Catalog Number 97000-18

Sigma 980 Flow Meter

INSTRUMENT MANUAL

05/03 5ed

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Model 980 Flow Meter

INSTRUMENT MANUAL

eac/dp 05/03 5ed

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Please read this entire manual before unpacking, setting up, or operating this instrument.

Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTE
Information that requires special emphasis.

Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

	This symbol, if noted on the instrument, references the instruction manual for operation and/or safety information.
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists and indicates that only individuals qualified to work with hazardous voltages should open the enclosure or remove the barrier.
	This symbol, when noted on the product, identifies the location of a fuse or current limiting device.
	This symbol, when noted on the product, indicates that the marked item can be hot and should not be touched without care.
	This symbol, when noted on the product, indicates the presence of devices sensitive to Electro-static Discharge and indicates that care must be taken to prevent damage to them.
	This symbol, when noted on the product, identifies a risk of chemical harm and indicates that only individuals qualified and trained to work with chemicals should handle chemicals or perform maintenance on chemical delivery systems associated with the equipment.
	This symbol, if noted on the product, indicates the need for protective eye wear.
	This symbol, when noted on the product, identifies the location of the connection for Protective Earth (ground).

Confined Space Entry

DANGER
Additional training in Pre-Entry Testing, Ventilation, Entry Procedures, Evacuation/Rescue Procedures and Safety Work Practices is necessary to ensure against the loss of life in confined spaces.

Important Note: *The following information is provided to guide users of 980 Flow Meters on the dangers and risks associated with entry into confined spaces.*

On April 15, 1993, OSHA's final ruling on CFR 1910.146, Permit Required Confined Spaces, became law. This new standard directly affects more than 250,000 industrial sites in the United States and was created to protect the health and safety of workers in confined spaces.

Definition of Confined Space
A Confined Space is any location or enclosure that presents or has the immediate potential to present one or more of the following conditions:

- An atmosphere with less than 19.5% or greater than 23.5% oxygen and/or more than 10 ppm Hydrogen Sulfide (H_2S)
- An atmosphere that may be flammable or explosive due to gases, vapors, mists, dusts, or fibers
- Toxic materials which upon contact or inhalation, could result in injury, impairment of health, or death

Confined spaces are not designed for human occupancy. They have restricted entry and contain known or potential hazards.

Examples of confined spaces include manholes, stacks, pipes, vats, switch vaults, and other similar locations.

Standard safety procedures must always be followed prior to entry into confined spaces and/or locations where hazardous gases, vapors, mists, dusts, or fibers may be present.

Before entering any confined space check with your employer for procedures related to confined space entry.

Hazardous Locations

DANGER
Although some Hach products are designed and certified for installation in hazardous locations as defined by the National Electrical Code, many Hach products are not suitable for use in hazardous locations. It is the responsibility of the individuals who are installing the products in hazardous locations to determine the acceptability of the product for the environment. Additionally, to ensure safety, the installation of instrumentation in hazardous locations must be per the manufacturer's control drawing specifications. Any modification to the instrumentation or the installation is not recommended and may result in life threatening injury and/or damage to facilities.

The 980 Flow Meter is not approved for use in hazardous locations as defined in the National Electrical Code.

Specifications are subject to change without notice.

General	
Dimensions	14.62" H x 11.88" W x 8.26" D
Weight	7.62 kg (16.80 lb)
Enclosure	NEMA 4X, IP 66 with front cover closed, UV resistant
Mounting	Wall mount and Rail/Pole mount
Graphics Display	Graphics Display: Back-lit liquid crystal display (LCD). 8 line × 40 character in text mode, 64 × 240 pixels in graphics mode. Displays level vs. time, flow vs. time, rainfall vs. time, pH, and temperature.
Keypad	19-position sealed-membrane switch with four “soft keys,” functions defined by display.
Totalizers	8-digit resettable and 8-digit non-resettable software Units: ft^3, gal, m^3, liter, acre-ft
Measurement Modes	Flumes: Parshall, Palmer Bowlus, Leopold-Lagco, H, HL, HS, Trapezoidal Weirs: V-notch, Contracted/Non-contracted rectangular, Thel-mar, Compound Cipolletti, Compound V-notch Manning Equation: Round, U, Rectangular, and Trapezoidal Channels Head vs. Flow: Two independent user-entered look-up tables of up to 100 points each. Level only: Inches, feet, centimeters, meters Area Velocity: Level-area table, circular pipe, U-shaped channel, trapezoidal channel, rectangular channel. Power Equation: $Q = K_1 H^{n_1} \pm K_2 H^{n_2}$
Data Logging	“Smart” Dynamic memory allocation automatically partitions memory to provide the maximum logging time. No manual memory partitioning required. Capacity: Up to 456k bytes, 402 days of level, velocity, and rainfall readings at 15 minute intervals plus 300 events. Memory Mode: Wrap-around Data Points: 116,000 data points Daily statistics: Available for up to 32 days Recording Intervals: 1, 2, 3, 5, 6, 10, 12, 15, 20, 30, 60 minutes Time base accuracy: ± 6 seconds (0.007%) per day
Electrical	
Power Specifications	0.25 amp maximum
Power Requirements	100–230 V ac, 50/60 Hz, single phase, 15 W max (0.25 amp max)
Installation Category	II
Electrical Connection	Seven 0.5 in. hubs, One 1.0 in. hub
Sampler Output	15 V dc, 100 mA at 500 ms duration
Environmental (for Controller)	
Temperature Ranges	Storage: -20 °C to 70 °C (-4 °F to 158 °F) Operating: -20 °C to 50 °C (-4 °F to 122 °F)
Humidity	0–90%, Non-condensing

Specifications

Integral pH Meter	
Control/Logging	Field selectable to log pH independent of flow or in conjunction with flow; also controls sample collection in response to value of low/high stipends
pH Sensor	Temperature compensated; impact resistant ABS plastic body Combination electrode with porous Teflon junction.
Measurement Range	2 to 12 pH
Operating Temperature Range	-18 to 80 °C (0 to 176 °F)
Dimensions	19.5 mm × 15.24 cm long (0.75 in. dia. × 6 in.) with 19.5 mm (0.75 in.) npt cable end
Rain Gauge Input	
General Information	For use with Tipping Bucket Rain Gauge. Flow measurement can be initiated upon field selectable rate of rain. Flow meter records rainfall data. Shielded cable, 100 ft length maximum Each tip = 0.25 mm (0.01 in.) of rain.
Analog Input Channels	
General Information	Up to 7 additional data logging channels record data from external source(s) Four channels with -4.5 to 4.5 V dc input with 1 meg ohm input impedance on each channel and three channels with 4–20 mA input.[1]
4–20 mA Output	
General Information	Two isolated output signals available. User assignable.
Maximum Resistive Load	600 ohms
Output Voltage	24 V dc—no load
Alarm Relays	
General Information	4 intergral alarm relays; form C (common, normally open, normally closed), 5 amp. Connection to instrument through terminal blocks.
Relay Contact Ratings	5 amps, (30–230 V ac)
Communications	
General Information	RS-232—up to 19,200 baud Modem—14400 bps., V.32 bis, V.42, MNP2-4 error correction. V.42 bis MNP5 data compression. MNP 10-EC Cellular Protocol Pager SCADA–Modbus® communication protocol (standard) via RS232 or optional modem

Ultrasonic Transducer	
Operating Frequency	75 kHz
Beam Angle	±12° (-10 dB)
Accuracy*	±0.03 ft over 2-ft change in head, @ 20 °C, still air, ideal target, 50 ft cable
Range	11.5 in. (minimum) to 10.7 ft (maximum), with ideal target @ 20° C, in still air with 50-ft cable.
Operating Temperature Range	-20 °C to 50 °C (-4 °F to 122 °F)
Material	PVC housing with acoustic window
Weight	1.5 lb
Cable	Low-loss cable, coax cable RG 62/U
Cable Length	25 ft (7.6 m) standard, custom lengths up to 500 ft (contact manufacturer for performance information at custom lengths)
Mounting	Permanent and Adjustable Mounting Brackets
Dimensions (transducer only)	12.7 cm x 5.7 cm (5.0" H x 2.25" D)
Connection	Bare wire lead connection via terminal blocks
In-Pipe Ultrasonic Sensor	
Operating Frequency	75 kHz
Accuracy	±0.014 ft for sensor to liquid distance between 2.86 inches and 13.5 ft at ±1 ft change in head from calibration point, 20 °C still air, ideal target, 50 ft cable.
Range	Distance from sensor to liquid: 0.64 inches (minimum) to 13.5 feet (maximum), @ 20 °C still air, ideal target, 50 ft cable.
Resolution	0.0075 inches
Operating Temperature Range	-20 to 60 °C (-4 to 140 °F)
Storage Temperature	-20 to 60 °C (-4 to 140 °F)
Temperature Error	0.00005 meter/°C typical
Material	Stat-Kon A-E ABS Plastic
Cable Length	7.6 m (25 ft) standard, custom lengths up to 200 m (500 feet)
Dimensions (transducer only)	4.44 cm (1.75 in.) maximum diameter, 31.435 cm (12.375 in.) long
Mounting	Dedicated Mounting Rings, Permanent Mounting Bracket (installs directly to pipe wall), Adjustable Mounting Band Kit.
Connection	Bare lead connection via terminal blocks

Specifications

Velocity Transducer	
Method	Doppler Principle
Accuracy*	±2% of reading; Zero Stability: ±1.52 cms (±0.05 fps)
Range	-1.52 to 6.1 m (-5 to +20 fps)
Resolution	0.3 cms (0.01 fps)
Response Time	4.8 seconds
Profile Time	4.8 seconds
Probe Dimensions	Length: 6.9 cm (2.7 in.), Width: 3.81 cm (1.5 in.), Height: 1.1 cm (0.44 in.)
Cable	Urethane sensor cable, shielded
Cable Length	7.6 m (25 ft), custom cable lengths up to 100 ft
Mounting	Dedicated Mounting Rings (mounting clips recommended for pipe diameters 8 in. or under), Mounting Plate (for permanent mounting—drills to pipe wall), Adjustable Mounting Band Kit
Connection	Sensor connector to Quick connect hub or bare leads connection via terminal block.
Submerged Area Velocity Probe	
Method	Doppler Principle / Pressure Transducer
Material	Polyurethane body, 316 series stainless steel diaphragm
Cable	Urethane sensor cable with air vent, shielded
Cable Length	7.6 m (25 ft) standard, custom cable up to 100 ft
Probe Dimensions	Length: 12.7 cm (5 inches), Width: 3.81 cm (1.5 inches), Height: 2.03 cm (0.8 inches)
Mounting	Dedicated Mounting Rings (mounting clips recommended for pipe diameters 8 in. or under), Mounting Plate (for permanent mounting—drills to pipe wall) Adjustable Mounting Band Kit.
Connection	Sensor connector to quick-connect hub, bare lead connection via terminal block or bare lead connection to junction box with bare lead junction box via terminal block.
Velocity	Velocity Accuracy: ± 2% of reading; Zero stability: <0.05 fps (<0.015 m/s)
	Response Time: 4.8 sec.
	Profile Time: 4.8 sec.
	Range: -1.52 to 6.1 m/s (-5 to +20 fps)
	Resolution: 0.0028 m/s (0.01 fps)
	Operating Temperature: -18° to 60 °C (0° to 140 °F)
Depth	Depth Accuracy: ±2% of reading
	Maximum Allowable Level: 3X over pressure
	Operating Temperature Range: 0° to 71 °C (32° to 160 °F)
	Compensated Temperature Range: 0 to 30 °C (32 to 86 °F)
	Temperature Error: 0.005 to 3.5 m ±0.0022 m/°C (0.018 to 11.5 ft ±0.004 ft/°F) 0.005 to 10.5 m ±0.006 m/°C (0.018 to 34.6 ft ±0.012 ft/°F) (maximum error within compensated temperature range - per degree of change)
	Draw down correction[2]: 0 to 3.05 mps (0 to 10 fps) = 0.085% of reading
	Air Intake: Atmospheric pressure reference is desiccant protected

1. See Troubleshooting Measurement Errors on page 99.
2. U.S. Patent 5,691,914

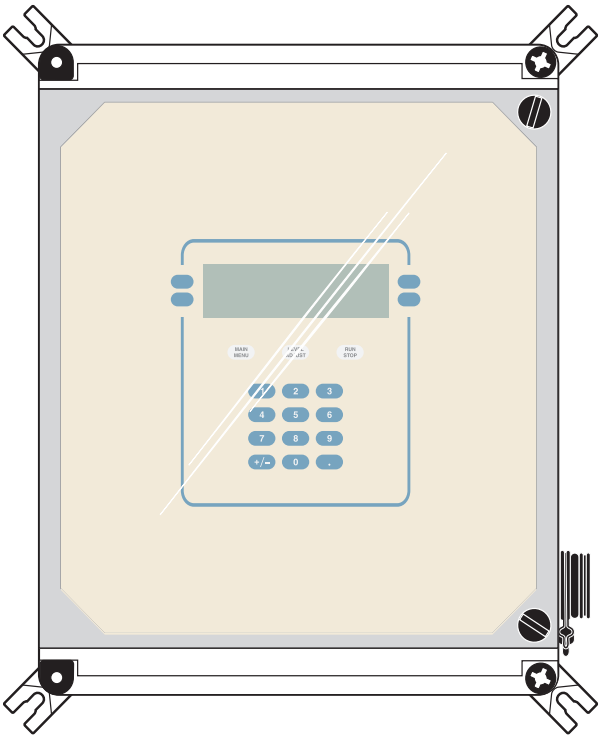
1.1 Instrument Description

The 980 Flow Meter is an ultrasonic level detection meter with rugged, NEMA 4X, IP66 construction. The 980 Flow Meter case has several unique features, all designed to simplify installation, operation, and maintenance. All controls are located within easy reach on the front panel behind a clear, protective front cover.

The 980 Flow Meter has eight wiring holes located along the bottom of the case. The one 1.38 in. and the seven 0.875 in. conduit holes provide easy access for all power, sensor, control, and communications wiring.

Connections to the 980 Flow Meter are made in the wiring panel behind the front cover. The interface connector ports are located on the bottom of the instrument. The 980 Flow Meter comes standard with a quick-connect RS232 serial communications port.

