instructions on replacing or reactivating desiccant.

### 2.3.2 Assemble the System

The 2100 Series System is modular; you build the system by connecting modules together. The most basic configuration is to stack a 2150EX module on top of a 2196EX battery module (Figure 2-6).

### 2.3.3 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 2-5 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, nonreplaceable 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 module 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.


*Figure 2-4 Flowlink low-voltage warning*

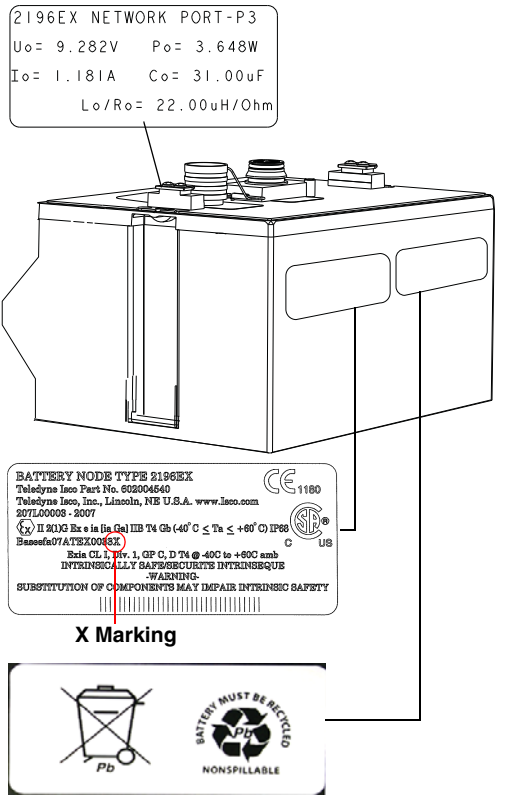



*Figure 2-5 2196EX battery module and labeling*

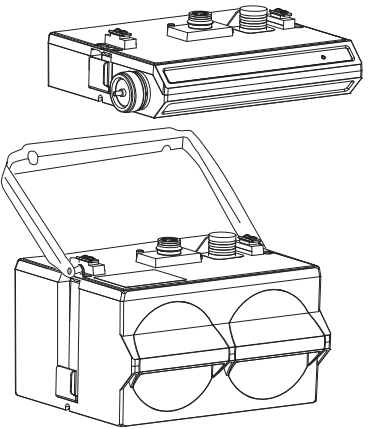


*Figure 2-6 Assembling a basic portable system*

To connect the 2150EX and 2196EX modules, refer to the following instructions and Figure 2-6.

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 (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. (A small quantity of lubricant is supplied in the maintenance kit.)

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 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).

**☑ 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.

**⚠ WARNING**

**Make sure 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.**

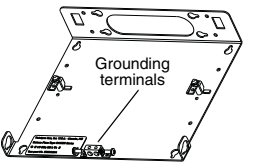
## 2.4 Permanent Installations

For permanent installations, the 2150EX is powered from a safe area by an associated apparatus, the 2194EX module. The 2194EX also serves as a network interface, with RS232 or RS485 communication via the top connector.

The following sections provide general information for installing a basic, permanent 2150EX system. Note that some instructions (such as installing the AV Sensor) are the same as for a portable installation.

1. Inspect the desiccant in the 2150EX and 2194EX modules (2.3.1)
2. Assemble the system (2.4.1)
   a. Install the 2150EX module
   b. Install the 2194EX module
3. Install the interface cable between the 2150EX and 2194EX and connect (2.3.2)
4. Connect the AV2150EX sensor (2.5)
5. Position the AV2150EX sensor (2.5.1)
6. Connect the interrogation cable (2.7)

### 2.4.1 Assemble the System



EX Bottom Plate
60-2004-344

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 (shown above, 60-2004-344) for suspension over the flow stream. The EX bottom plate has stainless steel ground terminals for attaching bonding conductors in permanent installations where circulating current presents a hazard. Use the plates's notched holes to insert fasteners to secure the module to a wall, or attach a carrying handle and suspension handle (69-2003-377 and 60-2004-386), which can be secured to a ladder rung.

