

# 2110 Ultrasonic Flow Module and Sensor

## Installation and Operation Guide



Part #69-2003-410 of Assembly #60-2004-410  
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Revision U, April 2017



# Radio Interference Statement

## FCC

This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which the user will be required to correct the interference at his own expense.

## Canada

This ISM apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Ce générateur de fréquence radio ISM respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

## Caution

Changes or modifications not expressly approved by the party responsible for compliance (Teledyne Isco) could void your authority to operate the equipment.

This equipment should be installed and operated using Isco's cables, such as the Flowlink Communication Cable or the optional Module-to-module Cable. Isco cables are listed in Appendix B, *Accessories*.



## 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 Material 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.**

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*General Warnings*

Before installing, operating, or maintaining this equipment, it is imperative that all hazards and preventive measures are fully understood. While specific hazards may vary according to location and application, take heed in the following general warnings.

This product is often installed in confined spaces. Some examples of confined spaces are manholes, pipelines, digesters, and storage tanks. These spaces may become hazardous environments that can prove fatal for those unprepared. These spaces are governed by OSHA 1910.146 and require a permit before entering.

*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 used 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 technical reference 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.

# 2110 Ultrasonic Flow Module

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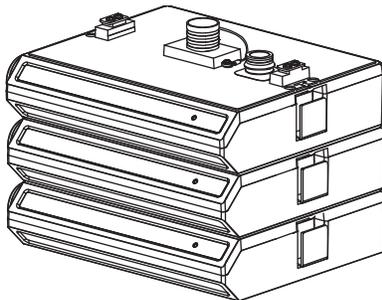
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# 2110 Ultrasonic Flow Module

## Section 1 Introduction

### 1.1 Product Description



A 3-module site

The 2110 Ultrasonic Module is part of Isco's 2100 Series system. The 2100 Series system measures parameters of open channel flow streams.

The 2100 Series system is designed to be modular so that you can expand the system to meet your data collection needs. By stacking the 2100 Series modules, a single site can measure multiple flow channels, collect redundant data, or add other available measurement capabilities. A site can include remote measurement points, as distant as 3300 feet, by connecting modules with cables. Even with several remote modules configured as a site, you can still retrieve all of the measurement data from a single connection.

The 2100 Series System is paired with Isco's *Flowlink* software. With this software application, you can quickly set up modules, retrieve measurement data, manage the sites and analyze the data.

The module's flexible data storage memory is able to store the measurements in intervals from 15 seconds to 24 hours. The modules 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 data when stored at fifteen minute intervals. The Flash memory also stores sensor calibration information. A separate Flash memory device inside the module stores the operating firmware.

The rugged 2100 series 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 modules, sensors, and communication cables "lock" in place. Each locking mechanism strongly secures the components and ensures a watertight seal.

The flow information from a 2110 can be used to pace an Isco 3700, GLS, or 6700 Series sampler. The connection is made using a 2100 Series Sampler Interface Cable (Isco part #68-2000-014). A flow pulse is sent out every 100 gallons or 500 liters of flow, depending on how the 2110 is configured.

## 1.2 2110 Operation Overview

The 2110 measures liquid level and calculates the flow rate and total flow. The liquid level measurements are read from an attached ultrasonic sensor that is mounted over the flow stream. Flow rate calculations are performed internally using the measured parameters from the sensor. Additionally, the 2110 can measure its input voltage – a service feature.

The 2110 is designed to provide durable operation with only a minimal amount of routine maintenance, all of which may be performed in the field. Typically, the 2110 and its sensor will only require that you keep the stream free from excessive debris, and replace spent desiccant and batteries.

### 1.2.1 Applications

Typical applications for the 2110 Module include:

- Measurement of sewer flow or in streams containing harsh chemicals, grease, or suspended solids
- Treatment capacity analysis
- Redundant level measurement in combination with a 2150 Area Velocity Flow Module
- Inflow and Infiltration (I&I) studies
- Storm Water Runoff Monitoring
- Combined Sewer Overflow (CSO) Monitoring.

### 1.2.2 Flow Rate

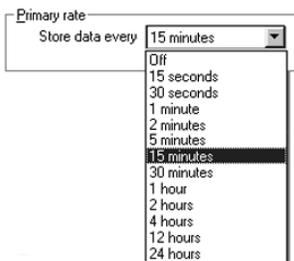
Using level measurements from the sensor, the 2110 can calculate the flow rate. The 2110 supports many different flow rate conversion methods:

- Data Points
- Manning Formula
- Two-term Polynomial Equations
- Flumes
- Weirs
- Area-Velocity (when connected to a 2150 module)

### 1.2.3 Data Storage

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 2110 will not store the measurement (unless a secondary rate is selected). However, the 2110 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 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.



*Time Resolution*

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, measurements are stored in a *rollover* type of memory. When full, the module overwrites the oldest data with the newest readings.

**1.2.4 Input Voltage**

The 2110 measures the input voltage so that it can be reported to the user. Input Voltage measurements are useful when estimating the remaining battery life and determining when the system must be serviced. You can log the Input Voltage readings in data storage to chart power consumption.

*2191 Battery module*

The 2191 Battery Module uses two 6 volt lantern batteries to supply 12VDC to 2100 system modules.

The Battery Module's only role is to supply DC power, yet it still supports communications between other modules. The upper and lower connectors pass along communications between modules attached above and below.

You can stack Battery Modules to increase the power available to a module or a stack of modules.

### 1.3 Component Identification

The components of the 2110, 2191 Battery Module, and Ultrasonic Level Sensor (USLS) are shown in Figures 1-1 through 1-4. Items referenced in the figures are summarized in the tables below.

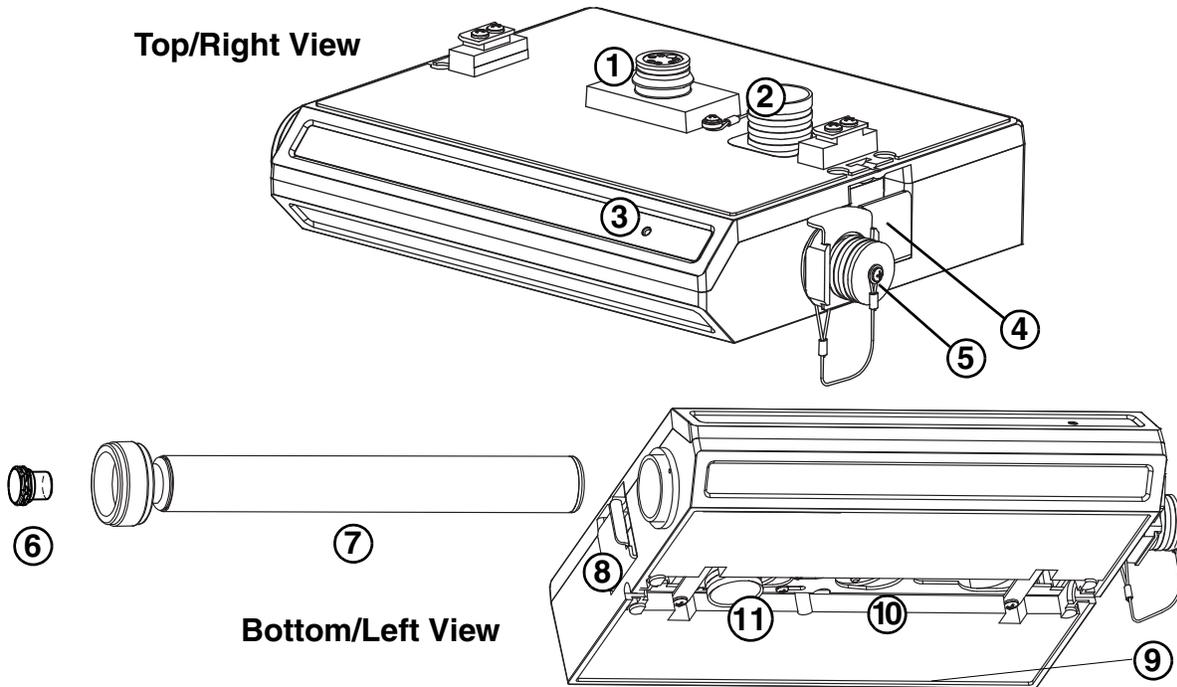


Figure 1-1 Controls, Connectors, and Indicators – 2110 Flow Module

Table 1-1 Components – 2110 Flow Module		
Item No.	Name	Description
1	Communication Connector	Upper communication port. The connection transfers data and 12 VDC power to other modules. The port is also used to connect to a PC running Flowlink software.
2	Connector Cap	Insert into unused communication connectors to terminate the network and protect them from moisture damage. When communication connectors are in use, the caps must be stowed as shown in Figure 1-1 to protect the terminating components inside the cap.
3	Communication Indicator	Illuminates when the module is active. With Flowlink, a user can turn on this light-emitting diode (LED) to identify the module at a multiple-module site.
4	Latch Release	Push in to release the module from a stack.
5	Sensor Receptacle	Port used to attach the USLS Sensor. Insert the protective cap when not in use.
6	Hydrophobic Filter	Prevents moisture from entering the case.
7	Desiccant Cartridge	Container holding desiccant that dries the internal air.
8	Latch	Push in to lock the module in a stack.
9	Serial Number Label	On back of unit - lists product ID and unit serial numbers.
10	Communication Connector	Lower communication port. The connector transfers data and 12 VDC power to other modules.
11	Connector Plug	Insert into the interface connector when the connector is not in use to protect it from damage.

1.3.1 Battery Module

Figures 1-2 and 1-3 identify key components of the model 2191 Battery Module.



Figure 1-2 Battery Module components, top view

Table 1-2 Battery Module Components - Top View	
Item No.	Description
1	Communication Connector
2	Connector Cap
3	Connector Cap Holder
4	Lantern Battery (Alkaline shown)
5	Door
6	Battery Carrier
7	Latch Release



Figure 1-3 Battery Module components, bottom view

Table 1-3 Battery Module Components - Bottom View	
Item No. Fig. 1-3	Description
1	Communication connector
2	Connector plug
3	Connector plug holder
4	Latch

1.3.2 Ultrasonic Level Sensor (USLS)

Figure 1-4 and Table 1-4 identify the parts of the 2110 Ultrasonic Sensor.



Figure 1-4 2110 Sensor parts

Table 1-4 2110 Sensor Parts and Descriptions

Item No. Fig. 1-4	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.
2	Connector	Attaches the USLS to the receptacle on the 2110 module.
3	Serial Number Label	Lists the product ID and unit serial number.
4	Cable	32.8 feet (10 m) containing conductors to transfer level data and power.
5	USLS Body	The Ultrasonic Level Sensor is placed above the surface of the flow stream to measure water level.

## 1.4 Latches

Latches must be operated to stack and unstack the modules. Take a moment to familiarize yourself with operating the latches. The latch is operated by pushing on one of the sides — the right side to unlock, and the left side to lock. Both latches are flush to the module's sides in the locked position.

 **CAUTION**

The latch can be damaged by applying too much force. Never press on both sides at the same time. Do not force the latch if it is obstructed. While some degree of pressure must be applied to slide the latch, the ends of the latches should never bend more than  $\frac{1}{8}$ ".

Figure 1-5 shows how to unlock the latch. You must unlock the latch to place the module on top of a stack. Otherwise, the latch is normally locked. Locate the latch release on the right side of the module. Push in to slide the latch toward the left of the module.

Module stacking is described in more detail in Section 1.8.



Figure 1-5 Unlocking the latch

 **Note**

Latches will “click” when they are fully locked and unlocked.

## 1.5 Communication Connectors

When a communication connector is not in use, the connector should always be capped (Figures 1-6 and 1-8). The cap will seal the connector to prevent corrosion, prevent moisture from entering the unit, and improve communications.

When a communication connector is in use, store the cap on the holder next to the connector (Figures 1-7 and 1-9). The communication connector will be sealed by its mating connector.

### CAUTION

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

### Note

For modules to correctly stack and lock together, protective caps between the modules must be stored on the holders. Section 1.8 shows how to store the caps so that you can stack the modules.

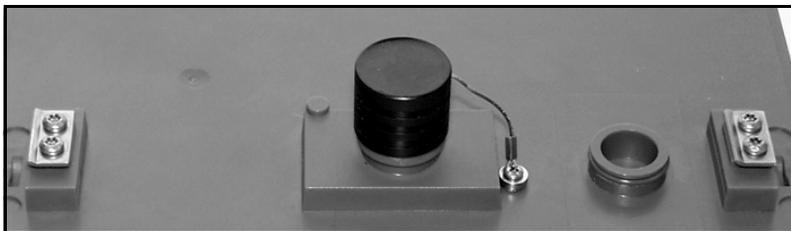


Figure 1-6 Flow Module - Upper connector, capped

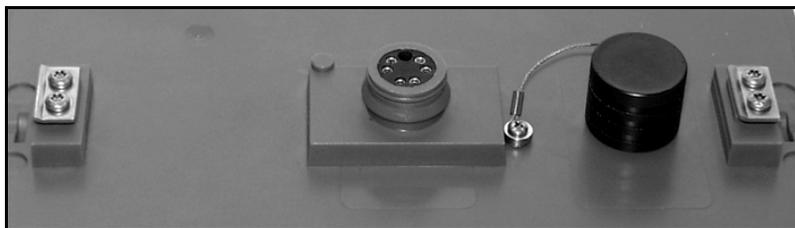


Figure 1-7 Flow Module - Upper connector, uncapped

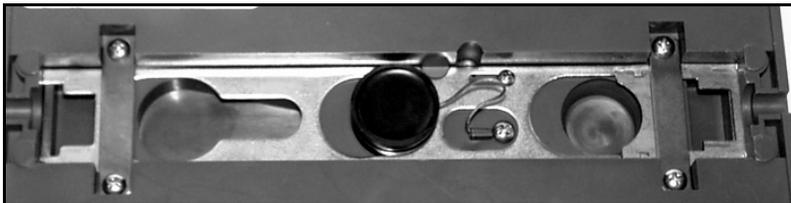


Figure 1-8 Flow Module - Lower connector, plugged

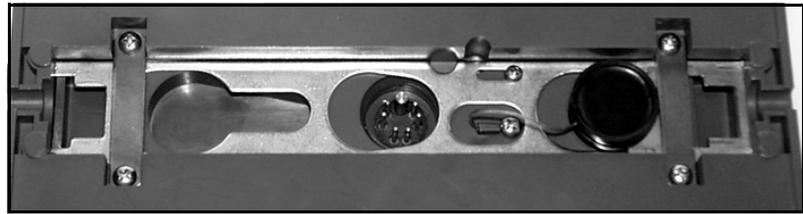


Figure 1-9 Flow Module - Lower connector, unplugged

### 1.6 Connecting the Sensor

To connect the Ultrasonic Level Sensor to the 2110 Flow Module, follow steps in Figures 1-10 and 1-11.

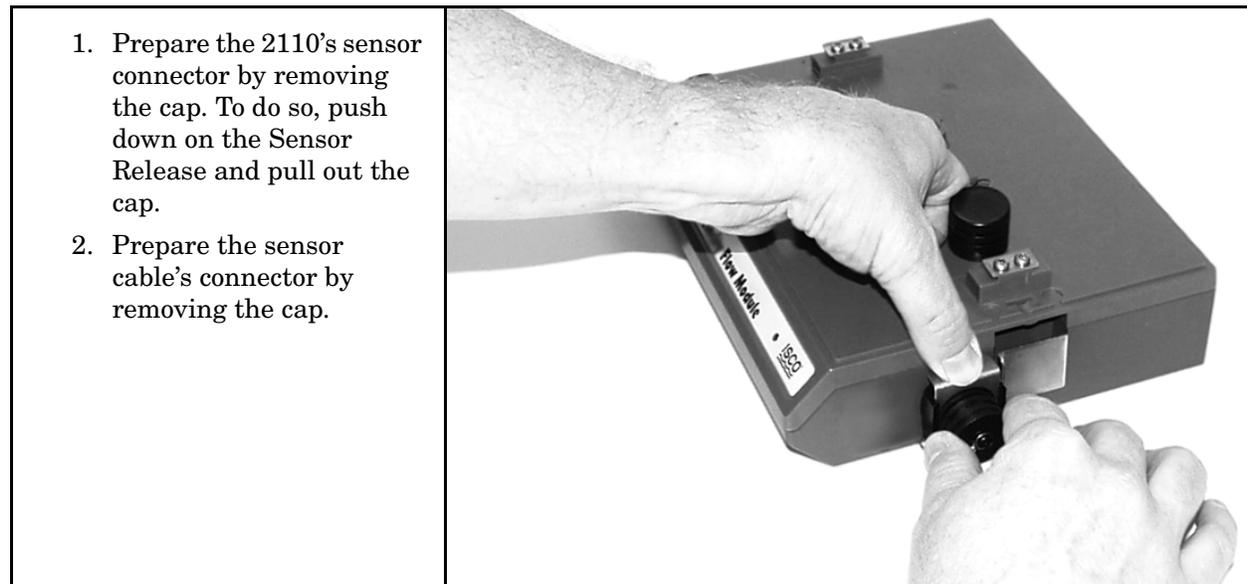


Figure 1-10 Flow Module - preparing the sensor connectors

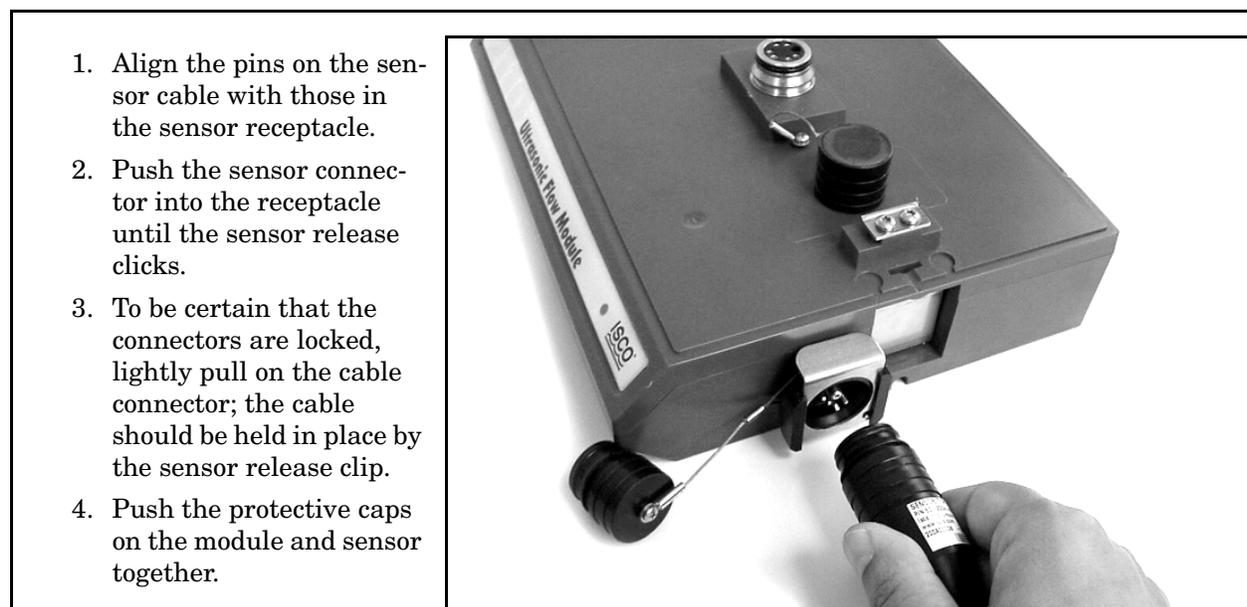


Figure 1-11 Flow Module - connecting the sensor

### 1.7 Installing the Batteries

The Battery Module requires two lantern batteries. The figures below show a 6 VDC alkaline battery. Rechargeable 6 VDC lead-acid batteries are also available for the module.

To install the batteries, follow the instructions in Figures 1-12 through 1-15.

Load the Lantern Battery into the Carrier.

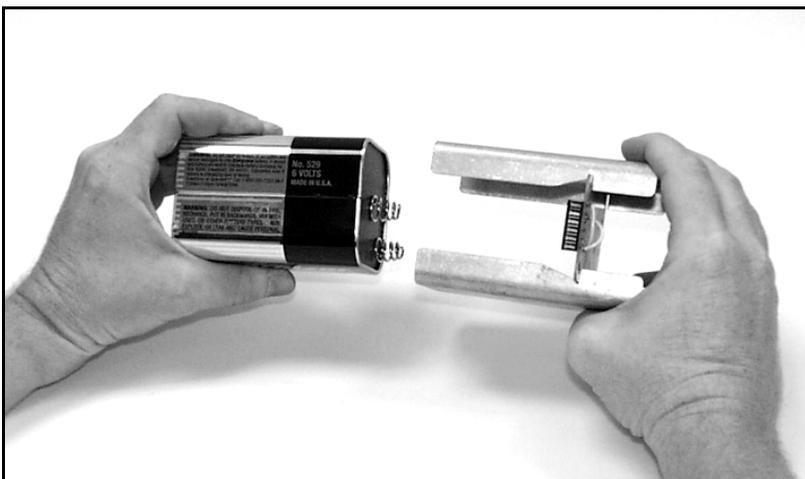


Figure 1-12 Insert Battery in carrier

Insert the carrier and battery into the module. Note the position of the carrier's connector; it must be aligned toward the center of the module.

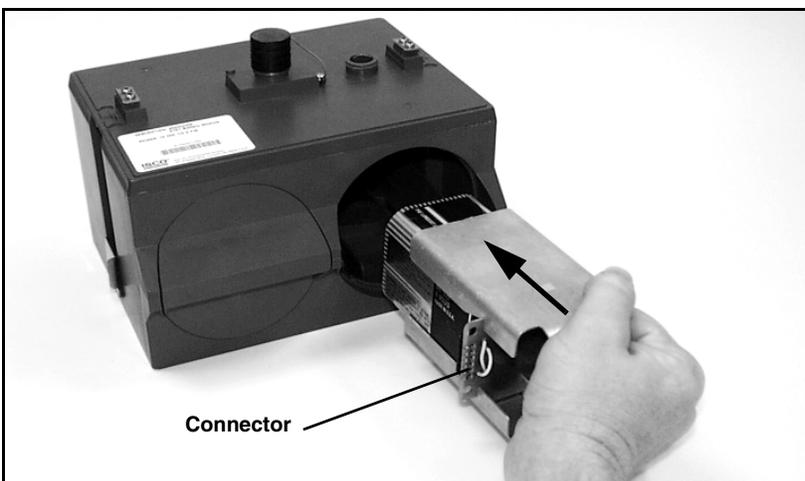


Figure 1-13 Battery Module - inserting carrier

While holding the door in your right hand, align the marks and insert the door.