Figure 1 980 Flow Meter



In addition, the flow meter can connect to a wide variety of optional peripheral devices:

- 4–20 mA Current Loop
- Up to three 4–20 mA Inputs
- Up to four 4.5 V dc Inputs
- Mechanical Totalizer
- Rain Gauge
- Sampler
- pH Sensor
- Modem

The 980 Flow Meter is available with one of the depth/velocity measurement technologies:

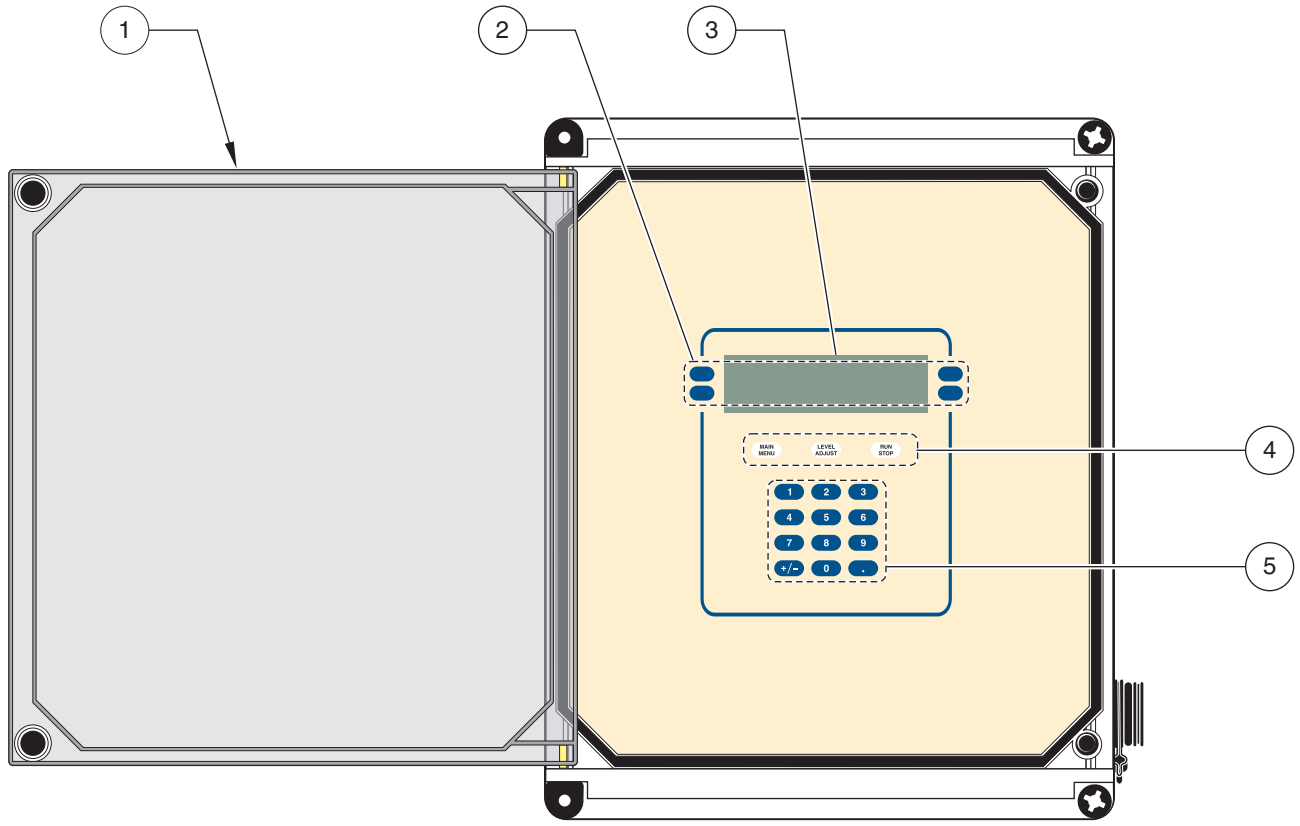
- Ultrasonic Sensor
- Velocity Sensor
- Area Velocity/Submerged Sensor

1.2 Front Panel Features and Controls

The 980 Flow Meter front panel features the keypad and the liquid crystal display (LCD). The side of the 980 Flow Meter provides a connection for an RS232 serial interface temporary connection.

The clear front cover of the instrument protects the control panel and display window while providing a clear view of the flow meter status on the display. The cover perimeter contains a gasket seal to keep moisture and dirt from entering the front panel area. This seal is required to maintain the NEMA 4X rating of the case.

Figure 2 Front Panel



1. Clear Front Cover	**4.** Function Keys
2. Soft Keys	**5.** Numeric Keypad
3. LCD Display	

1.3 Keypad Description

The 980 Flow Meter keypad has three components: numeric keypad, soft keys, and function keys. (See Figure 2).

Numeric Keypad
The numeric keypad consists of the digits 0 through 9, a +/- key, and a decimal key.

“Soft” Keys
Soft keys are blank, white keys located to the left and right of the display. The appearance of each function key depends on the display. The soft key labels appear on the display and point (with a straight line) to the proper soft key to push for that action. If no function is shown for a specific key, that key is not currently active.

In some cases during a programming step, an item from a list needs to be selected. The soft keys on the right side of the display will change to display “up” and “down” arrows. Us then to scroll up and down the list of choices. When the desired choice is highlighted, press the **SELECT** soft key.

Function Keys
Three dedicated function keys are used to allow quick access to frequently used functions. They are the white keys located just above the numeric keypad.

Function Key	Description
Main Menu	
	This is the starting point to access any other point in the program. Press the Main Menu key at any time during programming to return to the Main Menu Screen. The current action is cancelled if changes are not yet accepted.
Level Adjust	
	Adjust the flow meter to match the current head (or level contributing flow) in the channel.
Run/Stop	
	Runs (or resumes) a program. Stops a currently running program.

1.4 Liquid Crystal Display

The 980 Flow Meter liquid crystal display (LCD) works in conjunction with the four soft keys. When a soft key changes function, the display shows the new function.

Menu Bar
The Menu Bar appears in a black band on the top edge of the display. The upper left corner of the menu bar shows the time and date. The upper right corner shows the name of the current menu.

Status Bar
The Status Bar appears along the bottom edge of the display. The appearance of the status bar changes depending upon the function performed.

The lower left corner of the Status Bar indicates whether a program is Running, Halted, or Ready To Start. If it is not needed during a programming step, it disappears.

The lower right corner displays system alarm conditions, such as low memory battery. For a list of possible alarms see section 4.4 on page 66.

The status bar also lists the valid choices when entering certain programming information. For example, when selecting the units of level measurement from the Level Units menu, the status bar indicates that the valid choices are: cm, ft, in. or m.

1.5 Principle Operation

Measurement Capabilities
The 980 Flow Meter is often used to measure flow in conjunction with a primary measuring device (flume, weir, pipe, etc.) that has a known level-to-flow relationship. The 980 Flow Meter directly measures the level of liquid in a channel that is contributing to flow (referred to as “head”) and calculates the flow rate based on the head-to-flow relationship of the primary device. (Refer to Appendix A on page 99).

The 980 Flow Meter can also simultaneously measure and record:

- Level
- pH
- Rainfall
- Velocity (AV version only)
- Temperature
- Seven discrete analog inputs (voltage and/or current)

The AV option can also measure the average velocity of the flow stream using a submerged Doppler probe and calculate flow based on the current level and the formula: *Wetted Area* × *Velocity* = *Flow*.

Communication Capabilities
A graphical display allows fast, on-site review of historical data.

In addition to its extensive data logging capabilities, the 980 Flow Meter is capable of:

- Enabling a sampler
- Pacing a sampler
- Controlling four external devices with Normally Open/Normally Closed relays
- Controlling two external devices with 4–20 mA current outputs

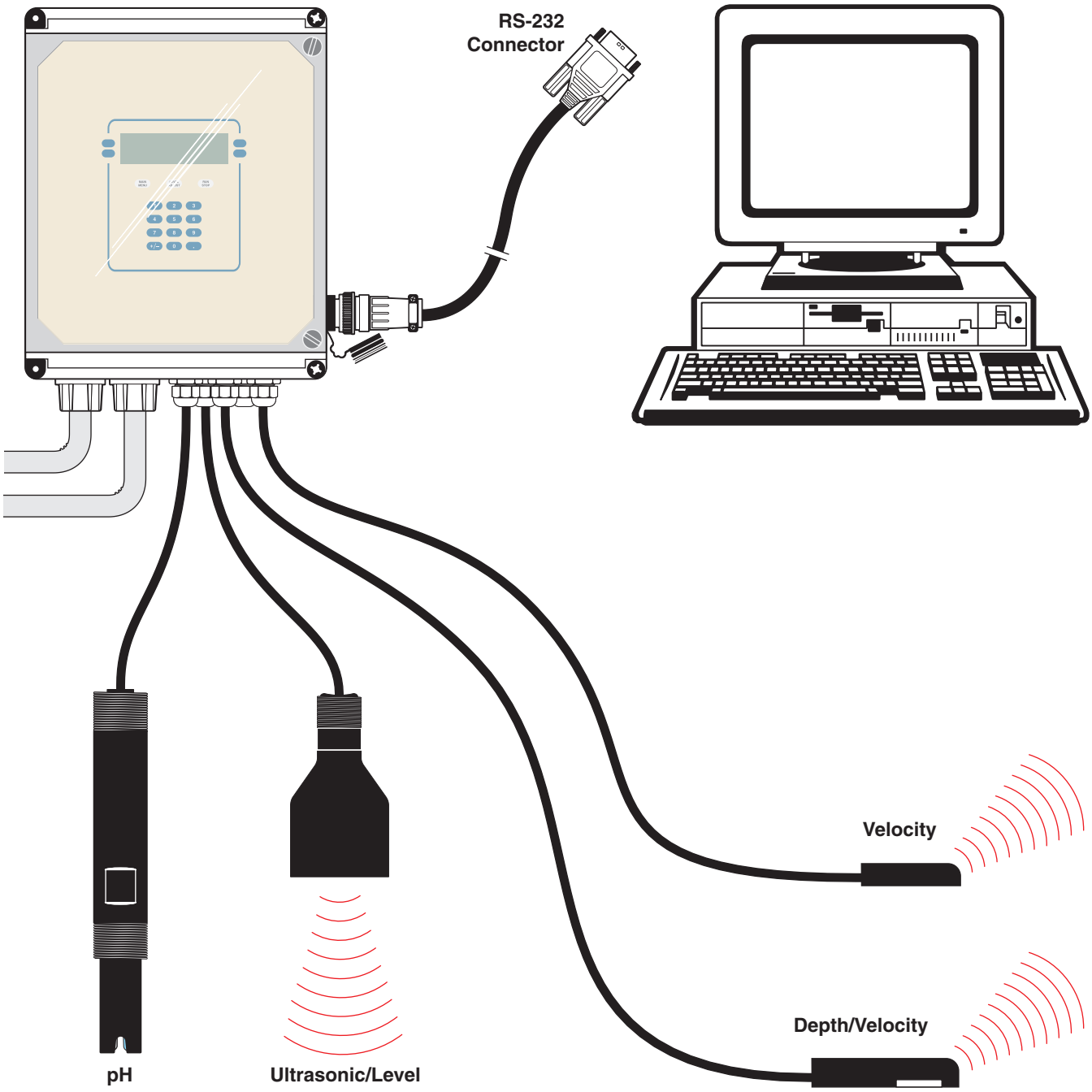
Communications capabilities include a standard RS232 port used for data transfer and updating internal embedded program using state-of-the-art Flash Memory technology.

The 980 Flow Meter also provides SCADA Communication Interface functionality using the Modbus® ASCII protocol. This software protocol communicates with the instrument via an RS232 or modem connection.

Using our InSight® data analysis software, users can download, remotely program, view real-time current status of logged parameters, and conduct other data manipulation via RS232 connection or the optional modem.

To protect the meter's functionality and data, an operator may set up password security access to the meter using the front-panel keypad.

Figure 3 Communication Capabilities



INSTALLATION

DANGER

Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the installation/maintenance tasks described in this portion of the manual.

DANGER

Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détérioration de l'appareil. Les tâches d'installation et d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire.

PELIGRO

Algunos de los capítulos del manual que presentamos contienen información muy importante en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de instalación y mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas.

GEFAHR

Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vermeiden. In diesem Abschnitt beschriebene Installations- und Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.

PERICOLO

Alcune parti di questo manuale contengono informazioni sotto forma d'avvertimenti, di precauzioni e di osservazioni le quali richiedono una particolare attenzione. La preghiamo di leggere attentivamente e di rispettare quelle istruzioni per evitare ogni ferita corporale e danneggiamento della macchina. Solo gli operatori qualificati per l'uso di questa macchina sono autorizzati ad effettuare le operazioni di manutenzione descritte in questa parte del manuale.

DANGER
This instrument should be installed by qualified technical personnel to ensure adherence to all applicable electrical codes.

2.1 Customer-supplied Equipment

- Four ¼–20 mounting screws
- Small flat-blade screwdriver
- Phillips screwdriver
- Needle-nose pliers
- 110–230 V single phase switched power
- Wire strippers
- Diagonal wire cutters
- Nylon wire ties
- 5/16 open-end wrench

2.2 Unpacking the Instrument

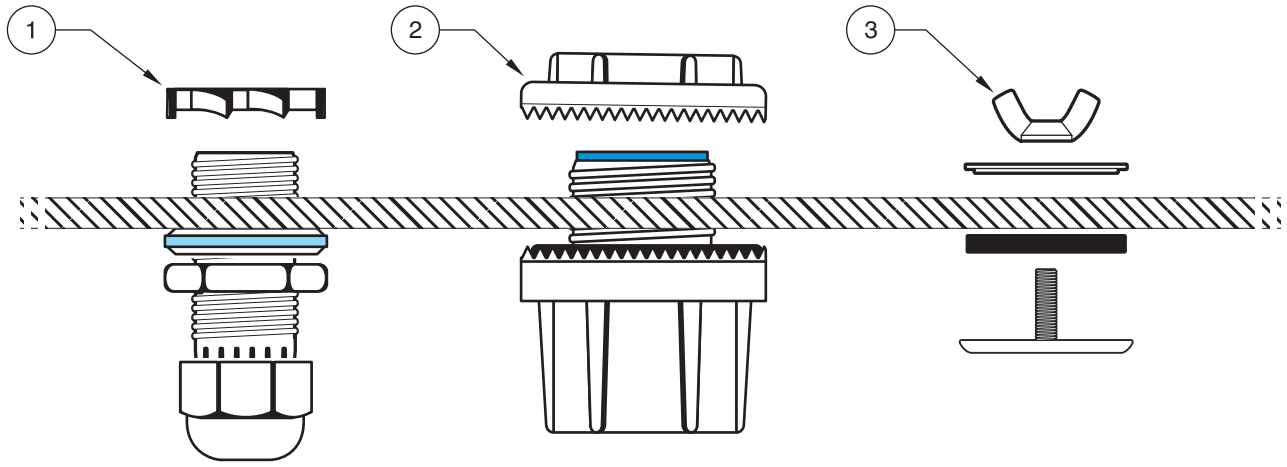
Remove the 980 Flow Meter from its shipping carton and inspect it for any damage. If the shipment arrives damaged or incomplete contact: Technical support at 1-800-635-1230 or send e-mail to techhelp@hach.com.

2.2.1 NEMA 4X Applications

Note: *The 980 Flow Meter ships with temporary push-in hole plugs which are not acceptable for use during operation. If circuit connections are not required, plug unused holes as shown in Figure 4.*

To maintain the NEMA 4X, IP66 enclosure rating, use strain-relief or conduit fittings that are a sealing type (not supplied, see note in left column). To make wire connections, refer to the sections that follow. Standard off-the-shelf NEMA-approved conduit hardware is available at most hardware and electrical appliance stores. Take care to select the style of conduit hardware that will seal to the enclosure wall when using flexible or rigid conduit. See Figure 4 and Parts and Accessories on page 137.