The 2194EX is installed in the safe area. There are several options for providing power to the 2194EX. It requires 12 or 24 volts DC, and may be powered by an Isco 910/920 series power pack, using power adapter cable 69-2004-451, which connects to the bottom of the 2194EX. You can also use an Isco 2191 battery module connected to the underside of the 2194EX, or another 12 or 24 VDC source rated for the power requirements. Other options, although the battery life is more limited, are Isco's 934 NiCad battery or 940 series lead acid battery, which also require the power adapter cable. For

details about Isco power supplies, see Isco's Power Products Guide (60-9003-092).

**☑ Note**

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

### 2.4.2 Install the Interface Cable

The network interface cable connects to the 2150EX (located in the potentially hazardous area) and the 2194EX module (located in the safe area). 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 and connect to the side port on the 2194EX.

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.

**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 interface cable assembly.

Two network cable assemblies are available: 75m (60-2004-337) and 150m (60-2004-338). Cut the cable to the appropriate length. The cable must be no longer than 150 meters to power one 2150EX module, and no longer than 75 meters to power two 2150EX modules.

After cutting the cable, assemble the end pieces as shown in Figure 2-7, and attach the wires to the socket insert as shown in Figure 2-8.

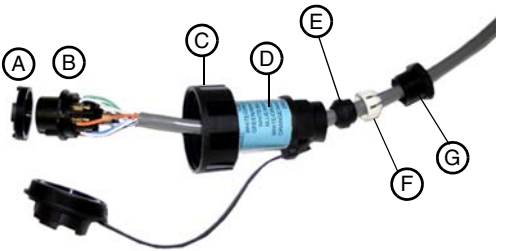



*Figure 2-7 Network interface cable connector*

Figure 2-7 shows the connector parts in order of assembly on the cable end: locking ring (A), socket insert (B), locking cap (C), main connector body (D), gland (E), gland cage (F), and a gland nut (G). When using conduit, the gland nut is replaced with an appropriate fitting.

**⚠ WARNING**

**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.**

For reference in wiring, the wire colors and corresponding pin numbers on the socket insert are printed on the blue label on the main connector body, as listed below:

| Wire | Pin |
|---|---|
| WHITE/GREEN | 1 |
| GREEN/WHITE | 2 |
| WHITE/BLUE | 3 |
| BLUE/WHITE | 4 |
| WHITE/ORANGE | 5 |
| ORANGE/WHITE | 6 |
| DRAIN | 7 |

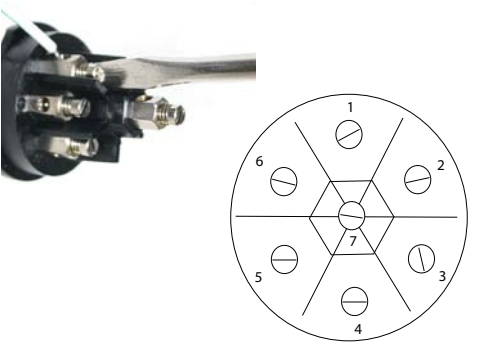



*Figure 2-8 Wiring the socket insert*

Once the interface cable is installed and wired, connect it to the bottom of the 2150EX and the side of the 2194EX.

For network communication (discussed in Section 2.7), 2100 series network devices, such as an Isco 2101 Field Wizard or a 2103 Modem Module, and the RS232 Communication Cable (see Section 2.7.4) can connect directly to the top connector on the 2194EX.

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 in the front of this book.

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.

## 2.5 Connecting the AV2150EX Sensor

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

**⚠ CAUTION**

The AV2150EX sensor is labeled for special usage conditions in order to prevent static electricity. Avoid conditions that may generate a static charge, such as rubbing the sensor with anything that might produce static.