Figure 1-14 Battery Module - aligning the door

Rotate the door  $\frac{1}{4}$  turn clockwise.

Repeat Steps 1-12 through 1-15 to install the second battery.

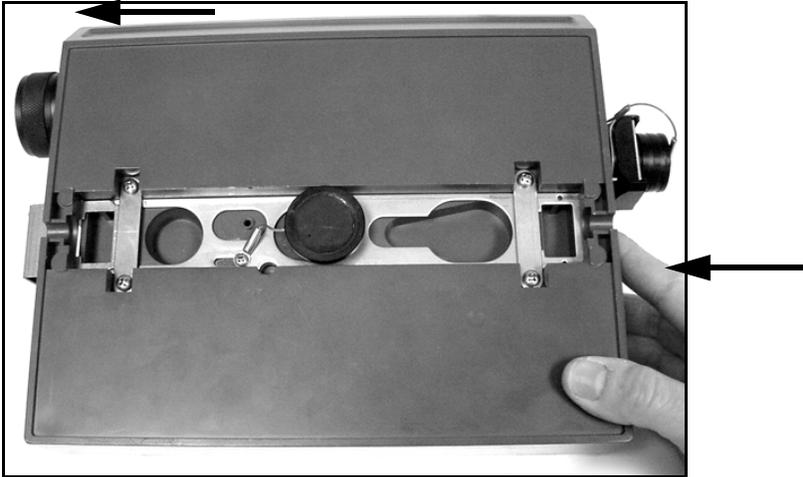


Figure 1-15 Battery Module - closing the door

## 1.8 Stacking Modules

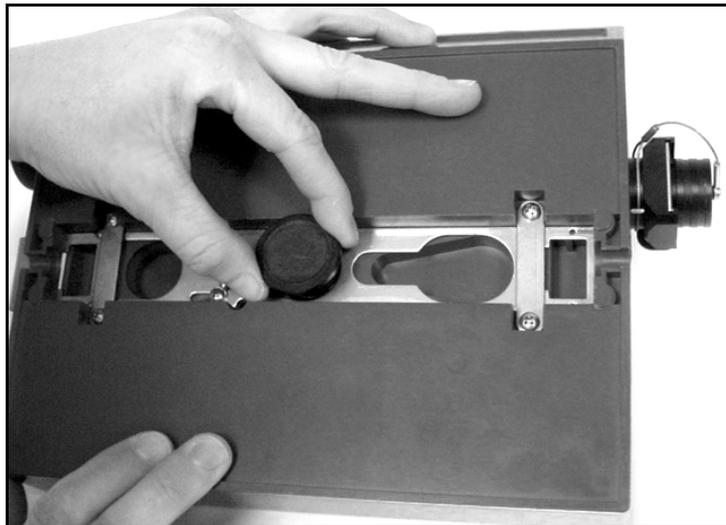
To stack a 2110 Flow Module on a 2191 Battery Module, follow the instructions in Figures 1-16 through 1-22.

Unlock the latch to release the connector plug.



*Figure 1-16 Flow Module - Unlocking the latch*

Pull the plug out of the connector.



*Figure 1-17 Flow Module - Unplugging the connector*

Push the plug into the holder.

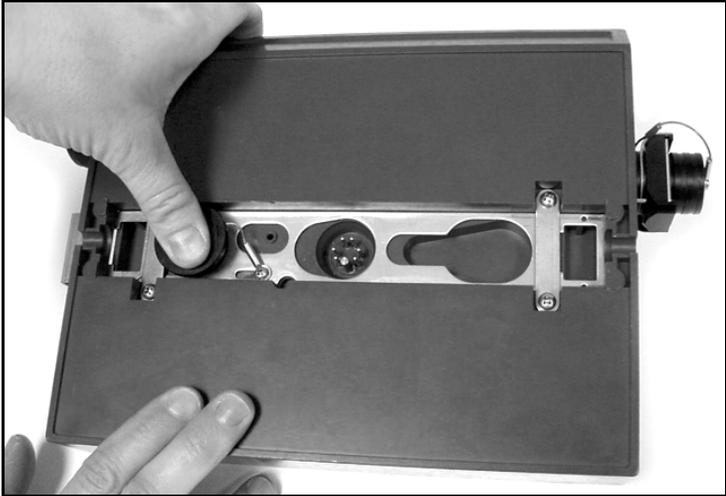


Figure 1-18 Flow Module - Pushing plug into holder

On the Battery Module, uncap the connector. Store the cap on the holder.

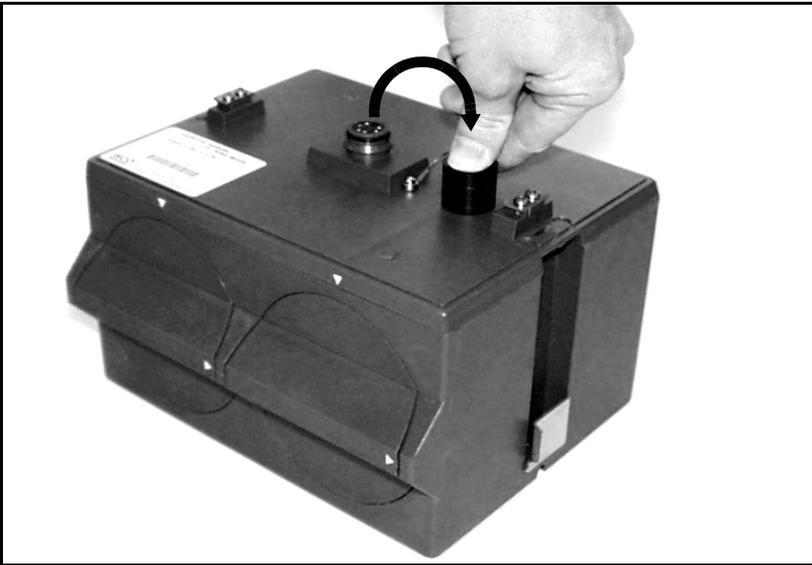


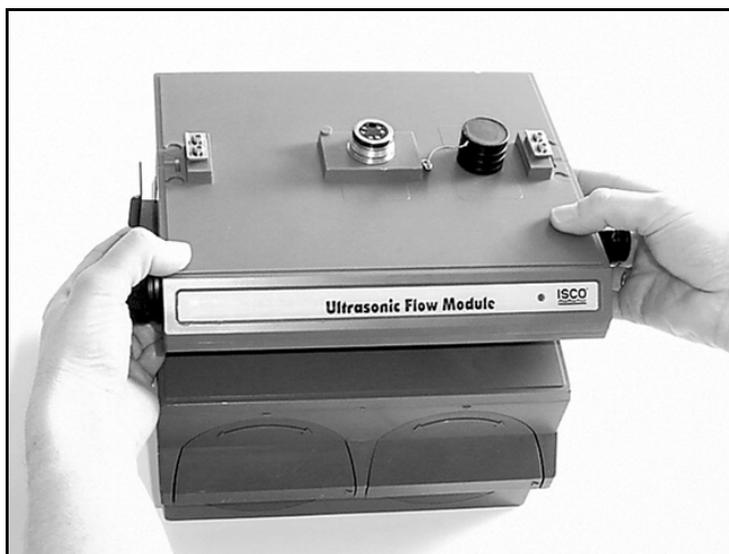
Figure 1-19 Battery Module - uncapping the connector

Place the handle on the Battery Module. The handle must rest towards the back of the module, otherwise its movement will be obstructed by the sensor cable, desiccant cartridge, and latches.



*Figure 1-20 Battery Module - inserting the handle*

Align the modules and gently press the 2110 module down onto the 2191 module.



*Figure 1-21 Aligning the modules*

Locate the latch extending from the left side of the 2110 module. Push in to slide the latch toward the right of the module.

Push →

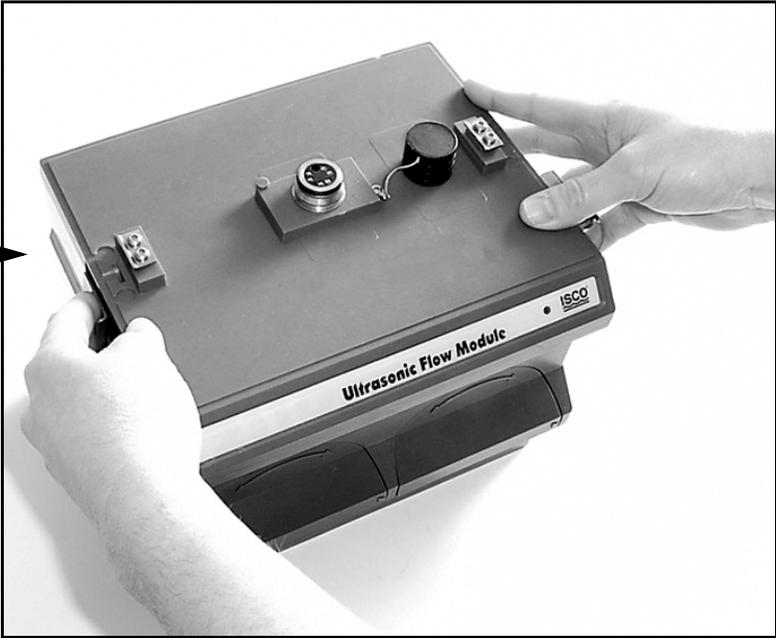


Figure 1-22 Locking the modules

## 1.9 Measuring Level with the Ultrasonic Level Sensor

The USLS consists of a 10 meter (32.8 ft) cable and a sealed, cylindrical enclosure containing an ultrasonic transducer and its supporting electronics. The sensor, when mounted or suspended over the flow stream, determines the stream's level by emitting an ultrasonic pulse and measuring the time it takes for the echo to return from the stream's surface. The transducer acts as both transmitter and receiver. The elapsed time is proportional to the distance to the surface.

The sensor is available with a measurement range of up to either 4 to 72 inches (0.1 to 1.8m) or 12 to 144 inches (0.3 to 3.6m).

### 1.9.1 Site Variables to Consider

**Distance** – To operate effectively, the sensor must be able to detect a returning echo under a variety of conditions. Although the signal strength of the echo depends on several factors — the distance from the transducer to the liquid surface, the humidity of the ambient air, or the amount of wind encountered by the sensor - distance influences the signal most.

**Ambient Temperature** – The USLS has a temperature probe in the enclosure to measure ambient air temperature. It uses the temperature probe in conjunction with microprocessor-based compensation to adjust level readings for air temperature variations.

**Acoustic Noise** – Acoustic and vibrational noise do not normally impair level measurement. However, it is possible for two adjacent sensors connected to different sites to measure incorrectly if they are mounted within a short distance of one another. One sensor may detect the echo of the other, causing erroneous readings. When connected to different sites, adjacent sensors should be spaced at least two times their full-scale measurement distance.

This precaution is not necessary for sensors connected to modules networked within a single site.

## 1.10 Technical Specifications

The following tables provide technical information about the 2110 Module and its related components:

- Table 1-5 lists the technical specifications of the 2110 Ultrasonic Flow Module
- Table 1-6 lists the technical specifications of the 2110 Ultrasonic Sensors
- Table 1-7 lists the technical specifications of the 2191 Battery Module
- Figure 1-23 and Table 1-8 list information about the 2110 Module's communication connector.

**Table 1-5 Specifications – 2110 Ultrasonic Flow Module**

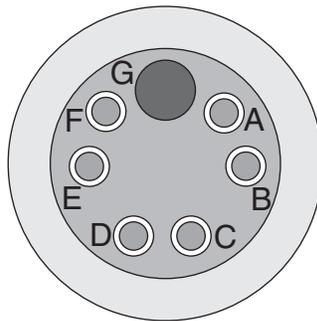
Size (H×W×D)	2.9 × 11.3 × 7.5 in.	7.4 × 28.7 × 19.1 cm
Weight	2.4 lbs	1.1 kg
Material	Molded polystyrene, 300 Series stainless steel	
Enclosure (self-certified)	NEMA 4X, 6P	IP 68
Power	7 to 16.6 VDC, Typical operating current 60 mA at 12 VDC, 0.3mA standby.	
	<div style="border: 1px solid black; padding: 5px;"> <input checked="" type="checkbox"/> <b>Note</b>                      The 2110, as well as some other system components including cables, cannot be connected in systems powered by more than 16.6 VDC. Refer to Section 2.3 for complete information.                 </div>	
Typical Battery Life <sup>a</sup> (one module)	Data Storage Interval 15 minutes	Alkaline Batteries 15 months Lead-Acid Batteries 2.5 months
Program Memory	Non-volatile, programmable flash; can be updated using PC without opening enclosure; retains user program after updating	
Number of Modules	Up to 4, field interchangeable	
Maximum Distance between Remote Modules	3300 ft	1000 m
Wiring between Modules	Twisted pair for communication, pair for power, gauge dependent on distance	
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	
Area-Velocity	When used in conjunction with a 2150 area-velocity flow module	
Total Flow Calculations	One independent, net positive or net negative, based on 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 readings at 15 minute intervals, plus total flow and input voltage readings at 24 hour intervals)	
Data Types	Level, flow rate, total flow, temperature, input voltage	
Storage Mode	Rollover with variable rate data storage based on level, velocity, flow rate, total flow, or input voltage	
Storage Interval	15 or 30 seconds; 1, 2, 5, 15, or 30 minutes; or 1, 2, 4, 12, or 24 hours	
Bytes per reading	5	
Setup and Data Retrieval	Serial connection to IBM PC or compatible computer with Isco Flowlink software	
Baud Rate	38,400	
Operating Temperature	0° to 140°F	-18° to 60°C
Storage Temperature	-40° to 140°F	-40° to 60°C

a. Specification for Eveready Energizer alkaline lantern batteries, model #529, Isco part #340-2006-02.

Table 1-6 Specifications – 2110 Ultrasonic Sensor		
Enclosure (self-certified, with connectors capped or mated)	NEMA 4X, 6P	IP68
Length	3.08 in.	7.8 cm
Diameter	1.9 in.	4.8 cm
Cable Length	32.8 ft.	10 m
Cable Diameter	0.3 in.	0.8 cm
Weight ( <i>including cable</i> )	2 lbs	0.9 kg
Level Measurement @ 20-25°C, 30-70% RH, Stable, non-stratified air		
Frequency	150 kHz, 95 kHz	
Cone Angle	8°	
Range <sup>a</sup>		
150 kHz	4 to 72 in. (0.1 to 1.8m)	
95 kHz	12 to 144 in. (0.3 to 3.6m)	
Accuracy	The greater of ±0.013 feet (3.96mm) or ±0.0084 feet (2.56mm) per foot (0.305m) from calibration point	
Resolution	0.01 in (0.25mm)	
Typical temperature error	± sum of 0.0042 ft + 0.00012 ft per degree from 68 °F	
Compensated temperature range	-4 to 149 °F (-20 to 65 °C)	
Temperature		
Operating	-4°F to 140°F	-20° C to 60°C
Storage	-40°F to 140°F	-40°C to 60°C
Humidity	0 to 95%, no condensation	
Materials		
Sensor	PVC (housing); Polyphthalamide (transducer surface)	
Cable	PVC Jacket	

a. Minimum range specification is not guaranteed at maximum operating temperatures. Zero deadband is possible for 150kHz sensor only, when installed with horizontal mounting bracket 60-2008-013.

Table 1-7 Specifications – 2191 Battery Module		
Size (H×W×D)	6.0 × 9.6 × 7.6 in.	15.2 × 24.4 × 19.3 cm
Weight ( <i>without batteries</i> )	3.2 lbs.	1.4 kg
Materials	High-impact molded polystyrene	
Enclosure ( <i>self-certified</i> )	NEMA 4X, 6P	IP68
Batteries	6V alkaline lantern or lead-acid lantern, quantity 2	
Capacity		
Alkaline Lantern Batteries	25 Ahrs	
Lead-acid Lantern Batteries	5 Ahrs	



**Communications Port  
 (upper connector shown)**

*Figure 1-23 2110 Module connector pins*

<b>Table 1-8 2110 Module Connector Pins</b>		
<b>Pin</b>	<b>Name</b>	<b>Description</b>
A	LONA	Neuron differential transceiver Data A
B	LONB	Neuron differential transceiver Data B
C	VIN+	Positive power supply voltage input (+12 VDC nominal)
D	VIN-	Negative power supply voltage input (0 VDC nominal)
E	RCVUP	PC data receiver RS-232 level input
F	XMTUP	PC data transmit RS-232 level output
G	Key	Aligns connector pins

# 2110 Ultrasonic Flow Module

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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.**

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

**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

## 2.2 Safety

Before installing, operating, or maintaining this equipment, it is imperative that all hazards and preventive measures are fully understood.

### 2.2.1 Site Conditions

The 2100 Series 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. These spaces are governed by OSHA 1910.146 and require a permit before entering.

 **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.**

## 2.3 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	
<b>2110</b>	<b>7-16.6 VDC</b>		N/A	
2101				
2103				
2102				10.2-16.6 VDC
2108				7-26 VDC
2105	7-26 VDC			
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.

## 2.4 Preparing for Installation

### 2.4.1 Locating the Site

The 2110 Flow Module 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.

#### *RF Interference*

Your instrument has been designed to operate under environments with some RF interference. If your installation is located near any source of radio frequencies, be aware that radio transmissions may interfere with the operation of your equipment. If changes are apparent, it is recommended that the equipment is moved to another location, or if possible, move the source of RF.

The 2110 sensor may produce RF interference with other equipment at 60 MegHz. Check the Declaration of Conformity at the end of this manual to see if there are known radio frequencies this equipment is susceptible to.

### 2.4.2 Channels Without a Primary Device

When the Ultrasonic Level Sensor (USLS) 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 sensor. The sensor should be located away from these disturbances to a point where the flow has stabilized. For best results, install the sensor where the flow is most uniform. Uniform flow is a condition where the water surface is parallel to the bottom of the channel.

### 2.4.3 Channels With a Primary Device

If the USLS 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.

### 2.4.4 2110 and Sensor Mounting Considerations

Ideal sites are easily accessible for service and data collection, while still providing protection for the 2100 Series devices. The 2100 Series 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 module is suspended inside a manhole. Suspending the module 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.

The sensor should be installed within 10 m (32.8 ft) of the module. Distances greater than 10 m require custom length cables. Call the factory or your representative.

## 2.5 Installation Check List

The following steps may be used as a guide to install a 2110 Module at a basic site. In the following example, a basic site is a single 2110 and Ultrasonic Level Sensor (USLS), and a Battery Module. Your steps may differ if you have selected an alternative power source, or if you are installing additional modules.

1. Prepare the Battery Module.
  - a. Install batteries (See section 2.6.1).
  - b. Inspect desiccant (2.6.2).
2. Inspect 2110 module desiccant (2.6.3).
3. Assemble the system.
  - a. Inspect all connectors and plugs. They should be clean and dry.
  - b. Connect the modules (2.6.4).
  - c. Attach the sensor cable to the 2110 (2.6.5).
4. Mount or suspend the sensor at optimal distance over the measuring point of the flow stream.
  - a. For wall, floor, and in-pipe mounting, use a bubble leveling device to ensure perpendicular aim of the signal before tightening the hardware to secure the sensor position.
5. Connect to the site with Flowlink software (2.9).
  - a. Create the site by Quick Connecting to the modules.
  - b. Set up the site and module settings.
  - c. Calibrate the level measurement.
6. Disconnect from the site and replace all protective caps.
7. Mount or suspend the modules (2.7).
8. Before leaving the site, ensure that all system components are positioned such that risk of submersion is minimized, and that all protective caps and plugs are in place (2.10).

## 2.6 Installation Procedures

The following sections provide instructions for the installation of the modules and connection of the sensor. For detailed instructions on sensor installation, see Section 2.7.

### 2.6.1 Install Module Batteries

The 2191 Module requires two 6V lantern-type batteries. The following batteries may be used in the battery module:

- commercially available 6VDC alkaline lantern batteries (Isco P/N 340-2006-02)
- rechargeable 6VDC lead-acid battery in a lantern-style case. This 5.0 ampere-hour battery can be ordered from Isco (P/N 60-2004-041).

To install batteries (refer to Figure 2-1):

1. Remove the battery door. To remove the door, turn it  $\frac{1}{4}$  turn counter-clockwise and pull it from the Battery Module.
2. Pull the lantern battery carrier out of the Battery Module.
3. Remove the old battery from the carrier.
4. Insert a fresh battery in the carrier. Slide in the battery so that the springs contact the plate inside the carrier.
5. Align the connectors and insert the battery carrier into the Battery Module.
6. Check the humidity indicator disk inside the door. (See section 2.6.2.)
7. Replace the door.

Repeat steps 1 through 7 to install the second battery.

#### **Note**

The batteries should always be replaced as a pair. Never mix old and new batteries.

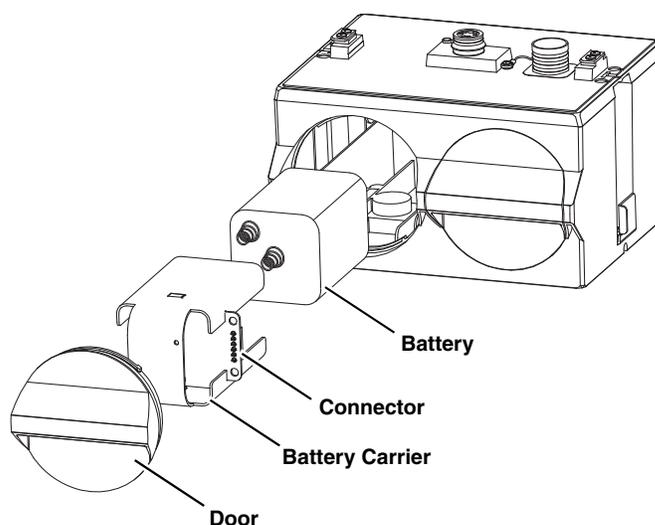
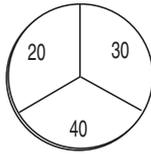


Figure 2-1 Installing a Battery

**2.6.2 Inspect the Desiccant –  
Battery Module**



A humidity indicator is mounted inside each battery cap on the Battery Module. The 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 turns pink, the Battery Module is no longer adequately protected and the desiccant must be replaced. Refer to section 5.4 for replacement instructions.

**2.6.3 Inspect the Desiccant –  
2110 Module**

A desiccant cartridge is inserted into the side of the 2110 Module. The cartridge is filled with silica gel beads that will indicate when they are saturated. When dry, the beads are blue. As the desiccant becomes saturated, the humidity levels will increase and the beads turn pink. If the entire length of the desiccant cartridge turns pink, the interior is no longer adequately protected and the desiccant must be replaced. Refer to section 5.4 for replacement instructions.