Figure 4 Sealing-type Strain Reliefs, Conduit Fittings, and Sealing Plugs



1.	Sealing-type Strain Relief (Cat. No. 8773 0.20-0.35" O.D. cable, Cat. No. 8786 0.23-0.47" O.D. cable)
2.	Conduit Fitting (½" (Cat. No. 16483), 1"(Cat. No. 4913600))
3.	Oil-tight Sealing Plug (Cat. No. 42210-00)

Figure 5 Mounting Dimensions (1 of 3)

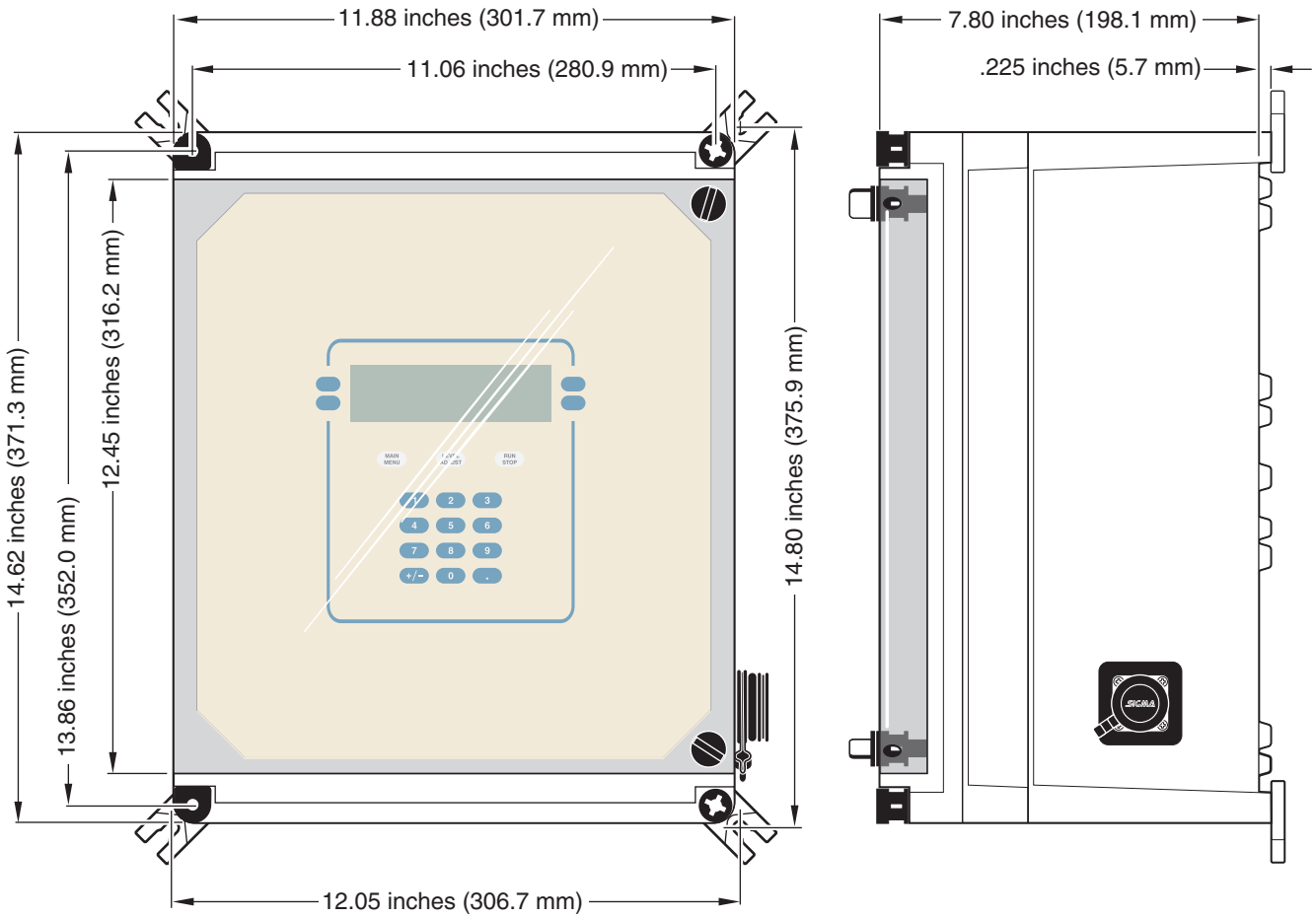
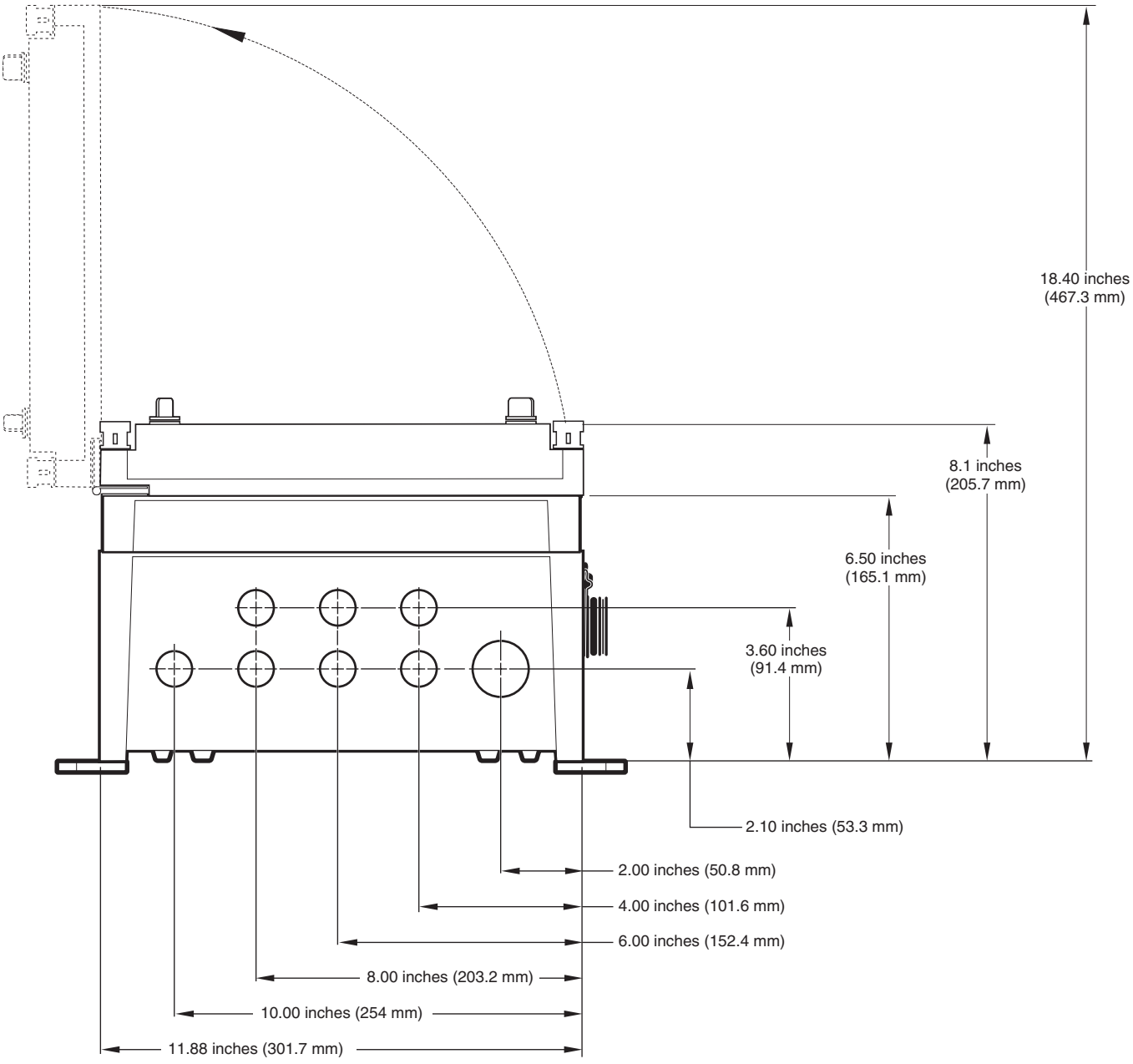


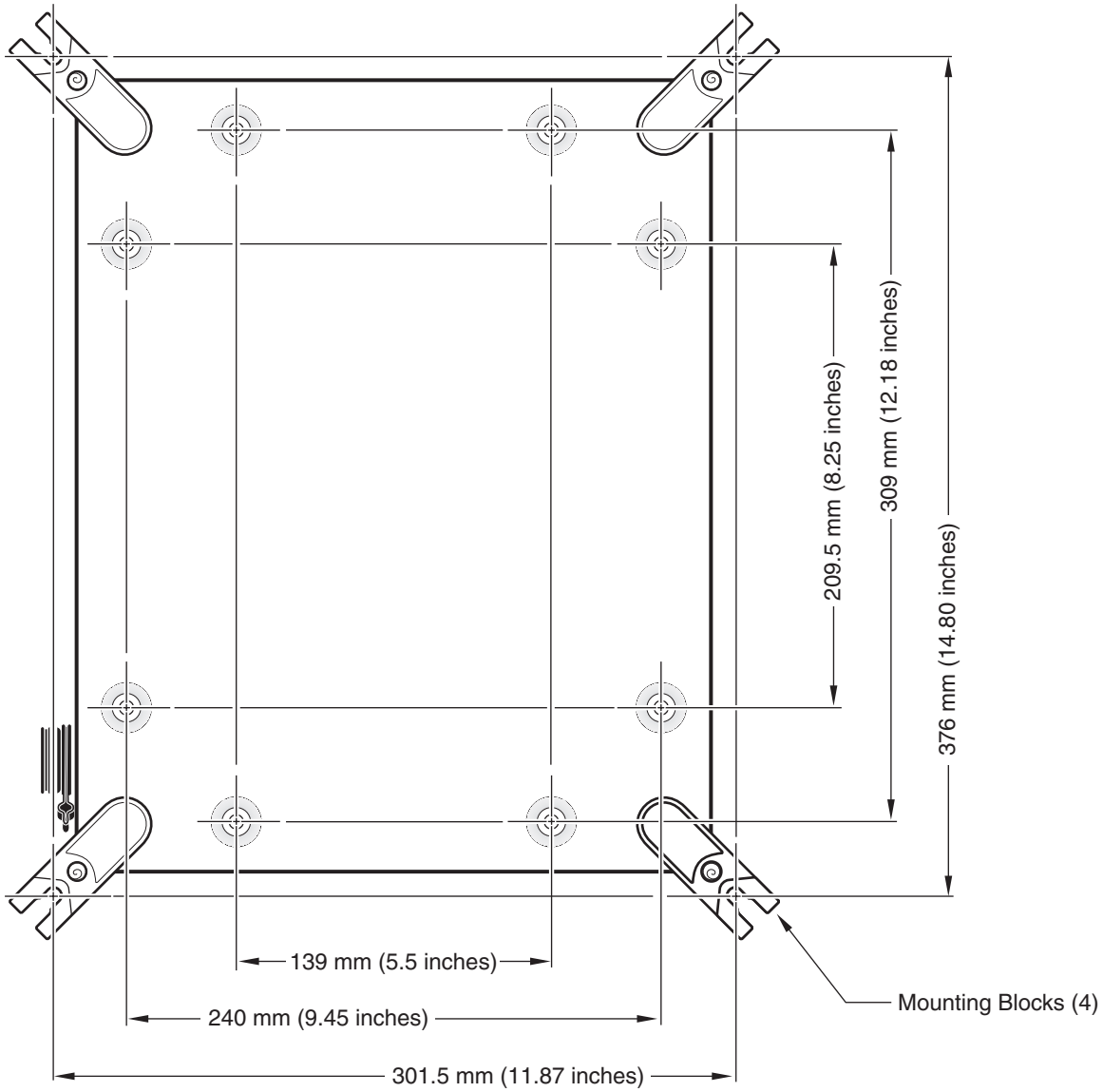
Figure 6 Mounting Dimensions (2 of 3)



2.3 Mounting Options

The 980 Flow Meter is designed for wall or rail/pole mounting. Wall mounting dimensions and hole patterns are found in Figure 7. For optimal viewing of the the front panel display, mount the instrument facing north to eliminate glare from the sun.

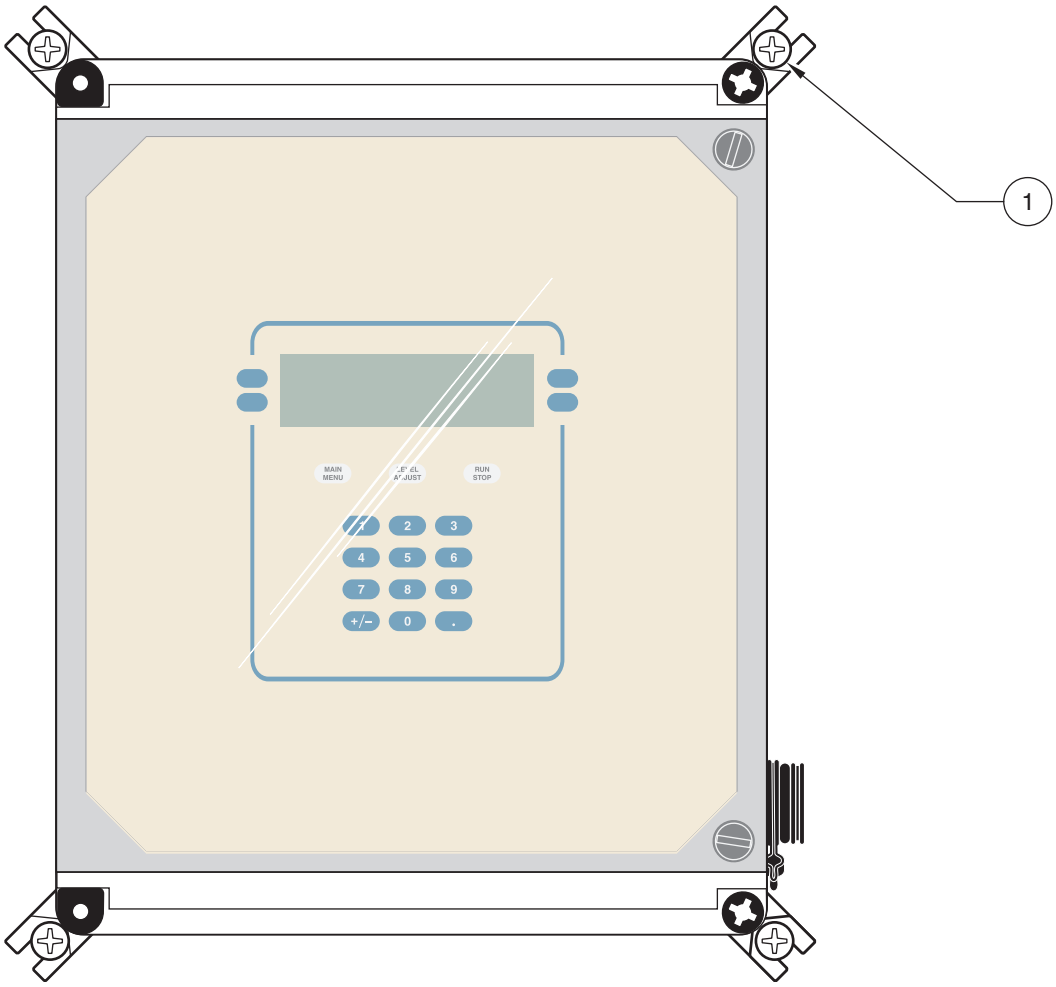
Figure 7 Mounting Dimensions (3 of 3)



2.3.1 Wall Mounting

Mount the 980 Flow Meter using the Wall Mounting Blocks that come installed on the unit, see Figure 7. These brackets provide secure mounting for the instrument. To wall mount the 980 Flow Meter use four ¼–20 screws. Refer to Figure 8.

Figure 8 Wall Mounting



1.	¼–20 screws (4)

2.3.2 Rail/Pole Mounting

Mount the 980 Flow Meter using the rail/pole mounting kit (Cat. No. 97091-00).

1. Determine if the brackets need to be placed horizontally or vertically, depending on the direction of the rail/pole. Refer to Figure 9.

