

2110 Ultrasonic Flow Module and Sensor

Installation and Operation Guide



Part #69-2003-410 of Assembly #60-2004-410
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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 the problem persists, call or e-mail the Teledyne Isco Technical Service Department for assistance. Simple difficulties can often be diagnosed over the phone.

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

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

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

Contact Information

Customer Service

Phone: (800) 228-4373 (USA, Canada, Mexico)
(402) 464-0231 (Outside North America)
Fax: (402) 465-3022
Email: IscoCSR@teledyne.com

Technical Service

Phone: (800) 775-2965 (Analytical)
(800) 228-4373 (Samplers and Flow Meters)
Email: IscoService@teledyne.com

Return equipment to: 4700 Superior Street, Lincoln, NE 68504-1398

Other Correspondence

Mail to: P.O. Box 82531, Lincoln, NE 68501-2531
Email: IscoInfo@teledyne.com
Web site: www.isco.com

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 (Isco, Inc.) 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.

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.

Hazard Symbols	
Warnings and Cautions	
	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.
Symboles de sécurité	
	Ce symbole signale l'existence d'instructions importantes relatives au produit dans ce manuel.
	Ce symbole signale la présence d'un danger d'électocution.
Warnungen und Vorsichtshinweise	
	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 Sei vor "gefährlichen Spannungen" im Inneren des Produkts warnt.
Advertencias y Precauciones	
	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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2110 Ultrasonic Flow Module

Section 1 Quick Start Guide

1.1 Getting Started

This Quick Start Guide provides a basic introduction to the Ultrasonic and Battery Modules.

In this section we discuss:

- Identifying key components of the 2110 Flow Module
- How to operate latches
- Module connectors and caps
- Attaching the Ultrasonic Sensor cable
- Identifying key components of the 2191 Battery Module
- How to install batteries
- How to stack modules

The intent of this section is only to familiarize you with the basics. Detailed information about the installation and operation of this system can be found in the following sections and appendices:

- Section 2, *Introduction*
- Section 3, *Preparation and Installation*
- Section 4, *Programming*
- Section 5, *Modbus Protocol*
- Section 6, *Maintenance*
- Appendix A, *Replacement Parts*
- Appendix B, *Accessories*
- Appendix C, *Material Safety Data Sheets*
- Appendix D, *Safety Information*

1.2 Ultrasonic Module

1.2.1 Identifying Module Components

Figures 1-1 and 1-2 identify key components of the 2110 Ultrasonic Flow Module.

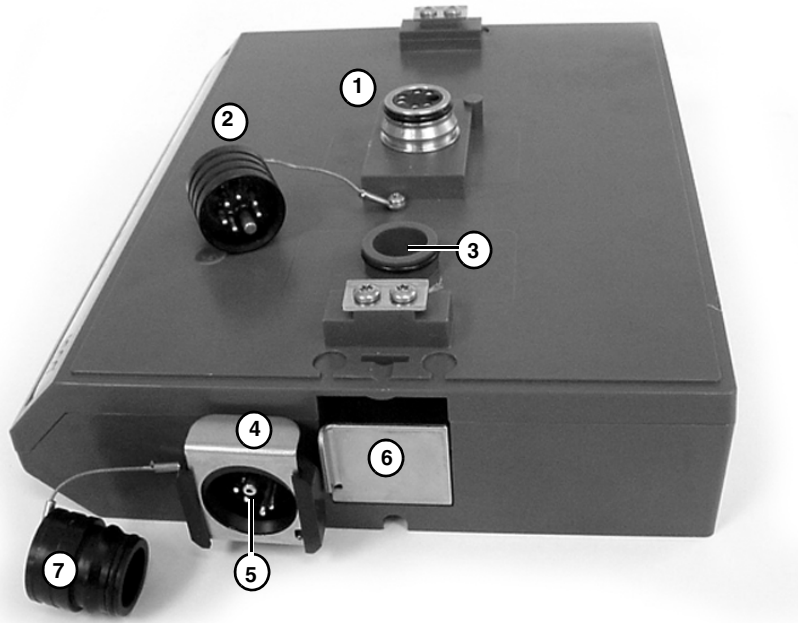


Figure 1-1 2110 Module Components: Top View

Table 1-1 2110 Module Components - Top View	
Item No. Fig. 1-1	Description
1	Communication Connector
2	Cap
3	Cap Holder
4	Sensor Release
5	Sensor Receptacle
6	Latch Release
7	Sensor Receptacle Cap

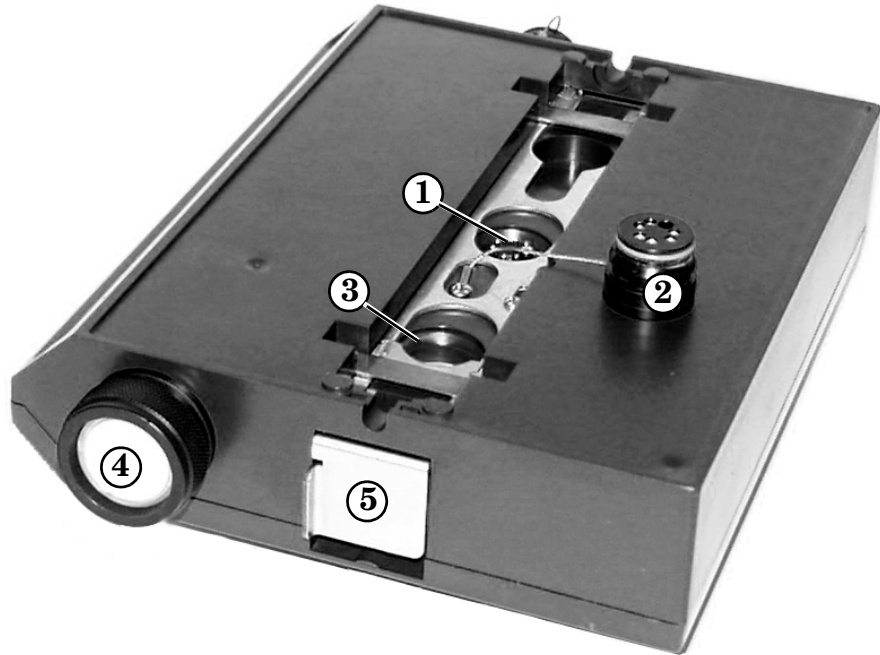


Figure 1-2 2110 Module Components: Bottom View

Table 1-2 2110 Module Components - Bottom View	
Item No. Fig. 1-2	Description
1	Communication Connector
2	Cap
3	Cap Holder
4	Desiccant Cartridge and Hydrophobic Filter
5	Latch

1.2.2 Latches - Locking and Unlocking

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 1/8".

Figure 1-3 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.



Figure 1-3 Unlocking the Latch

 **Note**

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

1.2.3 Communication Connectors

When a communication connector is not in use, the connector should always be capped (Figures 1-4 and 1-6). 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 1-5 and 1-7). 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 1.5 shows how to store the caps so that you can stack the modules.

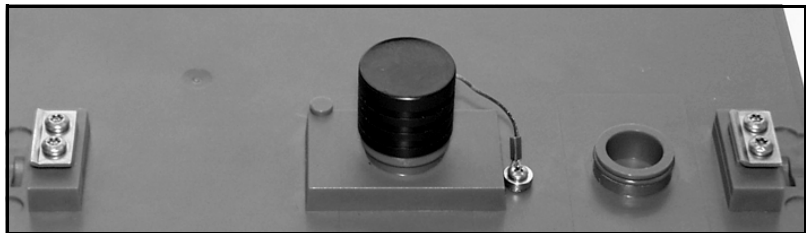


Figure 1-4 Flow Module - Upper Connector, Capped

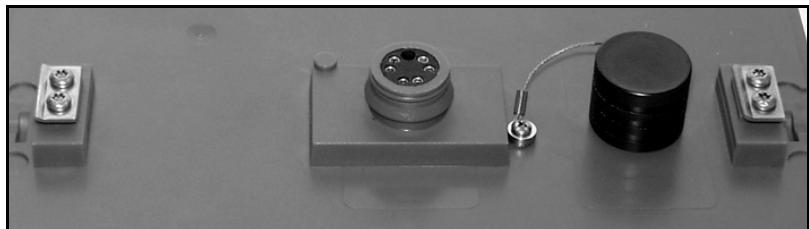


Figure 1-5 Flow Module - Upper Connector, Uncapped

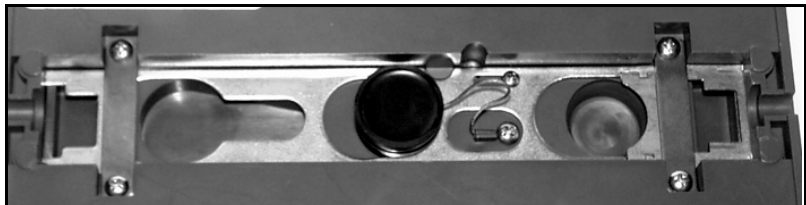


Figure 1-6 Flow Module - Lower Connector, Capped

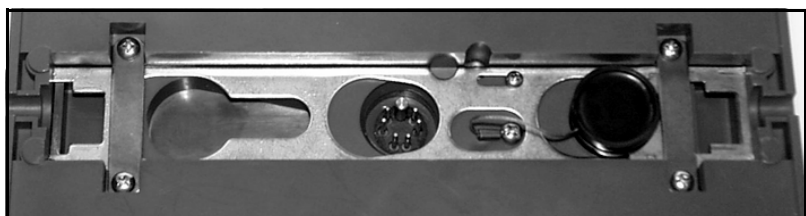


Figure 1-7 Flow Module - Lower Connector, Uncapped

1.3 Ultrasonic Level Sensor (USLS)

1.3.1 USLS Parts

Figure 1-8 and Table 1-3 identify the parts of the 2110 Ultrasonic Sensor.

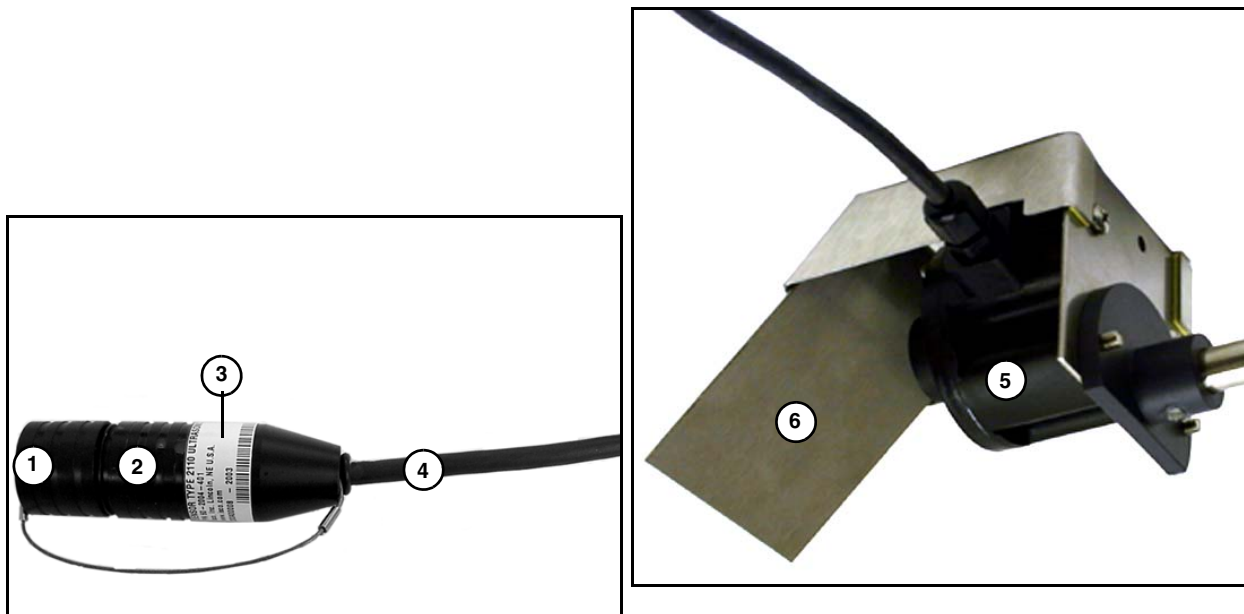


Figure 1-8 2110 Sensor Parts

Table 1-3 2110 Sensor Parts and Descriptions

Item No. Fig. 1-8	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.
6	Horizontal Mounting Bracket	The USLS is mounted to the bracket, which attaches to the mounting mechanism, and also provides a 45° reflective surface for the ultrasonic signal, preventing interference from water condensation on the face of the sensor.

1.3.2 Connecting the Sensor

To attach the Ultrasonic Sensor to the 2110 Flow Module, follow steps in Figures 1-9 and 1-10.

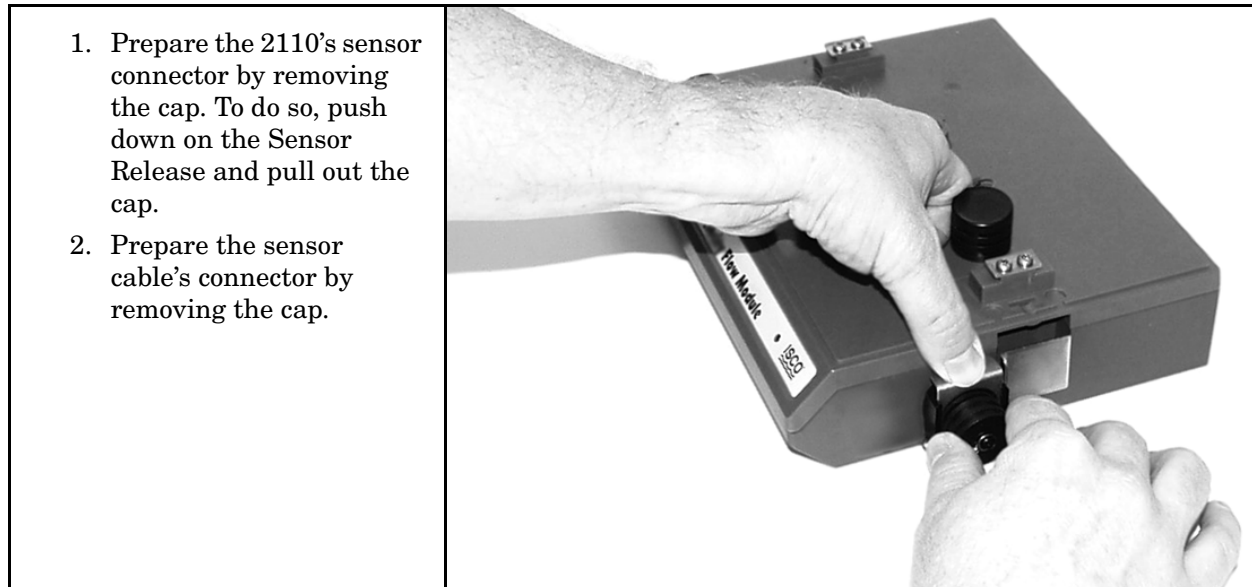


Figure 1-9 Flow Module - Preparing the Sensor Connectors

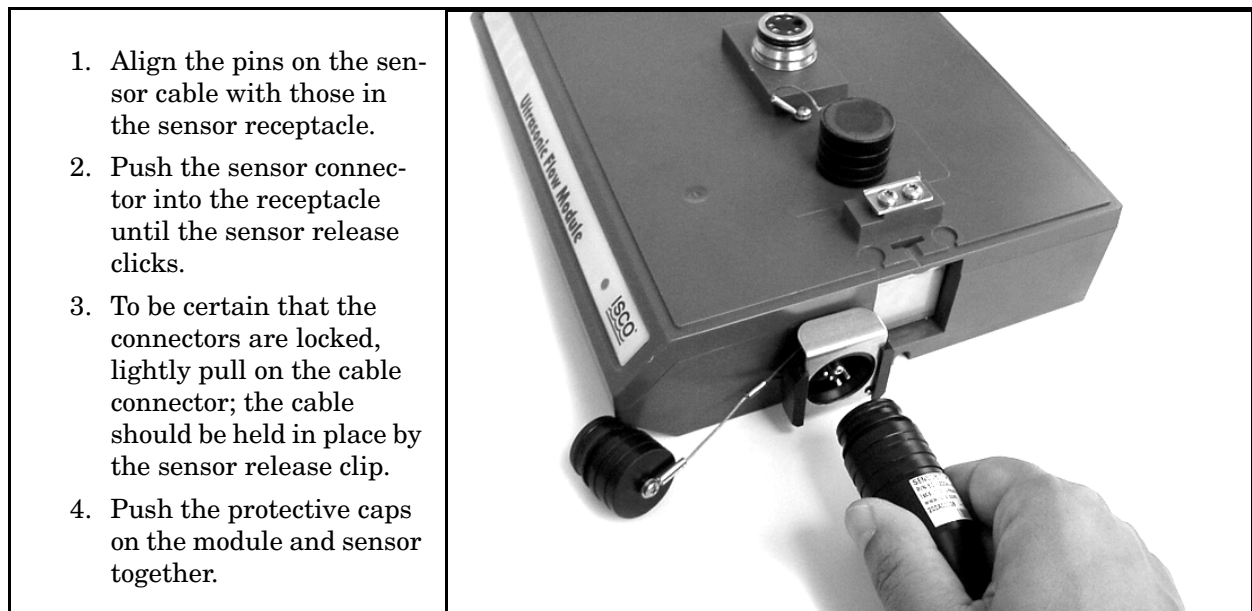


Figure 1-10 Flow Module - Connecting the Sensor

1.4 Battery Module

1.4.1 Identifying Module Components

Figures 1-11 and 1-12 identify key components of the Battery Module.



Figure 1-11 Battery Module Components, Top View

Table 1-4 Battery Module Components - Top View	
Item No. Fig. 1-11	Description
1	Communication Connector
2	Cap
3	Cap Holder
4	Lantern Battery (Alkaline shown)
5	Door
6	Battery Carrier
7	Latch Release



Figure 1-12 Battery Module Components, Bottom View

Table 1-5 Battery Module Components - Bottom View	
Item No. Fig. 1-12	Description
1	Communication Connector
2	Cap
3	Cap Holder
4	Latch

1.4.2 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 1-13 through 1-16.

Load the Lantern Battery into the Carrier.

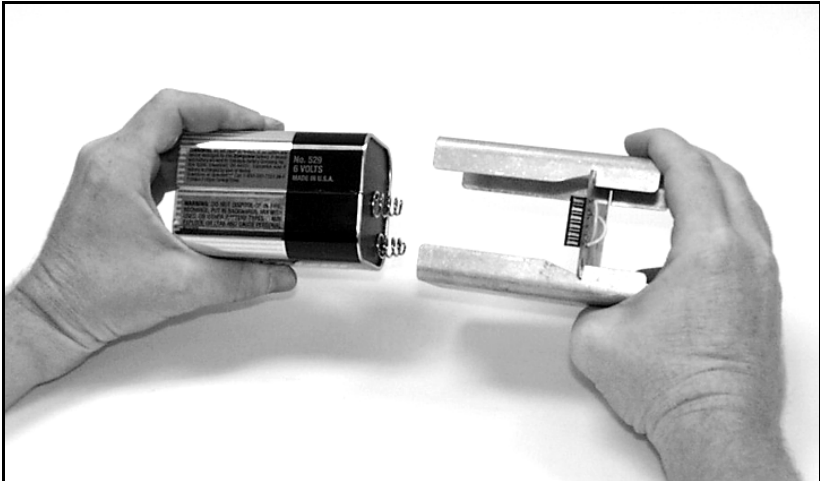


Figure 1-13 Insert Battery in Carrier

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.

