ADS Model 4000™ Installation, Operation, and Maintenance Manual

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CHAPTER 1

Introduction

The *ADS Model 4000™ long-term flow monitor* measures open channel flow in sanitary sewers, storm sewers, pump stations, and other environments to assist municipalities and other industry in addressing the following issues:

- Planning sewer systems (sizing and rehabilitation)
- Reducing infiltration and inflow (I/I)
- Monitoring combined sewer overflows (CSOs)
- Detecting and monitoring surcharges
- Billing
- Monitoring sewage handling facilities (wastewater treatment plants and pump stations)

The battery-powered, microprocessor-based 4000 monitor displays exceptional accuracy and reliability in measuring flow depth and velocity to determine flow rate (quantity) in sewer lines. This flow data is the essential element required to successfully perform investigative, analytical, and reporting activities. The 4000 also supports water quality sampling, event notification, and rain measurement.

The 4000 monitor uses three flow measurement devices to gather raw flow data: a quadredundant ultrasonic depth sensor, a pressure depth sensor, and a Doppler peak velocity sensor. The ultrasonic and pressure depth sensors apply independent measurement techniques to collect information used in flow depth calculations.

The Doppler velocity sensor gathers peak flow velocity data. These sensors display exceptional durability and accuracy, even under harsh and turbulent flow monitoring conditions.

The monitor receives the raw data from the sensors based on a defined time interval and then processes the data, which may involve calculating the flow rate. This data, stored in the monitor memory, is available to the user for collection, further processing, analysis, and reporting. The reports can assist municipalities and other industry in planning improvements and additions to sewer systems, improving the accuracy of billing information, and providing information for the overall management of sewer systems.

Special software called ***FieldScan***™ enables the user to configure and communicate with the monitor for activation, data collection, confirmation, and diagnostic purposes. Configuration involves defining the location information file (LIF) for storage in the user's local directory and building the BASIC code and variables for the site. The LIF contains information such as pipe characteristics, monitor identification, selected devices, sensor offsets, data log rate, and other parameters necessary for measuring the flow both accurately and efficiently.

> **Note:** Refer to the *FieldScan User's Guide* (#950021**) for more information.

Activation involves downloading the BASIC code and site-specific information from the LIF (stored in the user's local directory or network drive) to the monitor. It also includes initiating monitor activities such as taking sensor readings, logging flow data, recording pulses from a rain gauge, sending signals to a sampler, and managing event notification.

Communication between the monitor and the user’s office or field computer can occur over a telephone line (remote communication), cellular digital packet data (CDPD) device (wireless communication), or direct modem interface (DMI) cable (on-site communication).

A 4000 monitor specially equipped to receive power from an external DC power source is available by special order. A conversion kit also is available to convert existing battery-powered units to external power.

This manual offers detailed instructions on installing the 4000 flow monitor and sensors, providing communication with monitor (remote or on-site), and performing routine maintenance and troubleshooting on the system.

Warnings and FCC Compliance

Manhole and sewer system work involves confined space entry and is inherently dangerous. Therefore, installers and technicians should comply with all federal, state, and municipal regulations concerning confined space entry.

In addition, personnel installing and maintaining this equipment should follow all guidelines presented in this manual concerning monitor installation and maintenance. Failure to strictly adhere to these guidelines can result in personal injury and/or damage to the monitor.

> **Note:** This monitor *does not* possess intrinsic safety certification.

FCC Part 68 Compliance

To comply with the Federal Communications Commission (FCC), ADS® Corporation provides the following information concerning 4000 flow monitor installation and operation.

This equipment complies with FCC Rules, Part 68. It bears a label displaying, among other information, the FCC Registration Number and Ringer Equivalence Number (REN). The user must provide this information to the telephone company if requested.

The REN identifies the number of devices that may be connected to the telephone line. Excessive RENs on the telephone line may prevent devices from ringing in response to an incoming call. In most areas, the sum of the RENs should not exceed five. To determine the number of devices you may connect to a line, as determined by the RENs, contact your telephone company.

This equipment uses threaded-type posts for hardware connection to the telephone network.

The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of this equipment. If this occurs, the telephone company will provide advance notice so you can make necessary modifications to maintain uninterrupted service.

In the unlikely event that this equipment harms the telephone network, the telephone company will notify you that temporarily discontinuing telephone service may be required. Notification will occur in advance of discontinuation, or as soon as practically possible. They will also inform you of your right to file a complaint with the FCC if necessary.

This equipment may not be used on public coin phone service provided by the telephone company. Connection to party line service is subject to state tariffs.

Product Warranty

This section includes the warranty for the ADS Model 4000.

New Product Warranty

All new products manufactured by ADS Environmental Services® will be free from defects in material and workmanship for one year following the date of shipment from ADS. During this warranty period, upon satisfactory proof of a defect, the product may be returned for repair or replacement, at the option of ADS. No returns will be accepted unless the purchaser has prepaid shipping and has received a prior authorization return number from ADS. Please call ADS to obtain your authorization number. Warranty repairs and replacements will be performed only by ADS or its authorized representative. Any unauthorized repair or replacement will void this warranty relative to the product and all of its parts. Any repair or replacement will be covered by this new product warranty for 90 days from the date that such repaired or replaced product is shipped from ADS.

This warranty is available to the original purchaser of the product and only if it has been installed, operated, and maintained in accordance with the ADS operations and maintenance manual or as approved in writing by ADS or its authorized representative. This warranty does not apply to damage by catastrophes of nature, fire, explosion, acts of God (including, but not limited to, lightning damage), accidents, improper use or service, damage during transportation, or other similar causes beyond ADS's control.

Out-of-Warranty Product Repairs

After the new product warranty expires, a product may be returned, at the owner's prepaid expense, to ADS for repair. The owner will pay for all parts and labor associated with the repair. Any repair part will be covered by the new product warranty for 90 days from the date of shipment from ADS.

Troubleshooting Fee

ADS will charge a troubleshooting fee if the reported product defect cannot be found and/or the reported defect is not due to a defect in materials or workmanship.

Shipping

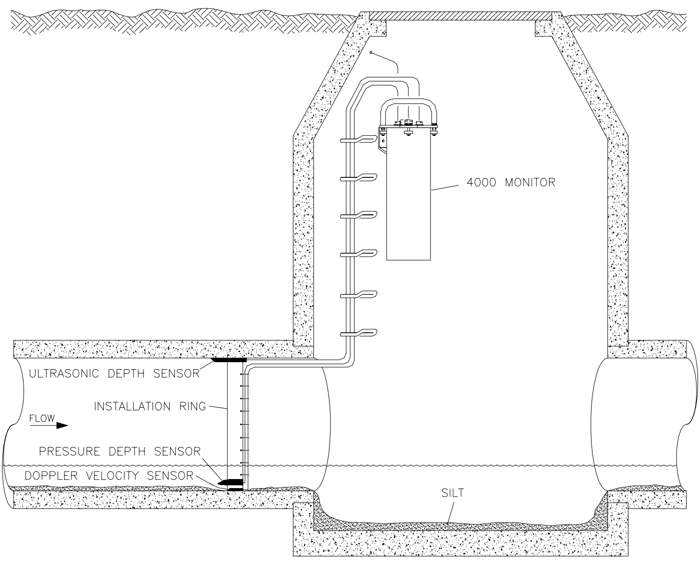
All repaired products will be returned via surface transportation prepaid by ADS. Import duties, fees, taxes, and other related charges are the responsibility of the owner.

THIS IS THE ONLY WARRANTY FOR ADS PRODUCTS. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY. PRODUCT REPAIR OR REPLACEMENT IS THE ONLY REMEDY. IN NO EVENT WILL ADS BE RESPONSIBLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL, OR SPECIAL DAMAGES.

CHAPTER 2

System Overview

The ADS Model 4000™ flow monitor and sensors are primarily designed for monitoring flow in sanitary and storm sewers. The monitor mounts to the manhole rim or wall slightly below the manhole cover; the sensors typically attach to a ring installed in the sewer pipe a short distance upstream from the manhole invert.



Typical 4000 flow monitoring system installation

The monitor transmits and receives electronic signals to and from the sensors to measure the flow depth and velocity based on a time defined interval. It then gathers and processes this information, which may involve calculating the flow rate. The monitor can transfer the recorded flow data to the user's PC for determining flow rate, performing flow analysis, and reporting. These reports can assist municipalities and industry in planning improvements and additions to sewer systems, improving the accuracy of billing information, and providing information for the overall management of sewer systems.

Special software called ***FieldScan*** enables the user to configure and communicate with the monitor for activation, data collection, and diagnostic purposes. Configuration involves defining the location information file (LIF) for storage in the user's local directory and building the BASIC code and variables for the site. The LIF contains information such as pipe characteristics, monitor identification, selected devices, sensor offsets, data log rate, and other parameters necessary for measuring the flow both accurately and efficiently.

Activation involves downloading the BASIC code and site-specific information from the LIF (stored in the user's local directory or network drive) to the monitor. It also includes initiating monitor activities such as taking sensor readings, logging flow data, recording pulses from a rain gauge, sending signals to a sampler, and managing event notification.

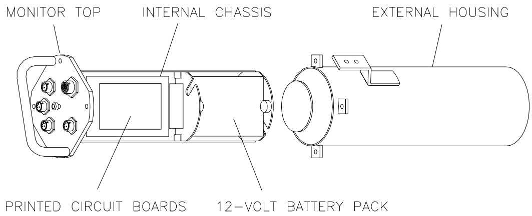
Another software package, ***Profile***, enables the user to process the flow data, generate graphical and tabular reports, organize data in the user's local directory, and maintain logs of communication between the monitor and the user's PC.

> **Note:** Refer to the *FieldScan User's Guide* (#950021**) and *Profile User's Guide* (#950015**) for more information.

ADS Model 4000 Flow Monitor

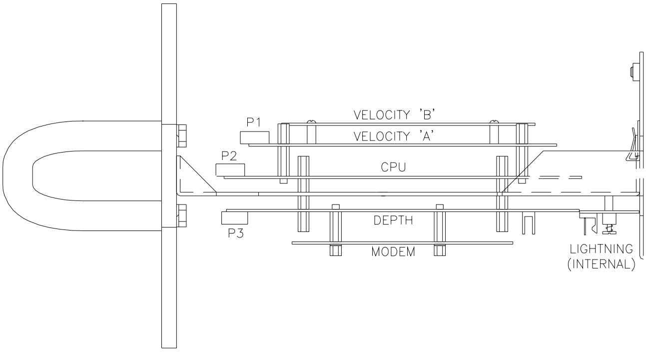
The ADS Model 4000 flow monitor is a waterproof, airtight, cylindrical, marine-grade aluminum canister housing a chassis securing multiple printed circuit boards and a portable power source. The one-piece internal chassis, attached to the inside of the monitor lid, provides a mounting surface for the following boards:

- Central processing unit (CPU) board
- Depth interface board
- Velocity interface boards
- Modem board
- Lightning protection board



4000 flow monitor with chassis (left) removed from enclosure (right)

The processor board mounts directly to one side of the chassis. The velocity boards mount on top of the processor board. The depth board mounts directly to the other side of the chassis. The modem board mounts on top of the depth board, and the lightning protection board mounts below the depth board. A ten-connector ribbon cable provides an interface among the processing, depth, and velocity boards.



Side view of 4000 flow monitor chassis assembly

ADS Model 4000 WR (Wireless-Ready)

The ADS Model 4000 WR flow monitor is designed to communicate through an external, wireless communication device. Wireless communication occurs through a connection between the monitor and a CDPD device called the ADS Model 3800™.

> **Note:** Since the 4000 WR does not communicate using telemetry, it contains neither a modem board nor a lightning protection board.

Processor Board

The processor board contains the central processing unit (CPU). As the source of all monitor activity, the processor board is responsible for all of the monitor's high-level functions, including the following:

- Controlling user communication with the monitor
- Scanning the sensor interface boards and the rain gauge input to retrieve and store data

- Maintaining the monitor time and date
- Performing power management
- Providing each board with the parameters required to carry out the associated operations
- Outputting a discrete signal to a sampler
- Transmitting the stored and current data to the user's PC

The board allocates portions of memory to firmware (permanently stored software), data storage, and program manipulation and calculation. A light-emitting diode (LED) located on the processor board indicates monitor communication status. The LED illuminates when the processor board is involved in external communications. A second LED indicates the processor board's current level of activity. The light increases in brightness as processor board activity increases. The board also includes the monitor clock and a 3-volt lithium backup battery. This battery maintains the monitor memory during a battery pack swap or power failure. Battery backed RAM chips provide backup power to the memory if the 3-volt lithium battery fails.

Sensor Interface Boards

The 4000 flow monitor chassis supports two sensor interface subsystems:

- A velocity subsystem consisting of two boards supporting the Doppler velocity sensor
- A depth subsystem consisting of one board supporting both the pressure depth sensor and the ultrasonic depth sensor

The sensor interface subsystems communicate with the corresponding sensors to acquire data, take sensor readings, and convert raw data to the appropriate engineering units of measurement.

Connectors

Connectors located on top of the monitor receive the following cabling and components:

- Ultrasonic depth sensor
- Doppler velocity sensor
- Pressure depth sensor
- Telemetry or serial (DMI or wireless) communication
- Rain gauge/sampler/external power

Battery Pack

The 12-volt battery pack, mounted to the bottom of the chassis, provides the power for operating the monitor and maintaining the monitor memory through the power supply on the processor board. The monitor measures the battery voltage, and the **FieldScan** and **Profile** software applications provide a user-defined setting to ensure the monitor signals a warning when the available power is low.

External Power

The 4000 monitor also can receive power from an external DC power source when equipped with a special conversion kit. External power requires a power source running between 9 and 14 volts at 1 amp of continuous current.

Sensors

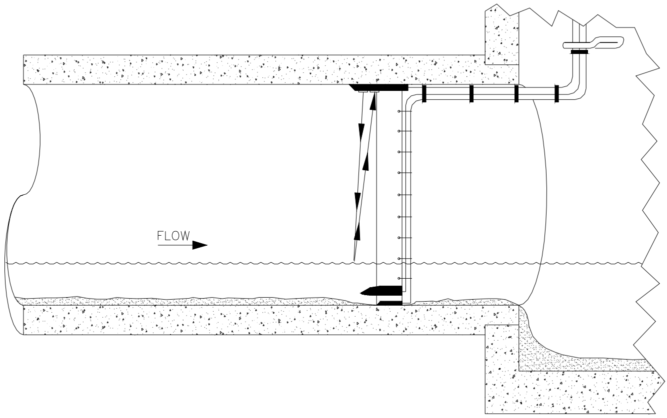
The 4000 flow monitor uses the sensors to gather raw flow data. The ultrasonic and pressure depth sensors use independent measurement techniques to collect information concerning the depth of the flow. The Doppler velocity sensor gathers peak flow velocity data.

A sewer system's hydraulics are much more stable and uniform in the incoming pipe than in the manhole invert or outgoing pipe. Therefore, the sensors mount to a stainless steel expandable ring or stainless steel bands installed in the pipe upstream from the manhole. Installing them upstream minimizes hydraulic effects and erroneous data readings caused by foamy waters, flow waves, sewer noise, non-laminar flow, and obstructions in the manhole.

The process of installing the sensors in the incoming pipe is patented by ADS.

Ultrasonic Depth Sensor

The ultrasonic depth sensor, which mounts at the crown of the pipe, transmits sound waves from the sensor face to the surface of the flow. It then measures the time elapsed between transmission and reception of the sound signal. The distance between the sensor face and flow surface is the *range*. Based on the elapsed time and the speed of sound, the monitor calculates the depth of the flow by subtracting the range from the pipe diameter. The monitor compensates for the speed of sound in the air using the temperature recorded by one of two temperature sensors housed within the ultrasonic depth sensor.



Ultrasonic depth sensor sending signals to flow surface to determine range

Quadredundancy

Each ultrasonic depth sensor contains four ultrasonic transducers. Taking readings with four transducer pairs gives the sensor *quadredundancy*, which ensures greater sensor reading reliability. To take a reading, one transducer transmits a sound wave while a second transducer listens for the returning echo. Each transducer has its own electronic circuitry and dedicated wiring for true redundancy.

Data Scrubbing

Flow conditions and internal structures introduce many potential obstacles to obtaining accurate flow data in sewer systems and manholes. Some of these obstacles may include noise, turbulent or wavy flow, a foamy flow surface, side connections, rungs, broken pipes, or drop connections.

To minimize these effects, ADS uses a process of eliminating erroneous data called *data scrubbing*. Initial data scrubbing occurs routinely in the following way as the monitor takes readings:

- The monitor fires each sensor and averages the multiple readings.

- The monitor discards the clearly erroneous readings (i.e., readings well outside the range of the majority of the readings).
- The monitor records the percentage of all acceptable readings used to arrive at the average value.

Secondary scrubbing also can occur during data collection from the monitor to the analyst's PC using the **Profile** software. Refer to the *Profile User's Guide* (950015**) for more information.

Standard Ultrasonic Depth

The standard method for processing ultrasonic depth involves firing the sensor once to take 32 readings for each of the 4 user-defined transducer pairs. The monitor discards all false and multiple echoes and then averages the good readings to arrive at the final reading for each pair. It then logs each of the 4 pairs.

Smart Depth

The 4000 also includes an enhanced algorithm in the firmware (permanently stored software), which can be enabled by the user, for processing ultrasonic depth that automatically filters out bad signals or erroneous readings due to flow problems or obstructions. This process produces more accurate data, yields one final depth measurement, and reduces the amount of stored data. It also significantly decreases the need for manual analysis and editing.