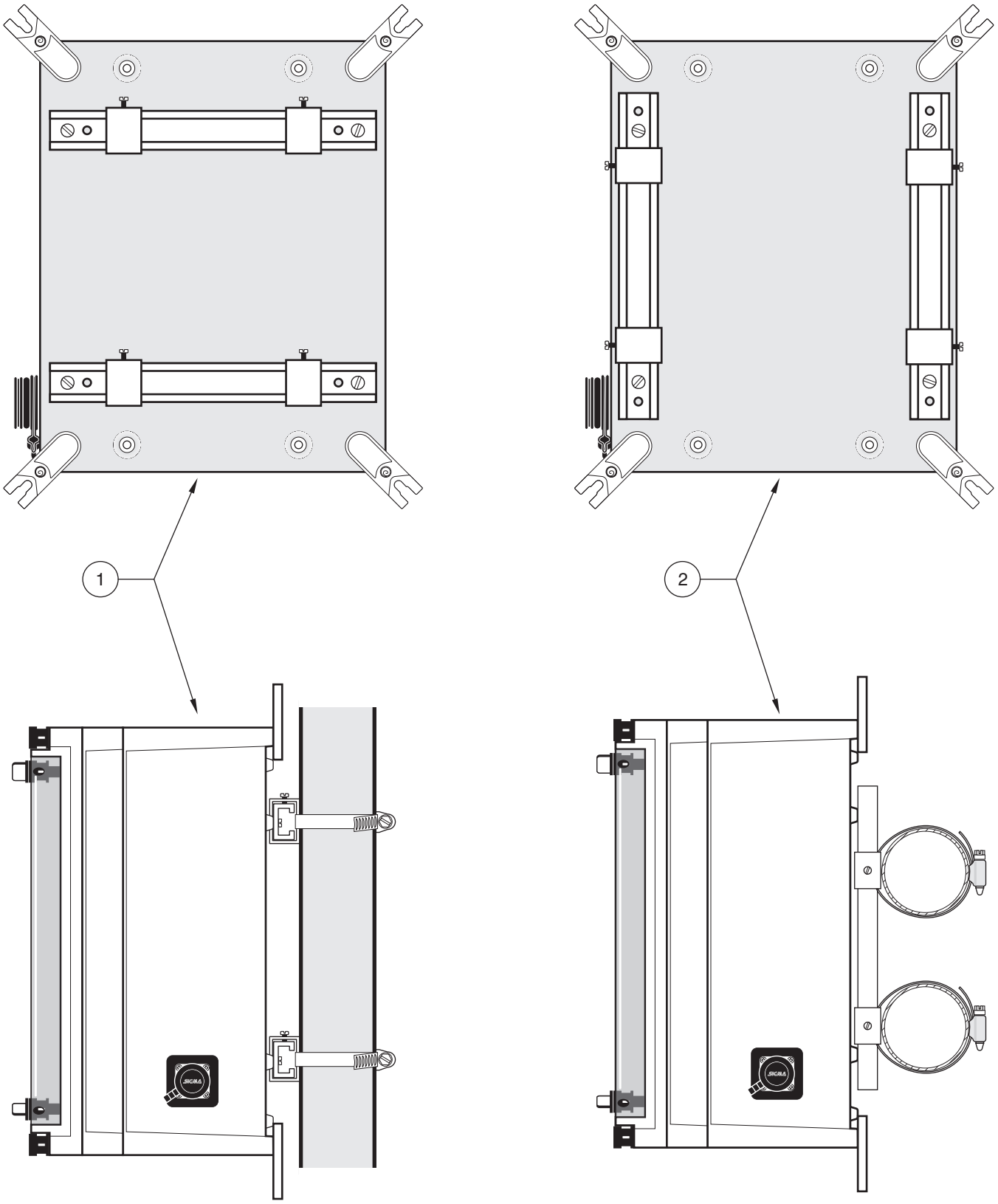
2. Tap the four brass inserts flush with the four holes on the back of the instrument. Refer to Figure 7.

3. Slide two adjustable clamps on each bracket. Adjust the clamps to meet the approximate size of the rail/pole and secure by tightening the clamp screw.

4. Match the screw holes on the bracket to the holes on the back of the instrument. Mount the bracket to the instrument using four M4 x 8 mm. screws. Refer to Figure 9.

5. Place a commercially–sold hose clamp through the bracket and clamps to attach the instrument to the rail/pole.

Figure 9 Rail / Pole Mounting



1. For mounting on a vertical pipe or rail.	**2.** For mounting on a horizontal pipe or rail.

2.4 Wiring Safety Information\

DANGER
Always disconnect power to the instrument when making electrical connections.

When making any wiring connections to the 980 Flow Meter, the following warnings and notes must be adhered to, as well as, any warnings and notes found throughout the individual installation sections. For more safety information refer to Safety Precautions on page 7.

Electrostatic Discharge (ESD) Considerations

Important Note: *To minimize hazards and ESD risks, maintenance procedures not requiring power to the analyzer should be performed with power removed.*

Delicate internal electronic components can be damaged by static electricity, resulting in degraded instrument performance or eventual failure.

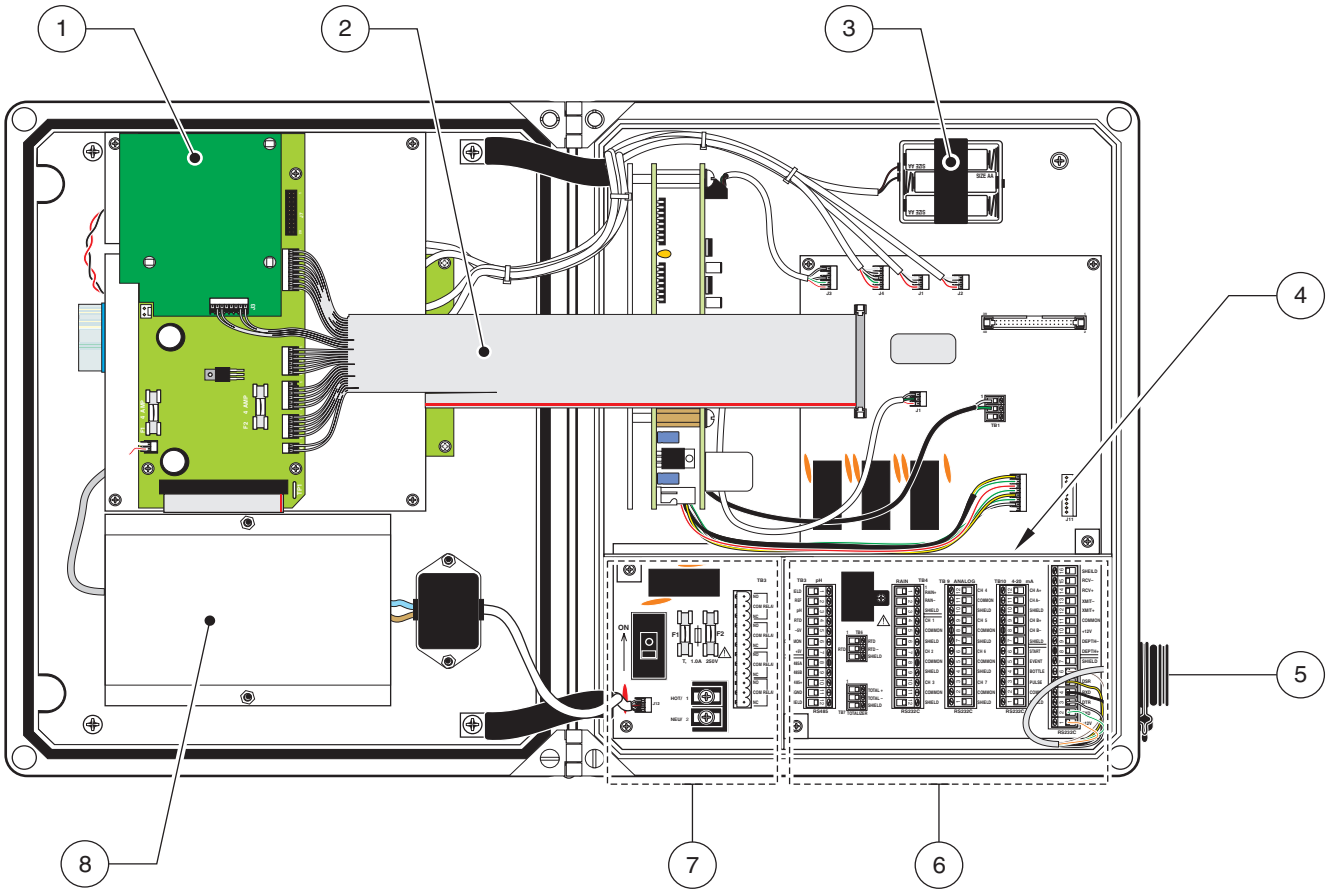
The manufacturer recommends taking the following steps to prevent ESD damage to your instrument:

- Before touching any instrument electronic components (such as printed circuit cards and the components on them) discharge static electricity from your body. This can be accomplished by touching an earth-grounded metal surface such as the chassis of an instrument, or a metal conduit or pipe.
- To reduce static build-up, avoid excessive movement. Transport static-sensitive components in anti-static containers or packaging.
- To discharge static electricity from your body and keep it discharged, wear a wrist strap connected by a wire to earth ground.
- Handle all static-sensitive components in a static-safe area. If possible, use anti-static floor pads and work bench pads.

2.5 Wiring the Controller

The 980 Flow Meter is divided into two sections by a voltage isolation barrier. The left side of the barrier contains the high voltage wiring and the right side of the barrier contains the low voltage wiring. See Figure 10 for proper placement of connectors.

Figure 10 Enclosure Wiring Access



1. Base, CPU, and 4–20 mA Circuit Boards	**4.** Voltage Isolation Barrier	**7.** High voltage wiring
2. Ribbon Cable Assembly	**5.** Pre-wired RS-232 connector	**8.** Power Supply
3. Batteries (3 AA-size)	**6.** Low voltage wiring	

2.5.1 Connecting ac Power to the 980 Flow Meter

DANGER
When high-voltage power is applied to the flow meter, provisions must be made for disconnecting external power to the flow meter during servicing.

Note: *If power cords are allowed by local electrical code, a 125 V UL/CSA–approved power cord with an approved NEMA-style strain relief and a standard 115 V North American-style plug (Cat. No. 4630600) or a 230 V VDE-approved power cord with an approved NEMA-style strain relief and a Continental European-style plug (Cat. No. 4630800) can be ordered.*

For process or industrial applications, the national electrical codes of most countries require that ac service feeds be hard-wired and contained in conduit systems. The 980 Flow Meter has been designed to conform to this requirement.

The manufacturer recommends conduit for two reasons:

1. It is generally required by most local electrical codes, and
2. Use of metal conduit can improve immunity to lightning surges and ac power transients.

Additionally, electrical and instrumentation standards require a local means of removing power from the product. **Since the 980 Flow Meter does not have an accessible ON/OFF switch, the customer must provide one. This may be accomplished with a customer-supplied switch box or with a power cord.** See Figure 12**.** As previously stated, a power cord method is only

acceptable if local codes permit its use and the considerations outlined in the previous paragraphs are addressed.

In hard-wired electrical applications the power and safety ground service drops for the 980 Flow Meter should be no longer than 6 meters (20 feet) unless metal conduit is used to shield the ac power wiring.

In applications where power cords are allowed by local electrical codes and power surges and transients are not a great concern, an 18 gauge, 3-conductor power cord (including a safety ground wire) can be used, but its length must not exceed 3 meters (10 feet).

Note: *The field wiring terminal barrier for ac power will accept wire between 18 and 12 gauge. The wire gauge must not be less than 18 AWG.*

Carefully read all of the warnings in this section, and refer to Figure 11 to ensure the connections are correctly installed.

1. Use a large flat-blade screwdriver to loosen the two screws securing the cover. Open the cover.

2. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the ac wires through this opening. See Figure 6.

3. Strip the wire insulation back enough to wrap around terminal screws.

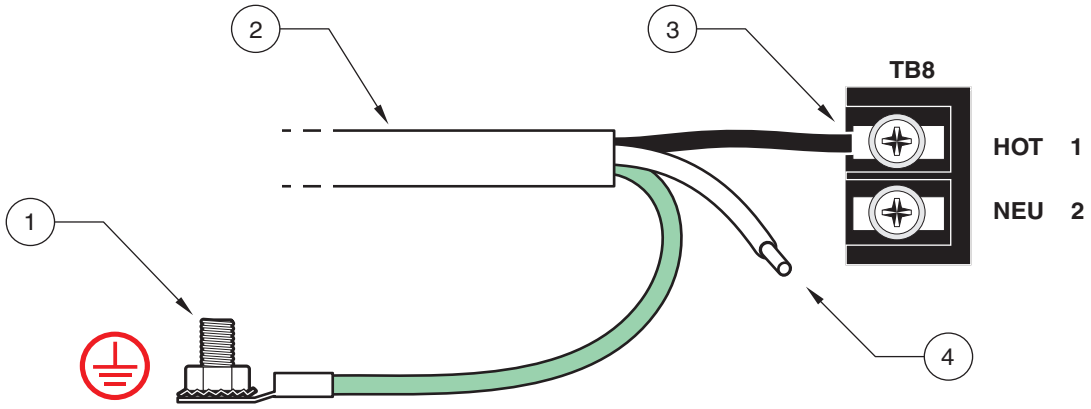
4. Connect the hot and neutral wires to the appropriate screw terminal (TB 8). Refer to Table 1. Do not leave any of the bare wire exposed.

5. Connect the green, green/yellow wire to the ground stud. Use a 5/16 inch open-end wrench to tighten the ground stud.

Table 1 ac Power Connections

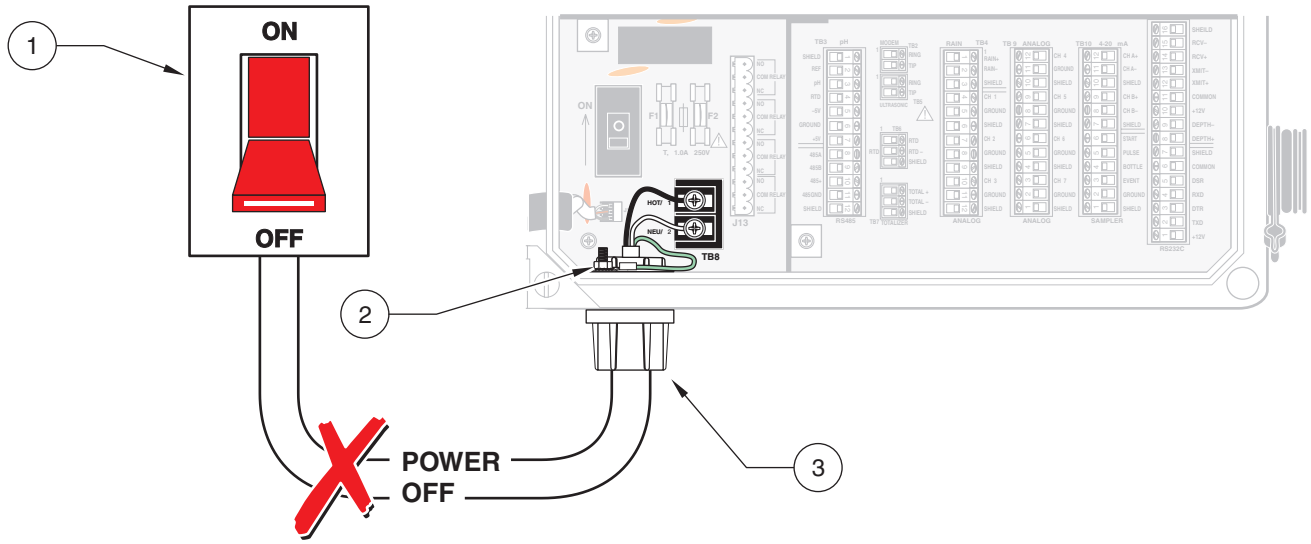
Location	Power Wire Color Codes	Circuit Board Marking	
		International	U.S.A.
TB8	White (North America) Blue (International)	→ 2	neutral
TB8	Black (North America) Brown (International)	→ 1	hot
Conduit Plate	Green (North America) or green/yellow (International)	⏚	ground

Figure 11 Proper Wire Connection



1.	Ground Stud	**3.**	Seat insulation against connector.
2.	18–12 gauge wire	**4.**	Strip wire ¼ inch

Figure 12 Connecting Power to the Instrument



1. Power switch	**2.** Green wire to ground stud	**3.** Appropriate NEMA 4X Hardware.

2.6 Wiring Optional Devices

The flow meter can connect to a wide variety of optional peripheral devices:

- 4–20 mA Current Loop
- Up to three 4–20 mA Inputs
- Up to four 4.5 V dc Inputs
- Mechanical Totalizer
- Rain Gauge
- Sampler
- pH Sensor
- Modem

The flow meter is available with one of the following depth/velocity measurement technologies:

- Ultrasonic Sensor
- Velocity Sensor
- Area Velocity/Submerged Sensor

After wiring the instrument and optional devices an operator must conduct the basic programming setup (Refer to Section 3 on page 53), conduct individual programming for the optional devices, and when necessary calibrate the devices. (Refer to Section 4 on page 61 for operator's setup).