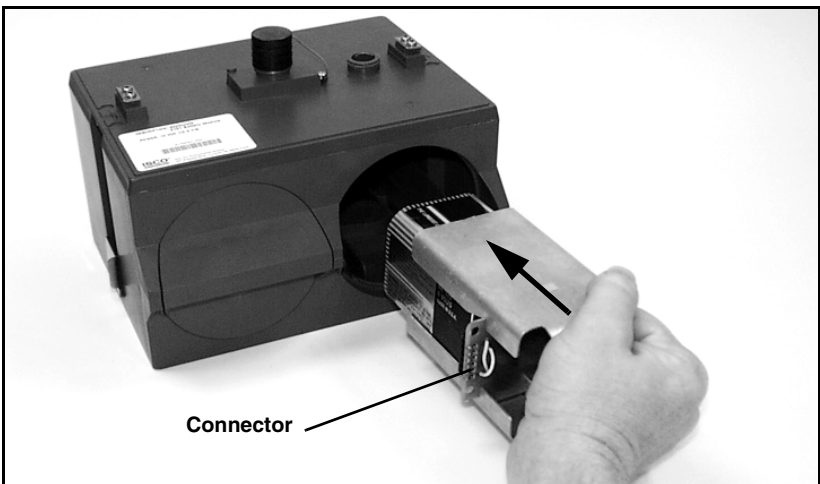


Figure 1-14 Battery Module - Inserting Carrier

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



Figure 1-15 Battery Module - Aligning the Door

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

Repeat Steps 1-13 through 1-16 to install the second battery.



Figure 1-16 Battery Module - Closing the Door

1.5 Stacking Modules

To stack a 2110 Flow Module on a Battery Module, follow the instructions in Figures 1-17 through 1-23.

Unlock the latch to release the lower cap.

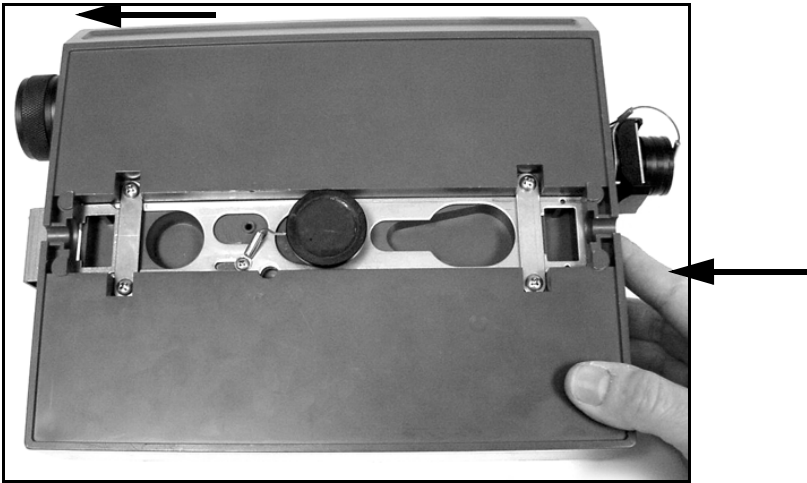


Figure 1-17 Flow Module - Unlocking the Latch

Pull the cap off of the connector.

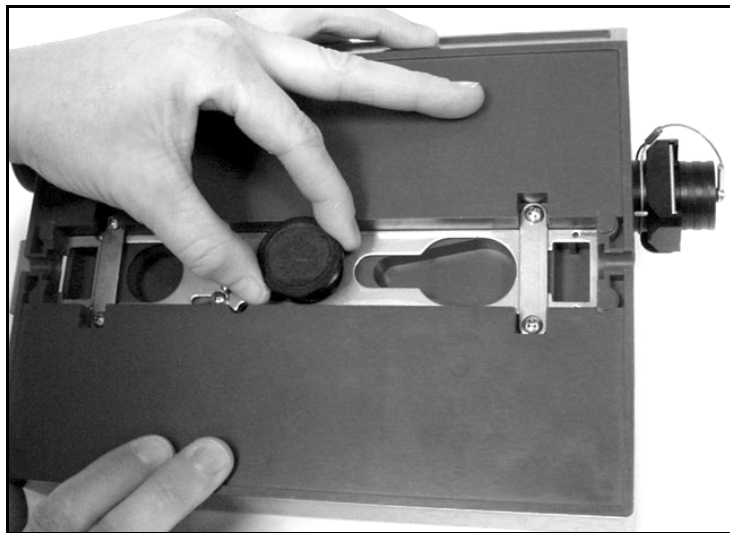


Figure 1-18 Flow Module - Uncapping the Connector

Push the cap into the holder.

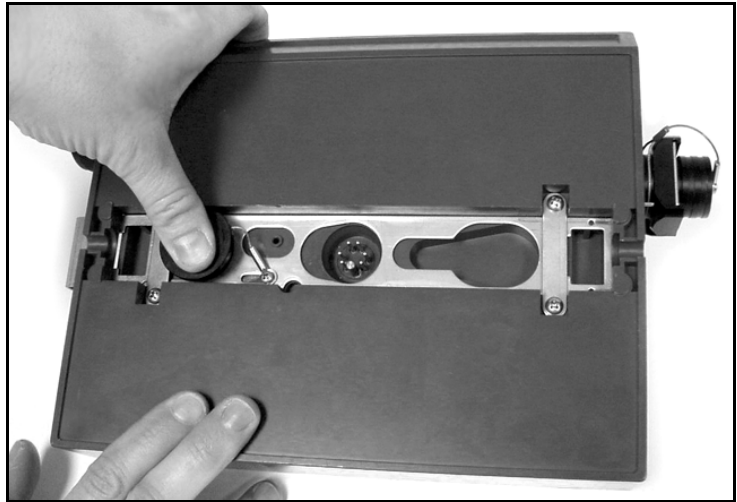


Figure 1-19 Flow Module - Pushing Cap into Holder

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

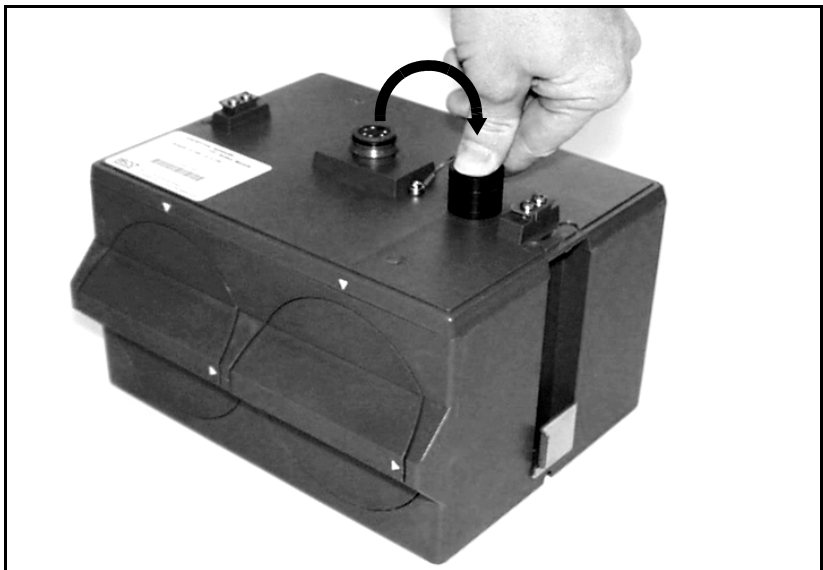


Figure 1-20 Battery Module - Uncapping the Connector

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.

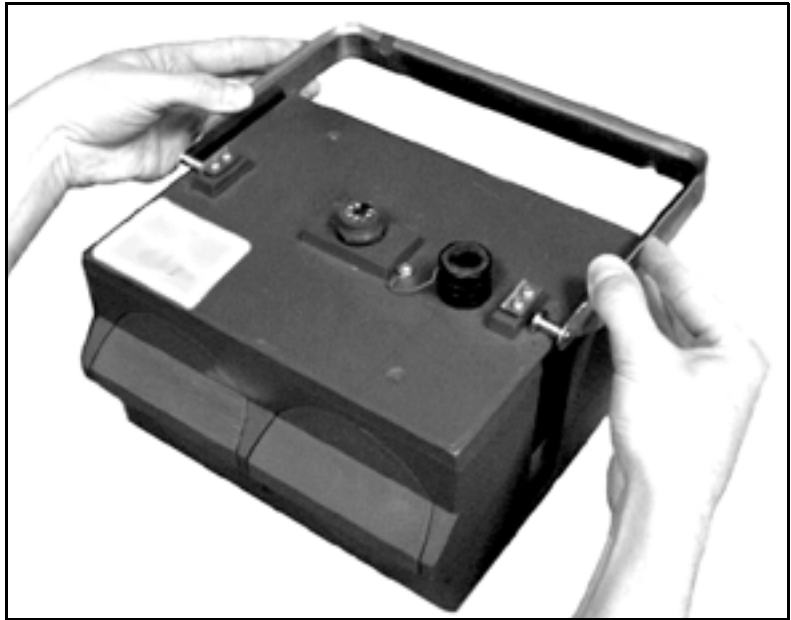


Figure 1-21 Battery Module - Inserting the Handle

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



Figure 1-22 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

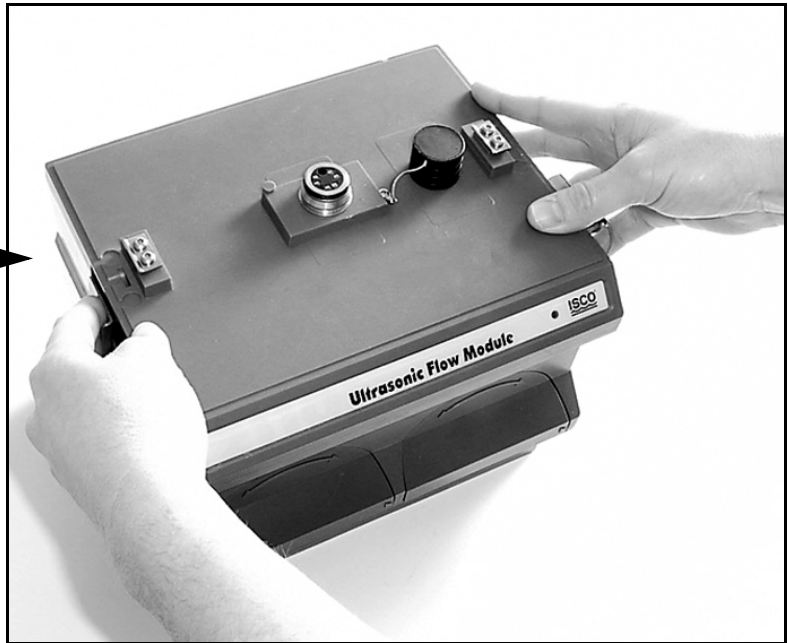
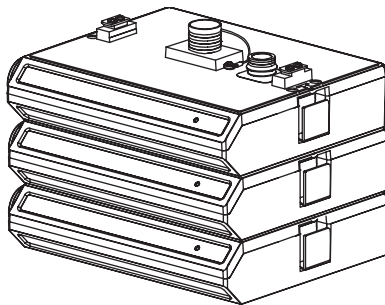


Figure 1-23 Locking the Modules

2110 Ultrasonic Flow Module

Section 2 Introduction

2.1 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 (PN 60-2004-260). A flow pulse is sent out every 100 gallons or 500 liters of flow, depending on how the 2110 is configured.

2.2 2110 Module 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.

Sections 2.2.1 through 2.2.3 describe the module and sensor in greater detail.

2.2.1 Flow Rate

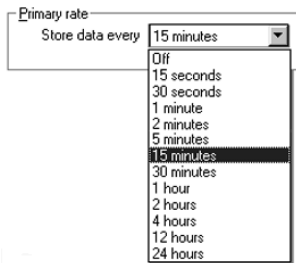
Using level measurements from the sensor, the 2110 can calculate the flow rate. The 2110 supports many different flow rate conversion methods:

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

2.2.2 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.

2.2.3 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.

2.3 2110 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.

2.4 2191 Battery Module Overview

The 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.

2.5 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.



Figure 2-1 2110 Ultrasonic Level Sensor (USLS)

2.5.1 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 to measure incorrectly if they are mounted within a short distance of one another. One sensor may detect the echo of the other by mistake, causing erroneous readings.

Adjacent sensors should be spaced at least two times their full-scale measurement distance.

2.6 Controls, Connectors, and Indicators

The controls, connectors, and indicators on the 2110 Module and 2191 Battery Module are shown in Figures 2-2 and 2-3. Items referenced in the figures are briefly discussed in Tables 2-1 and 2-2.

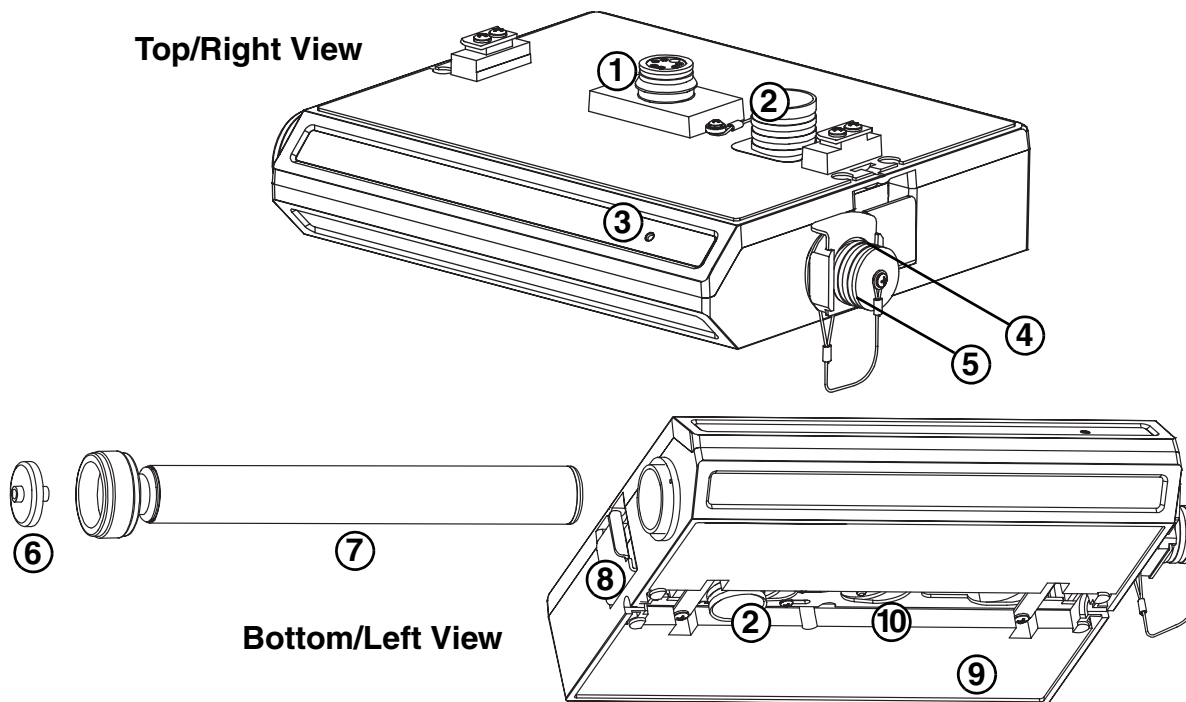


Figure 2-2 Controls, Connectors, and Indicators – 2110 Flow Module

Table 2-1 Controls, Connectors, and Indicators – 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 Caps	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 2-2 to protect the terminating components inside the caps.
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. (See Section 3.4.3).
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.

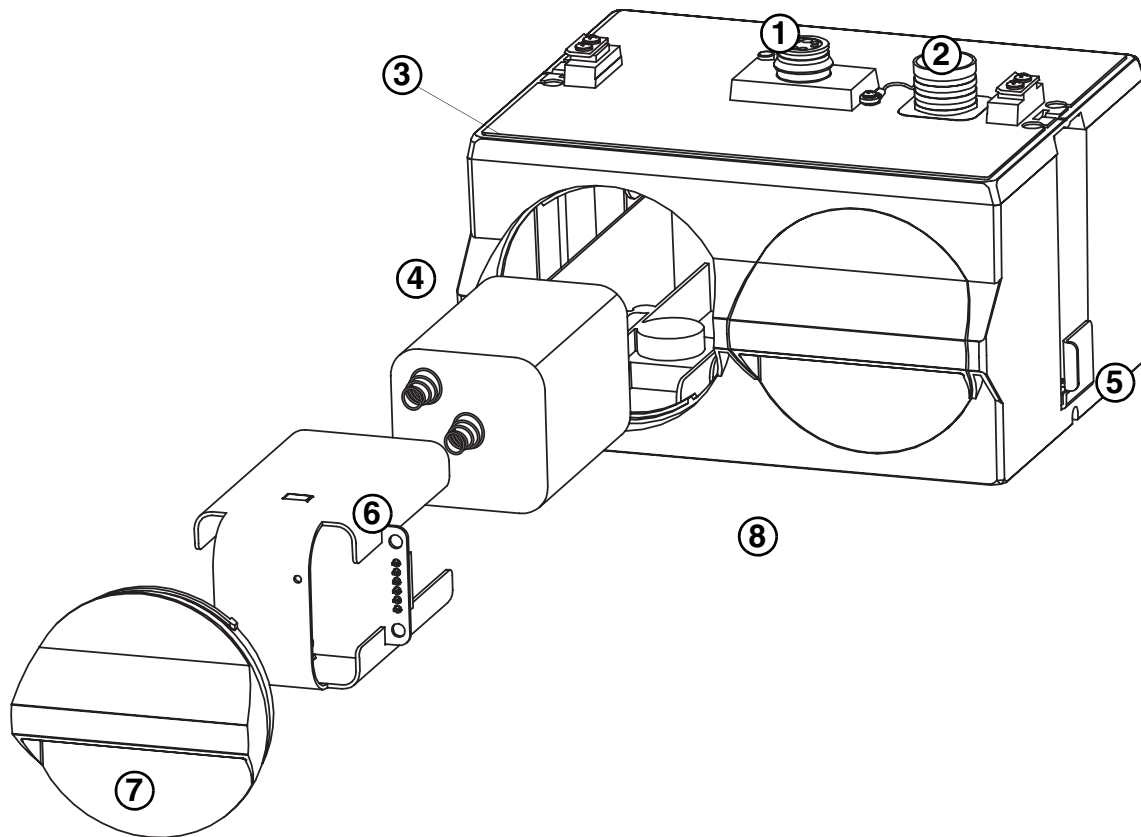


Figure 2-3 Controls, Connectors, and Indicators – 2191 Battery Module

Table 2-2 Controls, Connectors, and Indicators – 2191 Battery Module		
Item No. Fig. 2-3	Name	Description
1	Communication Connector (upper)	Upper communication port. The connector transfers data and 12 VDC power to other modules. Also used to connect to a PC running Flowlink software.
2	Connector Caps	Insert into unused connectors and receptacles 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 2-3 to protect the terminating components inside the caps.
3	Serial Number Label	On back of unit - lists product ID and unit serial numbers.
4	Latch (<i>not visible</i>)	Push in to lock the module in a stack.
5	Latch Release	Push in to release the module from a stack.
6	6 Volt Lantern Battery Carrier	Adapter to hold the battery in place. The carrier is necessary when using 6 volt lantern-style batteries.
7	Battery Door	Quarter-turn door seals the battery cavity. Inside each door is a humidity indicator and a bag of desiccant to prevent internal moisture damage. (See Section 6.4)
8	Communication Connector (lower - <i>not visible</i>)	Lower communication port. The connector transfers data and 12 VDC power to other modules.