To connect the AV Sensor, refer to Figure 2-9, and do the following:

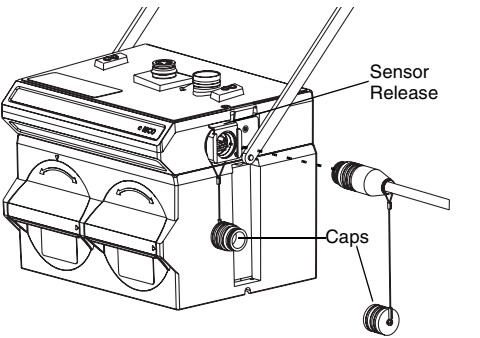



*Figure 2-9 Connecting the AV Sensor*

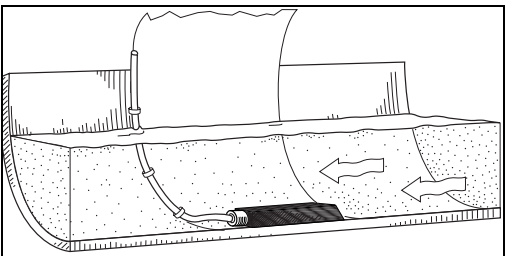
1. Remove the protective caps:
   a. On the 2150EX, push down on the sensor release while pulling the protective cap from the receptacle.
   b. On the AV Sensor cable, pull the cap from the end of its connector.
2. Prepare the AV Sensor connector:
   a. Inspect the connector. It should be clean and dry.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

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

### 2.5.1 Positioning the AV Sensor

Several factors concerning the AV Sensor's installation may affect your system's performance. Read the site selection information in Section 2.1.2 and 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 below.



**Ideal Conditions - Uniform Flow**

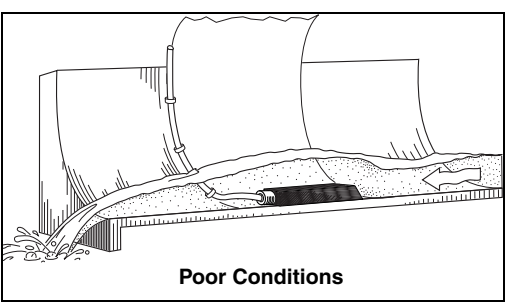
**Avoid poor channel conditions** - Poor channel conditions may cause incorrect or erratic readings. Areas to avoid are:

- outfalls or channel intersections

- flow streams at very low levels with high flow rates
- turbulence
- channel sections that could collect debris or silt
- depths consistently below 2.54 cm.

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

The illustration below shows an example 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.



**Poor Conditions**

**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 is easier to install 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** - 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.

If there is any extra length of cable left after installation, be sure to attach the cable to the flow stream wall. 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.

**⚠ 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.**

## 2.6 Mounting Rings

For pipes up to 38 cm in diameter, stainless steel self-expanding mounting rings (Spring Rings) are available for mounting the AV Sensor inside the pipe. For pipes larger than 38

cm in diameter, a Scissors Ring (Universal Mounting Ring) can be used. Both are briefly described in this section. Detailed information about these rings is available in the Isco Mounting Rings instruction manual.

**⚠ 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 EN50020:2002 clause 6.4.12. 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.**

### 2.6.1 Spring Ring

Attach an AV Sensor to a spring 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.

Attach the sensor cable to the downstream edge of the ring, routing it as shown in Figure 2-10. Other routing directions may affect measurement accuracy. Secure the cable by placing the self-locking plastic ties (supplied with the ring) into the holes in the mounting ring and locking them around the cable.

**⚠ CAUTION**

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 install the 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.

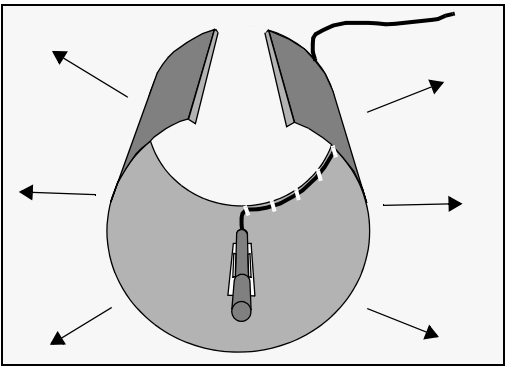


*Figure 2-10 Sensor installed on a spring ring*

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

The spring ring may need anchoring. Under conditions of high velocity (greater than 1.5 meters 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.

### 2.6.2 Scissors Mounting Ring

The scissors mounting ring (Figure 2-11) 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.