Each time the monitor fires the sensor to take a reading, the algorithm triggers two separate processes. First, the algorithm automatically determines a set of standards, or *range window*, for good return echoes. It accomplishes this by digitizing the analog return signals and firing all 12 transducer pairs 5 times each (60 total firings). Then, an average is taken of the pairs to determine the range. The range is set by scanning through the digital data and recording the strongest returning echoes. A range window is created around these echoes. From that point forward, the monitor accepts echoes only from within that range and screens out the bad signals.

The second process involves applying the standards set by the algorithm in the first sensor firing to process the return echoes and determine the range actually used to record the depth of flow in the pipe. The monitor takes 32 analog readings for each of the 12 transducer pairs (384 total firings). The analog signals produce a greater resolution and accuracy. The monitor applies the range window to each of the 32 readings and then screens out the signals outside of that window (data scrubbing). It takes intrapair and interpair averages, applies the scrubbing routine again, and produces one final range. To conserve memory, the monitor stores this single range rather than the four ranges used in the standard design. However, using the smart depth feature consumes battery life at a higher rate than standard ultrasonic depth.

Pressure Depth Sensor

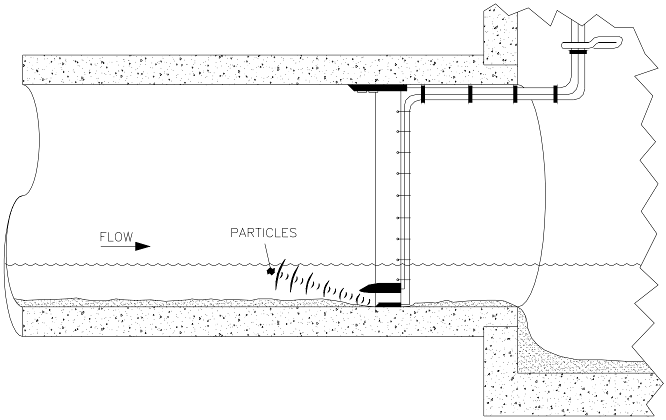
The pressure depth sensor typically mounts at the bottom of the pipe. While the ultrasonic depth sensor can only measure depths up to slightly below full pipe capacity, the pressure depth sensor can measure depths greater than a full pipe that might extend up into the manhole (surcharges).

The pressure depth sensor contains a differential pressure transducer that transmits an output voltage corresponding to the difference between the water pressure and the air pressure in the sewer. It measures water pressure through a port on the underside of the sensor and air pressure using an integral vent tube running to the top of the manhole. The monitor calculates the depth of the flow by reading the difference in pressures. The pressure depth system also compensates for temperature using a temperature sensor housed within the pressure depth sensor.

Doppler Velocity Sensor

The Doppler velocity sensor mounts at the bottom of the pipe. It emits a wide, omni-directional sound wave at a specific frequency upward into the flow. The sound wave bounces off particles in the flow and returns to the sensor. The velocity sensor measures the change in the sound wave's frequency from transmission to reception. This change is used to determine the velocity of the flow based on the *Doppler* effect.

The Doppler effect describes the shift in frequency of a sound wave emitted by a moving object in relation to a stationary point. In this case, the moving objects are particles in the flow, the stationary point is the velocity sensor, and the received signal is the reflection of the sound wave (emitted by the velocity sensor) off the particles.



Doppler velocity sensor sending signals reflecting off particles in the flow

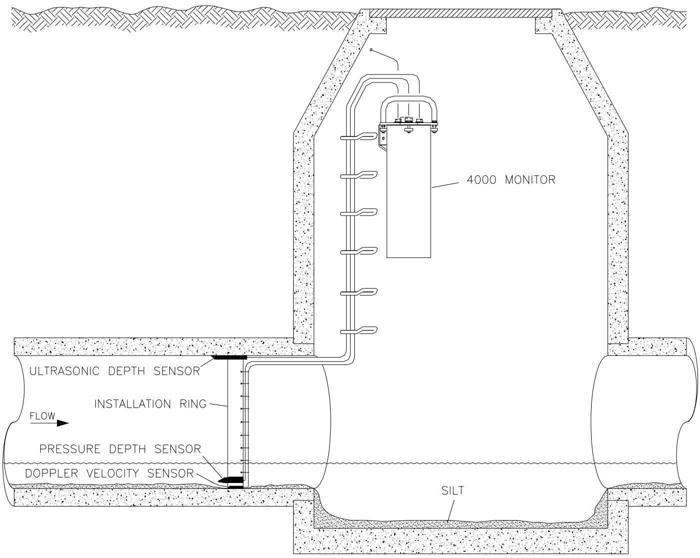
CHAPTER 3

Monitor and Sensor Installation

The ADS Model 4000™ flow monitor and sensors are primarily designed for monitoring flow in sanitary and storm sewers. The monitor mounts to the manhole rim or wall slightly below the manhole cover.

A sewer system's hydraulics are much more stable and uniform in the incoming pipe than in the manhole invert or outgoing pipe. Therefore, the sensors mount to a stainless steel expandable ring or stainless steel bands installed in the sewer pipe a short distance upstream from the manhole invert. Installing the sensors upstream minimizes the hydraulic effects and erroneous data readings caused by foamy waters, waves in the flow, sewer noise, non-laminar flow, and obstructions in the manhole.

The process of installing the sensors in the incoming pipe is patented by ADS®.



Typical 4000 flow monitor and sensor installation

This chapter contains general instructions for properly installing the monitor and sensors in sanitary, storm, and combined sewer lines and manholes.

> **Note:** Manhole and sewer system work involves confined space entry and is inherently dangerous. Therefore, installers and technicians must comply with all federal, state, and municipal regulations concerning confined space entry. ADS is not responsible for any injuries, damages, claims, or liability resulting directly or indirectly from the use of this installation guide or the installation of any ADS equipment.

Installing the Sensors in the Pipe

There are two types of sensor installations:

- Standard Installations
- Special Installations

Standard Installations involve installing a stainless steel ring to mount the sensors in round pipes up to 48 inches (122 cm) in diameter. *Special Installations* involve installing stainless steel bands to mount the sensors in round pipes over 48 inches (122 cm) in diameter or irregular-shaped pipes of any size. This chapter includes the procedures for performing sensor installations under either condition and connecting the sensors to the monitor.

Standard Installation

Performing a standard sensor installation involves the following process:

- Gathering the equipment and supplies
- Assembling the ring
- Mounting the sensors on the ring
- Installing the ring in the pipe

Before beginning the installation, conduct a thorough investigation of hydraulic and other site conditions. The hydraulics of a site directly affect the monitor's ability to accurately measure flow depth and velocity. In addition, measure the horizontal and vertical pipe dimensions carefully. Even slightly inaccurate pipe dimensions can significantly skew and misrepresent flow data.

Gathering Parts and Supplies

Obtain the following supplies before installing the ring and sensors to prevent any costly delays. When ordering, specify the 4000 flow monitor ring-mounted installation hardware.

> **Note:** The values and units that appear in *italics* are direct conversions; therefore, these mechanical sizes may not actually exist. ADS has included the conversions only to enhance readability.

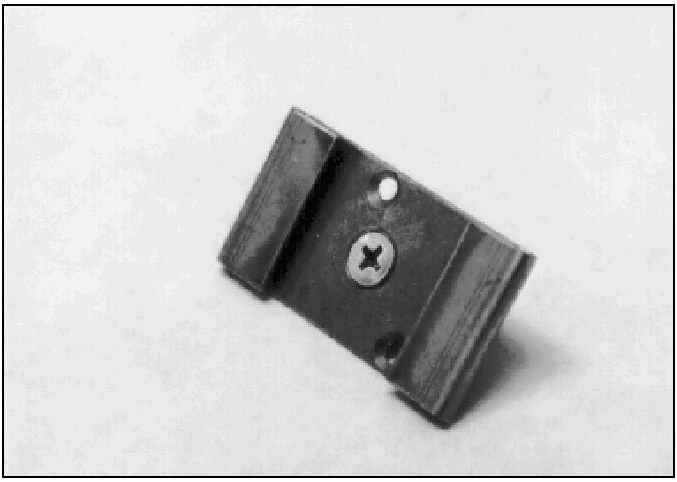
Quantity	Unit	Description	ADS Part Number
1	each	4000 flow monitor	ADS Model 4000
15	each	¼- × 2 ¼-inch stainless steel anchor bolt	I01-0002
15	each	plastic push mount	I01-0006
15	each	11-inch cable tie *(28-cm)*	I05-0003
25	each	4-inch cable tie *(10-cm)*	I05-0001
15	each	8-inch cable tie *(20-cm)*	I05-0002
15	each	anchor cable ties	I05-0004
1	each	stainless steel ring (sized for pipe)	I25-0053—0063
1	each	sliding ultrasonic sensor bracket	I25-0001
1	each	stabilizer sliding bracket	I25-0002
1	each	spreader assembly	I10-0003
1	each	18-inch (*46-cm*) stainless steel crank handle	I10-0012

Assembling the Ring

The flow sensors mount to a stainless steel ring that is installed in the pipe. Several different ring sizes exist, and each ring is adjustable within about 3 inches to fit pipes of different diameters. Assemble the ring in the following way:

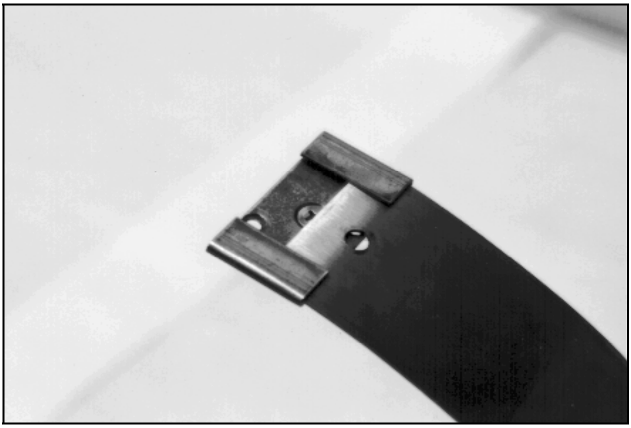
> **Note:** These instructions generally apply to overlapping rings. However, the 8-, 10-, and 12-inch rings do not have an overlapping section. Therefore, these non-overlapping rings will require small modifications to the assembly process. To assemble a non-overlapping ring, proceed directly to step 4.

1. Insert the spreader mechanism screw through the hole in the center of the ring stabilizer. Ensure that the head of the screw fits into the countersunk hole.



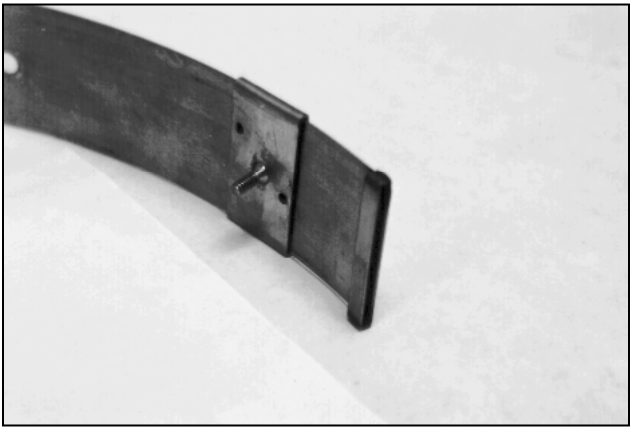
Ring stabilizer with spreader mechanism screw

2. Slide the open end of the ring (end without the welded metal band) through the flanges in the ring stabilizer, making sure the flanges face the outside of the ring and the spreader mechanism screw faces the inside of the ring.



Sliding the ring stabilizer onto the ring

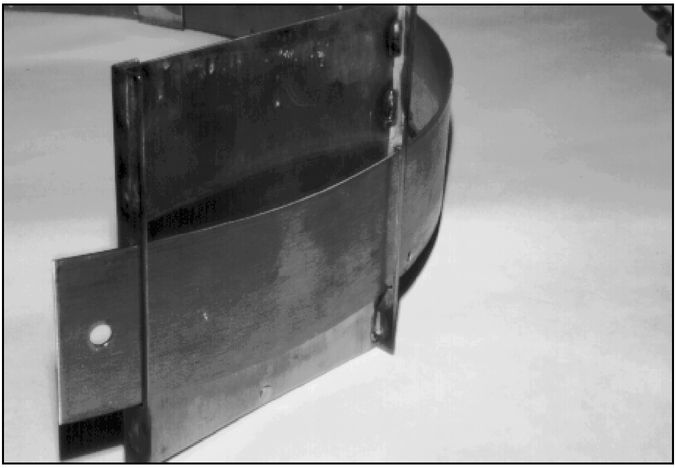
3. Slide the ring stabilizer all the way around the ring until it is about 4 inches (10 cm) from the welded metal band at the other end of the ring.



Moving the ring stabilizer into position

4. Position the ring with the downstream edge (edge with the holes) facing you.

5. Slide the ultrasonic sensor mount onto the open end of the ring with the back of the ultrasonic mount (side with the slots) facing the outside of the ring. The side with the backstop should face the inside of the ring.



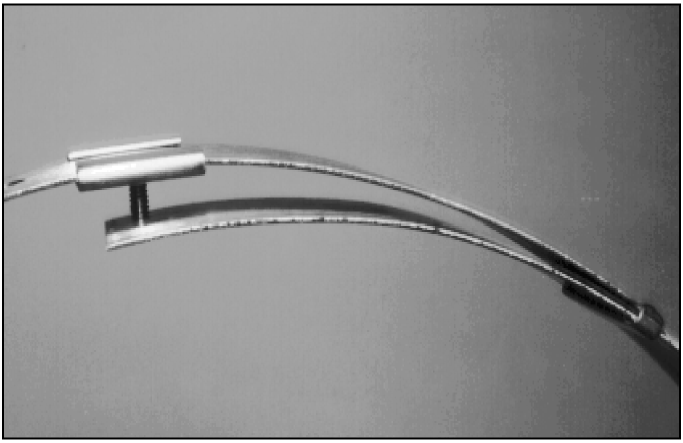
Sliding the ultrasonic sensor mount onto the ring

6. Move the ultrasonic sensor mount around the ring.

   Note: Steps 7 and 8 apply only to overlapping rings. Proceed directly to step 9 for non-overlapping rings.

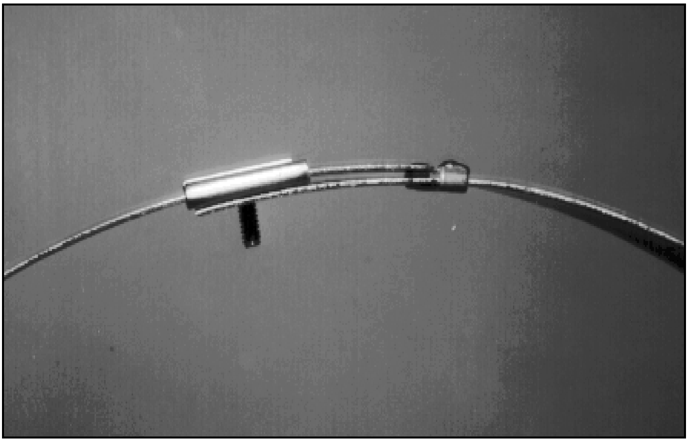
7. Slide the open end of the ring through the slot in the welded band of the ring until it overlaps about 4 inches (10 cm).

8. Spread the ring sections apart so that you can slide the ring stabilizer with the spreader mechanism screw into the gap.



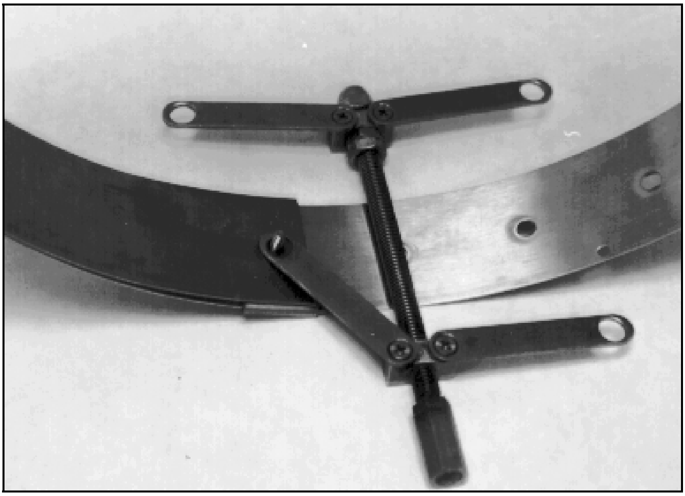
Moving the ring stabilizer into position

9. Perform the following based on the ring type:
   - ❑ **Overlapping** Insert the spreader mechanism screw completely through the hole at the open end of the ring.
   - ❑ **Non-Overlapping** Insert a spreader mechanism screw through the hole at the left end of the ring so that the end of the screw extends inside the ring.