2.7 Technical Specifications

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

- Table 2-3 lists the technical specifications of the 2110 Ultrasonic Flow Module
- Table 2-4 lists the technical specifications of the 2110 Ultrasonic Sensor
- Table 2-5 lists the technical specifications of the 2191 Battery Module
- Figure 2-4 and Table 2-6 list information about the 2110 Module's communication connector.

Table 2-3 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	High-impact molded polystyrene, stainless steel	
Enclosure (self-certified)	NEMA 4X, 6P	IP 68
Power	7 to 15 VDC, 170 mA typical at 12 VDC, 2.6 mA average, 0.4 mA standby	
Typical Battery Life ^a (one module)	Data Storage Interval 15 minutes	Alkaline Batteries 6.5 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	

Table 2-3 Specifications – 2110 Ultrasonic Flow Module (Continued)

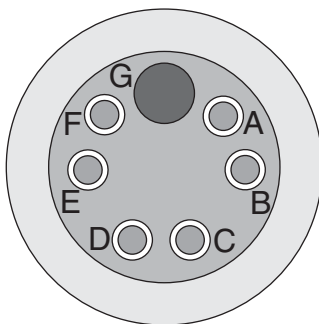
Setup and Data Retrieval	Serial connection to IBM PC or compatible computer with Isco Flowlink software	
Baud Rate	38,400	
Operating Temperature	0° to 140°F	-18° to 60°C
Storage Temperature	-40° to 140°F	-40° to 60°C

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

Table 2-4 Specifications – 2110 Ultrasonic Sensor

Enclosure	NEMA 4X, 6P	IP68
Length: 1.5 m range	2.7 in.	6.9 cm
Diameter	2.6 in.	6.6 cm
Cable Length	32.8 ft.	10 m
Cable Diameter	0.3 in.	0.8 cm
Weight (including cable)	1.8 lbs	0.8 kg
Level Measurement @ 22° C, 50% RH, Still Air		
Frequency: 1.5 m range	148 kHz	
Cone Angle: 1.5 m range	12°	
Span	48 inch (1.22 m)	
Dead Band	1.5 inch (3.8 cm)	
Accuracy	± 0.013 ft (0.38 cm), from 2 to 39.4 inches (0.051 to 1.0 m) ±0.029 ft (0.89 cm), from 39.4 to 50 inches (1.0 to 1.27 m)	
Temperature Error	± 0.001 ft/°F (0.005 cm/°C change in temperature after level calibration)	
Temperature Measurement		
Range	-40 to 185 °F (-40 to 85 °C)	
Resolution	0.9 °F (0.5 °C)	
Operating Temperature	-40°F to 185°F	-40° C to 85°C
Storage Temperature	-58°F to 221°F	-50°C to 105°C
Materials		
Sensor	6/6 Nylon, 20% Glass-filled; SST	
Cable	Thermoplastic Elastomer (Elezar 8614)	

Table 2-5 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 2-4 2110 Module Connector Pins

Table 2-6 2110 Module Connector Pins		
Pin	Name	Description
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

Section 3 Preparation and Installation

3.1 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.

 **WARNING**

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

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

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

FAX: (402) 465-3022

E-mail:
IscoInfo@teledyne.com

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

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

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

3.2 Preparing for Installation

3.2.1 Safety

 **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.

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.

3.2.2 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 equipment is moved to another location, or, if possible, move the source of RF. Check the Declaration of Conformity at the end of this manual to see if there are known radio frequencies this equipment is susceptible to.

3.2.3 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, invert, 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.

3.2.4 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.

3.2.5 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.

3.3 Installation Steps

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 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 3.4.1).
- b. Inspect desiccant (3.4.2).
2. Inspect module desiccant (3.4.3).
3. Assemble the system.
 - a. Connect the modules (3.4.4).
 - b. Attach the sensor cable to the 2110 (3.4.5).
4. Install the USLS over the measuring point of the flow stream.
5. Connect to the site with *Flowlink* for Windows (3.7).
 - 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 (3.5).

3.4 Installation Procedures

3.4.1 Install Battery Module Batteries

The Battery 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 3-1):

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 3.4.2.)
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.

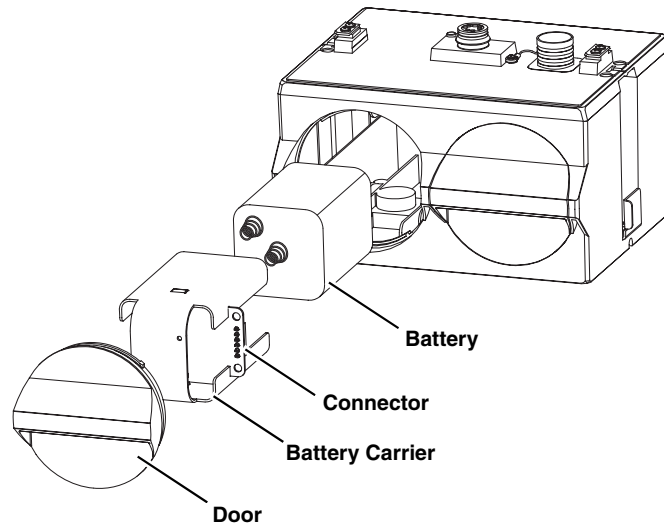
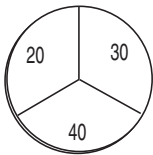


Figure 3-1 Installing a Battery

3.4.2 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 6.4 for replacement instructions.

3.4.3 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 6.4 for replacement instructions.

3.4.4 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 4.2.1), 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.

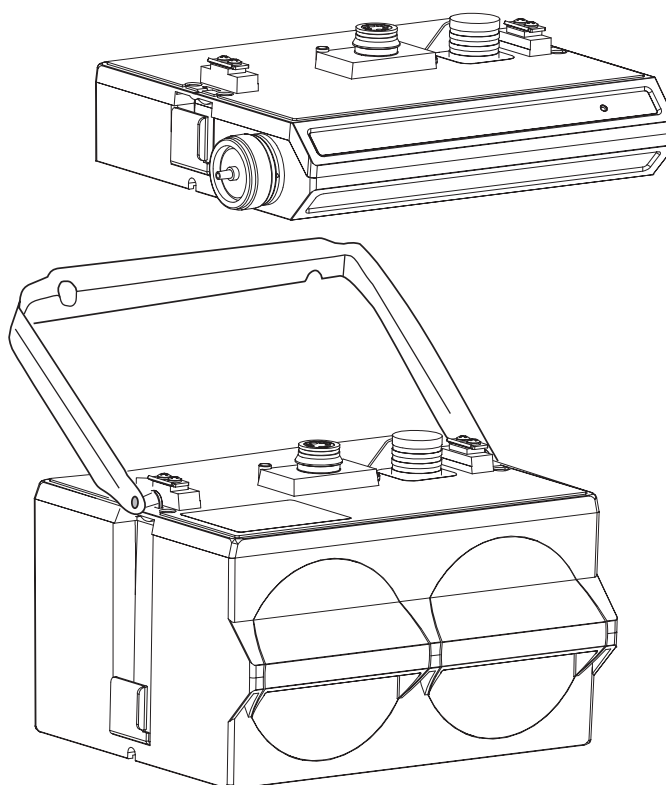


Figure 3-2 Assembling a Basic System

To connect the 2110 and Battery modules, refer to the following instructions and Figure 3-2.

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.

3.4.5 Connecting the USLS

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

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.

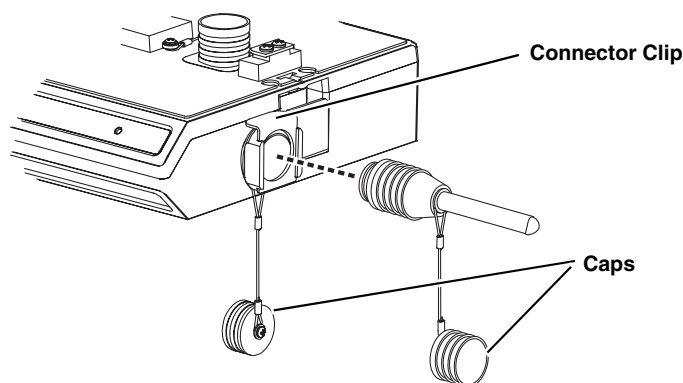


Figure 3-3 Connecting the USLS

3.5 Installing the USLS

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

- Abusive handling will damage the ultrasonic transducer inside the sensor. Although the USLS will survive normal handling and installation, treat the level sensor with reasonable care.
- When installing the sensor, place the sensor over the center 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 USLS depends on the primary device because the head-measuring point is unique to each device. Refer to Table 3-1 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 3-1 Typical Measuring Points	
Device	Head-Measuring Point
Weirs	Upstream from the weir plate by at least 3 times the maximum head.
Parshall Flumes	$\frac{1}{3}$ 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.

You can mount the ultrasonic level sensor over the flow stream in various ways. It is up to you to determine which method best fits the application. The reflector plate attached to the sensor is angled to bounce the ultrasonic signal between the surface of the stream and the face of the transducer, preventing the accumulation of moisture on the transducer, which can distort the signal. The USLS can be mounted within the pipe (Figure 3-12), either for stand-alone flow measurement, or for redundant level measurement paired with an area velocity probe. This option is discussed in detail in Section 3.5.3.

Optional equipment is available from Teledyne Isco for wall or floor mounting, or suspension. You can also run the ultrasonic level sensor cable through conduit to the 2110.

3.5.1 Wall or Floor Mounting

The Ultrasonic Level Sensor can be fastened to a wall (Figure 3-4) with the Isco mounting bracket (Figures 3-5 and 3-7). The sensor can also be mounted on the Isco floor stand (Figures 3-8 and 3-9). A circular bubble level and threaded bolt attach the reflector plate assembly and sensor to the bracket or horizontal arm.

To attach the reflector plate assembly and sensor, insert the head of the threaded bolt in a "button-hole" motion (Figure 3-6). Slide it into the square slot in the reflector plate, pulling it upright so that the slot acts as a wrench as you screw the bubble level down onto the plate.