**2.6.4 Connecting the  
Modules**

The 2100 Series System is modular; you build the system by connecting modules together. The instructions in this section describe how to connect an 2110 to a Battery Module in its most basic configuration — by stacking the two modules. Either module may be stacked on the other, but you may find it more convenient if you place the Battery Module at the bottom of the stack. This keeps the heavier items lower in the stack, making it easier to transport or store.

Other modules may be attached to this stack to increase the site's functions. You can add many modules to the stack as long as each module uses a unique module name (Section 3.2.1), and as long as you observe the power requirements of the extra modules.

*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.

*Communication*

The computer running **Flowlink** communicates with the modules. With Flowlink, you can name the site, set up its operation, and adjust the level measurement. To assist with servicing, Flowlink will also display input power voltage (indicating remaining battery life) and collect diagnostic reports.

A **communication cable** connects the computer and site. The cable supports the data transfers between modules and computer.

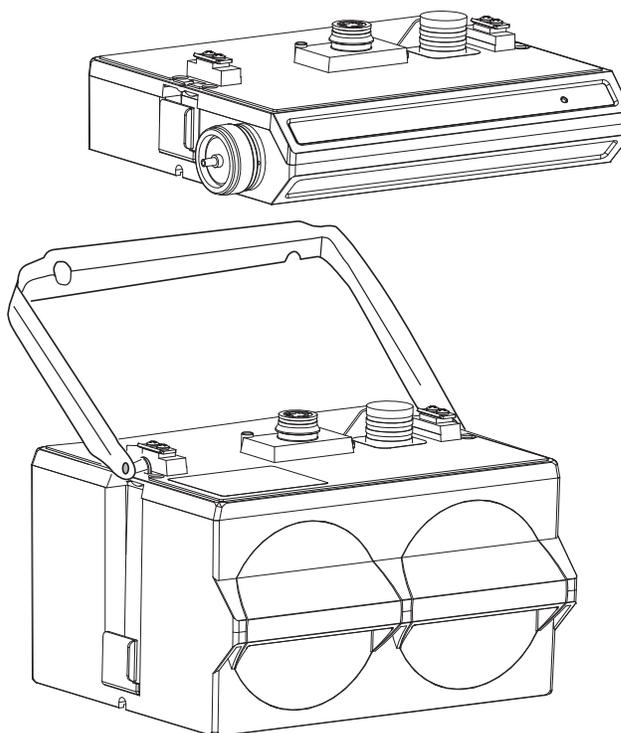


Figure 2-2 Assembling a basic system

To connect the 2110 and Battery modules, refer to the following instructions and Figure 2-2.

1. On the top of the Battery Module, remove the cap and stow it on the holder. This exposes the communication connector on the Battery Module.
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 (Isco P/N 202-1006-69) are supplied in the maintenance kit (60-2099-001).
  - b. Coat the O-ring's sealing surface with a *silicone* lubricant. A small amount of lubricant is included 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 several modules, it is recommended that you position the handle between the top two modules.)

4. Unlock the 2110's latch by pressing in on the latch release (right side).
5. Underneath the 2110, 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 2110 over the Battery Module. Align the connectors and lower the 2110 onto the Battery Module.
8. Unlock the 2110's latch by pressing in on the latch release (right side).
9. Firmly press the modules together and lock the 2110's latch (left side).

The Communications indicator will blink during the start-up routine to indicate the 2110 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.

### 2.6.5 Connecting the Ultrasonic Level Sensor

The sensor cable attaches to the sensor receptacle on the 2110. To connect the USLS (refer to Figure 2-3):

1. Remove the protective caps:
  - a. On the 2110, push down on the sensor release while pulling the protective cap from the receptacle.
  - b. On the USLS cable, pull the cap from the end of its connector.
2. Prepare the USLS connector:
  - a. Inspect the connector. It should be clean and dry. Damaged O-rings must be replaced. Spare O-rings (Isco P/N 202-1006-69) are supplied in the 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.

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

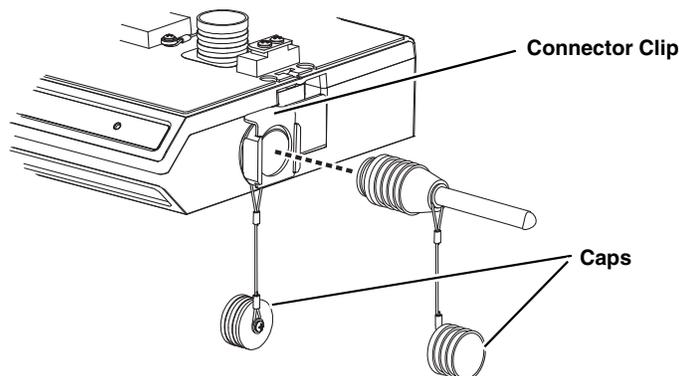


Figure 2-3 Connecting the USLS

## 2.7 Installing the Ultrasonic Level Sensor

Proper installation ensures reliable and accurate readings. Before installing the sensor, consider the following points:

- When installing the sensor, place the sensor over the center of the flow stream and align the sensor (or reflector plate) so that the ultrasonic signal is perpendicular to the surface of the flow stream. Misalignment can cause the echo to bounce off the channel walls, causing erratic or erroneous level readings.
- When installing the level sensor in a primary device, locate the sensor at the head-measuring point of the device.

The location of the sensor depends on the primary device because the head-measuring point is unique to each device. Refer to Table 2-2 for the typical measuring point for common devices. For more detailed information, refer to the *Isco Open Channel Flow Measurement Handbook* and to information provided by the device manufacturer.

If flow is measured by some other means — the Manning Equation or by calibrating a section of the flow channel, the head-measuring location varies with the hydraulic characteristics of the site and the method of level-to-flow conversion used. In open channel installation, where flow may exceed half of a full pipe, suspend the transducer at the midpoint between the pipe entrance and exit of the U-channel. This location normally produces the least turbulent flow.

**Table 2-2 Typical Measuring Points**

Device	Head-Measuring Point
Weirs	Upstream from the weir plate by at least 3 times the maximum head.
Parshall Flumes	1/3 of the way into the converging section.
Palmer-Bowlus Flumes	Upstream from the flume entrance bay at least half the pipe diameter.

- To minimize the effect of distance on the accuracy of the level readings, mount the level sensor at 1.5 inches above the maximum level anticipated for the channel, but no farther than the sensor's maximum range above the minimum level.
- Abusive handling will damage the ultrasonic transducer inside the sensor. Although the sensor will survive normal handling and installation, treat it with reasonable care.

### 2.7.1 Mounting Options

The Ultrasonic Level Sensor (USLS) can be mounted over the flow stream in various ways, depending on which method best fits the application.

Optional equipment is available from Teledyne Isco for wall, floor, suspension, and horizontal mounting (see the following sections in this manual). The sensor cable can be routed through user-provided conduit to the 2110.

The sensor can be mounted within the pipe, either for stand-alone flow measurement, or for redundant level measurement paired with an area velocity probe. This option is discussed in detail in Sections 2.7.5 through 2.7.8.

### 2.7.2 Wall Mounting

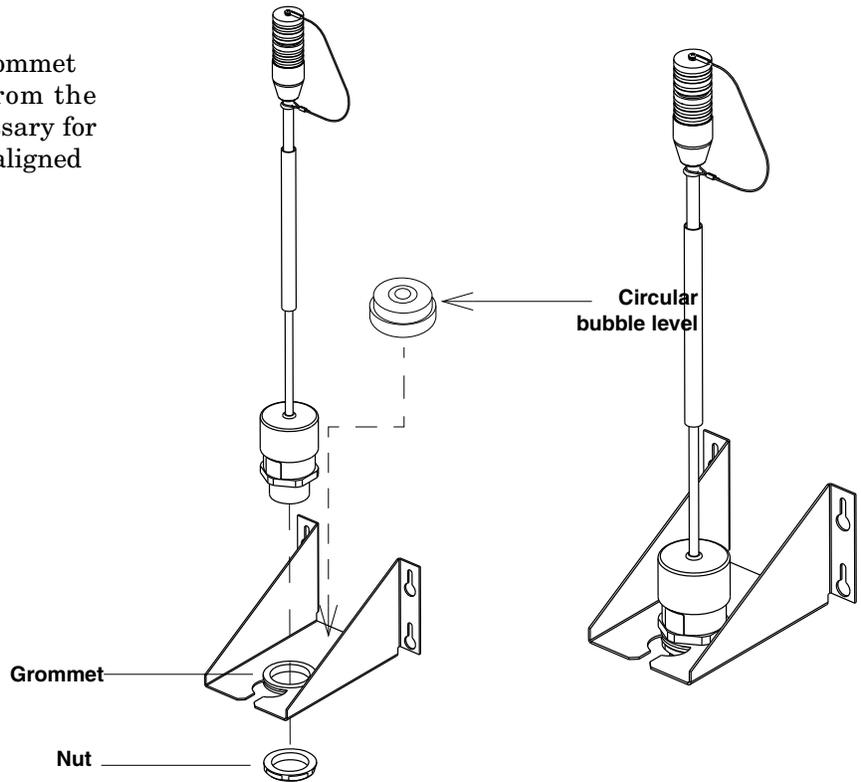
Wall mounting requires four drilled #8 anchors for securing the bracket to the wall. Ensure that the bracket is attached such that the sensor signal will be perpendicular to the flowstream surface. Insert the sensor down through the grommet as shown in Figure 2-4, and tighten the bottom nut with channel lock pliers.

 **Note**

The ultrasonic signal must be perpendicular to the surface of the flow stream before the sensor is secured in place. To ensure perpendicularity of the wall bracket, a user-supplied circular ("bullseye") or bar bubble level is recommended.

**NOTE:**

Do not remove the rubber grommet (Isco part #69-2003-608) from the mounting bracket; it is necessary for keeping the sensor properly aligned



*Figure 2-4 Sensor installation: Wall mounting*

### 2.7.3 Floor Mounting

Stabilize the floor mount base with drilled anchors or with a weighted object. Before tightening the two clamp screws and hinge bolt, ensure that the arm is extended to the proper location over the channel, and that the bracket is positioned such that the sensor signal will be perpendicular to the flowstream surface. Insert the sensor down through the grommet as shown below, and tighten the bottom nut with channel lock pliers.

Lock the mounting plate into the correct position by tightening the nut and hinge bolt that attach it to the horizontal bar.

**✓ Note**

The ultrasonic signal must be perpendicular to the surface of the flow stream before the sensor is secured in place. To ensure perpendicularity of the sensor mounting bracket, a user-supplied bar ("torpedo") bubble level is recommended.

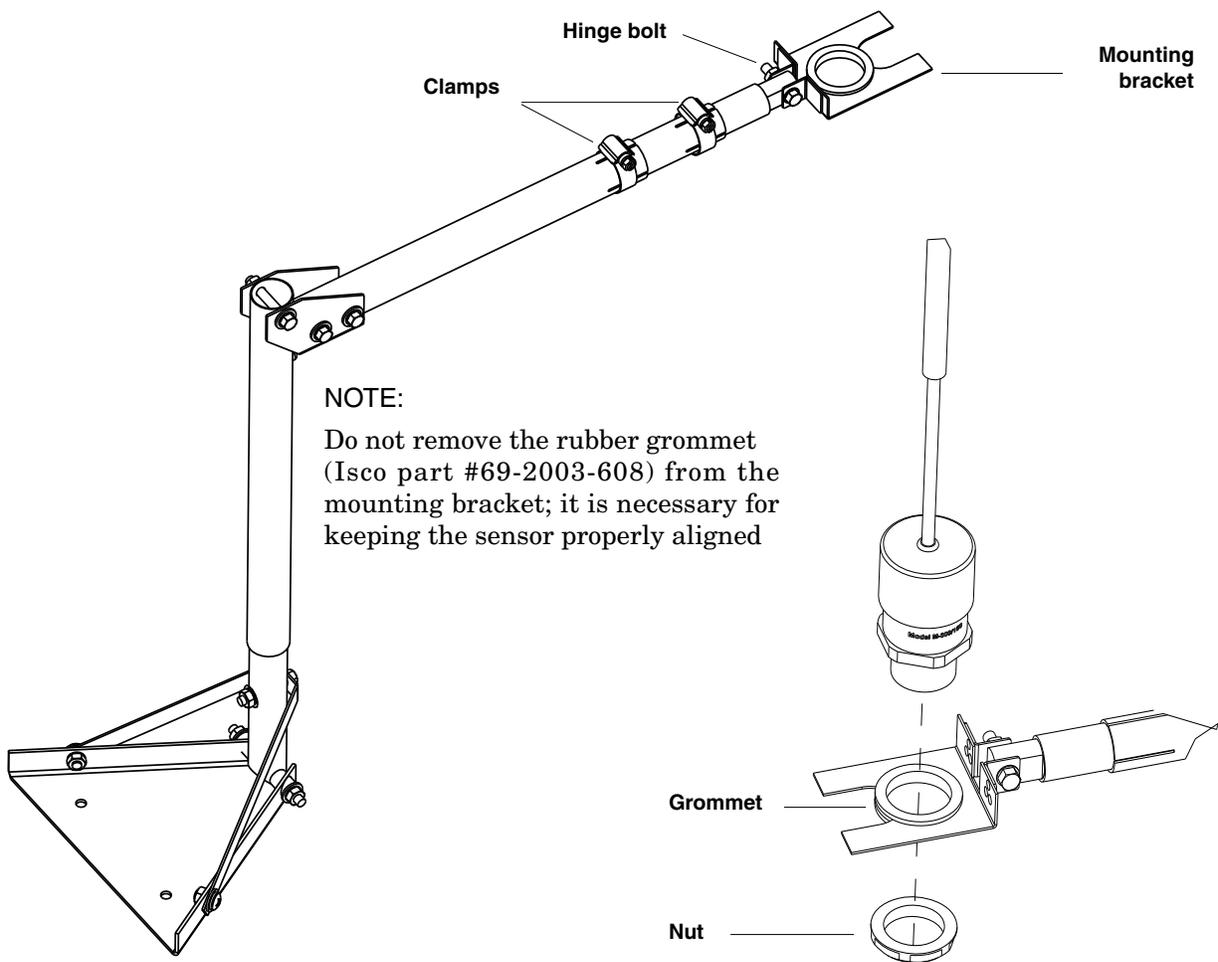


Figure 2-5 Sensor installation: Floor mounting

### 2.7.4 Suspending the Sensor

In a stable indoor environment, the sensor may be suspended over the flow stream from a stable location, such as the Isco spreader bar (part #60-3004-110). The sensor cable must be routed and secured without strain or pinching. The Isco cable clamp (part #60-3004-129) can be used to secure the cable to the suspension bar while removing strain from the sensor cable. The weighted cable straightener tube (part #60-2003-611) forces the sensor to hang plumb.

To assemble:

1. Feed the sensor connector into the bottom of the tube and out of the top.
2. Push the sensor head into the housing until fully inserted (may require slight twisting motions). The edges of the sensor cap and the housing should be flush (Figure 2-6).
3. Push the connector through the nylon nut. Put the washer and seal on the cable with the splits oriented away from each other (Figure 2-6), and screw the nut down over them onto the tube.

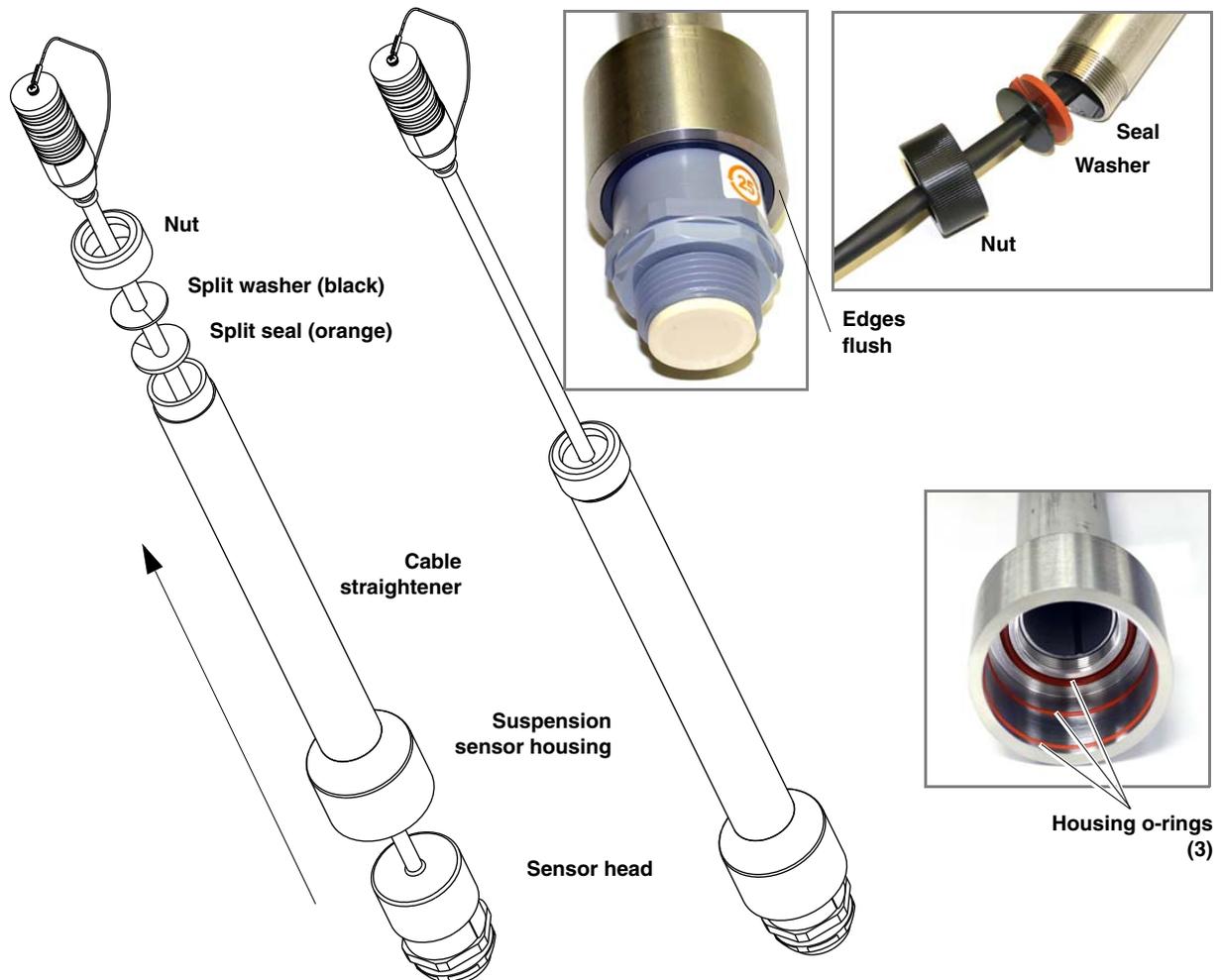


Figure 2-6 Sensor installation: Suspension

**✓ Note**

The black washer (Figure 2-6) is made of rigid plastic. Take care not to damage the cable (or your fingers) while putting it on.

**✓ Note**

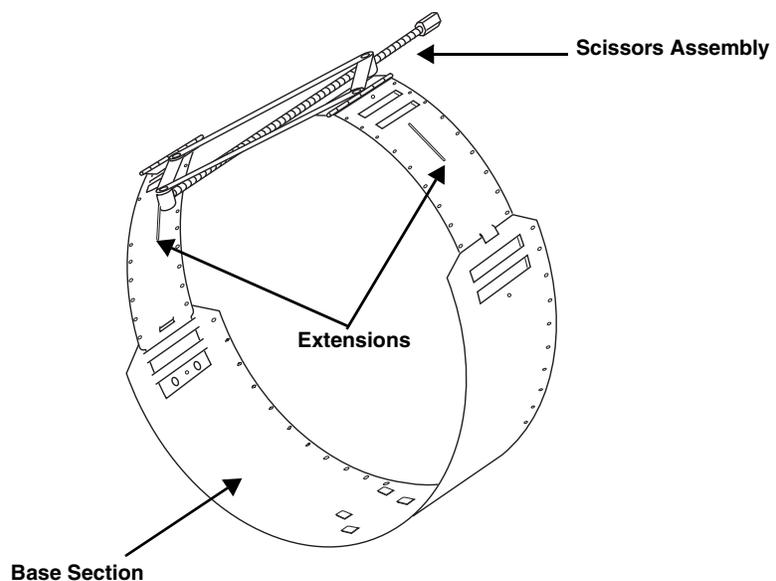
If the sensor requires excessive effort to install in the housing, remove it and ensure that the three rubber o-rings inside the housing are all properly seated in their respective grooves (Figure 2-6).

**2.7.5 In-Pipe Sensor Mounting for Diameters up to 80"**

In-pipe installation requires special hardware, including the sensor mount kit (60-2007-419), and the Isco Scissors Ring.

The adjustable Scissors Ring installs in large diameter pipes and manhole inverts from 16 inches to 80 inches in diameter. The Scissors Ring consists of a base section, two or more extension sections (usually), and a scissors section at the top for the dual purpose of supporting the sensor over the stream and expanding the entire assembly to tighten it inside the pipe.

The sensor mount kit contains hardware for mounting the sensor on the scissor mechanism. The scissors section contains a long screw that increases the length of the section as it is tightened. Section 2.7.6 details the sensor mount kit assembly and attachment of the sensor. Section 2.7.7 describes how the Scissors Ring can be used for installation of the USLS with an Area Velocity sensor for redundant measurement.



**Tightening the scissors assembly expands the ring to press firmly against the wall of the pipe, securing the ring.**

*Figure 2-7 Scissors ring adjustment*

 **Note**

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

*Tools required*

#2 Phillips screwdriver, 1/2" socket wrench, 5/16" socket wrench, 5/8" socket wrench, channel lock pliers, bar ("torpedo") level

*Additional recommended tools*

plumb weight, carpenter square

### 2.7.6 Sensor Mounting Kit

The following figures are a guide for assembly and installation of the sensor with a scissor ring.

1. Using a 5/16" socket wrench and a #2 Phillips screwdriver, attach the hinges to the sensor support brackets using #6 screws and locknuts.



*Figure 2-8 Assemble the hinges and brackets*

2. Attach the hinge and bracket assemblies to the scissor mechanism with the bracket clips facing opposite the hex drive, as shown in Figure 2-9.

