ADFM® Pro20/Hot Tap Acoustic Doppler Flow Meters

Installation and Operation Guide

TELEDYNE ISCO
Everywhere**you**look™

Foreword

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

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

If a problem persists, call or e-mail 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 Support

Phone:	Toll Free (866) 298-6174	(Samplers and Flow Meters)
	Toll Free (800) 775-2965	(Syringe Pumps and Liquid Chromatography)
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

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 of the following general warnings:

⚠ WARNING

Avoid hazardous practices! If you use this instrument in any way not specified in this manual, the protection provided by the instrument may be impaired.

⚠ AVERTISSEMENT

Éviter les usages périlleux! Si vous utilisez cet instrument d'une manière autre que celles qui sont specifiées dans ce manuel, la protection fournie de l'instrument peut être affaiblie; cela augmentera votre risque de blessure.

Safety Precautions

This section contains a list of items you should be aware of every time you use your ADFM Flow Meter.

- Servicing instructions are for use by service-trained personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so.

- Do not install substitute parts or perform any unauthorized modifications to the instrument.

- Any maintenance and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by skilled and qualified personnel.

- Capacitors inside the instrument may still be charged even if the instrument has been disconnected from power.

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.

ADFM® Flow Meter

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ADFM® Flow Meter

Section 1 Introduction

1.1 Overview

The **ADFM Pro20 Velocity Profiler** is designed for high accuracy flow measurement for applications in pipe diameters/flow depths up to 20 feet (6.1m), and in channels up to 10 feet (3m) wide. Common applications include installation in circular, rectangular, or trapezoidal channels. The system is also frequently installed in irregular shaped (multi-point) channels. A variety of hardware accessories for sensor installation is available from Teledyne Isco (see Table 2-1 in Section 2.6.8). In many cases, these accessories can be adapted for use in other channel shapes.

The **ADFM Intrinsic Safety Pro20 Velocity Profiler** is certified by Factory Mutual Research Corporation. An IS system consists of the flow meter located in a nonhazardous location, connected to a sensor located in a class I, II, and III, Division 1, Groups C, D, E, F, and G, or Class I, Zone 0, IIB hazardous (classified) locations with Type 6P protection; indoor/outdoor locations; and/or connection to a Druck Inc. PTX 1830 sensor in a class I, II, and III, Division 1, Groups A, B, C, D, E, F, and G hazardous (classified) locations.

Complete information about IS systems is provided in Appendix B.

The **ADFM Hot Tap Velocity Profiler** measures flow rates in full and pressurized pipes and forced mains with inner diameter of 1.5 feet (457 mm) to 9 feet (2.74m). The Hot Tap Insertion sensor (HTI) is inserted through the pipe wall via an industry standard, two-inch corporate-stop or ball valve and tapping saddle.

Both Pro20 and HTI systems use pulse-doppler velocity profiling technology to measure the velocity distribution within the flow.

For either system, the controlling electronics are housed in a wall or console mountable box enclosure, or in a cylindrical canister housing for suspension mounting in a manhole or other wet environment. All ADFM systems can be powered by external 24 VDC power. Internal batteries provide backup power for continuous operation.

Ordering information for parts and accessories for these systems can be found in Appendix A in the back of this manual.

1.2 Initial Inspection

Upon receipt, inspect the shipping container for any damage. If the shipping container or packing material shows signs of damage, it should be retained until the contents have been inspected for completeness and the system has been checked both mechanically and electrically. If the contents are incomplete or damaged, or if the system indicates a failure in some component during initial testing, notify Teledyne Isco as soon as possible, and notify the carrier regarding any damage to the shipping container and packing material.

Contact Information

Technical assistance for the ADFM flow meter can be obtained from:

Teledyne Isco
4700 Superior St.
Lincoln NE 68504

Phone: (866) 298-6174 or (402) 464-0231
Fax: (402) 465-3022
E-mail: IscoService@teledyne.com

1.3 Technical Specifications

The following tables provide technical specifications for the ADFM box and cylindrical electronics controllers, and for the Pro20 open channel and Hot Tap Insertion velocity sensors.

Table 1-1 Technical Specifications: ADFM Controller	
Physical	
Electronics Unit Enclosures	Wall or console-mounted box, or cylindrical canister
Operating Temperature	-15 to 125 °F (-26 to 52 °C)
Storage Temperature	-65 to 160 °F (-54 to 71 °C)
Packaging Box Canister	 NEMA 4X (IP66) NEMA 6P (IP68)
Dimensions Box Canister	 17.5 x 14.8 x 6.7 in. (445 x 375 x 170 mm) 28.5 x 10 in. (724 x 254 mm)
Weight Box Canister	 24 lbs (11 kg) 36 lbs (16 kg)
Measurement Performance	
Flow	
Accuracy	2% of reading in typical conditions
Velocity	
Maximum Velocity	±30.0 ft/s (± 9m/s)
Velocity Bin Size	2 to 12 inches (50 to 3000 mm) - user selectable

Table 1-1 Technical Specifications: ADFM Controller (Continued)	

Nominal Profiling Depth Range (for particle concentrations of 50-1000 ppm):
    Pro20
    Hot Tap
	9 inches to 20 feet (230 mm to 6 m)
	9 to 108 inches (230 to 2.7 m)

Accuracy	1.0% of reading ± 0.01 ft/sec (3.0 mm/s)
Pipe Sizes[a] (Hot Tap only)	15 to 108 inches (380 mm to 2.7 m)
Acoustic Frequency	
Frequency	1.23 MHz
Water Level (Pro20 Only)	
Measurement Range	4.5 inches to 20 feet (110 mm to 6 m)
Accuracy	0.5% of reading ± 0.2 inches (0.5 mm)
Data Management	
ADFM Data Types	
Q, V, D	Discharge, Average Velocity, Depth
Velocity	Velocity profile data (relative to acoustic beam directions) per beam and bin
Echo Intensity	Echo intensity data (relative backscatter intensity) per beam and bin
Data Quality	Profile data quality indicators (Correlation magnitude) per beam and bin
Temperature	Transducer temperature output range: 20 to 140 °F (-7 to 60 °C)
Sound Speed	One output for speed of sound data
Leader	Output of general leader information (time, data, record number, etc.)
Data Storage and I/O	
Storage Capacity	32 MB st. (140 days of data at one-minute intervals)
I/O Interface	RS232 std. Multiple industry-std analog and digital protocols optional.
Transfer Rate	Configurable to 57,600 bps
Power	
Internal Battery Voltage	24 VDC nominal
Internal Battery Capacity	26 Ah @ 75 °F (24 °C) - Alkaline Battery life: 22 weeks at 15 minute sampling interval
External DC	12 - 36 VDC; 10 VDC absolute minimum; 36 VDC/3W absolute maximum
Software	
WinADFM for data retrieval and analysis. BBTalk terminal emulation software tool included.	
Flowlink® 5.1 software may be purchased optionally. Call factory for details.	

a.   For pipes smaller than 18" ID, the site must be qualified by your Isco representative.

Table 1-2 Technical Specifications: Pro20 Open Channel Velocity Sensor

Sensor Body	
Operating Temperature	23 to 95 °F (-5 to 35 °C)
Housing Material	Urethane
Static Pressure	250 psi nominal
Dimensions	8 x 3 x 1.5 inches (200 x 75 x 40 mm)
Weight	3.2 lbs (1.5 kg)
Beam Angles	1 & 3: 10°front-back; 20°to side 2 & 4: 20° front-back; 30° to side
Sensor Signal Cable	
Operating Temperature	-40 to 125 °F (-40 to 52 °C)
Material	Polyethyline jacket
Length	50 ft (15 m) std. 100 ft (30 m) and 150 ft. (45 m) optional lengths available
Minimum Bend Radius	6 in (150 mm)
Outer Diameter	0.5 in (13 mm) nominal

Table 1-3 Technical Specifications: Hot Tap Insertion Velocity Sensor

Sensor Body	
Operating Temperature	23 to 95 °F (-5 to 35 °C)
Housing	Plastic transducer assembly on corrosion resistant stainless steel stem. Rated NEMA 6P, IP68, defined as validated for submersion to 20 feet of depth for 48 hours.
Static Pressure	200 psi nominal[a]

Dimensions:
 	
    Sensor Head Diameter
    Std stem length[b]
    Insertion
	
	1.375 in. (35 mm)
	2 feet (610 mm)
	Fits 2 inch NPT (50 mm) standard tap

Weight (includes 50 ft. cable)	15 lbs (6.8 kg)
Beam Angles	1 & 3: 10°front-back; 20° to side 2 & 4: 20° front-back; 30° to side
Sensor Signal Cable	
Operating Temperature	-40 to 140 °F (-40 to 60 °C)
Material	Polyethylene jacket
Length	50 ft (15 m) std; 100 ft (30 m) optional[c]
Minimum Bend Radius	6 in (150 mm)
Outer Diameter	0.5 in (13 mm) nominal

a. Use safety installation kit (60-7007-030) for pressures above 100psi. Applications with pressures between 200 and 300 psi require a schedule 80 nipple (contact factory).

b. Custom stem lengths are available; call factory for more information.

c. Custom cable lengths are available; call factory for more information.

1.4 Operating Principles

Figure 1-1 shows a typical ADFM Pro20 installation for measuring open channel flow in a pipe. The sensor is mounted on the invert of a pipe or channel. The sensor's piezoelectric ceramics emit short pulses along narrow acoustic beams pointing in different directions. Echoes of these pulses are backscattered from particles or bubbles suspended in the flow. As this material has motion relative to the transducer, the echoes are Doppler shifted in frequency. Measurement of this frequency enables the calculation of the flow speed. A fifth ceramic mounted in the center of the transducer assembly and aimed vertically is used to measure the depth.
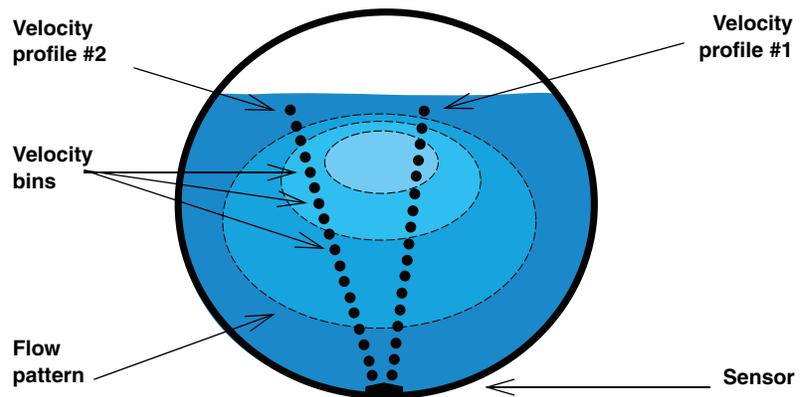
Figure 1-1   Typical Pro20 Installation (2 of 4 profiles shown)

The ADFM divides the return signal into discrete regular intervals that correspond to different depths in the flow. Velocity is calculated from the frequency shift measured in each interval. The result is a profile, or linear distribution of velocities, along the direction of the beam. Each of the small black circles in Figure 1-1 represent an individual velocity measurement in a small volume known as a velocity bin.

The directions of the velocity profiles are based on the geometry of the ADFM's transducer assembly. Figure 1-2 shows a side view of the transducer assembly. The profiles shown in Figure 1-1 are generated from velocity data measured by an upstream and downstream beam pair. The data from one beam pair are averaged to generate Profile #1, and a beam pair on the opposite side of the transducer assembly generates Profile #2.

Since Doppler measurements are directional, only the component of velocity along the direction of transmit and receive is measured. Narrow acoustic beams are required to accurately determine the horizontal velocity from the measured component. The narrow acoustic beams of the ADFM ensure that this measurement is accurate. Also, the range-gate times are short and the velocity bins occupy a small volume - cylinders approximately 5 centimeters (2 inches) long and 5 centimeters (2 inches) in diameter. This ensures that the velocity measurements are truly representative of that portion of the flow, avoiding potential bias

in the return energy spectrum due to range dependent variables. The result is a very precise measurement of the vertical and transverse distribution of flow velocities.
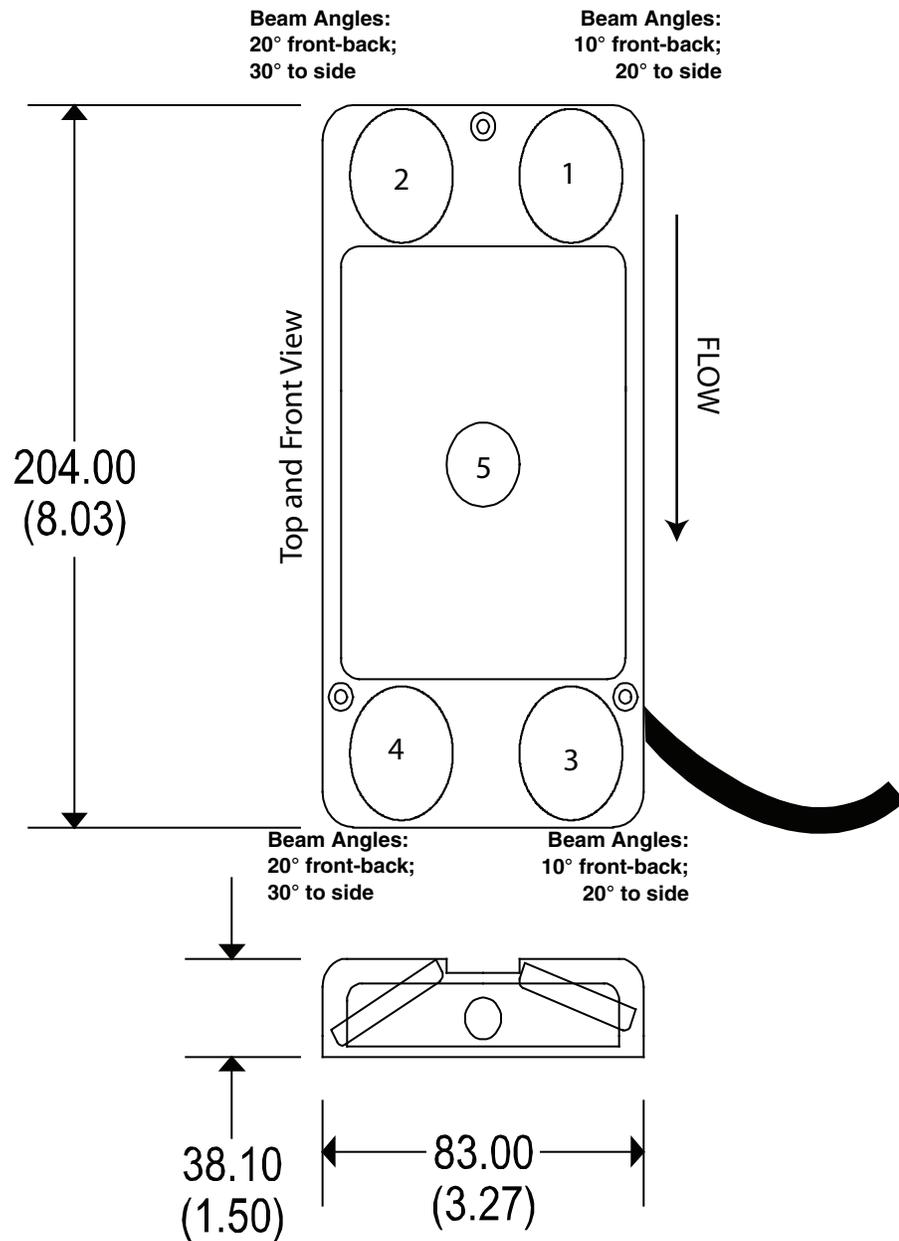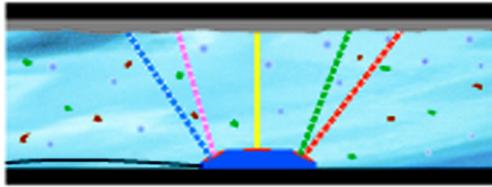
Figure 1-2   ADFM Pro20 dimensions and beam geometry

The velocity data from the two profiles are entered into an algorithm to determine a mathematical description of the flow velocities throughout the entire cross-section of the flow. The algorithm fits the basic functions of a parametric model to the actual data. The result predicts flow velocities at all points throughout the flow. These results are integrated over the cross-sectional area to determine the discharge.

The key benefit to this approach is that the system will operate accurately under different hydraulic conditions. As hydraulic conditions change, the change will manifest itself in the distribution of velocity throughout the depth of flow. As the ADFM is measuring the velocity distribution directly, it will adapt to the changes in hydraulics, and generate a flow pattern that is representative of the new hydraulic conditions, insuring an accurate estimate of flow rate.

Figure 1-3 shows a typical Hot Tap installation in a closed-pipe application. The operation of the Hot Tap Insertion velocity profiler works in the same manner as the Pro20, but for full and pressurized pipes. Mounted nearly flush with the inner pipe wall, the Hot Tap sensor is comprised of four ceramics that transmit and receive the acoustic signals.

Beam Angles:
10° front-back;
20° to side

Beam Angles:
20° front-back;
30° to side

Beam Angles:
10° front-back;
20° to side

Beam Angles:
20° front-back;
30° to side
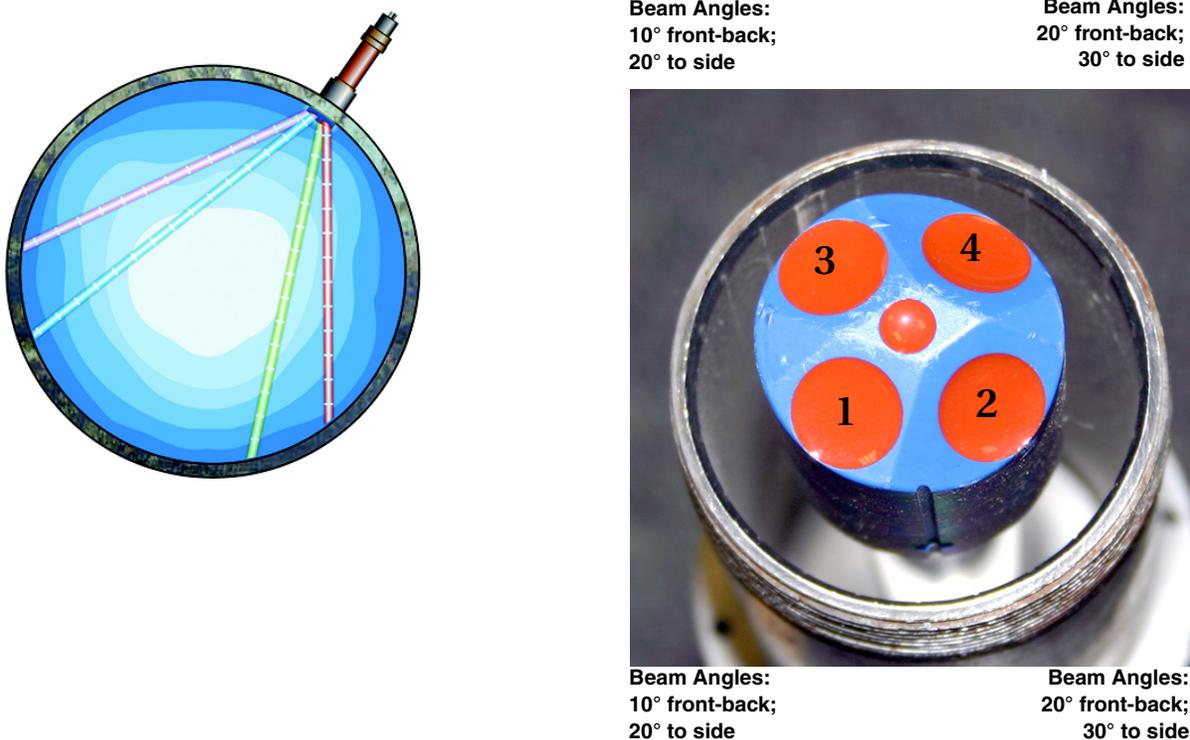
Figure 1-3   ADFM Hot Tap beam geometry

☑ **Note**

For Hot Tap dimensions, refer to Section 2.7.

1.5 Communication and Data Interfacing

The basic connection for initial configuration of the ADFM is a serial connection with a computer (RS-232 or RS-422), or with a modem.

The ADFM controller may optionally have a factory-installed 28800 bps modem with data compression and error correction capabilities.

The ADFM is configured and programmed using Isco's WinADFM software. WinADFM also retrieves the flow data, providing analysis, editing, and reporting.

Isco's Flowlink® 5.1 software may be purchased optionally. The ADFM can be configured and programmed using Flowlink. In addition to data retrieval, analysis, editing, and reporting, Flowlink 5.1 is compatible with most other Isco environmental instruments, providing a wide variety of networking and interfacing possibilities. The added capabilities of Flowlink Pro client software include support for an enterprise database, Web UI, and pushing data to a server.

1.5.1 Optional Interfacing Tools

Isco offers additional tools to expand the ADFM's communication capabilities. For detailed information about these instruments, visit our web site at **www.isco.com**.

accQcomm Interface Module – The accQcomm accepts RS232/RS422 serial data from up to three ADFM flow meters and converts the data to industry standard MODBUS protocol, or a 4-20 mA analog current loop. The module also provides programmable alarm outputs and data viewing on the Web.

While the ADFM controller has no data display (the box controller's internal display is only for test information), the accQcomm's front panel LCD is capable of displaying data output for each connected flow meter (flow, totalized flow, velocity, level and temperature), as well as 4-20 mA outputs. For additional information, see the accQcomm user manual on the Isco web site.

Figure 1-4   Optional accQcomm Interface Module

2105 Interface Module – The 2105 stores data from the ADFM and other Isco instruments. It also provides Modbus input, sampler interfacing, rain gauge and SDI-12 input, and cellular phone communication. For additional information, see the 2105 user manual on the Isco web site.

Figure 1-5   Optional 2105 Interface Module

Other options available   Wireless radio and other communication protocols are available. Contact the factory for more information about these options.

ADFM® Flow Meter

Section 2 Setup and Installation

This section of the manual contains information and instructions for configuration, testing, installation, and deployment of the ADFM Velocity Profiler. Included in this section are:

- Software
- Power options
- Final preparations for use
- Connecting the components
- Installation and deployment
- Built-in tests (BITs)

Use this guide to plan your installation layout. Teledyne Isco recommends distributing this information to your organization's planners and installation engineers.

2.1 Software

For accurate flow measurement, you will use either Flowlink® software (optional) or WinADFM software (standard) to program the ADFM with site-specific parameters for the pipe or channel in which it is installed.

While both software programs are capable of basic site setup and data retrieval, Flowlink software has expanded capabilities and features. Contact the factory for more information.

If you have purchased **Flowlink** software, refer to Section 2.2 for basic setup and Section 2.13 for basic data retrieval and viewing.

If you are using **WinADFM** software, refer to Section 2.3 for basic setup and Section 2.14 for basic data retrieval and viewing.

2.2 Flowlink Software

For complete information about setup and operation of Flowlink software, refer to the Flowlink user manual and Help files.

1. Connect the computer to the ADFM flow meter with the communication interface cable.
2. Click the Quick Connect button on the Flowlink toolbar, or press F11 on the keyboard. Flowlink opens the Quick Connect window.
3. Select the Type of connection (Direct for initial setup).
4. Check the Create new site check box and then click on the large button for pulse doppler instruments.
5. The Pulse Doppler Connect window will appear.
6. Enter a site name and a device name, and select the radio button for ADFM.

Click OK, and Flowlink creates a site window (Figure 2-1).

Site Info

The Site Info tab allows you to view and change the site name and date/time. Click the **Connect** button, and Flowlink starts communication with the ADFM.
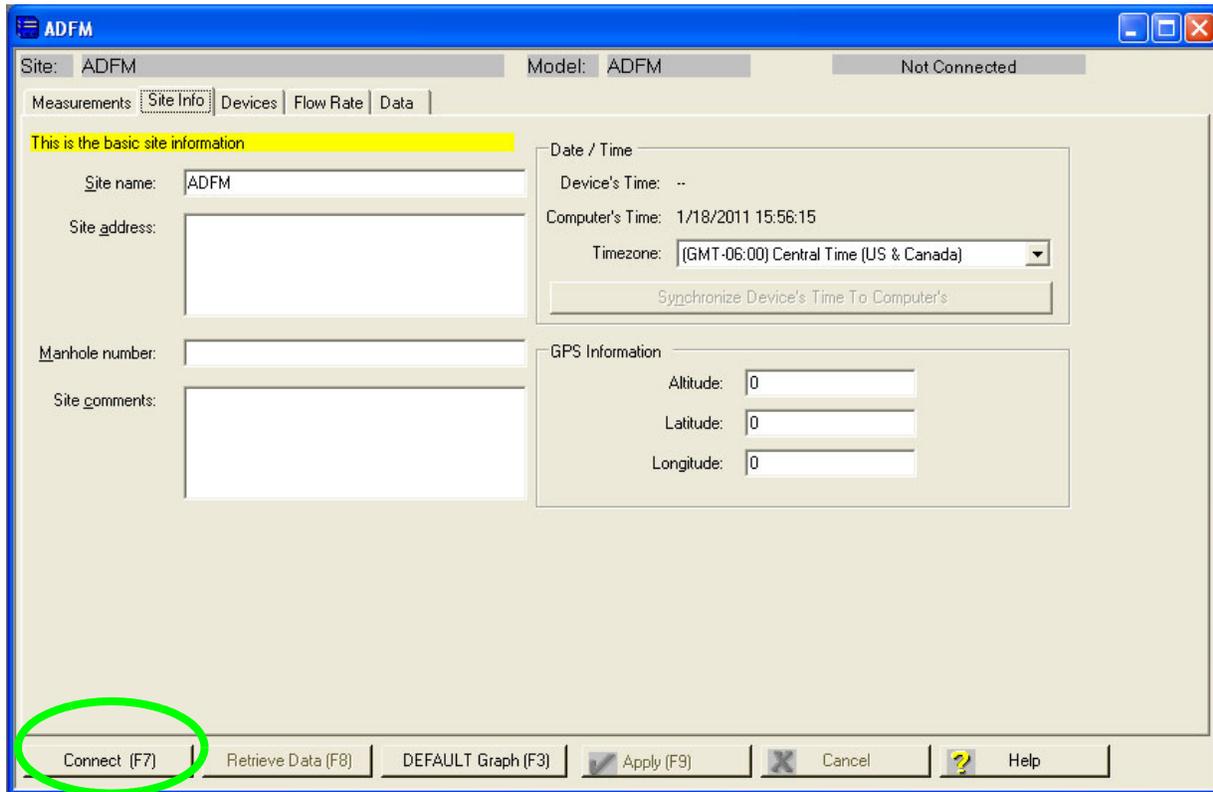
Figure 2-1 Flowlink Site Info tab

Devices

The Devices tab displays general information about the instrument, secondary depth sensor, and battery (if applicable), as well as connection information (which can be modified when offline).
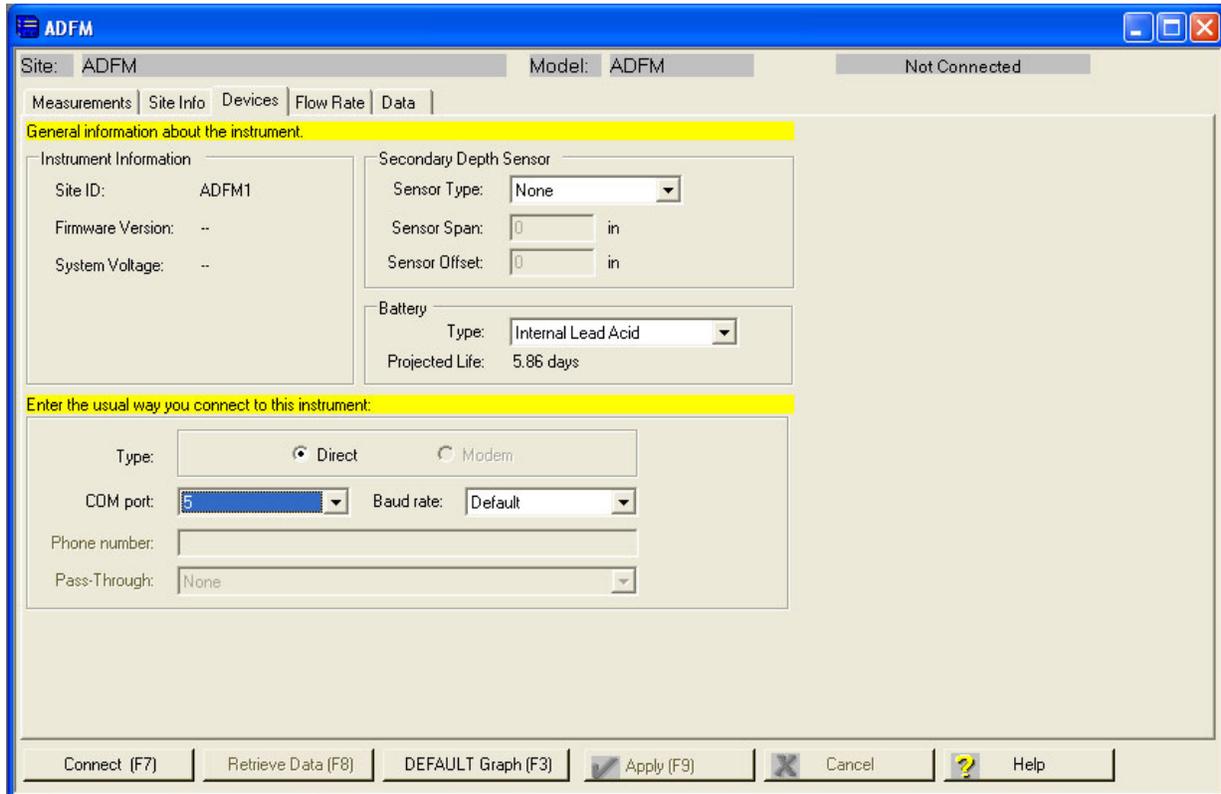
Figure 2-2   Flowlink Devices tab

Measurements

While connected, Flowlink continually polls the site for real-time readings. The Measurements tab displays the real-time readings, as well as test data, in the Output window.