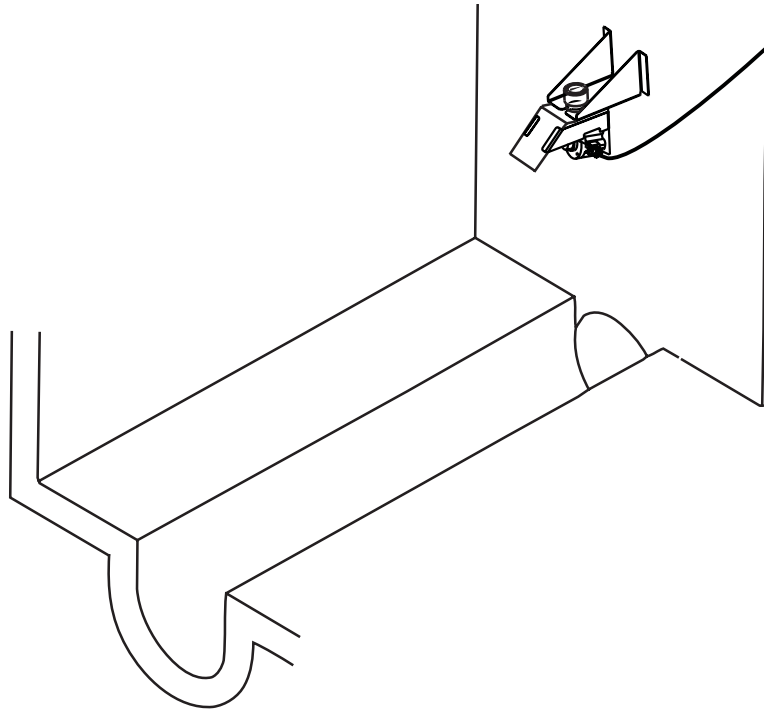


Figure 3-4 USLS mounted to a wall

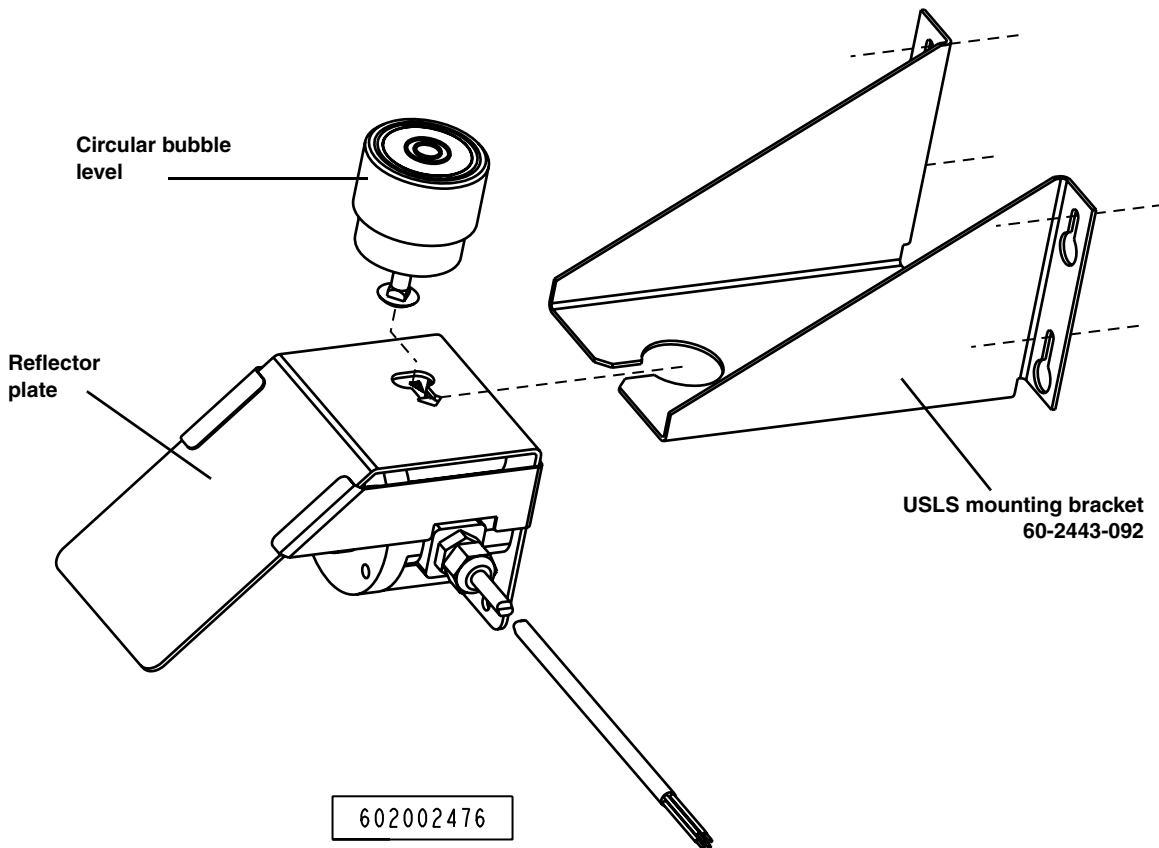


Figure 3-5 Sensor wall mount hardware



Figure 3-6 Attaching the reflector plate assembly to mounting hardware

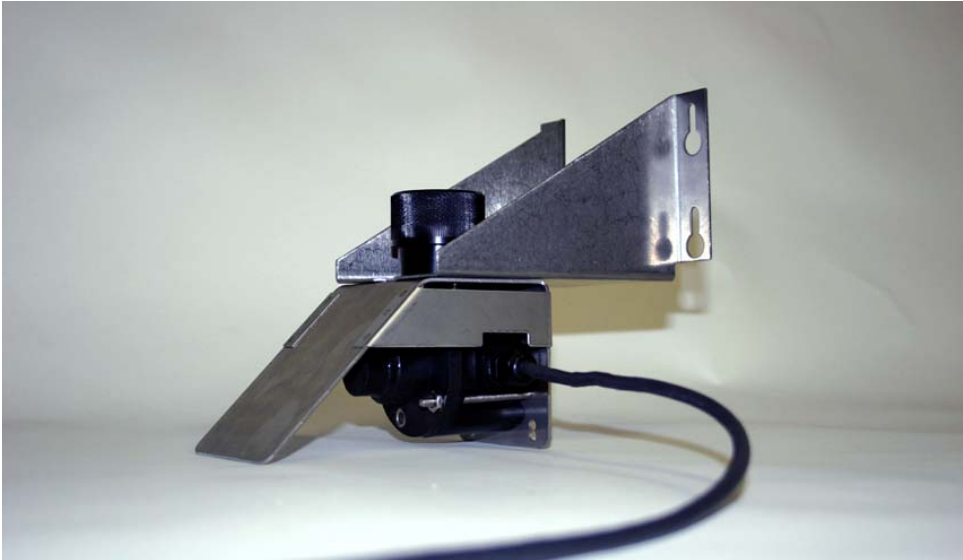


Figure 3-7 Side view of the USLS with wall-mount bracket

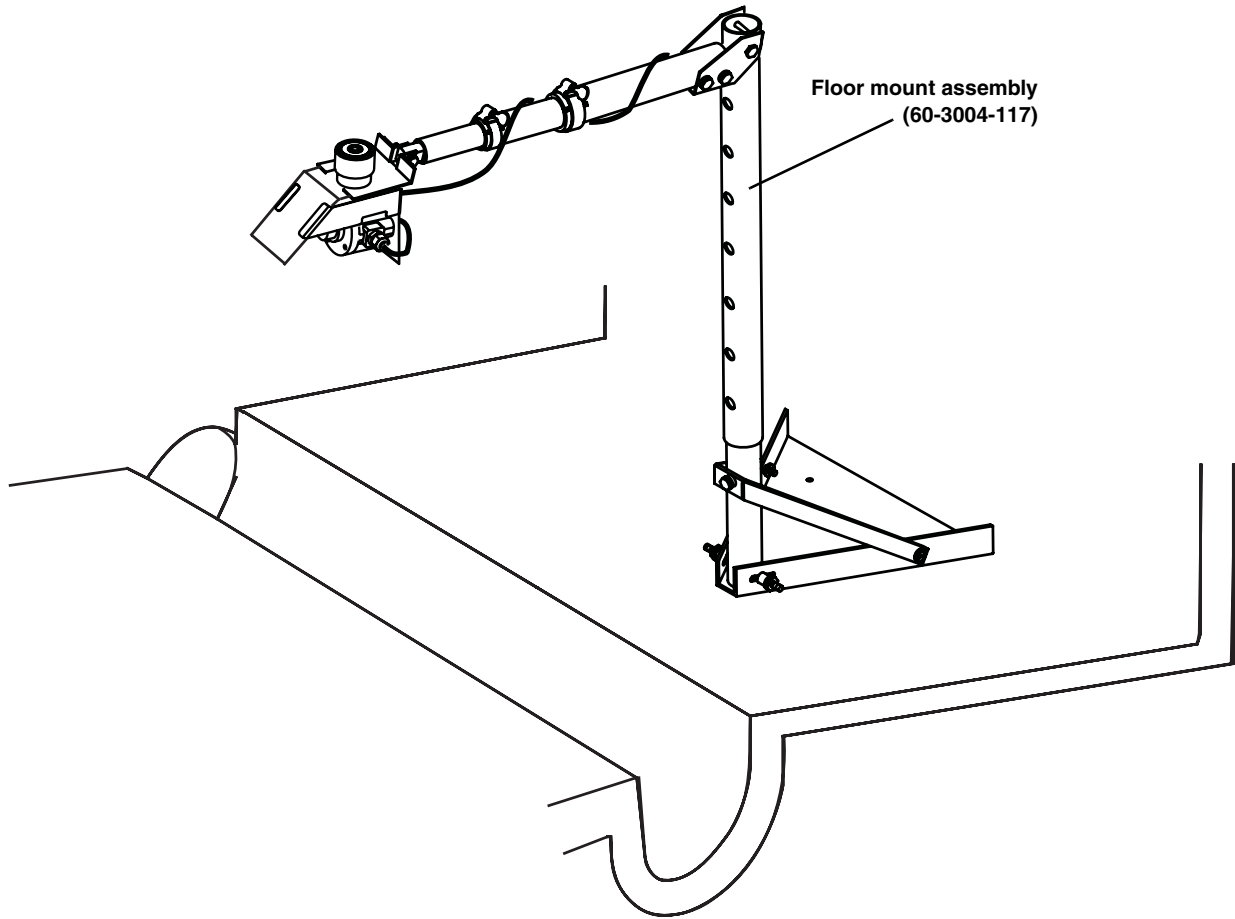


Figure 3-8 USLS installed on a floor mount

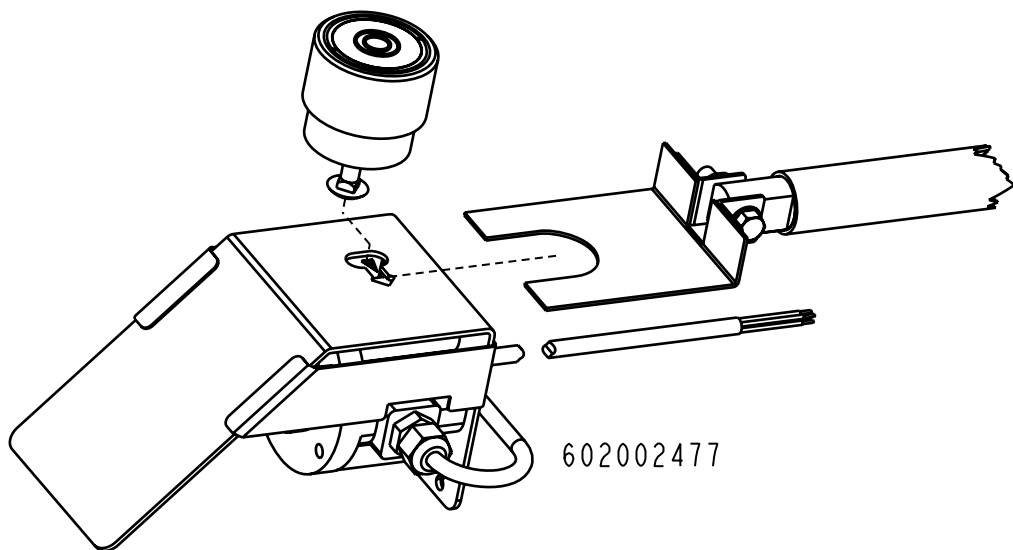


Figure 3-9 Sensor floor mount hardware

3.5.2 Suspending the Sensor In a stable indoor environment, the Ultrasonic Level Sensor may be suspended over the flow stream from a stabilizer bar (Figures 3-10 and 3-11). The weighted cable straightener, available from Teledyne Isco, forces the sensor to hang plumb.

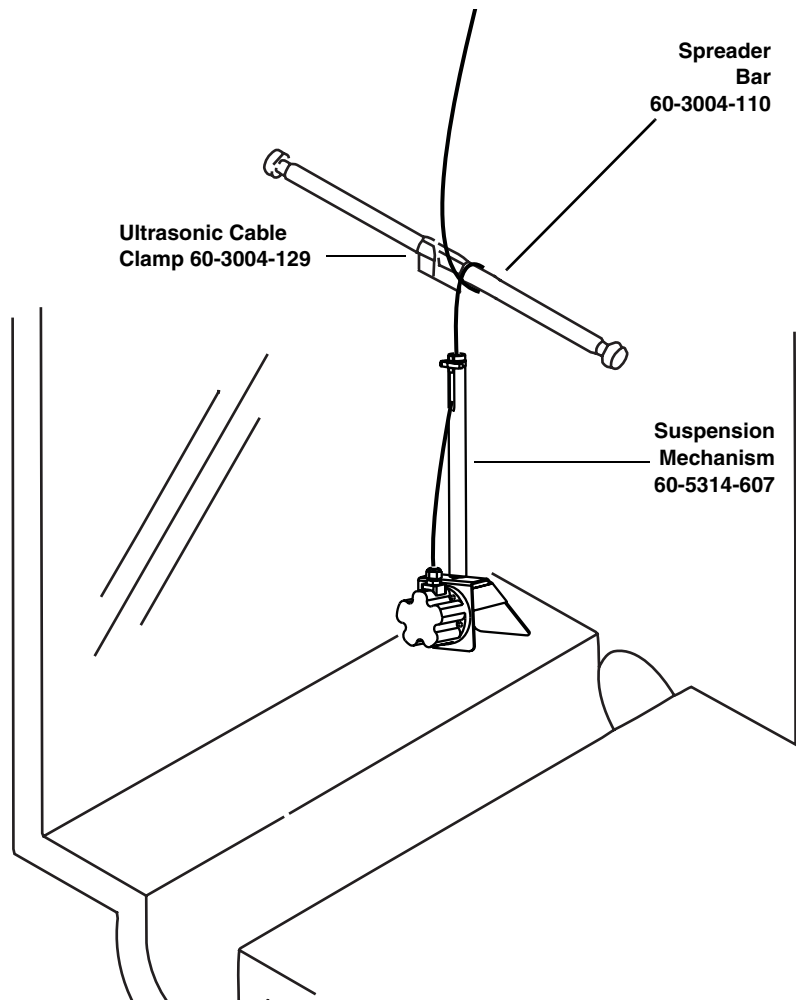


Figure 3-10 Suspension mounting of the USLS

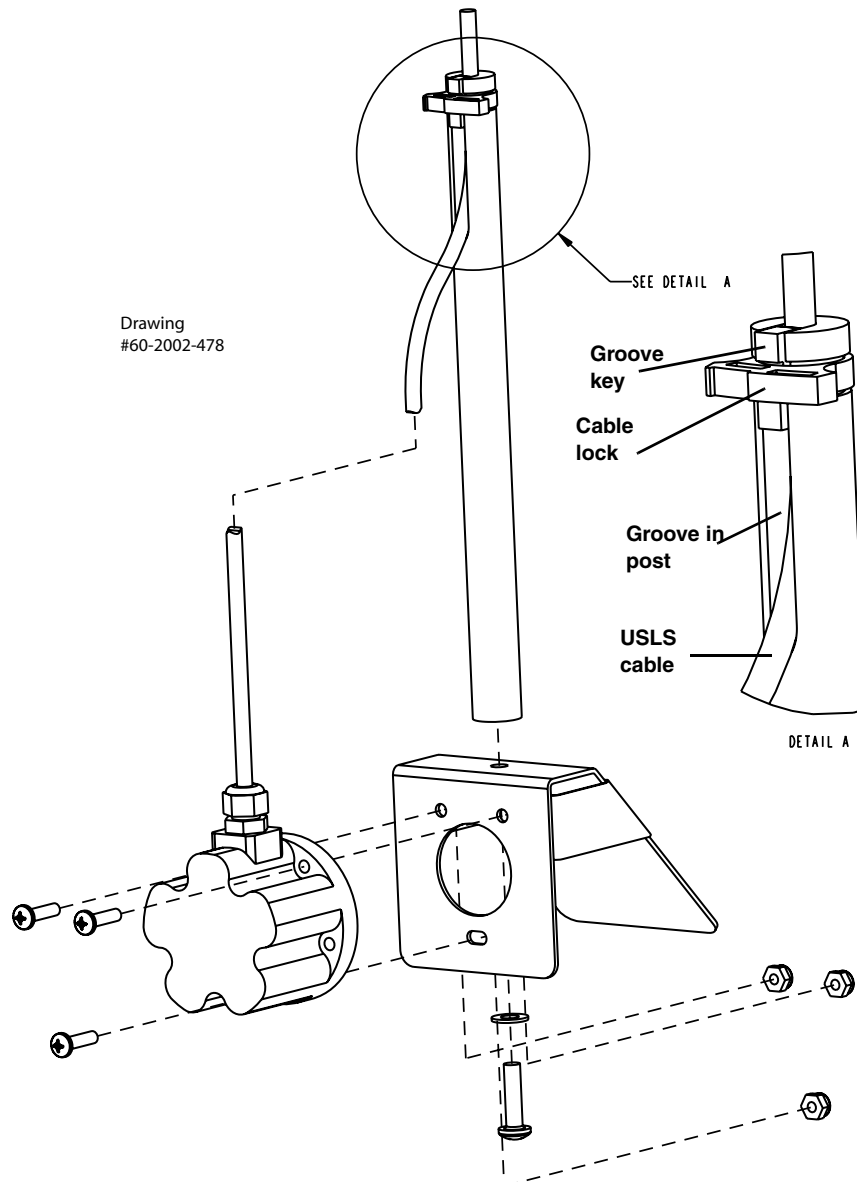


Figure 3-11 Suspension mounting hardware assembly

Note

When assembling the suspension mechanism, ensure that the groove in the suspension post remains aligned forward with the sensor cord as shown, and that the slot in the groove key is facing outward (Figure 3-11, Detail A).

3.5.3 In-Pipe Sensor Mounting

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 Ultrasonic Level Sensor is mounted inside the pipe, slightly ahead of the point where the submerged Area Velocity Probe is mounted (Figure 3-12).

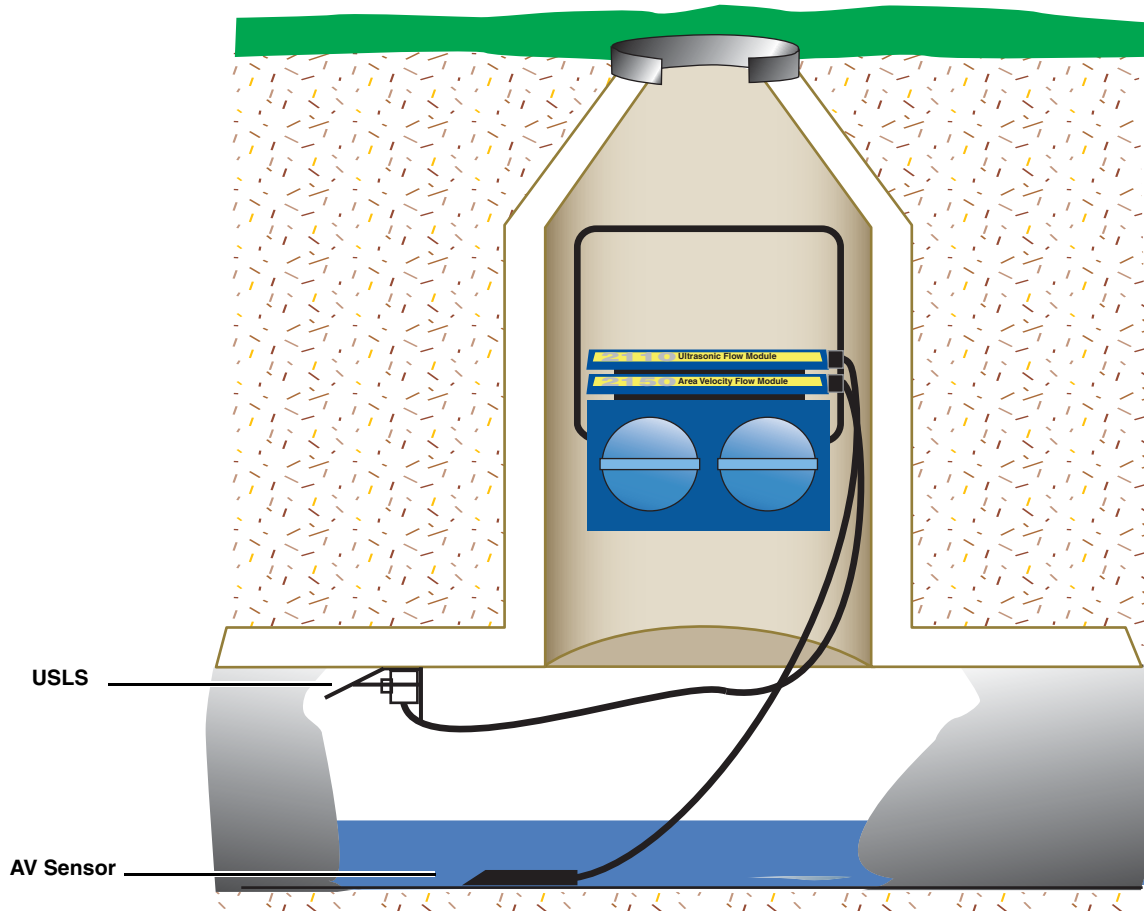


Figure 3-12 In-Pipe Mounting for Redundant Measurement (hardware not shown)

Scissors Ring

This type of installation requires special hardware, including the Scissors Ring (also known as the Universal Mounting Ring) and the sensor mount kit (60-3007-001).

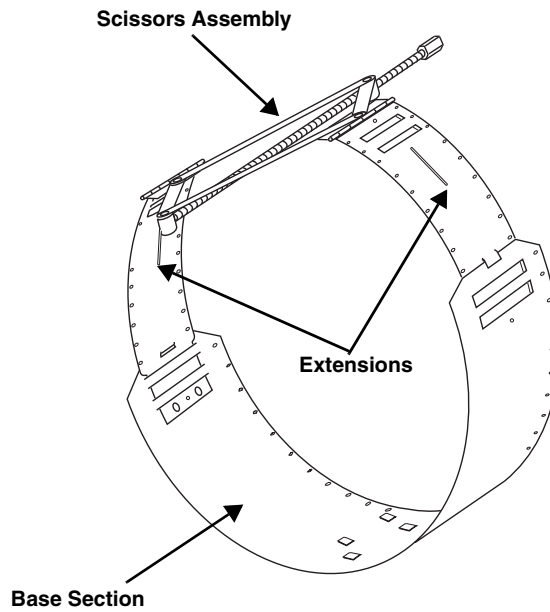
Note

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

The mounting ring consists of two or more metal strips that lock together with tabs to form a single assembly. There is a base section where the area velocity sensor is mounted, two or more extension sections (usually), and a scissors section at the top for the dual purpose of supporting the USLS over the stream and expanding the entire assembly to tighten it inside the pipe.

The sensor mount kit contains special hardware for mounting the USLS on the scissor mechanism. The scissors section contains a long screw that increases the length of the section as it is tightened. Section 3.5.4 details the USLS sensor mount kit assembly and attachment of the sensor.

The assembled scissors rings fit pipe diameters from 16" to 80".



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

Figure 3-13 Mounting Ring Adjustment

3.5.4 Scissor Mechanism and Sensor Mounting

The following figures are a guide for assembly and installation of the sensor with a scissor ring (kit #60-3007-001).

1. Using a $\frac{3}{8}$ " socket wrench and a #2 Phillips screwdriver, attach the hinges to the sensor support brackets using #6 screws and locknuts.



Figure 3-14 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 3-15.

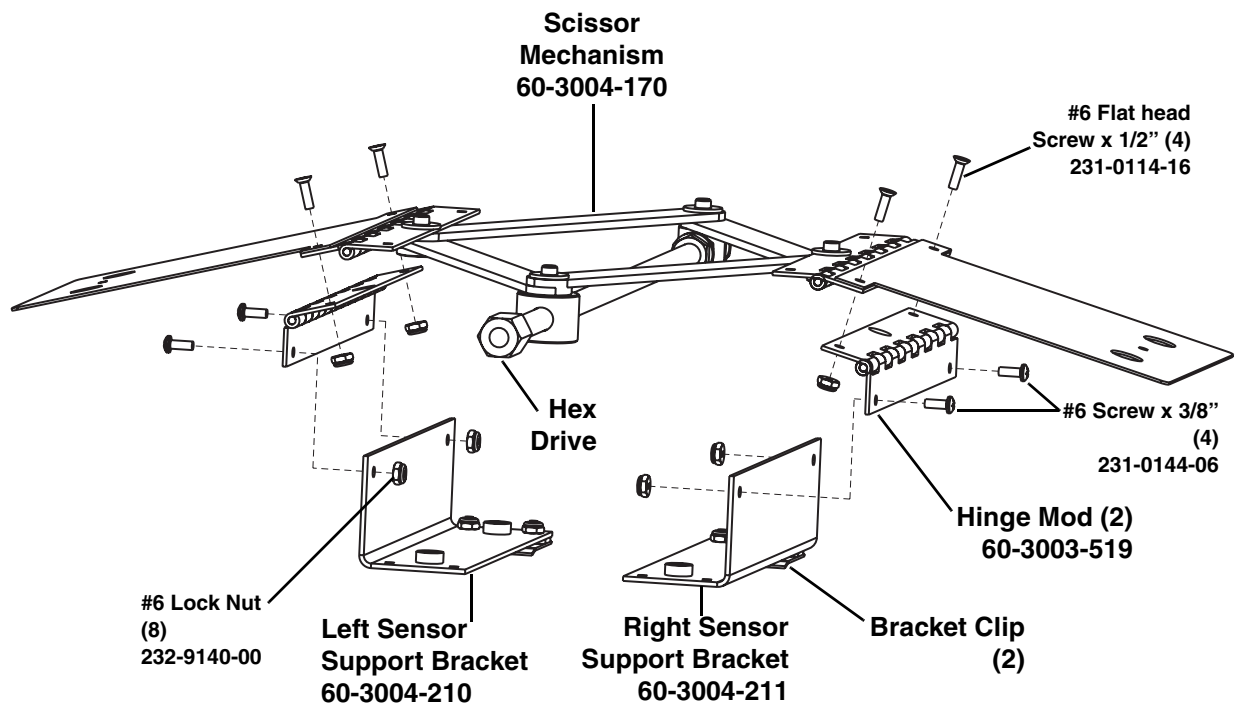


Figure 3-15 Assembling the Sensor Mount Kit

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 3-16), allowing more room. Both bracket clips **MUST** still point forward, away from the hex drive.