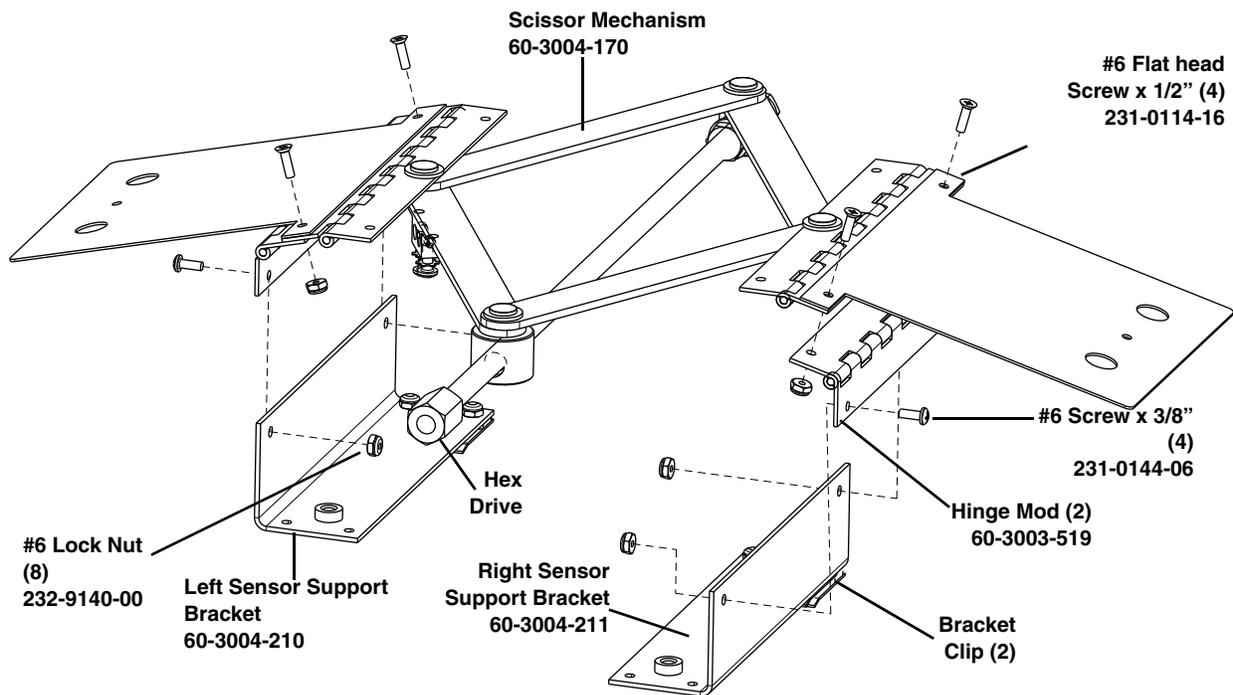


Figure 2-9 Assembling the sensor mount kit

**Note**

In the event that the scissors mechanism must be fully collapsed for the mounting ring to fit inside the pipe, the left and right sensor support brackets may be swapped straight across, facing outward (Figure 2-10), allowing more room. Both bracket clips **MUST** still point forward, away from the hex drive.

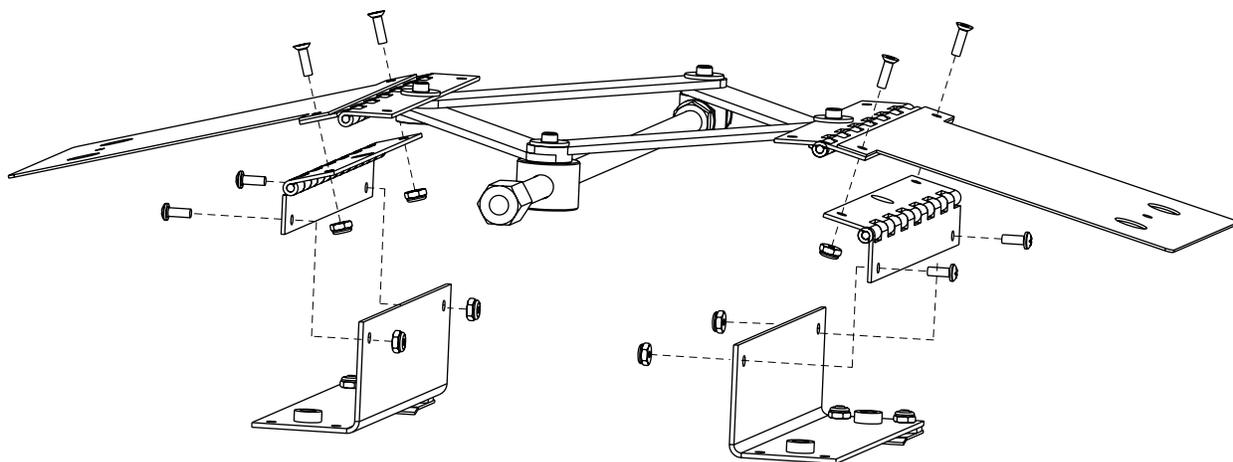
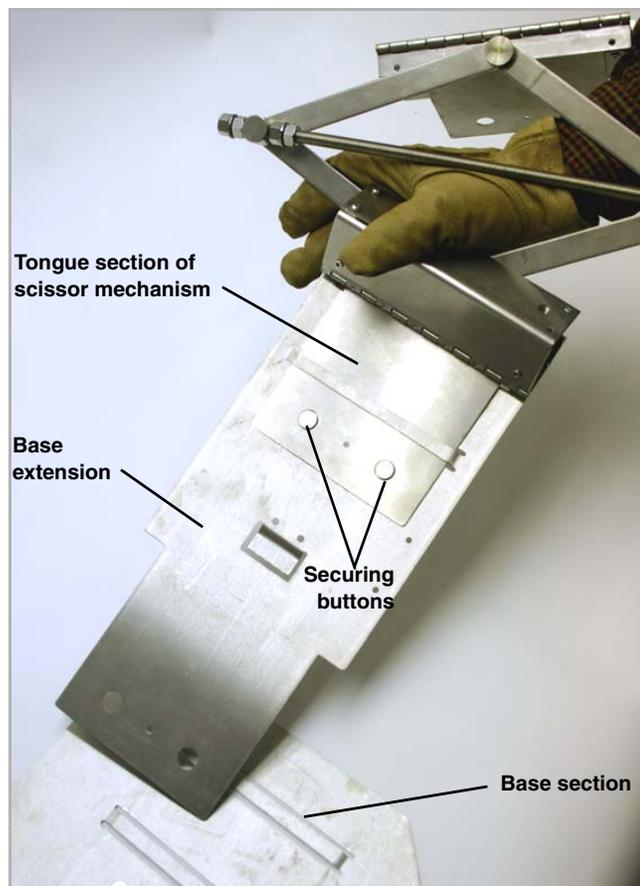


Figure 2-10 Sensor mount assembly with sensor support brackets reversed

3. Slide the tongue sections of the scissor mechanism into the slots and over the securing buttons on the base extensions (Figure 2-11) or at the ends of the base section (Figure 2-13).

**✓ Note**

To engage the slots with the buttons on the base section and/or extension, slightly bend the metal so that the buttons do not catch on the tongue's edge (Figure 2-12). It may also be necessary to use a hammer to very gently tap the rear edge of the hinge assembly to get the tongue fully into its slots.



*Figure 2-11 Connecting the scissor mechanism to a base extension*



Figure 2-12 Bend the base and/or extension to fully engage the buttons

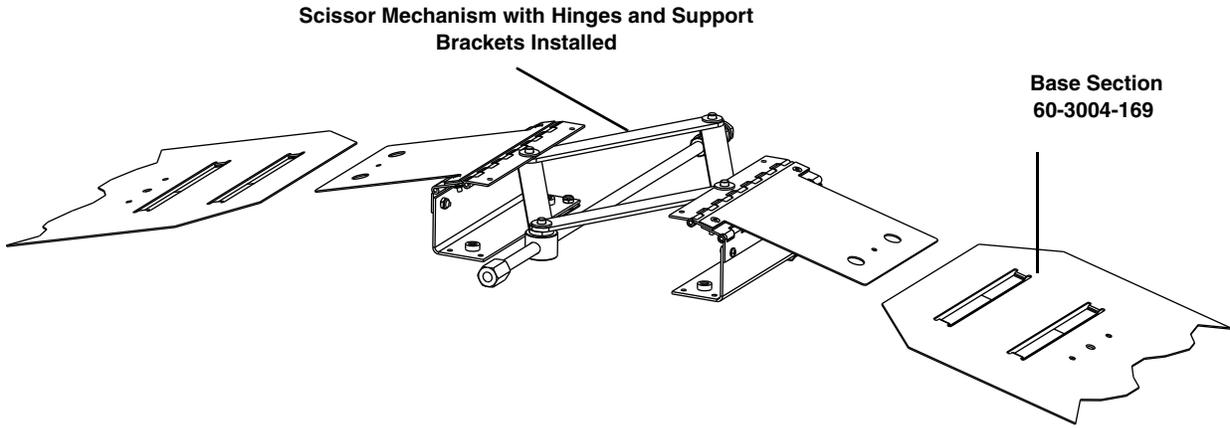
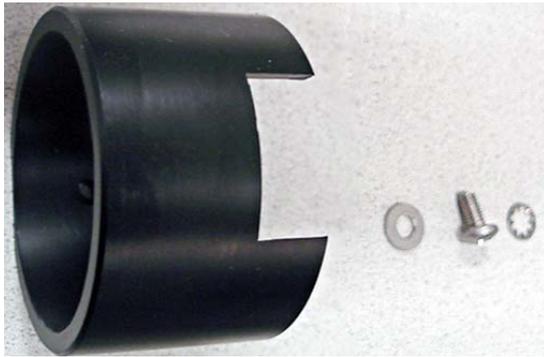


Figure 2-13 Attaching the scissor mechanism to the mounting ring



*Figure 2-14 Scissors mechanism connected with extension and base*

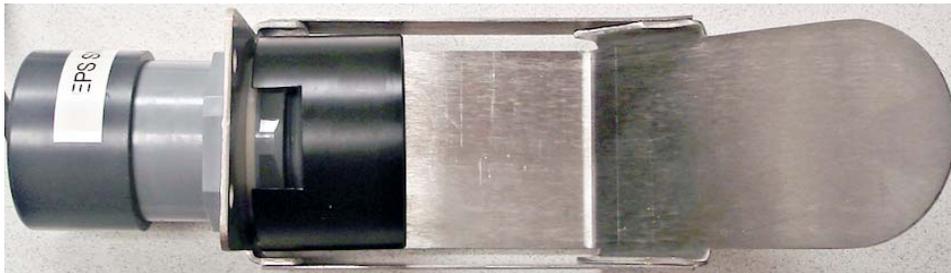
4. Insert the sensor through the grommet as shown in Figure 2-15 and 2-16, and tighten the threaded nut with channel lock pliers. Attach the horizontal mounting bracket to the mounting assembly as shown in Figure 2-15 and 2-17.



Sensor shield horizontal mount and screw set. Screw hole is on underside of mount (not visible).



Hardware assembled (top view)



Hardware assembled (bottom view)

Figure 2-15 Reflector plate mounting kit

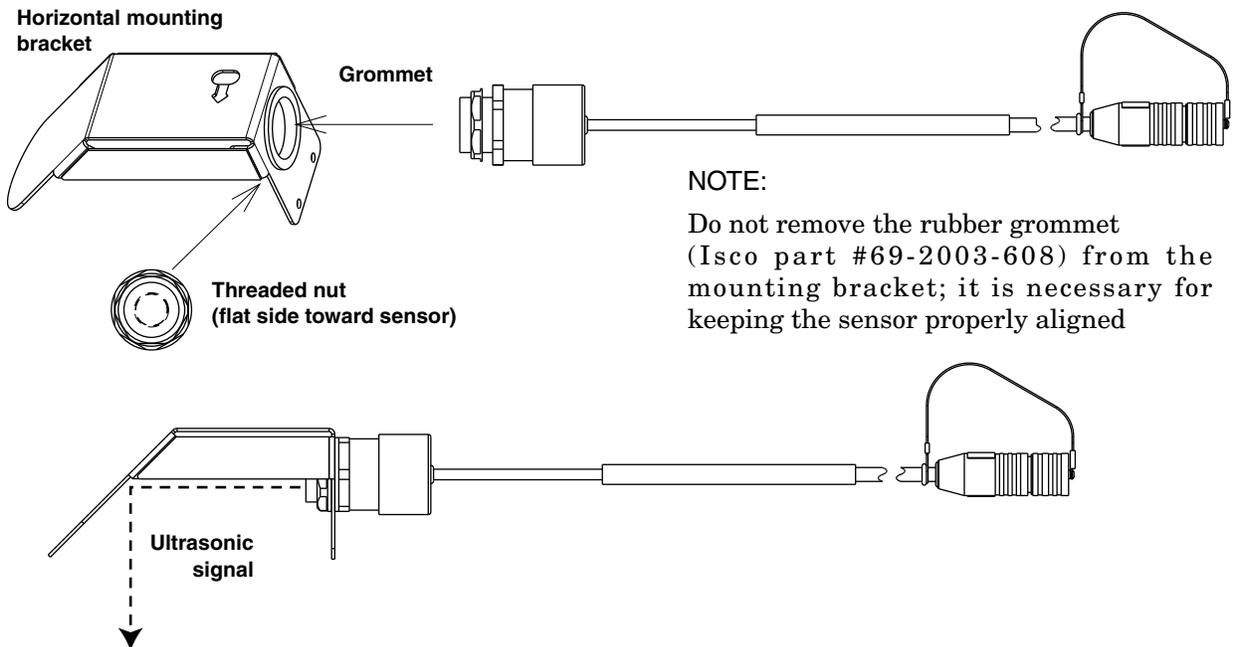
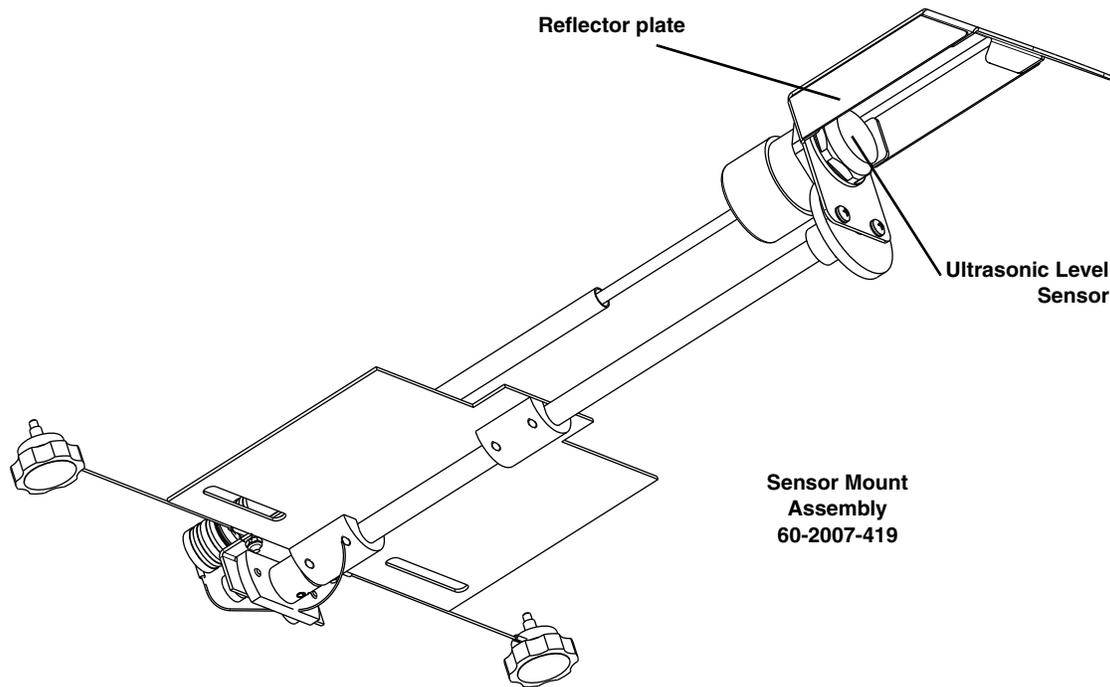
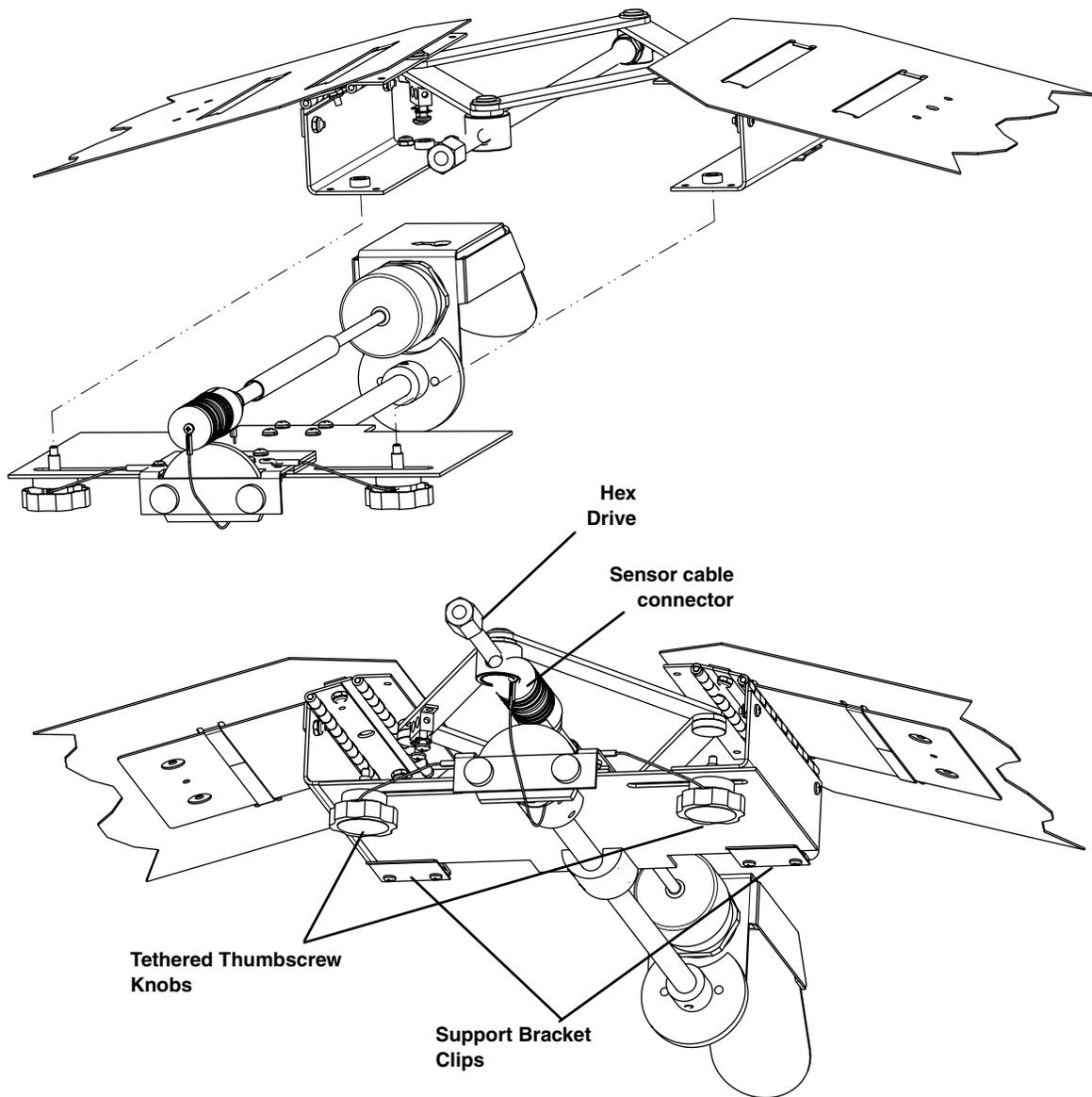


Figure 2-16 Attaching the sensor to the horizontal bracket



*Figure 2-17 Sensor attached to the mounting assembly*

5. Slide the Sensor Mount Assembly forward into the support bracket clips (Figure 2-18) with the sensor opposite to the hex drive.  
Install the two tethered thumbscrew knobs through the slotted underside of the sensor mount assembly and into the threaded inserts on top of the support brackets.

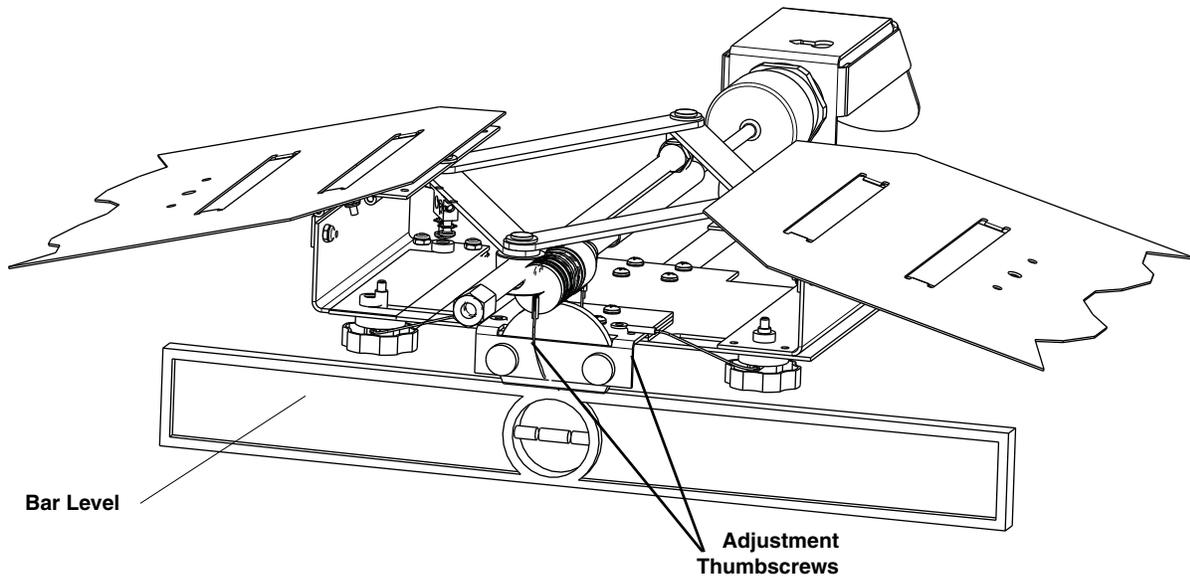


*Figure 2-18 Installing the sensor mount assembly on the scissors ring assembly*

6. Use a bar level to adjust the ultrasonic signal alignment, and tighten the adjustment thumbscrews (Figure 2-19). Secure the sensor cable to the scissor mechanism using the cable ties provided in the sensor mount kit.