Diagnostic tests are selectable from the buttons to the left of the screen. The results of each test are displayed and recorded in the station's Log File.

> ## ☑ *Note*
>
> The "Bench Test" function is for diagnostic purposes and is not required for routine operation. If for any reason the Bench Test *is* performed, regardless of the time interval between tests, Retrieve and save all recorded data before it is performed again. Prior to redeployment, select "Erase Recorder" and then "Restart."
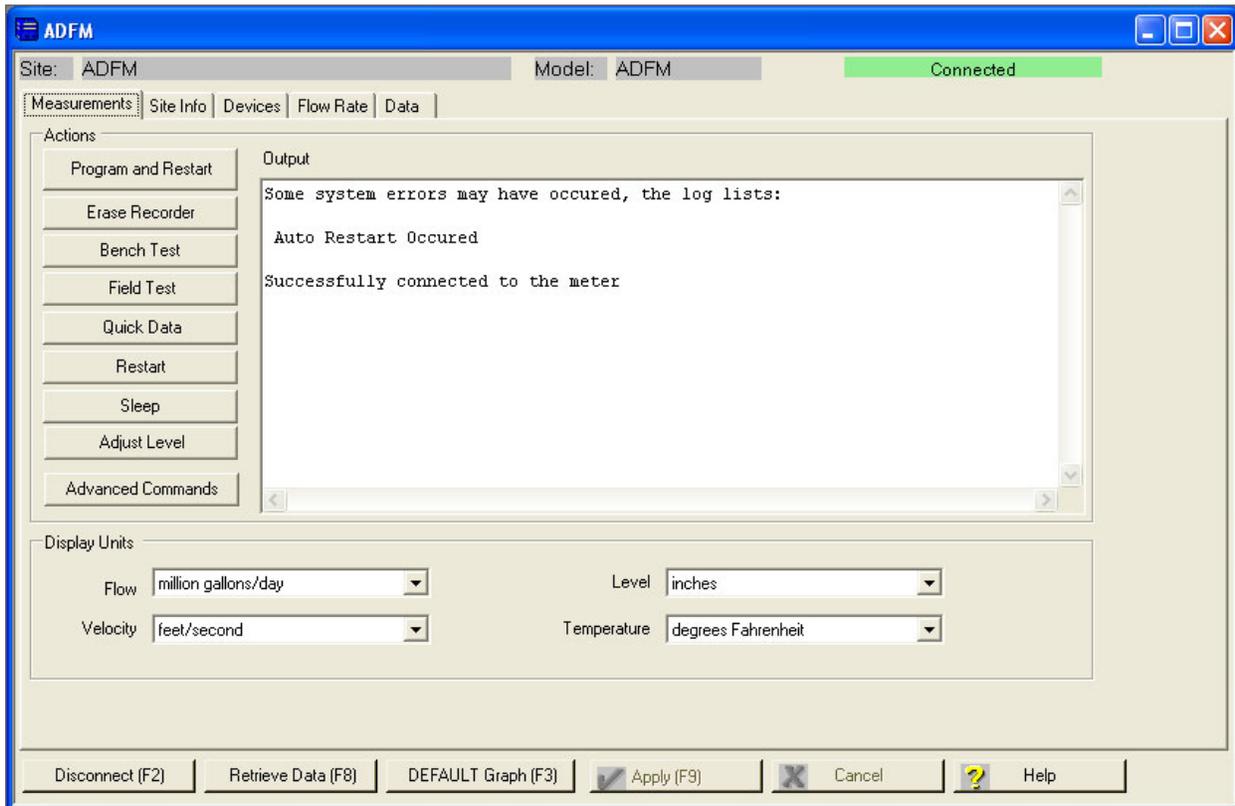
Figure 2-3   Flowlink Measurements tab

Flow Rate

Use the Flow Rate tab to specify the appropriate channel geometry (for detailed information about determining this data, refer to Section 2.6.1), dimensions, and sensor mounting information.
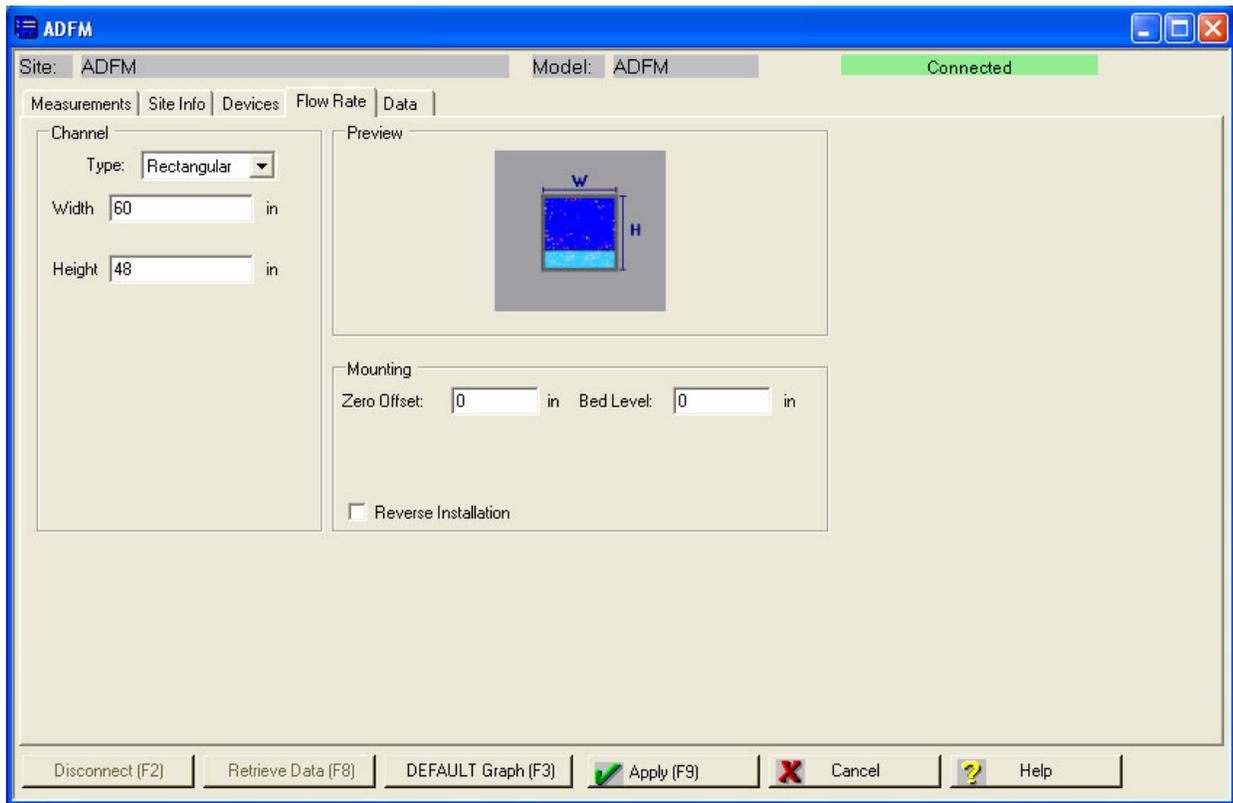
Figure 2-4   Flowlink Flow Rate tab: Rectangular channel

Flow rate tab: Multi-point channels

For multi-point (irregular) channel shapes, measure and record the channel width divided by 2 for 10 different depths:
Width/2 = X
Depth = Y
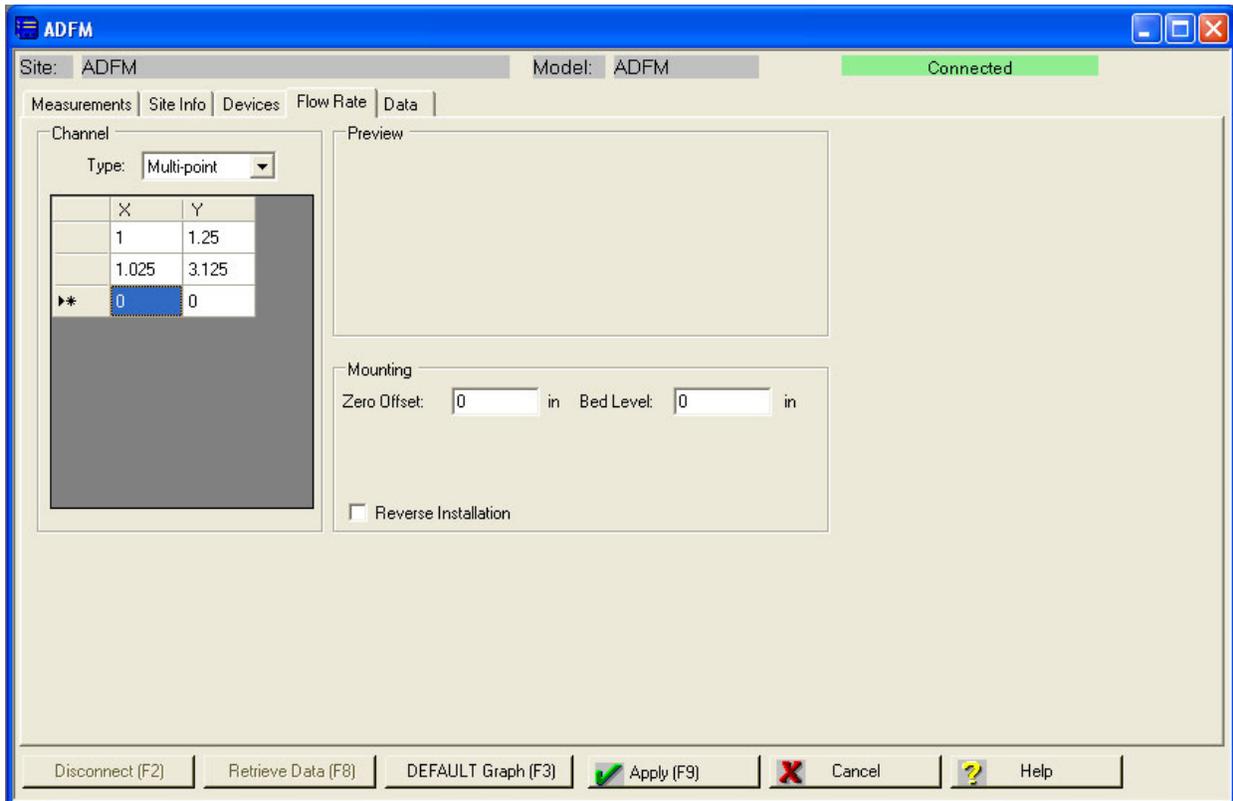
Figure 2-5   Flowlink Flow Rate tab: Multi-point channels

Data

The rate of data storage and adjustment of the number of velocity readings within a data storage interval can be set in the Data storage box. For the most possible velocity readings within an interval, check the box next to "Use Mode 12 Sampling."

Manage the data type(s), form of output, and amount of data stored in the Data Format box.
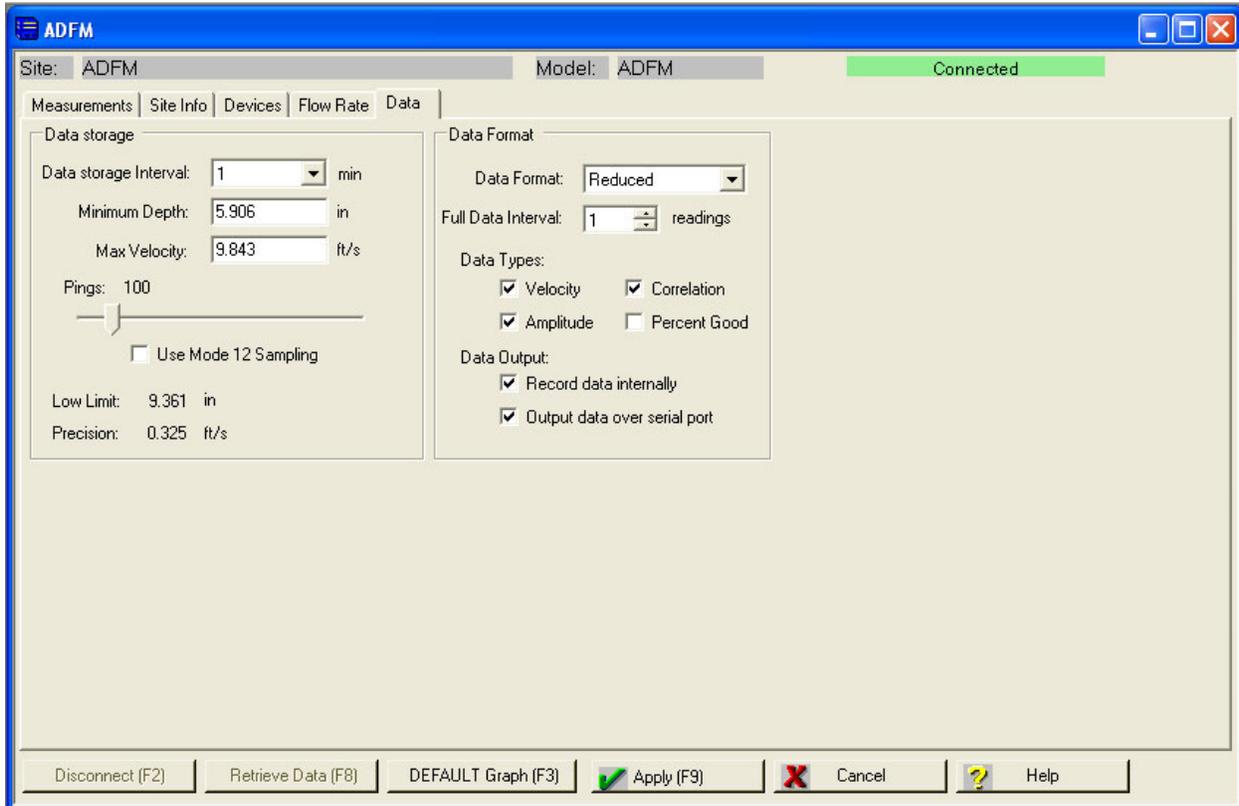
Figure 2-6   Flowlink Data tab

☑ *Note*

For complete information on programming and data retrieval, refer to the Flowlink software manual and Help files.

2.3 WinADFM Software

For complete information about setup and operation of WinADFM software, refer to the WinADFM user manual.

2.3.1 Setup

The following section contains the basic steps for setting up a site file and programming the ADFM. Basic data retrieval steps can be found in Section 2.12. For complete programming and data retrieval instructions, see the *WinADFM* software manual.

To begin setup and programming:

1. Start the *WinADFM* software. Create a Station file (application programming file) by selecting File > New. Select ADFM Station.
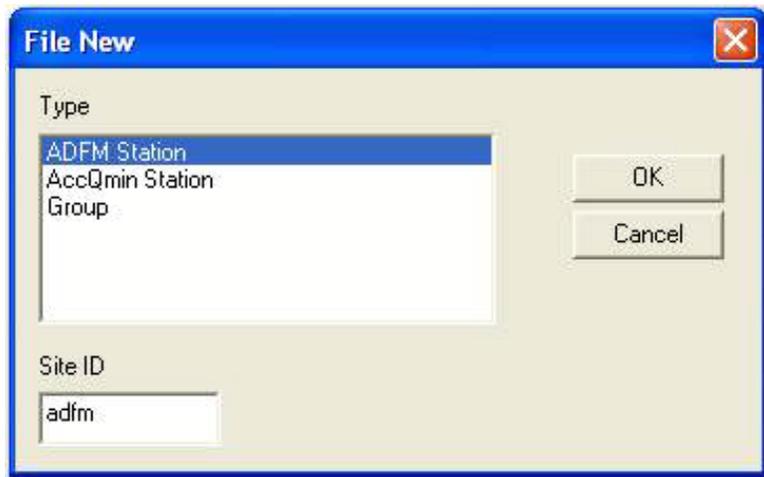
Figure 2-7   Creating a new Station file

2. Enter a Site ID with a maximum of 8 alphanumeric characters, with no spaces or symbols, and save.

3. Select ADFM > Setup.

   There are four tabs at the top of the window. Select each tab and enter the programming information in each tab window.

Site tab

4. Site Tab (Figure 2-8)
    Enter comments if desired. Select the units of measure
    from the dropdown list.
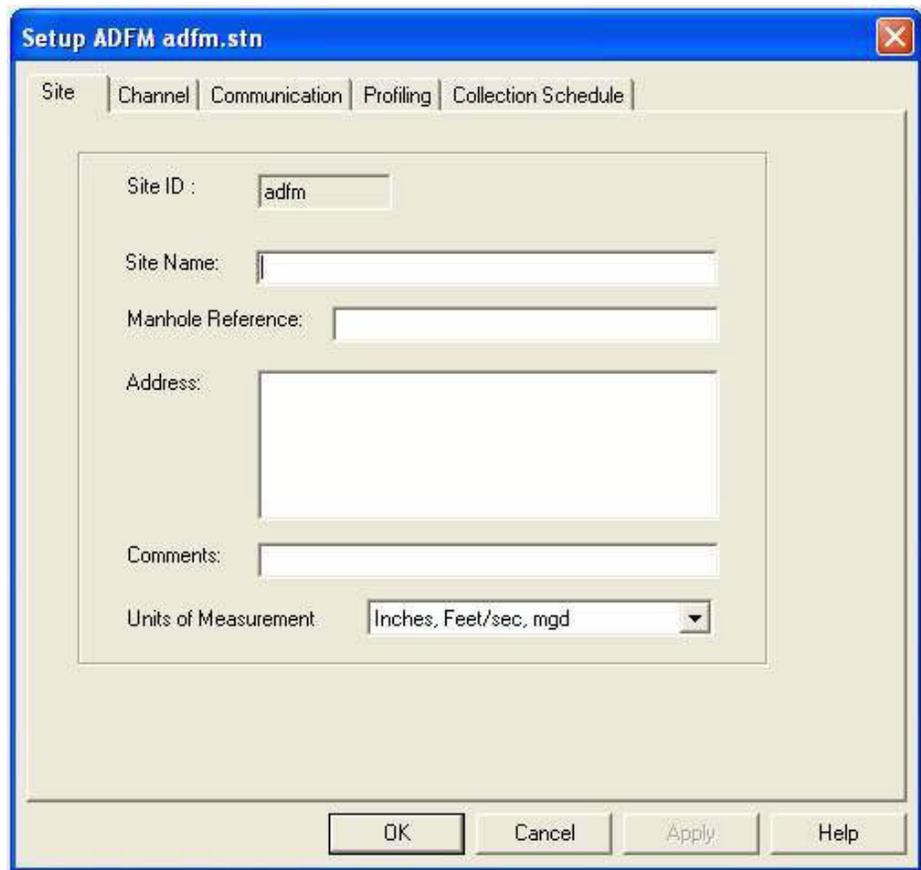
Figure 2-8 Site Tab window

Channel tab

5. Channel Tab
    Select the application geometry and enter the appropriate dimensions. For detailed information about determining channel geometry, see Section 2.6.1 *Pro20: Channel Geometry*.

    a. Bed Level is the level of permanent silt/debris in the bottom of the channel.

    b. Zero Offset is the distance from the bottom of the ADFM sensor to the bottom of the channel. If you are using the Flow Conditioning Platform (FCP), this value is typically 0.24 inches (6.1 mm).

    c. FCP Height is the height or thickness of the Flow Conditioning Platform. It is typically 0.88 inches (22.5 mm).

    If the channel type is not irregular, skip to step 9.
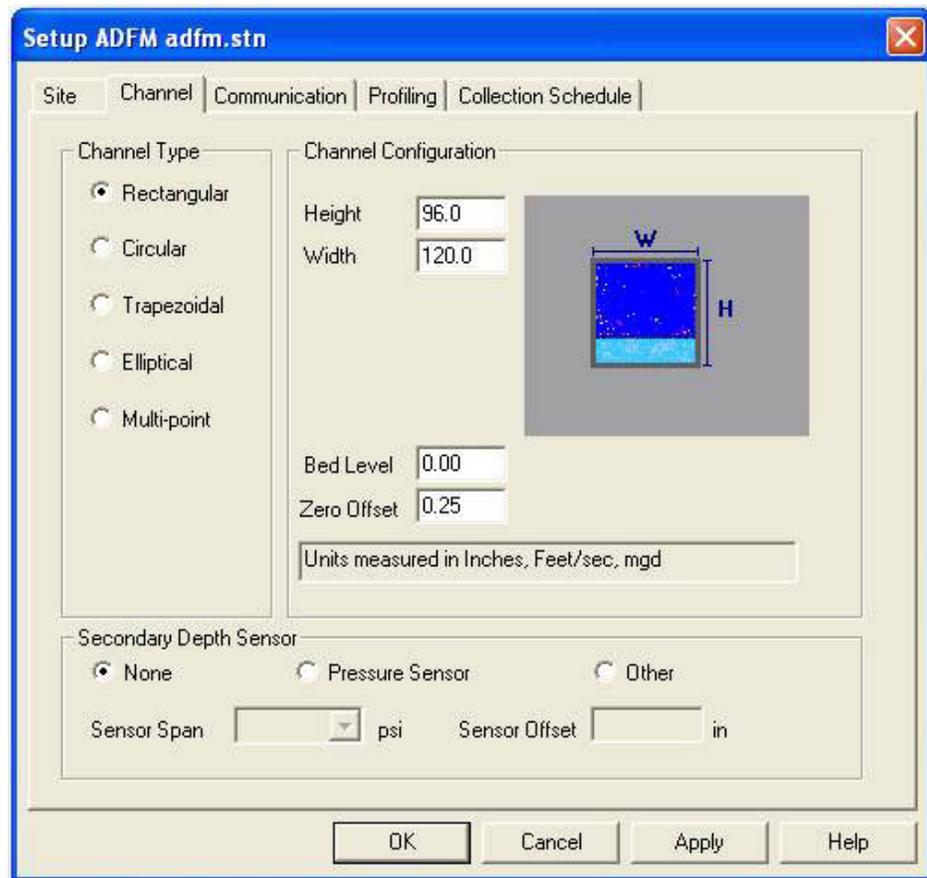
Figure 2-9   Channel Tab window

Irregular channels
(multi-point)

6. Irregular Channel Type
    For irregular shapes, select Irregular > Configure Points
    (Figure 2-10).
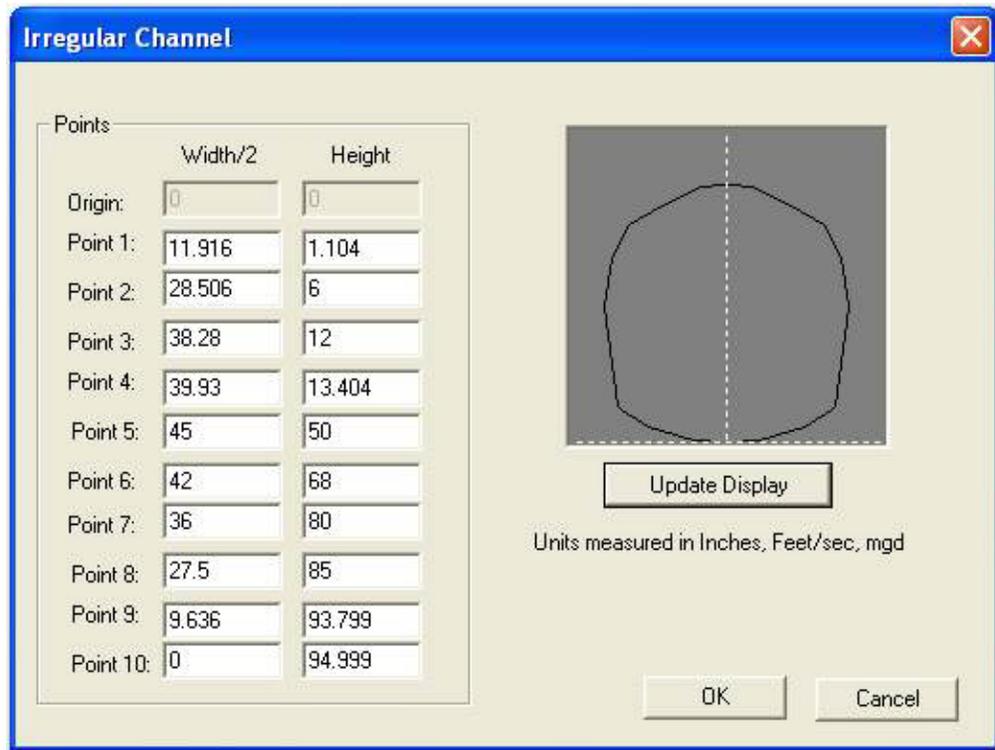
Figure 2-10 Irregular Channel Configure window

7. Enter the Width/2 (half the width) and its corresponding
    Height for ten different points (Heights) in the channel.
    Point 1 represents the lowest point in the channel. As you
    enter the widths/2 and their corresponding heights, click
    Update Display to see them represented graphically (Fig-
    ure 2-10).

8. When you are finished entering the points, the picture
    should be an approximate representation of the channel's
    geometry. Make any necessary corrections and click OK.