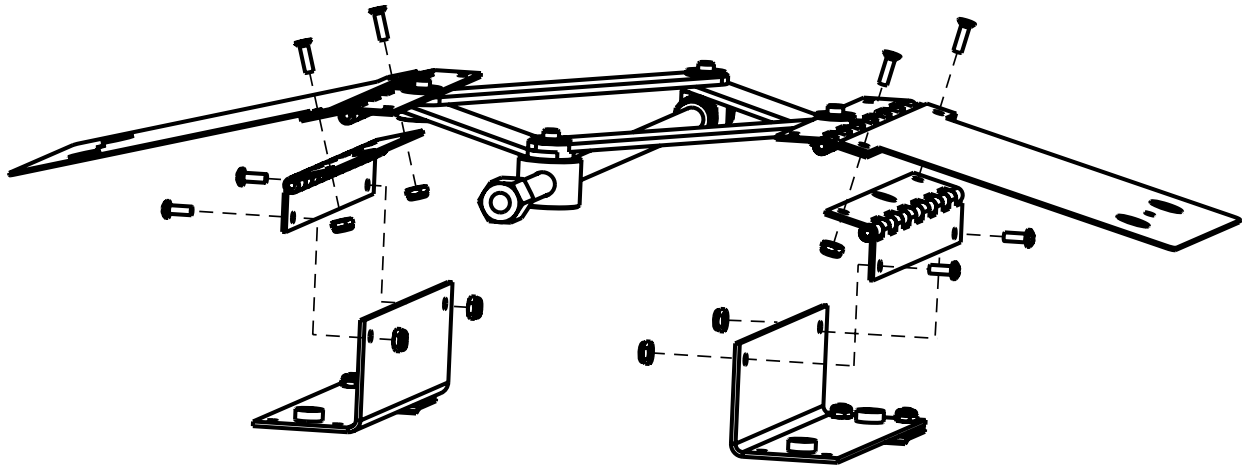


Figure 3-16 Sensor mount assembly with sensor support brackets reversed

3. Slide the tongue sections of the scissor mechanism into the slots and over the securing buttons on the base extensions (Figure 3-17) or at the ends of the base section (Figure 3-19).

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 3-18). 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.

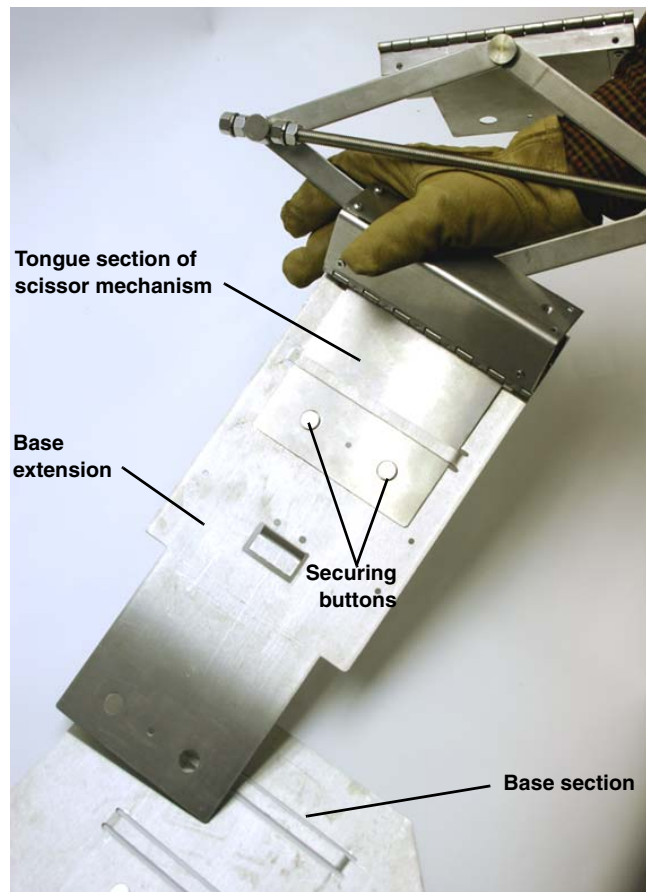


Figure 3-17 Connecting the scissor mechanism to a base extension



Figure 3-18 Bend the base and/or extension to fully engage the buttons

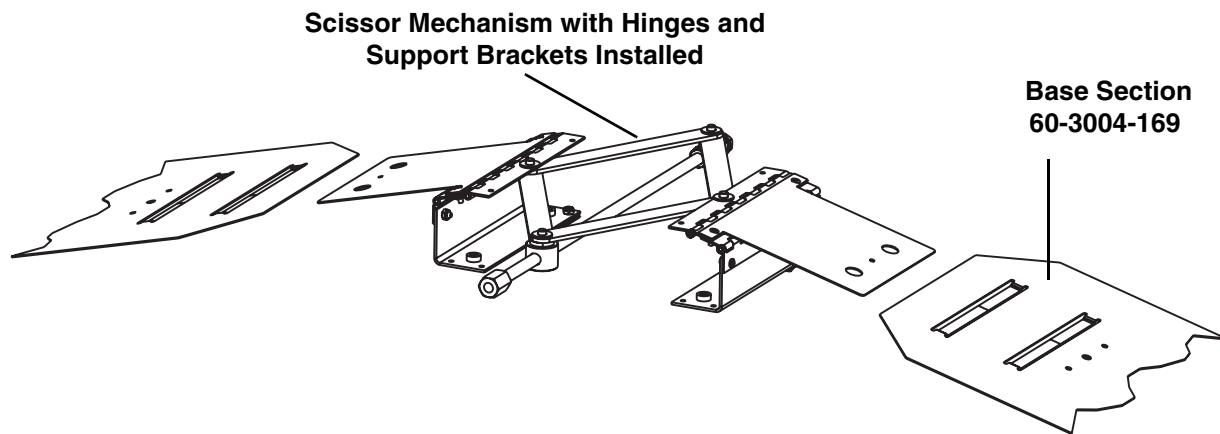


Figure 3-19 Attaching the scissor mechanism to the mounting ring



Figure 3-20 Scissors mechanism connected with extension and base

4. Attach the sensor mounting bracket to the mounting plate as shown in Figure 3-21. Attach the sensor to the mounting bracket with the transducer facing down through the hole, facing the same direction as the flat edge of the mounting plate.

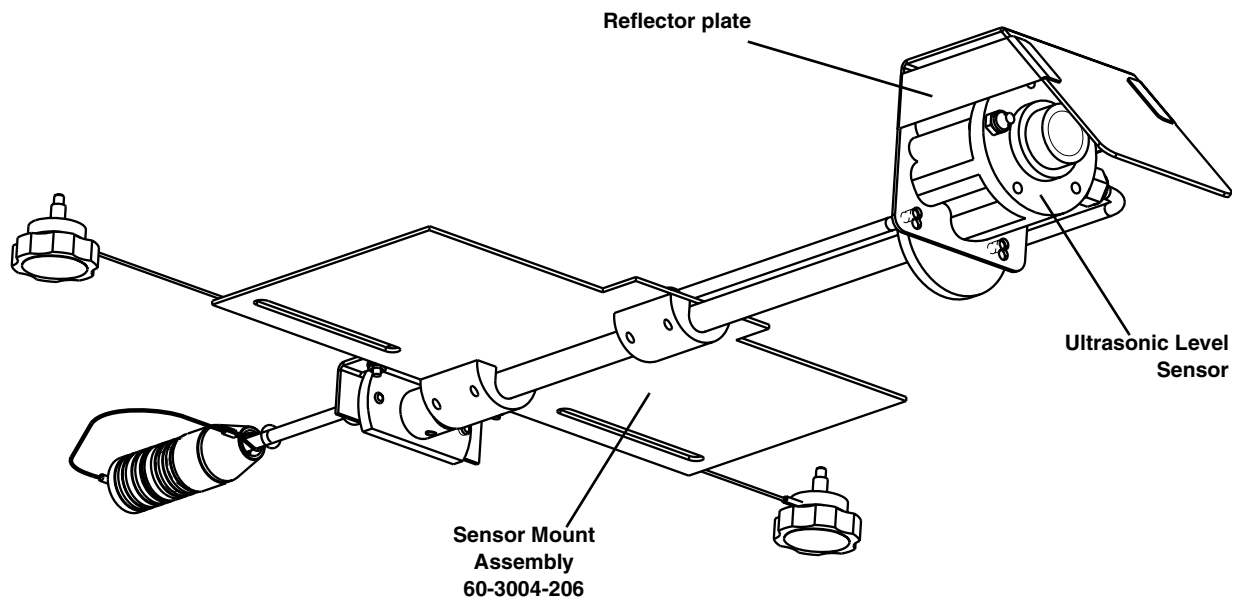


Figure 3-21 USLS attached to the sensor mount assembly

5. Slide the Sensor Mount Assembly forward into the support bracket clips (Figure 3-22) 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.

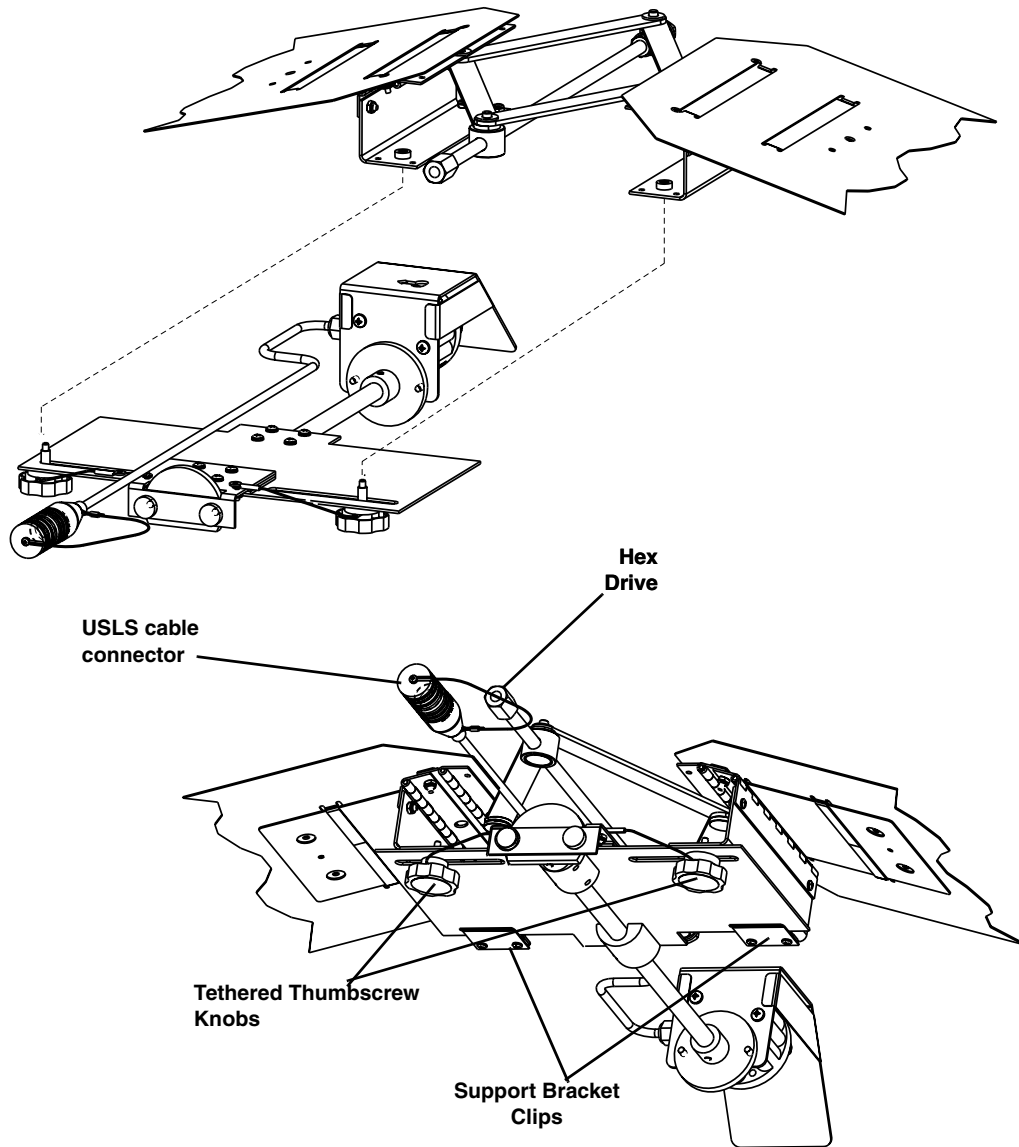


Figure 3-22 Installing the Sensor Mount Assembly on the Scissors Ring Assembly

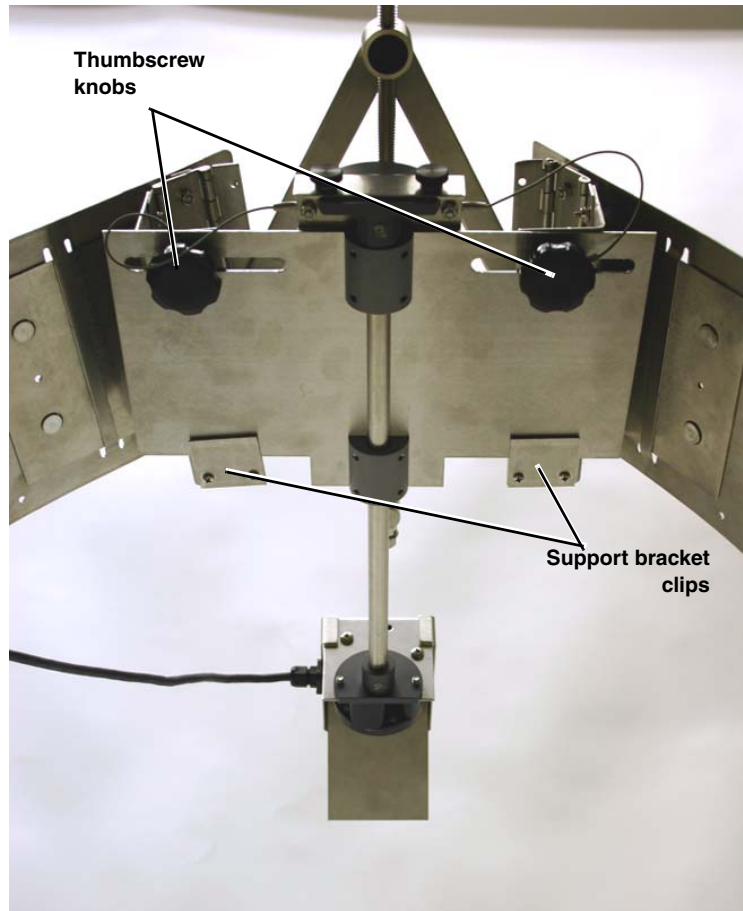


Figure 3-23 Sensor with mount assembly installed in scissors ring

6. Use a level to adjust the orientation of the sensor and tighten the adjustment thumbscrews (Figure 3-24). Secure the sensor cable to the scissor mechanism using the cable ties provided in the sensor mount kit.

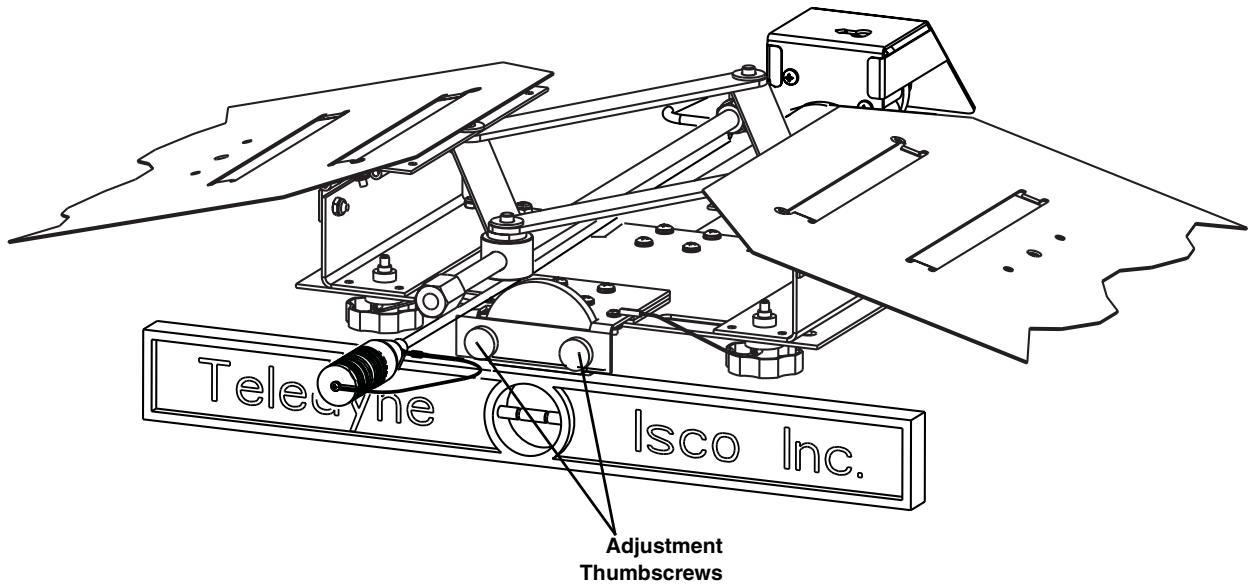


Figure 3-24 Adjusting Sensor Position



Figure 3-25 Scissor ring and sensor assembled

3.5.5 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.

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.

Errors caused by the ultrasonic level sensor operating at a different temperature than the ambient can be quite serious. For example, with a distance of only two feet and a temperature difference of 35° F, the level error is:

$$\text{Level Error} = 0.001 \times 35 \times 2 = 0.070 \text{ Foot}$$

(about 1 inch)

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 Prolonged 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 High-Frequency Background Noise – Noise in the transducer's operating frequency range (about 148 kHz) can interfere with the 2110's operation. The 2110 uses a tuned circuit to filter noise outside the operating frequency, but it cannot filter noise near the operating frequency without tuning out its own signal.

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, as shown in Figure 3-26.