2.7 Wiring the 4–20 mA Output

Two 4–20 mA dc outputs are available and may be independently assigned to any data channel (level, flow, pH, etc.)

The maximum cable length for either 4–20 mA output is defined based on the load of the instrument/device being connected and the gauge of wire being used to connect the instrument/device to the 980 Flow Meter. The total available load for either of the 4–20 mA outputs is 600 ohms.

For example: If the device that is being connected has a load of 550 ohms, this leaves 50 ohms available to define the maximum length of wire for connecting the device to the 980 Flow Meter. Each wire has an inherent resistance that can be obtained from the wire manufacturer. Divide the 50 ohms that is available for the wire by the resistance of wire (with units of ohms/ft). The result is the maximum cable length that can be used in that particular location. If an 18 gauge copper wire is being used, it has a resistance of 6.39 ohms/1000 feet. Dividing 50 ohms by 6.39 ohms/1000 ft results in a maximum cable length of 7,824 feet.

Note: *To minimize electromagnetic effects on the 980 Flow Meter, performance shielded cable is required. To ensure that ground currents in inadequate ground systems do not result in potential shock hazards do not connect the shields at both ends of the cable.*

1. Disconnect all power to the 980 Flow Meter. See Wiring Safety Information\ on page 27.
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Open the cover.
3. Strip insulation from 4–20 mA leads ¼ inch.
4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the 4–20 mA cable wires through this opening.
5. Connect wires to the proper screw terminal block (TB10). Refer to Table 2 and Figure 13.

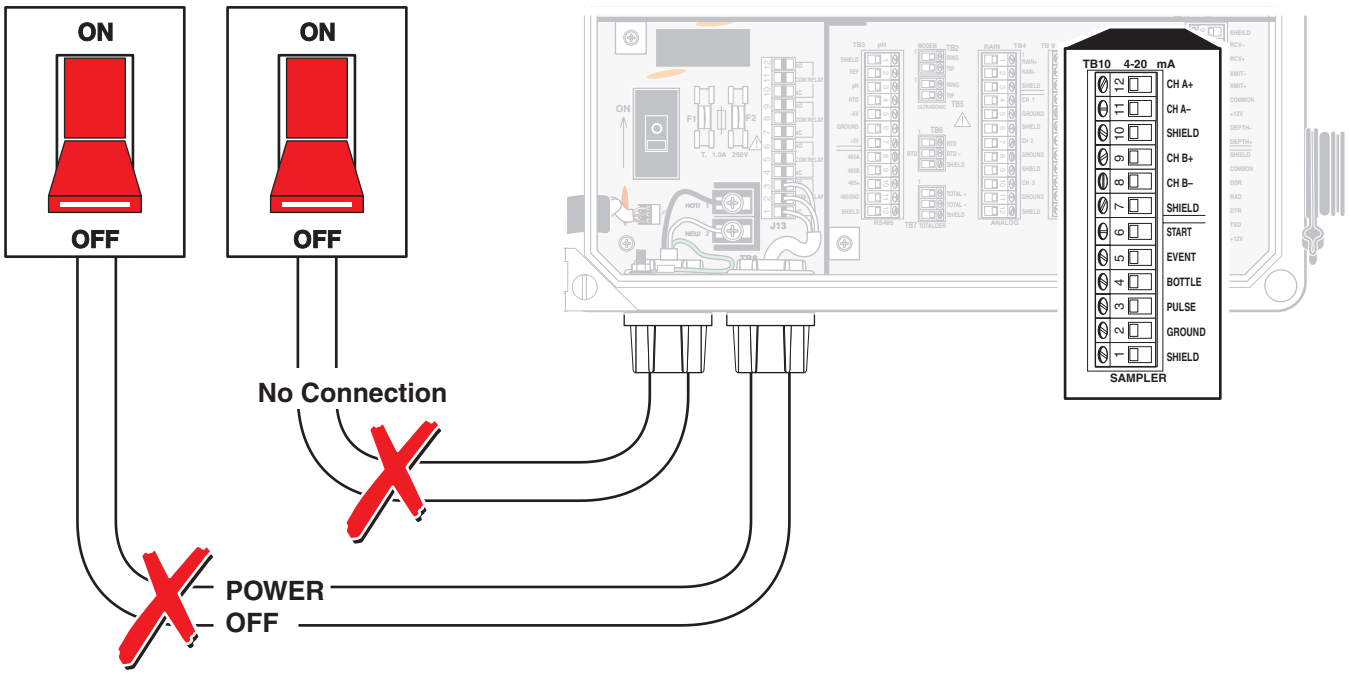
Note: *Use NEMA-approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter the enclosure.*

6. When wiring the cable sheild, connect to protective earth (ground) at the 980 Flow Meter. Do not connect the cable shield at the remote end of the cable. Cut the cable jacket far enough back to expose the conductors. Remove the shield by cutting it even with the cable jacket. Insulate the remaining exposed shield with tape or heat-shrink tubing.

Table 2 4–20 mA Terminal Block Connections (TB10)

Pin	Signal Description
7	shield
8	channel B - (neg)
9	channel B + (pos)
10	shield
11	channel A - (neg)
12	channel A + (pos)

Figure 13 Locating TB10 for 4–20 mA Output Connections



2.8 Wiring the Analog Input

Note: *Use NEMA-approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter. the enclosure.*

Note: *4–20 mA inputs must be isolated. Input impedance is 200 ohms.*

Note: *Input impedance for voltage inputs is equal to 1 meg ohm.*

Note: *To minimize electromagnetic affects on the 980 Flow Meter performance, shielded cable is required. To ensure that ground currents in inadequate ground systems do not result in potential shock hazards, do not connect the shields at both ends of the cable.*

1. Disconnect all power to the 980 Flow Meter. Refer to Wiring Safety Information\ on page 27.
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Open the cover.
3. Strip insulation from analog input leads ¼ inch.
4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the analog input cable wires through this opening.
5. Connect wires to the proper terminal block connection, TB4 for 4-20 mA dc wiring or TB9 for voltage wiring (See Figure 14). Refer to Table 3 and Table 4.
6. When wiring the cable sheild, connect to protective earth (ground) at the 980 Flow Meter. Do not connect the cable shield at the remote end of the cable. Cut the cable jacket far enough back to expose the conductors. Remove the shield by cutting it even with the cable jacket. Insulate the remaining exposed shield with tape or heat-shrink tubing.

There are a total of seven analog input channels available on the 980 Flow Meter. These inputs accept 4–20 mA dc or -4.5 to +4.5 V dc analog signals. They can be logged and graphed and can also be used to trigger alarms, cause set point samples, and control 4–20 mA outputs.

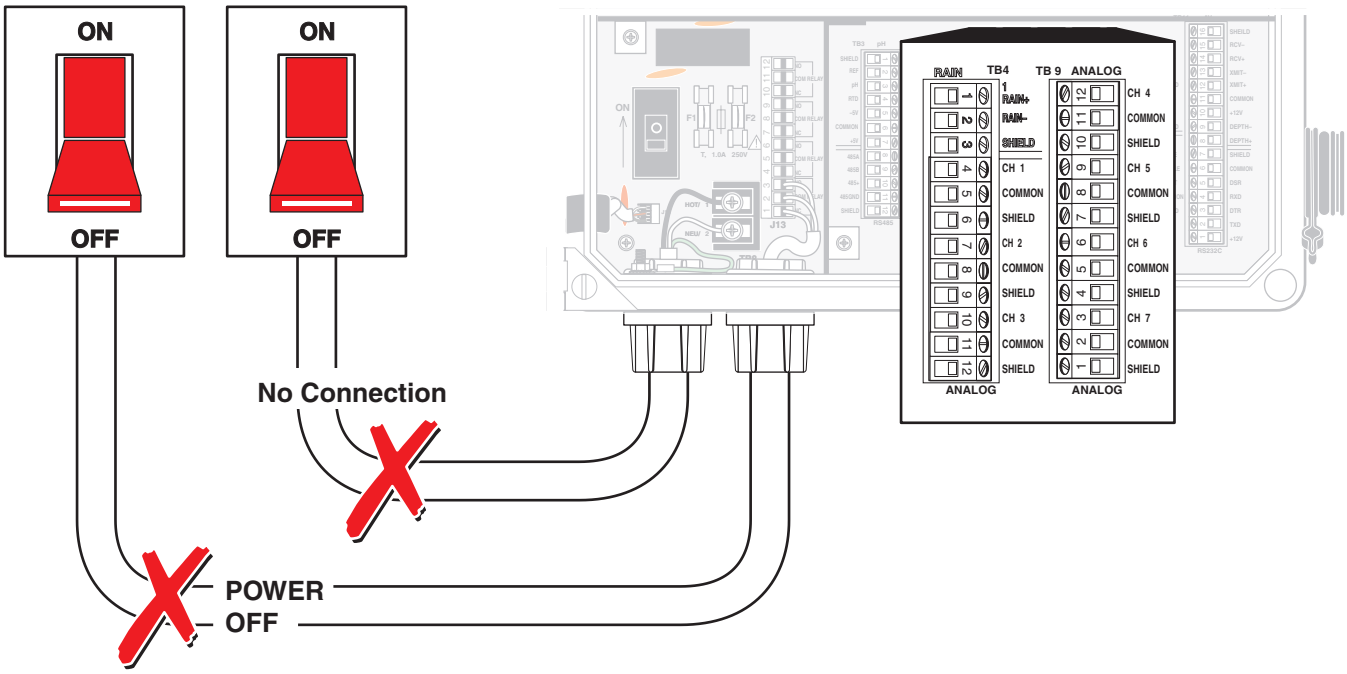
Table 3 Analog Input 4–20 mA dc Terminal Block Connections (TB4)

Input	Pin	Signal Description
Channel 1	4	4–20 mA dc
	5	common
	6	shield
Channel 2	7	4–20 mA dc
	8	common
	9	shield
Channel 3	10	4–20 mA dc
	11	common
	12	shield

Table 4 Analog Input Voltage Terminal Block Connections (TB9)

Input	Pin	Signal Description
Channel 4	12	-4.5 to +4.5 V dc
	11	common
	10	shield
Channel 5	9	-4.5 to +4.5 V dc
	8	common
	7	shield
Channel 6	6	-4.5 to +4.5 V dc
	5	common
	4	shield
Channel 7	3	-4.5 to +4.5 V dc
	2	common
	1	shield

Figure 14 Locating TB4 and TB9 for Analog Input Connections



2.9 Wiring the Mechanical Totalizer

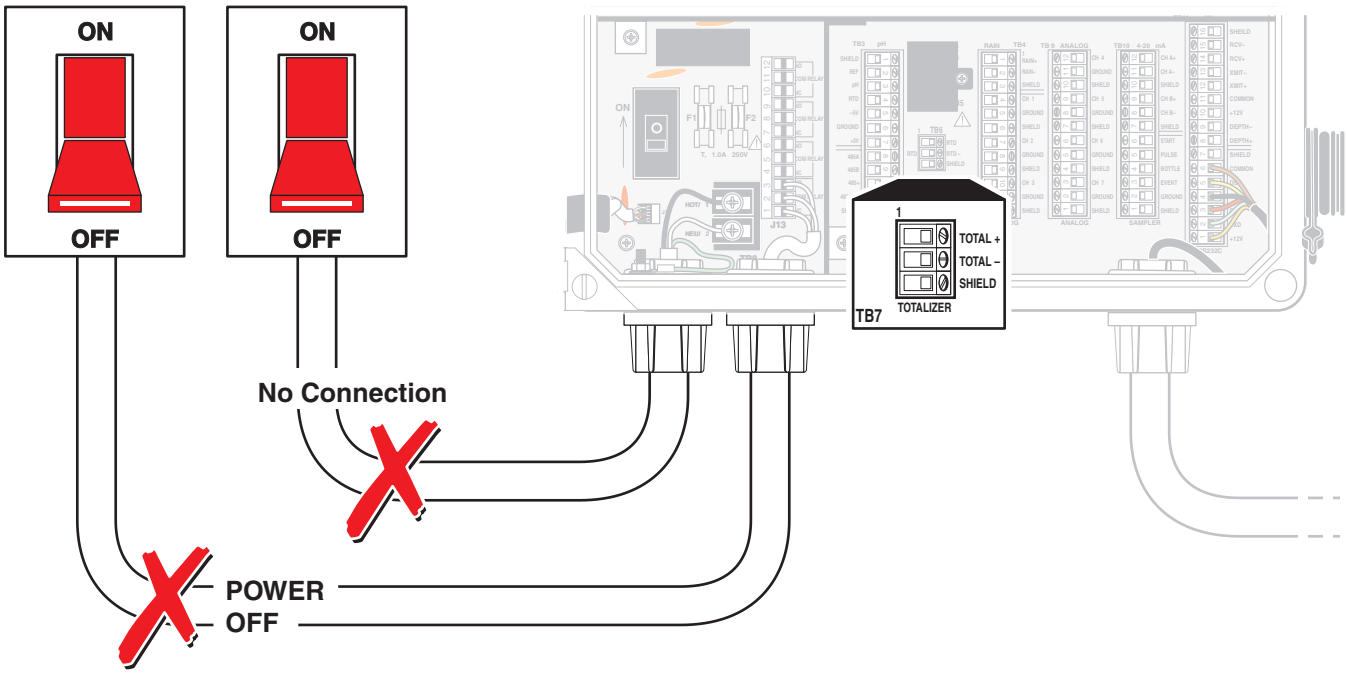
Note: *Use NEMA-approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter the enclosure.*

1. Disconnect all power to the 980 Flow Meter. Refer to Wiring Safety Information\ on page 27.
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Open the cover.
3. Strip the insulation from the mechanical totalizer leads ¼ inch.
4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the cable wires through this opening.
5. Connect wires to the proper terminal block connection (TB7), shown in Table 5 and Figure 15.

Table 5 Mechanical Totalizer Terminal Block Connections (TB7)

Pin	Signal Description
1	Total +
2	Total -
3	Shield

Figure 15 Locating TB7 for Mechanical Totalizer Connection



2.10 Wiring the Alarm Relays

DANGER
The relay connection area is designed for only high voltage (30-230 V ac) connections. A shock hazard can exist if low voltage (<30 V) connections are made in the relay connection area.

The alarm wiring can be sized according to the load being used. The relay connector will accept wire sizes from 18 AWG to 12 AWG. Do not use wire smaller than 18 AWG.

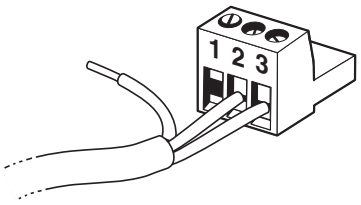
The alarm relays have unpowered contacts, and the power to operate the load is supplied by the user. Figure 16 shows a typical wiring configuration. The wires are routed through the conduit hole and are connected to the circuit board. Voltage range is 30–230 V ac, 50/60 Hz. The alarm relays can switch resistive loads of up to 5 A.