Communication tab

9. Communication Tab (Figure 2-11)
   Unless there is an external modem and phone line used, select Serial, the communication port of the laptop or computer used to program the ADFM, baud rate of 115200, Stop Bits 1, Data Bits 8, and Parity None.
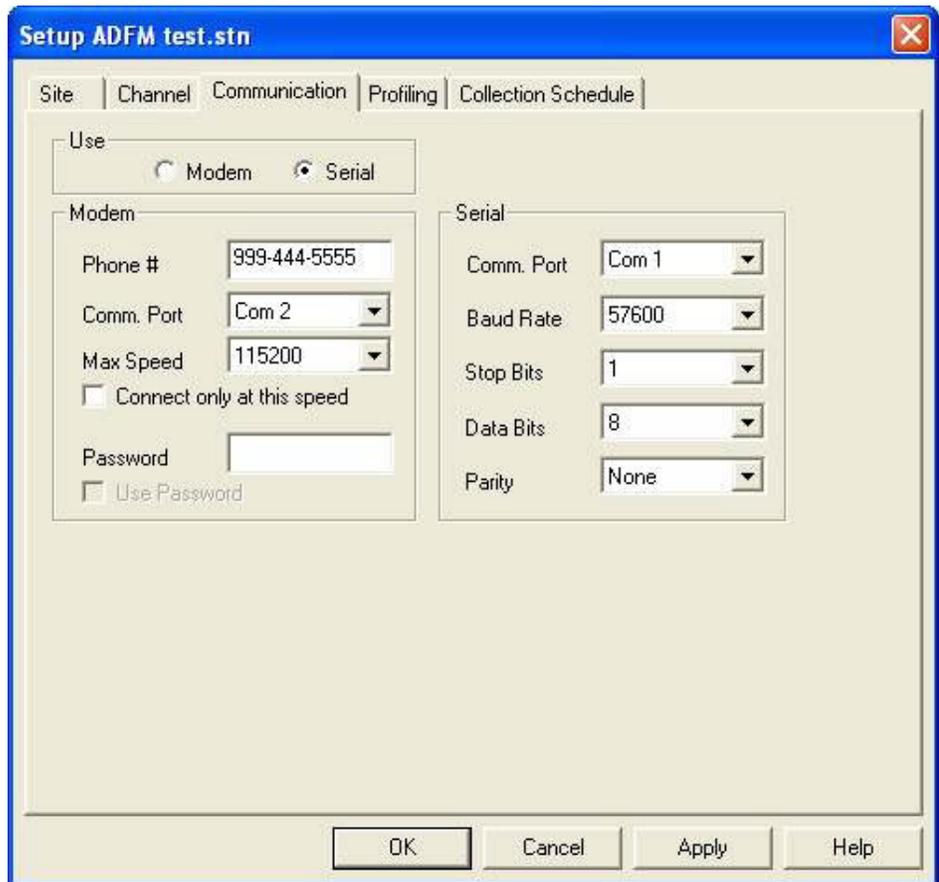
Figure 2-11 Communication tab

Profiling tab

10. Profiling Tab (Figure 2-12)
    Select the Data Interval (recording interval) in minutes from the dropdown list.

11. Select the Samples per Interval (measurement interval). From the drop-down list, select the desired number of measurements per Data Interval. A larger number will reduce battery life but improve measurement precision. Teledyne Isco recommends using no more than 5 Samples per Interval in most applications.

Burst sampling

12. Burst Sampling
    Burst sampling (reading interval) is a secondary data interval automatically triggered by a programmed threshold condition, such as a rain event or overflow.
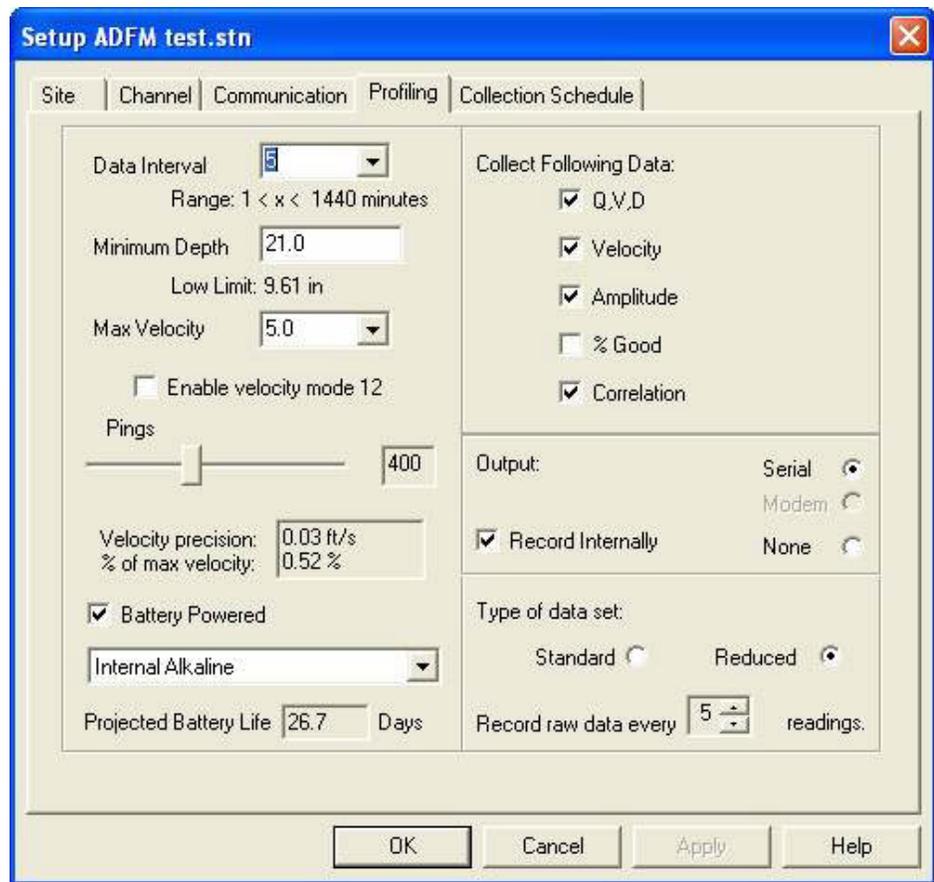
Figure 2-12 Profiling tab

13. To enable Burst Sampling, check the box next to Burst Sampling (Figure 2-12), then select Configure.

    a. In the Configure window that appears, select the data interval in minutes, and the number of samples (readings) to be taken when the specified trigger conditions are met.

b. In the Enter Level fields, enter the value of Flow (Q), Velocity (V), and Depth (D) that will trigger the Burst Sampling rate.

c. Enter the Exit Levels in the exit fields. When Q,V, or D drops below its Exit value, the ADFM will switch back to the normal operating sample interval, conserving battery power and data storage space.

14. Under Included Data Types, select all boxes. Select the appropriate output (Serial, unless a modem is used).

Data Recording

15. To activate recording and storage of flow information, check the Record Internally box, and select Slate or Wrap mode.
In Slate mode, the recorder will stop recording when full. In Wrap mode, the recorder will continue recording when full, overwriting the oldest data readings with the newest.

16. If using the Record Internally function, select the maximum number of intervals from the dropdown list. If the ADFM serial data is output to an Isco 4-20 mA Analog Module, select the same number, or 1 less, than the Data Interval.

17. Under Data Format, select Reduced.

18. The reading interval for Record Raw Data (Figure 2-12, below Data Format) is based on the sampling (reading) interval. Recording raw data for a single reading includes additional diagnostic information embedded within the Q, V, and D reading. The additional raw data creates a larger file.
The recommended raw data interval is 10 minutes, i.e., if the sample interval = 1, the raw data interval would be every 10 readings; if the sample interval = 10, the raw data interval would be every 1 reading, etc.

19. Click OK to save the programming information.

2.3.2 Connecting to the ADFM

To begin operating the ADFM through direct-connection:

1. Connect the computer to the ADFM flow meter with the communication interface cable.

2. Start *WinADFM* software.

3. Select ADFM > Operate.
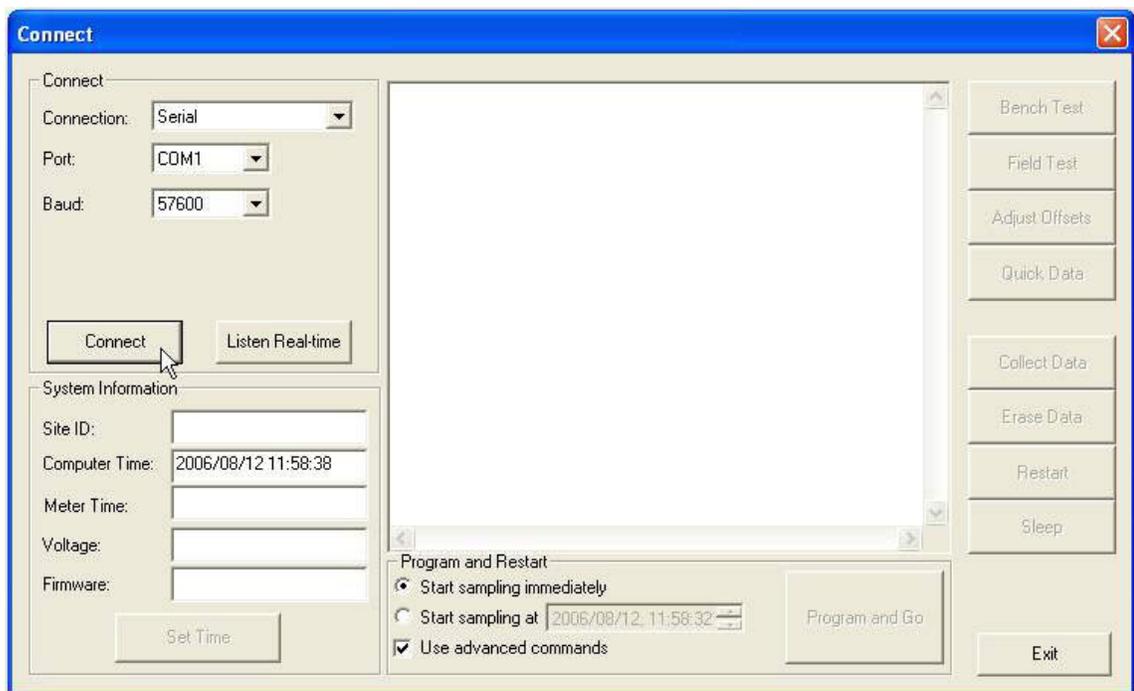
Figure 2-13 Connect screen

4. When the Connect screen appears, select Connect.
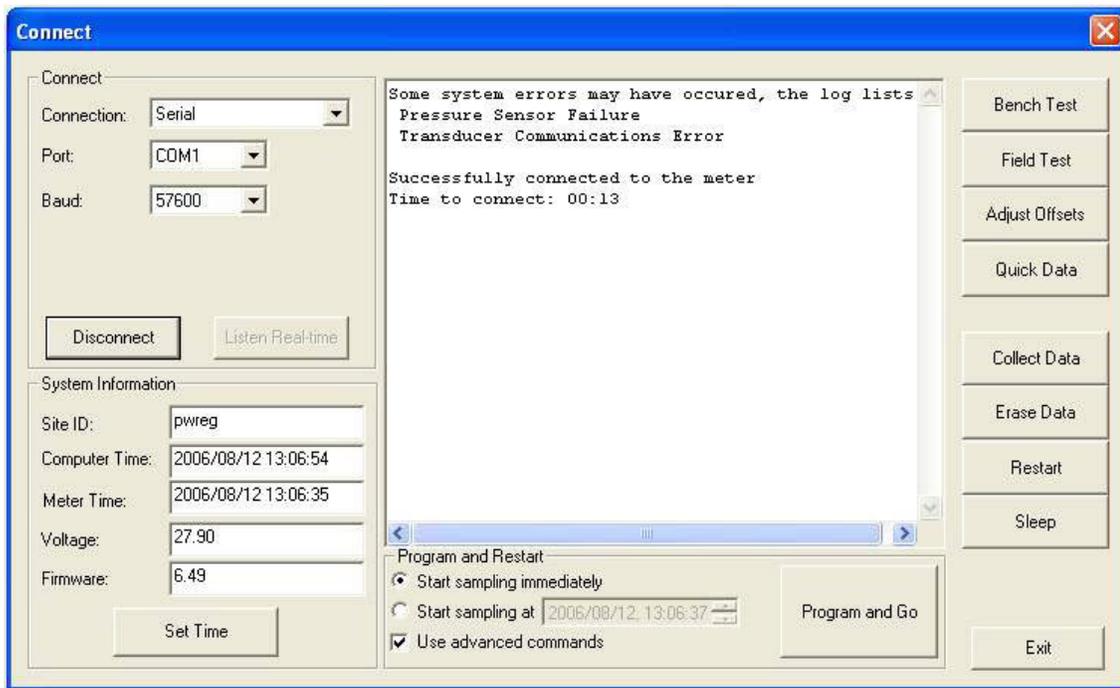
Figure 2-14 Connected screen (status window)

Testing the ADFM   Diagnostic tests are selectable from the buttons to the right of the screen. The results of each test are displayed and recorded in the station's Log File.

The Field Test should be performed in the field with the sensor installed and underwater. The test performs internal ADFM system checks. Click Field Test to perform the test.

☑ *Note*

The Bench Test function is for diagnostic purposes and is not required for routine operation. If for any reason the Bench Test *is* performed, regardless of the time interval between tests, first retrieve and save all recorded data before it is performed again. Prior to redeployment, select "Erase Recorder" and then "Restart."

---

5. When a connection is established, a status message will appear in the window; when the status message appears, select PROGRAM AND GO.
    This programs the ADFM with the information and operational parameters you saved in the Station file, and activates flow monitoring operation

☑ *Note*

If error messages appear when you select Quick Data or Program and Go, typical causes are a disconnected sensor cable and/or invalid station file settings. Ensure that the sensor is properly connected and that Channel Properties, as well as all other station file settings, are valid, and retry.
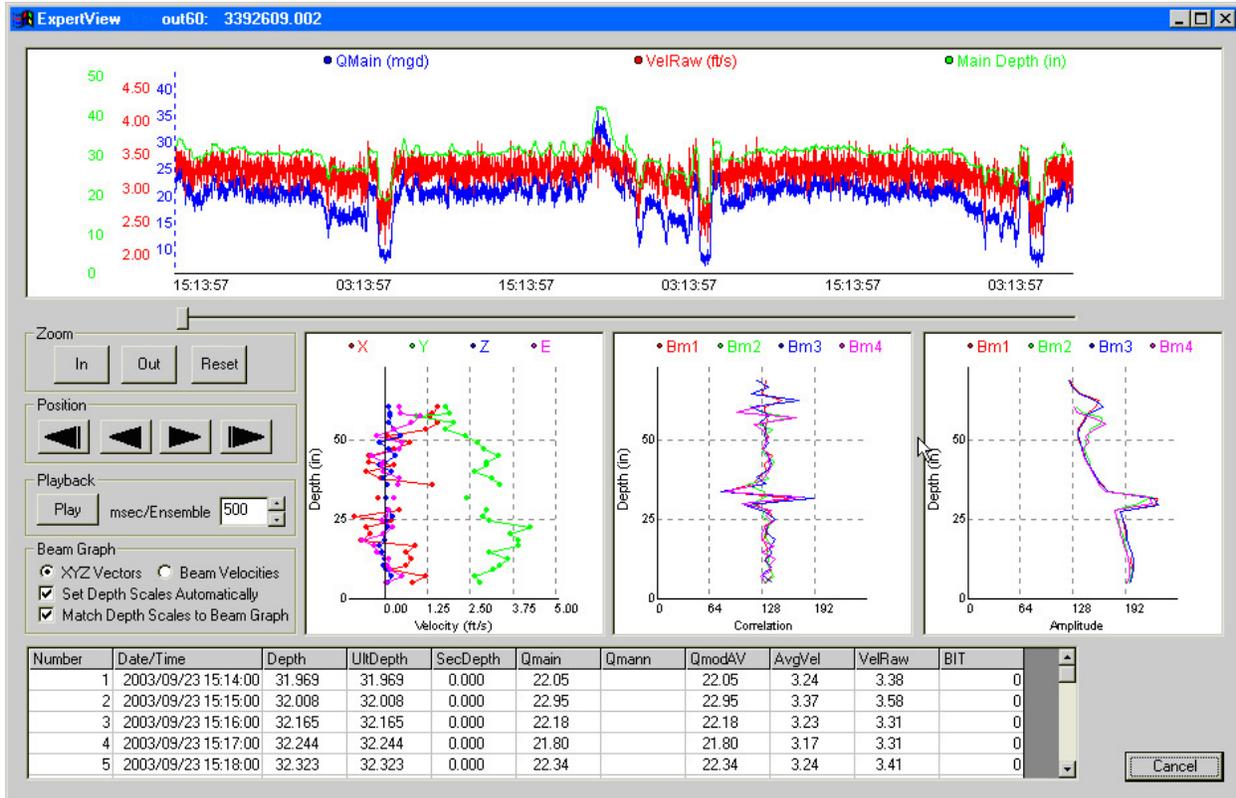
Figure 2-15 Real-time Data screen

6. When the Real-time Data screen appears (Figure 2-15), click Exit. Disconnect the interface cable and exit the Operate screen. Exit the *WinADFM* software program.

For an overview of data retrieval, turn to Section 2.14.

☑ *Note*

For complete information on programming and data retrieval, refer to the *WinADFM* software manual.

2.4 Preparing for Installation

Before deployment, your system configuration and site characteristics must be determined. This section will help you to prepare the ADFM for deployment.

2.4.1 Installation Checklist

The general sequence of steps in the installation and deployment of the ADFM are as follows:

1. Determine the installation site and sensor mounting location according to site requirements.
2. Measure and record all channel dimensions and determine geometry.
3. Prepare your laptop PC with Isco WinADFM software, to take to the installation site.
4. Perform pre-installation equipment and operational checks.
5. Install and secure the ADFM controller, and connect the sensor.
6. Connect power and conduct final tests.
7. Program the desired data logging parameters into the ADFM.

2.4.2 Basic Configuration   Basic ADFM system configurations are shown in Figures 2-16 and 2-17. Other configurations may include an environmental enclosure and optional interfacing device and/or heater.
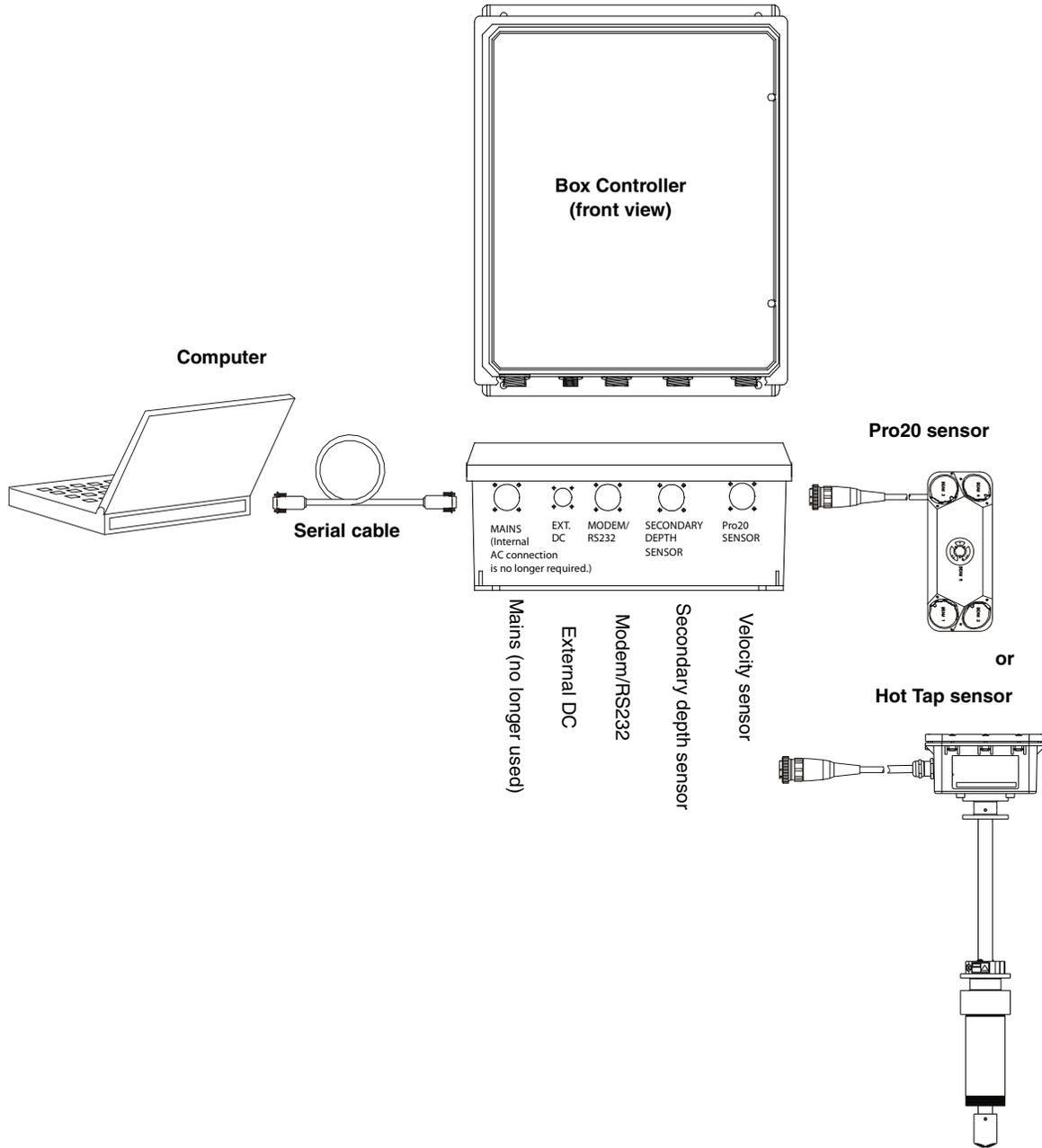
Figure 2-16 ADFM System configuration with box controller

Canister Controller

Computer

Serial Cable

Secondary depth sensor

Modem/RS232

Pro20 Sensor

External DC

Velocity sensor

or

Hot Tap Sensor
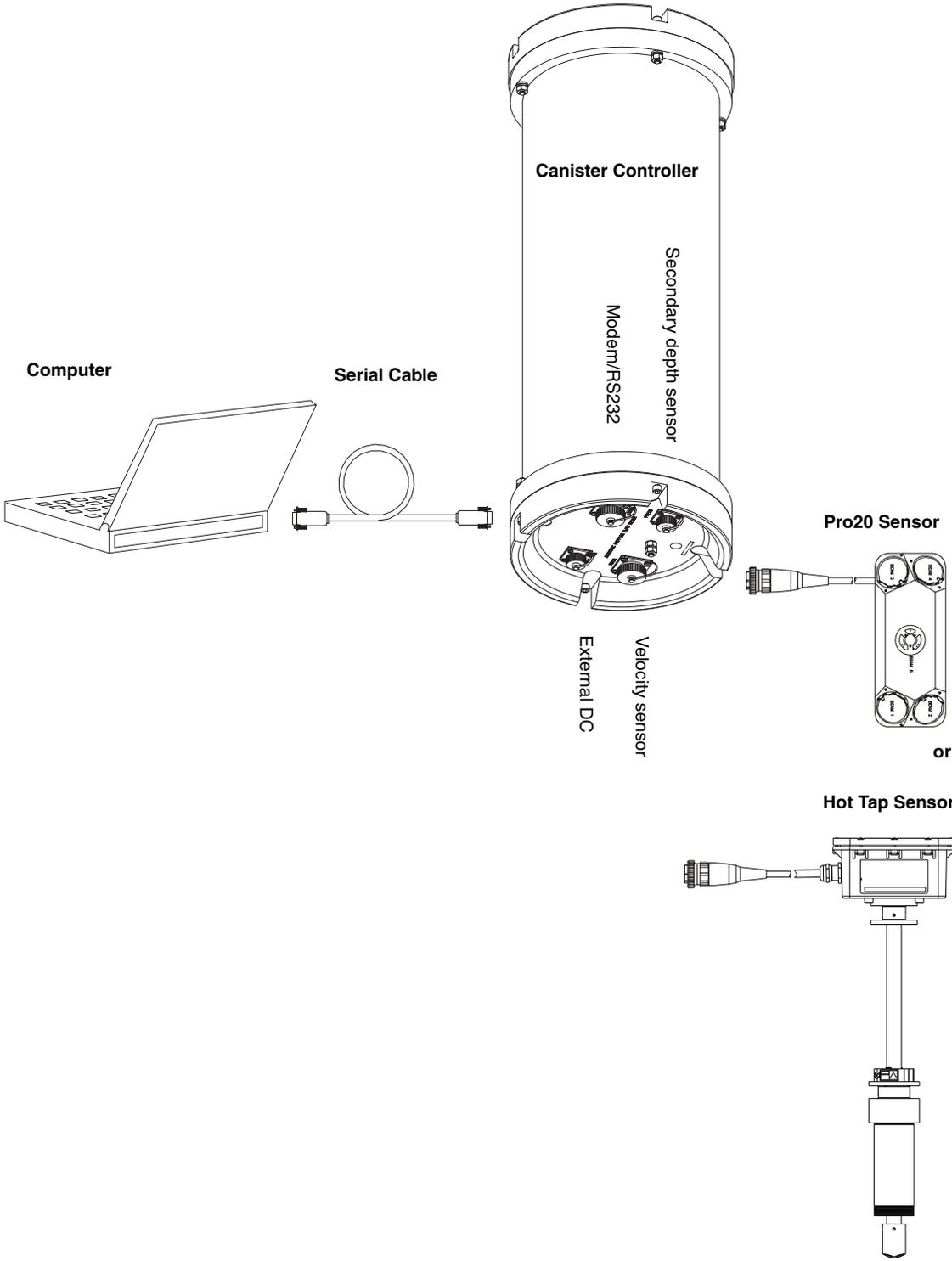
Figure 2-17 ADFM System configuration with canister controller

2.4.3   Power Selection

The ADFM is designed to operate from one of two independent power sources: internal batteries or external DC power supply. All sources may be used concurrently; the source that supplies the highest voltage will automatically supply power to the system.

Internal Batteries

The battery configuration consists of four 6-volt alkaline lantern batteries with spring terminals. Recommended alkaline batteries have 25Ah nominal capacity. These alkaline batteries have approximately 2.5 times the power/life of the lead-acid type.

A supply voltage of 24 to 36 VDC is recommended to allow operation from the internal batteries when the external power supply is interrupted.

External DC Power

The 24VDC power supply plugs directly into a standard AC outlet and terminates in a connector compatible with the DC connector on the box or canister controller, or with unterminated wires if the system includes an accQcomm Interface Module. This power supply is included with the ADFM system.

DC Power Supply Cable

This two-conductor pigtail cable provides no grounding. It mates with the DC connector on the controller. Wire colors for the power cable are designated as follows:

Pin	Color	Function
(+)1	Red	+ DC
(-)4	Black	- DC

This cable is installed at the factory as part of ADFM systems that are mounted inside an enclosure with a 24V DIN rail (example: Figure 2-20).

60-7004-041
For current model canister controller with metal Crown connectors.

60-7004-062
For box controller and older style canister controller with Amp connectors
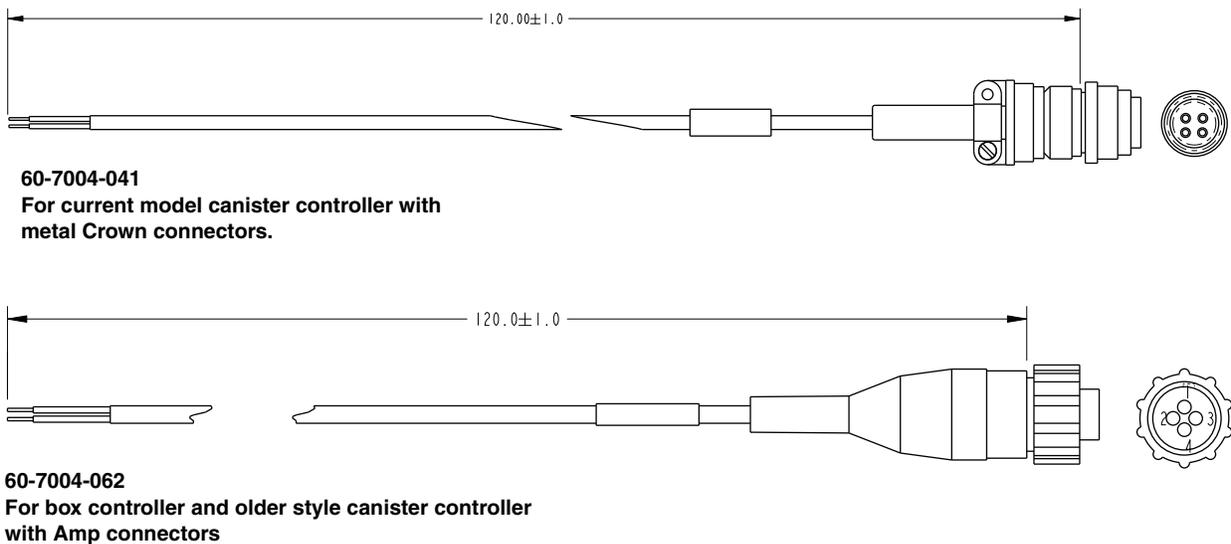
Figure 2-18 Pigtail DC power cable

External AC Power

Systems ordered with the environmental console enclosure (described on page 2-23) come with all components factory installed inside the enclosure and pre-wired to a 24V DIN rail. User-supplied AC power is connected at the installation site.