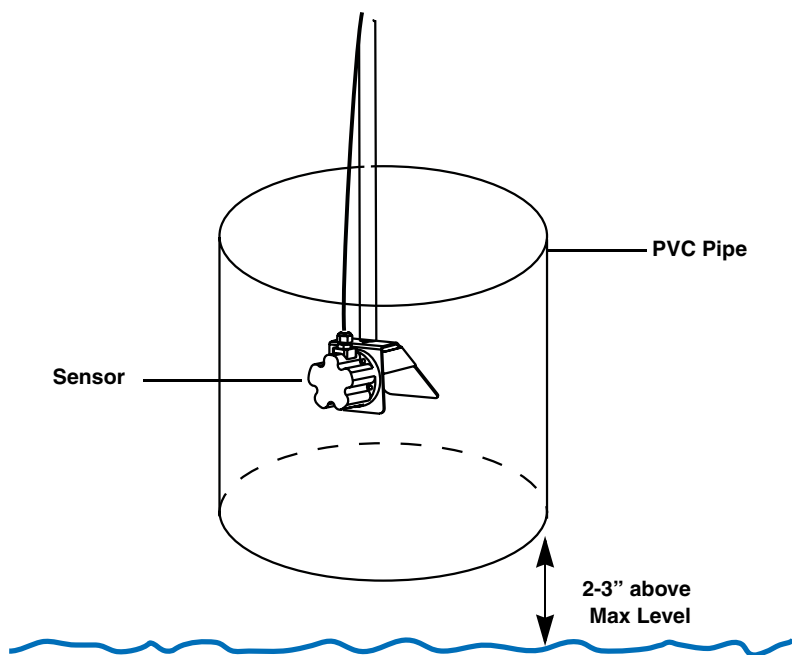


Figure 3-26 Shielding the Ultrasonic Wave

Avoid Excessive Distances – Although the ultrasonic level sensor cannot be mounted closer than 0.3 feet 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. Some users have found that mounting the ultrasonic level sensor horizontally and aiming it at a 45° angled reflector will keep water from collecting on the level sensor's radiating surface.

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.

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 12° 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 less. 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. For example, if the beam angle is 12° (1.5 m sensor), the equation is:

$$\text{Minimum Width} = 0.21 \times \text{Distance}$$

...where Distance is the distance from the bottom of the ultrasonic level sensor to the minimum expected level.

3.6 Installing the Modules

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

A **spreader bar** is 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 where they will be protected from 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 6.6.1.

 **CAUTION**

Long-term submersion (several hours or more), 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 P/N 202-1006-69).

Route the sensor cables carefully without kinks or sharp bends. Keep any excess cable out of the channel to prevent debris from snagging and collecting. Protect them from traffic in the area.

3.7 Program the Module

After you have installed the USLS above the flow stream, the flow stream properties must be defined. To do this, connect to the 2110 with *Flowlink* for Windows 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**

The 2100 System requires Flowlink 4.1 or later. Earlier versions do not support 2100 System instruments. For maximum Flowlink capabilities, Teledyne Isco recommends using Flowlink 4.16 or later.

Refer to Section 4, which describes how to define level, flow conversion, and other properties.

2110 Ultrasonic Flow Module

Section 4 Programming

4.1 Section Overview

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

Note

The 2100 System requires Flowlink 4.1 or later. Earlier versions do not support 2100 System instruments.

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).

4.2 Flowlink Connections

Make the necessary wiring connections to allow your computer to communicate with the site. Figure 4-1 shows a connection using Isco's *RS232 Communication Cable*, P/N 60-2004-046.

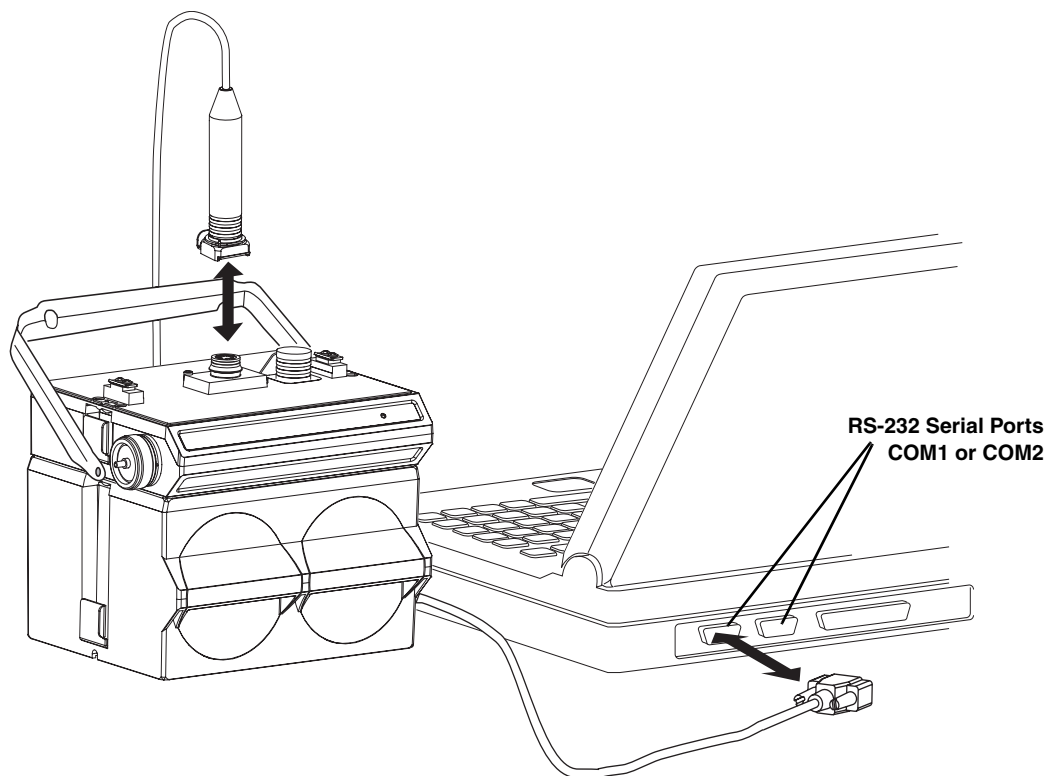


Figure 4-1 Flowlink Connections

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.

4.2.1 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.

4.3 Program Settings

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

Essential Settings

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 (4.3.1).
- **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 (4.3.2).

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 Storage tab to ensure that pertinent types of data are being stored, and that the rates will provide a sufficient amount of data for your application. Refer to section 4.3.3 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

Changing a Setting

“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 4.3.4 and 4.3.5.

After modifying a setting as described in sections 4.3.1 through 4.3.5, 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.

4.3.1 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

Before calibrating the level, allow a newly installed USLS to stabilize under site conditions. If the sensor undergoes wide temperature variations between its storage and operating environments, it may take several minutes to stabilize.

4.3.2 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 4-1 on the following page lists the available flow conversion methods. Flow conversions are defined on the *Flow Rate* measurement tab in Flowlink. To do this, select the *Conversion Type* that matches your application, then enter the required parameters in the field to the right of the selected conversion type.

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 4-1 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^0.00) + 0.00*(Head^0.00)	
Level-to-Flow Rate Data Points	User-developed tables for level-to-flow rate	3 to 50 data points	
Area Velocity (when connected to a 2150 module)	Channel Shape	Area × Velocity	Round Pipe, U-Channel, Rectangular, Trapezoidal, Elliptical
	Level-to-area Data Points	User-developed Table	3 to 50 data points

4.3.3 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 1 reading every 15 seconds, faster storage rates will shorten battery life, increase memory usage, and lengthen *Retrieve Data* (interrogation) times.

You can also create conditional data storage rates. The 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 1 minute when the level reading is greater than or equal to 1 foot. Secondary rates allow you to collect detailed data when defined events of interest occur, while reducing power and memory consumption when detailed readings are not needed.

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

4.3.4 Site Name

The 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

4.3.5 Module Name

The 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 *Modules* 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 *Modules* tab includes an *Identify* button. Highlighting a module name and clicking the *Identify* button will turn on the module's Communication Indicator.

Module names can be up to 20 characters long. Any character may be used in the name, except for those noted in *Site Name*, section 4.3.4.

2110 Ultrasonic Flow Module

Section 5 Modbus Protocol

Sections 5.1 through 5.5 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 5.4 and 5.5.

For Modbus technical specifications, turn to section 5.6.

5.1 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 flexible 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.

5.2 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. A list of the 2100 register addresses, and what parameters are held where, is available in section 5.6.

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.

**5.2.1 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.

5.2.2 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

5.3 Configurations

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

In the example shown in Figure 5-1, you are direct-connecting a server PC to two individual 2150s through Modbus, using the COM ports on the OPC Server, which are directly connected to the remote 2150s.

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 5-1, the OPC Server PC must have two COM ports. Modbus requires one COM port each, for direct connection of each 2150.

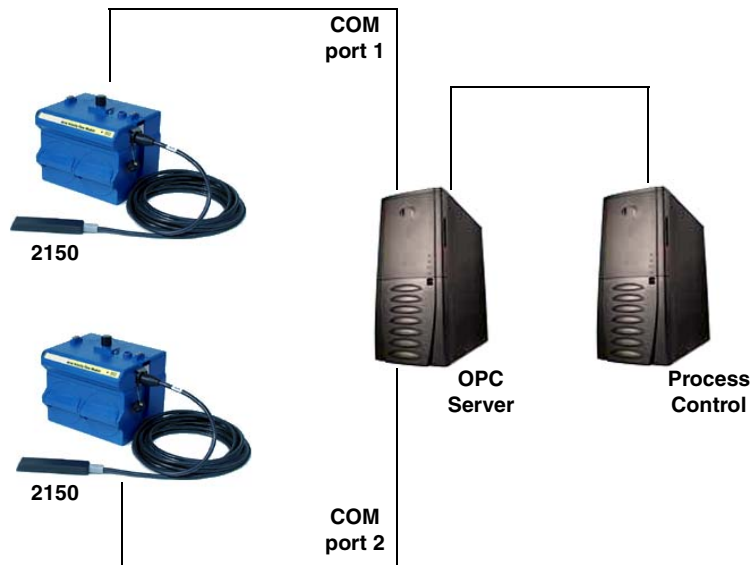


Figure 5-1 Configuration Example (Direct Connection Shown)

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.

5.4 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.

5.5 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

5.6 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 modules plus 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.

The register definitions for the Site Information device (Modbus ASCII address 1) are in Table 5-1 below:

Register Number(s)	Name	Data type	Units	Read/Write
1	Number of modules (N) (1-4)	16 bit integer	None	Read
2-20	Site name	38-byte string	None	Read

The register definitions for the individual modules (Modbus ASCII addresses 2-(N+1)) are in Table 5-1 below:

Table 5-2 Modbus ASCII Address 2-(N+1) Register Definitions				
Register Number(s)	Name	Data Type	Units	Read/Write
1-4	Model number	8-byte string	None	Read
5-23	Module name	38-byte string	None	Read
24 ¹	Identify module	16 bit integer	None	Read/Write
25 ²	Take reading flag	16 bit integer	None	Read/Write
26 ³	Update interval	16 bit integer	Seconds	Read/Write
27 ⁴	Active flag 1	16 bit field	None	Read
28	Active flag 2	16 bit field	None	Read
29	Active flag 3	16 bit field	None	Read
30	Active flag 4	16 bit field	None	Read
40,41	Level	4-byte float	Meters	Read
42	Level status code ⁵	16-bit integer		Read
43-52	Level time record	Time ⁶		Read
55,56	Velocity	4-byte float	Meters/second	Read
57	Velocity status code	16-bit integer		Read
58-63	Velocity time record	Time		Read
70,71	Flow	4-byte float	Cubic Meters/sec	Read
72	Flow status code	16-bit integer		Read
73-78	Flow time record	Time		Read
85,86	Flow 1	4-byte float	Cubic Meters/sec	Read
87	Flow 1 status code	16-bit integer		Read
88-93	Flow 1 time record	Time		Read
100,101	Volume	4-byte float	Cubic Meters	Read
102	Volume status code	16-bit integer		Read
103-108	Volume time record	Time		Read
115,116	Volume 1	4-byte float	Cubic Meters	Read

Table 5-2 Modbus ASCII Address 2-(N+1) Register Definitions (Continued)

Register Number(s)	Name	Data Type	Units	Read/Write
<p>(1) A write to the Identify module register will cause the module to perform the identify operation which may be a steady LED for a few seconds or a beep in the Field Wizard.</p> <p>(2) Setting the Take Reading flag to 1 will cause the module to update the registers with current data readings. It will be set to zero when the readings have all been updated. This may be used to initiate readings and poll for when they are ready to be read. It may take up to 50 seconds to update all the readings, depending upon the flow conditions. Setting the Take Reading flag to 2 causes an automatic, 15 second update of readings when a Modbus master is polling the 2100.</p> <p>(3) The Update Interval specifies an interval in seconds that the registers are automatically updated. It defaults to zero, which indicates that no automatic updating will occur.</p> <p>(4) The Active Flag (1-4) bit fields specify what fields/registers are active in the list. This provides support for a maximum of 64 fields. For example, if bit 0 of register 27 is set, the Level (registers 40,41) is active. If bit 1 of register 27 is set, then the Velocity (registers 55,56) is active. If bit 0 of register 28 is set, the Analog channel 7 (registers 265,266) is active.</p> <p>(5) A non-zero status code indicates a measurement problem.</p> <p>(6) Time is represented in a series of registers: Order is from lowest address to highest - Seconds (0-59), Minutes (0-59), Hours (0-23), Days (1-31), Month (1-12) and Year (1977-2099).</p>				
117	Volume 1 status code	16-bit integer		Read
118-123	Volume 1 time record	Time		Read
130,131	Voltage	4-byte float	Volts	Read
132	Voltage status code	16-bit integer		Read
133-138	Voltage time record	Time		Read
145,146	Temperature	4-byte float	Degrees Celsius	Read
147	Temperature status code	16-bit integer		Read
148-153	Temperature time record	Time		Read
160,161	Internal Temp	4-byte float	Degrees Celsius	Read
162	Internal Temp status code	16-bit integer		Read
163-168	Internal Temp time record	Time		Read
175,176	Analog channel 1	4-byte float	0-100 percent	Read
177	Analog channel 1 status code	16-bit integer		Read
178-183	Analog channel 1 time record	Time		Read
190,191	Analog channel 2	4-byte float	0-100 percent	Read
192	Analog channel 2 status code	16-bit integer		Read
193-198	Analog channel 2 time Record	Time		Read
205,206	Analog channel 3	4-byte float	0-100 percent	Read
207	Analog channel 3 status code	16-bit integer		Read
208-213	Analog channel 3 time record	Time		Read
220,221	Analog channel 4	4-byte float	0-100 percent	Read
222	Analog channel 4 status code	16-bit integer		Read
223-228	Analog channel 4 time record	Time		Read
235,236	Analog channel 5	4-byte float	0-100 percent	Read
237	Analog channel 5 status code	16-bit integer		Read

Table 5-2 Modbus ASCII Address 2-(N+1) Register Definitions (Continued)

Register Number(s)	Name	Data Type	Units	Read/Write
238-243	Analog channel 5 time record	Time		Read
250,251	Analog channel 6	4-byte float	0-100 percent	Read
252	Analog channel 6 status code	16-bit integer		Read
253-258	Analog channel 6 time record	Time		Read
265,266	Analog channel 7	4-byte float	0-100 percent	Read
267	Analog channel 7 status code	16-bit integer		Read
268-273	Analog channel 7 time record	Time		Read
280,281	Analog channel 8	4-byte float	0-100 percent	Read
282	Analog channel 8 status code	16-bit integer		Read
283-288	Analog channel 8 time record	Time		Read

Table 5-3 Measurement Parameters by Model Number*

2103, 2103C	2108	2110	2150, 2151
Voltage	Analog channel 1	Level	Level
	Analog channel 2	Flow	Velocity
	Analog channel 3	Volume	Flow
		Voltage	Flow 1
		Temperature	Volume
			Volume 1
			Voltage
			Temperature
*Subject to change.			

2110 Ultrasonic Flow Module

Section 6 Maintenance

6.1 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 6.3)
- Desiccant (section 6.4)
- Channel conditions (section 6.5)

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 obviously affect the service life of the desiccant, and the amount of debris in the stream can drastically alter the channel conditions.

As a guide, a basic system installed in an environment with moderate humidity levels and 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.

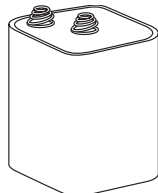
6.2 Maintenance Kits

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

Many of the parts called out in the *Installation* and *Maintenance* sections of this manual are available in maintenance kits. Kit number 60-2059-001, which supports the 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. A maintenance kit for the Ultrasonic Level Sensor is also available. You can order the kits by calling Teledyne Isco's Customer Service Department.

6.3 Batteries

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 3.4.1.

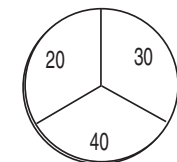


Lantern Battery

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).

6.4 Desiccant



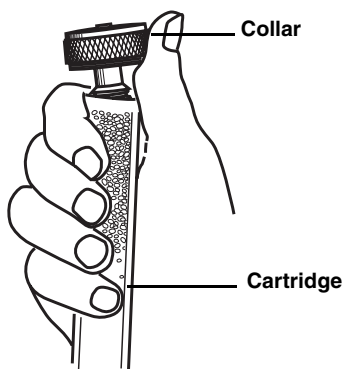
Battery Module
Humidity Indicator

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.

6.4.1 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 6.4.3) 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.

6.4.2 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 6.4.3) bag.
4. Replace the retaining plate and secure it with the screws.

6.4.3 Reactivating the Desiccant

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

 **CAUTION**

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

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

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

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

Silica gel

To reactivate the silica gel desiccant, pour the spent desiccant into a heat resistant container. Never heat the cartridge assembly; it will melt. Heat the silica gel in a *vented convection oven* at 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.

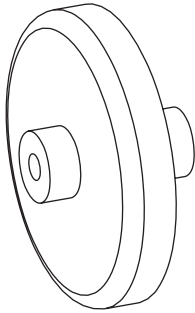
6.5 Channel Conditions

Clean the channel upstream and downstream from the sensor periodically. This maintains the hydrostatic conditions on which the level-to-area conversion is based.

6.6 Other Maintenance

Other maintenance may be performed on the 2110 and sensor as needed. Sections 6.6.1 through 6.6.3 describe these activities.

6.6.1 Hydrophobic Filter



If the 2110 is submerged, a hydrophobic filter prevents water from entering the desiccant cartridge.

To remove the hydrophobic filter, grasp the filter and pull it from the desiccant cartridge collar. The filter is only held in place by its friction fitting; rocking it back and forth while pulling may help. Firmly press the replacement filter (Isco P/N 60-2005-003) in place.

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

6.6.2 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 USLS may also be cleaned with mild detergent and warm water.

6.6.3 Sensor Cable Inspection

Erroneous level readings may not always indicate a fault inside the USLS 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 you cannot remove or replace it.

6.7 How to Obtain Service

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.

Teledyne Isco, Inc.
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 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.

6.7.1 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

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.