Table 6 Relay Terminal Block Connections (J13)

J13	Signal Description	J13	Signal Description
1	normally closed 1	7	normally closed 3
2	common relay 1	8	common relay 3
3	normally open 1	9	normally open 3
4	normally closed 2	10	normally closed 4
5	common relay 2	11	common relay 4
6	normally open 2	12	normally open 4

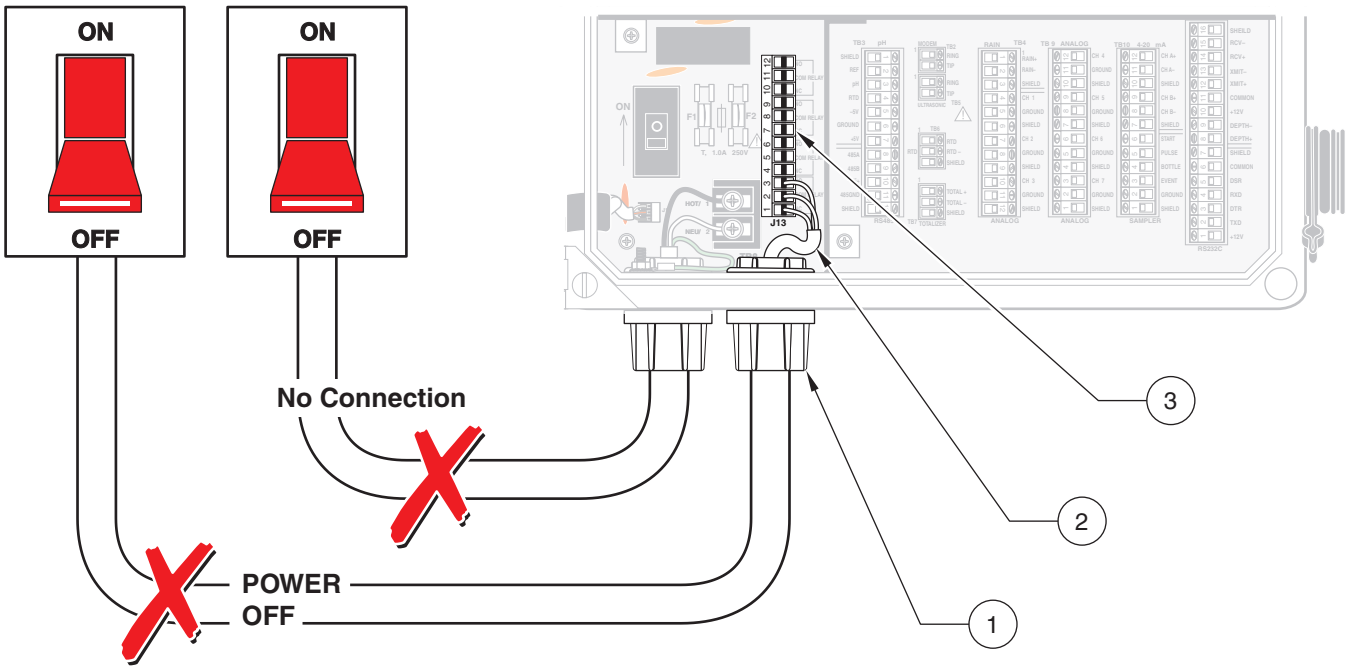
Note: *Current to the relay contacts must be limited to 5 amps. A means to remove power from the relays locally in case of an emergency or for servicing the product must be provided by the user. This can be accomplished with an external switch and a 5-amp fuse or with a switched 5-amp circuit breaker.*

Note: *Use NEMA-approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter the enclosure.*



1. With the power disconnected to the controller, use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Refer to Wiring Safety Information\ on page 27.
2. Open the cover.
3. Strip the insulation from alarm relay leads ¼ inch.
4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the cable wires through this opening.
5. Pull out the twelve-pin removable terminal block. See Figure 16 for terminal block position.
6. Insert each bare wire end into the supplied twelve-pin connector until the wire insulation is seated against the connector. Do not leave any of the bare wire exposed.
7. Plug the connector back onto the circuit board.

Figure 16 Locating TB13 for Alarm Relay Connection



1. Appropriate strain relief, or seal.	**2.** One relay connection shown.	**3.** J13, 12-pin terminal block

2.11 Wiring the Rain Gauge

An external “tipping bucket” rain gauge (such as Cat. No. 9708400) can be connected to the rain gauge connector of the 980 Flow Meter. The rain gauge provides a dry contact closure to the flow meter.

1. Disconnect all power to the 980 Flow Meter. See Wiring Safety Information\ on page 27.
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Open the cover.
3. Strip insulation from the rain gauge leads ¼ inch.

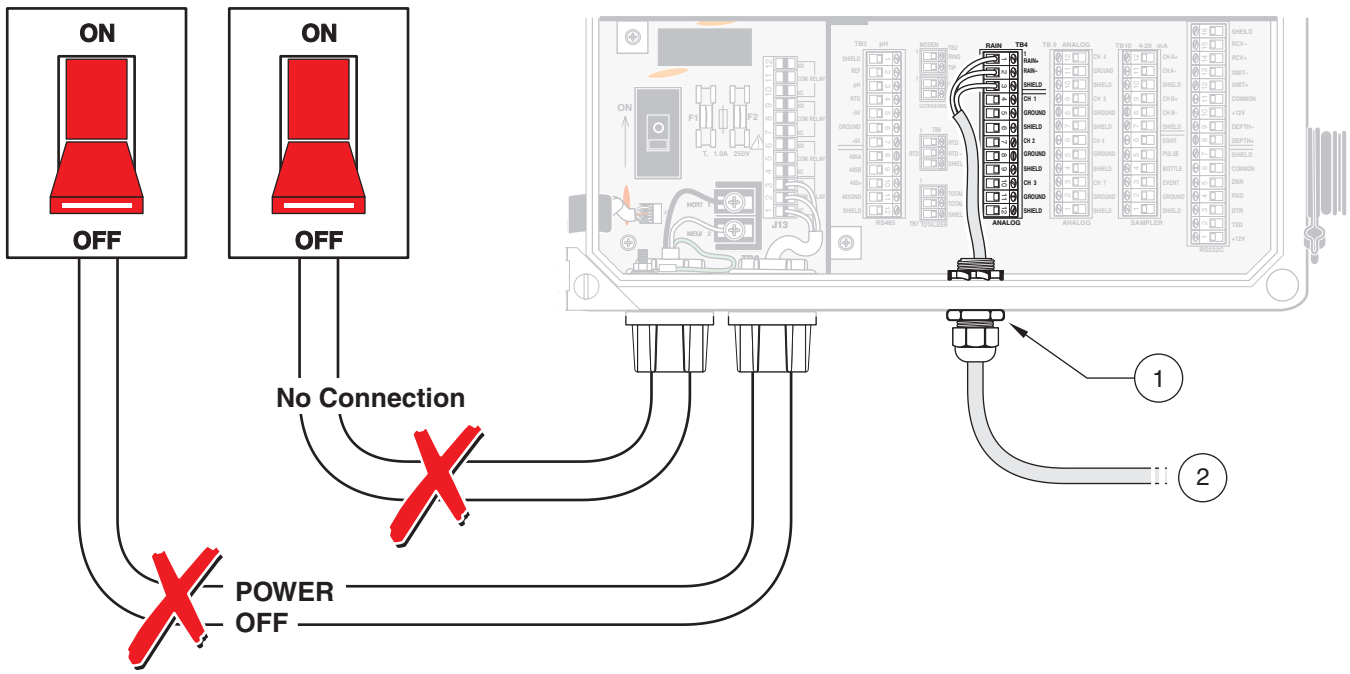
Note: *Route wires through NEMA-approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter the enclosure.*

4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the wires through this opening.
5. Connect wires to the proper screw terminal block (TB4). Refer to Table 7 and Figure 17.

Table 7 Rain Gauge Terminal Block Connections (TB4)

Pin	Signal Description
1	Rain + (pos)
2	Rain - (neg)
3	Shield

Figure 17 Connecting to a Rain Gauge



1. Strain Relief	**2.** Input from Rain Gauge

2.12 Wiring the Sampler

1. Disconnect all power to the 980 Flow Meter. See Wiring Safety Information\ on page 27.
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Open the cover.
3. Strip insulation from the sampler leads ¼ inch.
4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the wires through this opening.
5. Connect wires to the proper screw terminal block (TB10). Refer to Table 8 and Figure 18 for wire connections.

Note: *Route wires through NEMA-approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter the enclosure.*

Cable Required for Sampler Connections

- Multi-Purpose Half Cable Assembly, 10 ft (3.0 m), 6-pin connector on one end, tinned wire leads on the other end (Cat. No. 9708700).

Figure 18 Locating TB10 for Sampler Connections

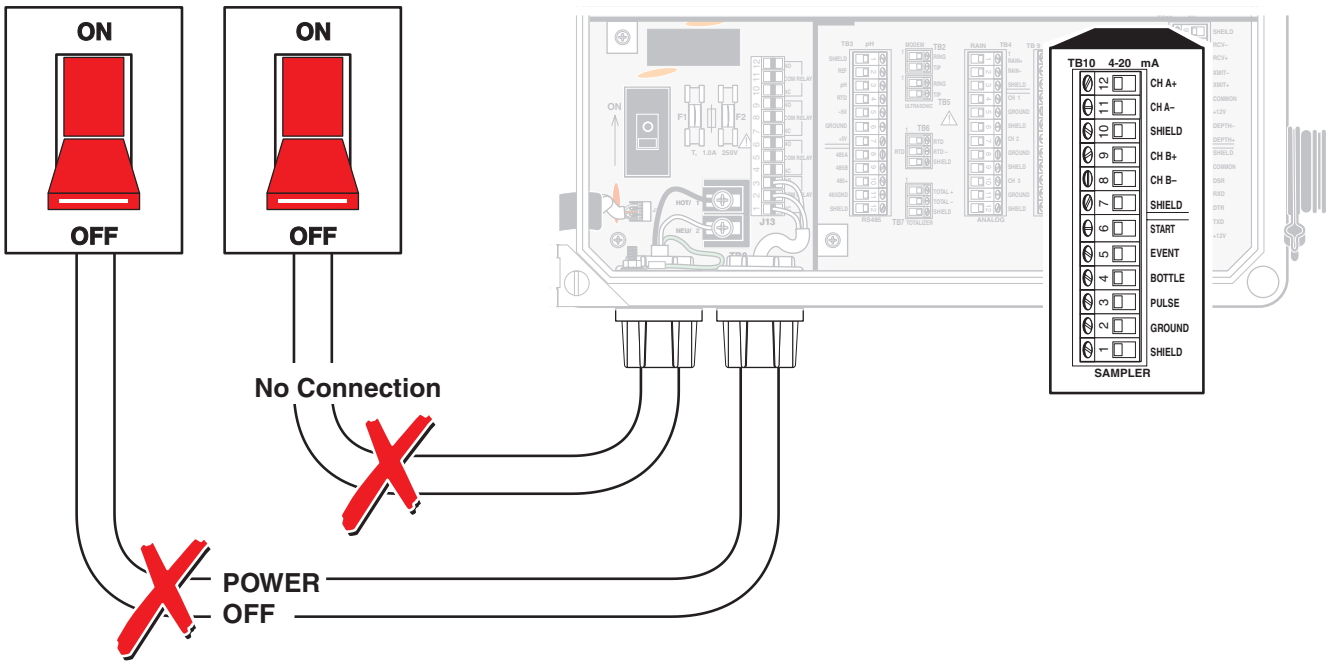


Table 8 Sampler Terminal Block Connections (TB10)

Pin	Signal Description	Wire Color	Purpose	Rating
1	shield	—	Noise Suppression	N/A
2	common	brown	Provides the ground line used in conjunction with the other signals on the connector.	N/A
3	flow pulse output	yellow	Used in conjunction with common signal to notify that a pre-determined amount of flow has accumulated.	12 to 15 V dc
4	bottle number input	green	Received from a wastewater sampler and used in conjunction with the Event Input signal. It tells the flow meter which bottle was used when a sample was taken. “Sample Times and Dates” information will appear in the data printout when downloaded.	0 to 5 V dc input (10 K ohm pull up to 5 V)
5	event input	red	Received from a wastewater sampler and indicates that a sample has been collected. “Sample Taken” information will appear in the data printout when downloaded.	0 to 5 V dc input (11 K ohm input resistance)
6	sampler start output	black	Used to “wake up” a wastewater sampler when a set point condition is met so that it can begin its sampling program. Configure the flow meter for this pin in Set Point Sampling on page 109. Used in conjunction with common, this line is normally allowed to float and is switched to ground (by transistor) for the entire period that the set point condition exists.	12 V dc (max) at 100 mA (max) open collector output

2.13 Wiring the RS232

Note: *Do not connect the RS232 port to more than one external device at the same time. Connecting an external device to both the side panel quick-connect fitting and the terminal circuit board inside the 980* Flow Meter *can cause instrument failure and unreliable communications.*

The quick-connect RS-232 connector is located on the side panel of the 980 Flow Meter housing. The RS232 is intended for temporary connection between a PC and 980 Flow Meter using a serial interface cable (Cat. No. 1727) or a DTU-II. The 980 Flow Meter also allows for a permanent connection that is routed by an external communications cable to the 980 Flow Meter through a conduit opening.

Permanent Conduit Connection

1. With power to the controller off, use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Open the cover. See Wiring Safety Information\ on page 27.

Note: *To minimize electromagnetic affects on the 980 Flow Meter performance shielded cable is required. To ensure that ground currents in inadequate ground systems do not result in potential shock hazards do not connect the shields at both ends of the cable.*

2. Disconnect the RS232 Quick-connect attached to the TB11 pins. No wires should remain in the socket.

3. To prevent dangling wires from touching the circuit nodes, tape each individual wire then bundle the wires and tape wires together. See Figure 19.

4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the RS232 permanent connection 6-wire cable and five conductors with shield.

Note: *Route wires through NEMA-approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter the enclosure.*

5. Strip the outer insulated jacket back 2 inches from the end of the RS232 cable. Use care when removing the outer jacket to ensure that the insulation around the inner conductors is not nicked. Nicked insulation on inner conductors can lead to shorting.

6. Strip insulation of the individual wires back ¼ inch.

7. Connect each bare wire end to the proper screw terminal block (TB11). Refer to Table 9 and Figure 19. Do not leave any of the bare wire exposed.

8. Connect the cable shield to protective earth (ground) at the 980 Flow Meter. Do not connect the cable shield at the remote end of the cable. Cut the cable jacket back far enough to expose the conductors and remove the shield by cutting it even with the cable jacket. Insulate the remaining exposed shield with tape or heat shrink tubing.