**✓ Note**

The ultrasonic signal must be perpendicular to the surface of the flow stream before the sensor is secured in place. To ensure perpendicularity of the wall bracket, a user-supplied bar ("torpedo") bubble level is recommended.



*Figure 2-19 Adjusting sensor position*

7. Secure the ring in place by tightening the scissors mechanism with a  $\frac{5}{8}$ " socket wrench. Do not overtighten.

### 2.7.7 Redundant Flow Measurement

For redundant flow measurement installations where 2110 Ultrasonic Flow Modules are being used to duplicate the readings of 2150 Area Velocity Flow Modules in the flow stream, the Area Velocity Sensor is mounted on the base section of the scissors ring. The Ultrasonic Level Sensor is mounted at a point slightly ahead of the submerged Area Velocity Probe (Figure 2-20).

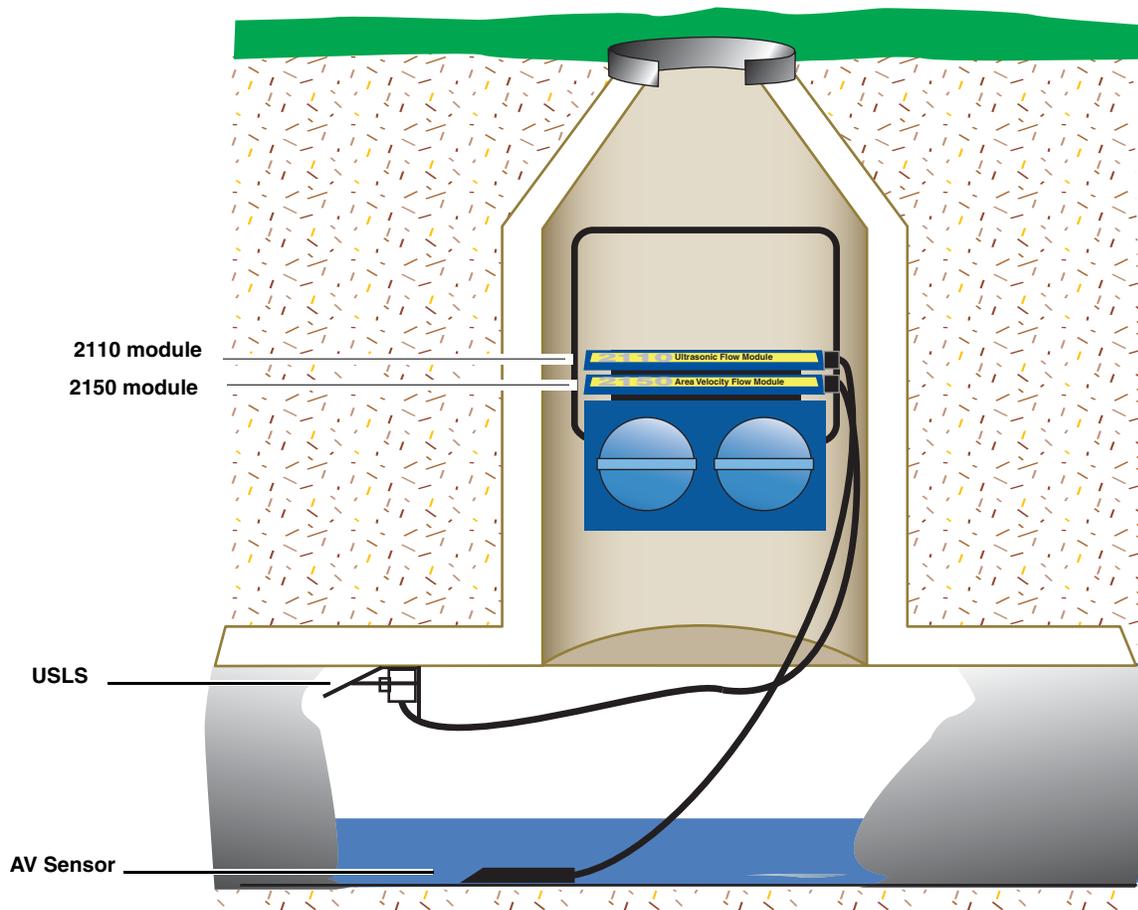


Figure 2-20 Sensor installation: In-Pipe mounting for redundant measurement  
(hardware not shown)

**2.7.8 In-Pipe Sensor  
Mounting: Large or  
Flat-Roof Channels**

For installations in pipes larger than 80 inches or flat-roofed channels, the Large In-Pipe mounting bracket (60-2003-622) can be attached directly to the top center of the pipe. This type of installation also requires the sensor mount kit (60-2007-419), described in Section 2.7.6. The bracket is fastened to the top of the pipe invert with user-supplied  $\frac{5}{16}$ " anchors.

Before assembling the system, hold the mounting bracket against the mounting surface and mark the locations for the anchors. Then attach the hinged brackets from the sensor mount kit to the large bracket, as shown in Figure 2-21. Finally, fasten the bracket in place at the top center of the pipe (Figure 2-22).

*Tools required*

$\frac{1}{2}$ " socket wrench, #2 Phillips screwdriver,  $\frac{5}{16}$ " socket wrench,  $\frac{5}{8}$ " socket wrench, channel lock pliers, bar ("torpedo") level

*Additional recommended  
tools*

plumb weight, carpenter square

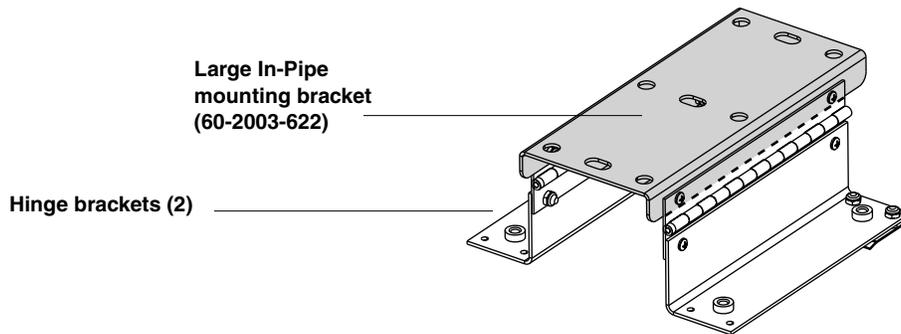


Figure 2-21 Preparing the Large In-Pipe bracket

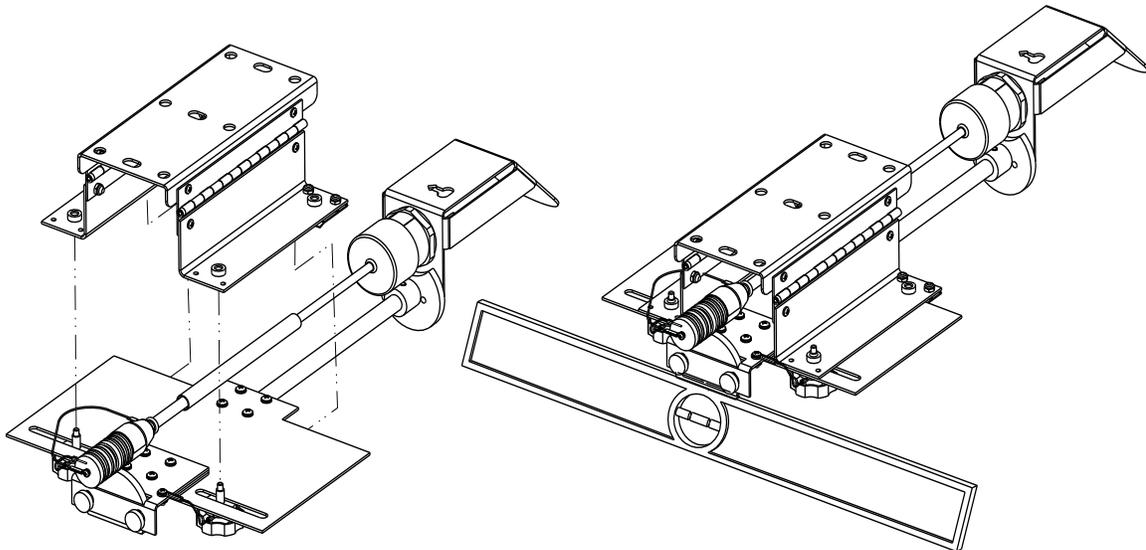


Figure 2-22 Assembling the Large In-Pipe mounting system

 **Note**

The ultrasonic signal must be perpendicular to the surface of the flow stream before the sensor is secured in place. To ensure perpendicularity of the wall bracket, a user-supplied heavy-duty bar ("torpedo") bubble level is recommended.

## 2.8 Minimizing Level Measurement Errors

In order to minimize measurement errors with the 2110, the following precautions should be observed in the installation of the ultrasonic level sensor. These are listed in the approximate order of their significance.

**Small Pipes and Channels** – Small circular pipes, narrow channels, and small flumes may also cause problems with ultrasonic distance measurement. Since the ultrasonic pulse expands outward at a beam angle of approximately 8° as it travels away from the ultrasonic level sensor, it may strike the sides of a channel or the sloping sides of a circular pipe with low flow. This can result in false echoes and incorrect level readings. The term “small channels” generally refers to U-shaped channels and pipe inverts 4" in diameter and smaller. The term “small flumes” generally refers to 1" and 2" Parshall flumes. It should be noted that the level measuring point for many types of flumes (Palmer-Bowlus, Leopold-Lagco, etc.) is not in the flume, but upstream in the invert of the pipe; for these types of flumes, the section of interest is in the pipe invert, not in the flume itself. Thus, care should be exercised in the use of 4" or smaller Palmer-Bowlus and Leopold-Lagco flumes.

**Determining Suitability** – The channel to be measured can be pre-qualified by a simple equation that will determine whether or not the channel is wide enough to allow correct positioning of the ultrasonic sensor:

$$\text{Minimum Width} = 0.14 \times D$$

...where D is the distance from the bottom of the ultrasonic level sensor to the minimum expected level. (0.14 is the tangent of 8°.)

**Avoid Temperature Differences** – Avoid installations where the ultrasonic level sensor will operate at a different temperature than the air between the level sensor and the flow stream through which the ultrasonic beam passes. The reason is that the temperature sensor mounted in the ultrasonic level sensor is intended to provide the flow meter with temperature readings taken from the surrounding air. If the ultrasonic level sensor operates at a different temperature than the surrounding air, the temperature compensation will be based on the temperature of the level sensor rather than the surrounding air.

**This will lead to significant errors.**

Temperature differences between the ultrasonic level sensor and the flow stream surface will lead to velocity errors because the ultrasonic level sensor is at a different temperature than the air. Also, air layers of different temperatures between the level sensor and the flow stream surface will cause an abnormal reduction in the strength of the ultrasonic pulse. (The 2110 is

designed to interpret the normal pulse correctly, not an abnormal one.) This may lead the flow meter to detect the wrong wave and introduce a wave detect error.

**Use a Sunshade in Outdoor Applications** – This situation is most likely to occur where the ultrasonic level sensor is installed outside and is directly exposed to the sun. In such installations, a sunshade should be provided to keep the sun from shining directly on the level sensor, as sunlight will raise the temperature of the level sensor's housing significantly higher than the surrounding air temperature.

**Avoid Submersion** – The sensor cannot work when submerged. The sensor is completely sealed, and temporary submersion in the flow stream will not damage it. However, prolonged submersion or submersion in dirty or greasy flow streams may coat the surface of the transducer with solid matter, causing the sensor to malfunction until cleaned.

**Avoid Wind Currents** – As much as possible, the ultrasonic level sensor should be installed in a location protected from air currents. Wind reduces the strength of the ultrasonic pulse and echo. This causes the 2110 to have difficulty detecting the proper wave in the echo, resulting in a wave detect error. In severe cases, it is possible for the 2110 to lose the echo completely.

One solution for protecting the ultrasonic wave from wind and other sources of interference is to construct a plastic shield around the sensor.

**Avoid Excessive Distances** – Although the ultrasonic level sensor cannot be mounted closer than 4" (2m sensor) or 12" (4m sensor) from the maximum level of the flow stream, it is recommended that the mounting be kept as close to the water surface as possible. The reason is that the error made by the flow meter in calculating the velocity of sound in the air is multiplied by the distance from the level sensor to the surface of the flow stream. Minimizing the distance will minimize the error.

**Calibrate at Expected Temperature** – You should calibrate the level reading under temperature conditions as near as possible to those expected during operation. For small changes of level, the error due to temperature is determined by the product of the distance (from the transducer to the flow stream surface) and the temperature change. Calibrating the 2110 at the same temperature as the expected operating temperature will minimize this error.

**Avoid Water Condensate** – The ultrasonic level sensor will not operate properly if the bottom surface collects water droplets. This may occur if water condenses on the transducer surface as a result of high ambient humidity.

**Avoid Foam, Oil, and Turbulence** – If the flow stream surface is absorbent (such as with foam) or very irregular (such as highly turbulent water), the ultrasonic echo may not be correctly reflected back to the ultrasonic level sensor. This can result in a false measurement or no measurement at all. If the foam is

reflective, the system will detect the top of the foam rather than the liquid surface. Also, if grease or oil is floating on the flow stream surface, it will be detected rather than the liquid surface.

## 2.9 Programming

After you have installed the sensor above the flow stream, the flow stream properties must be defined. To do this, connect to the 2110 with Isco Flowlink® software and define the stream properties in the 2110's program settings. These ensure that the system correctly reads the liquid level and converts the measured level to flow rate.

### **Note**

For maximum Flowlink capabilities, Teledyne Isco recommends using Flowlink 5.1 or later.

For additional programming information, refer to Section 3, which describes how to define level, flow conversion, and other properties.

For complete programming information, refer to the Flowlink Software user manual and Flowlink's Help files.

## 2.10 Final Installation Check

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

The Isco Spreader Bar (part #60-3004-110) is commonly used to suspend the modules in a manhole. Spreader bars are adjustable to fit openings from 22.5 to 48 inches (60 to 120 cm).

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

1. The modules should be positioned to minimize the risk of submersion.

### **Note**

To protect the 2110, the hydrophobic filter seals off the desiccator when it is exposed to excessive moisture. When sealed, the filter prevents irreparable damage. This single-use filter must be replaced once it becomes sealed. See Section 5.5.1.

### **CAUTION**

Prolonged submersion may permanently damage the modules and sensors.

2. Ensure that all of the protective caps are in place. Unused upper and lower communication connections must be capped. The caps prevent damage and terminate the communication lines. Caps for any communication connectors that are in use 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 (Isco part #202-1006-69).
3. Route all cables carefully without kinks or sharp bends. Keep any excess cable out of the flow to prevent debris from snagging and collecting. Protect them from traffic in the area.



# 2110 Ultrasonic Flow Module

## Section 3 Programming

### 3.1 Section Overview

This section describes how to set up the operation of a 2110 Module using Isco Flowlink® for software.

**Note**

For maximum Flowlink capabilities, Teledyne Isco recommends using Flowlink 5.1 or later.

*Flowlink Help*

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

Make the necessary wiring connections to allow your computer to communicate with the site. Figure 3-1 shows a connection using Isco's USB Communication Cable, Isco part #60-2004-507.

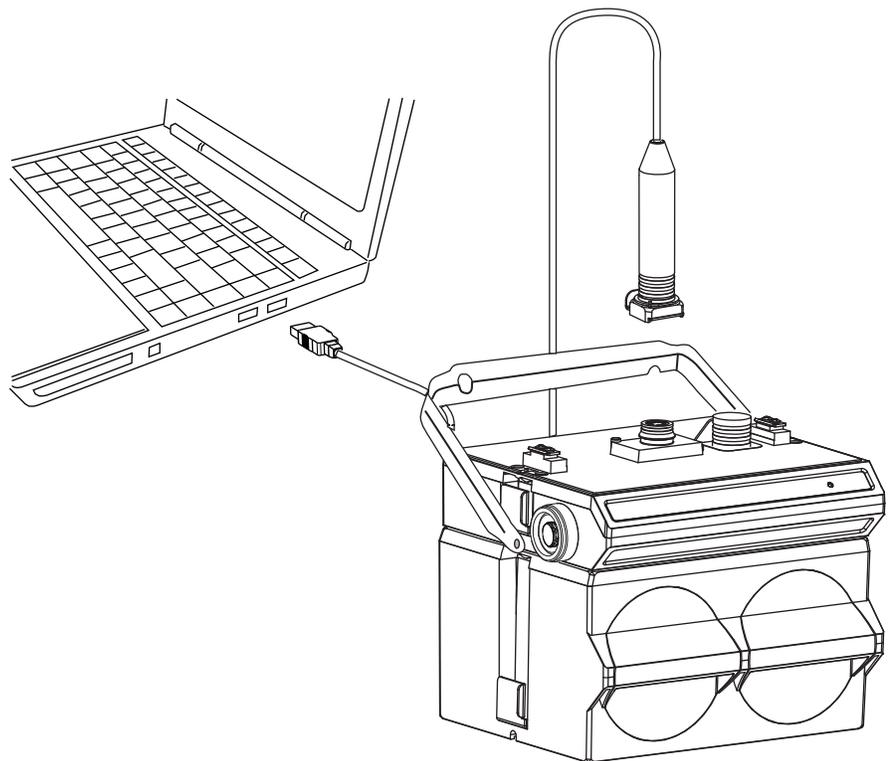


Figure 3-1 Connecting the 2110 to a computer

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.

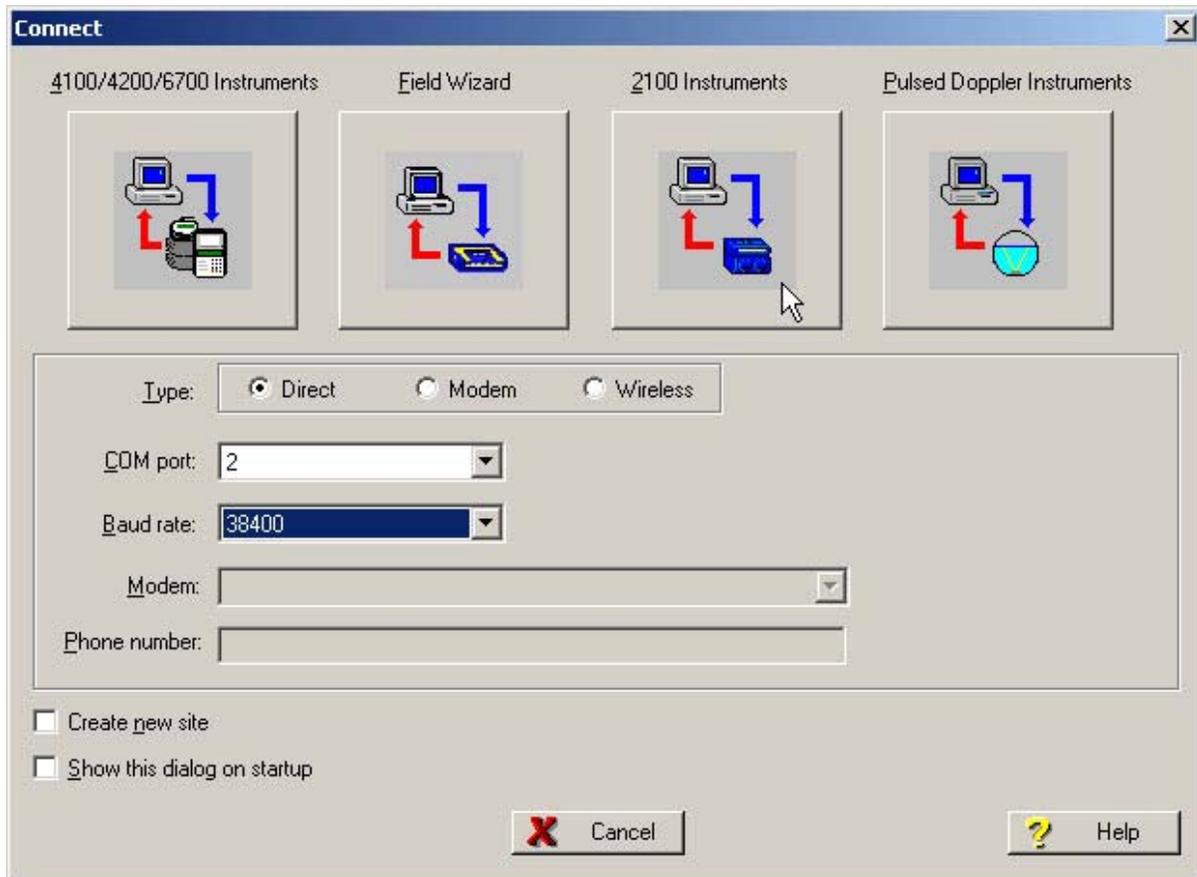


Figure 3-2 Flowlink connect screen

### 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 *Communication 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 Communications Resolution window lets you choose how the modules should be reconfigured 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 from 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 categorized using six tabs: Site Info, Devices, Measurements, Data, Measurement Properties, and a variable tab used to set up the various measurement types.

Some program settings are essential to the operation of a 2110 module and its attached USLS. The following program settings should always be verified when you are setting up a new site:

- **Level** – Enter a liquid level measurement to calibrate the level readings from the sensor (3.3.1).
- **Flow Conversion** – The 2110 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 (3.3.2).

These 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 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 3.3.3 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 3.3.4 and 3.3.5.

#### Changing a Setting

After modifying a setting as described in Sections 3.3.1 through 3.3.5, 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

A measurement of the actual liquid depth should be taken to calibrate the level readings. The value of this measured depth should be entered on the *Level* measurement tab in Flowlink.

#### **Note**

Level calibration of a newly installed sensor should be performed **only after**:

- a) the sensor is allowed to stabilize under site conditions (allow approximately one hour per 10 °F difference between storage and operating environments), and
- b) initial connection has been made with the site using Flowlink software, due to self-heating of the sensor, which occurs when the Measurements tab is displayed.

### 3.3.2 Flow Conversion

The 2110 is capable of calculating and storing flow rates using either area velocity conversion (if connected to a 2150 module) or level-to-flow rate conversion. Table 3-1 on the following page lists the available flow conversion methods. Flow conversions are defined in the *Flow Rate* measurement window in Flowlink, accessed by clicking on the “Flow Rate” label on the *Measurements* tab. To do this, select the *Conversion Type* that matches your application, then enter the required parameters in the field provided.

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.