**☑ 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 separated.

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

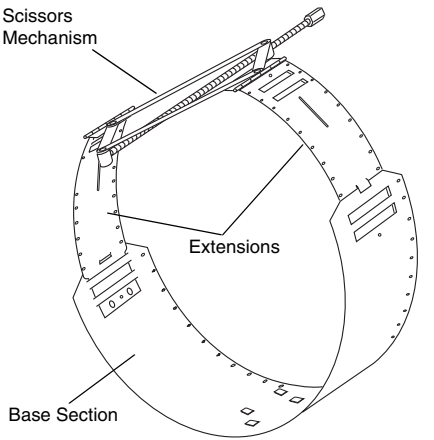



*Figure 2-11 Scissors Ring*

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.

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 mounting ring holes and lock them around the cable.

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

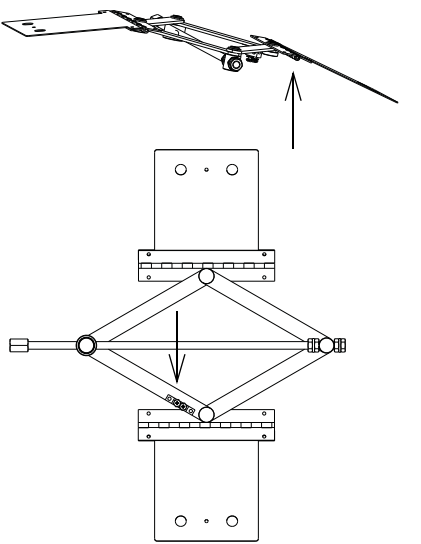


*Figure 2-12 Scissors mechanism ground terminals*

## 2.7 Network Communication

To connect the 2150EX for network communication, the type of cable used depends 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.

### 2.7.1 EX Network Cable

The EX Network cable (2m 60-2004-335, 8m 60-2004-336) is used for portable installations. It connects to the top of the 2150EX stack and extends to the interface of the safe and hazardous areas, where the actual isolation is located.


*Figure 2-13 EX Network Cable*

In Figure 2-13, one cable end (A) connects to the 2150EX and the other end (B) connects to an RS232EX (see section 2.5.2) or RS485EX (see section 2.5.3) isolator cable.

To connect the EX network cable:

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.

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.

### 2.7.2 RS232EX Isolator Cable

The RS232EX isolator cable (60-2004-339) is used in portable installations and allows the 2150EX to be connected to a computer located in the safe area.

In Figure 2-14, one cable end (A) is connected to the computer running Isco's Flowlink software, and the hazardous area end (B) is connected to the EX network cable. This enables you to update the 2150EX's software without entering the potentially explosive atmosphere.


*Figure 2-14 RS232EX Isolator 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 RS232EX isolator cable can be connected directly to the top of the 2150EX.

**☑ 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.

### 2.7.3 RS485EX Isolator Cable

The RS485EX isolator cable (60-2004-340) is used in portable installations and allows the 2150EX to be connected to a 2100 series network device, such as an Isco Field Wizard, located in the safe area.

In Figure 2-15, one cable end (A) is connected to the 2100 series device, and the hazardous area end (B) is connected to the EX network cable.


*Figure 2-15 RS485EX isolator 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.

**☑ Note**

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

### 2.7.4 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 2-16 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.

## 2.8 Final Installation Check

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. 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.
3. Carefully route the 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 Programming the Module

After you have followed all the steps for installing the 2150EX system, 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.

Refer to Section 3 *Operation* for instructions on how to operate the flow module and to Section 3.3 for setting up the basic properties for your system in Flowlink.

# 2150EX Area Velocity Flow Module

## *Section 3 Operation*

This section describes how to operate the flow module. These instructions assume that the 2150EX has been correctly installed (Section 2).