Table 9 Conduit RS232 Terminal Block Connections (TB11)

Pin	Signal Description
2	TXD
3	DTR
4	RXD
5	DSR
6	common
7	shield

Reconnecting the RS232 Quick-Connect

1. With the power to the controller off, use a flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover.

2. Disconnect the RS232 permanent conduit connection.

3. Connect RS232 side connector Quick-connect to the hub on the side panel of the instrument.

4. Wire the RS232 side-connector. Refer to Table 10 and Figure 19.

Table 10 Side Connector RS232 Terminal Block Connections (TB11)

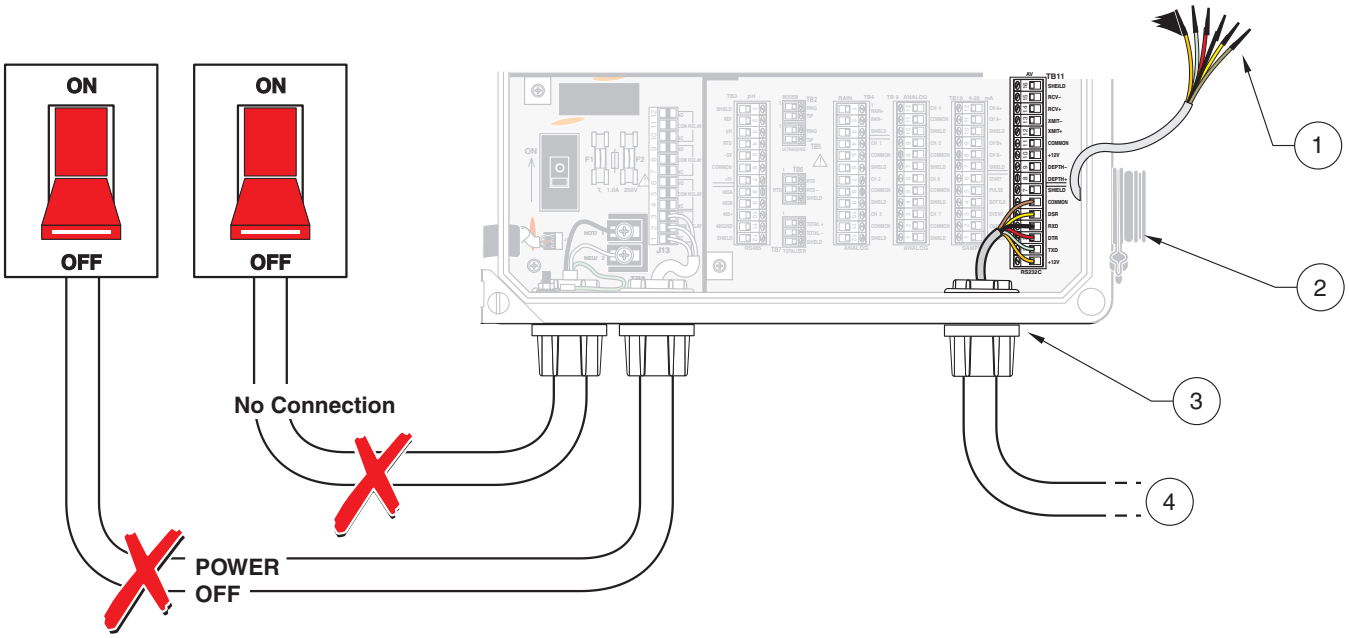
Pin	Signal Description	Wire Color
1	+12 V	orange
2	TXD	green
3	DTR	red
4	RXD	black
5	DSR	yellow
6	Common	brown

This serial interface can be used for the SCADA-Modbus interface.
See Appendix D on page 117.

This port may be configured to communicate at 1200, 2400, 4800, 9600, or 19,200 baud.

Cable Required
RS232 Flow Meter to PC Cable Assembly, 10 ft (3.0 m) long, 6-pin connector on one end, 9-pin connector on the other end (Cat. No. 1727).

Figure 19 RS232 Wiring Connections



1.	Disconnect wires and secure appropriately.	**3.**	Conduit Hub
2.	RS-232 Quick Disconnect (shown disconnected)	**4.**	RS-232 Input/Output

2.14 Wiring the Modem Interface

DANGER
Use care when making modem connections as high voltage may be present on the phone wires!

DANGER
Users should not attempt to make electrical connections themselves, but should contact the appropriate electric inspection authority, or electrician, as appropriate

Use this connection with the internal modem and a standard dial-up public telephone line. This interface can also be used for the SCADA-Modbus interface. See Appendix D on page 117.

The Load Number (LN) assigned to each terminal device denotes the percentage of the total load to be connected to a telephone loop which is used by the device to prevent overloading. The termination on a loop may consist of any combination of devices subject only to the requirement that the total of the Load Numbers of all the devices does not exceed 100.

1. Disconnect all power to the 980 Flow Meter. See warning in Wiring Safety Information\ on page 27.
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Open the cover.
3. Use a Phillips screwdriver to remove the modem terminal protective cover. See Figure 20.

Note: *Route wires through NEMA-approved conduit hubs (Cat. No. 16483) to ensure that water and dust do not enter the enclosure.*

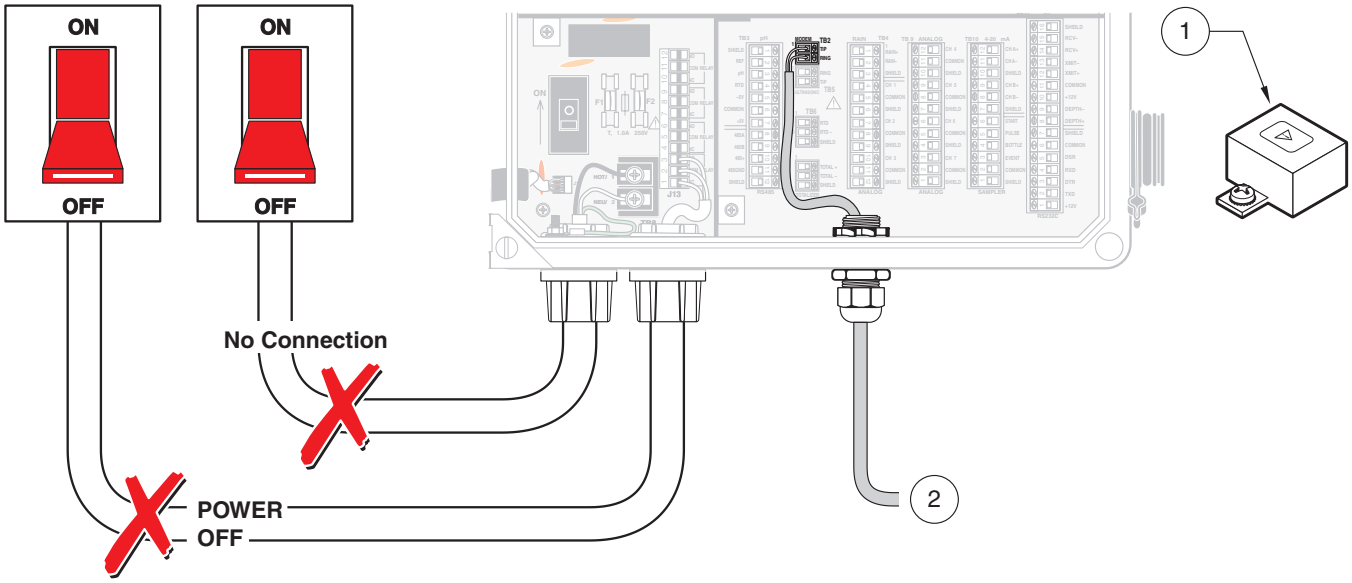
4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the modem cable wires through this opening.
5. Strip insulation ¼ in. from the modem leads.
6. Connect wires to the proper screw terminal block (TB2) as shown in Table 11 and Figure 20.

7. To ensure protection against electrical shock, reinstall the protective cover (Cat. No. 49170-00) over the modem terminal connections.

Table 11 Modem Terminal Block Connections (TB2)

Pin	Signal Description
1	tip
2	ring

Figure 20 Modem Wiring Connections



1. Protective Cover for TB2	**2.** Cable to Modem

2.15 Wiring the pH Sensor

The pre-amp junction box (Cat. No. 9708300) is used to connect the pH probe to the 980 Flow Meter. The pH probe wires attach to a terminal strip in the junction box.

2.15.1 pH Junction Box to Instrument

To connect the pH junction box to the 980 Flow Meter follow the steps below and refer to Figure 21.

1. Disconnect ac power from the 980 Flow Meter. See warning information in Wiring Safety Information\ on page 27.

2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 Flow Meter cover. Open the cover.

3. Strip the insulation from the pH junction box leads ¼ inch.

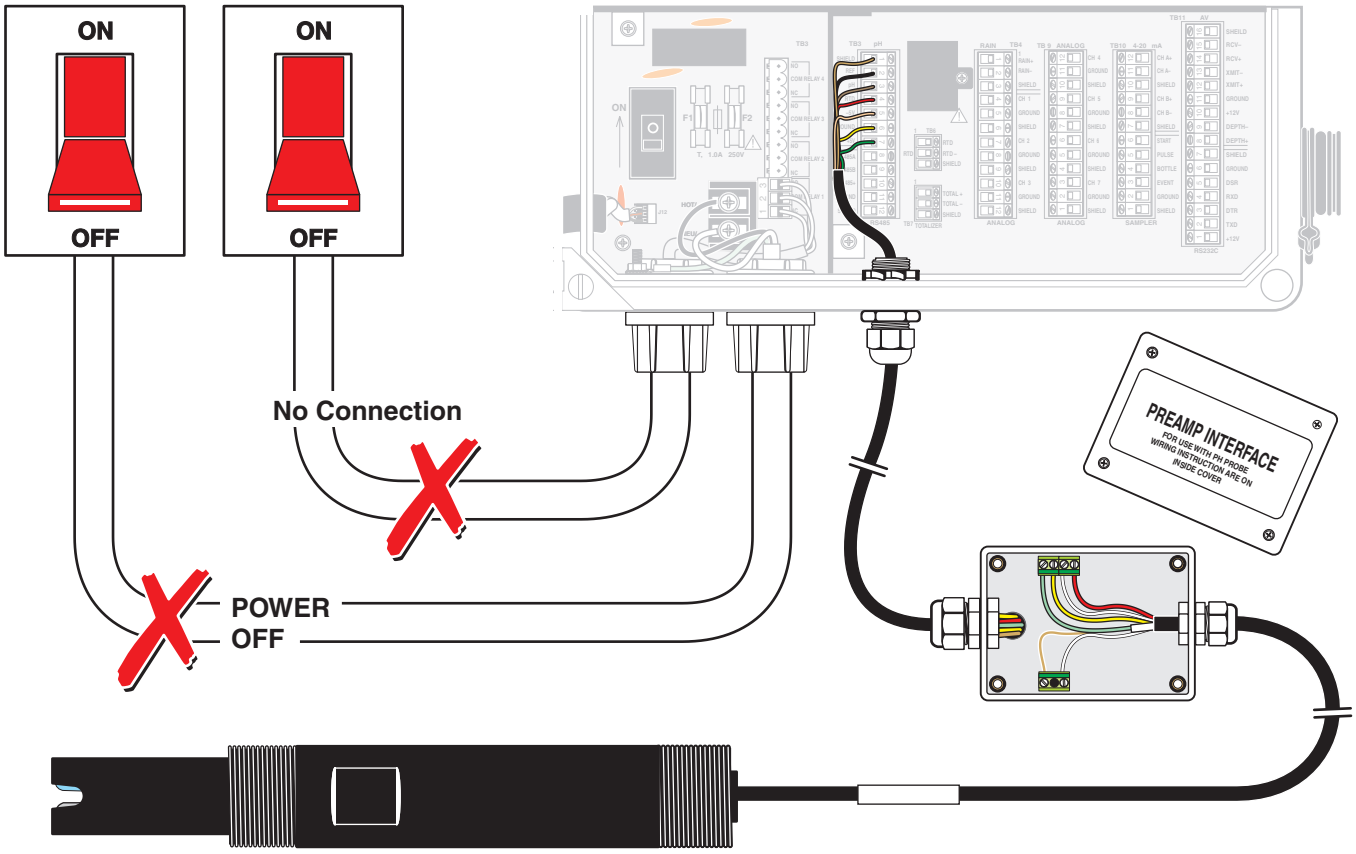
4. Route the cable (Cat. No. 9708800) from the pH junction box through a NEMA-rated compression fitting (Cat. No. 16483) or conduit to one of the ½ in. openings on the bottom of the 980 Flow Meter.

5. Connect the wires to the proper screw terminal blocks (TB3). Refer to Table 12 and Figure 21.

Table 12 pH Terminal Block Connections (TB3)

Pin	Signal Description	Wire Color
1	shield	clear
2	reference	black
3	pH	brown
4	RTD	red
5	- 5 V dc	orange
6	common	yellow
7	+ 5 V dc	green

Figure 21 Junction Box to Instrument



2.15.2 pH Probe to Junction Box

Note: *pH sensor wire connections are found inside the junction box cover.*

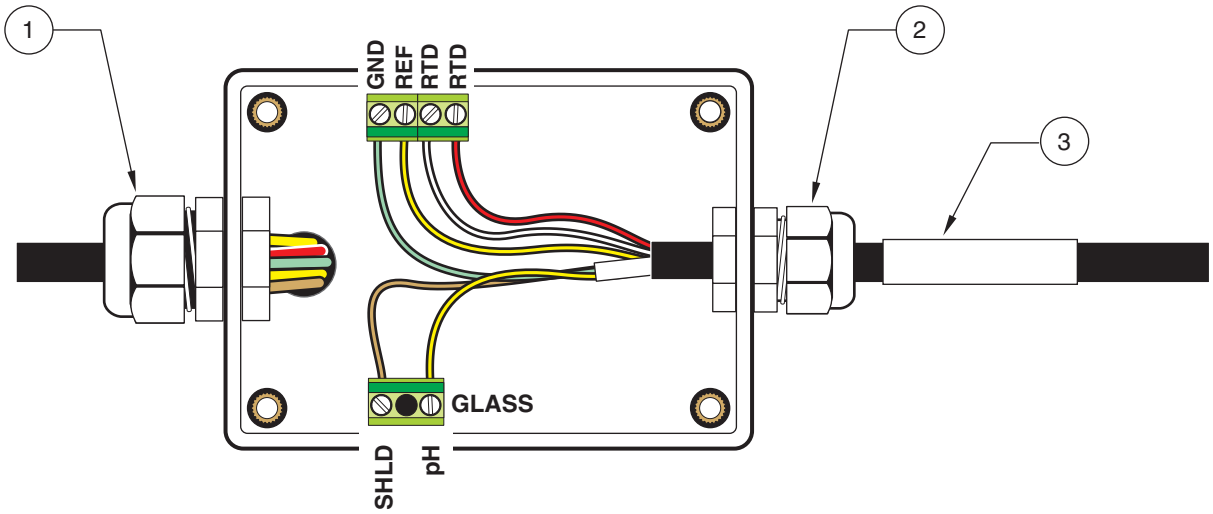
To connect the pH Sensor to the pH Junction Box:

1. Remove the four hold-down screws and nylon taper seals on the cover of the pH junction box with a Phillips-head screwdriver. Remove the cover.
2. Loosen the compression fitting and route the pH sensor cable through the fitting. Pull the cable into the junction box.

Note: *Pull excess slack cable out of the junction box and tighten the compression fitting on the box.*

3. Connect the pH sensor wires to the screw terminals. Refer to Figure 22.
4. Replace the cover, the cover gasket, and the nylon taper seals on all four screws.

Figure 22 pH Probe to Junction Box



1. Pre-wired strain relief	**2.** Compression Fitting (NEMA-approved strain relief)	**3.** pH Probe Cable

2.16 Wiring the Downlook Ultrasonic Sensor

Note: *To ensure protection against electrical shock reinstall cover over sensor terminal connection.*

1. Disconnect all power to the 980. Refer to Wiring Safety Information\ on page 27.
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 cover. Open the cover.
3. Remove the protective cover over the sensor terminal connection.

Note: *Route wires through NEMA-approved conduit hubs (Cat. No. 16483) to ensure water and dust do not enter the enclosure.*

4. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the ultrasonic cable through the opening.
5. Install wires to the proper screw terminal block (TB5 and TB6). Refer to Table 13 and Table 14 for connection pin assignments and Figure 23.

6. To ensure protection against electrical shock reinstall the protective cover over the Ultrasonic + and - terminal connections.