**Table 3-1 Flow Conversion Methods**

Conversion Type		Device, Formula, or Table	Size or Parameters
Level to Flow	Weir	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
	Flume	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
	Flow Metering Insert	V-notch	6, 8, 10, 12 inches
		Round Orifice	6, 8, 10, 12 inches
	Manning Formula	Round Pipe	Slope, Roughness, Diameter
		U-Channel Pipe	Slope, Roughness, Width
		Rectangular Pipe	Slope, Roughness, Width
		Trapezoidal	Slope, Roughness, Bottom Width, Top Width
	Equation	Flow = 0.00*(Head <sup>0.00</sup> ) + 0.00*(Head <sup>0.00</sup> )	
	Level-to-Flow Rate Data Points	User-developed tables for level-to-flow rate	3 to 50 data points

**Table 3-1 Flow Conversion Methods (Continued)**

Area Velocity (when connected to a 2150 module)	Channel Shape	Area × Velocity	Round Pipe, U-Channel, Rectan- gular, Trapezoidal, Elliptical
	Level-to-area Data Points	User-developed Table	3 to 50 data points

### 3.3.3 Data Storage Rates

The data storage function of an 2110 can record level, velocity, flow rate, total flow (volume), temperature, and input voltage readings. The interval at which the 2110 stores the readings is called the *Data Storage Rate*. The 2110 is shipped with default storage rates of 15 minutes for the level 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 2110 can store data as fast as one 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 2110 can log data at a secondary rate when user-defined conditions have been met. For example, a 2110 can store level readings at a primary rate of 15 minutes, and a secondary rate of one minute when the level reading is greater than or equal to one 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.

### 3.3.4 Site Name

2100 modules are shipped with default names so that they 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           |

### 3.3.5 Module Name

2100 modules are shipped with default names so that they can immediately begin to communicate with Flowlink. You can change a Module name to a more descriptive name on the *Devices* tab in Flowlink. Keep in mind that the name must be unique among the other Module names connected at that site.

To help you match up a single module in a stack with its module name in Flowlink, the Devices tab includes an *Identify* button. To identify a module, highlight the Module Name, then click the Identify button. The module will turn on its front-panel light so that you can identify which module at the site corresponds with the highlighted Module Name.

Module names can be up to 20 characters long. Any character may be used in the name, except for those noted under *Site Name*, Section 3.3.4.

# 2110 Ultrasonic Flow Module

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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.

**Note**

For low power operation, we recommend connecting the module(s) to the computer using the straight-through cable (Isco part number 60-5314-529), which consumes less power, instead of our standard interrogation cable.

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.

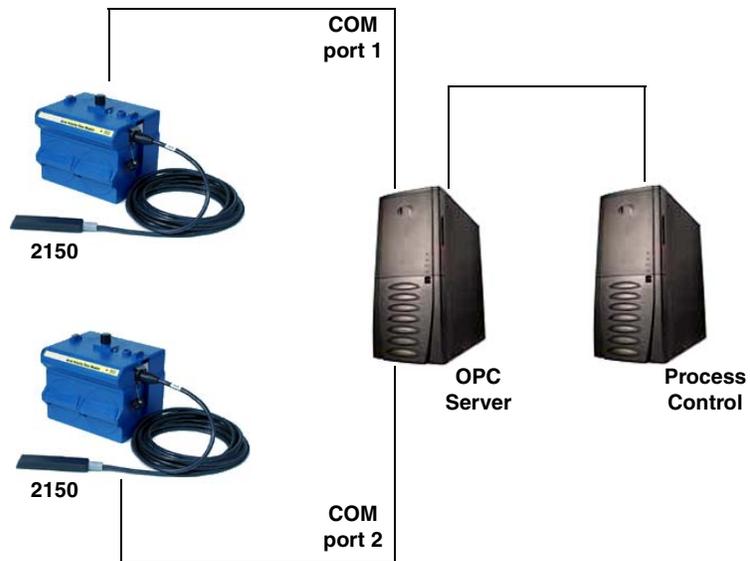


Figure 4-1 Configuration example

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.



# 2110 Ultrasonic Flow Module

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## Section 5 Maintenance

### 5.1 Maintenance Overview

This section explains the maintenance requirements of the 2110 Module and its sensor.

The 2100 Series 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:

- Battery power (section 5.3)
- Desiccant (section 5.4)

Maintenance intervals are affected by many variables. The number of modules powered by a Battery Module and 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.

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

- a single 2110 and Ultrasonic Level Sensor
- powered by a fresh pair of alkaline lantern batteries
- 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 2110'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

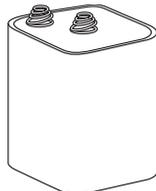
Many of the parts called out in the *Installation* and *Maintenance* sections of this manual are available in maintenance kits. Kit number 60-2009-400, which supports the 2110, contains O-rings for the connectors and desiccant cartridge, a hydrophobic filter, and a one-pound container of indicating silica gel desiccant.

Kit number 60-2099-001, which supports the Battery Module, contains O-rings for the connectors, gaskets for the battery doors, humidity indicators, and bags of desiccant.

Kit number 60-2009-401 supports the Ultrasonic Level Sensors.

You can order the kits by calling Teledyne Isco's Customer Service Department.

### 5.3 Batteries



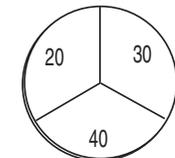
Lantern Battery

Input voltage can be monitored while you are connected to the 2110 with Flowlink. The 2110 also can record Input Voltage readings to closely track the power consumption. Keep in mind that battery discharge rates vary widely depending on the configuration of your system and its operating environment. Batteries should be replaced according to the instructions in Section 2.6.1.

The batteries should be replaced with:

- new 6V alkaline lantern batteries (Isco P/N 340-2006-02), *or*
- fully-charged lead-acid batteries (Isco P/N 60-2004-041).

### 5.4 Desiccant

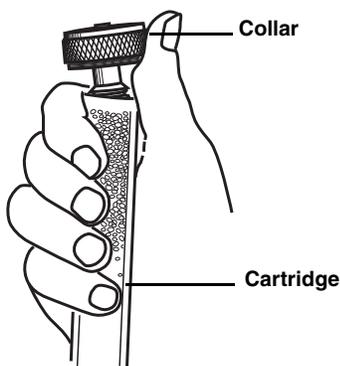


Battery Module  
Humidity Indicator

The 2100 System devices use desiccant to protect the internal components from moisture damage. In the 2110, a desiccant cartridge is used to dry the interior air. 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 Module uses desiccant bags to keep the interior of the case dry. The bags are located inside the battery caps. Attached to the inside face of each 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.

#### 5.4.1 Replacing the Desiccant: 2110 Module



The desiccant is contained in a cartridge located on the left side of the 2110. To remove the cartridge, unscrew the collar and slide the cartridge out of the 2110. The clear tube reveals the silica gel desiccant inside.

To replace the silica gel desiccant:

1. Hold the cartridge upright with the collar at the top.
2. As shown in the margin, push the collar off the cartridge.
3. Empty the saturated silica gel beads or granules.
4. Fill the tube with new (Isco P/N 099-0011-03) or reactivated (see section 5.4.3) silica gel desiccant.
5. Press the collar onto the tube.
6. Slide the cartridge into the 2110. Tighten the collar to seal the cartridge in place.

#### 5.4.2 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 (Isco P/N 099-0002-33) or reactivated (see section 5.4.3) bag.
4. Replace the retaining plate and secure it with the screws.

#### 5.4.3 Reactivating the Desiccant

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

 <b>CAUTION</b>
--

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 212° to 350°F (100° to 175°C) 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 245°F (120°C) for sixteen hours.

## 5.5 Other Maintenance

### 5.5.1 Hydrophobic Filter



209-0093-93

Other maintenance may be performed on the system components as needed. Sections 5.5.1 through 5.5.3 describe these activities.

If the module is in a humid location or submerged, a hydrophobic filter prevents moisture from entering the desiccant cartridge. Any amount of water will plug the filter and it must be rinsed with clean water and allowed to dry, or replaced.

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 requires frequent replacement, consider relocating the modules so that they are better protected.

### 5.5.2 Cleaning

The 2110 case may be cleaned with mild detergent and warm water. Before cleaning the module, ensure that all protective connector caps are in place.

The cable and outer surfaces of the sensor may be cleaned with mild detergent and warm water. Zep Powerhouse™ foam cleaner has also been found to be effective.

 <b>CAUTION</b>
--

Do not use a pressure washer, or abrasive pads or cleansers. This could result in damage to the sensor.

### 5.5.3 Sensor Cable Inspection

Erroneous level readings may not always indicate a fault inside the sensor body. A damaged cable can affect the operation of the sensor. Damaged cables cannot be spliced or repaired.

If the sensor cable is damaged, you must replace the entire assembly, as the sensor body, cable, and connector 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.

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 it cannot be removed or replaced.

## 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 2110 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 ultrasonic transducer, cable connections, and the electronic components of the USLS are encapsulated in plastic resin and are not user-serviceable. If any part of the USLS 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.



# 2110 Ultrasonic Flow Module

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## *Appendix A Replacement Parts*

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

Replacement parts are called out on the following pages for the 2110 Module, Battery Module, and Ultrasonic Level Sensor. Reference the call-out in the adjacent table to determine the part number for the item.

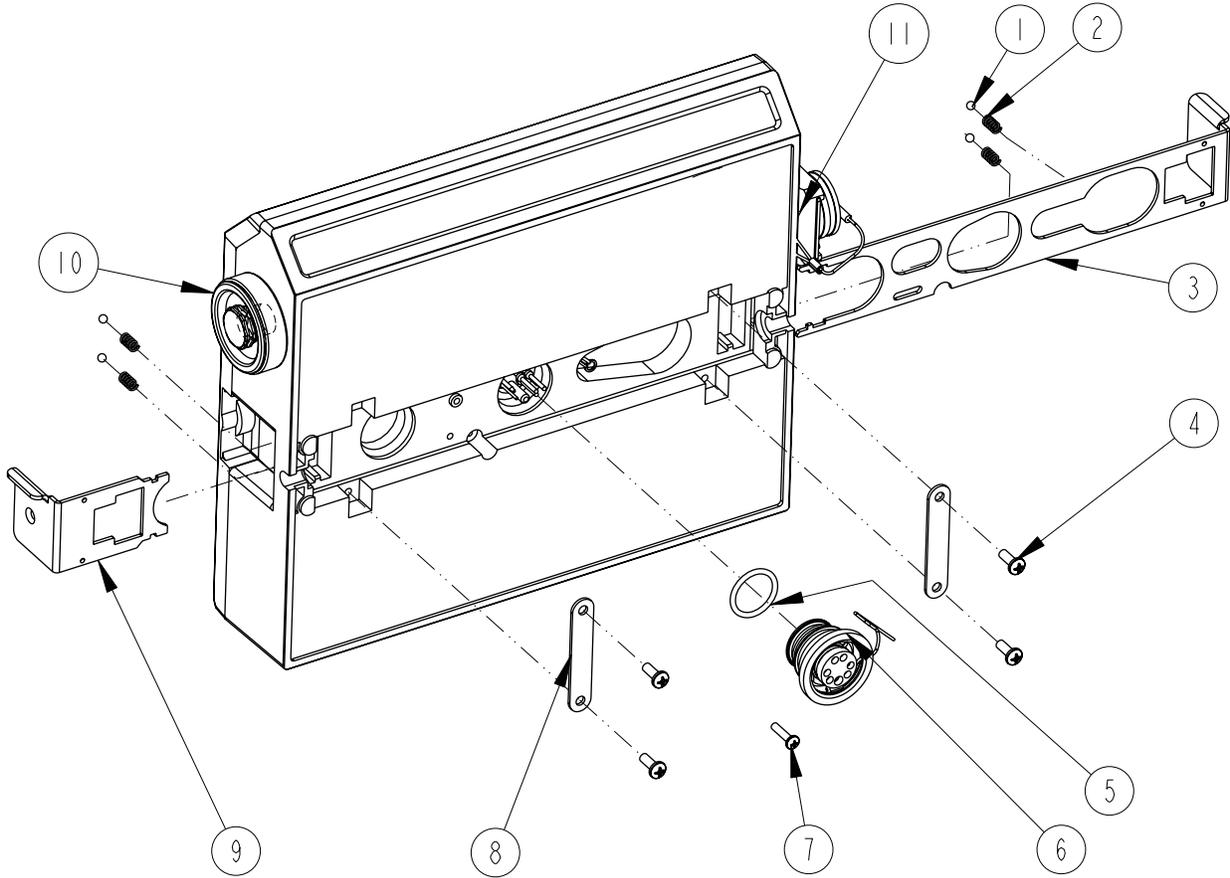
Replacement parts can be purchased by contacting Teledyne Isco's Customer Service Department.

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

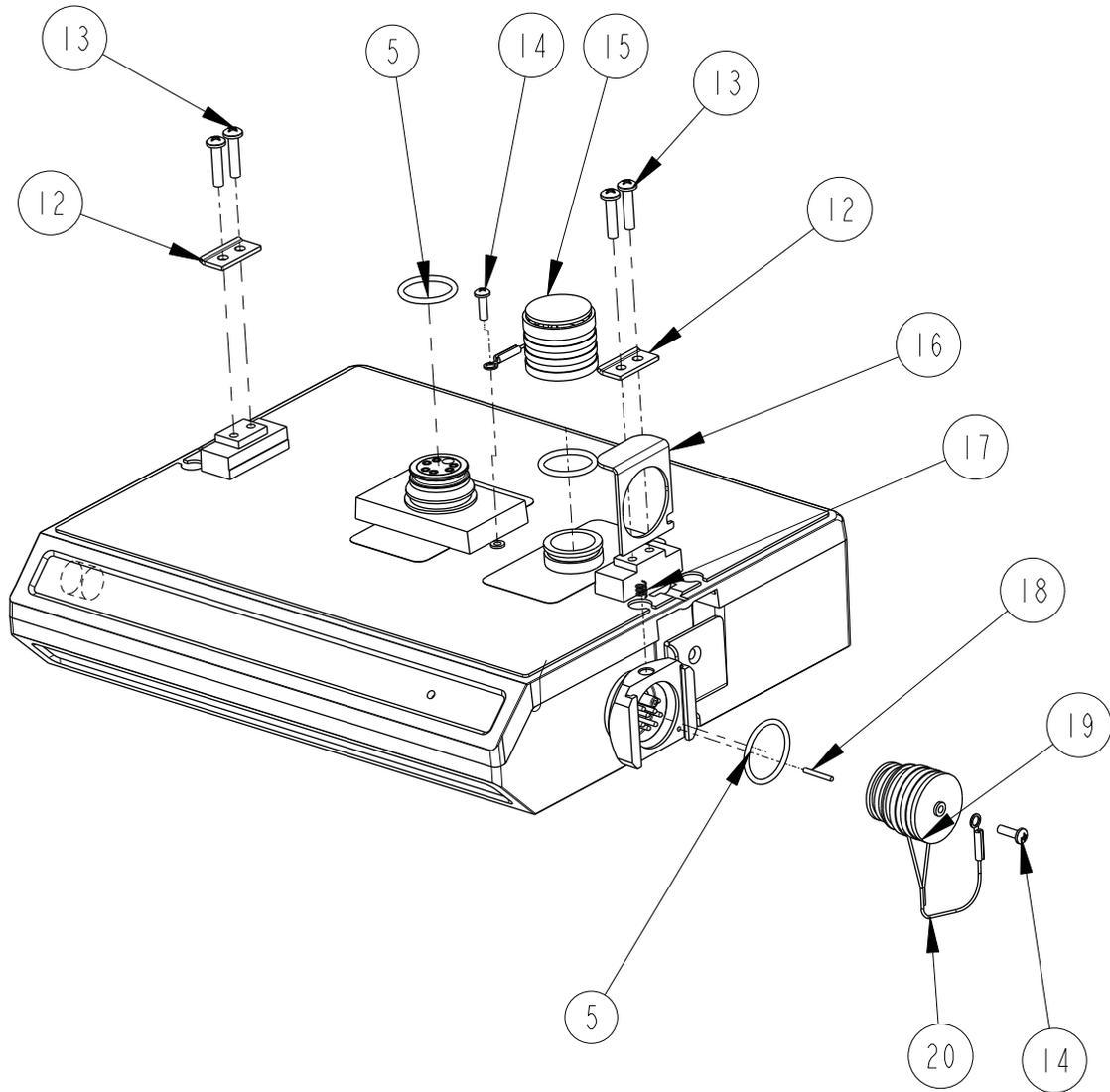
Phone: (800) 228-4373  
(402) 464-0231  
FAX: (402) 465-3022

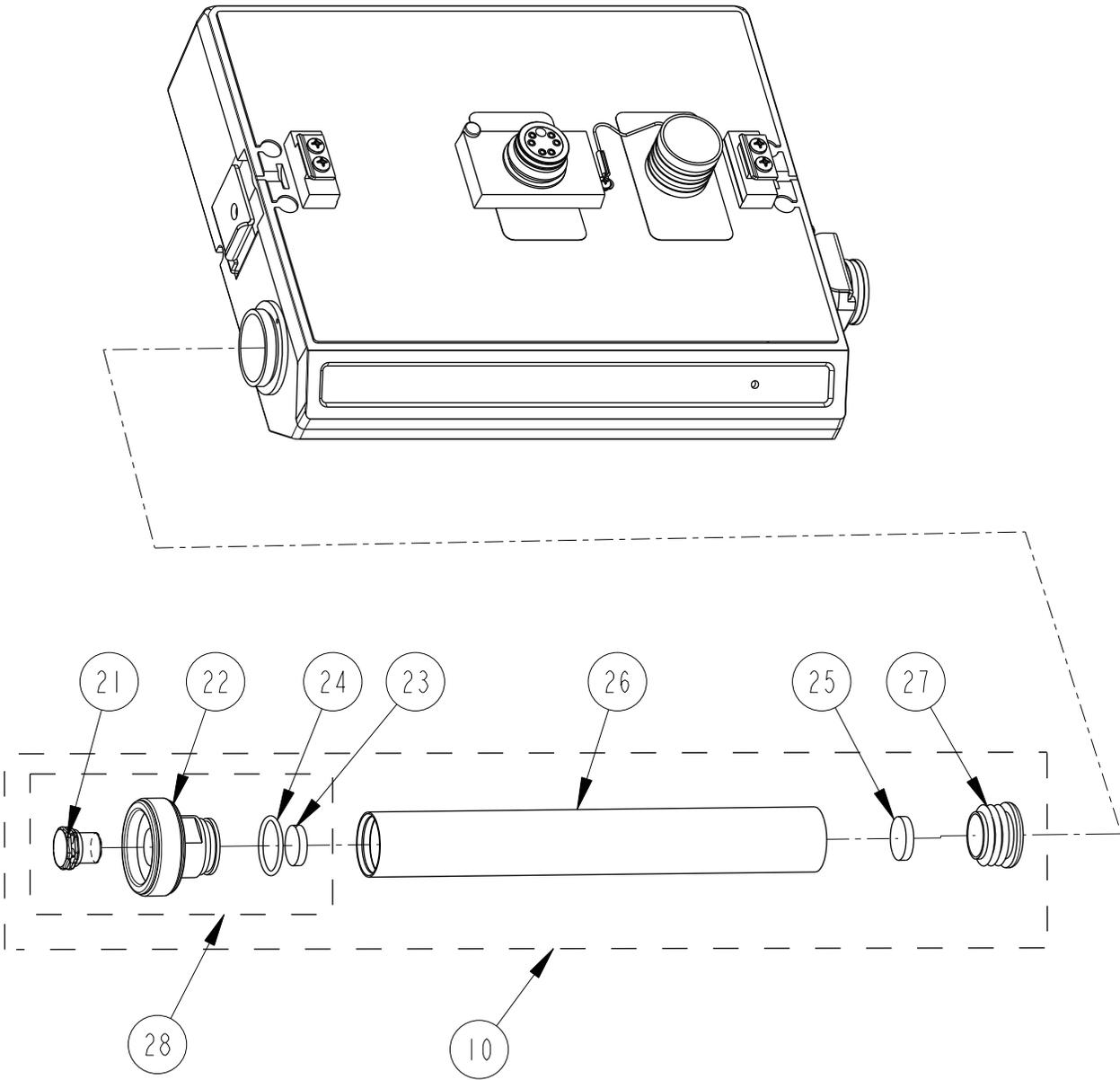
E-mail: [IscoInfo@teledyne.com](mailto:IscoInfo@teledyne.com)