### 3.1 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 (Figure 3-1).

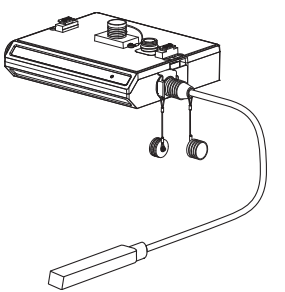
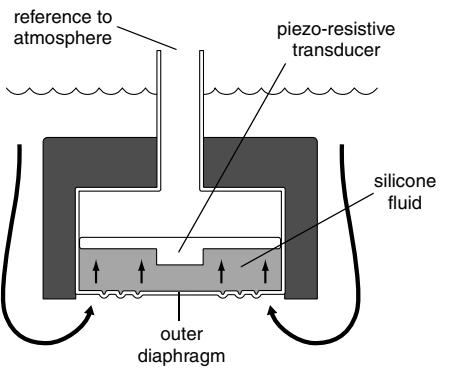


*Figure 3-1 2150EX module with sensor*

The 2150EX can be powered by a 2196EX battery module, or (for permanent installations) a 2194EX network interface module.

### 3.1.1 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

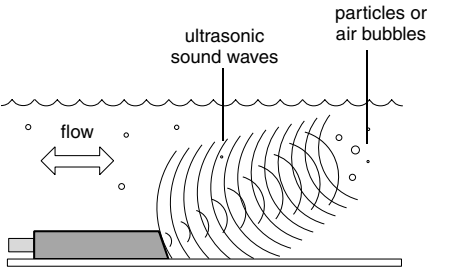
stream. The inner face of the transducer is exposed, or referenced, to the atmosphere through the internal vent tube that runs the full length of the AV Sensor's cable. The difference between the pressures exerted on the transducer is the hydrostatic pressure, which is proportional to the level of the stream.

At the factory each sensor is measured at many 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 micro controller applies the known correction factor to produce highly accurate level readings.

### 3.1.2 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.

### 3.1.3 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

For applications where a primary device is not available or practical, area velocity is usually the conversion method of choice.

The 2150EX can calculate and store 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.

### 3.1.4 Total Flow

The2150EX 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.

## 3.2 Flowlink Software

The 2150EX is used with Isco's Flowlink software. This program lets you set up the module(s), manage sites, retrieve measurement data, analyze data, and update the module's software, all without entering the hazardous area.

To allow interrogation of data using a computer connected to the 2150EX, you need to make the necessary connections so your computer can communicate with the site. Refer to Section 2 of this manual for installation details.

The module is shipped with a default site and module name so it can immediately begin to communicate with Flowlink.

You can change to more descriptive names. Use the Site Info tab in Flowlink to change the site

name, or the Modules tab to change the module name. The name must be unique, and 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 |

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 2100 Instruments button to connect.

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

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 Flowlink Programming

While connected, Flowlink displays the Site View window. This window, organized by a series of tabs, contains all of the program settings that control the site's operation.

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

- **Level** - Enter a liquid level measurement to adjust the sensor's level readings.
- **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.
- **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 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.
- **Silt Level** – This setting compensates for a build up of silt around the sensor.

These five program settings directly affect the data collection. Incorrect settings may introduce errors in the measured data. After

modifying a setting, click on the Apply button (or press F9 on your keyboard). Flowlink will send the change to the module and update the site's settings in its Flowlink database.

### 3.3.1 Level

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 (Figure 3-2). 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.

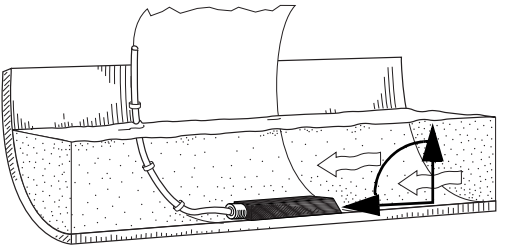
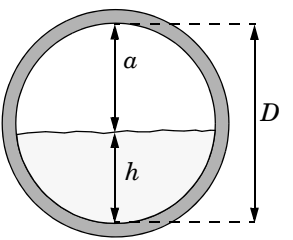


*Figure 3-2 Preferred measurement location*

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, you can measure the level without disturbing the stream surface. This method is preferred. Refer to the diagram below.




*Level (h) = D – a*

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 (d) 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).