2.4.4 Site Requirements

The installation site must allow for proper securing of all electronics, cables, sensors, and hardware. Whenever possible, the sensor's mounting location should allow for easy removal and reinstallation in the event that cleaning, testing, or replacement is required.

24 VDC at 3W is required. Depending on the configuration, some installations require AC voltage for heaters and other options.

2.4.5 Installing the Electronics Controller

The ADFM electronics controller housing and options are selected according to your application needs. The electronics are housed in either a box, which can be mounted on a wall or in an environmental console enclosure, or in a cylindrical canister for suspension within a manhole. Either housing can be ordered with or without an internal modem; contact Teledyne Isco for more information.

Wall Mounting

The ADFM NEMA 4X electronics box may be used indoors or outdoors. However, some other system components, such as the accQcomm Interface Module (see Section 1.5.1), must be installed in a dry, dust-free, climate-controlled environment, or in a console enclosure (see next section).

Figure 2-19 ADFM controller: wall mounting

Console Enclosure Mounting

Stainless steel environmental console enclosures are available from Teledyne Isco for outdoor or indoor installations without climate control, and where dust or moisture is present. The electronics box and all other electronics must be mounted within the enclosure.

The environmental console enclosure can be ordered with or without a 400- or 800-watt heater; contact Teledyne Isco for more information.

Where a console enclosure will be used, a user-supplied concrete pad and steel stand, or other secure method, as well as cable conduit with minimum 2" ID, are recommended.

☑ *Note*

Environmental enclosures are not shipped with access holes for conduit connection.

All cable entries must have appropriate ID, user-supplied conduit connections or cord-grip fittings to retain the NEMA 4X rating. Conduit and wires must be sealed to prevent harmful gases and moisture from entering the enclosure. **Failure to seal conduit could reduce equipment life.**

Figure 2-20 ADFM controller: environmental console enclosure

Cylindrical Canister   The cylindrical canister houses all electronics, and usually the batteries, and is designed for suspension within a manhole or other wet environment.

Figure 2-21 ADFM controller: cylindrical canister suspended in manhole

> ☑ **Note**
>
> The current canister controller has four connector ports. Earlier models included a fifth Auxiliary port for the connection of an external modem.
> A fifth port is sometimes still added to current models as a special power switch controlled by a sampler enable signal input.
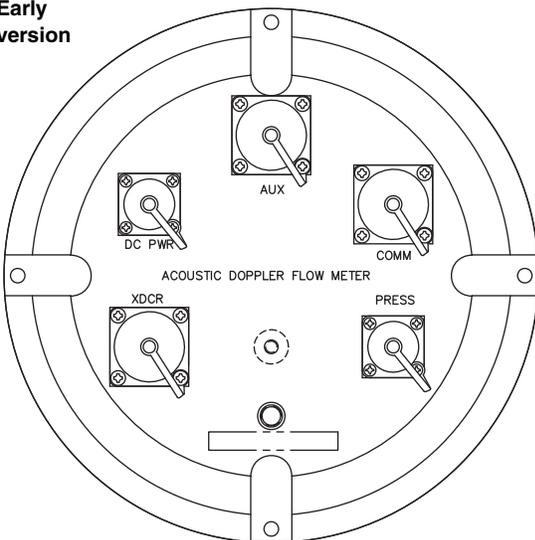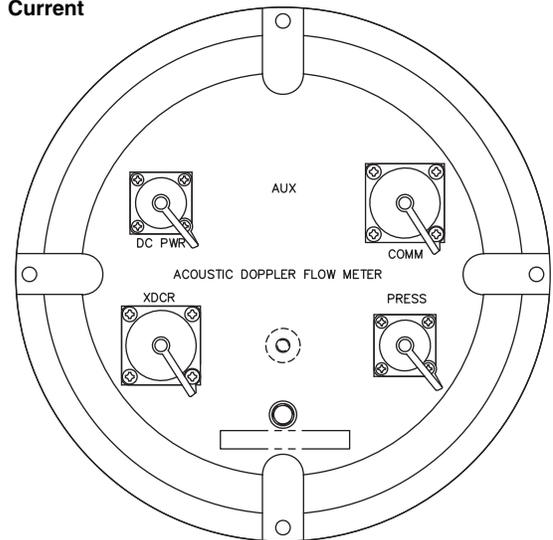
Figure 2-22 Connector port changes in the canister controller

2.5 Sensor Installation

The Pro20 and Hot Tap sensors are connected to the control box in the same manner, as described below. Following this are sections dedicated to the physical installation of both the Pro20 and the Hot Tap.

Technical support

For additional assistance with installing the sensor, contact our Environmental Product Specialists at:

> **Teledyne Isco**
> 4700 Superior St.
> Lincoln NE 68504

Phone: (866) 298-6174 or (402) 464-0231
Fax: (402) 465-3022
E-mail: IscoService@teledyne.com

2.5.1 General Cabling and Connection

The sensor cable is a multi-pair, multi-shielded cable designed specifically for use with the ADFM. The standard cable length is 49.2 feet (15 meters), but other lengths are available upon request.

⚠ CAUTION

Never allow the connectors to be exposed to moisture, foreign matter, or physical shock. Failure to do so can result in permanent damage to the system and may render it inoperable.

To connect the sensor cable, remove the blank cap from the sensor port on the controller (see Figure 2-16, above). Insert the cable connector into the port, rotating it until it stops with the keyed portions aligned. Thread the cable's coupling ring onto the port threads.

User-supplied cable conduit, if required, must have a minimum inner diameter of **2 inches** (to accommodate the cable connector). If routing requires bending the cable, it must have a minimum bend radius of **6 inches**. The sensor cable should not be spliced, and should remain intact from the sensor to the control box.

2.6 Pro20 Sensor Installation

2.6.1 Pro20: Channel Geometry

Information about the sensor installation site, and pipe or channel cross-sectional geometry must be measured and recorded. You will need this information in order to select the proper hardware and accessories, and to program the ADFM. Accurate flow measurement is dependent upon exact dimensional data.

After you have recorded all of the information about the installation site, enter it at the Channel screen of the software you will use to program the ADFM. The Isco software programs available for this are Flowlink and WinADFM. For basic software information, refer to Sections 2.1 *Software*, 2.2 *Flowlink Software*, and 2.3 *WinADFM Software* in this manual. For more complete information, refer to the software user manual and Help files.

Measure and record the distance from the bottom of the channel to the top of permanent silt, if any. This is the **Bed Level** entered into your software, and is used to calculate required sensor elevation, if any (see *Applications With Permanent Silt* Section 2.6.7).

Measure and record the distance from the invert (bottom) of the pipe or channel to the bottom of the sensor. This is the **Zero Offset** entered into your software.

Common Channel Shapes

For common geometries with the standard measurements described below, the channel shape must be symmetrical about the vertical center line. These common geometries include: Circular, Rectangular, Trapezoidal, and Elliptical (Figure 2-23).
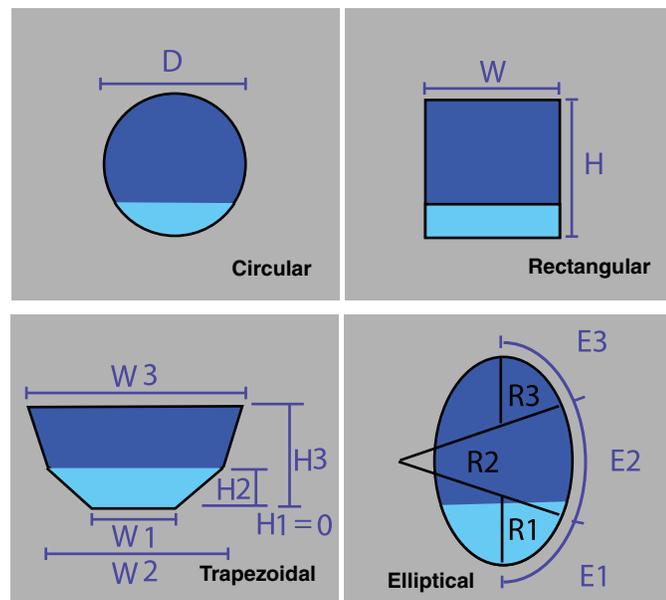
Figure 2-23 Common pipe and channel shapes

Geometry and Parameters

Circular

> D = Diameter

Rectangular & Trapezoidal

> W = Width

> H = Height

> H1 = 0

Elliptical

> R = Radii

> E = Angles

Irregular (Multi-Point) Channel Shapes

For irregular-shaped channels, measure and record the channel width divided by 2 for 10 different depths:

Width/2 = X

Depth = Y

2.6.2 Sensor Positioning   Place the sensor in the straightest possible run, typically at a minimum of 5 channel diameters downstream from a bend and 2 channel diameters upstream from a bend. The sensor should be securely positioned, with minimal potential for fouling or damage from sediment or debris. In installations where high velocity/debris will be present, you may consider protecting the entire cable length (i.e., with user-supplied rigid conduit or metal framing).

FLOW
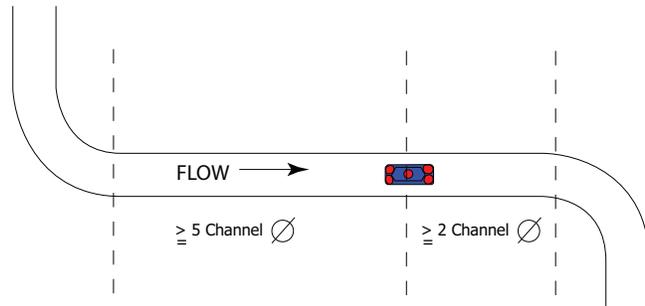
≥ 5 Channel ⌀   ≥ 2 Channel ⌀

Figure 2-24 Sensor positioning

In all installations, the sensor mounting must be firmly anchored flat against the invert (center) of the channel (zero pitch, zero roll).

NO

NO

YES
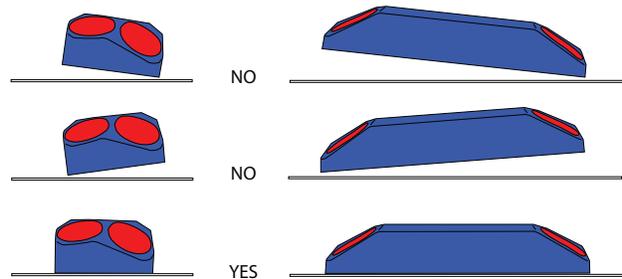
Figure 2-25 Mount sensor flat on channel floor

☑ *Note*

If debris and/or silt are expected, the sensor must be elevated with the proper fairing/spacer combination to ensure proper operation, as described in Section 2.6.7.

The long side of the sensor must be parallel with the longitudinal axis of the channel.
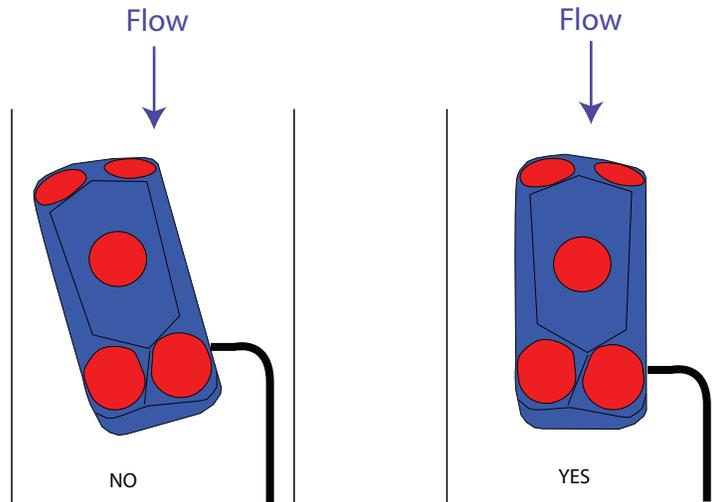
Figure 2-26 Sensor alignment with channel wall

Sites where a large amount of aeration or turbulence will be present often require the use of a secondary pressure transducer. In these cases, the mounting of the secondary sensor, including elevation and orientation, must also be considered.

2.6.3   Pro20: Cabling

Be careful to route the cable away from the side of the sensor where it is attached. Improper cable routing increases the possibility of debris fouling.
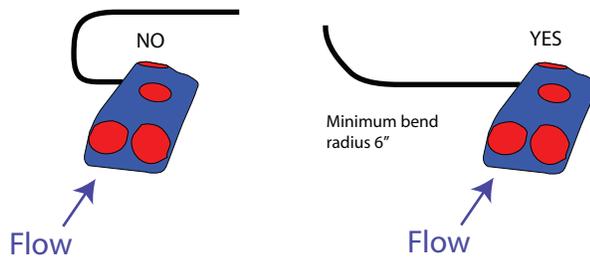
Figure 2-27 Sensor cable direction

During installation, ensure that the cable connector end is sealed for protection in case it comes into contact with water.

If a mounting apparatus (such as a ring or rectangular frame) is used, cables should be fastened to its downstream side. All permanent installations require the cables to be secured to the channel wall and mounting apparatus with rubber-cushioned stainless steel loop straps at 6" (nominal) intervals.

Cable mounting kit, Pro20 only:

part #60-7709-003

Cable mounting kit, Pro20 + pressure sensor:

part #60-7709-002
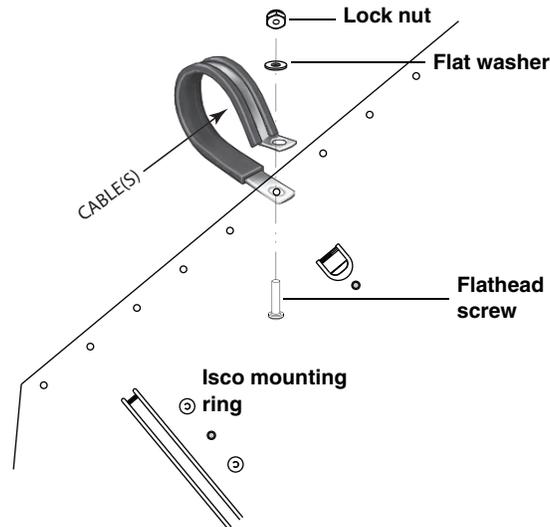
Figure 2-28 Securing the cable(s) with SST straps

☑ *Note*

Always secure the sensor cable to the mounting apparatus and channel wall. **Permanent installations** require the use of bolted stainless steel straps. Plastic cable ties alone are not recommended for any installation, but if used, should have minimum 50 lb loop strength.

2.6.4   Circular Channels

For large ID pipes and manhole inverts, Isco's adjustable Scissors Ring (also known as the Universal Mounting Ring) is available in sets consisting of a base section, a scissors mechanism for adjustment, and one or more pairs of extensions to fit the specific channel size. The base section is equipped with holes and tabs for mounting other Isco sensors.

☑ *Note*

Complete information about the Scissors Ring is beyond the scope of these instructions. See the *Isco Mounting Rings Installation and Operation Guide* (available at www.isco.com) or call the factory for details about choosing and installing your configuration.

⚠ **WARNING**

Use gloves and eye protection when assembling and installing the Isco Mounting Rings.

Scissors mechanism

Bolt holes

Slots for bolting to channel wall

Extensions

Sensor mounting location

Holes for securing cable

Flow
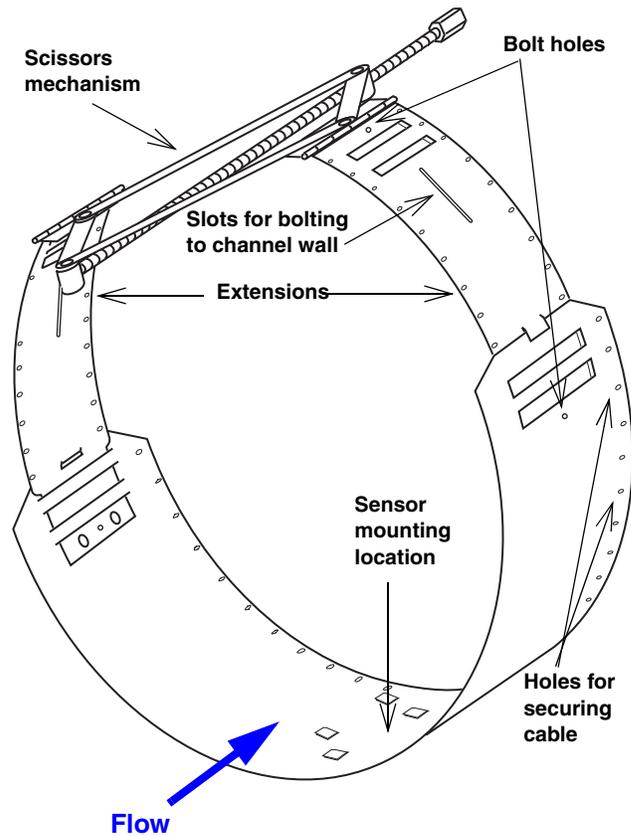
Sensor Mounting Hardware Kit: Part #60-3004-178
Secondary Sensor Hardware Kit: Part #60-7709-001

Figure 2-29 Scissors Ring

Scissors ring assembly:

1. In order for the Pro20 sensor (or fairing/spacer) to be mounted flush against the bottom of the scissors ring, and to avoid accumulation of debris, the six tabs in the center of the base section must be flattened. This can be accomplished by hammering and bending the tabs (Figure 2-30).
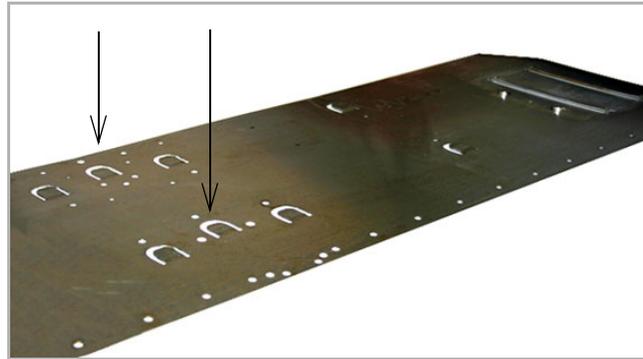
Figure 2-30 Flatten six center tabs on base section

2. Assemble the Scissors Ring, attach the sensor, and secure the cables above ground.

3. Assemble the ring, making sure the tongue sections are fully inserted into the slotted sections and over the securing buttons.

4. Bolt the sections together to increase safety and prevent the assembly from being dislodged or separated by the flow stream.
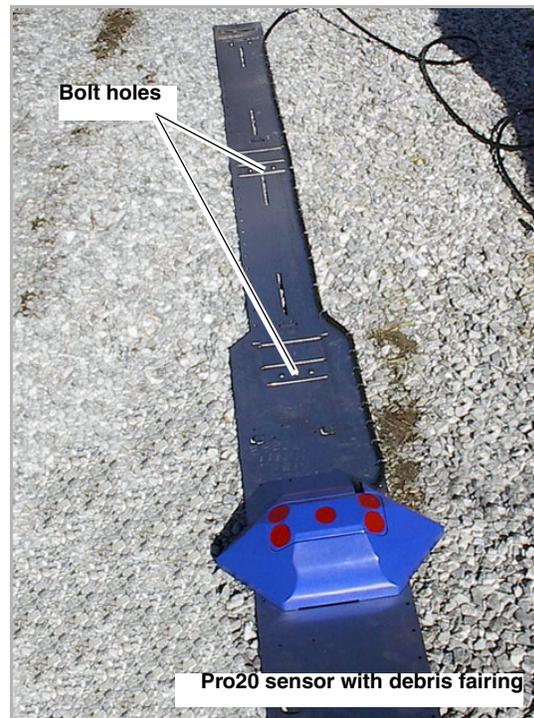
Figure 2-31 Assembling the ring and mounting the sensor
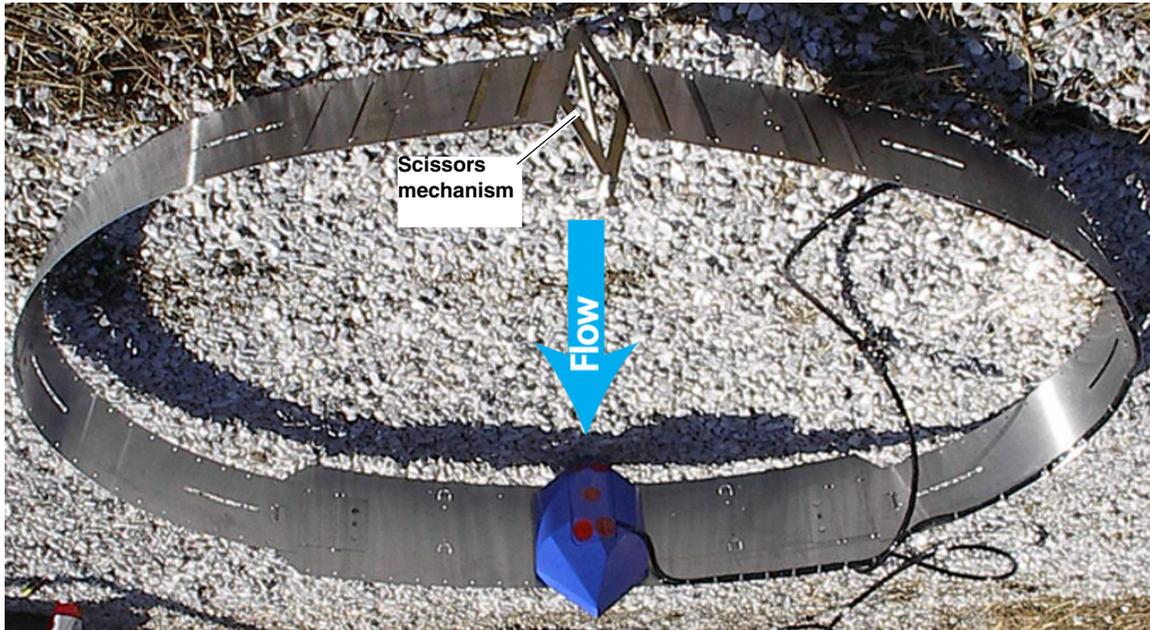
Figure 2-32 Ring assembled, ready for installation

5. Lower the assembly into the pipe with the sensor directly on the bottom center, parallel with the channel wall, facing into the flow. Tighten the scissors assembly to expand the ring outward so that it is pressed entirely flat against the pipe wall (Figure 2-33).

    a. For additional reinforcement, anchor the ring to the pipe wall using the slots provided and user-supplied $^1/_4$" x $2^1/_4$" SST concrete wedge anchors.

☑ *Note*

Wedges are for reinforced concrete only. For pipes made of other materials, such as composite fiber, contact the manufacturer or Teledyne Isco for attachment recommendations. For pipe IDs of 60" or smaller, the full scissors ring is recommended.

    b. For manhole invert installations, the scissors mechanism may be omitted. Anchor the base section and any extensions to the pipe wall.

☑ *Note*

Be very careful to position the sensor flat against the channel floor, facing into the flow.

6. Secure the cable along the top or side of the pipe to prevent damage, dislodging, and collection of debris.
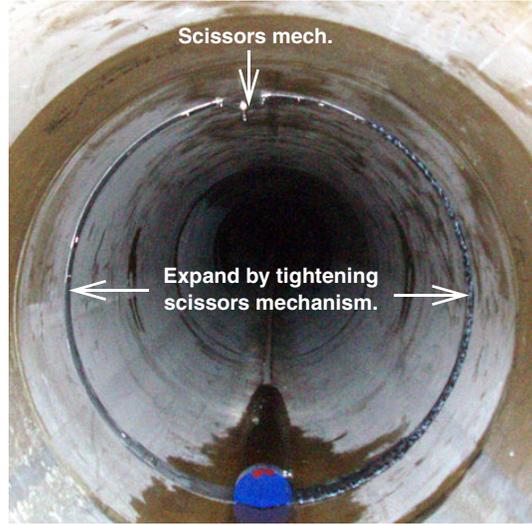
Figure 2-33 Expand and secure the ring against the channel wall

2.6.5   Large Flows and Moving Debris

Under high velocity conditions (greater than five feet per second or 1.5 meters per second) and/or moving debris, the ring may require anchoring to keep it tight against the pipe. The flow could lift the ring off the bottom of the pipe, or even carry it downstream.

This problem is more prevalent in larger diameter pipes, and in pipes with a smooth inside surface (plastic, for example). If any of these conditions are present, or if movement of the spring ring is suspected, anchoring the ring is highly recommended. This is usually accomplished using threaded fasteners anchored or driven into the wall of the channel, typically wedge anchors set in a pre-drilled hole, or with a power actuated stud gun.

Please contact the factory for recommendations on installation in manhole inverts, or in pipes larger than 80 inches in diameter.

2.6.6   Rectangular Channels

In rectangular channels, the Pro20 sensor is commonly installed using a flat mounting plate anchored to the channel floor, and/or a removable rectangular frame inserted into guide slots in the channel walls.

In some cases, particularly when the Pro20 sensor will be installed using a diver or other special methods, the sensor will be mounted on a rectangular plate, which is then anchored directly to the channel floor.