Ring stabilizer fully connected

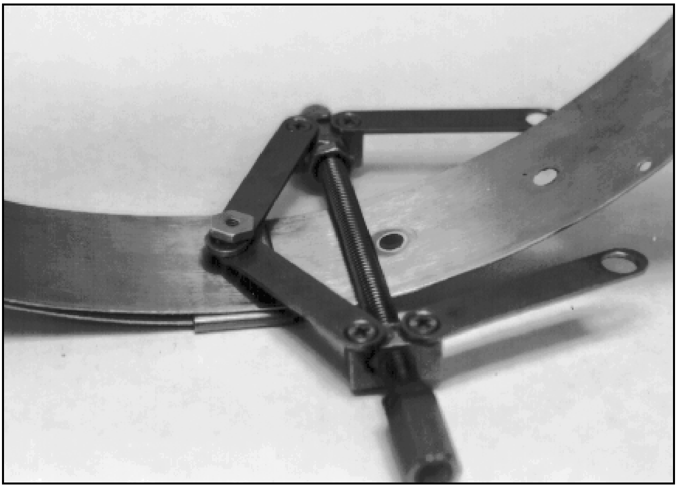
10. Place the ring on a flat surface with the spreader mechanism screw facing up.
11. Orient the ring with the downstream edge (edge with small holes) facing you.
12. Lay the spreader mechanism across the inside of the ring with the downstream end of the mechanism (end with the large welded nut) facing you, the four spreader bars facing toward the inside of the ring, and the shoulder bolts pointed outside the ring.
13. Place a washer and then the downstream, left spreader bar over the spreader mechanism screw.



Orienting and attaching the spreader mechanism

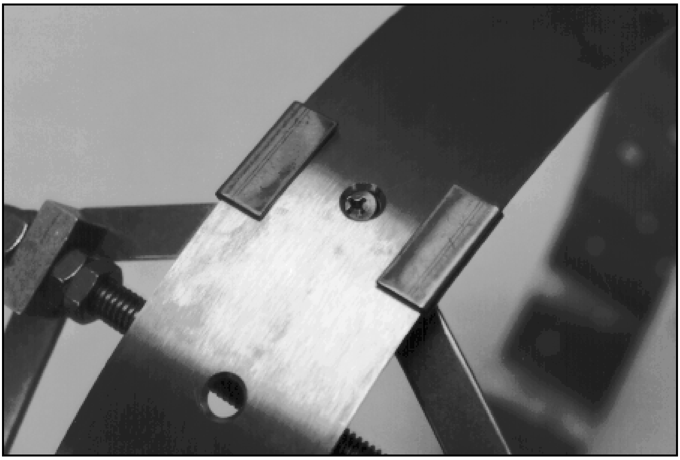
14. Place the upstream, left spreader bar onto the same screw.
15. Lightly turn the hex nut onto the screw, ensuring that it passes through the holes in the end of the spreader bar.

Note: Steps 16 through 18 apply only to overlapping rings. For a non-overlapping ring, proceed to step 19.



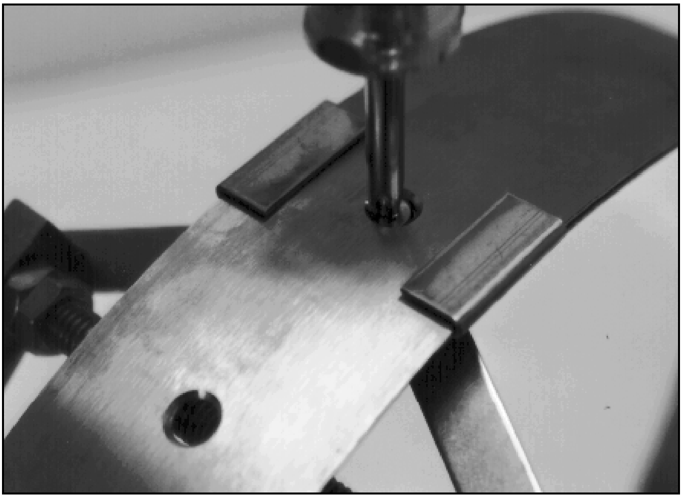
Attaching the spreader bars

16. Turn the ring until the spreader mechanism is in the 12:00 position.
17. Align the spreader mechanism screw so that the head is visible through one of the ring size adjustment holes.



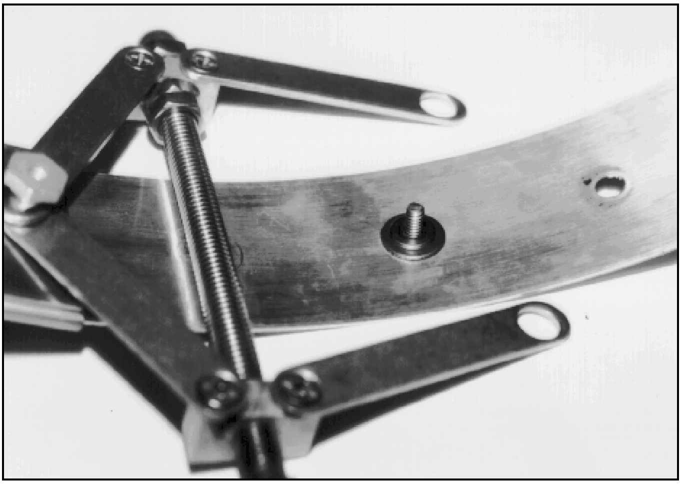
Aligning the screw head and adjustment hole

18. Tighten the screw through the hole using a Phillips-head screwdriver while holding the hex nut with a ½-inch (13 mm) nut driver.



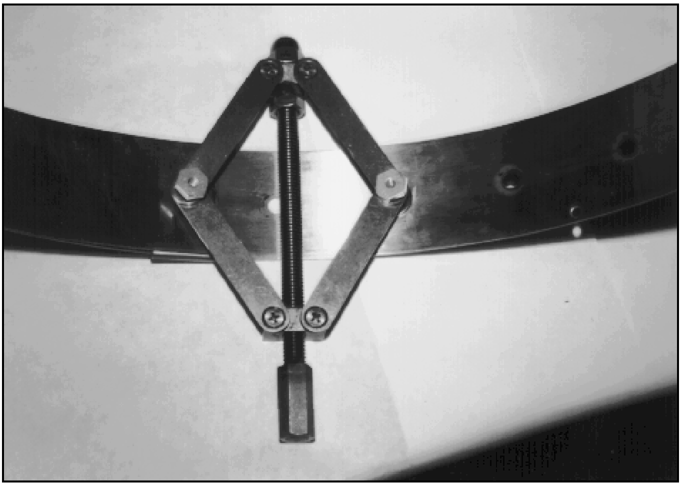
Tightening the spreader mechanism screw and hex nut

19. Insert the second spreader mechanism screw through the following hole based on the ring type:
    - ❑ **Overlapping** Appropriate ring size adjustment hole on the outside of the ring
    - ❑ **Non-overlapping** Last hole on the other free end of the ring (inserting the screw from the outside of the ring)
20. Slip the large washer onto the screw on the inside of the ring.



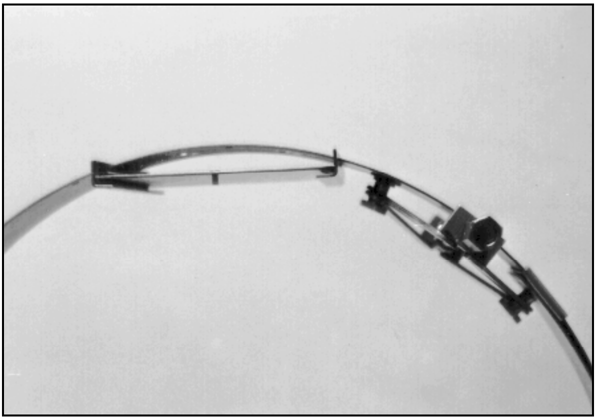
Place the washers onto the second spreader mechanism screw

21. Place the spreader bars over the screw, and tighten a hex nut on the screw.



Spreader mechanism attached to the ring (view from inside the ring)

Although the spreader mechanism fits snugly against the inside of the ring, the spreader mechanism may seem loose on the hex nuts. Do not be concerned. The spreader mechanism will tighten once the ring is installed and tightened inside the pipe. The following picture displays how a properly assembled ring should look.



Properly attached spreader mechanism

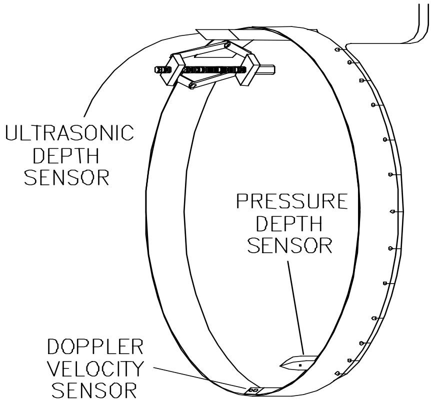
Mounting the Sensors to the Ring

The following sections provide instructions on mounting the ultrasonic depth, velocity, and pressure depth sensors to the ring. To ensure the most accurate flow data, standard pipe installations require proper positioning of the sensors on the ring as well as in the pipe. When facing the downstream edge of the ring, the sensors should be mounted on the ring in the following locations:

- **Ultrasonic Depth Sensor** Twelve o'clock position (top of the pipe) when the spreader mechanism is in the one o'clock position

- **Doppler Velocity Sensor** As close as possible to the six o'clock position (bottom), provided it is mounted above the level of any silt present at the bottom of the pipe (Any silt covering the sensor could interfere with the sensor signals, potentially producing inaccurate or erroneous readings.)

- **Pressure Depth Sensor** Bottom of the ring slightly to the left of the Doppler velocity sensor (when present)



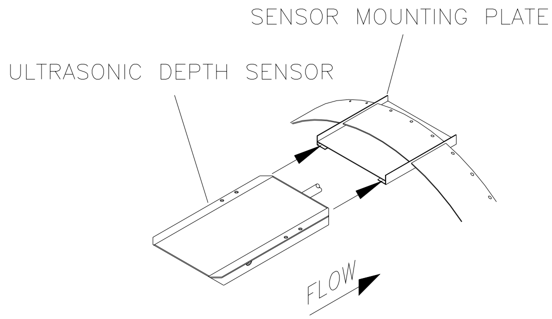
Proper positioning of sensors on the ring

Caution: Handle all sensors and cables with extreme care. The sensors and cables contain delicate mechanisms and electronics. Keep sharp objects away from sensor cables, and avoid stepping or placing heavy objects on the cable during installation.

Mounting the Ultrasonic Depth Sensor

Mount the ultrasonic depth sensor to the ring in the following way:

1. Slide the sensor into the grooves on the sensor mount (at the top of the ring) from the upstream end of the mount until the sensor contacts the backstop. The sensor cable should exit the downstream edge of the ring. Orient the sensor with the four transducers facing downward toward the inside of the ring (flow surface).



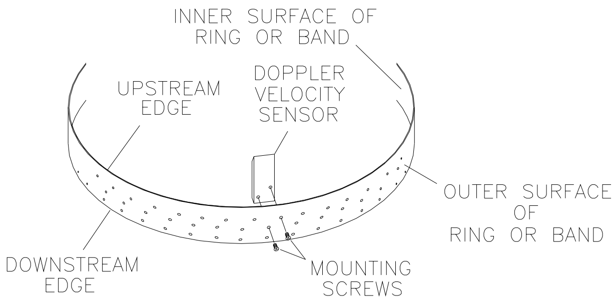
Mounting the ultrasonic depth sensor to the mounting plate on the ring

2. Verify that the ultrasonic depth sensor mounts to the ring at the crown of the pipe.

Mounting the Doppler Velocity Sensor

Mount the Doppler velocity sensor to the ring in the following way:

1. Use two M-3 × 10 mm stainless steel screws (do not substitute any other screws) to mount the sensor at the bottom of the ring opposite the ultrasonic depth sensor with the beveled edge of the sensor facing upstream.



Mounting the Doppler velocity sensor to the ring

2. Secure the sensor cable to the ring. Refer to *Securing the Cables to the Ring (or Band)* on page 3-42 for instructions on properly securing the cable.

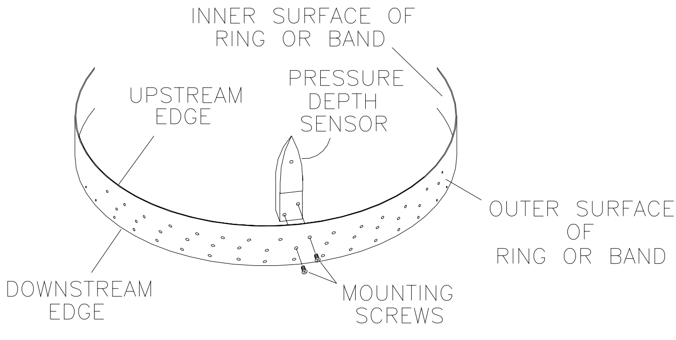
   Note: If the installation includes a pressure depth sensor, wait to secure the sensor cables until both sensors are installed on the ring.

Mounting the Pressure Depth Sensor

Mount the pressure depth sensor to the ring in the following way:

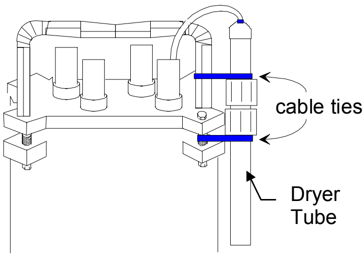
1. Orient the ring so that the ultrasonic depth sensor is directly on top. If an ultrasonic depth sensor is not in use, make sure the spreader assembly is directly on top.

2. Use two M-3 × 10 mm stainless steel screws (do not substitute any other screws) to mount the pressure depth sensor on the bottom inside of the ring with the pointed end of the sensor facing upstream. Mount the pressure depth sensor about 2 inches (5 cm) to the left of the velocity sensor (when present).



Mounting the pressure depth sensor to the ring

3. Attach the dryer tube in the vertical position to the monitor handle using cable ties.



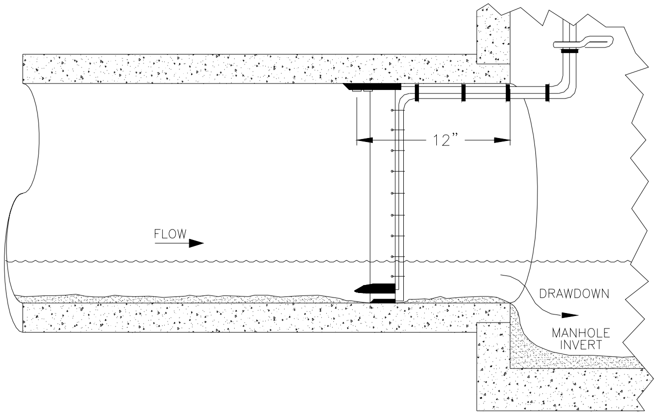
Properly securing the dryer tube to the monitor

4. Secure the sensor cable to the ring. Refer to *Securing the Cables to the Ring (or Band)* on page 3-42 for instructions on properly securing the cable.

Installing the Ring in the Manhole

The ring must fit securely in the pipe with the sensors properly positioned to ensure the most accurate monitoring results. Install the ring in the pipe in the following way:

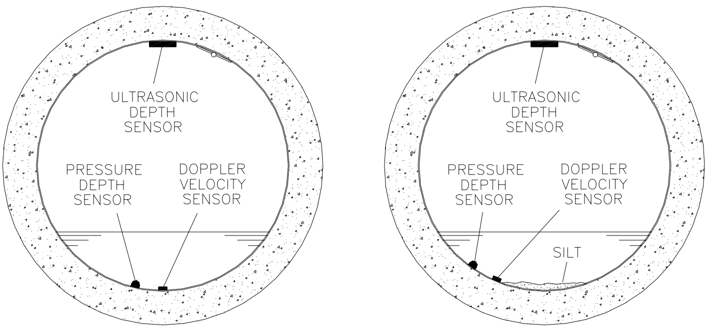
1. Examine the pipe for possible obstructions to the flow or inhibitors to ring installation.
2. Adjust the ring size to slightly less than the pipe diameter before placing the ring in the pipe by turning the spreader mechanism adjustment nut clockwise.
3. Place the ring in the input pipe at least 12 inches (30 cm) upstream from the manhole or edge of the pipe with the sensors facing upstream toward the oncoming flow. It must be located far enough upstream from the manhole to minimize the effect of the draw-down caused by a possible drop in the manhole invert.



Installing the ring at least 12 inches upstream from the manhole invert

Keep the following in mind:

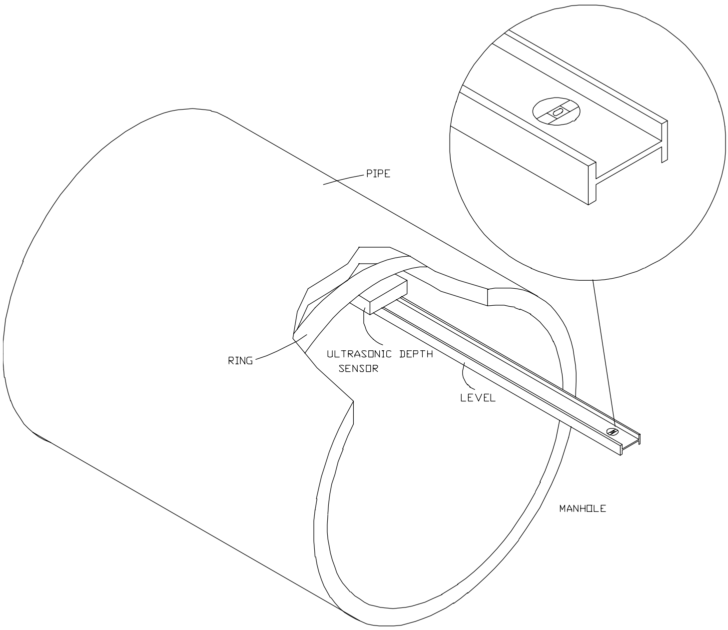
- ❑ Make sure the ultrasonic depth sensor is at the top (crown) of the pipe, the Doppler velocity sensor is at the bottom of the pipe *above* any silt present and *below* the flow surface (during minimum flows), and the pressure depth sensor is near the bottom.