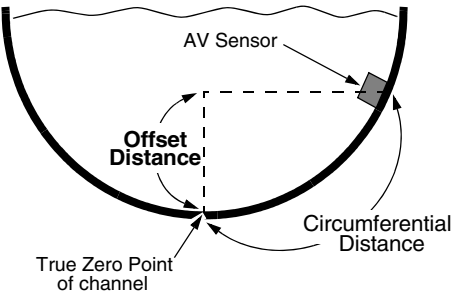



*Figure 3-3 Zero Level Offset Measurement*

### 3.3.3 No Velocity Data or Flow Rate

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.

Use the "Set flow rate to zero if no velocity data" checkbox, found on Flowlink's Velocity Measurement tab, to control how flow rate readings are reported during these conditions.

- 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.

**☑ Note**

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.

To avoid signal interference between closely placed sensors at a multiple module site, you can synchronize the modules so only one module may take a velocity measurement at any given moment.

To do this, check the Prevent Interference box 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 can determine flow rates using either area velocity conversion or level-to-flow rate conversion. Refer to Table 1-6 for a list of the available flow conversion methods.

The 2150EX can calculate and store any two conversion methods simultaneously. Flow conversions are defined on the Flow Rate and Flow Rate 2 Measurement tabs in Flowlink. Select the Conversion Type that matches your application, and then enter the required parameters in the fields to the right of the selected conversion type.

If the selected flow conversion requires channel dimensions, actual channel measurements

should be taken, and 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 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 30 centimeters. 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.

**☑ Note**

Detailed Flowlink instructions are beyond the scope of this pocket guide. 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).

## 3.4 Modbus Protocol

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.

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 configuration of the module that is programmed into Flowlink. Modbus cannot be used to retrieve historical data from a module's memory.

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 want. The reading(s) can then be displayed or stored wherever you designate as a destination; for example, a process control computer.

Not all registers are limited to read-only data storage. You can also use some registers for control purposes, such as lighting the LED on the front of the module.

More detailed information about Modbus is in Section 4 of the 2150EX instruction manual. That section includes configuration information, a glossary of terms, and tables of register definitions.

# 2150EX Area Velocity Flow Module

## *Section 4 Maintenance*

This section describes how to maintain your 2150EX flow module, sensor, and battery module. If you think your module requires repair, or if you have questions concerning its operation or maintenance, contact your authorized Isco service facility or Teledyne Isco's Technical Service Department:

Phone: (866) 298-6174
(402) 464-0231 (international)
FAX: (402) 465-3001
E-mail: IscoService@teledyne.com

## 4.1 Maintenance Overview

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
- Channel conditions

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

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.

Maintenance kits are available. Kit number 60-2059-001, which supports 2100 Modules, contains O-rings for the connectors and desiccant cartridge, a hydrophobic filter, and a one-pound container of silica gel desiccant. You can order the kits by calling Teledyne Isco's Customer Service Department.

## 4.2 2196EX Batteries

The 2196EX is a rechargeable battery module with two batteries permanently contained in an IP68 enclosure. The 2196EX may be safely connected to or disconnected from a 2150EX flow module within a hazardous area.

The module protects the lead-acid batteries from damage due to deep discharge by first indicating low voltage through Flowlink, and then by shutting off when the voltage becomes critically low. However, cycle life is improved

when regular charging is performed before a drop in voltage is indicated.

2196EX port connector

Flowlink will likely be the primary source of voltage information. You can test voltage manually with a voltmeter for **8V** at the port connector on pins c (+) and d (–).

Additionally, voltage can be tested on the circuit board mounted inside the left compartment door by measuring for **12V** between Test Point 1 (TP1) and H5 (negative terminal). Note that there is a 60K ohm resistor in the voltage-sensing circuit on the board. The measured voltage may vary slightly, depending on the voltmeter used.

The 2196EX module requires a lead-acid battery charger with a maximum rating of 20 volts, 2 amps. Teledyne Isco offers a 2A charger with alligator clips, part #68-2000-044. The 2196EX can also be charged using the Isco Model 965 five-station battery charger, or the Isco Model 963 desktop charger. Both Isco chargers require the card edge adaptor cable for use with the 2196EX (part #60-2004-547).

**⚠ 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 Um = 250V and Un = 20V. The charger output must not exceed 20 volts or 2 amperes as labeled.**

In order to recharge the batteries, the 2196EX module case must be opened. The 2196EX has only one desiccant holder, located on the inside of the right compartment door.