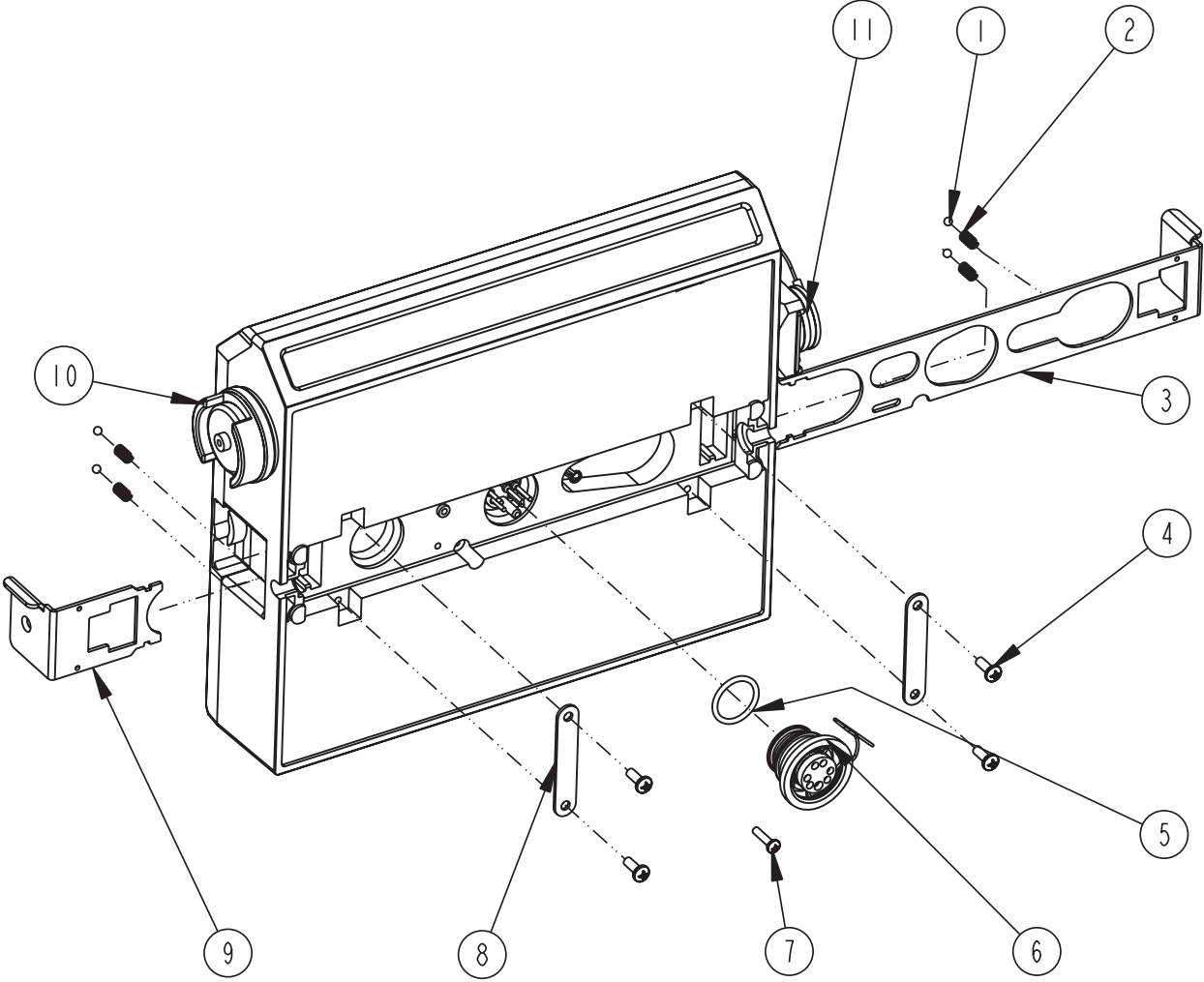
Replacement parts can be purchased by contacting Teledyne Isco's Customer Service Department.

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

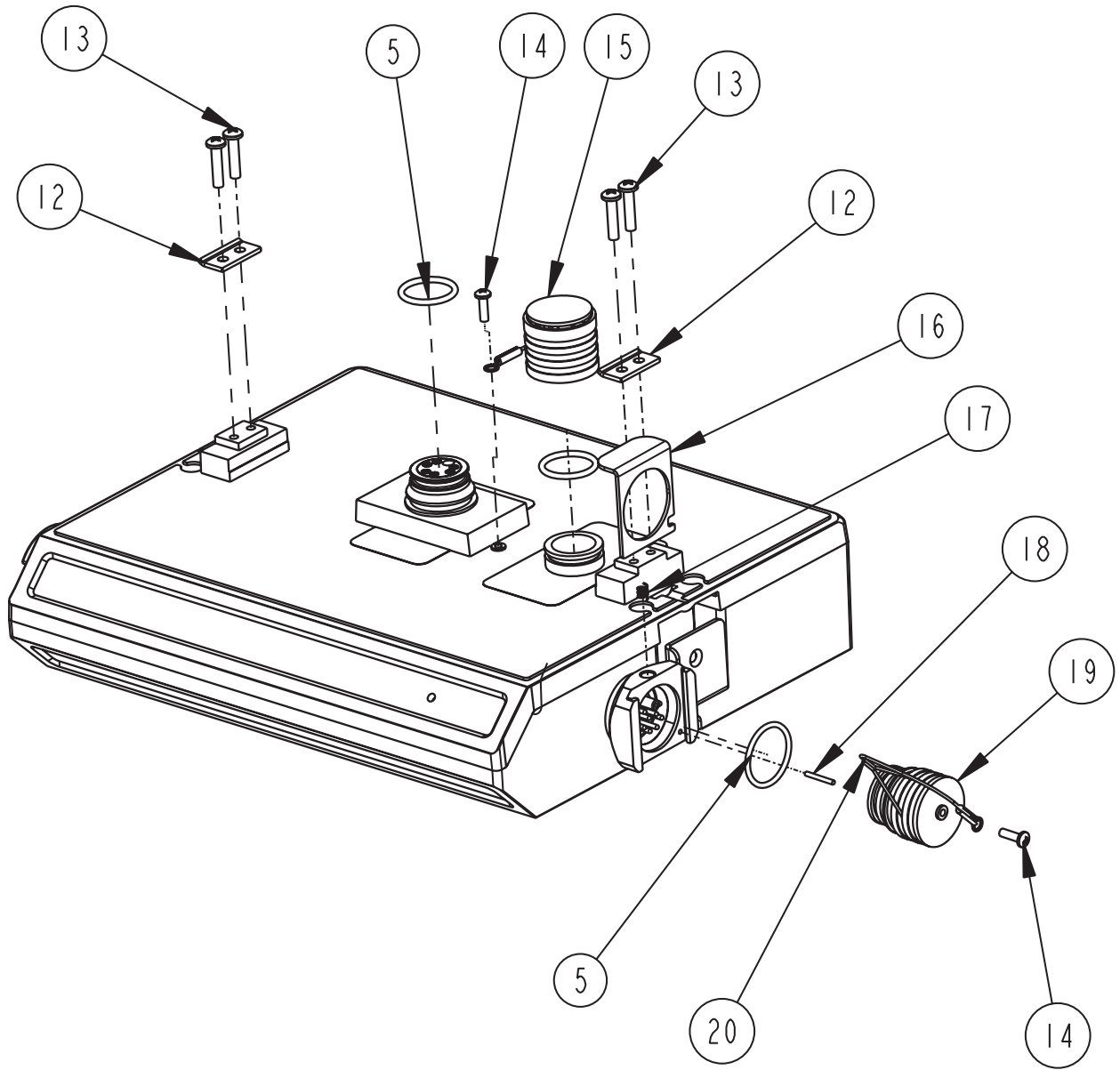
Phone: (800) 228-4373
(402) 464-0231
FAX: (402) 465-3022

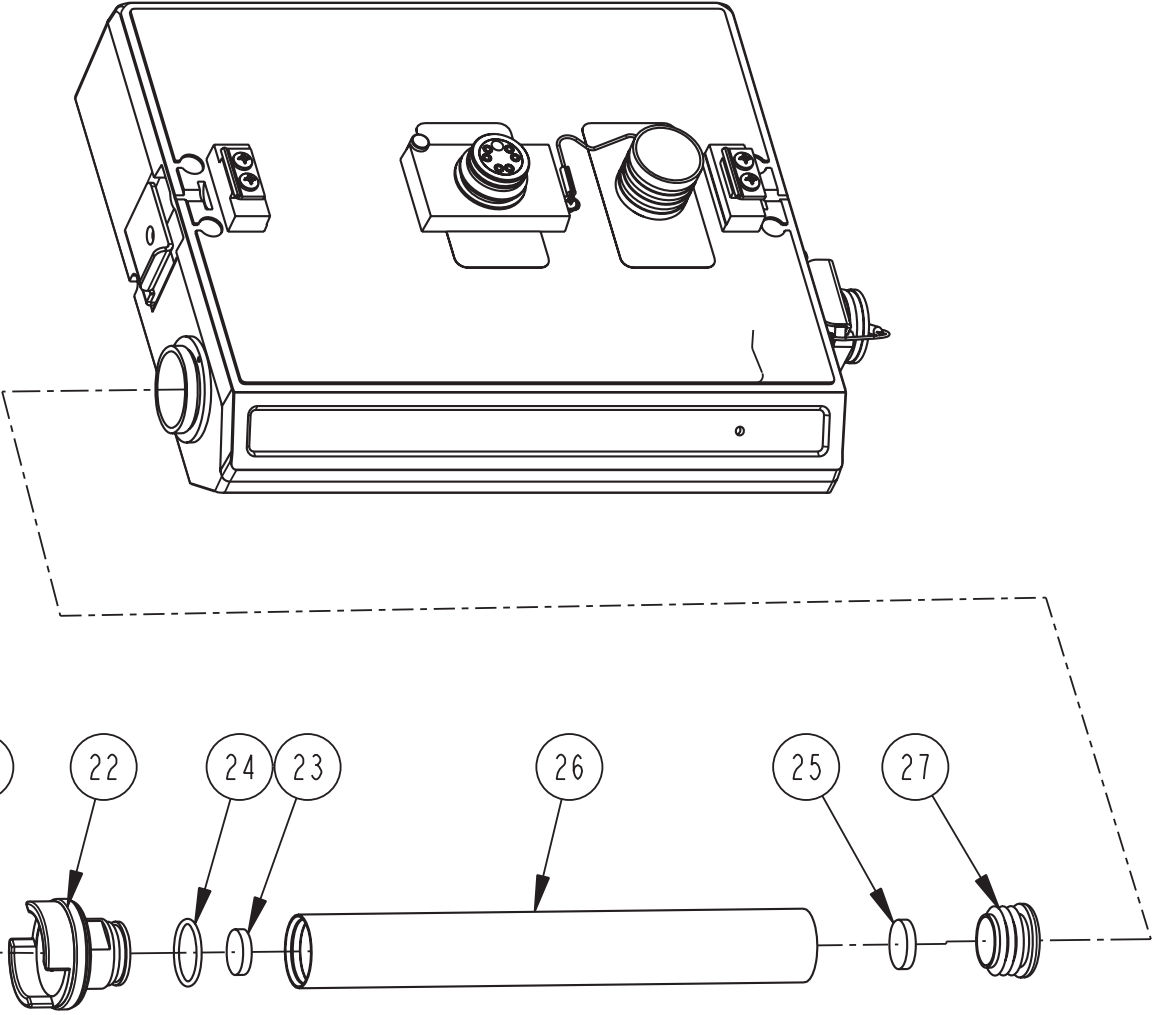
E-mail: IscoInfo@teledyne.com

2110 Ultrasonic Flow Module
Appendix A Replacement Parts



DRAWING NO.
602003112
SHEET 1 OF 5
C





REPLACEMENT PARTS LIST		602003112
TELEDYNE ISCO, INC.		SHEET: 4 OF 5
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	602005003	AIR FILTER MODIFICATION, IN-LINE
22	602004264	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.

602003112

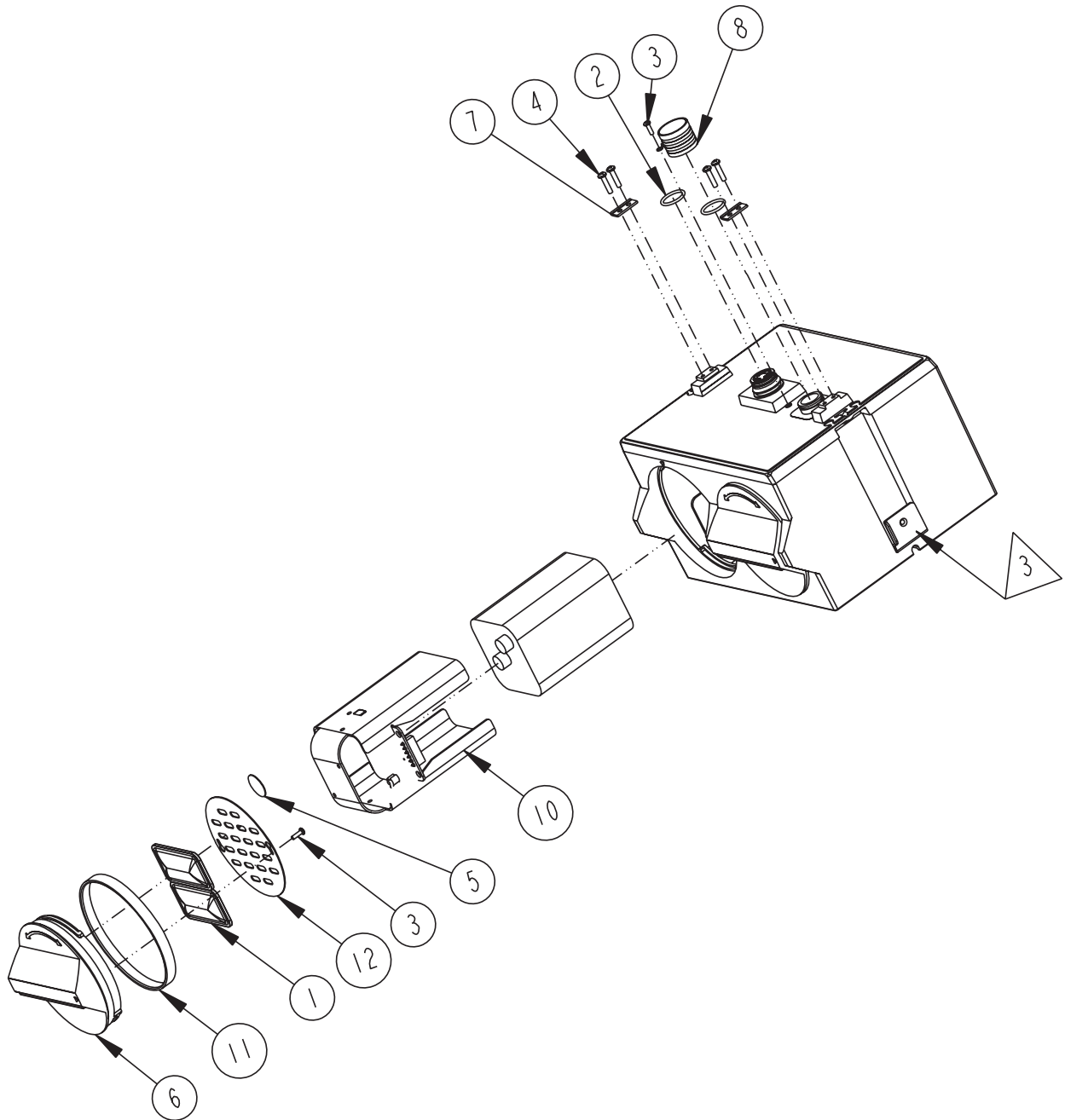
SHEET: 5 OF 5

REV: C	DATE: 06233
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REPLACEMENT PARTS LIST
TELEDYNE ISCO, INC.

ITEM NO.	PART NUMBER	DESCRIPTION
27	602003074	CAP PLUG MODIFICATION, DESICCANT

NOTE: 1. For current prices and quotations on parts, contact Isco Service Department.
2. This list is subject to change without notice.




602003113

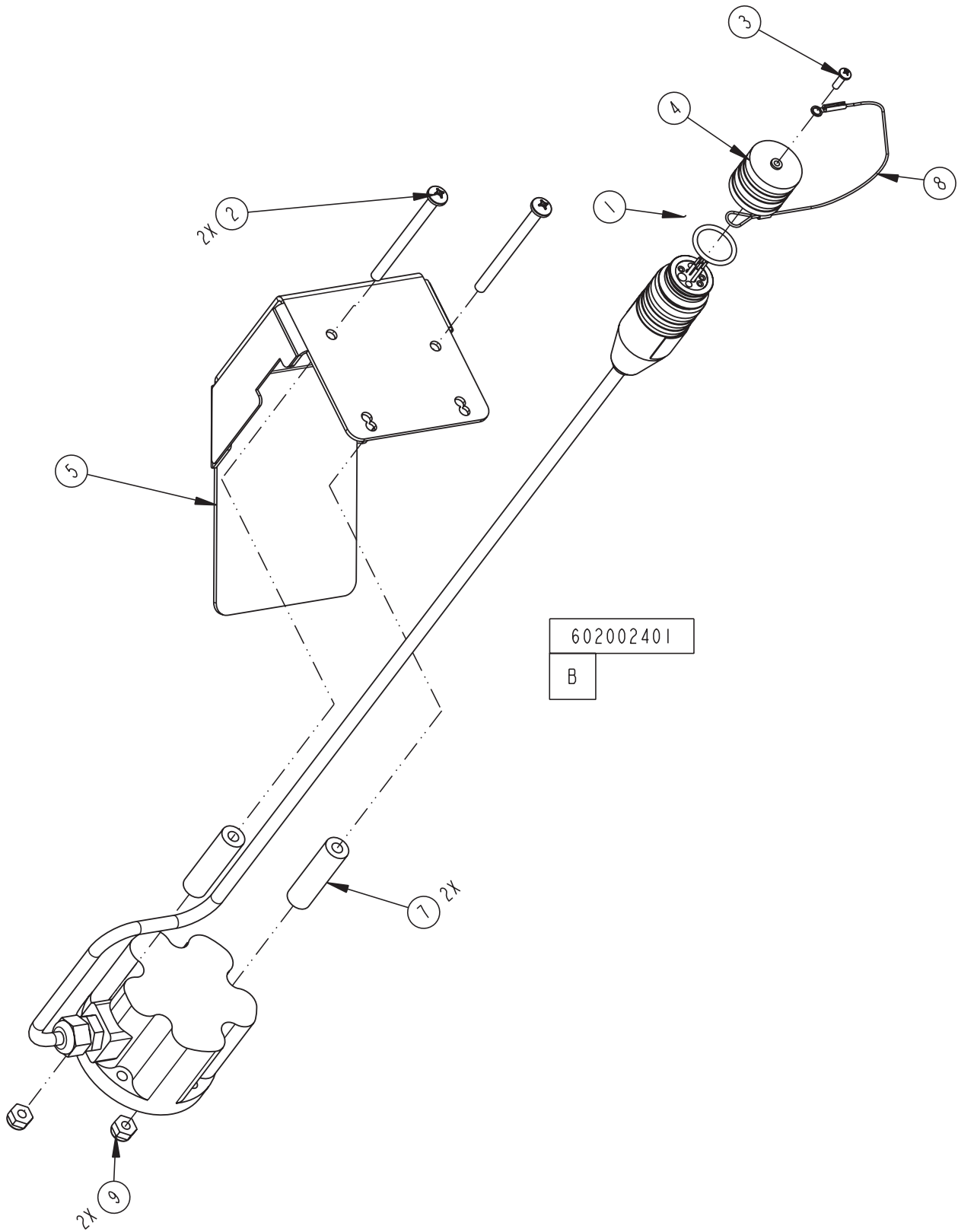
REPLACEMENT PARTS LIST

TELEDYNE ISCO, INC.