Proper orientation of the ring with the sensors in the pipe with and without silt present

- ❑ If necessary, temporarily clear away silt to install the ring.
- ❑ Make sure the ring is flat (flush) against the inside wall of the pipe to avoid obstructing the flow or catching debris.

4. Expand the ring by turning the spreader mechanism nut counter-clockwise with the crank handle or socket. *However, do not tighten the ring against the pipe completely at this point.*
5. Level the ultrasonic depth sensor at the top of the pipe so that the sensor face is parallel and level (from side to side) with the flow surface and pipe crown.



Leveling the ultrasonic depth sensor

If necessary, adjust the level in the following way:

- ❑ Remove the ultrasonic depth sensor from the mount.
- ❑ Loosen the ring slightly to allow the plate to move on the ring.

- ❑ Tap the sensor mount to the right or left with a rubber mallet until it is level.

Warning: Tapping the sensor mount with the sensor attached could damage the sensor. Always remove the sensor before tapping the mount with a mallet.

- ❑ Remount the sensor onto the mount, and recheck the level.

6. Fully tighten the ring until it fits securely and completely flush against the pipe wall.

Warning: Avoid overtightening the ring. This could bend the crank assembly.

7. Restore any silt moved to its previous level, and confirm that the Doppler velocity sensor is still above the silt level.

8. Secure the sensor cables from the ring to the future monitor location in the manhole. Refer to *Securing the Cables in the Pipe and Manhole* on page 3-43 for more information.

Special Installations

A special installation requires two independent installations; one for the ultrasonic depth sensor and one for the Doppler velocity and pressure depth sensors.

Note: Special installations do not involve spreader mechanisms or rings. All hardware mounts directly to the pipe surface with anchor bolts.

Performing a special installation involves the following process:

- Gathering the equipment and supplies
- Mounting the ultrasonic depth sensor
- Mounting the Doppler velocity sensor
- Mounting the pressure depth sensor

Before beginning the installation, conduct a thorough investigation of hydraulic and other site conditions. The hydraulics of a site directly affect the monitor's ability to accurately measure flow depth and velocity. In addition, measure the horizontal and vertical pipe dimensions carefully. Even slightly inaccurate pipe dimensions can significantly skew and misrepresent flow data.

> **Caution:** Handle all sensors and cables with extreme care. The sensors and cables contain delicate mechanisms and electronics. Keep sharp objects away from sensor cables, and avoid stepping or placing heavy objects on the cable during installation.

Gathering Parts and Supplies

Be sure to obtain the following supplies before performing a special installation to prevent any costly delays. When ordering, specify the 4000 flow monitor special installation hardware.

> **Note:** The values and units that appear in *italics* are direct conversions; therefore, these mechanical sizes may not actually exist. ADS has included the conversions only to enhance readability.

Quantity	Description	ADS Part Number
1	4000 flow monitor	ADS Model 4000
15	11-inch cable tie *(28-cm)*	I05-0003
25	4-inch cable tie *(10-cm)*	I05-0001
15	8-inch cable tie *(20-cm)*	I05-0002
10	anchor cable tie	I05-0004
15	¼- × 2 ¼-inch anchor bolt (with 7/16-inch nut and washer)	I01-0002
3	3/8—3/16-inch × 1-inch nut	I15-0002
6	3/8—3/16-inch washer	I55-0001
3	3/8—3/16-inch × 1-inch bolt	I01-0001
1	3/8- × 2-inch *(8- × 50-mm)* stud	I01-0009
2	4-40 × 5/16-inch screw	I35-0001
8	6-32 washer	I55-0002
4	6-32 × 1-inch *(25-mm)* machine screw	I35-0004
4	6-32 × 5/16 in. *(8 mm)* nut	I15-0003
8	6-32 washer	I55-0002
1	12-inch (*30-cm*) stainless steel mounting band	I25-0080
1	sliding ultrasonic plate	I25-0001
as required	surcharge mounting bracket	I40-0002
1	¼-inch (*6.5-mm*) masonry drill bit	F35-0018
1	special predrilled 8-foot *(2.5-m)* metal band	I40-0007

Mounting the Ultrasonic Depth Sensor

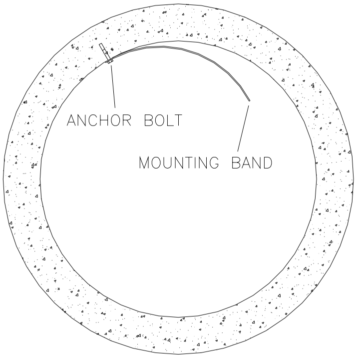
Two special installation methods are available for mounting the ultrasonic depth sensor:

- **Standard Ultrasonic Mount** This mount, the most common mounting method in use today, is used for mounting the ultrasonic depth sensor in the pipe during special installations.
- **Surcharge Mount** This mount primarily is used for mounting the ultrasonic depth sensor in the manhole at sites where the flow continually occurs within 2 inches of the top of the pipe or sites where a pressure sensor is not available and *surcharges* frequently occur. Surcharges are conditions where the flow completely fills the pipe and extends up into the manhole.

Standard Ultrasonic Mount

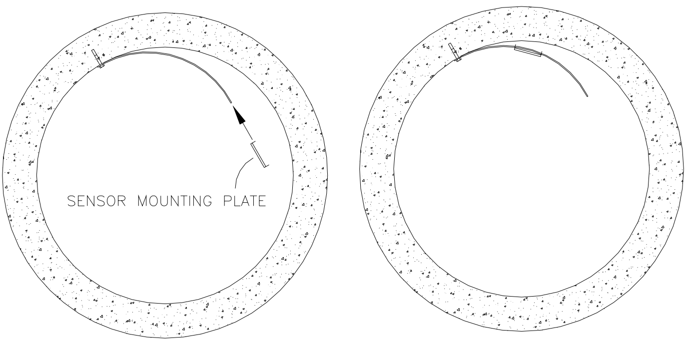
Mount the ultrasonic depth sensor using this method in the following way:

1. Position the sliding ultrasonic plate in the center apex of the pipe, and scribe a mark on both sides of the ultrasonic plate.
2. Center the 12-inch (30-cm) mounting band, allowing the band to extend about 4 inches (100 mm) beyond each side of the scribed location.
3. Conform one end of the curved band to the pipe configuration, and spot drill to mark the bolt location.
4. Remove the curved band, drill an anchor bolt hole, and gently tap a ¼-inch anchor bolt into the hole.
5. Mount the curved band to the anchor bolt through the pre-drilled hole on the band, and hand-tighten a 7/16-inch (11-mm) nut with washer to the anchor bolt to secure the band.



Securing one end of the ultrasonic depth sensor mounting band

6. Slide the adjustable ultrasonic plate onto the band with the backstop edge closest to the invert and the two band slots facing up.

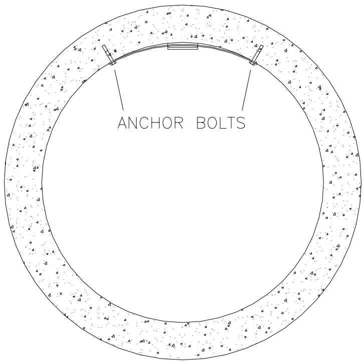


Sliding the ultrasonic depth sensor mounting plate onto the band

7. Align the sliding ultrasonic plate with the scribe marks, and conform the other end of the curved band with the pipe.

8. Spot drill to mark an anchor bolt location, and mount another anchor bolt to the pipe.

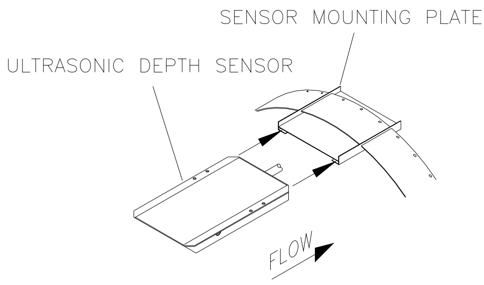
9. Hand-tighten a 7/16-inch (*11-mm*) nut with washer to secure the other end of the band.



Securing the other end of the band

> **Note:** If the plate has too much play, attach another anchor bolt approximately 1 inch (25 mm) from the plate.

10. Slide the ultrasonic plate along the metal band until it is level (from side to side) with the flow surface and pipe crown, and tighten the nuts securely with a nut driver. See illustration on page 2-19.
11. Slide the ultrasonic depth sensor into position from the upstream end of the ultrasonic plate until the back of the sensor comes in contact with the backstop.



Sliding the ultrasonic depth sensor into place

12. Confirm the ultrasonic depth sensor is still level.

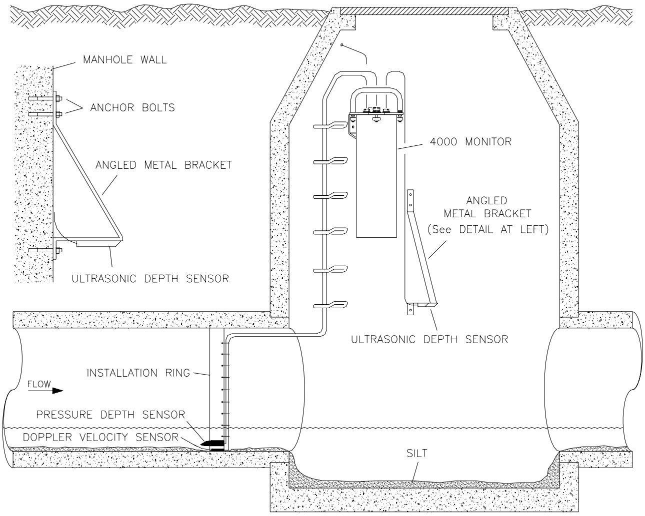
Surcharge Mount

Use the following method to mount the ultrasonic depth sensor at a site that may experience surcharge conditions:

1. Place the top of the ultrasonic depth sensor against the base of the surcharge plate, aligning the holes of the plate with the holes on top of the sensor.

2. Insert a 6-32 × 1-inch (25-mm) round-head machine screw with a 6-32 washer through the ultrasonic plate and sensor, and secure with a 6-32 washer and 5/16-inch (8-mm) nut.

3. Secure the three remaining locations.



Surcharge Mount

4. Determine the appropriate height at which to mount the ultrasonic depth sensor portion of the bracket. In making this determination, keep in mind that the maximum range of the ultrasonic depth sensor is 10 feet (3.05 m).

5. Press the bracket firmly against the manhole wall.

6. Identify the three pre-drilled holes at the top of the bracket, and spot drill the manhole wall through the middle hole with a drill.
7. Remove the bracket, and drill and mount an anchor bolt.
8. Secure the top of the bracket to the manhole wall with a washer and 7/16-inch (11-mm) nut.
9. Push up on the bottom portion of the bracket until the ultrasonic depth sensor portion of the bracket is level.
10. Hold the bracket firmly in place against the manhole wall.
11. Identify the three pre-drilled holes on the bottom of the bracket, and spot drill the manhole wall through the middle hole with a drill.
12. Rotate the bracket 90°, and drill and mount an anchor bolt.
13. Secure the bottom of the bracket with a washer and 7/16-inch (11-mm) anchor bolt.
14. Verify that the ultrasonic depth sensor portion of the bracket is level. If it is slightly out of level, make horizontal adjustments to the bottom portion of the bracket by moving it to the left or right. The oval bottom mounting holes allow minor horizontal adjustments.
15. Drill and mount an anchor bolt in one of the pre-drilled holes at the top portion of the bracket for extra security.
16. Confirm that the ultrasonic depth sensor is level.

Mounting the Doppler Velocity and Pressure Depth Sensors

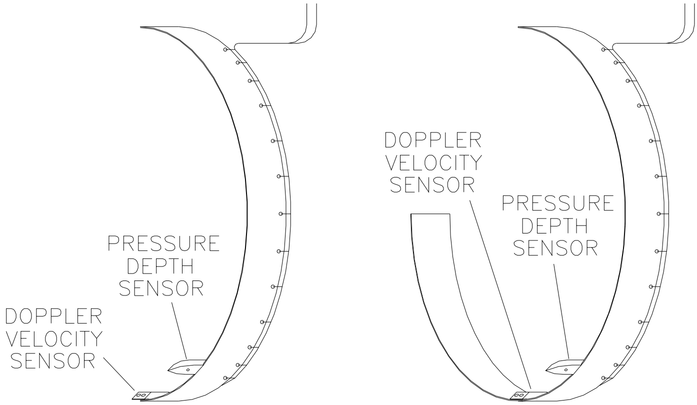
Two special installation methods are available for mounting the Doppler velocity and pressure depth sensors:

- ¾-band mount
- ½-band mount

Both mounts require almost identical installation methods. The only significant differences are that the ¾-band mount allows the installer to secure the band to both sides of the pipe wall and to position the Doppler velocity sensor at the bottom center of the pipe. These options are not possible using the ½-band mount. Therefore, the ¾-band mount is the preferable method for mounting the sensors.

However, a ½-band mount may be appropriate for monitoring under the following circumstances:

- Large pipes with deep minimum flows
- Large pipes with excessive silt present



½- (left) and ¾-band (right) mounts

¾-Band Mount

Perform the following procedure to mount the Doppler velocity sensor and pressure depth sensor (when applicable) in a pipe using the ¾-band mount:

1. Use a hacksaw to cut the band to the appropriate length. Cut the band so that, when installed, it will run approximately ¾ of the length around the inside of the pipe.

> **Note:** The metal bands come in 8-foot (2.5-m) lengths. Some larger pipes may require attaching two bands together. In addition, for square-shaped pipes, use an 8-foot (2.5-m) straight metal strip.

2. Determine which end of the band will be the long end (end extending almost completely up one side of the pipe). For cable routing purposes, ADS recommends reserving the left side of the pipe (upstream from the manhole) for the long end of the band.

   Note: Position the edge of the band with the cable tie holes (edge with small holes) facing downstream.

3. Determine the appropriate location on the band to mount the Doppler velocity sensor, making sure the sensor will be both *above* the silt level and *below* the flow surface during minimum flows.

   - ❑ If silt is not present, locate the sensor on the band so it will be at the bottom center of the pipe once installed.
   - ❑ If silt is present, locate the sensor slightly up the long end of the band so it will be above the silt level once installed.

4. Mount the sensor onto the inside of the band with two 3 mm x 8 mm countersink screws, making sure the beveled end of the sensor faces the upstream edge of the ring (edge opposite cable tie holes). If holes do not exist on the band at or near the desired mounting location for the sensor, drill holes in the band using a 7/32-inch (3 mm) drill bit.

5. When applicable, mount the pressure depth sensor to the band in the following way:

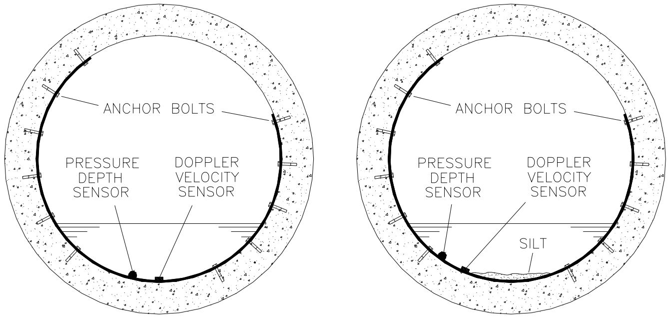
   - ❑ Mount the pressure depth sensor 2 inches (5 cm) to the left of the Doppler velocity sensor. *Make sure the sensor will be underneath the flow once installed*.
   - ❑ Secure the pressure depth sensor to the band using two 3-mm × 8-mm countersink screws. If the sensor does not have screw inserts, use two medium-sized cable ties to secure the sensor to the ring. Crisscross the cable ties across the top of the sensor and underneath the band.
   - ❑ Attach the dryer tube in the vertical position to the monitor handle using cable ties. See illustration on page 3-16.

6. Secure the sensor cables along the downstream edge of the long end of the band according to the instructions in *Securing the Cables to the Ring (or Band)* on page 3-43.
7. Position the band in the pipe so that the sensors will remain below the flow surface (even during minimum flows) and above the silt level.
8. Make sure two pre-drilled holes are visible above the flow surface on the short end of the band. Maneuver the band so that the lowest hole is almost at the flow surface.
9. Mark the pipe wall through the lowest hole with a drill, and install an anchor bolt with a pneumatic drill.
10. Secure the band to the anchor bolt with a washer and 7/16-inch (11-mm) nut.
11. Conform the band to the pipe wall around to the long end of the band so that it is flush with the pipe wall.

Note: Temporarily remove any silt preventing the band from sitting flush against the bottom of the pipe.

12. Install an anchor bolt through the pre-drilled hole closest to the flow surface on the *long* end of the band, and secure the band with a washer and 7/16-inch (11-mm) nut.
13. Make sure the band and sensors are flush against the pipe wall with no gaps, and conform the rest of the band to the pipe wall.
14. Install anchor bolts, nuts, and washers at the pre-drilled hole at the short end of the band and at the pre-drilled holes along the long end of the band (above the flow surface) approximately every 12 to 24 inches (30 to 61 cm) to the top end of the band.

Note: Whenever possible, secure the band with an additional anchor bolt approximately 3 inches (8 cm) below the flow surface on each side of the pipe. This will help ensure that the band remains flush against the bottom of the pipe below the flow surface.