***☑ 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 make sure that only dry desiccant is installed when re-sealing the case.

The charging terminals are located on the circuit board attached to the inside of the left compartment door (Figure 4-1). A cable ending in alligator clips may be connected to these terminals for charging. Observe polarity as shown in Figure 4-1.

**⚠ CAUTION**

The circuit board is permanently connected to the interior of the module by wiring. Use care when opening the case.

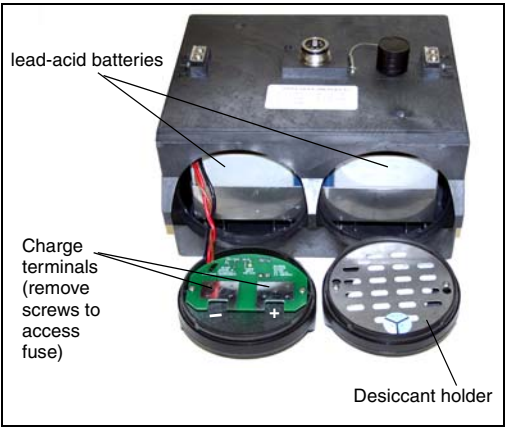



*Figure 4-1 2196EX charge terminals*

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.

To access the 2A charge fuse (F1), remove the two mounting screws holding the circuit board inside the compartment lid (Figure 4-1). Replace the fuse with the specified Littelfuse 216002 or Cooper/Bussman S501-2A only (part #411-9922-60).

## 4.3 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.

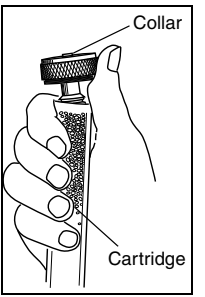
The battery modules use desiccant bags, located inside the battery caps, to keep the interior of the case dry. Attached to the inside face of the cap is a humidity indicator, with regions that display 20, 30, and 40 percent humidity levels. Ideally, each region should be blue. As the desiccant becomes 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 or reactivated.

### 4.3.1 Replacing Desiccant

The 2150EX has a desiccant cartridge on the left side. To remove the cartridge, unscrew the collar and slide the cartridge out of the 2150EX.

**⚠ 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, hold the cartridge upright with the collar at the top and push the collar off the cartridge. Empty the cartridge and fill with new (P/N 099-0011-03) or reactivated silica gel desiccant. Press the collar onto the tube, and slide the cartridge into the 2150EX Module. Tighten the collar to seal the cartridge in place.

The 2196EX has one desiccant bag, located inside the cap on the right hand side.

To replace the desiccant bags, loosen the two mounting screws that secure the retaining plate. Rotate the retaining plate until it is free from the mounting screws. Remove the spent desiccant bag from the cap and replace it with a new (P/N 099-0002-33) or reactivated bag. Replace the retaining plate and secure it with the screws.

### 4.3.2 Reactivating Desiccant

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

**⚠ CAUTION**

Desiccant may produce irritating fumes when heated. 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.

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.

Bagged desiccant will often include reactivation instructions on the bag's label. 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.

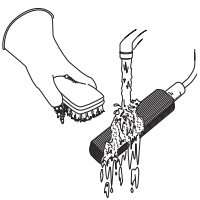
## 4.4 Other Maintenance

To maintain the hydrostatic conditions on which the level-to-area conversion is based, you should clean the channel upstream and downstream from the sensor on a periodic basis.

The sensor and cable should also be inspected. A damaged cable can affect the operation of the sensor. The sensor body and cable are a factory sealed unit; if there is damage to the sensor or cable, the entire assembly must be replaced.

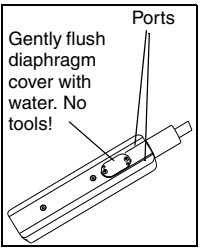
Do not leave cables lying around where they may be stepped on or run over by heavy equipment. Do not leave extra cable loose in the flow stream where it can trap debris.