Plate: Part #60-7613-003
FLH M6 X 10mm SST Screws: Part #231-8116-10
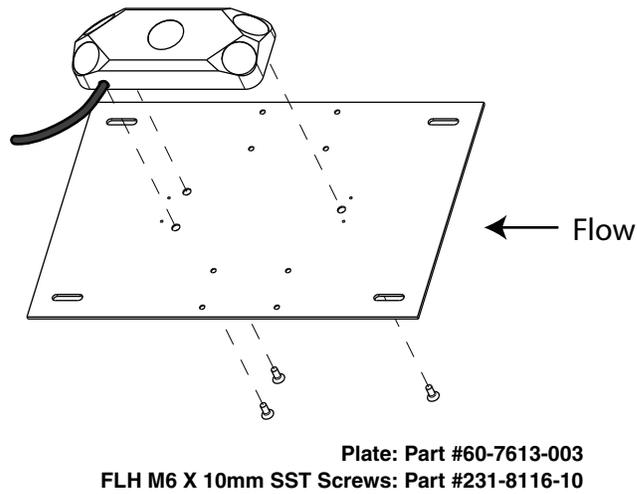
Figure 2-34 Attaching the sensor to a mounting plate
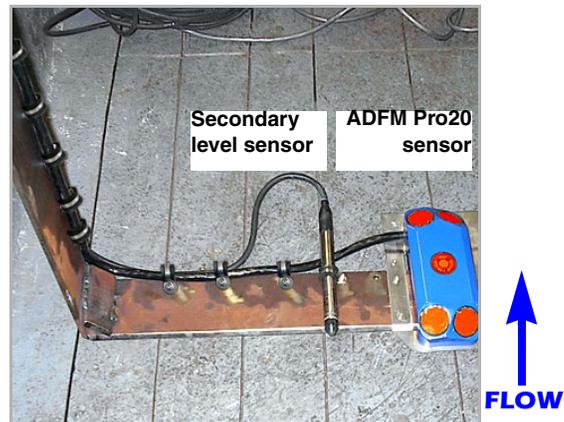
Figure 2-35 Rectangular frame mounting

Where a rectangular frame is used, verify the exact channel width at different depths and ensure that no obstructions will hinder insertion and removal of the frame. When designing mounting methods and accessories, avoid conditions where accumulation of solids on or against the frame is likely. Ensure that the installation allows access for servicing, clearing of debris, and removal/replacement of the frame.
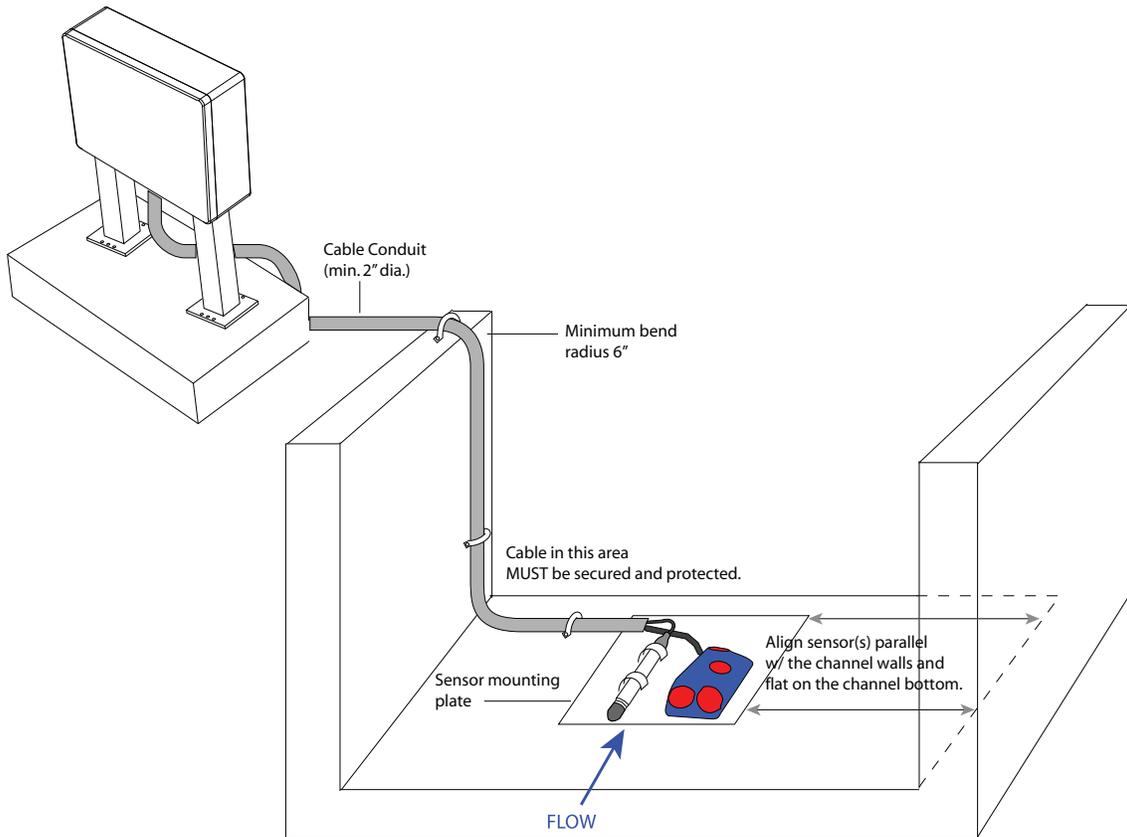
Figure 2-36 Installation example

2.6.7 Applications With Permanent Silt

For pipes or channels where sediment or debris will be present, Teledyne Isco offers mounting accessories for elevating the sensor.

The debris fairing attaches directly to the mounting plate or ring, and the sensor is mounted in the top of the fairing for a lift of 3 inches. Fairing spacers add 1, 2, and 4 inches each, and may be combined for additional lift.

The sensor, fairing, and spacer(s) are attached to the mounting plate with three threaded couplers and mounting screws.

Figure 2-37 Fairing and spacers for added lift

1. Insert the threaded couplers into the fairing or bottom spacer.
   Additional couplers may be connected if extra spacers are required.
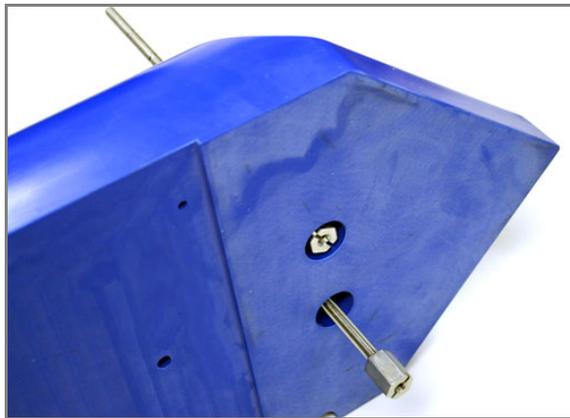
Figure 2-38 Inserting the threaded couplers

2. Position the mounting plate over the couplers with the countersunk holes facing out. Attach with the mounting screws.
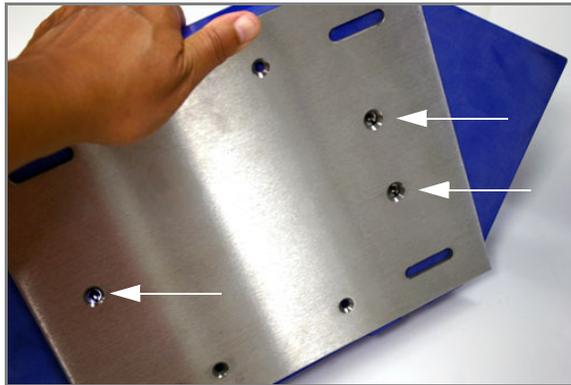
Figure 2-39 Attaching the mounting plate
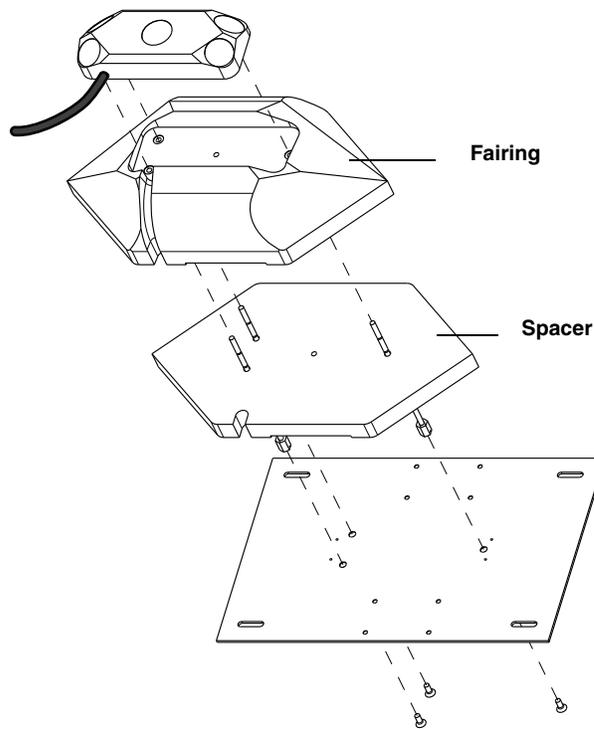
Figure 2-40 Sensor with fairing and fairing spacer

3. Break off any excess length from the threaded couplers (Figure 2-41) such that the remaining threads attach the sensor snugly into the fairing.
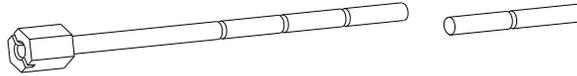
Figure 2-41 Threaded couplers: break off at joint

2.6.8   Pro20 Sensor Mounting Hardware

Table 2-1 List of Pro20 Sensor Mounting Accessories	
Cable mounting kit - Pro20 sensor only	60-7709-003
Cable mounting kit - Pro20 & pressure sensor	60-7709-002
Single SST Loop - Pro20 sensor only	489-0016-23
Single SST Loop - Pro20 & pressure sensor	489-0016-25
Scissors Ring standard sensor mounting hardware kit	60-3004-178
Scissors Ring secondary sensor mounting hardware kit	60-7709-001
Sensor mounting plate	60-7613-003
Sensor mounting screws	231-8116-10
Debris fairing	60-7004-042
Spacer, 1 inch lift	60-7004-043
Spacer, 2 inch lift	60-7004-044
Spacer, 4 inch lift	60-7004-045
Threaded coupler	60-7614-001
Replacement hardware kit for fairing/spacer	60-7619-001

2.7 Hot Tap Sensor Installation

Recent changes have been made to the design of the Hot Tap Insertion (HTI) sensor. The two versions have slightly different dimensions and hardware. Operation is exactly the same for both.

The two versions are most distinguishable from one another by the appearance of the box at the head of the shaft. See Figure 2-42, below. If your sensor has the smaller, metal box on the left, follow the instructions in Section 2.8 *Insertion: Early Version HTI*. If your sensor has the larger, molded box on the right, follow the instructions in Section 2.9 *Insertion: Current HTI*.

Early HTI

Current HTI

Figure 2-42 Early and current versions of the HTI sensor

⚠ **WARNING**

Never loosen any hardware on the Hot Tap sensor when the pipe is pressurized. Pressure within the pipe can force the shaft to come out of the pipe, causing grave injury to anyone nearby.
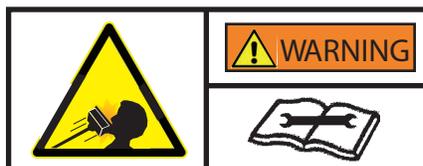
2.7.1 Forced Depth and Scaling Constant (Hot Tap only)
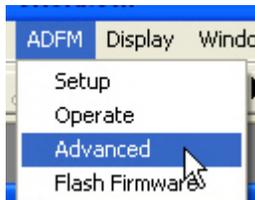
During Hot Tap site setup (Flowlink) or station setup (WinADFM), you must open the Advanced Commands field and enter the following information:

Forced Depth (QF) – The value of QF is the pipe's inside diameter (ID) in millimeters.

Example: For an ID of 22.5 inches, enter QF572 (22.5 x 25.4 mm/in, rounded up).

Scaling Constant (QS) – This is the number printed on the serial tag of every Hot Tap sensor. Enter as QS### or QS####, depending on how many numbers are given.

Example: Figure 2-43 shows the location of this value on old (QS1005) and new (QS982)sensors.

Early version HTI
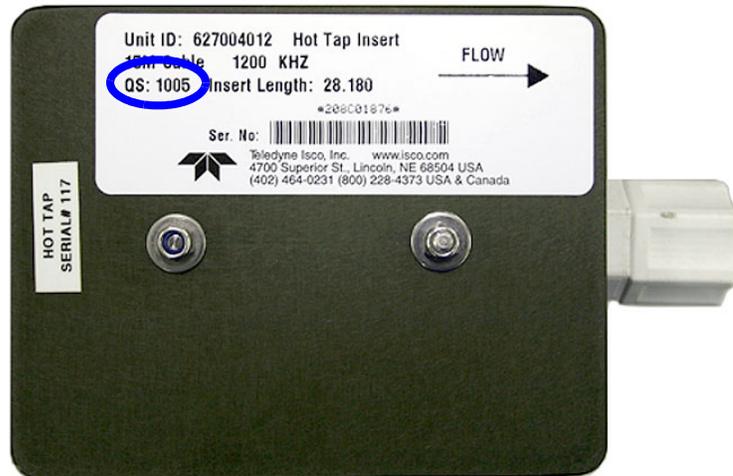
Current HTI

Figure 2-43 Location of the QS value on Hot Tap label

2.8 Insertion: Early Version HTI

These instructions refer to Figure 2-44 on the following page.

The preferred locations for sensor installation in a horizontal pipe are between the clock positions 1 and 5, and 7 and 11, as shown in Figure 2-44. Installation at the top and bottom of the pipe should be avoided due to the possibility of trapped air or sedimentation. The sensor may be installed at any position in a vertical pipe, provided the stream is flowing upward.

For all other variations in position or flow, contact Teledyne Isco for assistance.

Tools and supplies

Installation of the Hot Tap requires the following user-provided tools and supplies:

- Tapping saddle, thread-o-let, or spool piece
- 2" NPT Corporation stop or ball valve
- $9/64$" hex screwdriver
- Pipe wrench
- PTFE pipe thread tape
- Optional cable conduit (min. 2" dia.)

The standard length of the Hot Tap sensor cable is 50 ft (15m). A custom-length cable can be up to 100 ft (30m). If conduit is used, a minimum diameter of 2 in. is required. Minimum bend radius for the cable is 6 in.

Dimensional requirements

When determining the installation location, consider the minimum clearance required for installation and removal of the sensor from the pipe. The minimum clearance required is found by calculating the dimension **C**.

For the standard length sensor, the distance from the top of the valve to the inner pipe wall (**D**) must not exceed 15" in order to have an insertion depth of up to $1\frac{1}{2}$" past the inner pipe wall.

☑ *Note*

Typical insertion depth is usually between $1/4$ in. and $1/2$ in. However, installations in pipes where buildup of grease or debris is expected, deeper insertion will ensure unimpaired flow readings.

If **D** exceeds 15 inches, a custom length sensor shaft (part #60-5314-677) must be ordered. Contact Teledyne Isco for assistance with custom length selection.

L	Sensor length (printed on box; standard 28" nom.)	P	Pipe wall thickness
E	Extended length (L + 2.25")	C	Minimum clearance for sensor removal (E + V + T)
V	Valve (user-supplied)	D	Distance from top of valve to inner wall (V + T + P)
T	Tapping saddle, thread-o-let, or spool piece (user-supplied)	I	Insertion depth (L - (S+P))
S	Sensor tip insertion depth ($^1/4$" to $^1/2$")		
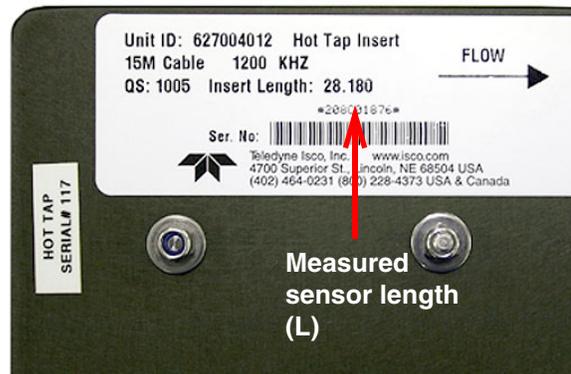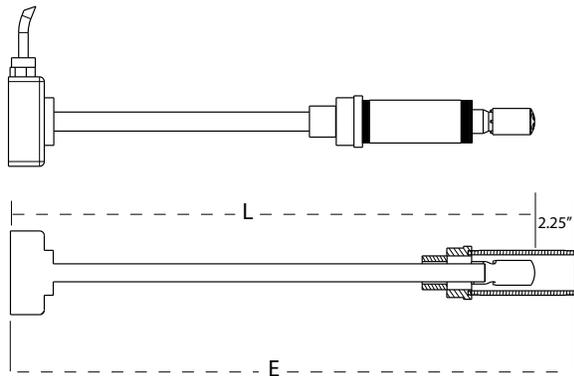
Figure 2-44 Early HTI: Component measurements and sensor positioning

Before installation, fully extend the Hot Tap by loosening the clamping collar (lock ring) screw (Figure 2-45) and pulling the sensor all the way back inside the nipple, as shown at the bottom left of Figure **2-44**.

Collar screw ———

Figure 2-45 Early HTI Hardware

The sensor's extended length **E** is 2.25 inches greater than the sensor length **L**. Use Figure **2-44** as a guide when calculating distances **C** and **D**.

Installation

1. With the sensor fully extended, apply pipe thread tape to the nipple threads.

2. Screw the nipple into the valve.

3. Open the valve and push the sensor into the pipe to Dimension **I**.

4. Align the arrow printed on the sensor head box (bottom right, Figure 2-44) with the direction of flow (downstream). (The cable is also attached on the downstream side of the box.)

☑ *Note*

For highest accuracy, the box must be aligned exactly parallel to the flow in the pipe, with the cable end facing downstream. When adjusting this alignment, ROTATE THE SHAFT, not the box itself.

Flow →

Figure 2-46 Align the edges of the box parallel to flow

5. Lock the sensor shaft in place by tightening the collar screw.
Note that there are two screws; the screw to be tightened is on the side of the collar, not the top.

⚠ **WARNING**

Never loosen any hardware on the Hot Tap sensor when the pipe is pressurized. Pressure within the pipe can force the shaft to come out of the pipe, causing grave injury to anyone nearby.

Early version HTI: safety reinforcement

A secondary clamping collar (kit 69-7303-012) is included with the early version Hot Tap sensor. Should the secondary collar become necessary, install it on the shaft directly behind the first collar.

1. Remove the Allen screw from the top of the first collar.

2. Place one half of the new collar on top of the old one, aligning the holes. Insert the long Allen screw, with spring lock washer, through the new collar clamp and down into the threaded hole of the old collar, and tighten down firmly.
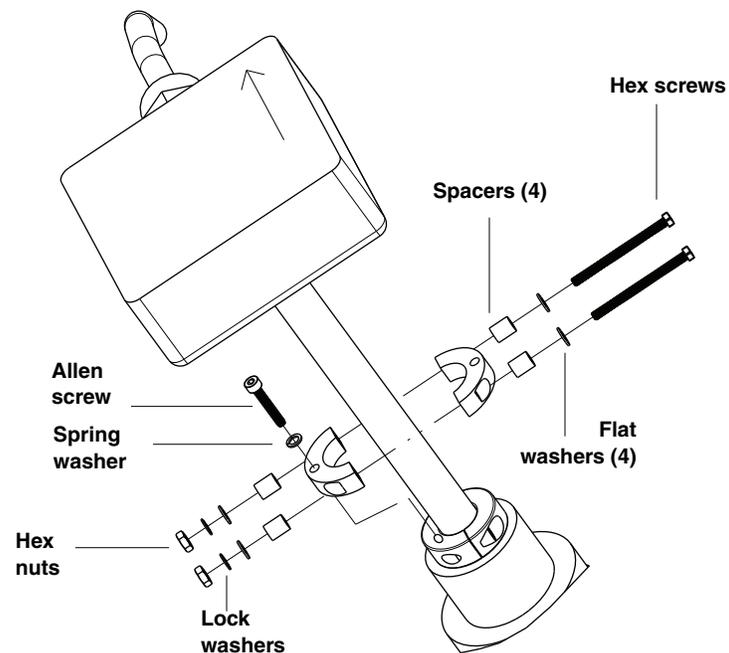
Figure 2-47 Secondary collar installation

3. Place the other half of the new collar on top of the old one to form the new collar.

4. Insert the two long screws, including washers, spacers, and nuts, as shown above. Tighten the screws until the collar is snug against the shaft and cannot rotate.

Figure 2-48 Early version Hot Tap with secondary collar installed

⚠ **WARNING**
Never loosen any hardware on the Hot Tap sensor when the pipe is pressurized. Pressure within the pipe can force the shaft to come out of the pipe, causing grave injury to anyone nearby.
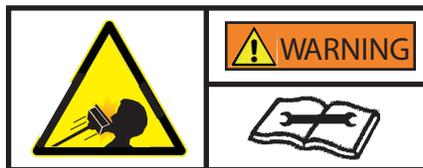
2.9 Insertion: Current HTI

These instructions refer to **Figure** 2-49 on the following page.

The preferred locations for sensor installation in a horizontal pipe are between the clock positions 1 and 5, and 7 and 11, as shown in Figure 2-49. Installation at the top and bottom of the pipe should be avoided due to the possibility of trapped air or sedimentation. The sensor may be installed at any position in a vertical pipe, provided the stream is flowing upward.

For all other variations in position or flow, contact Teledyne Isco for assistance.

Tools and supplies

Installation of the Hot Tap requires the following user-provided tools and supplies:

- Tapping saddle, thread-o-let, or spool piece
- 2" NPT Corporation stop or ball valve
- $^3/_{16}$" hex screwdriver
- Pipe wrench
- PTFE pipe thread tape
- Optional cable conduit (min. 2" dia.)

The standard length of the Hot Tap sensor cable is 50 ft (15m). A custom-length cable can be up to 100 ft (30m). If conduit is used, a minimum ID of 2 in. is required. Minimum bend radius for the cable is 6 in.
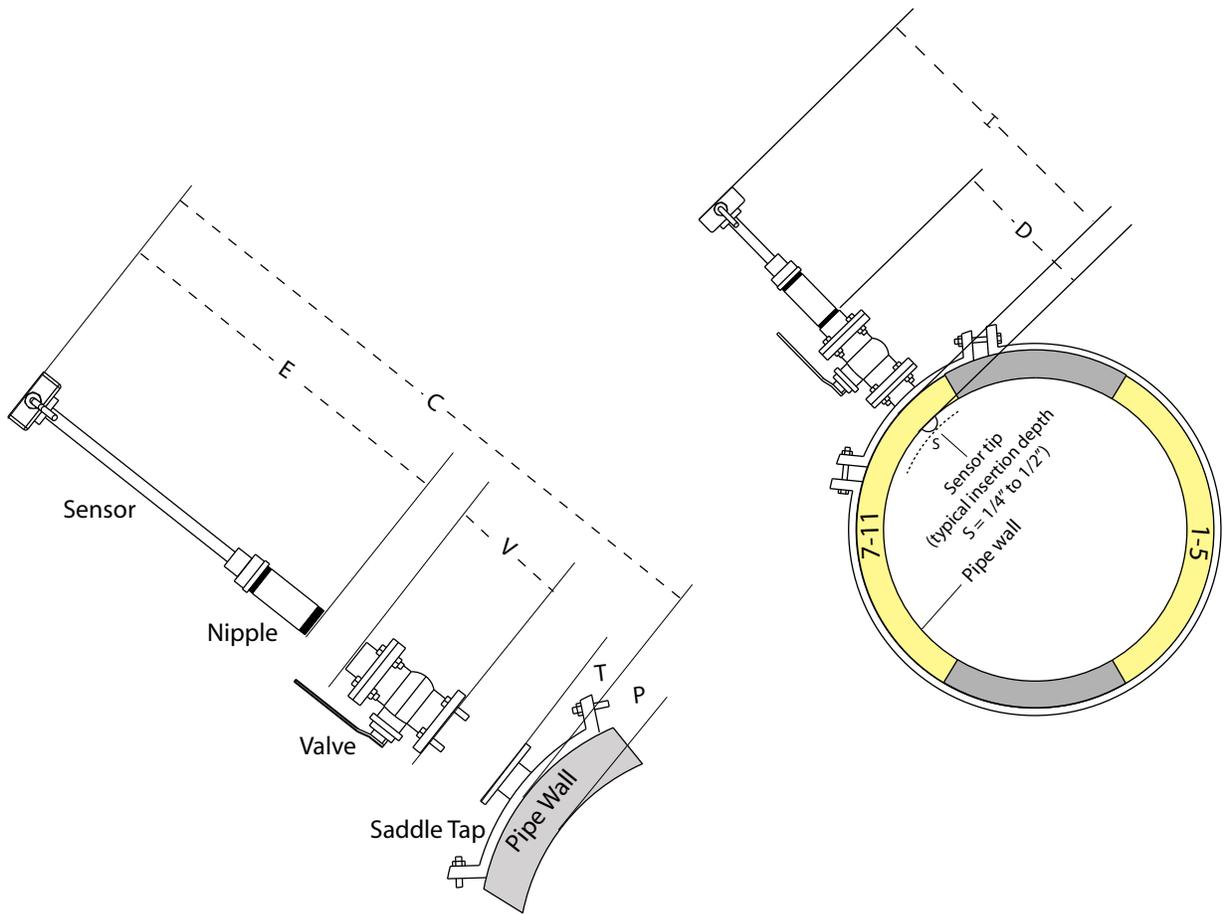
Dimensional requirements

When determining the installation location, consider the minimum clearance required for installation and removal of the sensor from the pipe. The minimum clearance required is found by calculating the dimension **C**.

For the standard length sensor, the distance from the top of the valve to the inner pipe wall (**D**) must not exceed 15" in order to have an insertion depth of up to $1^1/_2$" past the inner pipe wall.

☑ *Note*

Typical insertion depth is usually between $^1/_4$ in. and $^1/_2$ in. However, installations in pipes where buildup of grease or debris is expected, deeper insertion will ensure unimpaired flow readings.

If **D** exceeds 15 inches, a custom length sensor shaft (part #60-5314-677) must be ordered. Contact Teledyne Isco for assistance with custom length selection.

| Sensor length: 28.785 in. (73.114 cm)	P	Pipe wall thickness
Extended length: 31.035 in. (78.829 cm)	C	Minimum clearance for sensor removal (31.035" + V + T)
V	Valve (user-supplied)	D	Distance from top of valve to inner wall (V + T + P)
T	Tapping saddle, thread-o-let, or spool piece (user-supplied)	I	Insertion depth (28.785" - (S+P))
S	Sensor tip insertion depth ($1/4$" to $1/2$")		
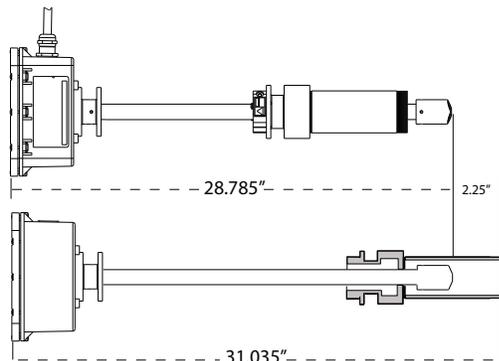
Figure 2-49 Current HTI: Component measurements and sensor positioning

Before installation, fully extend the Hot Tap by loosening the clamping collar screws (Figure 2-50) and pulling the sensor all the way back inside the nipple, as shown at the bottom left of Figure 2-49.

⚠ WARNING

Never loosen any hardware on the Hot Tap sensor when the pipe is pressurized. Pressure within the pipe can force the shaft to come out of the pipe, causing grave injury to anyone nearby.
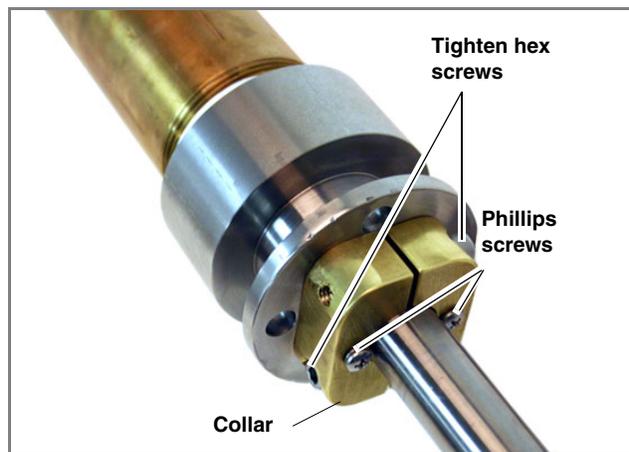
Figure 2-50 Current HTI Hardware

The sensor's extended length, 31.035 inches, is 2.25 inches greater than the sensor length (28.785 in.). Use Figure 2-49 as a guide when calculating distances **C** and **D**.

Installation

1. With the sensor fully extended, apply pipe thread tape to the nipple threads.

2. Screw the nipple into the valve (Figure 2-44).

3. Open the valve and push the sensor into the pipe to Dimension **I**.

4. Align the arrows printed on the Hot Tap's electronics box with the direction of flow (downstream). (The cable is also attached on the downstream side of the box.)