Sensors mounted using a ¾-band mount in the pipe with and without silt

15. Run the sensor cables from the sensor location in the pipe to the monitor location in the manhole according to the instructions in *Securing the Cables in the Pipe and Manhole* on page 3-43.

½-Band Mount

Perform the following procedure to mount the Doppler velocity sensor and pressure depth sensor (when applicable) in a pipe using the ½-band mount:

1. Use a hacksaw to cut the band to the appropriate length. Cut the band so that, when installed, it will run almost completely down the left side of the pipe.

2. Determine the best location on the band to mount the Doppler velocity sensor. The sensor should mount as close as possible to the bottom of the band, making sure the sensor will be both *above* the silt level and *below* the flow surface once installed.

3. Mount the sensor onto the inside of the band with two 3-mm x 8-mm countersink screws, making sure the beveled end of the sensor faces the upstream edge of the ring. If holes do not exist on the band at or near the desired mounting location for the sensor, drill holes in the band using a 7/32-inch (3-mm) drill bit.

Note: The edge of the band with the cable tie holes is the downstream edge.

4. When applicable, mount the pressure depth sensor to the band in the following way:

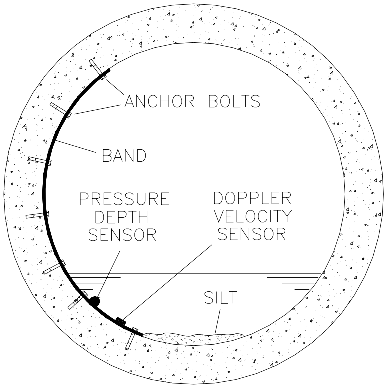
   - ❑ Mount the pressure depth sensor 2 inches to the left of the Doppler velocity sensor. *Make sure the sensor will be underneath the flow once installed*.
   - ❑ Secure the pressure depth sensor to the band using two 3-mm × 8-mm countersink screws. If the sensor does not have screw inserts, use two medium-sized cable ties to secure the sensor to the ring. Crisscross the cable ties across the top of the sensor and underneath the band.
   - ❑ Attach the dryer tube in the vertical position to the monitor handle using cable ties. See illustration on page 3-16.

5. Secure the sensor cables along the downstream edge of the band according to the instructions *in Securing the Cables to the Ring (or Band)* on page 3-42.
6. Place the band in the pipe upstream at least 12 inches (same distance as ultrasonic depth sensor, when present) from the manhole invert. Position the band on the left side of the pipe so that the sensors will remain below the flow surface (during minimum flows) and above the silt level.
7. Orient the band so that one of the pre-drilled anchor bolt holes is just above the flow surface.
8. Spot drill the pipe wall through the hole, install an anchor bolt, and secure the band to the anchor bolt with a washer and a 7/16-inch (11-mm) nut.

   Note: Make sure the submerged portion of the band is flush with the pipe wall. If it is not, remove the band and conform the band to the pipe.

9. Install an anchor bolt below the flow surface 1 to 3 inches (25 to 75 mm) away from the Doppler velocity sensor on each side. This will hold the sensor securely against the pipe wall and prevent the end of the band from twisting in the flow or catching debris.

10. Conform the portion of the band above the flow surface to the pipe wall, and install an anchor bolt, nut, and washer every 12 to 24 inches (30 to 61 cm) up to the top of the band.



Completed ½-band mount in pipe

11. Run the sensor cables from the sensor location in the pipe to the monitor location in the manhole according to the instructions in *Securing the Cables in the Pipe and Manhole* on page 3-43.

> **Note:** If the pipe is large and the Doppler velocity sensor and pressure depth sensor cables cannot reach the pipe crown, attach the sensor cables to ½-inch (13-mm) PVC tubing and anchor the tubing to the wall. This will help prevent sensor damage during heavy flow.

Installing the Monitor in the Manhole

After installing the sensors and establishing telephone service, install the monitor in the manhole. The monitor mounts inside the manhole by an aluminum mounting bracket attached to the monitor and bolted to the manhole wall or rim. The following procedures for monitor installation apply to most sites. However, because manholes differ in many ways, some sites may require the installer to implement slight modifications to the standard installation technique.

Before installing the monitor at the site, activate the monitor to verify that the monitor is configured correctly for the application and that the battery pack is operating at an adequate voltage. Make any necessary changes to the configuration *before* mounting the unit. Refer to *Chapter5*, *Maintenance and Troubleshooting*, for information on replacing the battery pack, when necessary.

> **Note:** Manhole and sewer system work involves confined space entry and is inherently dangerous. Therefore, installers and technicians must comply with all federal, state, and municipal regulations concerning confined space entry. ADS is not responsible for any injuries, damages, claims, or liability resulting directly or indirectly from the use of this installation guide or the installation of any ADS equipment.

Mounting the Monitor to the Manhole Wall

Mount the monitor to the manhole wall in the following way:

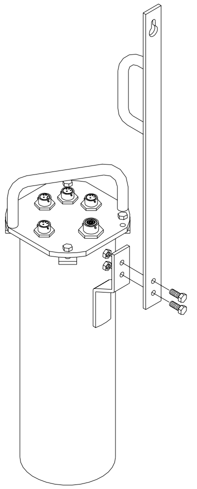
1. Determine the appropriate location to mount the monitor to the manhole wall. Consider the following when selecting the proper location:

- ❑ Select a location that will allow you to remove the monitor easily during service visits using the mounting bracket (extension handle).
- ❑ Select a location that provides only a minimal potential for the monitor to experience surcharge conditions.
- ❑ Select a location that will prevent the manhole lid from potentially damaging the monitor during removal or when rotating in the opening.

2. Hold the top end of the mounting bracket against the manhole wall, and mark the location for the mounting hole through the keyhole in the bracket.
3. Install an 3/8-inch (8 mm) anchor bolt in the hole.

Note: Make sure all anchor bolts, studs, nuts, and washers used in mounting the monitor are stainless steel.

4. Twist a 3/8-inch (8 mm) nut onto the anchor bolt, but do not tighten it down. Leave enough space between the nut and the wall for the thickness of the mounting bracket.
5. Mount the bottom of the bracket onto the monitor flange with two 3/8- x 2-inch (8- × 50-mm) bolts and nuts. It may be necessary to drill new holes in the bracket.

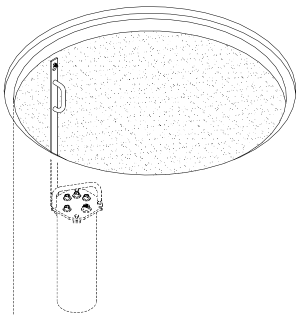


Bolting the mounting bracket to the flange welded to the monitor

6. Carefully lower the monitor into the manhole, and place the keyhole of the mounting bracket over the anchor bolt.

> **Note:** ADS strongly recommends attaching a security line to the monitor before lowering it into the manhole to prevent the monitor from accidentally dropping down the manhole during installation.

7. Tighten and secure the bolt against the mounting bracket.



Monitor installed in the manhole

8. Neatly coil and secure the excess sensor and telephone cables in the manhole to simplify future monitor service activities. Secure the cables to plastic anchors or anchor bolts using 14-inch (35-mm) cable ties.

   Note: Be careful to avoid damaging the sensor cables during installation activities. Even small pinholes in the cable can cause a sensor to malfunction or fail.

Mounting the Monitor to the Manhole Rim

Mount the monitor to the manhole rim in the following way:

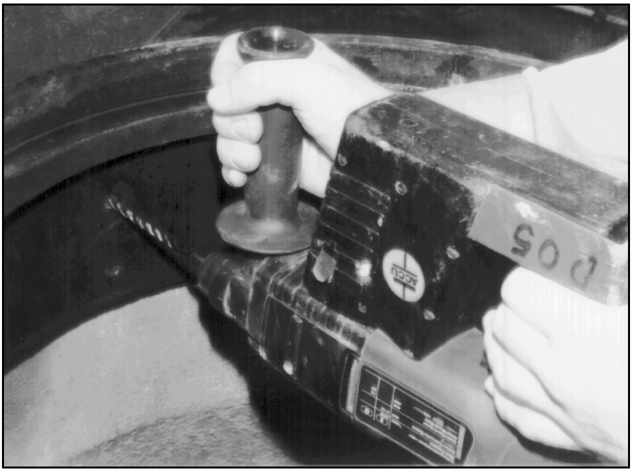
1. Determine the appropriate location to mount the monitor to the inside of the iron manhole rim. Consider the following when selecting the proper location:

   - ❑ Select a location that will allow you to remove the monitor easily during service visits using the mounting bracket (extension handle).
   - ❑ Select a location that provides only a minimal potential for the monitor to experience surcharge conditions.
   - ❑ Select a location that will prevent the manhole lid from potentially damaging the monitor during removal or when rotating in the opening.

2. Hold the keyhole at the top end of the bracket against the lower inner rim of the manhole, and mark the location for the stainless steal stud through the keyhole in the bracket. Make sure there will be enough room to lift the bracket up and over the stud when installed.

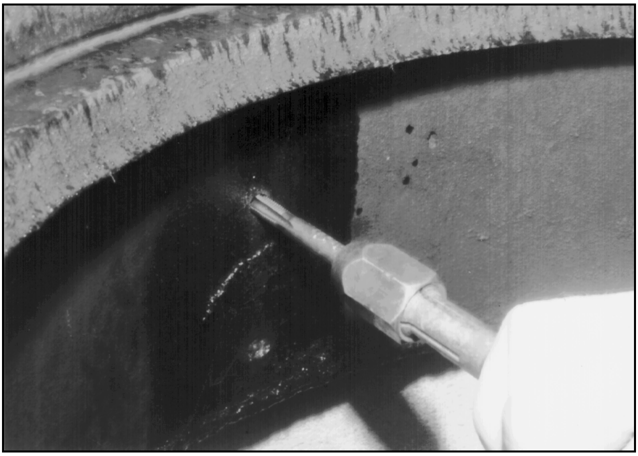
3. Drill a hole(s) into the manhole rim 1 inch (25 mm) deep using a 5/16-inch (8 mm) carbide-tipped drill bit.

   Note: Consider starting the hole using smaller bits and increasing up to a 5/16-inch bit. In addition, spray cutting oil or another lubricant into the hole while drilling and tapping.



Drilling the hole in the manhole rim

4. Use a 3/8-inch (9-mm) x 16 threads-per-inch tap to cut threads in the hole. Twist the tap clockwise ¾ turn, and then back out ½ turn before continuing deeper.

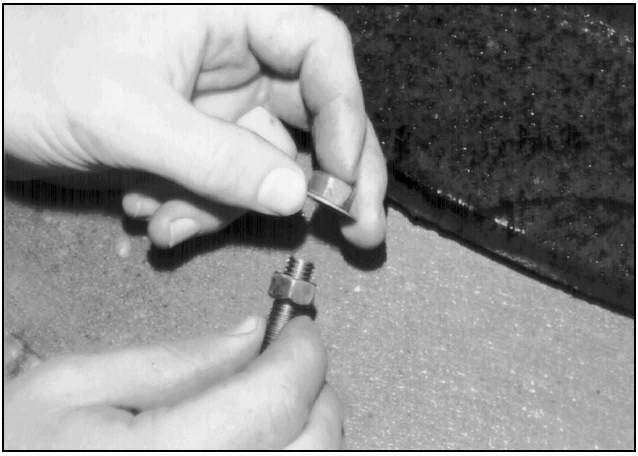


Using the tap to thread the hole

5. Chase the threading action at intervals to clear the metal debris by backing the tap almost completely out of the hole and then

screwing it back into the hole. Lubricate the hole between threading.

6. Place two 9/16-inch (14-mm) nuts (with a washer in between) onto one end of the 3/8- × 2-inch (8- × 50-mm) stud.

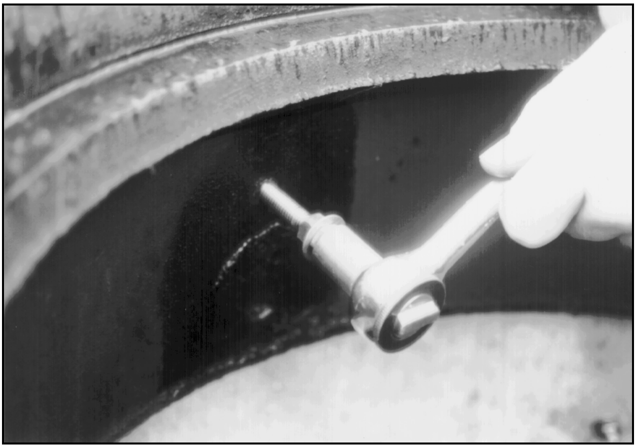


Placing two nuts and a washer onto the stud

7. Using two wrenches, turn the inner nut counter-clockwise and the outer nut clockwise simultaneously to bind the two nuts together on the stud.

Binding the nuts together with the washer in between

8. Install the stud into the tapped hole using the outer nut to engage the wrench. Continue turning the nut clockwise until the stud is seated at least ¾ inch (19 mm) deep in the hole.



Installing the stud into the hole in the manhole rim

9. Separate the nuts, and turn the inner nut until it is flush against the rim.

10. Slide the washer against the inner nut, and turn the outer nut toward the edge of the stud.

Positioning the nuts on the stud to receive the mounting bracket

11. Mount the bottom of the mounting bracket onto the monitor flange with two 3/8- x 2-inch (8- × 50-mm) bolts and nuts. It may be necessary to drill new holes in the flange.
12. Carefully lower the monitor into the manhole, and place the keyhole in the bracket over the outer nut on the stud.

Note: ADS strongly recommends attaching a security line to the monitor before lowering it into the manhole to prevent the monitor from accidentally dropping down the manhole during installation.

13. Slide the bracket against the inner nut and washer, and tighten and secure the outer nut against the bracket.
14. Neatly coil and secure the excess sensor and telephone cables in the manhole to simplify future monitor service activities. Secure the cables to plastic anchors or anchor bolts using 14-inch (35-mm) cable ties.

Note: Be careful to avoid damaging the sensor cables during installation activities. Even small pinholes in the cable can cause a sensor to malfunction or fail.

Securing the Sensor Cables

The following sections address securing the sensor cables to the ring (or band), pipe, and manhole.

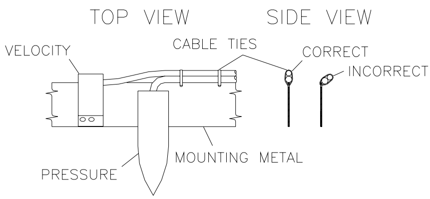
Securing the Cables to the Ring (or Band)

Securing the Doppler velocity sensor and pressure depth sensor cables to the ring (or band, when applicable) helps prevent debris from collecting between the cable and the ring or catching on the loose cable. It also prevents the loose cables from disrupting the flow.

Secure the Doppler velocity and pressure depth sensor cables in the following way:

1. Starting at the appropriate sensor location, begin securing the sensor cable with 4-inch (10-cm) x 0.08-inch (2-mm) cable ties through the pre-drilled holes along the downstream trailing edge of the ring up the side of the ring. Run the cable up the side of the ring opposite the spreader mechanism (the left side of the ring when facing the downstream edge of the ring).

Note: When securing both a pressure depth sensor and a Doppler velocity sensor cable to the ring, place the velocity cable on top of the pressure cable and secure both together.



Sensor cabling

2. Continue securing the cables until reaching the ultrasonic depth sensor or the top of the pipe.

3. Pull the ties until they are taut, and cut off the excess portion of the cable ties.

> **Warning:** *Do not overtighten the cable ties or kink the sensor cables!* The pressure depth cable sheathes two components: the electrical cables that operate the sensor and an air tube that ventilates the sensor. Overtightening the ties or kinking the cable can damage or restrict the air tube, causing incorrect pressure depth readings. In addition, make sure the connector-end of the sensor is not kinked, does not contain moisture, and includes an attached dryer tube filled with active *blue* desiccant.

Securing the Cables in the Pipe and Manhole

Securing the sensor cables from the ring (or band, when applicable), along the pipe crown, and up the manhole helps prevent debris from collecting on sagging cables or between the cables and the pipe crown. However, rings or bands installed within 36 inches (91 cm) of the manhole may not require securing the cable along the pipe crown. Secure the cables along the pipe crown under any of the following conditions:

- Rings (or bands) installed more than 36 inches (91 cm) from the manhole
- Cables sagging down from the pipe crown
- Cables may capture debris during deep flows

Secure the cables from the ring (or band) to the monitor location in the manhole in the following way:

1. Neatly bundle the cables together with an 8-inch (20 cm) by 0.14-inch (0.4 mm) cable tie attached to a plastic anchor installed at the top of the pipe.

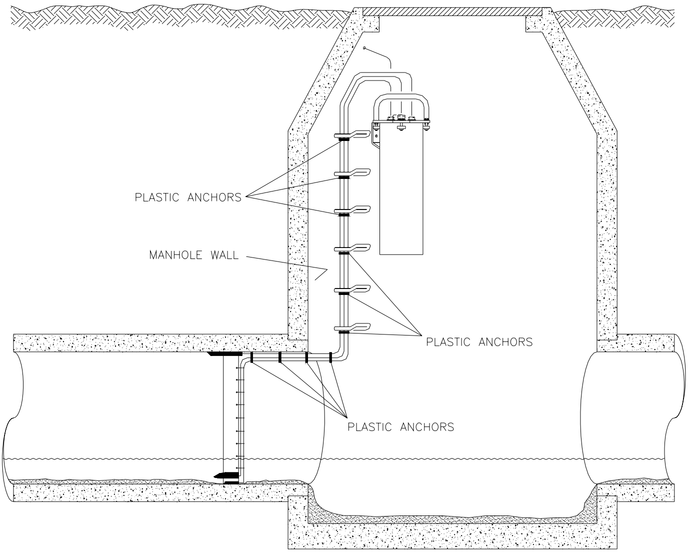
   - ❑ Drill a 3/8-inch hole in the pipe crown.