2110 Ultrasonic Flow Module  
Appendix A Replacement Parts



DRAWING NO.  
602003112  
SHEET 1 OF 5

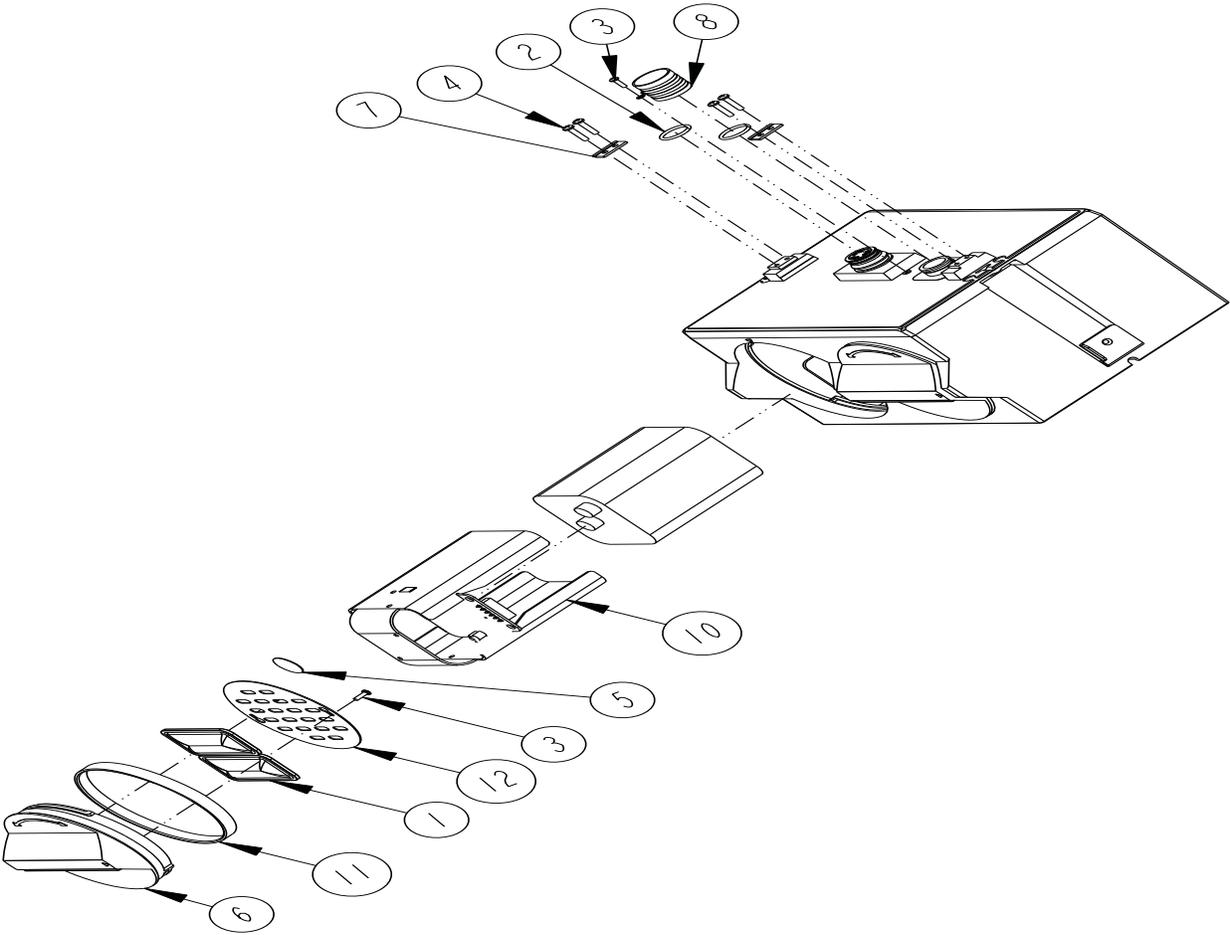




<b>REPLACEMENT PARTS LIST</b>		
<b>TELEDYNE ISCO, INC.</b>		
		602003112
		SHEET: 4 OF 5
		REV: E    DATE: 022008
ITEM NO.	PART NUMBER	DESCRIPTION
1	201900102	BALL .125 DIAMETER 316 SST
2	203011602	COMPRESSION SPRING, .022 DIAMETER WIRE, .31 FREE LENGTH
3	692003190	LARGE LATCH
4	231311206	SCREW, SELF TAP #6 X 3/8, PAN HEAD, PHILLIPS, SST
5	202100669	O RING, .669 ID, .079 CROSS SECTION, BUNA-N RUBBER
6	602004013	PLUG ASSEMBLY FEMALE CONNECTOR (includes item 5)
7	231611108	SCREW, SELF TAP, #4 X 1/2, PAN HEAD PHILLIPS, SST
8	602003022	LATCH HOLD
9	692003189	SMALL LATCH
10	602004016	DESICCANT ASSEMBLY (includes items 21 thru 27)
11	602004033	PLUG ASSEMBLY, FEMALE PROBE (includes items 5, 14, 19, and 20)
12	602003019	NODE CLIP
13	231514920	SCREW, SELF TAP, 6-19 X 5/8 TORX, PAN HEAD, SST
14	231310140	SCREW, SELF TAP, #4 X 3/8, PAN HEAD PHILLIPS, SST
15	602004012	CAP ASSEMBLY, MALE CONNECTOR
16	602003018	CONNECTOR CLIP
17	203011105	COMPRESSION SPRING, .026 DIAMETER WIRE, .31 FREE LENGTH
18	236410408	PIN, SPRING, 1/16 X 1/2 LONG SST
19	602003076	PLUG, FEMALE PROBE
20	692003172	CABLE, FEMALE PROBE PLUG
21	209009393	SCREW IN FILTER
22	602004265	DESICCANT CAP ASSEMBLY
23	692203300	FRIT, .620 DIA.
24	202500017	O-RING, .676 ID, .070 CROSS SECTION, BUNA-N RUBBER
25	692203301	FRIT, .670 DIA.
26	602003046	DESICCANT TUBE
NOTE: 1. For current prices and quotations on parts, contact Isco Service Department. 2. This list is subject to change without notice.		

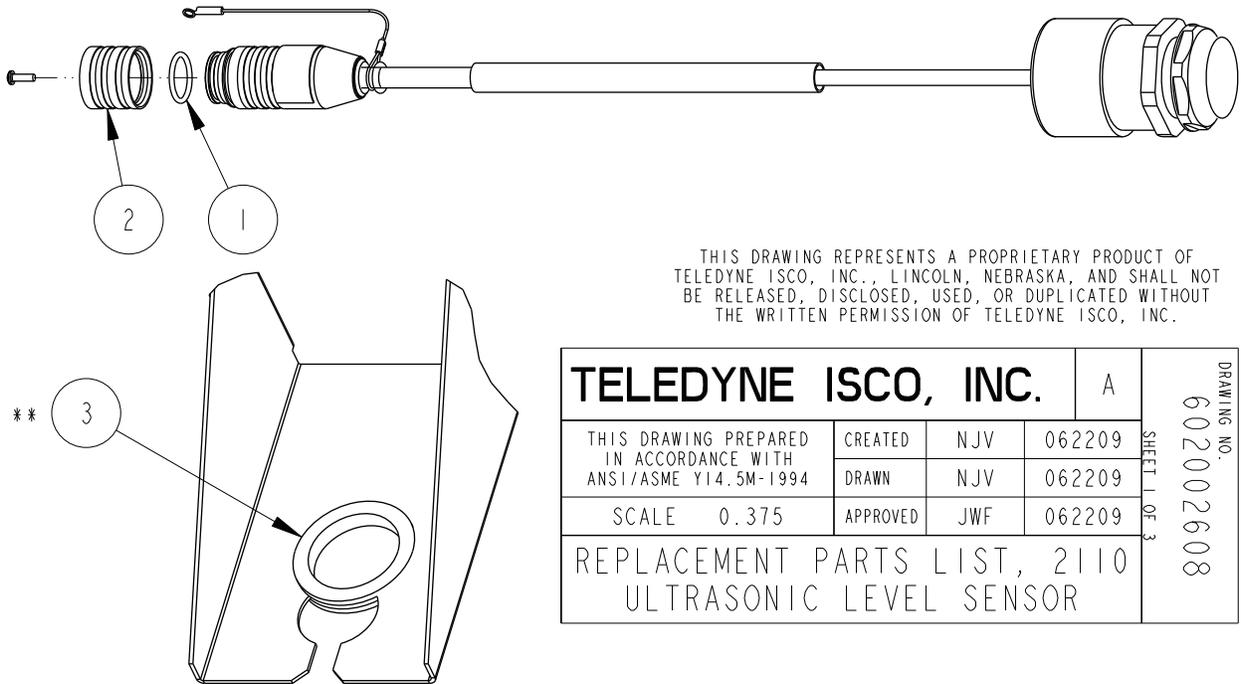


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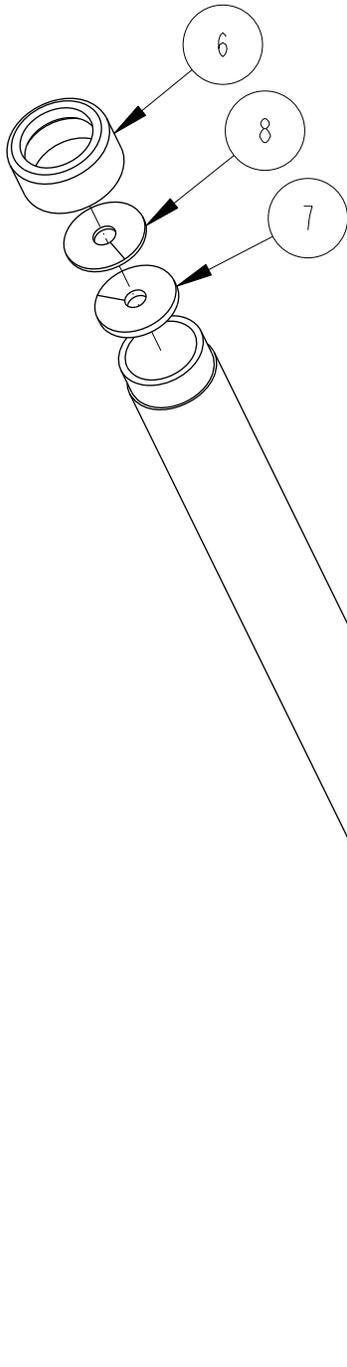


2110 Ultrasonic Flow Module  
 Appendix A Replacement Parts



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 TELEDYNE ISCO, INC., LINCOLN, NEBRASKA, AND SHALL NOT  
 BE RELEASED, DISCLOSED, USED, OR DUPLICATED WITHOUT  
 THE WRITTEN PERMISSION OF TELEDYNE ISCO, INC.

<b>TELEDYNE ISCO, INC.</b>			A	DRAWING NO. 602002608 SHEET 1 OF 3
THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI/ASME Y14.5M-1994	CREATED	NJV	062209	
	DRAWN	NJV	062209	
SCALE 0.375	APPROVED	JWF	062209	
REPLACEMENT PARTS LIST, 2110 ULTRASONIC LEVEL SENSOR				



THIS DRAWING REPRESENTS A PROPRIETARY PRODUCT OF  
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BE RELEASED, DISCLOSED, USED, OR DUPLICATED WITHOUT  
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<b>TELEDYNE ISCO, INC.</b>		A		DRAWING NO. 602002608	
THIS DRAWING PREPARED IN ACCORDANCE WITH ANSI/ASME Y14.5M-1994	CREATED	NJV	062209		SHEET 2 OF 3
	DRAWN	NJV	062209		
SCALE	0.375	APPROVED	JWF		062209
REPLACEMENT PARTS LIST, 2110 ULTRASONIC LEVEL SENSOR					



# 2110 Ultrasonic Flow Module

---

## *Appendix B Equipment and Accessories*

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

Equipment and 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

### **B.2 General Equipment**

2110 Ultrasonic Module . . . . .	60-2004-400
2110 Ultrasonic Sensor, 2m . . . . .	60-2004-419
2110 Ultrasonic Sensor, 4m . . . . .	60-2004-420
2110 Ultrasonic Module with 2m Sensor . . . . .	68-2000-072
2110 Ultrasonic Module with 2m Sensor and 2191 Battery Module . . . . .	68-2000-073
2110 Ultrasonic Module with 4m Sensor . . . . .	68-2000-074
2110 Ultrasonic Module with 4m Sensor and 2191 Battery Module . . . . .	68-2000-075

### **B.3 General Accessories**

Alkaline Lantern Battery . . . . .	340-2006-02
Rechargeable 6V Lead-acid Lantern Battery . . . . .	60-2004-041
Charging Adapter for 6V Lead-acid Lantern Battery . . . . .	60-2004-040
Power adaptor cable for Isco batteries and power packs, 2 ft standard, CE-rated . . . . .	69-2004-451
USB Communication Cable . . . . .	60-2004-507
RS232 Communication Cable . . . . .	60-2004-046
2100 Module to Module Extension Cable . . . . .	60-2004-056
Sampler Interface Cable . . . . .	60-2004-260
2108 Analog Output Module . . . . .	68-2000-010
Flowlink for Windows Software . . . . .	CALL
Spreader Bar <i>adjusts from 22.5 to 48 inches (57 to 122 cm)</i> . .	60-3004-110
2110 Instruction Manual . . . . .	60-2004-410

Teledyne Isco Open Channel Flow Measurement Handbook . . . . .	60-3003-041
Flow Module Maintenance Kit . . . . .	60-2059-001
Battery Module Maintenance Kit . . . . .	60-2099-001

**B.4 USLS Mounting  
Accessories**

The 2110 Ultrasonic Level Sensor can be installed using Teledyne Isco's standard-sized installation systems listed below.

Sensor Wall Mount Bracket. . . . .	60-2003-615
Sensor Floor Mount . . . . .	60-2004-611
Floor Mount Plate Assembly . . . . .	60-2008-011
<i>(Replaces plate assembly on existing floor mounts)</i>	
Sensor Ring Mount Kit . . . . .	60-2007-419
Sensor Mounting Bracket for Large Pipe. . . . .	60-2003-622
Sensor Horizontal Bracket . . . . .	60-2008-013
Sensor Suspension Mount . . . . .	60-2004-610
Sensor Cable Clamp. . . . .	60-3004-129
Calibration Target . . . . .	60-3004-143

*(For sensor calibration without manhole entry)*

# 2110 Ultrasonic Flow Module

---

## *Appendix C Material Safety Data Sheets*

### **C.1 Overview**

This appendix to the manual provides Material Safety Data Sheets for the desiccant used by the 2110 Ultrasonic Module and 2191 Battery Module.

Teledyne Isco cannot guarantee the accuracy of the data. Specific questions regarding the use and handling of the products should be directed to the manufacturer listed on the MSDS.

[101 Christine Drive](#)  
[Belen, New Mexico 87002](#)  
[Phone: \(505\) 864-6691](#)  
[Fax: \(505\) 861-2355](#)



---

MATERIAL SAFETY DATA SHEET -- September 28, 1998  
SORB-IT®  
Packaged Desiccant

---

### SECTION I -- PRODUCT IDENTIFICATION

<b>Trade Name and Synonyms:</b>	Silica Gel, Synthetic Amorphous Silica, Silicon, Dioxide
<b>Chemical Family:</b>	Synthetic Amorphous Silica
<b>Formula:</b>	SiO <sub>2</sub> .x H <sub>2</sub> O

### SECTION II -- HAZARDOUS INGREDIENTS

Components in the Solid Mixture

COMPONENT	CAS No	%	ACGIH/TLV (PPM)	OSHA-(PEL)
Amorphous Silica	63231-67-4	>99	PEL - 20 (RESPIRABLE), TLV - 5	LIMIT - NONE, HAZARD - IRRITANT "

Synthetic amorphous silica is not to be confused with crystalline silica such as quartz, cristobalite or tridymite or with diatomaceous earth or other naturally occurring forms of amorphous silica that frequently contain crystalline forms.

This product is in granular form and packed in bags for use as a desiccant. Therefore, no exposure to the product is anticipated under normal use of this product. Avoid inhaling desiccant dust.

### SECTION III -- PHYSICAL DATA

<b>Appearance and Odor:</b>	White granules; odorless.
<b>Melting Point:</b>	>1600 Deg C; >2900 Deg F
<b>Solubility in Water:</b>	Insoluble.
<b>Bulk Density:</b>	>40 lbs./cu. ft.
<b>Percent Volatile by Weight @ 1750 Deg F:</b>	<10%.

101 Christine Drive  
Belen, New Mexico 87002  
Phone: (505) 864-6691  
Fax: (505) 861-2355



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SORB-IT®  
Packaged Desiccant

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#### SECTION IV -- FIRE EXPLOSION DATA

**Fire and Explosion Hazard** - Negligible fire and explosion hazard when exposed to heat or flame by reaction with incompatible substances.

**Flash Point** - Nonflammable.

**Firefighting Media** - Dry chemical, water spray, or foam. For larger fires, use water spray fog or foam.

**Firefighting** - Nonflammable solids, liquids, or gases: Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fire in enclosed area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of the tank due to fire.

#### SECTION V -- HEALTH HAZARD DATA

Health hazards may arise from inhalation, ingestion, and/or contact with the skin and/or eyes. Ingestion may result in damage to throat and esophagus and/or gastrointestinal disorders. Inhalation may cause burning to the upper respiratory tract and/or temporary or permanent lung damage. Prolonged or repeated contact with the skin, in absence of proper hygiene, may cause dryness, irritation, and/or dermatitis. Contact with eye tissue may result in irritation, burns, or conjunctivitis.

**First Aid (Inhalation)** - Remove to fresh air immediately. If breathing has stopped, give artificial respiration. Keep affected person warm and at rest. Get medical attention immediately.

**First Aid (Ingestion)** - If large amounts have been ingested, give emetics to cause vomiting. Stomach siphon may be applied as well. Milk and fatty acids should be avoided. Get medical attention immediately.

**First Aid (Eyes)** - Wash eyes immediately and carefully for 30 minutes with running water.

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**NOTE TO PHYSICIAN:** This product is a desiccant and generates heat as it adsorbs water. The used product can contain material of hazardous nature. Identify that material and treat accordingly.

#### SECTION VI -- REACTIVITY DATA

**Reactivity** - Silica gel is stable under normal temperatures and pressures in sealed containers. Moisture can cause a rise in temperature which may result in a burn.

#### SECTION VII --SPILL OR LEAK PROCEDURES

Notify safety personnel of spills or leaks. Clean-up personnel need protection against inhalation of dusts or fumes. Eye protection is required. Vacuuming and/or wet methods of cleanup are preferred. Place in appropriate containers for disposal, keeping airborne particulates at a minimum.

#### SECTION VIII -- SPECIAL PROTECTION INFORMATION

**Respiratory Protection** - Provide a NIOSH/MSHA jointly approved respirator in the absence of proper environmental control. Contact your safety equipment supplier for proper mask type.

**Ventilation** - Provide general and/or local exhaust ventilation to keep exposures below the TLV. Ventilation used must be designed to prevent spots of dust accumulation or recycling of dusts.

**Protective Clothing** - Wear protective clothing, including long sleeves and gloves, to prevent repeated or prolonged skin contact.

**Eye Protection** - Chemical splash goggles designed in compliance with OSHA regulations are recommended. Consult your safety equipment supplier.

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Packaged Desiccant

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**SECTION IX -- SPECIAL PRECAUTIONS**

Avoid breathing dust and prolonged contact with skin. Silica gel dust causes eye irritation and breathing dust may be harmful.

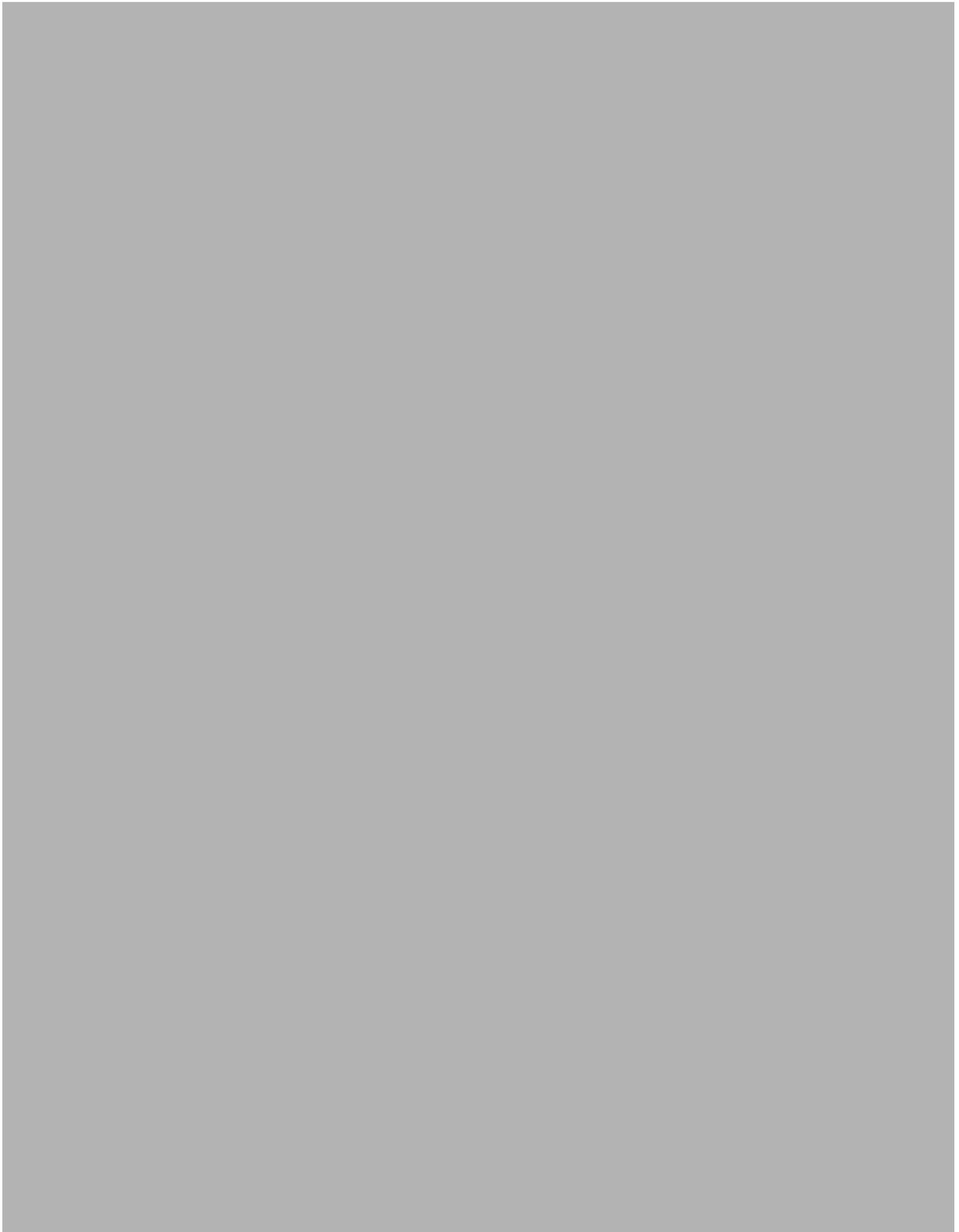
\* No Information Available

HMIS (Hazardous Materials Identification System) for this product is as follows:

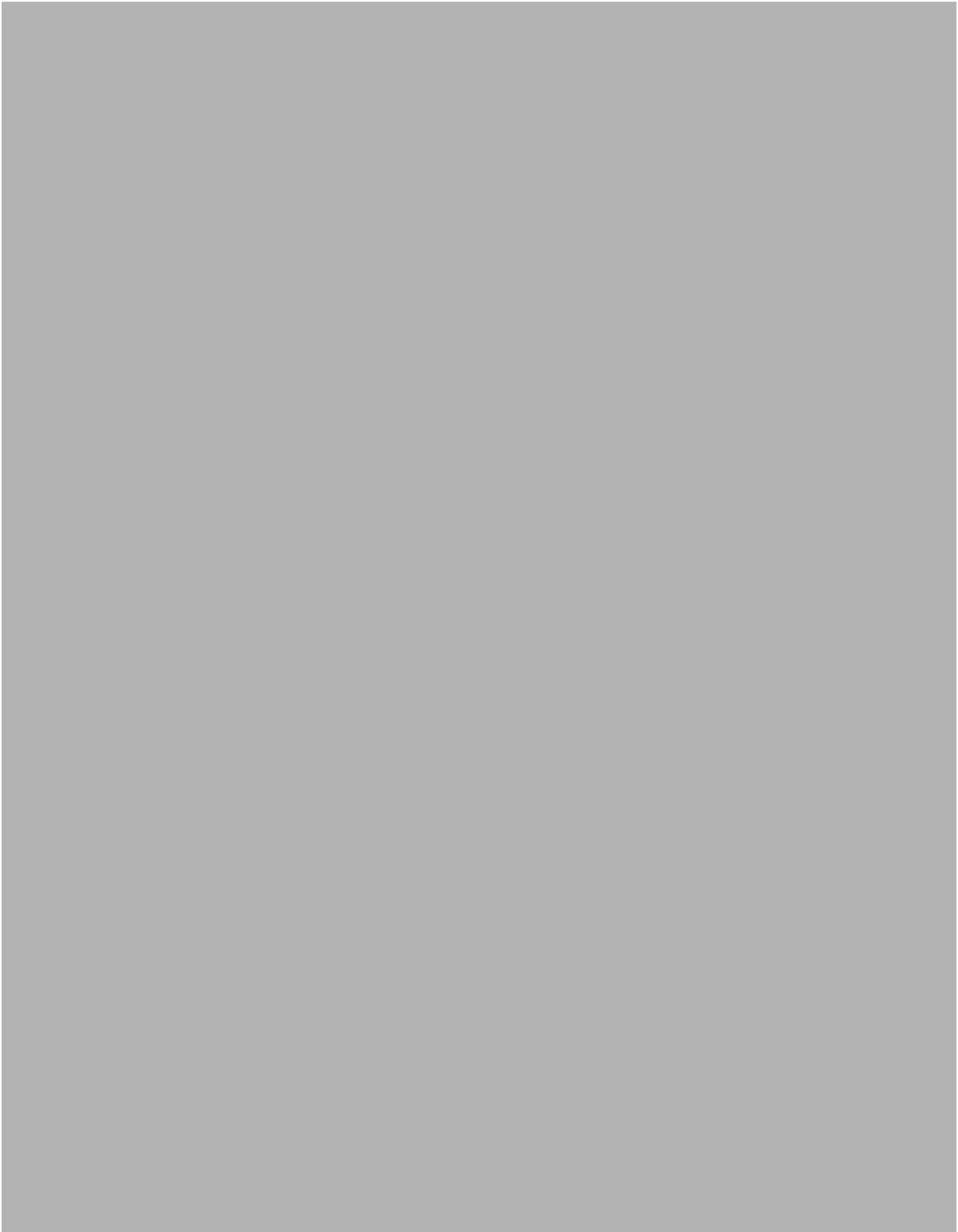
Health Hazard	0
Flammability	0
Reactivity	0
Personal Protection	HMIS assigns choice of personal protective equipment to the customer, as the raw material supplier is unfamiliar with the condition of use.