☑ *Note*

For highest accuracy, the box must be aligned exactly parallel to the flow in the pipe, with the cable end facing downstream. When adjusting this alignment, ROTATE THE SHAFT, not the box itself.
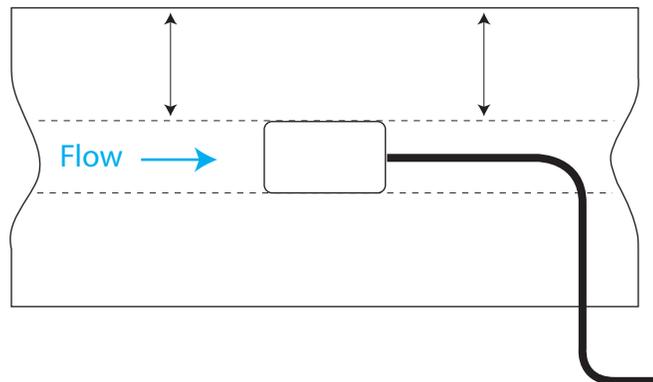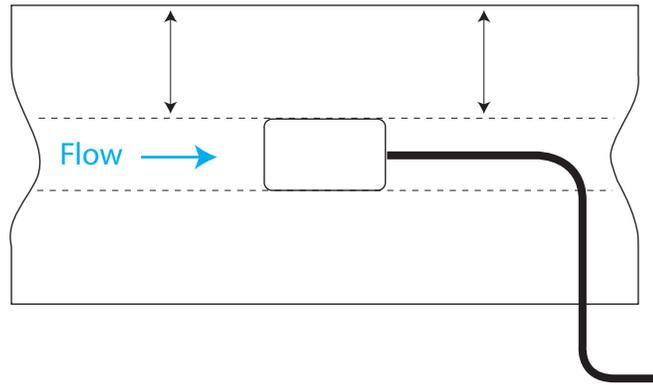

Figure 2-51 Align the edges of the box parallel to flow

5. Loosen the two Phillips screws on the back of the two-piece clamping collar.

⚠ WARNING

Never loosen any hardware on the Hot Tap sensor when the pipe is pressurized. Pressure within the pipe can force the shaft to come out of the pipe, causing grave injury to anyone nearby.

Safety reinforcement

6. Lock the sensor shaft in place by evenly tightening the two hex socket screws in the sides of the two-piece clamping collar, and then re-tighten the two Phillips screws.

The sensor assembly includes a tethering chain as a precautionary measure in the event that the clamping collar is inadvertently loosened.

Attach the quick disconnect links through holes in each of the two flanges on the sensor shaft, adjusting the chain to proper length.

Figure 2-52 Attaching the tether chain

Figure 2-53 Adjust chain to proper length

Additional Safety Equipment   For installation of the sensor in pipes with pressures above 100psi, Teledyne Isco recommends the Safety Installation Kit, part #60-7007-030 as an additional safety measure.
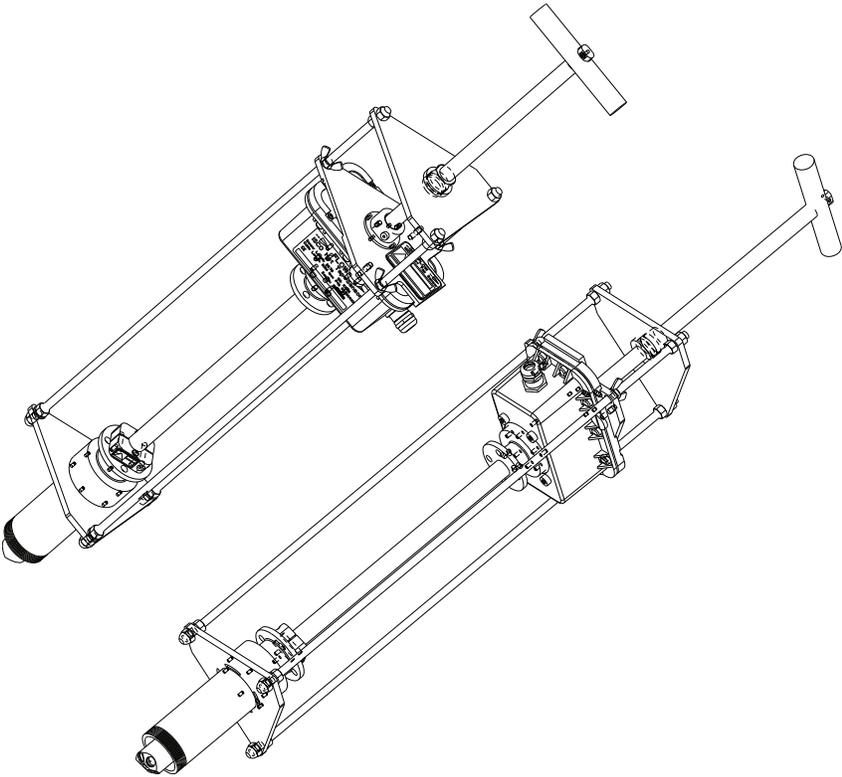
Figure 2-54 Safety Installation Kit

2.10 Applying Power

Connect the appropriate power supply to the ADFM and the power source, and/or ensure that the batteries are securely mounted inside the control box.

2.10.1 Box Controller Batteries

To install the four lantern batteries:

1. Remove the top cover by loosening the four large screws holding it in place.

2. Remove the two small, flathead screws holding the inner front panel closed. The screws are not attached. Take care not to lose the plastic washers.

3. Remove the battery housing lid by loosening the four large screws holding it in place. The screws remain attached to the lid.

Figure 2-55 Box controller: remove the battery compartment

4. Place the four batteries inside the compartment with the terminals facing downward.

Figure 2-56 Box: Battery compartment

5. Replace the housing lid, installing it so that the metal screw tab in the chassis is over the cutout in the upper right corner of the lid, as before.
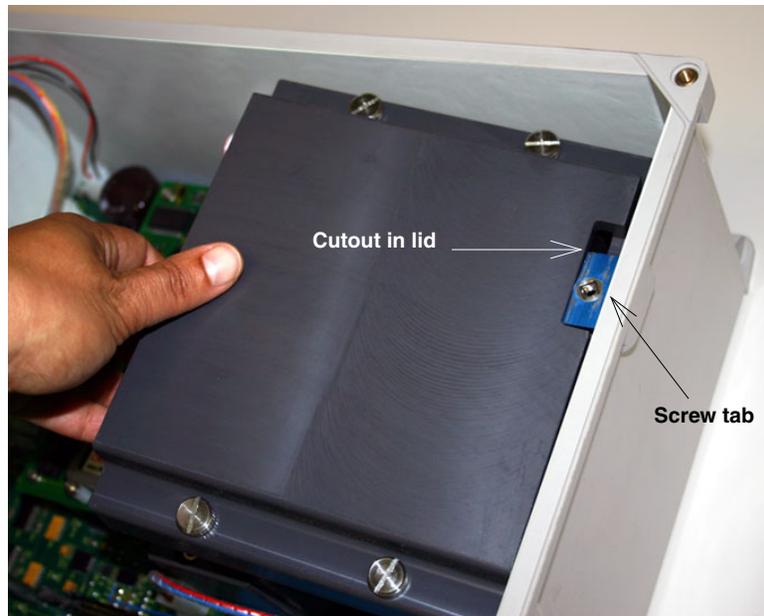
Figure 2-57 Reinstalling the battery compartment lid

2.10.2 Box Controller On and Reset Switches

In the box controller, the On switch is a key switch located on the left side of the inner front panel (Figure 2-58), inside the area labeled Power. Note that there are two switches, labeled Battery and Mains. **Only the switch labeled Battery is functional.** This switch controls all DC power, including batteries and external power. The Mains switch is not connected or functional, since current ADFM units do not use line voltage.

To power up the ADFM, use the switch-key provided to turn the "Battery" switch to the On position, indicated by the number **1** (one).
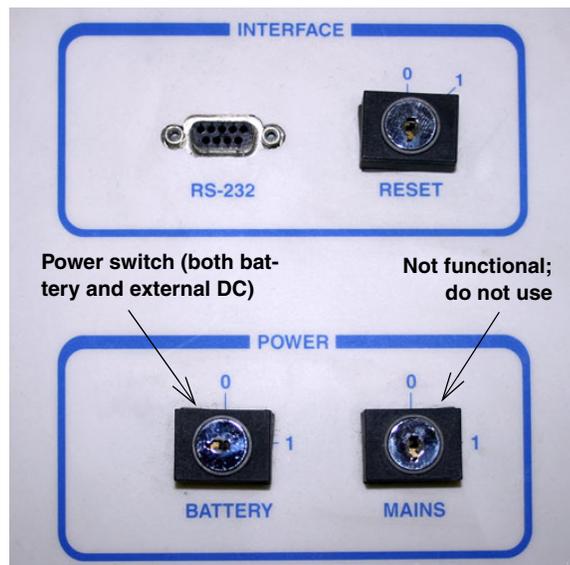
Figure 2-58 Control box power switches

To reset the ADFM, turn the spring-loaded Reset switch to the **1** (one) position and release it.

2.10.3 Canister Controller Batteries

To install the four lantern batteries:

1. Unscrew the four eye bolts on the canister's suspension end, taking care not to lose the washers and the black o-ring seal around the base of the lid.

Unscrew suspension bolts (4)

Figure 2-59 Canister: remove battery compartment lid

2. Remove the butterfly screw and battery retaining cover.
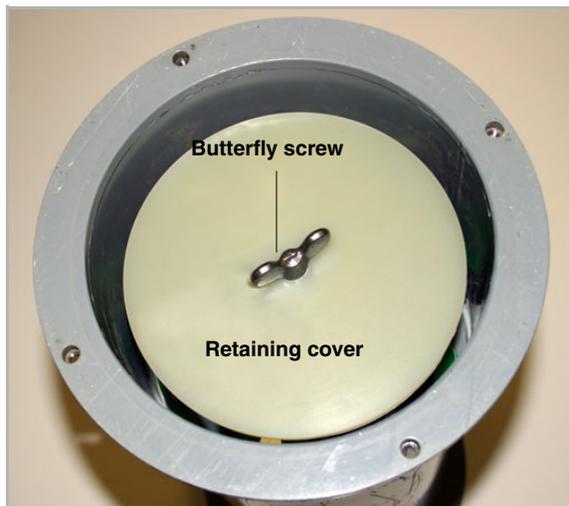
Figure 2-60 Remove battery retaining cover and screw

3. Place the four batteries inside the compartment with the terminals facing downward.
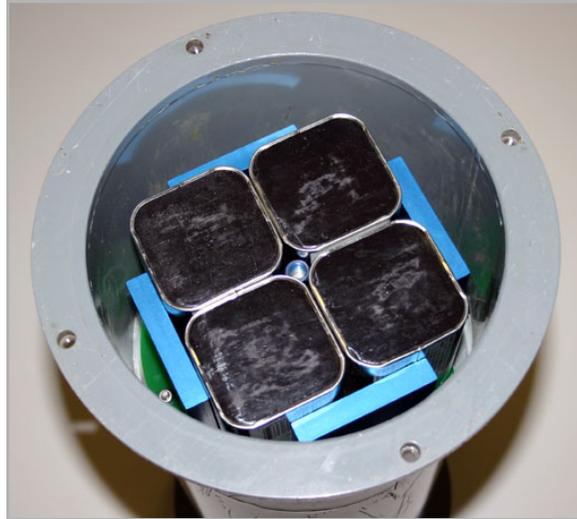
Figure 2-61 Canister: Battery compartment

4. Reinstall hold-down and outer covers.

2.10.4 Resetting the ADFM Canister

To reset the ADFM canister, disconnect and reconnect power cable and/or battery power (by removing and replacing the batteries).

2.11 Built In Tests (BITs) (Box Controller Only)

When power is first applied to the ADFM box controller, an internal self-test will automatically be performed. On the control box, result messages will scroll on the LCD display, finishing with a display showing the ADFM firmware version number on the first line and a hexadecimal-coded event/error map on the second line.

2.11.1 Testing Interval

Routine execution of the built-in tests is not required during normal system operation. Execution of selected built-in tests from software is recommended quarterly or at each battery change, whichever is more frequent. The built-in tests should also be performed whenever a hardware problem with the ADFM is suspected.

2.11.2 Test Record

By default, the software will create a log containing details of all ADFM operations, including the status of the error code map and the results of all built-in tests. No further test record is required unless specifically requested by Isco Service personnel.

2.11.3 Power-up BIT Procedure/Sequence

Switch off the power to the ADFM.

After an interval of at least ten minutes, switch the power on again. The ADFM's LCD display should show the firmware version and error code map followed by the wakeup message:

```
RD Instruments:
------------------
Acoustic Doppler
Flow Meter
```

The ADFM should begin displaying the results of the power-up BIT. The power-up BITs will last approximately one to two minutes, after which the LCD will show the firmware version on the first line and BIT error and event code on the second line:

```
ADFM Ver. V6.xx
09000080
```

For code definitions, refer to Table 2-2 on the following page.

☑ *Note*

If no events or errors occurred, the second line will show only zeros (`00000000`).

To repeat the power-up BIT tests, turn and release the spring-loaded Reset key switch located on the front panel.

Table 2-2 BIT Hexadecimal Code Definitions		
Code	**Definition**	**Explanation**
`01nnnnnn`	Autostart:	Unit has been restarted or restarted itself.
`80nnnnnn`	Modem dial failure	
`40nnnnnn`	Modem listen failure	
`20nnnnnn`	Recorder failure	
`10nnnnnn`	Recorder full	
`08nnnnnn`	Transducer communication failure	
`04nnnnnn`	Power time fail:	Motherboard failure
`02nnnnnn`	Fifo fail:	
`008nnnnn`	DeMod LCA fail:	
`00000040`	Intrup Err:	
`00000020`		
`00000010`		
`00000008`	Divo Err:	
`00000004`	Inst Err:	
`00000002`	Addr Err:	
`00000001`	Bus Err:	Possible motherboard failure, but may correct itself upon restart.
`004nnnnn`	Comm Timeout: Communication times out in the ADFM after several minutes of no activity. To reestablish communication, disconnect the ADFM from the computer and then reconnect.	
`002nnnnn`	Pressure fail: Failure of secondary depth sensor if it is a pressure type sensor; no code for other sensor types.	
`00000080`	Cold WU (wakeup): Manual restart occurred while ADFM was connected to computer.	

> ☑ *Note*
>
> Each code indicates one error or event type. However, if two or more events are present, the code will appear as the sum of the most significant digits of their corresponding codes.
> Example: If the ADFM has been restarted and also experienced a transducer communication failure, the code displayed would be: `09nnnnnn`.

2.12 Data Retrieval

This section offers a brief overview of collecting data from your ADFM system with Teledyne Isco's software programs. For full details of site setup and data management, refer to the software instruction manual.

☑ *Note*

The flow meter's recorder must be cleared following data retrieval. Save all downloaded data and, prior to redeployment, erase the recorder and restart the ADFM. This applies to both Flowlink and WinADFM software programs.

2.13 Flowlink

To begin downloading data from the ADFM through direct connection:

1. Connect the computer to the ADFM flow meter with the communication interface cable.

2. Start Flowlink software.

3. In the workspace on the left, open the desired site file. The site window opens.
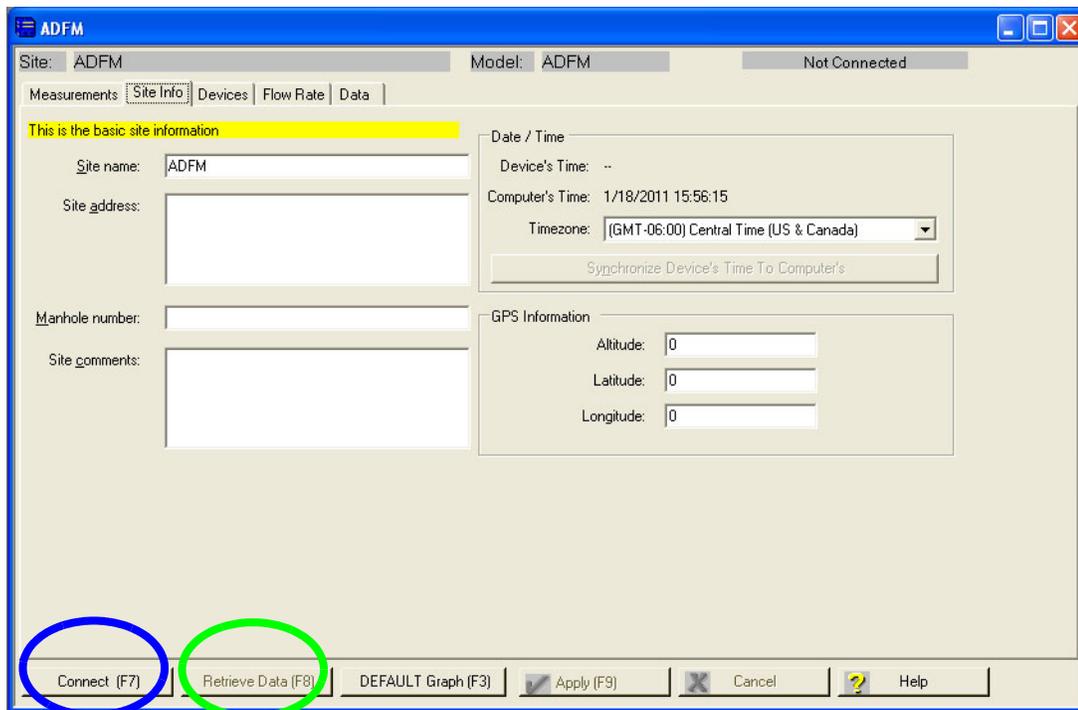
Figure 2-62 Site Info tab: Connect and Retrieve Data buttons

4. On the Site Info tab, click the Connect button.

5. Once the site is online, the Retrieve Data button becomes active. Click the Retrieve Data button to download data from the site.
A progress bar will indicate the download status.

☑ *Note*

To retrieve only the data collected since the last interrogation, press Shift + F8 to open the Retrieve Options window.
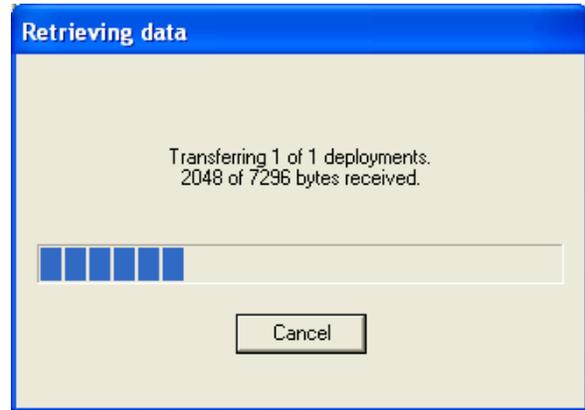
Figure 2-63 Flowlink: Data download

6. Upon completion, click Erase Data to erase the recorder. The software will remind you to back up your data first:
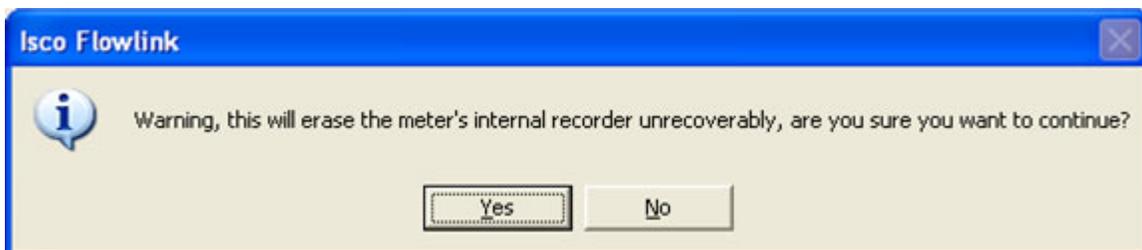
Figure 2-64 Erasure warning - Flowlink

7. Click Yes to continue. The data window will say:
   PLEASE WAIT, ERASING RECORDER...
   RECORDER WAS ERASED.

8. Restart the ADFM by doing one of the following:

   a. To save new program settings, click Program and Restart. The timeout warning will appear:
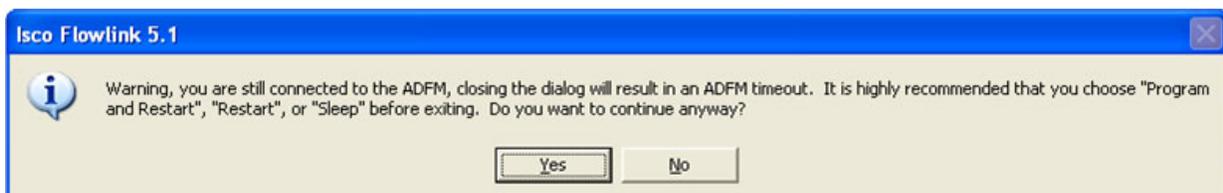
Figure 2-65 Timeout warning - Flowlink

Click Yes to continue.

---

b. To keep current program settings, click Restart.
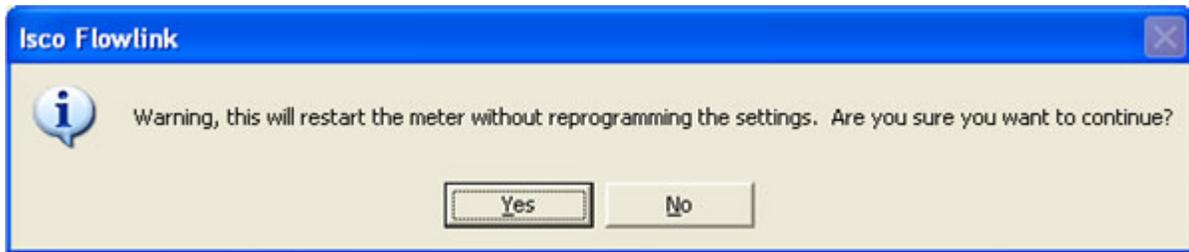
Figure 2-66 Restart warning - Flowlink

2.13.1 Viewing the Data   In the workspace on the left, expand the site file tree to display devices in the site and the ADFM's measured parameters. To quickly graph data, double-click on any parameter (Figure 2-67).
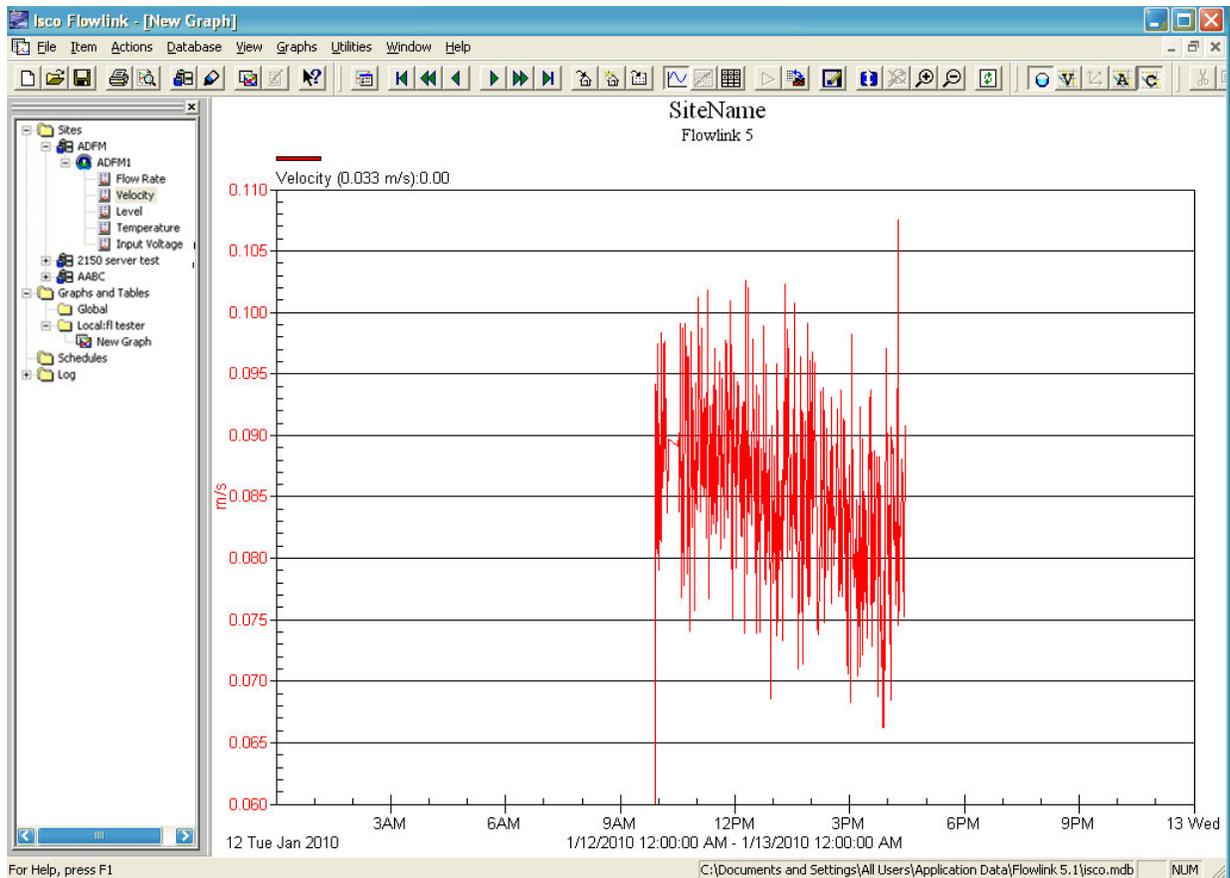
Figure 2-67 Flowlink: Graphing data (velocity shown)

To view multiple parameters on the graph, simply drag and drop them into the graph.
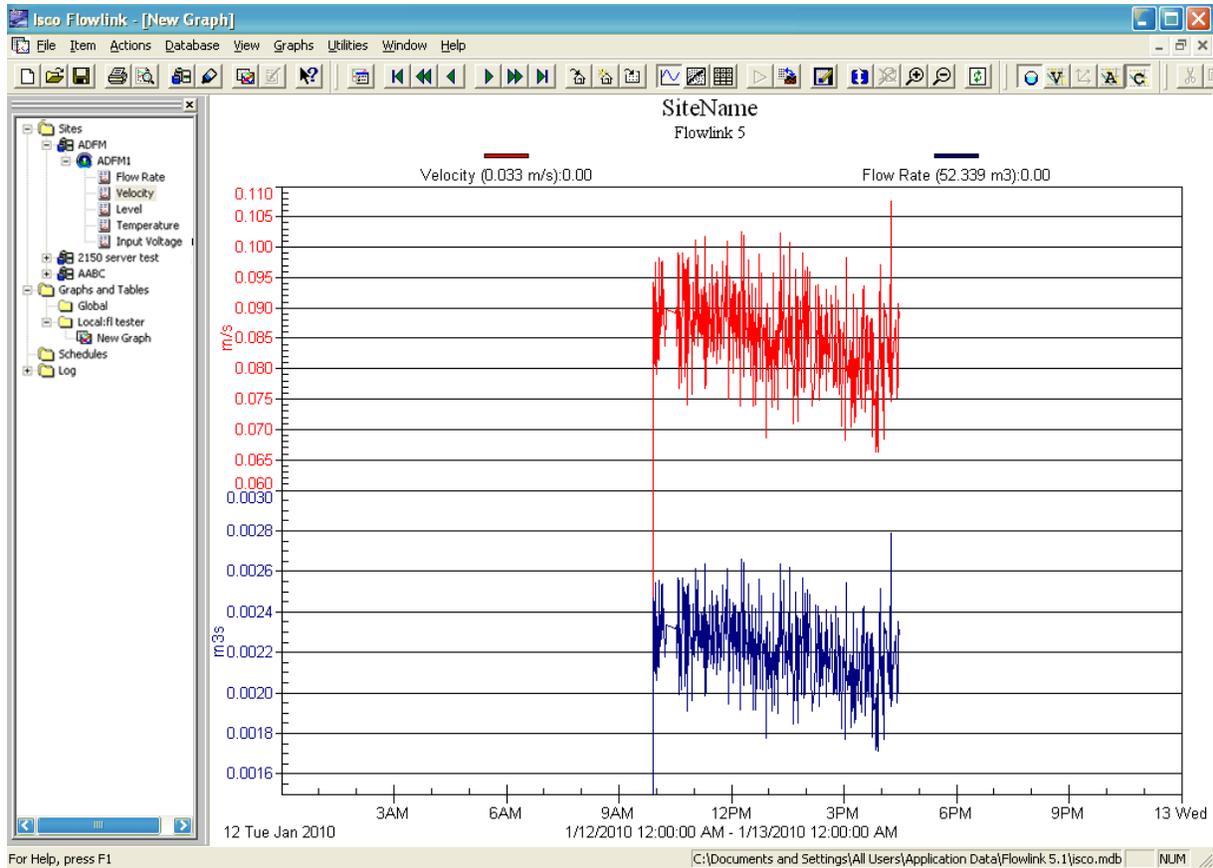
Figure 2-68 Flowlink: Drag & drop data parameters on graph (velocity and flow shown)

Flowlink's Pulsed Doppler graphing properties include many editing and formatting capabilities, and other features such as Scatter plots, Flow Profile, and data quality indicators of amplitude and correlation. For detailed information, refer to the Flowlink user manual and Help files.