- ❑ Drive the plastic anchor into the pipe with a hammer until flush and secure.
- ❑ Run the cable tie through the loop in the plastic anchor and around the cables.
- ❑ Tighten the cable tie around the cables, and cut off the excess cable tie material.

Warning: Overtightening the cable ties may damage the sensor cables.

2. Secure the cables with a cable tie and plastic anchor every 18 to 24 inches (46 to 61 cm) along the pipe crown (when necessary) from the ring to the manhole.

3. Secure the cables every 18 to 24 inches (46 to 61 cm) up the side of the manhole to the monitor location. Loose cables could present a manhole safety hazard or increase the potential for sensor or monitor damage to occur.



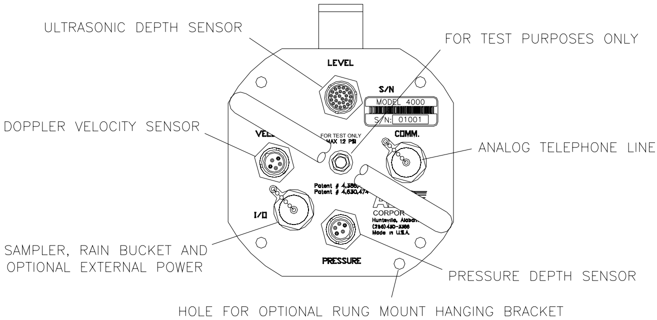
Securing the sensors cables along the pipe and into the manhole

Connecting the Sensors to the Monitor

After attaching the sensors to the ring, connect the sensor cables to the appropriate ports on the top of the monitor. The ports are labeled to identify the appropriate connection for each sensor.

Connect the sensor cables to the monitor ports in the following way:

1. Place the monitor in an upright position to view the monitor connector ports.



Cable connector ports

2. Visually inspect each sensor connector and monitor connector port for damaged or broken pins. Replace a monitor or sensor with defective ports or connectors.

3. Visually inspect each sensor and monitor connector port for debris and moisture. Clean off any debris, and dry any surface moisture. Compressed air is useful for removing moisture from the inside of the connectors or ports (pin and socket surfaces).

4. Verify that the waterproof seal is present inside each connector port. The bright orange, rubber seal should sit at the bottom of the connector port with the pins protruding through the seal.

5. Connect each sensor cable to the appropriate port. Tighten each connector in a clockwise direction until it clicks, and verify that it is seated correctly. While the Doppler velocity sensor and pressure depth sensor have identical pin configurations, they are *not* interchangeable when connecting to the monitor. Therefore, be careful to connect the sensors to their *assigned* ports on the monitor. The monitor will not operate properly if these sensors are interchanged.
6. Seal any unused connectors with a cap.

CHAPTER 4

Communication and Activation

After installing the sensors in the pipe and connecting the sensors to the monitor, it is necessary to establish communication with the monitor (through telemetry or the direct modem interface) and activate the monitor. This chapter contains instructions on establishing telephone service at the monitor location for communicating with the monitor from a remote location and using the direct modem interface (DMI) cable to communicate with the monitor at on site. It also includes basic information concerning monitor activation.

> **Note:** Manhole and sewer system work involves confined space entry and is inherently dangerous. Therefore, installers and technicians must comply with all federal, state, and municipal regulations concerning confined space entry. ADS® is not responsible for any injuries, damages, claims, or liability resulting directly or indirectly from the use of this installation guide or the installation of any ADS equipment.

Providing Telephone Service

Providing telephone service to the monitor involves the following steps:

- Running the telephone cable between the monitor and service locations
- Mounting the lightning protection module
- Preparing the telephone cable
- Wiring the telephone cable to the monitor
- Wiring the telephone cable to the lightning protection module
- Wiring the lightning protection module to the network interface box

Warning: To avoid possible shock, make all connections to the monitor before wiring to the lightning protection module and the telephone company's network interface box.

Running the Telephone Cable Between the Monitor and Service Locations

The first step in establishing telephone service involves running the telephone cable between the monitor and service locations. However, before this can occur, the installer must evaluate the most suitable location for the service pedestal and the most appropriate route for running the cable. Pedestal location and cable route evaluation criteria may include issues such as the monitor's location in relation to the closest service pole or pedestal, existing landscape, utilities present, and excavation costs.

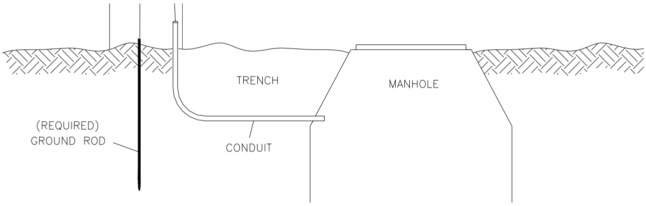
Note: For more information on determining the most suitable pedestal location and cable route, consult your ADS® representative.

In addition, notify the local underground utilities locating service concerning the desired pedestal location and cable route. Typically, notification must occur 2 to 3 days before excavation activities are scheduled to begin.

After finalizing the pedestal location and cable route, run the telephone cable between the monitor location and the designated pedestal location in the following way:

1. Excavate a trench at least 12 inches deep from the designated telephone service pedestal location to the monitor location. Consult the local regulations to verify the required trench depth for the area.
2. Drill a hole in the corbel (structural foundation holding the manhole cover) of the manhole large enough to accommodate the diameter of ¾-inch electrical conduit plus an extra ½ inch.
3. Run the telephone cable from the monitor location in the manhole to the telephone service pedestal location through ¾-inch electrical conduit. Consider the following parameters and recommendations when running the cable:
   - Use four-conductor Belden® cable.
   - Do *not* use plumbing conduit or water fittings.
   - Run the telephone cable through the conduit one section at a time as you lay the conduit in the trench and connect the sections of conduit together. When necessary, use fish tape to feed the telephone cable through the conduit.
   - Provide enough slack in the cable at the manhole end to allow removal of the monitor from the manhole during service activities.
   - Provide approximately 12 to 15 inches of excess cabling at the telephone service pedestal.
   - Create a drip loop for any wires or cables that may be subject to condensation to prevent moisture from entering the electrical or telephone boxes.
   - Extend the conduit through the hole in the corbel of the manhole at the monitor location.

- ❑ Extend the conduit approximately 12 inches vertically out of the trench (from the ground surface) at the designated pedestal location.



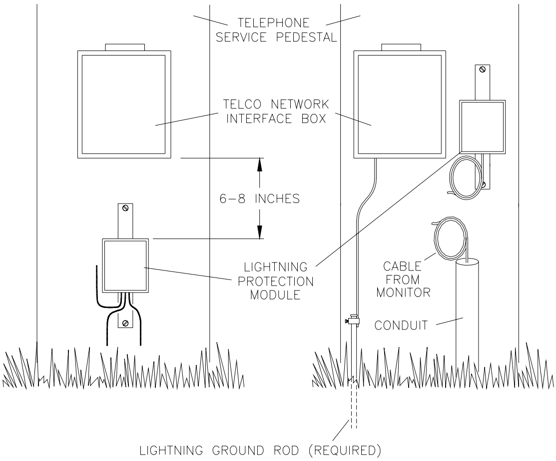
Running conduit from the telephone service location to the manhole

4. Use urethane foam to seal the space between the conduit and the corbel to prevent infiltration into the manhole.
5. Use urethane foam or a weatherhead to form a seal between the telephone cable and conduit at each end of the conduit. This will prevent sewer gases from entering the telephone service pedestal, moisture from entering the conduit during a surcharge, and inflow from entering the manhole.
6. Backfill the trench, and restore the landscape as necessary.
7. Install a service pedestal at the designated location based on the manufacturer's instructions.
8. Make sure the telephone company installs a network interface box inside the pedestal.
9. Make sure a ground rod (stake) is buried inside the pedestal. This rod is critical to ensuring proper lightning protection. If one does not exist, bury an 8-foot copper-coated steel rod vertically into the ground inside the pedestal until it is completely submerged. Refer to the National Fire Protection Association (NFPA) Standard 70 National Electrical Code (NEC) Article 250 for detailed instructions on proper grounding when an 8-foot vertical depth is not available.

Mounting the Lightning Protection Module

The next step in establishing telephone service is mounting the lightning protection module to the service pedestal. Mount the module in the following way:

1. Remove the front cover from the pedestal.
2. Use the screws included with the lightning protection module to mount the module on the pedestal at *least* 12 inches (30 cm) above the ground surface and next to or 6 to 8 inches (15 to 20 cm) below the network interface box.



Positioning of the lightning protection module and network interface box in the pedestal

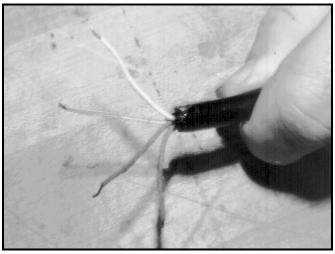
Preparing the Telephone Cable

The next step in establishing telephone service is preparing the telephone cable for connection to the monitor and lightning protection module. Prepare the cable in the following way:

1. Carefully strip about 3 inches of the external insulation from each end of the telephone cable.

Stripping the external insulation from the telephone cable

2. Remove the internal braiding, and separate the four insulated wires.

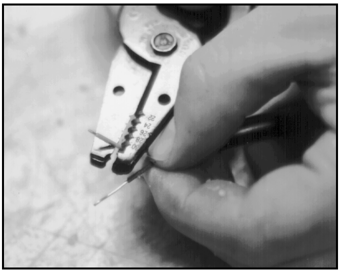


Separating the insulated wires

3. Cut off both the black and white wires down to the level of the external insulation. These wires will not be used in this application.

Note: The wire colors referenced in this manual are based on the telephone cable recommended for use in these applications. However, the wires inside some telephone cables may vary in color and number. Therefore, when the actual wire colors and number differ from those designated in this manual, connect the available wiring in reference to ground, ring, and tip.

4. Strip ½ inch (13 mm) of insulation from the remaining wires.



Stripping ½ inch (13 mm) of insulation from each wire

5. At the *pedestal* end of the cable, fold over both exposed wires (doubling the thickness). Insert each wire into an uninsulated #10 ring terminal lug (22-18 gauge), and crimp the wires to the lugs.

Wiring the Telephone Cable to the Monitor

After preparing the telephone cable, wire the telephone cable to the monitor in the following way:

1. Seat the mating telephone connector onto the communications port (**COMM.**) on top of the monitor.

2. Insert the telephone cable through the plastic potting collar past the loose wires.

Inserting the telephone cable through the plastic potting

3. Apply solder to the end of each wire by heating the wire with a soldering iron and contacting the wire with the solder. This will cause the solder to flow onto the heated wire.

Applying solder to the wire ends

4. Fill the wire sockets on the connector labeled A and D with solder by heating each socket with the soldering iron and

contacting the socket with the solder. This will cause the solder to flow into the socket.

Filling the wire sockets in the connector with solder

5. Heat the socket until the solder inside melts, and then insert the wire into the socket:

   - ❑ Insert the *red* wire into socket *A* (tip)
   - ❑ Insert the *green* wire into socket *D* (ring)

Soldering the wires to the designated sockets

6. Wrap the exposed wire ends with small pieces of plastic or tape to prevent a possible short from occurring if they contact during the potting process.
7. Slide the plastic potting collar over the soldered wires, and secure the collar onto the threaded portion of the metal connector.

Sliding the potting collar over the soldered wires

Note: Consider wrapping tape around the joint where the plastic collar and moveable metal locking collar meet for protection against resin that may spill during the process.

8. Mix the epoxy compound to pot the connector. Cold weather conditions may prevent the epoxy from curing properly. If this occurs, mix the epoxy in the vehicle.
9. Centering the telephone cable in the plastic collar, pour the epoxy compound into the collar.
   - ❑ Pour slowly to avoid air pockets.
   - ❑ Pour in only a little at a time to allow the resin time to flow around the wires and completely fill the connector.

Note: The final potted connector should have a bead of resin rising slightly above the top of the collar, appearing slightly overfilled.

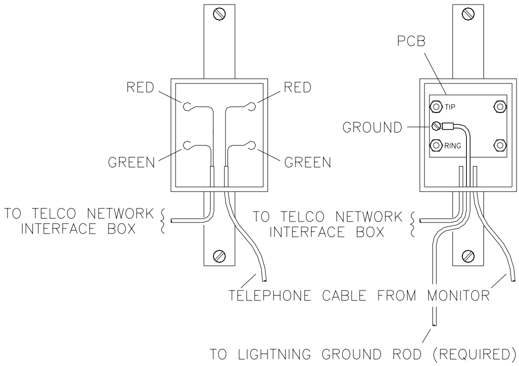
10. Use 3M™ Linerless Rubber Splicing Tape to secure the cable to prevent it from moving during the curing process. Wrap the tape around the entire connector/cable assembly and about 1 inch (25 mm) up the telephone cable beyond the assembly.

Note: Support the telephone cable during the curing process by running a cable tie between the telephone cable and the monitor flange. Curing typically requires about 25 minutes. However, colder temperatures can extend that time up to 2 hours.

Wiring the Telephone Cable to the Lightning Protection Module

Next, wire the telephone cable to the lightning protection module in the following way:

1. Open the front cover of the lighting protection module, and remove the nuts, washers, and card from the posts inside the module. Leave only the bottom-most nut on each post.
2. Slice a hole in the grommet in the bottom of the module, and run the telephone cable up through the grommet into the module.
3. Place the lugs for the following wires onto the designated posts, and then re-place a washer and nut onto each post:
   - ❑ Red wire to Telco network interface — Top left post (tip)
   - ❑ Green wire to Telco network interface — Bottom left post (ring)
   - ❑ Red wire from monitor — Top right post (tip)
   - ❑ Green wire from monitor — Bottom right post (ring)



Lightning protection module wiring diagram

Note: Remember, the wire colors referenced in this manual are based on the telephone cable ADS recommends for these applications. However, the wires inside some telephone cables may vary in color and number. Therefore, when the actual wire colors and number differ from those designated in this manual, connect the available wiring in reference to ground, ring, and tip.

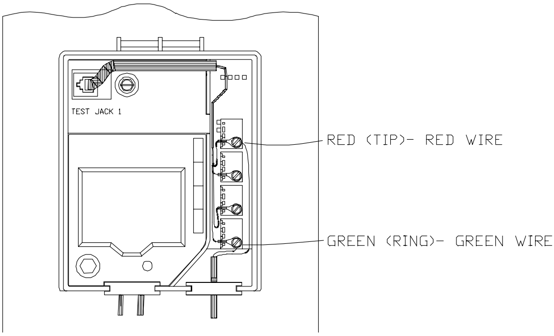
4. Run the two wires (secured to the posts on the left) down and out through the grommet in the bottom of the module.
5. Place a washer onto each post, and replace the card.
6. Securely tighten a washer and nut onto each post over the card.
7. Make sure the ground wire (included with the lightning protection module) is secured at the designated location on the front left side of the card, and run the wire down through the bottom grommet of the module.
8. Close and secure the front cover of the module.
9. Cut ½ inch (13 mm) of insulation from the loose end of the black ground wire running from the lightning protection module.

10. Clamp the exposed wire to the ground rod protruding from the ground inside the pedestal or to the telephone company's existing ground wire (when properly connected to the ground rod).

Wiring the Lightning Protection Module to the Network Interface Box

The final step in establishing telephone service is wiring the lightning protection module to the telephone company’s network interface box. Accomplish this task in the following way:

1. Open the front cover of the telephone company's network interface box, and temporarily disconnect the test plug. Opening some network interface boxes may require a special tool available only through the telephone company.
2. Remove 3 inch (7.6 cm) of insulation from the lightning protection module service cable to expose the four insulated wires.
3. Cut off the black and yellow wires (running from the lightning protection module) down to the level of the external insulation.
4. Strip ½ inch of insulation from the green and red wires.
5. Slice a hole in the rubber grommet in the bottom of the network interface box (when necessary), and run the wires up through the grommet into the box.
6. Loosen the screws for tip and ring in the network interface box. Wrap the following wires around the designated posts and then re-tighten the screws until snug:
   - ❑ Red wire — tip
   - ❑ Green wire — ring



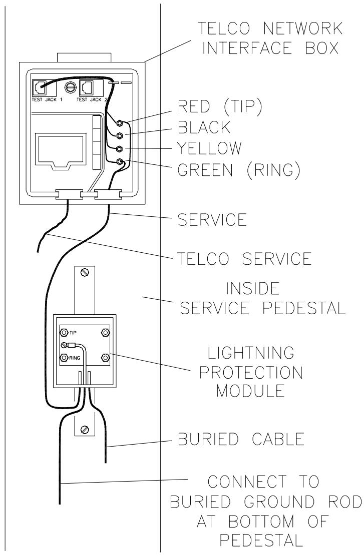
Wiring diagram of telephone company network interface box

Note: Since the colors inside some boxes vary, this manual does not reference colored posts for connection. The installer should connect the wires to the posts in reference to ring and tip.

7. Use urethane foam to seal the space between the telephone cable coming from the manhole and the conduit. This prevents sewer gases from traveling through the conduit from the manhole into the pedestal. These gases could produce a potentially explosive environment inside the service pedestal.