### 4.4.1 Cleaning



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

If the flow stream carries a great deal of debris, beware of organic materials that may collect beneath the 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 sensor. Keeping the ports clean not only prevents damage, but assures you that the sensor will respond to the hydrostatic pressure above instead of the pressure created by swollen material.




If the ports become blocked, remove the sensor from its mounting ring, plate, or carrier. Scrape any accumulated solids off the exterior of the sensor. Use a brush and flowing water. Remove debris that has accumulated in the ports.

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. Contact with the outer diaphragm may permanently damage the sensor.

## 4.5 Diagnostics

To assist with troubleshooting, 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 kept in Flowlink's database where they can be viewed offline at a later time. To enable Flowlink to automatically collect all diagnostic files while retrieving the data, open Utilities>Options from the main menu and under the 2100 tab, check the *Retrieve data gets text reports* box.

# Compliance Statements

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
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
Provisions of the Directive fulfilled Group II Category (1)G [EEx ia] IIB (-40C < Ta < +60C)
by the Equipment:
Notified Body for EC-Type Examination: Baseefa 1180 Buxton UK
EC-type Examination Certificate: Isolator Cable Type RS232EX: Baseefa04ATEX0147
Isolator Cable Type RS485EX: Baseefa04ATEX0261
Notified Body for Production: Baseefa 1180 Buxton UK
Harmonized Safety Standards: EN50020:2002, EN50284:1999
Other Standards and Specifications EN 50014:1997 + Amd 1&2 -(A review against EN60079-0:2006, which is used: harmonized, shows no significant changes relevant to this equipment, so EN 50014:1997 + Amd1&2 continues to represent “State of the Art”.)
*EN 61326-1998 -EMC Requirements for

Electrical Equipment for Measurement, Control, and Laboratory Use
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, EN61000-44, and EN61000-4-6 showed performance criteria “A”. EN61000-4-2 tests showed Performance Criteria “B”
60-2002-084 Rev E

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
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 AV2150EX Sensors
Year of Issue: 2004
Review of Harmonized Standards: 2008
Provisions of the Directive fulfilled by the Equipment: Group II Category 1G EEx ia IIB T4 (-40C < Ta < +60C)
Notified Body for Production: Baseefa 1180 Buxton UK

Harmonized Safety Standards:
EN50020:2002, EN50284:1999
Other Standards and Specifications used:
EN 50014:1997 + AMD 1&2 – (A review against EN60079-0:2006, which is harmonized, shows no significant changes relevant to this equipment, so EN 50014:1997 + Amd1&2 continues to represent “State of the Art”.)
*EN 61326-1998 – EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use
EN60529:1992 – Degrees of Protection Provided by Enclosure; Self Certified as IP-68 by submersion in water at 3meters for 24Hrs.
*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”
60-2002-333 Rev D

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
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
Provisions of the Directive fulfilled Group II Category (1)G [EEx ia] IIB T4 (-40C < Ta < +60C)
by the Equipment:
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
Harmonized Safety Standards: EN50020:2002, EN50284:1999
Other Standards and Specifications EN 50014:1997 + Amd 1&2 -(A review against EN60079-0:2006, which is used: harmonized, shows no significant changes relevant to this equipment, so EN 50014:1997 + Amd1&2 continues to represent “State of the Art”.)
*EN 61326-1998 -EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use
EN60529:1992 -Degrees of Protection Provided by Enclosure; Self
Certified as 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.)
60-2002-335 Rev C

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
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
Provisions of the Directive Group II Category 2G Ex e ia IIB T4 (-40C < Ta < +60C) fulfilled by the Equipment: Notified Body for EC-Type Examination: Baseefa 1180 Buxton UK EC-type Examination Certificate: 2196EX Battery Pack Node: Baseefa07ATEX0033X
Notified Body for Production: Baseefa 1180 Buxton UK Harmonized Safety Standards: EN50020:2002, EN60079-0:2004, EN50079-7:2007 Other Standards and Specifications *EN 61326-1998 -EMC Requirements for Electrical Equipment for used:Measurement, Control, and Laboratory Use EN60529:1992 -Degrees of Protection Provided by Enclosure; Self Certified as IP-68 by submersion in water at 3meters for 24Hrs.
*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.
60-2002-541 Rev C