☑ *Note*

Real-time data viewing requires pushed data capability, available with Flowlink Pro. Contact the factory for more information.

2.14 WinADFM
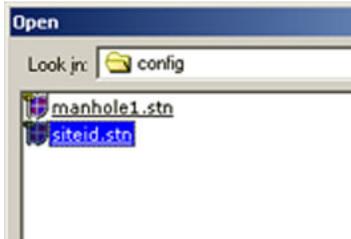
To begin downloading data from the ADFM through direct-connection:

1. Connect the computer to the ADFM flow meter with the communication interface cable.
2. Start *WinADFM* software.
3. Select File > Open.
4. Select the appropriate Station file (.stn file).
5. Select ADFM > Operate.
6. Click Connect (Figure 2-69).
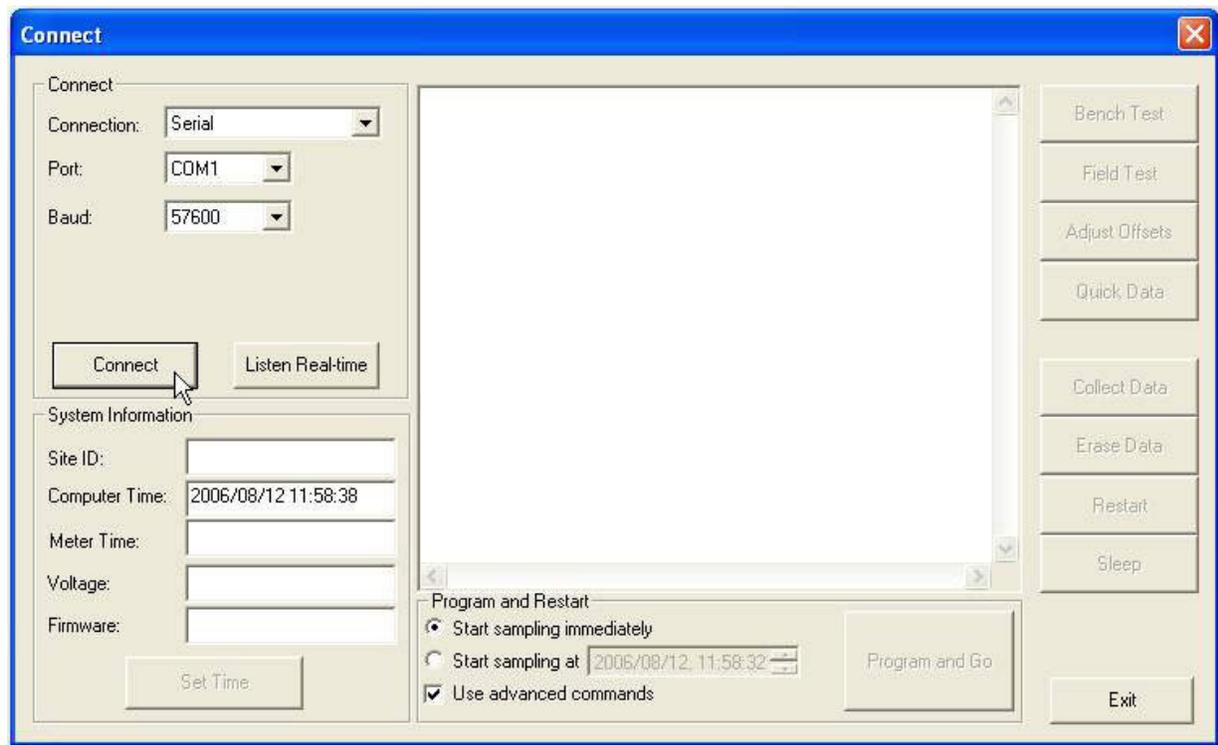
Figure 2-69 Connect Screen

7. Select Collect Data.
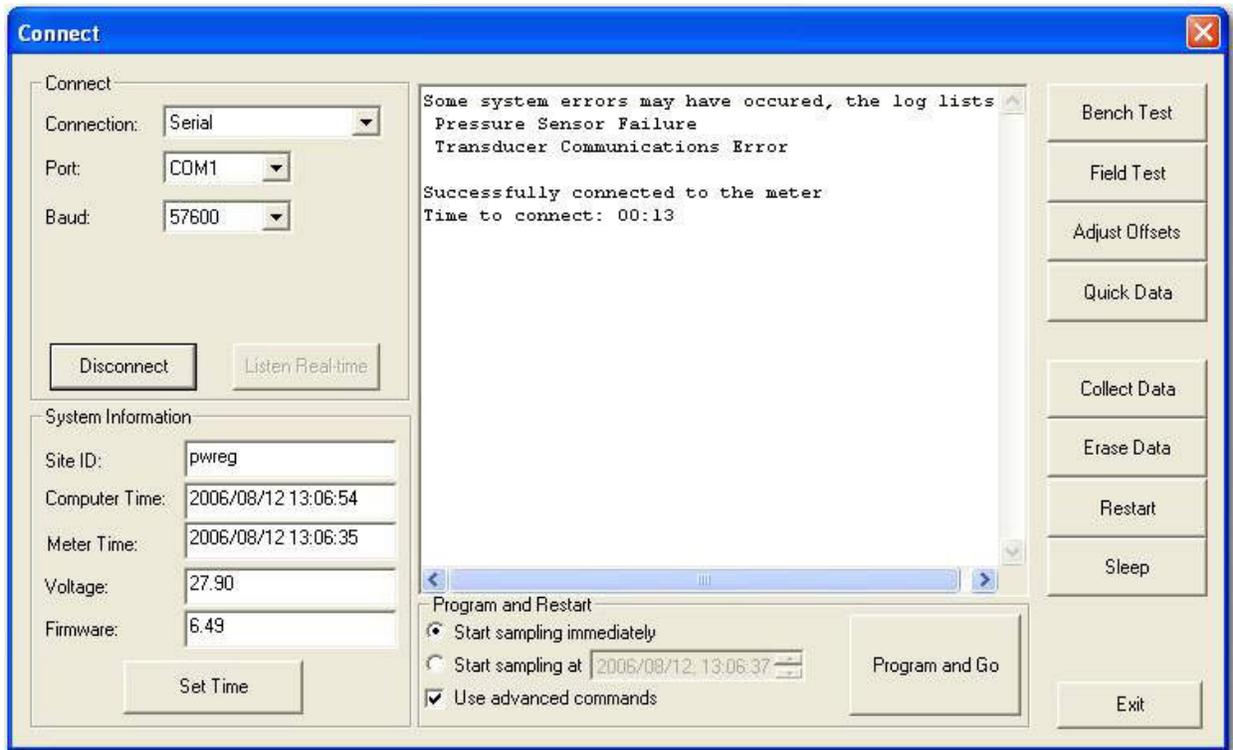
Figure 2-70 Collect/Erase Data

The Collect window shows the name of the data file being collected and the number of bytes transferred, as well as the size of the data file.
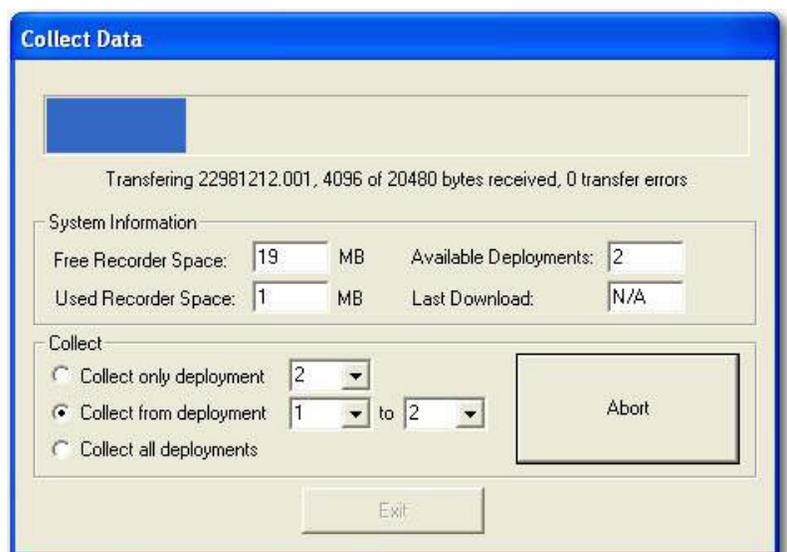
Figure 2-71 Data transfer indicator

When the download is finished, erase the recorder by clicking Erase Data.

8. When finished, restart the ADFM by doing one of the following:

    a. Click Restart to keep current program settings.

    b. Click Program & Go to save new program settings. When the Program & Go screen appears, click Exit.

9. Disconnect the communication interface cable from the ADFM, exit the Operate screen, and quit the *WinADFM* software program.

2.14.1 Viewing the Data

To view the downloaded data, start *WinADFM* and open the desired Station file. Select Display, then Data.
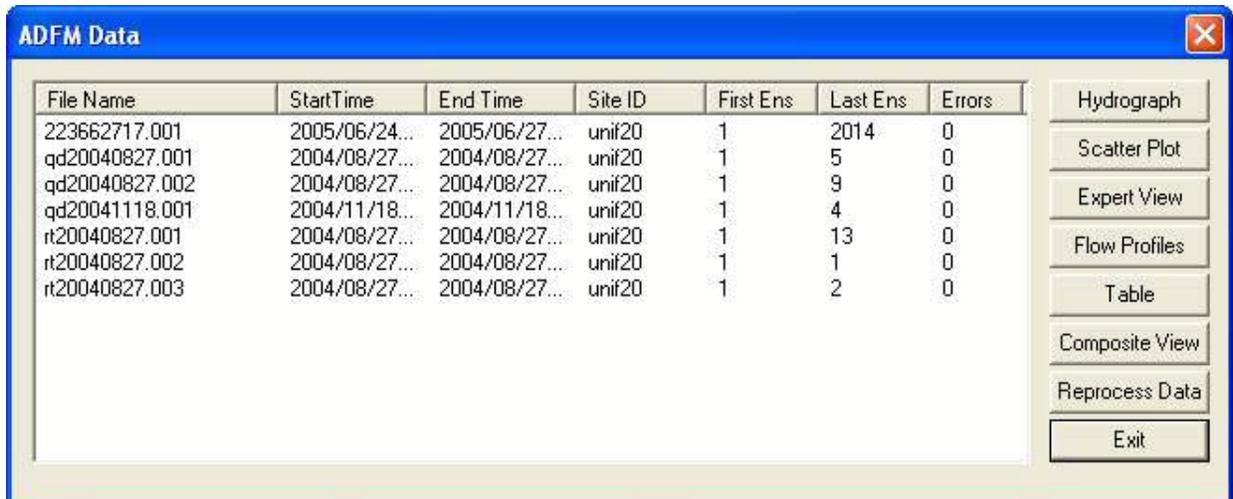
Figure 2-72 ADFM Data window

The data files available for viewing will appear in the Data window (Figure 2-72). Click the data file to view and select the viewing mode from the column of buttons on the right. For example, selecting Expert View would result in a view similar to Figure 2-73.

Exit *WinADFM* when finished.
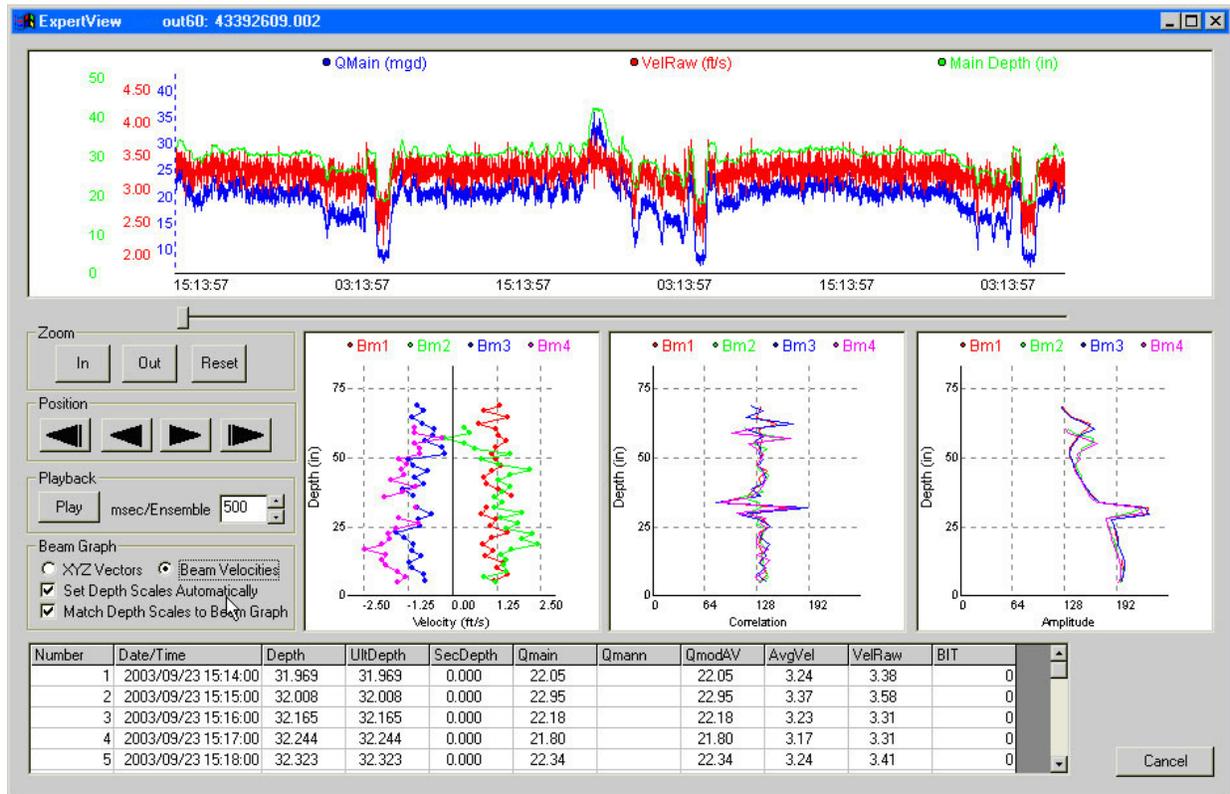
Figure 2-73 Viewing data in Expert View

ADFM® Flow Meter

Section 3 Maintenance and Troubleshooting

This section explains the maintenance requirements of the ADFM Velocity Profiling System.

The ADFM is designed to perform reliably in adverse conditions with a minimal amount of routine service requirements. To keep your system working properly, inspect the battery voltage and the condition of the internal desiccant regularly.

Maintenance intervals are affected by many variables. 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.

3.1 How to Obtain Service

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

Phone: (866) 298-6174
(402) 464-0231
FAX: (402) 465-3085

E-mail:
IscoService@teledyne.com

If you think your equipment requires repair, contact Teledyne Isco's Technical Service Department.

The cable connections and electronic components of the sensor are encapsulated in plastic resin and are not user-serviceable.

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 for returning it to the factory.

Before packaging and shipment, clean and dry the flow meter and sensor, and include important information as described in the following sections.

3.1.1 Cleaning

The electronics case, cables, and sensor may be cleaned with mild detergent and warm water. Before cleaning, ensure that all protective connector caps are in place. Do not use abrasive agents or solvents; they will damage the surfaces of the equipment. Mild chlorine bleach solutions may be used for disinfection and elimination of odors.

3.1.2 Packaging

Attach documentation to the equipment identifying the owner and owner address, complete instrument model and serial number, and a description of the problems observed with the equipment.

Whenever possible, the original factory packaging material should be retained for reuse. For repackaging with commercial materials, follow these instructions:

- Wrap the flow meter and sensor assemblies separately in bubble wrap or other cushioning material.
- Use a strong shipping container suitable for the weight of the ADFM. Shipping containers made of wood or

plastic are preferable; however, corrugated shipping boxes of at least 200-lb test may also be used.

- Use a layer of shock absorbing material at least one inch thick around all sides of the flow meter and transducer assemblies to firmly cushion and prevent movement within the container. Special care must be taken to protect the transducer ceramics on the upper face of the transducer assembly from damage.

- Seal the shipping container securely.

- Mark the container FRAGILE to ensure careful handling.

- In any correspondence, refer to the system by model number and serial number.

3.2 Desiccant

The ADFM flow meter uses desiccant to protect the internal components from moisture damage. When the desiccant becomes saturated, it must be replaced or reactivated.

If the controller is unable to connect, this could be an indication of humidity within the controller.

⚠ **CAUTION**
Do not allow the flow meter to operate with saturated desiccant. In many flow environments, gases are present in the atmosphere that can combine with available water vapor to form acids. The acids formed this way can corrode the internal components of the flow meter, ruining them. An active desiccant canister inhibits the formation of these acids by absorbing water vapor. Keep the lid closed whenever possible. Inspect and regenerate the canister when necessary.

3.2.1   Box Controller Desiccant

Part #099-0012-00

Only open the controller case in a clean, dry environment.

As shown in Figure 3-1, the box controller is equipped with a reusable desiccating canister attached to the inside of the case. This canister contains silica gel that attracts moisture trapped inside the flow meter's case when it is closed. This keeps the inside of the case completely dry during shipment, storage, and use. If you leave the case open, the desiccant will attract moisture from the surrounding air. Eventually, its absorption capacity will be reached, and it will no longer be able to protect the internal components of the flow meter.
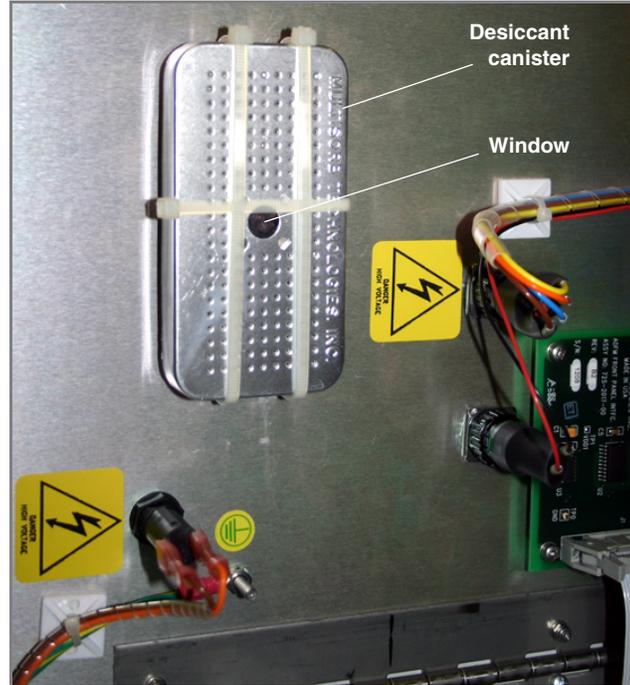
Figure 3-1   Internal desiccant canister

Inspect the desiccant canister each time the case is opened. The desiccant canister has a window on its side that looks blue or yellow when the desiccant is dry. As the desiccant absorbs moisture, the pebbles in the window will turn from blue to pink, or from yellow to green. When the pebbles turn pink or green, the desiccant needs to be regenerated, or replaced with the spare canister provided in the flow meter's accessory package.

Remove the canister from the flow meter and heat it in a **vented** oven at 300°F (150°C) for about three hours, or until the blue or yellow color returns. After cooling, put the canister back in the flow meter; make sure the window on the side of the canister remains visible.

⚠ **CAUTION**

Desiccant may produce irritating fumes when heated. Leave the room while the desiccant is being recharged.

Important Guidelines to Follow:

- Always use a vented, circulating forced air, convection oven in a well-ventilated room.

- DO NOT use a microwave oven to recharge the desiccant cartridge.

- Always use the recommended temperature. Never heat the desiccant at higher than recommended temperatures.

- Avoid heating the desiccant longer than necessary.

3.2.2   Canister Controller Desiccant

Part #099-0002-01

The canister controller desiccant is in a bag that cannot be regenerated and must be replaced.

⚠ **CAUTION**

Opening the electronics cover on the canister will void the NEMA/IP rating. To preserve the NEMA/IP rating, send the canister controller to the factory for service and inspection of the desiccant.

If you choose to void the NEMA/IP rating, only open the case in a clean, dry environment. You can access the desiccant bag for replacement and inspect the controller interior for humidity by performing the following steps:

1. Remove the four ^{3}/16" Allen screws holding the electronics cover in place.

Allen screws (4)
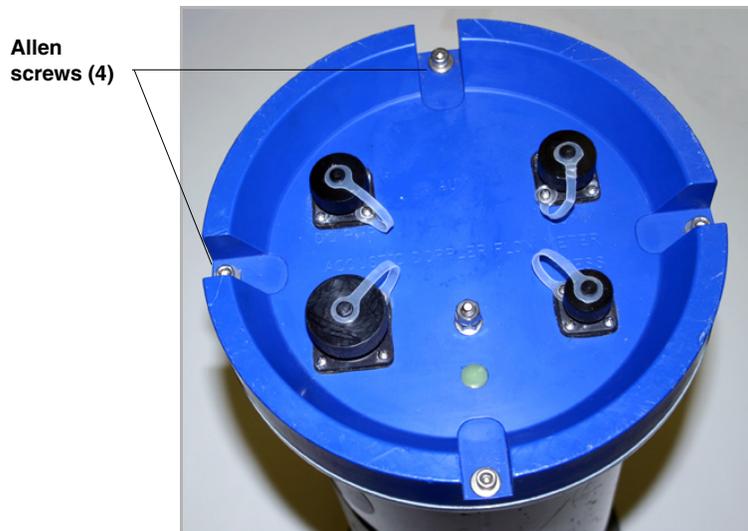
Figure 3-2   Canister controller: opening the electronics lid

2. The interior electronics are attached to the lid. Laying the controller on its side, very carefully ease the lid a few inches away from the case (Figure 3-3).
   Wiring from the battery compartment is connected to the electronics. **Do not attempt to pull the electronics all the way out of the case.**

3. A humidity indicator card is located inside the case along with the desiccant bag. The indicator turns pink or white when the humidity level exceeds the printed value. Ideally, all three sections of the indicator should be blue. If the 20% and 30% sections are pink or white, replace the desiccant. (The card may be square or round.)
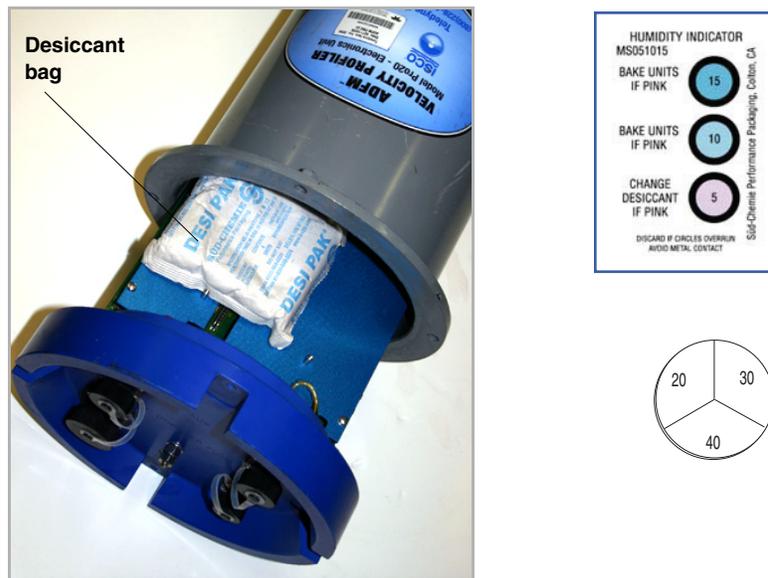
Figure 3-3   Canister case desiccant and humidity indicator card

3.3 Real Time Clock Backup Battery

The real time clock is designed to keep the time updated when the flow meter's power is removed. In the box controller, the backup battery is a single, 3-volt, 250 mAh lithium coin cell, located near the bottom left corner of the ADFM motherboard.

The lithium battery life is approximately ten years. To replace the battery in a box controller, refer to the following steps. The canister controller must be returned to the factory to have the battery replaced.

⚠ **CAUTION**

Never open the flow meter housing in a damp or corrosive atmosphere. Only perform maintenance work inside the case in a clean, dry location.

---

1. Turn the "Battery" switch to the OFF **(0)** position to remove power.
2. Remove the front cover and open the interior panel.
3. With a small-blade, non-conductive screwdriver, gently lift and slip out the coin cell.
4. Install a new coin cell (Panasonic PR2330 or equivalent).
5. Reapply power to the instrument.
6. Test the system for proper operation.

3.4 Troubleshooting the ADFM

The following sections provide assistance in locating and isolating faults in the system.

3.4.1 Troubleshooting Tables

Troubleshooting information for system power-up is provided in Table 3-1, and for system operation in Table 3-2. Possible problems and actions are listed in order of likelihood.

☑ *Note*

Call the factory for assistance before replacing the motherboard.

Table 3-1 Troubleshooting on Power-Up		
Symptom	**Possible Problem(s)**	**Action(s)**
No wakeup message on LCD or computer screen	Power Motherboard	Verify battery voltage and connections. Verify connection to external DC supply. Contact the factory.
No wakeup message on LCD, but computer displays wakeup message when a manual reset is performed.	LCD Front panel interface board Cable connection between LCD and front panel Cable connection between front panel interface board and motherboard. Motherboard	Replace LCD Replace front panel interface board Replace ADFM Motherboard.
No wakeup message on computer screen, but LCD displays wakeup message and completes Built-In-Tests (BIT).	RS-232 connection Incorrect port settings on computer Front panel interface board Motherboard	Troubleshoot cabling Adjust communication port settings on computer Replace front panel interface board Replace motherboard.

Table 3-2 Troubleshooting During Operation		
Symptom	**Possible Problem(s)**	**Action**
Message: "Transducer not found"	Sensor cable connector Cabling between Motherboard and sensor connector of flow meter Sensor or sensor cable	Refer to Section 3.4.4.
Message: "Recorder not found"	Recorder cable assembly Recorder Assembly Motherboard	Check recorder ribbon cable connection to motherboard. Replace recorder assembly. Replace motherboard.
Message "No Command Prompt Found" Message "Cannot Open Port"	Incorrect port settings on computer	Adjust communication port settings on computer
Ancillary Data VXDR, VDD1, and VDC are outside the range listed in section "Maintenance and Trouble-shooting."	Batteries or power supply Motherboard	Replace batteries. Check power supply. Replace motherboard.
Transmit Test Failure	Cabling between the sensor interface board and the ADFM rear panel sensor connector. Connection between motherboard and sensor interface board Transducer cable or connectors Motherboard	Verify all connections. Replace motherboard.
Message: "Loop Test Failure." An occasional loop test failure may be normal since this is a statistical test. The percentage of loop test failures should typically be less than 10%.	Transducer improperly connected, or damaged High interference source Motherboard.	Eliminate interference source[a,] or shield transducer environment. Perform Field Test in WinADFM (refer to WinADFM software manual). The Correlation Magnitude at Lag 0 should be 255; at Lag 7 it should be typically < 20. Also, the High Gain RSSI should be typically < 65. Otherwise it may indicate a high source of interference. Call the factory.
Any RAM Test failure Message: "Clock Interrupt failed"	Motherboard	Replace motherboard

a.   It is recommended to record the values for Correlation Magnitude, High Gain RSSI, and the results of the transmit test for later reference.