8. Re-connect the test plug.

9. Close and secure the cover of the network interface box.

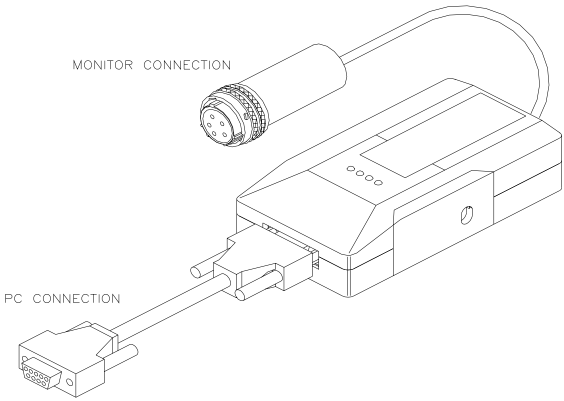


Complete wiring diagram

Using the Direct Modem (DMI) Cable

Communicating with the monitor on site requires the direct modem interface (DMI) cable and a field computer running the **FieldScan**™ software. Equipped with an inline modem, the DMI cable provides direct communication between the user and the monitor without the need of telemetry.

To use the DMI cable for performing on-site communication, connect the cable's DB-9 connector to the field computer's serial communication port and the other end to the monitor's communication port. Refer to the *Direct Modem Interface (DMI) Operating Instructions* (#3506AI0050) and the *FieldScan User's Guide* (#950021**) for detailed information concerning power options and serial port assignment in **FieldScan**.



Direct Modem Interface (DMI) cable

Activating and Confirming the Monitor

After installing the monitor, *activate* and *confirm* the monitor to initiate the data collection process. Activation involves using the **FieldScan** software to download the BASIC code, configuration information, and other parameters to the monitor. The monitor requires these files and information to properly measure the flow.

Activating the monitor also tests communication between the user's computer and the monitor. To test communication, connect to the monitor on site (using the DMI cable) or have an analyst call the monitor from any telephone or computer at a remote location while a technician is on site to verify that the monitor modem responds. This also will verify the monitor telephone number entered in **FieldScan**.

Confirming the monitor involves comparing manual flow depth and velocity measurements taken in the field against monitor readings taken electronically to verify the accuracy of the data. The technician or analyst confirms the accuracy of the data based on the difference between the monitor and field readings.

Refer to the *FieldScan User's Guide* for detailed instructions on installing the software, collecting monitor data, and configuring, activating, and confirming the monitor.

CHAPTER 5

Maintenance and Troubleshooting

While the ADS Model 4000™ flow monitor and sensors are designed for dependability and durability, all electronic devices are vulnerable to wear, malfunction, or failure, particularly in a harsh sewer environment. However, many system problems can be avoided altogether by performing routine maintenance and inspections. The design of the monitor enables the user to perform general diagnostics and troubleshooting to prevent, isolate, and correct many problems easily. These serve to minimize unnecessary monitor downtime and data loss.

This chapter provides routine maintenance instructions as well as general diagnostic and troubleshooting guidelines for isolating and correcting monitoring system problems.

> **Warning:** Remove the monitor from the manhole before replacing the battery pack or performing service activities which may involve disconnecting cables from the monitor. In addition, disconnect telephone service at the network interface box before disconnecting cables from the monitor lid and disconnect the battery inside the monitor before replacing boards or cables inside the monitor. These activities help prevent possible shock or injury to personnel as well as damage to the equipment during service visits at the monitor location.

Maintaining the System Components

The 4000 flow monitor and sensors should receive routine on-site inspections and remote confidence checks to maintain the equipment in optimal working condition, minimize monitor downtime, and prevent possible data loss.

ADS® recommends performing these inspections following initial system installation, during site visits, and on a scheduled interval (i.e., quarterly or during battery replacement).

Inspecting the Monitor

Perform the following inspections during site visits or from a remote location (when applicable):

- Inspect the monitor mounting bracket to verify that the bracket and bolts are free of heavy corrosion and the bolts are tightened and secure.
- Verify that the four bolts holding the monitor together are snug, and tighten any loose the bolts.
- Verify that the monitor is mounted securely in the manhole.
- Inspect the monitor for general integrity. Verify that nothing more than surface corrosion is present and that the monitor has no obvious mechanical defects. Replace the monitor if necessary.
- Perform monitor data confirmations. These should occur from a remote location when telephone communication is available.
- Review the applicable logs in **Profile®** or **FieldScan™** to verify the status of the monitor clock, communications, BASIC code, battery pack, and temperatures.

Confirming the Monitor

Confirm the accuracy of the sensor subsystems in the monitor on a regular basis. Confirmation involves comparing manually-measured depth of flow and velocity readings to the monitor's readings. This process also verifies sensor calibrations. Refer to the *FieldScan User's Guide* (#950021**) for detailed information on confirmation procedures.

Opening the Monitor Enclosure

Removing the monitor chassis during battery or board swaps increases the risk of damaging internal components or introducing debris or moisture to the monitor electronics. Make every effort to prevent water, dirt, and debris from contacting the monitor's internal components during routine maintenance or part replacement.

The chassis includes a special Velcro® strap for securing the chassis cables within the enclosure to prevent damage or pinching between the monitor top and enclosure. Inspect the strap whenever you open the monitor to replace the batteries, and always replace this strap following board swaps.

Replacing the Battery Pack

Check the battery voltage using **FieldScan** before installing the monitor and after collecting data. The projected life for the battery pack is 365 days at a 15-minute sample rate. However, replace the battery pack as soon as possible whenever the voltage reads below 8.0 volts or **FieldScan** or **Profile** provides a **Low** battery status.

> **Warning:** A dead battery will prevent communication with and data collection from the monitor.

Refer to the *FieldScan User's Guide* (#950021**) for instructions on requesting the battery voltage and status.

Replace the battery pack in the following way:

1. Collect data from the monitor.

2. Loosen bolts and remove the monitor lid with chassis from the aluminum canister.

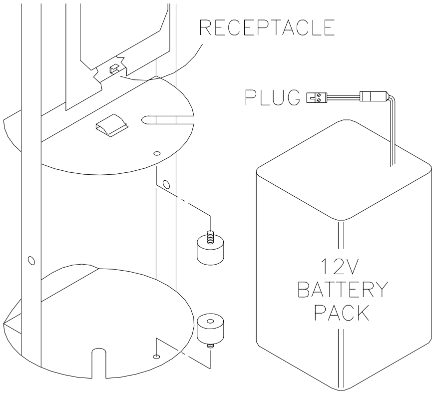
3. Remove the cables ties securing the battery pack, and unscrew the rubber stops holding the battery pack in place.

4. Disconnect the orange connector (attached to the cable running from the battery pack) from the processor board (P6).

5. Remove the battery pack from the chassis.

6. Place the new battery pack into the chassis, and replace the rubber stops. Press the stops against the battery pack to ensure proper installation.

7. Connect the orange connector from the battery pack to the processor board (P6 connector).



Replacing the battery pack in the monitor

Note: A green light on the processor board will flicker on and off upon connection.

8. Have an analyst call the monitor or connect to the monitor on site to verify communication.

9. Carefully replace the monitor chassis into the enclosure, and torque down the bolts securing the chassis to the enclosure to 35 inch pounds (+/- 5 inch pounds).

Checking the Sensors

Perform the following sensor inspections during regular site visits:

- Verify that the installation ring or bands are secure and clear of debris.
- Clean the face of the ultrasonic sensor gently with a soft brush saturated with rubbing alcohol, and wipe the sensor with a clean, moist cloth.
- Verify that the face of the ultrasonic depth sensor is horizontally level with the flow. Reposition, if necessary, according to the procedures in Chapter 3.
- Scrub the pressure sensor and face of the velocity sensor with a soft brush saturated with rubbing alcohol.
- Confirm that all sensor cables are neatly arranged, securely fastened, and free of debris, cuts, and breaks that may affect performance. Replace sensors that exhibit damaged cables.
- Replace the desiccant in the pressure depth sensor's dryer tube on a regular basis. Make sure the desiccant is still blue. Pink desiccant indicates that it will no longer absorb moisture. If it appears pink upon inspection, replace the desiccant immediately in the following way:
    - ❑ Unscrew the middle of the dryer assembly.
    - ❑ Remove and save the used desiccant.
    - ❑ Refill the dryer tube with new desiccant.
    - ❑ Monitor pressure depth sensor performance for a while to ensure no damage to the sensor electronics has occurred.

Note: Replacing desiccant quarterly may be sufficient; however, replace it more frequently when necessary.

Checking Communication Devices

Inspect the following communication devices during site visits:

- **Lightning Protection Module** Check the lightning protection module for lightning strikes, damaged or poor connections, or corrosion. Replace a burned out module, and repair any bad or corroded connections in the wiring.
- **Network Interface Box** If any problems exist with the network interface box, check the connectors to ensure that the cable entries are tight and waterproof. If this does not resolve the problem, contact the telephone company.

Note: Make sure both the lightning protection module and network interface box are still waterproof.

Troubleshooting

The 4000 flow monitoring system contains several different components that perform many different functions. Since a malfunctioning component increases the risk of losing data, isolating the part containing the problem quickly is essential to performing troubleshooting activities efficiently. Minimizing monitor downtime is critical.

Consider the following when trying to isolate the component or subsystem exhibiting the problem:

- Problems affecting only one of the sensor subsystems are usually caused by one subsystem alone. The problem may exist in the board, sensor (or other input device), or cabling.
- Problems affecting more than one subsystem usually can be traced to a problem with the processor board, power source, or communication lines. Problems in one subsystem can create problems in other subsystems when the power source or communication lines are faulty.
- Problems with communication lines, clock readings, time stamps, and data storage intervals usually arise from faulty processor boards, incorrect information entered on the user's PC, or low batteries.
- Failures occurring outside a connector (i.e., between a connector and the field input or output device) may arise from problems with the field unit or component cabling. Failures occurring on the *inside* (i.e., between a connector and the printed circuit boards) may arise from problems with boards or their cabling.

Note: If possible, collect all monitor data prior to swapping sensors or troubleshooting a monitor to prevent possible data loss. Swapping sensors or batteries does *not* result in stored data loss. In addition, remove the monitor from the manhole before disconnecting cables from the monitor to avoid possible hazards.

Some problems that occur will not require a site visit, such as incorrect equipment identification numbers or other system parameters the user can re-enter on the local PC. However, many problems will require a site visit. When this is necessary, inform the data analyst any time a field crew is en route to a monitor site to troubleshoot problems so that the analyst can attempt to collect the monitor data before they arrive. If the problem is a faulty monitor and the analyst cannot collect the data remotely, replace the monitor and deliver the faulty monitor to the office so the analyst can attempt to collect the data directly. Then, send the monitor to ADS® for repair.

This chapter provides general guidelines for troubleshooting and correcting problems with the 4000 monitor and sensor subsystem.

General Monitor Problems

The following tables contain general troubleshooting techniques for the ADS Model 4000 flow monitor.

Problem	Monitor does not answer a telephone call.
Possible Causes	Telephone connection at monitor may be damaged, loose, or leaking. Telephone cable may be noisy, damaged, or dead. Lightning protection module may be damaged. Battery pack may be dead or below minimum voltage requirement (8.0 volts). Monitor may be defective. Lightning protection board in monitor may be defective. Modem in monitor may be defective. Modem in office or field computer may be defective.
Possible Solutions	Make sure phone cable connection at monitor base is secure and dry. Check telephone cable for damage. Use voltmeter to check voltage on telephone cable and at lightning protection module. Voltage should be approximately 48 Vdc on hook. Replace 12-volt battery pack if below 8.0 volts. Attempt to direct connect to monitor. Contact telephone company for repair if noise, no tone, or constant busy signal occurs at network interface box.

Problem	Busy signal occurs when calling the monitor.
Possible Causes	Someone else may be communicating with monitor. Telephone cable may be damaged. Lightning protection module may be damaged. Telephone cable may have shorted. Lightning protection board in monitor may be damaged. Modem in monitor may be damaged.
Possible Solutions	Wait a few minutes, and attempt to communicate with monitor again. Connect at the site using the DMI cable, and try to communicate with monitor. Use voltmeter to check voltage on telephone cable. Voltage should be approximately 48 Vdc on hook. If it is not, disconnect phone line at the lightning protection module and check the voltage at the network interface box. Make sure telephone cable is not damaged or severed, and repair or replace cable if necessary. Check telephone connector for moisture.

Problem	Monitor establishes a connection, but does not respond to any message.
Possible Causes	User may have entered incorrect identification information. Cabling may be loose. Lightning protection board in monitor may be damaged. Modem in monitor may be faulty.
Possible Solutions	Verify the identification information (monitor serial number, telephone number, etc.) and correct if necessary. Listen for noise at the site using a field phone. If noise is present, inspect the wirings and replace wiring if necessary. Replace the lightning protection board or module. Contact telephone company. Collect the data from the monitor on site using the DMI cable, and replace the modem. Contact your regional ADS representative.

Problem	Time stamp on the collected data is incorrect.
Possible Causes	Monitor clock may be faulty. 12-volt battery pack may be low. PC clock may read incorrect time.
Possible Solutions	Verify the time on the PC clock and correct if necessary. Replace 12-volt battery pack. Reactivate the monitor to enable the clock. Collect the data from the monitor and replace monitor.

Problem	Time on the monitor clock is incorrect.
Possible Causes	Monitor clock may be a faulty. PC clock may read incorrect time.
Possible Solutions	Verify the time on the PC clock and correct if necessary. Reactivate the monitor to enable the clock. Collect the data from the monitor and replace monitor.

Problem	You receive a **Device Time Out** message in **FieldScan**.
Possible Cause	Depth or velocity board may be faulty.
Possible Solutions	Re-attempt communication with monitor. Contact your regional ADS representative.

Problem	Gap exists within the collected data.
Possible Cause	Monitor time may be incorrect. Monitor basic code or variable file may be corrupt.
Possible Solutions	Check monitor time, and reset clock if necessary. Attempt to collect data within the gap. Contact your regional ADS representative.

Problem	Data is missing at the beginning or end of the date range following data collection.
Possible Causes	Monitor activation may have failed. Monitor time may be incorrect. Monitor's basic code or variable file may be corrupt.
Possible Solutions	Verify whether the monitor has been activated, and activate if necessary. Check monitor time, and reset clock if necessary. Run diagnostics in **FieldScan** to verify whether a basic code problem may exist. Contact your regional ADS representative.

Problem	An I/O error message displays when communicating with the monitor.
Possible Cause	Processor board, depth board, or velocity board may be faulty.
Possible Solutions	Re-attempt communication with the monitor. Contact your regional ADS representative.

Ultrasonic Depth Subsystem

The following tables contain general troubleshooting techniques for problems with the ultrasonic depth subsystem.

> **Note:** Contact a trained ADS technician for further diagnosis prior to replacing a sensor.

Problem	Range from ultrasonic depth subsystem is slightly inconsistent with manually measured range.
Possible Causes	Electronic or physical offset(s) may be incorrect. Pipe height may be incorrect.
Possible Solutions	Verify the electronic and physical offsets, and adjust offsets if necessary. Verify the pipe height. Adjust the electronic offset(s).

Problem	Range from ultrasonic depth subsystem is significantly greater than manually measured range.
Possible Causes	Electronic or physical offset(s) may be incorrect. Pipe height may be incorrect. Ultrasonic depth sensor may not be receiving an echo because the pulse command parameter is too small. Sensor may not be level. Foam or other substance may be absorbing the pulse. Sensor may be faulty.
Possible Solutions	Verify the electronic and physical offsets. Verify the pipe height. Verify the pulse command parameter is set properly. It should be 4 for ultrasonic and 8 for Smart Depth. Make sure the sensor is level and in good condition. Check the hydraulic conditions in the pipe. Fire the ultrasonic depth sensor at a shorter distance onto a hard surface to confirm accuracy. Contact a trained ADS technician.

Problem	Range from the ultrasonic depth subsystem is too short (but not zero).
Possible Causes	Electronic or physical offset(s) may be incorrect. Pipe height may be incorrect. Ultrasonic depth sensor may be dirty. Pulse Command and Spare 2 Delay parameters may not be adjusted properly. Ultrasonic depth sensor may be faulty.
Possible Solutions	Verify the electronic and physical offsets. Verify the pipe height. Clean the ultrasonic depth sensor. Verify the pulse command and spare 2 delay parameters. The pulse command should be 4 for ultrasonic and 8 for smart depth, and the spare 2 delay should be 1 for both devices. Contact a trained ADS technician. Replace the ultrasonic depth sensor. Contact your regional ADS representative.

Problem	Raw ultrasonic depth data shows depths greater than the pipe diameter.
Possible Causes	Electronic or physical offsets may be incorrect. Pipe height may be incorrect. Pipe may be surcharged. Ultrasonic depth sensor may be dirty. Ultrasonic depth sensor may be faulty.
Possible Solutions	Verify the physical and electronic offsets. Verify the pipe height. Clean the ultrasonic depth sensor. Contact a trained ADS technician. Replace the ultrasonic depth sensor. Replace the depth board.

Problem	Depth data indicates a surcharged pipe, but the pipe is free flowing.
Possible Causes	Electronic or physical offsets may be incorrect. Pipe height may be incorrect. Ultrasonic depth sensor may be dirty. Ultrasonic depth sensor may be faulty. Depth board may be faulty.
Possible Solutions	Verify the electronic and physical offsets. Verify the pipe height. Clean the ultrasonic depth sensor. Contact a trained ADS technician. Replace the ultrasonic depth sensor. Replace the depth board.