SHEET: 2 OF 2

REV: A DATE: 06200

ITEM NO.	PART NUMBER	DESCRIPTION
1	099000201	DESICCANT BAG 16.5 GRAM
2	202100669	O RING, .669 ID, .079 CROSS SECTION, BUNA-N RUBBER
3	231310140	SCREW, SELF TAP, #4 X 3/8, PAN HEAD, PHILLIPS, SST
4	231514920	SCREW, SELF TAP 6-19 X 5/8, TORX, PAN HEAD, SST
5	490001300	HUMIDITY INDICATOR CARD
6	602003014	CAP BATTERY NODE
7	602003019	NODE CLIP
8	602004012	CAP ASSEMBLY, MALE CONNECTOR
9	602004017	BATTERY CAP ASSEMBLY (Includes 1, 3, 5, 6, 11, & 12)
10	602004030	BATTERY HOLDER ASSEMBLY
11	692003017	BATTERY CAP GASKET
12	692003067	BATTERY CAP PLATE
	Refer to 2150/2110 module for a listing of parts associated with latch and lower communication port cap.	
NOTE: 1. For current prices and quotations on parts, contact Isco Service Department. 2. This list is subject to change without notice.		



2110 Ultrasonic Flow Module

Appendix B Accessories

B.1 How to Order

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

Teledyne Isco, Inc.
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 Accessories

2110 Ultrasonic Module	60-2004-400
2110 Ultrasonic Module with 1.5m Sensor	68-2000-018
2110 Ultrasonic Module with 1.5m Sensor and 2191 Battery Module	68-2000-019
2110 Ultrasonic Sensor, 1.5m	60-2004-407
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
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
ProHanger bracket for 18-20 inch (45-50 cm) manhole.	209-9006-01
ProHanger bracket for 20-22 inch (50-56 cm) manhole.	209-9006-02
Spreader Bar adjusts from 22.5 to 48 inches (57 to 122 cm)	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
Sunshade	60-3004-142

**B.3 USLS Mounting
Accessories**

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

Sensor Mounting Bracket	60-2443-092
Sensor Floor Mount	60-3004-117
Sensor Cable Clamp	60-3004-129
Sensor Ring Mount Kit	60-3007-001
Sensor Grommet	60-2003-404
Weighted Sensor Suspension Mechanism	60-2003-404

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

Trade Name and Synonyms:	Silica Gel, Synthetic Amorphous Silica, Silicon, Dioxide
Chemical Family:	Synthetic Amorphous Silica
Formula:	SiO ₂ .x H ₂ 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

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

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

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

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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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.

Material Safety Data Sheet

Indicating Silica Gel

Identity (Trade Name as Used on Label)

Manufacturer : MULTISORB TECHNOLOGIES, INC. (formerly Multiform Desiccants, Inc.)	MSDS Number* : M75
Address: 325 Harlem Road Buffalo, NY 14224	CAS Number* :
Phone Number (For Information): 716/824-8900	Date Prepared: July 6, 2000
Emergency Phone Number: 716/824-8900	Prepared By* : G.E. McKedy

Section 1 - Material Identification and Information

Components - Chemical Name & Common Names (Hazardous Components 1% or greater; Carcinogens 0.1% or greater)	%*	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED
Silica Gel SiO ₂	98.0	6mg/m ³ (total dust)	10mg/m ³ (total dust)	
Cobalt Chloride	>2.0	0.05mg/m ³ (TWA cobalt metal dust & fume)	.05mg/m ³ (Cobalt, TWA)	
Non-Hazardous Ingredients				
TOTAL	100			

Section 2 - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H ₂ O = 1)	2.1
Vapor Pressure (mm Hg and Temperature)	N/A	Melting Point	N/A
Vapor Density (Air =1)	N/A	Evaporation Rate (=1)	N/A
Solubility in Water	Insoluble, but will adsorb moisture.	Water Reactive	Not reactive, but will adsorb moisture.
Appearance and Odor	Purple crystals, no odor.		

Section 3 - Fire and Explosion Hazard Data

Flash Point and Methods Used	N/A	Auto-Ignition Temperature	N/A	Flammability Limits in Air % by Volume	N/A	LEL	UEL
Extinguisher Media	Dry chemical, carbon dioxide and foam can be used.						
Special Fire Fighting Procedures	Water will generate heat due to the silica gel which will adsorb water and liberate heat.						
Unusual Fire and Explosion Hazards	When exposed to water, the silica gel can get hot enough to reach the boiling point of water. Flooding with water will reduce the temperature to safe limits.						

Section 4 - Reactivity Hazard Data

STABILITY <input type="checkbox"/> Stable <input type="checkbox"/> Unstable	Conditions To Avoid	Moisture and high humidity environments.
Incompatibility (Materials to Avoid)	Water.	
Hazardous Decomposition Products	Carbon dioxide, carbon monoxide, water	
HAZARDOUS POLYMERIZATION <input type="checkbox"/> May Occur	Conditions To Avoid	None.

*Optional

Indicating Silica Gel

Section 5 - Health Hazard Data					
PRIMARY ROUTES OF ENTRY	<input type="checkbox"/> Inhalation <input type="checkbox"/> Ingestion <input type="checkbox"/> Skin Absorption <input type="checkbox"/> Not Hazardous				
HEALTH HAZARDS	<table style="width: 100%; border: none;"> <tr> <td style="width: 20%; border: none;">Acute</td> <td style="border: none;">May cause eye, skin and mucous membrane irritation.</td> </tr> <tr> <td style="border: none;">Chronic</td> <td style="border: none;">Prolonged inhalation may cause lung damage.</td> </tr> </table>	Acute	May cause eye, skin and mucous membrane irritation.	Chronic	Prolonged inhalation may cause lung damage.
Acute	May cause eye, skin and mucous membrane irritation.				
Chronic	Prolonged inhalation may cause lung damage.				
Signs and Symptoms of Exposure	Drying and irritation.				
Medical Conditions Generally Aggravated by Exposure	Asthma.				
EMERGENCY FIRST AID PROCEDURES - Seek medical assistance for further treatment, observation and support if necessary.					
Eye Contact	Flush with water for at least 15 minutes.				
Skin Contact	Wash affected area with soap and water.				
Inhalation	Remove affected person to fresh air.				
Ingestion	Drink at least 2 glasses of water.				

Section 6 - Control and Protective Measures	
Respiratory Protection (Specify Type)	Use NIOSH approved dust mask or respirator.
Protective Gloves	Light cotton gloves.
Eye Protection	Safety glasses.
VENTILATION TO BE USED	<input type="checkbox"/> Local Exhaust <input type="checkbox"/> Mechanical (General) <input type="checkbox"/> Special <input type="checkbox"/> Other (Specify)
Other Protective Clothing and Equipment	None.
Hygienic Work Practices	Avoid raising dust. Avoid contact with skin, eyes and clothing.

Section 7 - Precautions for Safe Handling and Use/Leak Procedures	
Steps to be Taken if Material Is Spilled Or Released	Sweep or vacuum up and place the spilled material in a waste disposal container. Avoid raising dust.
Waste Disposal Methods	Dispose in an approved landfill according to federal, state and local regulations.
Precautions to be Taken In Handling and Storage	Cover promptly to avoid blowing dust. Wash after handling.
Other Precautions and/or Special Hazards	Keep in sealed containers away from moisture. The silica gel will readily adsorb moisture.

*Optional

Indicating Silica Gel



MATERIAL SAFETY DATA SHEET

Effective Date March 8, 2005
MSDS Number M163

Section 1 – Product and Company Information

Product Name: Silica gel, indicating, yellow

Product Use: Desiccant, absorbent

Grades: Silica gel, indicating

Synonyms: Amorphous silica gel, SiO₂, silicon dioxide (amorphous)

Company: Multisorb Technologies, Inc.

Street Address: 325 Harlem Road

City, State, Zip, Country: Buffalo, NY 14224-1893 USA

Telephone Number: (716) 824 8900 [USA] Monday - Friday (8:00 - 5:00 EDT)

Fax Number: (716) 824 4091 [USA]

Website / E-Mail : multisorb.com

Section 2 – Composition / Information on Ingredients

Component Name	CAS Number	% by Weight
Synthetic amorphous silica gel (SiO ₂)	112926-00-8	100
Phenolphthalein	77-09-08	100 ppm

While this material is not classified, this MSDS contains valuable information critical to the safe handling and proper use of this product. This MSDS should be retained and available for employees and other users of this product.

Section 3 – Hazard Identification

Emergency Overview: A yellow bead or granular material that poses little or no immediate hazard. This material is not combustible.

Potential Health Effects:

Eyes: Dust and or product may cause eye discomfort and irritation seen as tearing and reddening.

Skin: The product dust may cause drying of the skin. Silica gel may get hot enough to burn skin when it adsorbs moisture rapidly. Use an excess of water to cool the silica gel.

Ingestion: Material is not toxic and will pass through the body normally.

Inhalation: Slight irritation is possible but none is expected.

Medical Effects Generally Aggravated by Exposure: Respiratory ailments.

Chronic Effects/Carcinogenicity: May cause eye, skin and mucous membrane irritation and drying.

Section 4 – First Aid Measures

- Eyes:** Rinse the eyes well with water while lifting the eye lids. If irritation persists, consult a physician.
- Skin:** Wash affected area with soap and water.
- Ingestion:** Ingestion is unlikely, this material will pass through the body normally.
- Inhalation:** Remove the affected person to fresh air and get medical attention if necessary.
- Notes to Physician:** Not applicable

Section 5 – Fire Fighting Measures

- Flammable Properties:** Not flammable
- Flash Point:** Not applicable **Method:** Not applicable
- Flammable Limits:** Not flammable
- Lower Flammability Limit:** Not applicable
- Upper Flammability Limit:** Not applicable
- Autoignition Temperature:** Not applicable
- Hazardous Combustion Products:** Not applicable
- Extinguishing Media:** Use extinguishing media that is appropriate for the surrounding fire. Silica gel is not combustible.
- Fire Fighting Instructions:** Not combustible
- Unusual Fire and Explosion Hazards:** None

Section 6 – Accidental Release Measures

- Spill:** Sweep or vacuum up and place the spilled material in a waste disposal container. Avoid raising dust. Wash with soap and water after handling.

Section 7 – Handling and Storage

- Handling:** Avoid raising dust and minimize the contact between worker and the material. Practice good hygienic work practices.
- Storage:** Store in a cool, dry location. Keep in sealed containers away from moisture. The silica gel will readily adsorb moisture.

Section 8 – Exposure Controls/Personal Protection

- Engineering Controls:** Use exhaust ventilation to keep the airborne concentrations below the exposure limits.
- Respiratory Protection:** Use NIOSH approved respirator when the air quality levels exceed the TLV's.
- Skin Protection:** Light gloves will protect against abrasion and drying of the skin.
- Eye Protection:** Safety glasses.

Component Name	Exposure Limits		
	OSHA PEL	ACGIH TLV	Other Recommended Limits
Silica gel	TWA 20 mppcf (80 mg / m ³ % SiO ₂)	TWA 10 mg / m ³	NIOSH REL TWA 6 mg / m ³ IDLH 3000 mg / m ³
Phenolphthalein	Not Applicable	Not Applicable	Not Applicable

Section 9 – Physical and Chemical Properties

- Appearance:** Yellow beads or granules **Vapor Density:** Not applicable
- Odor:** None **Boiling Point:** 4046° F (2230° C)
- Physical State:** Solid bead **Melting Point:** 3110° F (1710° C)
- PH:** Not applicable **Solubility:** Insoluble in water
- Vapor Pressure:** Not applicable **Specific Gravity:** 2.1

Section 10 – Stability and Reactivity

- Stability:** Stable
- Conditions to avoid:** Moisture and high humidity environments.
- Incompatibility:** Water, fluorine, oxygen difluoride, chlorine trifluoride
- Hazardous Decomposition Products:** None
- Hazardous Polymerization:** Will not occur

Section 11 – Toxicological Information

This product and its components are not listed on the NTP or OSHA Carcinogen lists.

Animal Toxicology Tests for DOT Hazard classification
(Tests Conducted on finely ground silica gel)
1 - hour LC₅₀ (rat) > 2 mg / l
48 - hour oral LD₅₀ (rat) est. > 31,600 mg / kg
48 - hour dermal LD₅₀ (rabbit) est. > 2,000 mg / kg
Considered an ocular irritant

Human Toxicology Silica gel is a synthetic amorphous silica not to be confused with crystalline silica. Epidemiological studies indicate low potential for adverse health effects. In the activated form, silica gel acts as a desiccant and can cause a drying irritation of the mucous membranes and skin in cases of severe exposure. Multisorb Technologies Inc. knows of no medical conditions that are abnormally aggravated by exposure to silica gel. The primary route of entry is inhalation of dust.

Section 12 – Ecological Information

Not known to have any adverse effect on the aquatic environment. Silica gel is insoluble and non-toxic.

Section 13 – Disposal Information

Disposal Information If this product as supplied becomes a waste, it does not meet the criteria of a hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) 40 CFR 261. Materials of a hazardous nature that contact the product during normal use may be retained on the product. The user of the product must identify the hazards associated with the retained material in order to assess the waste disposal options. Dispose according to federal, state and local regulations.

Section 14 – Transportation Information

U.S. Department of Transportation Shipping Name: Not classified as a hazardous material. Not regulated.

Section 15 – Regulatory Information (Not meant to be all inclusive - selected regulations represented)

TSCA Listed: Yes

DSL/NDSL (Canadian) Listed: Yes

OSHA: TWA 20 mppcf (80 mg / m³ % SiO₂) for Silica gel

NIOSH: REL TWA 6 mg / m³ IDLH 3,000 mg / m³ for silica gel
Animal tests conducted in 1976 - 1978. 18 month exposure at 15 mg / m³ showed silica deposition in respiratory macrophages and lymph nodes, minimum lung impairment, no silicosis.

ACGIH: TLV - 10 mg / m³ for Silica gel

DOT: Not classified as a hazardous material.

Section 16 – Other Information

HMIS – Hazardous Materials Identification System

HMIS Rating	
Health	0
Flammability	0
Reactivity	0

0 - minimal hazard, 1 - slight hazard, 2 - moderate hazard, 3 - serious hazard, 4 - severe hazard

This MSDS was prepared by: George E. Mckedy
Senior Applications Development Specialist
Multisorb Technologies, Inc.

This data and recommendations presented in this data sheet concerning the use of our product and the materials contained therein are believed to be correct but does not purport to be all inclusive and shall be used only as a guide. However, the customer should determine the suitability of such materials for his purpose before adopting them on a commercial scale. Since the use of our products is beyond our control, no guarantee, expressed or implied, is made and no responsibility assumed for the use of this material or the results to be obtained therefrom. Information on this form is furnished for the purpose of compliance with Government Health and Safety Regulations and shall not be used for any other purposes. Moreover, the recommendations contained in this data sheet are not to be construed as a license to operate under, or a recommendation to infringe, any existing patents, nor should they be confused with state, municipal or insurance requirements, or with national safety codes.

2110 Ultrasonic Flow Module

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 H₂S. 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 H₂S, in the air. This is considered to be a lethal concentration. Many people have died from H₂S, not only in sewers and industries, but also from swamps and from hot springs. In one resort area, at least five persons died from H₂S poisoning before the people were ready to admit that H₂S is not a therapeutic agent. Hardly a year passes in the U.S. without a sewer fatality from H₂S as well as deaths elsewhere in the world.

The presence of H₂S 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 H₂S 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 H₂S 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 H₂S 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 H₂S.

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 dTeledyne Iscomfort 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 H₂S concentrations, flammable atmospheres, and hazards of physical injuries. Remember that much H₂S 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 ₃	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 ₆ H ₆	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 ₂	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 ₂	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 ₄	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 ₂	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 ₂ 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 ₅ H ₁₂ to C ₉ H ₂₀	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 ₂	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 ₂ 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 ₂ S Ampoule. 2. 5% by weight lead acetate solution.
Methane	CH ₄	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 ₂	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 ₂ detector tube.
	N ₂ O	Colorless, sweet odor.	1.53	Asphyxiant.						
	NO ₂	Reddish-brown. Irritating odor. Deadly poison	1.58	100 ppm dangerous. 200 ppm fatal.						
Oxygen	O ₂	Colorless, odorless, tasteless. Supports combustion.	1.11	Normal air contains 20.8% of O ₂ . 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 ₃	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 ₂	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 ₅ H ₁₂ to C ₉ H ₂₀	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 ₁₀ H ₁₆	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 ₈ H ₁₀	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.

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。

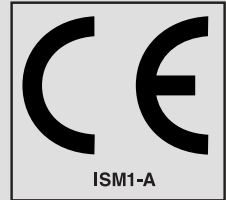
The Environmentally Friendly Use Period (EFUP) was determined through experience.

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.

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: 2110 Ultrasonic Level Flow Module and Sensor
Year of Issue: 2004
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	A
EN61000-4-3	Radiated RF Immunity	80 MHz to 1000MHz 80% AM at 1kHz Level 3 – 10V/m	A
EN61000-4-4	Electrical Fast Transient	Level 3 – 1kV on 10m sensor cable	A
*EN61000-4-6	*Conducted RF Immunity	*Level 2 – 150Khz to 30Meghz 3Vrms on 10m sensor cable	B
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	

*Sensor levels changed beyond published specifications between 159 KHz to 367 KHz and 367 KHz to 374 KHz.

We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of January 15, 2004

William Foster
USA Representative

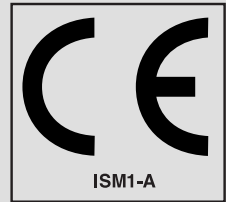


William Foster
Director of Engineering
Isco, Inc.
4700 Superior Street
Lincoln, Nebraska 68504

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

60-2002-404
Rev A.

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 *

Teledyne Isco warrants covered products against failure due to faulty parts or workmanship for a period of one year (365 days) from their shipping date, or from the date of installation by an authorized Teledyne Isco Service Engineer, as may be appropriate.

During the warranty period, repairs, replacements, and labor shall be provided at no charge. Teledyne Isco's liability is strictly limited to repair and/or replacement, at Teledyne Isco's sole discretion.

Failure of expendable items (e.g., charts, ribbon, tubing, lamps, glassware, seals, filters, fittings, and wetted parts of valves), or from normal wear, accident, misuse, corrosion, or lack of proper maintenance, is not covered. Teledyne Isco assumes no liability for any consequential damages.

This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

This warranty applies only to products sold under the Teledyne Isco trademark and is made in lieu of any other warranty, written or expressed.

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

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

*** This warranty applies to the USA and countries where Teledyne Isco Inc. 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.**

In the event of instrument problems, always contact the Teledyne Isco Service Department, as problems can often be diagnosed and corrected without requiring an on-site visit. In the U.S.A., contact Teledyne Isco Service at the numbers listed below. International customers should contact their local Teledyne Isco agent or Teledyne Isco International Customer Service.

Return Authorization

A return authorization number must be issued prior to shipping. Following authorization, Teledyne Isco will pay for surface transportation (excluding packing/crating) both ways for 30 days from the beginning of the warranty period. After 30 days, expense for warranty shipments will be the responsibility of the customer.

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

Mailing address: Teledyne Isco, Inc.
PO Box 82531
Lincoln NE 68501 USA

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

Fax: (402) 465-3001

Email: iscoservice@teledyne.com **Web site:** www.isco.com