3.4.2 Troubleshooting Steps   The following procedures are intended to assist fault isolation in cases where the Built-in-Test (BIT) cannot be executed (no ADFM wakeup for example), or the BIT determines a problem with the sensor.

It is not necessary to follow these procedures for routine maintenance. However, the Built-In Tests may be executed on a routine basis.

For the following procedure, the top cover of the ADFM controller must be removed from the chassis. This exposes the controller's circuitry, which contains electro-static sensitive devices. To prevent electro-static discharge (ESD) to these components, you must ground the controller as well as yourself. Use an ESD wrist strap (or other accepted means) to ground yourself. Please keep in mind that even if an ESD has occurred, the ADFM may still work, but its reliability may be seriously impaired.

3.4.3   BIT Not Executing (Box Controller Only)

If the built-in test (BIT) cannot be executed, it is likely caused by either faulty communication, or power loss or a faulty ADFM power supply.

Communication

If communication cannot be established, the following procedure may help you to isolate the problem:

1. Verify that the internal or external power sources are properly connected to the ADFM, and sufficient to supply it.

2. Verify that the computer's serial port is functioning normally. In Windows, go to Start, Settings, Control Panel. Select System, go to the Hardware tab, and click Device Manager and Ports to determine if the computer's serial port is properly operating. Verify line continuity on the RS-232 Serial Communications Cable.

3. If remote communications still cannot be established, perform a manual reset by turning and releasing the keyed RESET switch on the ADFM box's inner front panel, or by disconnecting and reconnecting power from the ADFM canister. This should start the built-in test. If you are using the box enclosure, the wake-up message, and a series of built-in test results, should appear on the ADFM's display.

4. If these steps are not successful, the motherboard may have to be replaced.

5. If all tests are successful (i.e., the computer screen produces normal, legible results), yet the ADFM box display is blank or scrambled, the display or front panel interface may need to be replaced.

6. It is also possible that there is a problem with the power supply, as discussed in the following section.

Power

If the Built-In Tests cannot be executed locally or remotely, or if communication cannot be established, perform the following steps to isolate the problem:

1. If you tried to use internal batteries to power the ADFM, you may alternatively try DC power if possible. If you are successful, the problem is likely to be a faulty battery switch, or its wiring. Also check the internal batteries' wir-

ing harness for good connection at the battery terminals, and the motherboard battery connector.

2. If you are using an external DC power supply, ensure that it is supplying proper voltage to the ADFM controller (12 to 26 VDC). On the electronics box, ensure that the Battery switch at the front panel is in the On ("**1**") position.

3. Perform a manual reset by turning and releasing the keyed RESET switch on the ADFM box's inner front panel, or by disconnecting and reconnecting power from the ADFM canister.

If the above procedures are not successful in establishing communications with the ADFM, the problem may be internal. Contact the factory.

The BIT should display the following voltages for the ADFM:

VMVDC	Interior and/or Exterior exterior power supply	12 - 36 VDC
VMVDD1	Main supply of electronics	5.0 VDC ± 0.2
VMVXDR	Recorder	10.7 VDC ± 0.2V

3.4.4 BIT Determines a Problem Associated with the Sensor

The built-in test (BIT) is not able to isolate the exact problem in all cases. If, with help of BIT, you determined the fault to be within the transducer or the Transmit Test failed, the problem may be associated with the following items:

Any connection between the ADFM motherboard and the transducer cable

A malfunctioning or damaged sensor

Check the pins on the sensor cable connection. There should be a total of 11 pins, and the pins should be free of moisture and corrosion.

☑ *Note*

It is very important to keep all unused connectors capped. Moisture penetration and corrosion can cause permanent damage to the ADFM and/or the sensor.

With the exception of the sensor cable, the ADFM box controller must be opened to check any other sensor related connection.

Ensure that the connections between the sensor interface board and the motherboard are properly seated. There are two connections: a ribbon cable for VCC and grounding connections, and a coaxial cable for transmission of the sensor's analog signal.

Do not alter the connections made on the motherboard for any reason other than to re-establish proper connection.
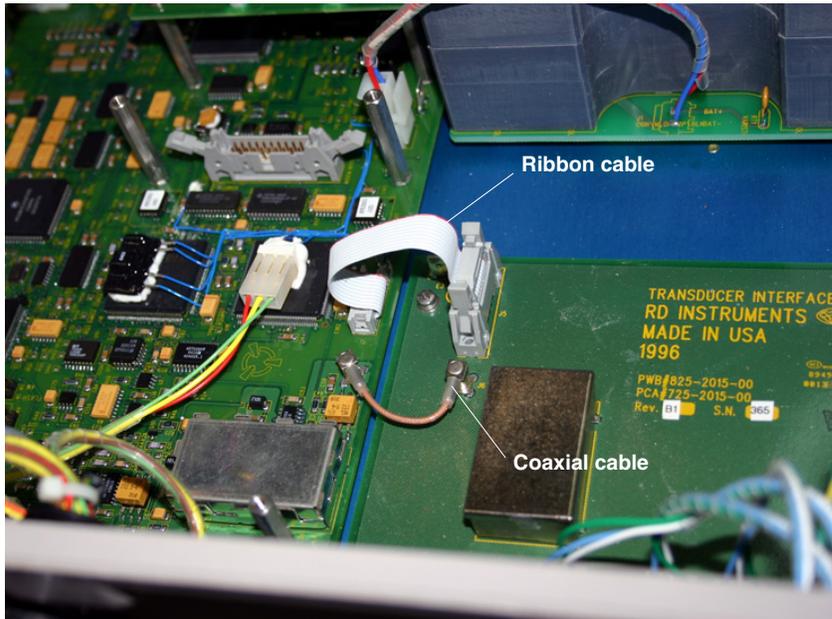
*Figure 3-4   Box controller sensor interface board
         connections*

**3.4.5   Sensor Malfunction
         With Canister
         Controller**

Check the pins on the sensor cable connection. There should be a total of 11 pins, and the pins should be free of moisture and corrosion.

☑ *Note*

It is very important to keep all unused connectors capped. Moisture penetration and corrosion can cause permanent damage to the ADFM and/or the sensor.

⚠ **CAUTION**

The canister controller contains electronics similar to those in the box; however, opening the canister in the field will void the NEMA/IP rating. To preserve the NEMA/IP rating, send the canister controller to the factory for service and inspection of the desiccant.

If you choose to void the NEMA/IP rating, only open the case in a clean, dry environment. You can access the circuit boards by performing the following steps:

1. Remove the four ^{3}/16" Allen screws holding the electronics cover in place (Figure 3-5).
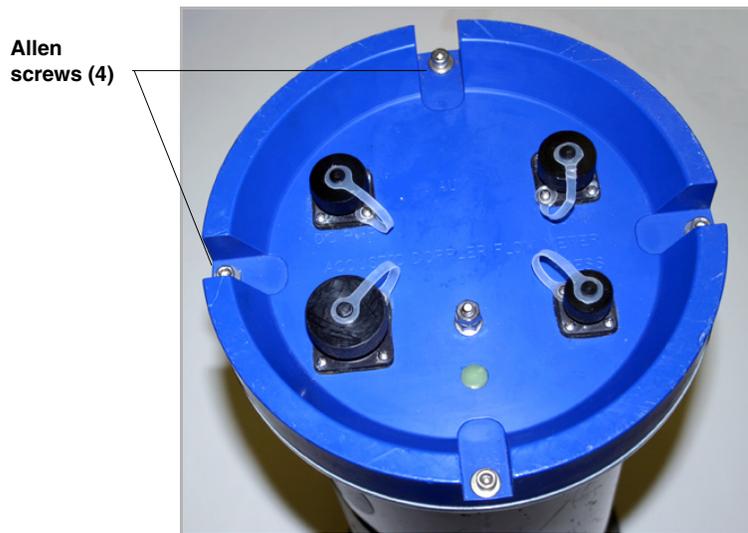
Figure 3-5   Canister controller: opening the electronics lid

2. The interior electronics are attached to the lid. Laying the controller on its side, very carefully ease the lid a few inches away from the case (Figure 3-6).
    Wiring from the battery compartment is connected to the electronics. **Do not attempt to pull the electronics all the way out of the case.**

Ensure that the connections between the sensor interface board and the motherboard are properly seated. There are two connections: a ribbon cable for VCC and grounding connections, and a coaxial cable for transmission of the sensor's analog signal.
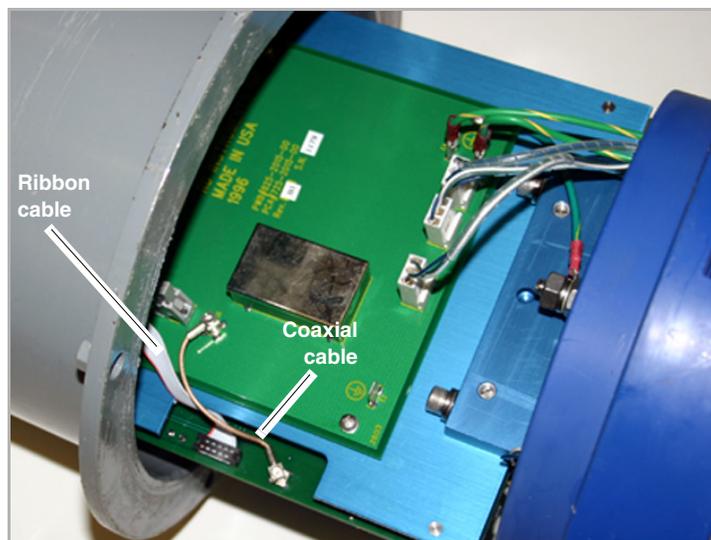
Figure 3-6   Canister controller sensor interface board connections

Do not alter the connections made on the motherboard for any reason other than to re-establish proper connection.

ADFM® Flow Meter

Appendix A Parts and Accessories

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

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

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

E-mail:IscoInfo@teledyne.com

A.1 General Spare Parts and Accessories

ADFM control box 62-7100-005

ADFM canister controller 62-7110-005

ADFM IS control box 62-7100-105

ADFM IS canister controller 62-7110-105

Internal modem (for both box and canister). 60-7004-015

RS232 Communication cable, 3 m (10 ft). Connects PC with 9-pin serial port with ADFM box, or ADFM canister with
Amp connectors 60-7004-057

RS232 Communication cable, 3 m (10 ft). Connects PC with 9-pin serial port with ADFM canister with
Crown connector 60-7004-027

DC power cable pigtail for ADFM box,
and ADFM canister with Amp connectors 60-7004-062

DC power cable pigtail for ADFM canister
with Crown connectors 60-7004-041

Flow meter suspension harness kit60-7109-002

Pro20 sensor with 15 m (49 ft) cable. 60-7004-004

Pro20 sensor with 30 m (98 ft) cable. 60-7004-005

Pro20 sensor with 45 m (147 ft) cable. 60-7004-006

Extension cable for Pro20 sensor, 15 m (49 ft) 60-7004-061

> *(Total cable length should not exceed 150 ft without prior factory approval.)*

Extension cable for Pro20 sensor, 30 m (98) ft 60-7004-013

> *(Total cable length should not exceed 150 ft without prior factory approval.)*

Pro20 IS sensor with 15 m (49 ft) cable 60-7004-028

Pro20 IS sensor with 30 m (98 ft) cable 60-7004-029

Pro20 IS sensor with 45 m (147 ft) cable 60-7004-030

Hot Tap insertion sensor with 15 m (49 ft) cable 62-7004-012

Hot Tap insertion sensor with 30 m (98 ft) cable 62-7004-016

Hot Tap safety installation kit 60-7007-030

A.2 Standard Pro20 Mounting Rings

Standard Scissors Rings

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

16-24" Pipe 68-3000-042

26-38" Pipe 68-3000-043

38-44" Pipe 68-3000-044

44-48" Pipe 68-3000-045

60" Pipe. 68-3000-046

72" Pipe. 68-3000-047

16-80" Pipe 68-3000-048

Base Section 60-3004-169

(with plastic ties and manual)

A.3 Pro20 Debris Fairing Kits

Debris fairing kit, 3-inch lift 60-7004-042

Fairing spacer, 1-inch lift. 60-7004-043

Fairing spacer, 2-inch lift. 60-7004-044

Fairing spacer, 4-inch lift. 60-7004-045

Fairing/spacer hardware kit 60-7619-001

(Includes all mounting hardware. Accommodates up to 8 inches total height. For greater heights, use multiple kits.)

A.4 Secondary Depth Sensors

Custom-length pressure sensor. 60-5314-730

Specify maximum pressure rating (2.5 to 30 psi) and cable length up to 250 ft (76.2 m)

Custom-length pressure sensor for
Intrinsically Safe ADFM system. 60-5314-762

Specify maximum pressure rating (2.5 to 30 psi) and cable length up to 250 ft (76.2 m)

Custom-length ultrasonic sensor 68-5304-008

ADFM® Flow Meter

Appendix B Material Safety Data Sheets

This appendix provides Material Safety Data Sheets (MSDS) for the internal desiccant used inside the ADFM electronics housing.

Specific questions regarding the use and handling of this product should be directed to the manufacturer listed in the MSDS.

MATERIAL SAFETY DATA SHEET

SÜD-CHEMIE
Creating Performance Technology

Date Issued: 07/06/2004
MSDS No: 5008
Date-Revised: 11/28/2011
Revision No: 3

Desi Pak®

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: Desi Pak®
GENERAL USE: Desiccant

MANUFACTURER
Süd-Chemie Performance Packaging
101 Christine Drive
Rio Grande Industrial Park
Belen, NM 87002
Customer Service: 505-864-6691

24 HR. EMERGENCY TELEPHONE NUMBERS
CHEMTREC :   (800) 424 - 9300
Outside the U.S. Call Collect : 001 (703) 527-3887

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
  PHYSICAL APPEARANCE: Performance packaging product, size and type vary.
  IMMEDIATE CONCERNS: Poses little or no immediate hazard.
POTENTIAL HEALTH EFFECTS
  EYES: Route of exposure unlikely. Dust may cause a mechanical irritation which can scratch the eye.
  SKIN: No adverse effects expected.
  INGESTION: Non-toxic by ingestion. Packets or canisters may pose a choking hazard. Keep away from children and pets.
  INHALATION: Route of exposure unlikely. This material is normally packaged and contained in a pouch, bag or canister. If the container is opened, prolonged or repeated inhalation of high dust concentrations may cause lung damage.

3. COMPOSITION / INFORMATION ON INGREDIENTS

INGREDIENT(S)	CAS	Wt.%
Pouch, Bag, Canister, Stopper, or Cap		1 - 75
Clay	1302-78-9	25 - 99
Silica, quartz	14808-60-7	<0.5

See Section 8 for Exposure Limits

4. FIRST AID MEASURES

EYES: Do not rub eyes. Flush with lukewarm, gently flowing water for 5 minutes or until the particle/dust is removed, while holding the eyelid(s) open. Obtain medical attention.
SKIN: Wash with soap and water.

Desi Pak®

INGESTION: Normally not needed. If large quantities are ingested, call your local Poison Control Center (1-800-222-1222 in the U.S.).

INHALATION: Normally not needed. If exposed to excessive levels of dust or fumes, remove to fresh air and seek medical attention of cough or other symptoms develop or persist.

5. FIRE FIGHTING MEASURES

FLASHPOINT AND METHOD: Material is not flammable

EXTINGUISHING MEDIA: Use extinguishing agent applicable to surrounding fire.

FIRE FIGHTING PROCEDURES: As in any fire, wear self-contained breathing apparatus operated in pressure-demand mode, (NIOSH approved or equivalent) and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

SMALL SPILL: No special precautions required.

LARGE SPILL: With shovel or scoop, place material into appropriate container.

7. HANDLING AND STORAGE

HANDLING: Use of proper hygiene practices in the workplace is recommended.

STORAGE: Store in a dry area.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE GUIDELINES

HAZARDOUS COMPONENTS					
		EXPOSURE LIMITS			
		OSHA PEL		ACGIH TLV	
Chemical Name		ppm	mg/m^3	ppm	mg/m^3
Clay	**TWA**	[1]	[1]	[1]	[1]
Silica, quartz	**TWA**	[2]	[2]	[3]	0.025 [3]

OSHA TABLE COMMENTS:
1. Exposure limits not established.
2. Total Dust = (30 mg/m3)/(%SiO2+2)
3. Respirable

ENGINEERING CONTROLS: If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit.

PERSONAL PROTECTIVE EQUIPMENT

EYES AND FACE: Follow facility guidelines.

SKIN: Use of proper hygiene practices in the workplace is recommended.

RESPIRATORY: Use local exhaust if dusting occurs. Good general ventilation is adequate in the absence of dusts.

COMMENTS: All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the Particulates Not Otherwise Regulated (PNOR) limit which is 5 mg/m3 for respirable fraction and 15 mg/m3 for total dust. ACGIH exposure guidelines of less than 3 mg/m3 (respirable) and 10 mg/m3 (inhalable) have been established for particles (insoluble/poorly soluble) not otherwise specified (PNOS).

Desi Pak®

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9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: Solid
ODOR: None
pH: Not Determined
PERCENT VOLATILE: None
VAPOR PRESSURE: Not Applicable
VAPOR DENSITY: Not applicable.
EVAPORATION RATE: Not Applicable
VISCOSITY: Not Applicable
OXIDIZING PROPERTIES: None

10. STABILITY AND REACTIVITY

STABLE: Yes
HAZARDOUS POLYMERIZATION: No

11. TOXICOLOGICAL INFORMATION

ACUTE

Chemical Name	ORAL LD$_{50}$ (rat)	DERMAL LD$_{50}$ (rabbit)	INHALATION LC$_{50}$ (rat)
Clay	> 5000 gm/kg(b.w.)		> 200 mg/L/1H
Silica, quartz	500 gm/kg(b.w.)	No Data Available	No Data Available

CARCINOGENICITY

Chemical Name	NTP Status	IARC Status	OSHA Status
Clay	Not listed.	Not listed.	Not listed.
Silica, quartz	Known Carcinogen	Group I	Not listed.

SENSITIZATION: Not sensitizing
GENERAL COMMENTS: Crystalline silica present is contained within a pouch, canister or bag. No exposure to airborne particles of respirable size is expected under normal conditions of use.

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA: Low hazard for usual industrial or commercial handling.
CHEMICAL FATE INFORMATION: This material is of mineral origin. It is not biodegradable.

13. DISPOSAL CONSIDERATIONS

DISPOSAL METHOD: This product, if discarded as sold, is not a Federal RCRA hazardous waste. Processing, use or

Desi Pak®

contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations.

14. TRANSPORT INFORMATION

DOT (DEPARTMENT OF TRANSPORTATION)
  PROPER SHIPPING NAME: Not regulated
ROAD AND RAIL (ADR/RID)
  PROPER SHIPPING NAME: Not regulated
AIR (ICAO/IATA)
  SHIPPING NAME: Not regulated
VESSEL (IMO/IMDG)
  SHIPPING NAME: Not regulated
CANADA TRANSPORT OF DANGEROUS GOODS
  SHIPPING NAME: Not regulated

15. REGULATORY INFORMATION

UNITED STATES
  SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)
    FIRE: No **PRESSURE GENERATING:** No **REACTIVITY:** No **ACUTE:** No **CHRONIC:** Yes
    313 REPORTABLE INGREDIENTS: Not listed.
  CERCLA (COMPREHENSIVE RESPONSE, COMPENSATION, AND LIABILITY ACT)
    CERCLA REGULATORY: Not listed.
  TSCA (TOXIC SUBSTANCE CONTROL ACT)
    TSCA STATUS: All components are listed on the TSCA Inventory or are excluded or exempt.
  REGULATIONS
    STATE REGULATIONS: California
  CALIFORNIA PROPOSITION 65: This product does not contain chemical(s) known to the state of California to cause cancer, birth defects, or reproductive harm.

  Crystalline silica present is contained within a pouch, canister or bag. There is no exposure to airborne particles of respirable size under normal conditions of use.

Chemical Name	Wt.%	Listed
Silica, quartz	<0.5	Cancer

  RCRA STATUS: This product, if discarded as sold, is not a Federal RCRA hazardous waste. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations.
CANADA
  WHMIS HAZARD SYMBOL AND CLASSIFICATION

        Does not meet classification criteria pursuant to the Canadian Hazardous Products Act.

  WHMIS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM): This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.
  CANADA INGREDIENT DISCLOSURE LIST: Contains component(s) listed on the Canadian Hazardous Products Act Ingredient Disclosure List.
  CANADIAN ENVIRONMENTAL PROTECTION ACT: All ingredients are listed on the Canadian Domestic Substances List inventory.

Desi Pak®

EUROPEAN COMMUNITY
   **EEC LABEL SYMBOL AND CLASSIFICATION**

        Not classified as dangerous

16. OTHER INFORMATION

APPROVED BY: Prepared and approved by SHE Dept. Sud-Chemie Inc.

INFORMATION CONTACT: E-mail - MSDS_US@sud-chemie.com

REVISION SUMMARY: This MSDS replaces the 01/21/2009 MSDS. Revised: **Section 1:** INFORMATION
CONTACT. **Section 16:** HMIS RATING (HEALTH, PHYSICAL HAZARD, HMIS RATINGS NOTES, CHRONIC).

HMIS RATING		
HEALTH	*	1
FLAMMABILITY		0
PHYSICAL HAZARD		0
PERSONAL PROTECTION		

NFPA CODES

Red: 0
Blue: 0
Yellow: 0
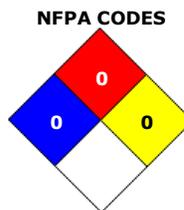
HMIS RATINGS NOTES: Personal Protection should be determined based on workplace conditions.

MANUFACTURER DISCLAIMER: The information presented herein is believed to be accurate but is not warranted.
Recipients are advised to confirm in advance that the information is current, applicable and suitable to their
circumstances.

Multisorb Technologies, Inc.   Drican® (Indicating Silica Gel – Al Case)   July 21, 2008   Page 1 of 4

MULTISORB
Multisorb Technologies Inc.

MATERIAL SAFETY DATA SHEET

Effective Date   July 21, 2008
MSDS Number   M119

Section 1 – Product and Company Information

Product Name:	Drican® (Indicating Silica gel, Aluminum case)
Product Use:	Desiccant, absorbent
Grades:	Silica gel, indicating
Synonyms:	Amorphous silica gel, SiO_2, 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 – Hazard Identification

Emergency Overview: An aluminum case containing a clear blue granular material that poses little or no immediate hazard. The case and the contents of the case are not combustible.

Potential Health Effects:

Eyes: None

Skin: None

Ingestion: Ingestion is very unlikely but if ingested get medical attention.

Inhalation: None

Medical Effects Generally Aggravated by Exposure: None

Chronic Effects/Carcinogenity: None

Section 3 – Composition / Information on Ingredients

Component Name	CAS Number	% by Weight
Synthetic amorphous silica gel (SiO_2)	112926-00-8	80 - 90
Cobalt chloride	7646-79-9	.5
Aluminum	7429-90-5	10 - 20

While this material is not classified as hazardous under OSHA regulations, 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 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 but if ingested get medical attention.

Inhalation: Remove the affected person to fresh air and get medical attention if necessary.

Notes to Physician: Not applicable

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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. The silica gel and the aluminum case are not combustible.

Fire Fighting Instructions: The silica gel and the aluminum case are 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: Not required.

Respiratory Protection: Not required.

Skin Protection: Not required.

Eye Protection: Not required.

Exposure Limits			
Component Name	**OSHA PEL**	**ACGIH TLV**	**Other Recommended Limits**
Silica gel	TWA 20 mppcf (80 mg / m^3 % SiO_2)	Not applicable	NIOSH REL TWA 6 mg / m^3 IDLH 3000 mg / m^3
Cobalt chloride	.1 mg / m^3 (cobalt metal dust & fume)	TWA .02 mg / m^3 (as cobalt)	NIOSH REL TWA .05 mg / m^3 (Cobalt metal dust & fume as cobalt) IDLH 20 mg / m^3 (as metal dust & fume as cobalt)
Aluminum	TWA 15 mg / m^3 (total dust) TWA 5 mg / m^3 (respirable fraction)	1 mg / m^3 (respirable fraction of aerosol)	NIOSH REL TWA 10 mg / m^3 (total dust) TWA 5 mg / m^3 (respirable fraction)

Section 9 – Physical and Chemical Properties

Appearance:	Silver metal canister	**Vapor Density:**	Not applicable
Odor:	None	**Boiling Point:**	4046° F (2230° C) (Silica Gel)
Physical State:	Silver metal canister	**Melting Point:**	3110° F (1710° C) (Silica Gel)
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 LC_{50} (rat) > 2 mg / l
48 - hour oral LD_{50} (rat) est. > 31,600 mg / kg
48 - hour dermal LD_{50} (rabbit) est. > 2,000 mg / kg
Considered an ocular irritant

IARC Amorphous silica gel IARC - 3 (Unclassifiable as to Carcinogenicity in Humans)

ACGIH Cobalt and inorganic compounds, as Co are rated as A3 (confirmed animal carcinogen and unknown relevance to humans).

IARC Cobalt and cobalt compounds are rated as Group 2B (possible carcinogens to humans).

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.

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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 (Ingredients)

DSL/NDSL (Canadian) Listed: Yes (Ingredients)

OSHA: See section 8 above.

NIOSH: See section 8 above.
Animal tests conducted in 1976 - 1978. 18 month exposure at 15 mg / m^3 showed silica deposition in respiratory macrophages and lymph nodes, minimum lung impairment, no silicosis.

ACGIH: See section 8 above.

DOT: Not classified as a hazardous material.

Section 16 – Other Information

HMIS – Hazardous Materials Identification System

HMIS Rating	
Health	1
Flammability	0
Physical	0

The HMIS rating information is intended solely for the use of individuals trained in the use of the HMIS rating system.

The NPCA specifically recommends that prepares of MSDSs should not place HMIS PPE designation codes on the MSDSs or labels that leave the facility as it is not known the conditions under which the customer will use this product.

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.

ADFM® Flow Meter

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DECLARATION OF CONFORMITY

CE ISM1-A
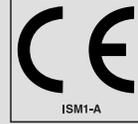
Application of Council Directive: 2004/108/EC -The EMC Directive

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: Pro20 and Hot Tap Sensor
Year of Issue: 2007
Standards to which Conformity is Declared: EN 61326:1998 EMC 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	C*
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 2 – 2kV on AC lines	C***
EN61000-4-5	Surge on AC Lines	2kV L-Gnd, 1KV L-L	C***
EN61000-4-6	Conducted RF on AC lines	150 kHz to 80 MHz, 3V rms, 80% modulated	B**
EN61000-4-11	AC Dips and Short Interruptions	0.5 Cycle, each polarity/100%	A
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	Passes
EN61000-3-2, 3-3	Harmonic, Flicker		Passes

*Unit is susceptible to ESD. In dry environments (<40% humidity), user must discharge themselves to earth before touching front panel to prevent program lock-up.
**Unit's flow sensor/cable is susceptible to RF. Unit must not be located near an RF source (radio/TV tower) to prevent erroneous flow/depth measurements.
***Unit is susceptible to AC line transients and/or surges. If program lock-up occurs, unit's wall mount power supply must be connected to an AC power conditioner or operated on its internal batteries.

We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of July 5, 2007

William Foster
USA Representative

TELEDYNE ISCO
A Teledyne Technologies Company

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

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

60-7102-003
Rev. A

Teledyne Isco One Year Limited Factory Service Warranty*

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

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

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

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

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

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

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

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

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

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

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

Shipping Address:	Teledyne Isco - Attention Repair Service 4700 Superior Street Lincoln, NE 68504 USA
Mailing Address:	Teledyne Isco PO Box 82531 Lincoln, NE 68501 USA
Phone:	Repair service: (800) 775-2965 (lab instruments) (866) 298-6174 (samplers & flow meters) Sales & General Information: (800) 228-4373 (USA & Canada)
Fax:	(402) 465-3001
Email:	IscoService@teledyne.com

February 28, 2012 P/N 60-1002-040 Rev G

TELEDYNE ISCO
Everywhere**you**look™