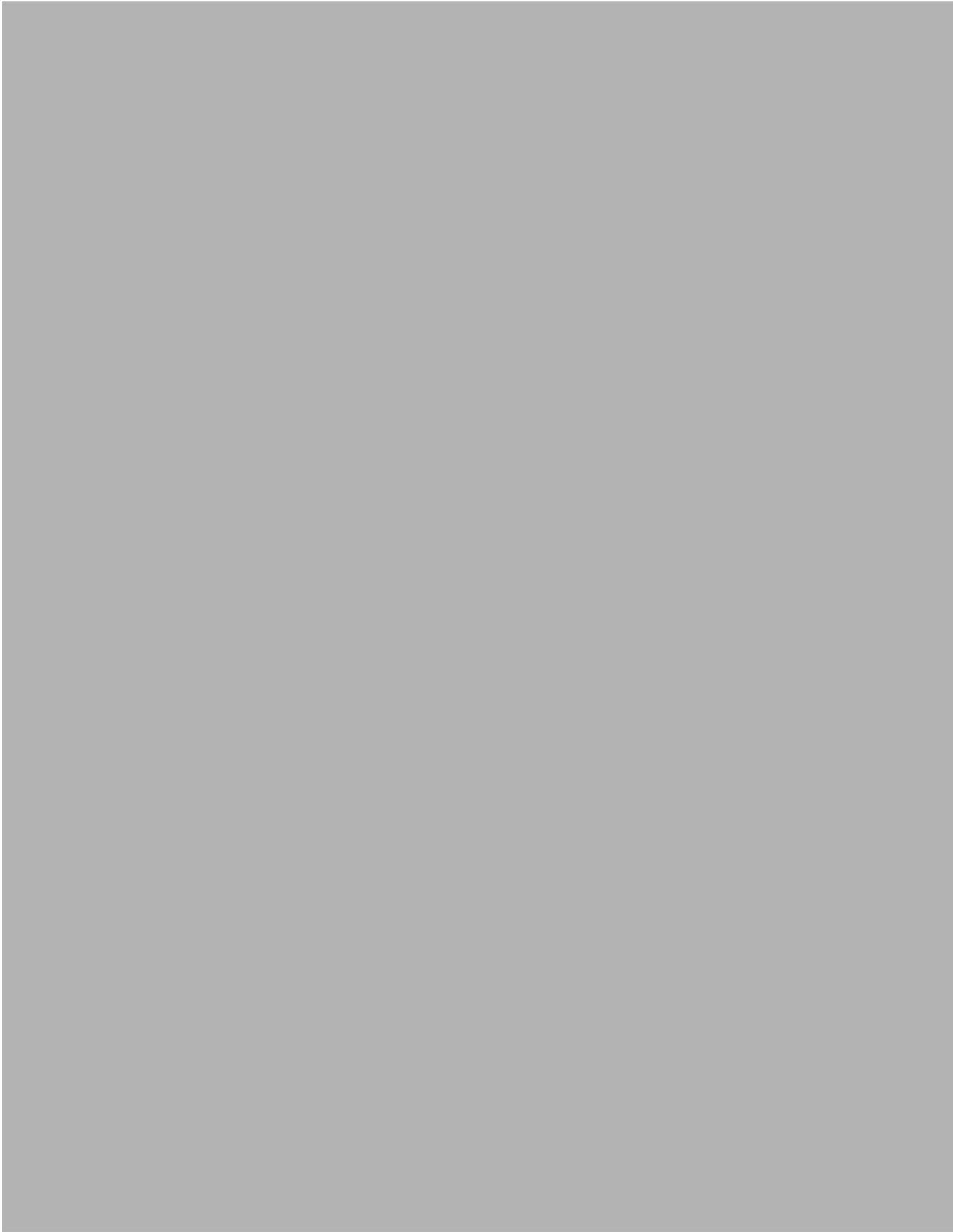
The information contained herein is based upon data considered true and accurate. However, United Desiccants makes no warranties expressed or implied, as to the accuracy or adequacy of the information contained herein or the results to be obtained from the use thereof. This information is offered solely for the user's consideration, investigation and verification. Since the use and conditions of use of this information and the material described herein are not within the control of United Desiccants, United Desiccants assumes no responsibility for injury to the user or third persons. The material described herein is sold only pursuant to United Desiccants' Terms and Conditions of Sale, including those limiting warranties and remedies contained therein. It is the responsibility of the user to determine whether any use of the data and information is in accordance with applicable federal, state or local laws and regulations.

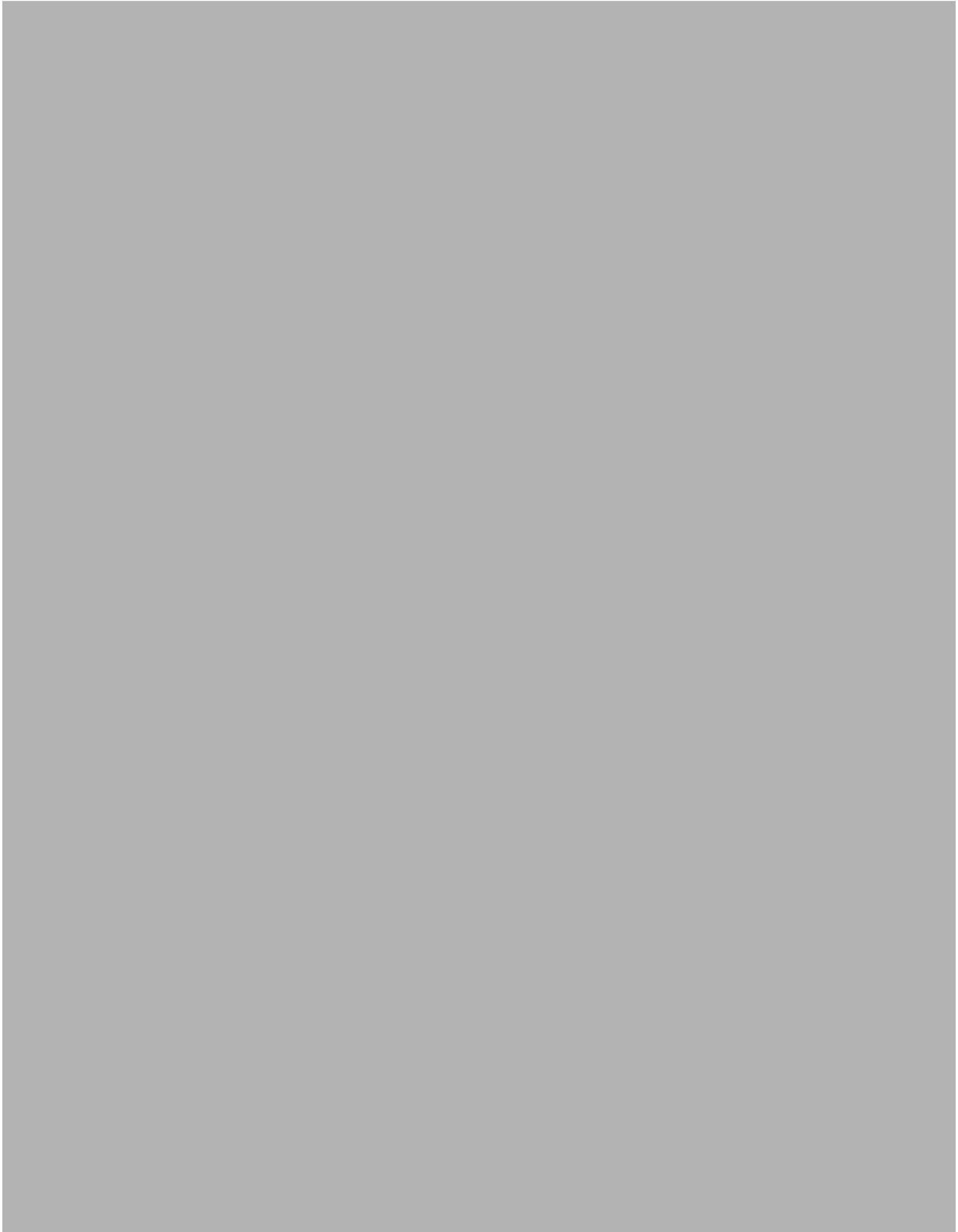


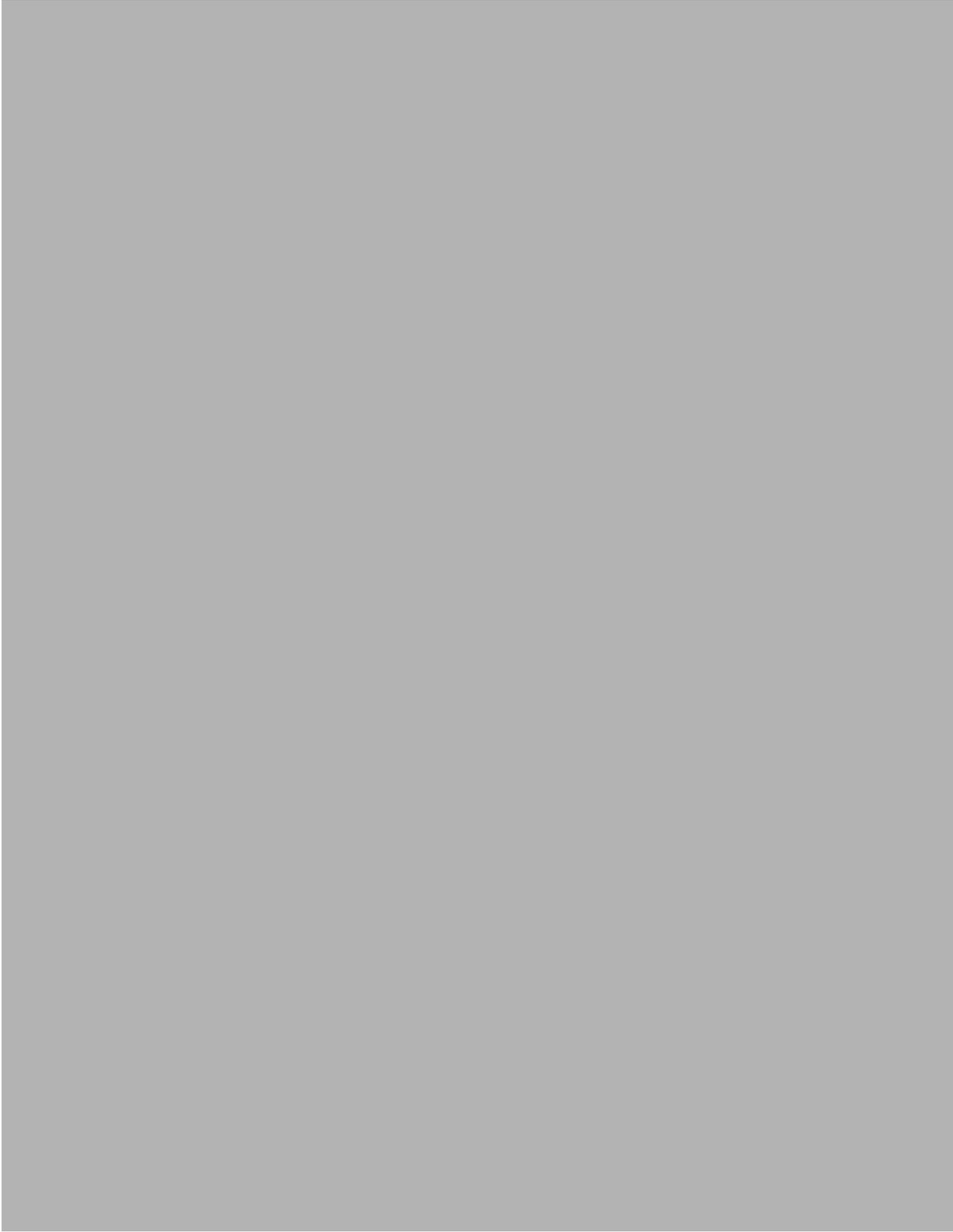












# 2110 Ultrasonic Flow Module

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## *Appendix D Safety Information*

### **D.1 Safety Considerations**

In field installations of Teledyne Isco wastewater samplers and associated equipment, the safety of the personnel involved should be the foremost consideration. The following sections provide safety procedures for working in and around manholes and sewers. The first section offers general safety advice. The second section deals with the special problem of hazardous gases found in sewers.

The 2110 has not been approved for use in hazardous locations as defined by the National Electrical Code.

### **D.2 Practical Safety Precautions**

The following procedures 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.

#### **D.2.1 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.

**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.

#### **D.2.2 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.

### D.2.3 Adverse Atmospheres

[Refer to Table D-1, 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.

### D.2.4 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 a 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.

#### **D.2.5 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.

#### **D.2.6 Falling Objects**

All loose items should be kept away from the manhole opening. This applies to hand tools as well as stones, gravel and other objects.

#### **D.2.7 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.

#### **D.2.8 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.

#### **D.2.9 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.

#### D.2.10 Field Equipment

The following equipment will be available for use:

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

#### D.3 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  $H_2S$ . 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  $H_2S$ , in the air. This is considered to be a lethal concentration. Many people have died from  $H_2S$ , not only in sewers and industries, but also from swamps and from hot springs. In one resort area, at least five persons died from  $H_2S$  poisoning before the people were ready to admit that  $H_2S$  is not a therapeutic agent. Hardly a year passes in the U.S. without a sewer fatality from  $H_2S$  as well as deaths elsewhere in the world.

The presence of  $H_2S$  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  $H_2S$  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  $H_2S$  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  $H_2S$  concentrations. 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  $H_2S$ .

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."

#### D.4 Hazardous Gases

The following table contains information on the properties of hazardous gases.

**Table D-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 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 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 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	— —	At bottom; when heated may stratify at points above bottom.	Products of combustion, sewer gas, sludge. Also issues from carbonaceous strata.	Oxygen deficiency indicator

**Table D-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
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 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	— —	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	— —	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 73.0	Near bottom.	Incomplete combustion of organics. Common air pollutant, fungicide.	Detectable odor.
Gasoline	C <sub>5</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 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 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 40.0	Near top.	Insecticide and rodenticide.	Detector tube
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

**Table D-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 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 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 19.3	Near top of structure.	From digestion of sludge.	See components.

**Table D-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
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>5</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 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 concentration. 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 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.



# 2110 Ultrasonic Flow Module

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产品中有毒有害物质或元素的名称及含量

Name and amount of Hazardous Substances or Elements in the product

部件名称 Component Name	有毒有害物质或元素 Hazardous Substances or Elements					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二联苯 (PBDE)
线路板 Circuit Boards	X	O	O	O	O	O

产品中有毒有害物质或元素的名称及含量：Name and amount of Hazardous Substances or Elements in the product

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在ST/ 标准规定的限量要求以下。

O: Represent the concentration of the hazardous substance in this component's any homogeneous pieces is lower than the ST/ standard limitation.

X：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出ST/ 标准规定的限量要求。

(企业可在此处，根据实际情况对上表中打“X”的技术原因进行进一步说明。)

X: Represent the concentration of the hazardous substance in this component's at least one homogeneous piece is higher than the ST/ standard limitation.

(Manufacturer may give technical reasons to the "X"marks)

环保使用期由经验确定。

The Environmentally Friendly Use Period (EFUP) was determined through experience.

生产日期被编码在系列号码中。前三位数字为生产年(207 代表 2007 年)。随后的一个字母代表月份：

A 为一月，B 为二月，等等。

The date of Manufacture is in code within the serial number. The first three numbers are the year of manufacture (207 is year 2007) followed by a letter for the month. "A" is January, "B" is February and so on.



产品中有毒有害物质或元素的名称及含量

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部件名称 Component Name	有毒有害物质或元素 Hazardous Substances or Elements					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二联苯 (PBDE)
线路板 Circuit Boards	X	O	O	O	O	O
外部电缆 External Cables	X	O	O	O	O	O

产品中有毒有害物质或元素的名称及含量：Name and amount of Hazardous Substances or Elements in the product

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在ST/ 标准规定的限量要求以下。

O: Represents the concentration of the hazardous substance in this component where all homogeneous pieces are lower than the ST/ standard limitation.

X: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出ST/ 标准规定的限量要求。

(企业可在此处，根据实际情况对上表中打“X”的技术原因进行进一步说明。)

X: Represents the concentration of the hazardous substance in this component where at least one homogeneous piece is higher than the ST/ standard limitation.

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环保使用期由经验确定。

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# DECLARATION OF CONFORMITY



Application of Council Directive: 2004/108/EC -The EMC Directive  
 2002/96/EC – The WEEE Directive  
 2006/95/EC– The Low Voltage 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  
 Phone: +1 (402) 464-0231  
 FAX: +1 (402) 465-3799

Equipment Type/Environment: Laboratory Equipment for Light Industrial/Commercial Environments

Trade Name/Model No: 2110 Ultra Sonic Module with Sensor; powered with 923 Power Pack or 2191 Battery

Year of Issue: 2009

Standards to which Conformity is Declared: EN 61326:2006 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use  
 EN61010-1:2002 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2	Electrostatic Discharge	4kV/8kV contact/air discharge	*C
EN61000-4-3	Radiated RF Immunity	10V/m (80 mHz to 1GHz) 3V/m (1.4GHz to 2 GHz) (2.0GHz to 2.7GHz) 1V/m	**B A A
EN61000-4-4	Electrical Fast Transient (EFT)	2kV (5/50ns, 5kHz) on AC lines 1kV (5/50ns, 5kHz) on I/O line (sensor)	**B **B
EN61000-4-5	Surge on AC Lines	2kV Line-Ground 0.5kV Line-Line	**B
EN61000-4-6	Conducted RF on AC & I/O lines	3V rms (150 kHz to 80 mHz)	**B
EN61000-4-11	Voltage Dips	0% during 1 cycle, 40% during 10/12 cycles, 70% during 25/30 cycles	A A A
EN61000-4-11	Short Interruptions	0% during 250/300 cycles	*C
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	***Exceeds Limits
EN61000-3-2, 3-3	AC Harmonics, Flicker		

\*2110 froze up and lost communications with computer. Required cycling of power to restore functionality.  
 \*\*Sensor levels changed beyond specifications during test.  
 \*\*\*Sensor exceeds EN55011/CISPR11 Limits and may cause unwanted interference with other equipment at 60MegHz.

We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of July 2009.

USA Representative

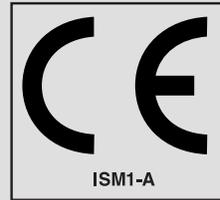
William Foster  
 Vice President of Engineering Isco, Inc.



60-2002-421



# DECLARATION OF CONFORMITY



Application of Council Directive: 89/336/EEC – The EMC Directive  
73/23/EEC – The Low Voltage 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  
Trade Name/Model No: 2191 Battery Module  
Year of Issue: 2001

Standards to which Conformity is Declared: EN 61326-1998 EMC Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use  
EN 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory use.

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	B B
EN61000-4-3	Radiated RF Immunity	80 MHz to 1000MHz 80% AM at 1kHz Level 1 – 10V/m	B
EN61000-4-4	Electrical Fast Transient	Level 1 – 1kV on I/O lines	B
EN61000-4-5	Surge on I/O Lines	1kV common mode, 0.5KV differential mode	B
EN61000-4-6	Conducted RF on I/O lines	150 kHz to 80 MHz, 3V rms, 80% modulated	B
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	

We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of July 1, 2001.

William Foster  
USA Representative



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

Phone: (402) 464-0231  
Fax: (402) 464-4543

60-2002-158  
Rev A



## 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 desiccant, pH sensors, charts, ribbon, lamps, tubing, and glassware; fittings and wetted parts of valves; check valves, pistons, piston seals, wash seals, cylinders, pulse damper diaphragms, inlet lines and filter elements; and damage due to corrosion, misuse, accident, or lack of proper **installation or** 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 (RMA) 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.**

Problems can often be diagnosed and corrected without returning the instrument to the factory. Before returning any instrument for repair, please contact the Teledyne Isco Service Department for instructions and to obtain a return material authorization number (RMA).

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 WRITE THE RMA NUMBER ON THE OUTSIDE OF THE SHIPPING CONTAINER** and 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



March 2, 2016 P/N 60-1002-040 Rev J