Problem	Ultrasonic depth readings are erratic.
Possible Causes	Noise may exist in the sewer pipe. Ultrasonic depth sensor may be dirty. Flow may be choppy or foamy. Ultrasonic depth sensor may not be level. Pulse command and spare 2 delay parameters may be set too low for the pipe.
Possible Solutions	Check the flow conditions. Clean the ultrasonic depth sensor. Check the level of the ultrasonic depth sensor. Review and adjust the pulse command and spare 2 delay parameters.

Problem	Less than six good pairs are received when firing the ultrasonic depth sensor.
Possible Causes	Ultrasonic depth sensor may be dirty. Ultrasonic depth sensor may be faulty. Depth board may be faulty.
Possible Solutions	Clean the ultrasonic sensor. For less than four good sensor pairs, contact a trained ADS technician. Replace the ultrasonic depth sensor. Replace the depth board.

Problem	Ultrasonic depth sensor reports two abnormal temperatures.
Possible Causes	Ultrasonic depth sensor connection to monitor may be loose. Both temperature sensors may be faulty. Ultrasonic depth sensor may be faulty.
Possible Solutions	Secure ultrasonic depth sensor connection to monitor (if necessary). Replace the ultrasonic depth sensor. Replace the depth board.

Doppler Velocity Subsystem

The following tables contain general troubleshooting techniques for the Doppler velocity subsystem.

> **Note:** Contact a trained ADS technician for further diagnosis prior to replacing a sensor.

Problem	Monitor often provides a velocity reading of 0.
Possible Causes	Doppler velocity sensor may be dirty or broken. Cabling between the velocity board and the velocity sensor may be bad. Velocity board may be faulty. Velocity parameters may require adjustment.
Possible Solutions	Clean the velocity sensor. Check the velocity parameters. Consider increasing the maximum carrier parameter. Inspect the velocity sensor cables for tightness. Check for moisture in the connector. Contact a trained ADS technician. Replace the velocity sensor. Replace the velocity board.

Problem	Velocity data does not fluctuate much (but is not 0).
Possible Cause	Doppler velocity sensor may be dirty Velocity sensor may be broken.
Possible Solutions	Clean the velocity sensor. Check the velocity sensor connections. Check the velocity parameters. Contact a trained ADS technician. Replace the velocity sensor. Replace the velocity board.

Problem	Velocity data seems erratic.
Possible Causes	Velocity sensor may be dirty. Velocity sensor may be faulty. Velocity board may be faulty.
Possible Solutions	Clean the velocity sensor. Check the sensor connections. Check the velocity parameters. Contact a trained ADS technician. Replace the velocity sensor. Replace the velocity board.

Problem	Velocity readings are abnormally high.
Possible Causes	Wires on the P2 connector may be loose. Doppler velocity sensor may be covered with silt. Velocity sensor may be out of the flow. Flow may be reversed or slower than 0.5 ft/s (0.15 m/s).
Possible Solutions	Check the site conditions, and relocate the velocity sensor if necessary. Replace the velocity board.

Pressure Depth Subsystem

The following tables contain general troubleshooting techniques for the pressure depth subsystem.

> **Warning:** Contact a trained ADS technician for further diagnosis before replacing a sensor.

Problem	Temperature reading from the pressure depth sensor shows a value of -273° C (-459° F).
Possible Causes	Cable connecting the pressure sensor to the monitor may be loose or broken. Pressure sensor may be faulty. Depth board is not responding or may be faulty.
Possible Solutions	Secure pressure sensor connection to monitor (if necessary). Replace the pressure sensor. Replace the depth board.

Problem	Pressure depth readings are consistently incorrect.
Possible Causes	Coefficients may be incorrect. Pressure dryer tube may not be functioning properly.
Possible Solutions	Retrieve or enter the correct coefficients, and reactivate the monitor. Inspect and replace (if necessary) desiccant in pressure dryer tube.

Problem	Pressure depth readings are consistently off by up to 3 inches (7.62 cm), but temperature readings are accurate.
Possible Cause	Monitor may be configured with an incorrect pressure sensor offset.
Possible Solution	Enter an offset to depth for consistency with confirmation readings.

Problem	Pressure depth sensor temperature readings are incorrect, but depth data is accurate.
Possible Causes	Temperature sensor may be faulty. Depth board may be faulty.
Possible Solutions	Replace the sensor. Replace the depth board.

Problem	Pressure depth sensor temperature and depth readings are erratic.
Possible Causes	Pressure sensor may be faulty. Depth board may be faulty.
Possible Solutions	Examine the pressure sensor and clean if necessary. Replace the pressure sensor. Replace the depth board.

APPENDIX A

Specifications

This appendix contains specifications for the ADS Model 4000™ flow monitor; associated processor, modem, lightning protection, and sensor boards; sensors; and lightning protection module.

ADS® 4000/4000WR Flow Monitor

The following section contains specifications for the 4000/ 4000 WR flow monitor, processor board, and modem board. All references to the modem, modem board, and lightning protection board or module apply only to the 4000. The 4000 WR does not contain a modem or lightning protection of any kind.

> **Note:** The 4000 and 4000 WR flow monitors (including all associated circuit boards and assemblies) are not intrinsically safe.

Monitor

Enclosure	Cylindrical 0.13-inch (0.30 cm) thick seamless, marine-grade aluminum with stainless steel hardware
Dimensions	20 inches (50.80 cm) long by 6.38 inches (16.21 cm) diameter
Weight	25 pounds (11.5 kg)

Operating Temperature	0° to 60° C (32° to 140° F)
Power	Primary Power: 12-volt battery pack (approximate life-span of 365 days at 15-minute sample rate) Memory Backup: 3-volt lithium battery (maintains monitor memory during primary power loss or battery swap) Secondary Backup: Battery-backed RAM (maintains monitor memory during primary power and lithium battery failure)
Connectors	U.S. MIL-C-26482 series 1 with gold-plated contacts
Inputs and Outputs	Ultrasonic depth sensor input Doppler velocity sensor input Pressure depth sensor input Sampler output/rain gauge input/external power input Communication (telemetry or DMI cable)

Processor Board

Processor	80C31 CMOS Microprocessor
Memory	EPROM: 64K bytes (program storage) RAM: 1024K bytes (battery-backed data storage)
Data Storage	365 days (1 velocity and 2 depth readings at a 15-minute sample rate)
Programming Language	BASIC
Protocol	Proprietary YAPP query-response protocol with CRC-16 error detection for modem and serial communications
Discrete Input	16-bit counter for counting external contact closures
Discrete Output	Optically-isolated, open collector programmable output

Temperature Measurement	On-board (standard) and off-board (optional) temperature sensors
Clock	Crystal-controlled, hardware clock/calendar (lithium battery backed)
Switches	8-position identification switch 8-position option switch for selecting operating parameters

Modem Board

Modem	1200 baud Hayes-compatible, non-autoanswer
Communication	1200 baud analog

Depth Subsystem

The following includes specifications for the ultrasonic depth sensor, the pressure depth sensor, and the depth board in the monitor.

Ultrasonic Depth Sensor

Housing	Marine-grade aluminum
Dimensions	7.5 inches (19.05 cm) long x 4.25 inches (10.79 cm) wide x 0.875 inches (2.22 cm) high
Accuracy	0.125 inches (0.32 cm)
Deadband	Less than 1 inch (25 mm)
Frequency	40 kHz
Range	10.0 feet (3.05 m)
Resolution	0.02 inches (0.05 cm)

Drift	0.0 inches
Cable	Standard size: 35.0 feet (10.67 m) long x 0.50 inches (1.27 cm) diameter

Pressure Depth Sensor

Enclosure	Streamlined molded epoxy
Dimensions	5.0 inches (12.7 cm) long x 1.36 inches (3.45 cm) wide x 1.0 inch (2.54 cm) high
Range	0.0 to 5.0 psi: up to 11.5 feet (3.5 m) 0.0 to 15.0 psi: up to 34.5 feet (10.5 m) 0.0 to 30.0 psi: up to 69.0 feet (21.0 m)
Accuracy	0.2% of full scale for these ranges: 0.1-5.0 psi: 0.25-11.5 feet (0.08-3.5 m) 0.1-15.0 psi: 0.25-34.5 feet (0.08-10.5 m) 1.0-30.0 psi: 2.3-69.0 feet (0.7-21.0 m)
Resolution	0.025% of full scale
Cable	Standard size: 40 feet (12.2 m) long x 0.30 inches (0.76 cm) diameter

Depth Board

Processor	80C320 CMOS microprocessor
Memory	EPROM: 64K bytes RAM: 32K bytes
Communication	UART (to communicate over a logic-level bus with the processor)

Doppler Velocity Subsystem

The following contains specifications for the Doppler velocity sensor and Doppler velocity board.

Doppler Velocity Sensor

Enclosure	Molded PVC plastic
Dimensions	2.375 inches (6.03 cm) long x 1.125 inches (2.85 cm) wide x 0.5 inches (1.27 cm) high
Range	-5.0 to 20.0 feet per second (-1.5 to 6.1 m/s)
Accuracy	0 to 5.0 feet per second (-1.5 to 1.5 m/s): 0.8% full scale 5.0 to 10.0 feet per second (1.5 to 3.0 m/s): 1.2% full scale 10.0 to 15.0 feet per second (3.0 to 4.5 m/s): 2.8% full scale
Resolution	0.04 feet per second (0.01 m/s)
Cable	Standard size: 40 feet (12.2 m) long x 0.225 inches (0.57 cm) diameter

Velocity Board

Processor	80C31 CMOS microprocessor and digital signal processor
Memory	EPROM: 64K bytes RAM: 32K bytes
Communication	UART (to communicate over a logic-level bus with the processor board)

Lightning Protection

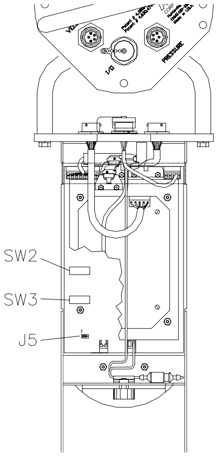
The following table contains the specifications for the lightning protection module and board.

Lightning Protection Module **(Service Location)**	Housing: Gray PVC Dimensions: 4.13 inches (10.5 cm) high x 3.25 inches (8.3 cm) wide x 1.88 inches (4.8 cm) deep Polyswitch: 600-volt 150-milliamps over-current protector Varistor: 240-volt over-voltage protector Sidactor: 280-volt over-voltage protector Ground Wire: 12 AWG black stranded Service Wire: 22 AWG 4-conductor gray unshielded
Lightning Protection Board **(Monitor Chassis)**	Varistor: 240-volt over-voltage protector Sidactor: 280-volt over-voltage protector PTC Thermistor: 265-volt 300-milliamps over-current protector Maximum Surge Current: 7 kA (8 x 20 uS) Maximum Transient Voltage: 20 kV (1.2 x 50 uS) Maximum Clamping Voltage: 100 volts @3kA Maximum Line Capacitance: 1600 pF DC Operating Current: 300mA

APPENDIX B

Switch and Jumper Settings

This appendix contains instructions for changing the ID switch, options switch, and jumper settings. ADS Model 4000™ and 4000 WR monitors are preset by the manufacturer with the correct settings; therefore, ADS® discourages opening new monitors. However, technicians must adjust these settings on a new board when a board swap occurs or on an existing board when storing the monitor. The following sections provide instructions for changing these settings.



Locations of jumpers and switches on the processor board: ID switch (SW2); Options switch (SW3), and battery backup jumper (J5)

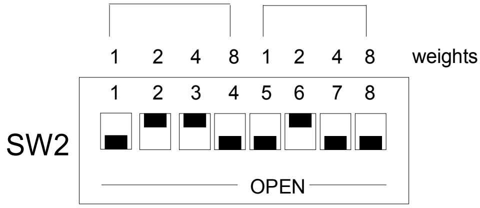
ID Switch Settings

The ID switch, designated as *SW2* on the processor board, identifies the monitor serial number. This number must be correct to ensure successful communication operations with the monitor.

The switch consists of 8 settings representing the last 2 digits of the 5-digit monitor serial number. The first 4 numbers (settings) represent the last (fifth) digit of the serial number; the last 4 numbers (settings) represent the fourth digit. Each setting has a corresponding value (weight). The sum of the weights of all settings in the closed position for the first 4 settings represents the last digit in the serial number. The sum of the weights of all settings in the closed position for the last 4 settings represents the fourth digit in the serial number.

For example, a monitor with the serial number 3526 would require the user to close (turn on) settings 2 and 3 for the last digit of the monitor serial number and setting 6 for the fourth digit of the serial number. The weights corresponding to the settings for the last digit are 2 and 4, for a sum of 6 (the last digit in the serial number). The weight corresponding to the setting for the fourth digit is 2 (the fourth digit in the serial number).

> **Note:** For SW2, closed means *on* and open means *off*.



ID switch settings for monitor serial number 35P26

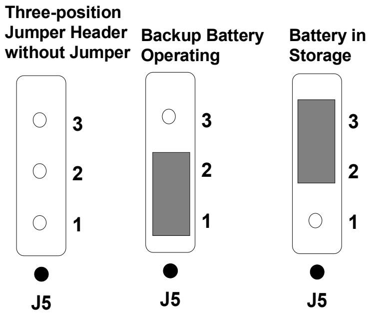
Options Switch Settings

The options switch, identified by *SW3* on the processor board, indicates the specific configuration of the monitor, including parameters such as the method of communication (modem/serial) and baud rate. For the *4000* monitor, *switch 4* is the only switch that should be in the *closed* position on the options switch. *All other switches* should remain in the *open* position. For the *4000 WR* monitor, *switches 4* through *8* should be in the closed position and *switches 1* through *3* should be in the open position.

Jumper Settings

The following figure shows the correct jumper settings for the 4000 flow monitor backup battery. If the technician disables a board and places it in storage, the technician must re-configure the backup battery prior to use.

Storing a monitor requires disabling the backup battery. To disable the backup battery, locate *Jumper 5* (three-position jumper header) and move the jumper to cover positions *2 and 3*. This disables the battery. Placing the jumper covering positions *1 and 2* initiates backup battery operation. Use the following table to disable and enable a backup battery.



Backup battery configuration and jumper position

APPENDIX C

External Power

This appendix contains instructions for converting the ADS Model 4000™ from receiving power via the internal battery pack to receiving power via an external DC power source. This conversion requires a special kit available by special order through Accusonic® Technologies (part # 3506-0023). The monitor requires a DC power source with a voltage between 9 and 14 volts at 1 amp of continuous current for proper operation.

Install the conversion kit in the following way:

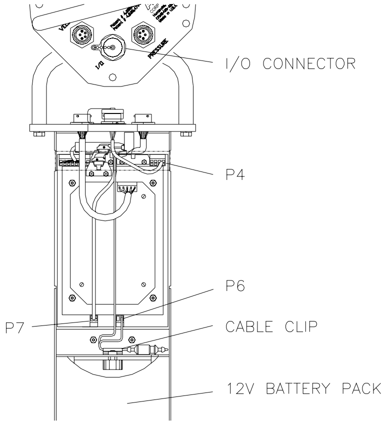
1. Remove the monitor chassis from the enclosure.
2. Unplug the 12-volt battery pack from the bottom of the processor board at P6.
3. Remove the battery pack from the monitor chassis.
4. Detach the Velcro strap located at the top of the chassis.
5. Remove the I/O chassis cable from the monitor in the following way:
   - ❑ Disconnect the cable from the top, right-hand side of the processor board at P4.
   - ❑ Disconnect the cable from the bottom, left-hand side of the processor board at P7.
6. Loosen and unscrew the chassis connector nut on top of the monitor, and completely remove the I/O connector/cable from the monitor.

7. Install the replacement I/O cable (part # 103197B) for external power into the empty I/O hole. Insert the connector up into the hole through the bottom of the monitor lid, making sure the O-ring seats properly against the chassis. Hold the connector in place with one hand to keep the O-ring in place while tightening the connector nut.

8. Connect the new I/O cable to the processor board in the following way:

   - ❑ Connect the *shortest wire* to the processor board at *P4* (upper-right).
   - ❑ Connect the *long gray wire* with the two-position orange connector to the processor board at *P7* (bottom-left).
   - ❑ Connect the *long red wire* with the yellow inline fuse holder to the processor board at *P6* (bottom-center).
   - ❑ Secure the excess wire in the plastic cable clip located below the processor board.

Note: The inline fuse on the red wire protects the monitor from oversurges, short circuits, and reverse polarity. Therefore, do not defeat the fuse.



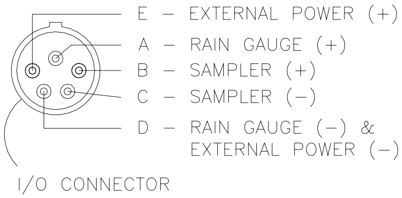
Ports for wiring external power I/O cable

9. Securely connect the mating connector (without cable) to the I/O connector on top of the monitor.
10. Strip ½ inch (13 mm) of insulation from the positive and negative wires coming from the external power source.

Note: Make sure the external power source is off while stripping, soldering, and connecting the wires.

11. Solder the wires to the connector, and pot the connector using the same technique applied for wiring the telephone cable to the monitor in *Chapter 4*, *Communication and Activation*. Solder the wires to the connector in the following configuration:

- ❑ Positive - socket *E*
- ❑ Negative - socket *D*



Power cable connector pinout

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