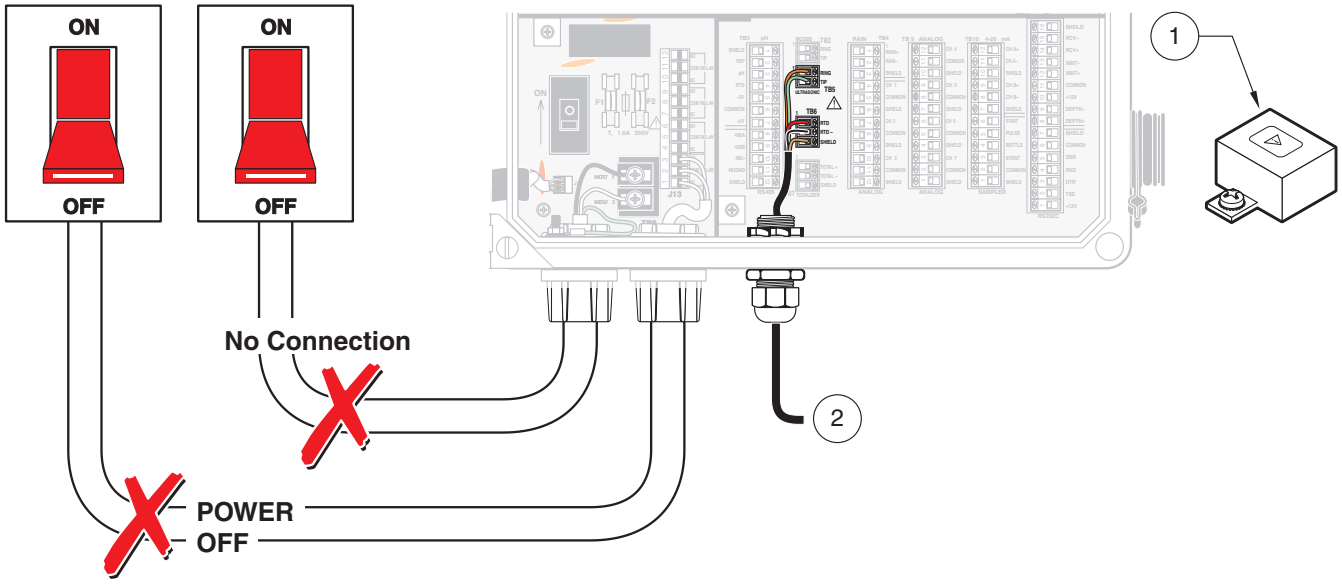
Table 13 Ultrasonic Terminal Block Connections (TB5)

Pin	Signal Description	Wire Type	Wire Color
1	Ult + (pos)	Coax Inner Conductor	yellow
2	Ult - (neg)	Coax Outer Conductor	orange

Table 14 Ultrasonic Terminal Block Connections (TB6)

Pin	Signal Description	Wire Color
1	RTD + (pos)	red
2	RTD - (neg)	black
3	shield	clear

Figure 23 Ultrasonic Transducer Connections



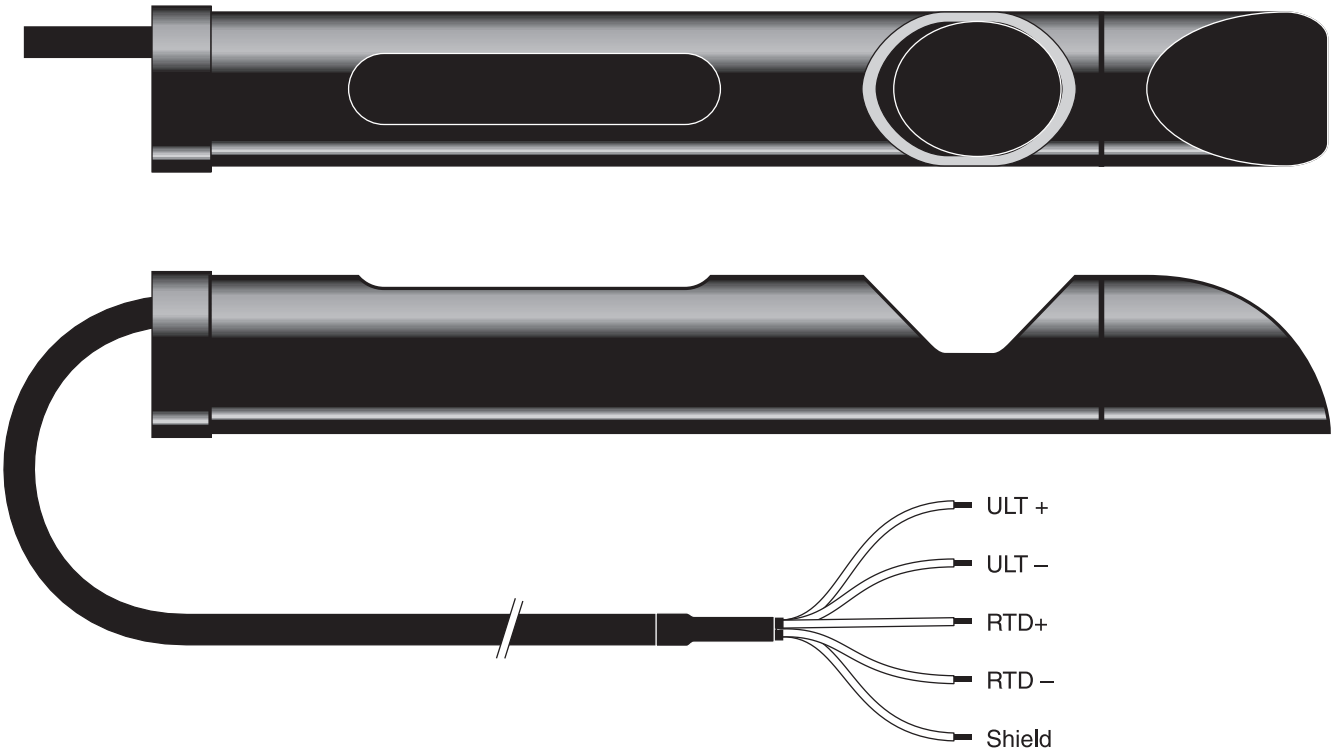
1. Protective Cover for TB5 and TB6	**2.** Cable to Ultrasonic Sensor

2.17 Wiring the In-Pipe Ultrasonic Sensor

The in-pipe ultrasonic sensor is wired to the 980 Flow Meter the same way as the ultrasonic downlook. Refer to section 2.16 Wiring the Downlook Ultrasonic Sensor on page 44

Only install an ultrasonic downlook or an in-pipe ultrasonic sensor to the instrument, they cannot be connected at the same time.

Figure 24 In-Pipe Ultrasonic Sensor



2.18 Wiring the Velocity-Only Sensor

2.18.1 Bare Lead Sensor Cables

Note: *Bare lead connections and Quick-connections cannot be made at the same time.*

Note: *The velocity-only probe and the submerged AV probe cannot be connected at the same time. Disconnect all bare lead connections or submerged AV quick-connect connections to TB11 before connecting a velocity-only bare lead connection. To prevent dangling wires from touching the circuit nodes, tape each individual wire then bundle the wires and tape them together.*

Bare lead sensor cables are used when the cable will be run through a conduit. When conduit is used, it is recommended that the conduit be 1 in. or larger.

Wiring Procedure

1. Disconnect all power to the 980. Refer to the Wiring Safety Information\ on page 27.
2. Use a large flat-blade screwdriver to loosen the two screws securing the 980 cover. Open the cover.
3. Attach a NEMA-approved conduit or compression fitting to one of the ½ in. openings on the bottom of the instrument, and route the velocity-only cable wires through the opening
4. Connect the bare leads to the proper screw terminal block (TB11) as shown in Table 15

Table 15 Velocity-Only Sensor Terminal Block Connections (TB11)

Pin	Signal Description	Factory Wire Color[1]	Trimmed Cable Wire Color
10	+ 12 V dc	red	red
11	common	green	green
12	XMIT + (pos)	gray	gray
13	XMIT - (neg)	violet	violet
14	RCV + (pos)	orange	orange
15	RCV - (neg)	yellow	b/w shield
16	shield	clear	clear

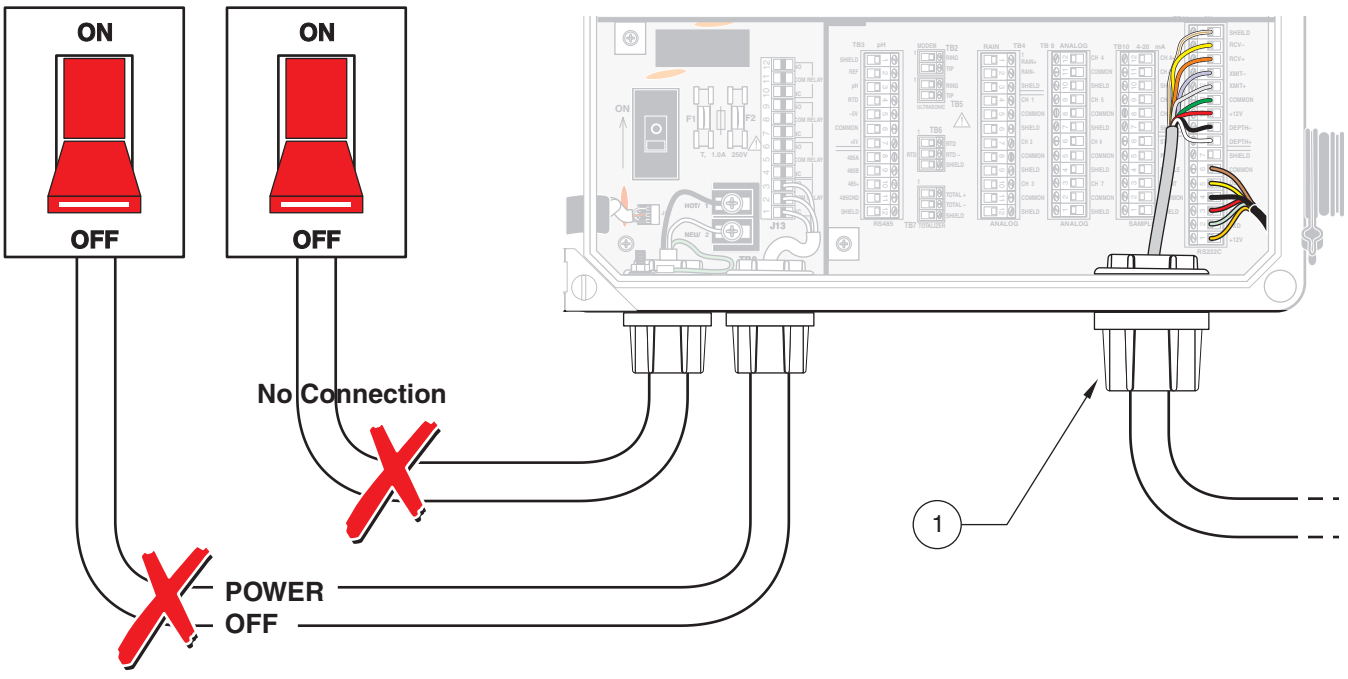
1. If the factory prepared cable end is cut off, the wire colors will no longer match. Use the trimmed cable wire colors.

2.18.2 Velocity-Only Sensor Cable Quick-Connect

The quick-connect hub allows easy installation and removal of the velocity-only sensor. Refer to Figure 25 on page 47. To connect the velocity-only sensor cable to the quick-connect hub:

1. Remove the rubber cap on the quick-connect hub.
2. Place the connector-end of the cable to the quick-connect hub and tighten the connection by turning the cable connector securement ring clockwise.

Figure 25 Quick-Connect Hub



1.	Quick-connect Hub

2.19 Wiring the Submerged Area Velocity Sensor

2.19.1 Bare Lead Sensor Cables

Note: *Bare lead connections and Quick-connections cannot be made at the same time.*

Bare lead sensor cables are used in those cases when the cable will be run through a conduit. When conduit is used, it is recommended that the conduit be 1 in. or larger to the junction box and ½ in. to the instrument.

2.19.1.1 Junction Box Connection Procedure

Connect the bare leads to the flow meter using a junction box (Cat. No. 9702500). This junction box is a physical connection point for the sensor wires and breather tubing.

1. Disconnect all power to the 980 Flow Meter. Refer to Wiring Safety Information\ on page 27.
2. Loosen the four cover screws and remove the cover from the junction box. Unscrew the cable-clamp hex nut on the box enough to allow insertion of the sensor cable.
3. Insert the sensor cable into the box.
4. Refer to the wiring diagram on the inside cover of the box. Connect each wire to its corresponding screw terminal in the upper row, according to the wire colors listed in that diagram. See Figure 26 on page 49

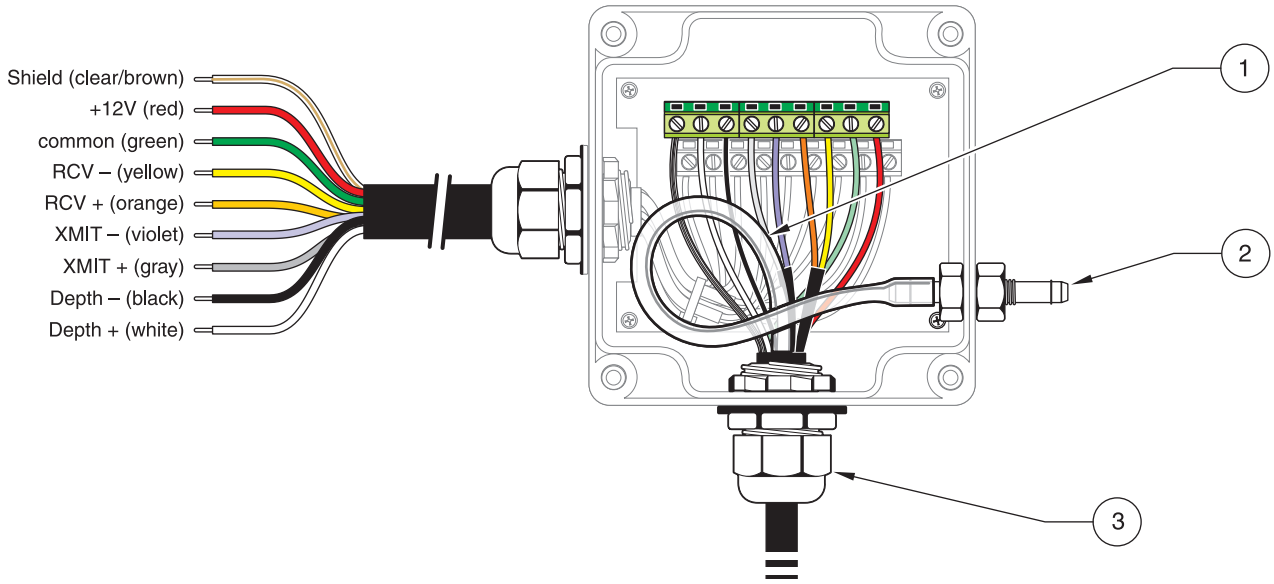
Note: *The submerged AV probe and the velocity-only probe cannot be connected at the same time. Disconnect all bare lead connections or submerged AV quick-connect connections to TB11 before connecting a submerged AV bare lead connection. Refer to* *section 2.18 on page 46.*

5. Connect the cable tubing to the clear tubing that is connected to the exit fitting in the junction box.
6. Create a strain relief by slipping the cable in or out of the box to sufficiently create a slight loop in the wires and tubing. Tighten the cable clamp hex nut.
7. Verify that the sealing gasket is in place in the cover, then replace the cover on the junction box and tighten screws.
8. Connect clear tubing between the top tubing nipple on the desiccant canister and the brass tubing nipple on the junction box.
9. Connect the short, bare wire cable to TB11. Refer to Table 16 and Figure 27 on page 49.

Table 16 Submerged Area Velocity Sensor Terminal Board Connections (TB11)

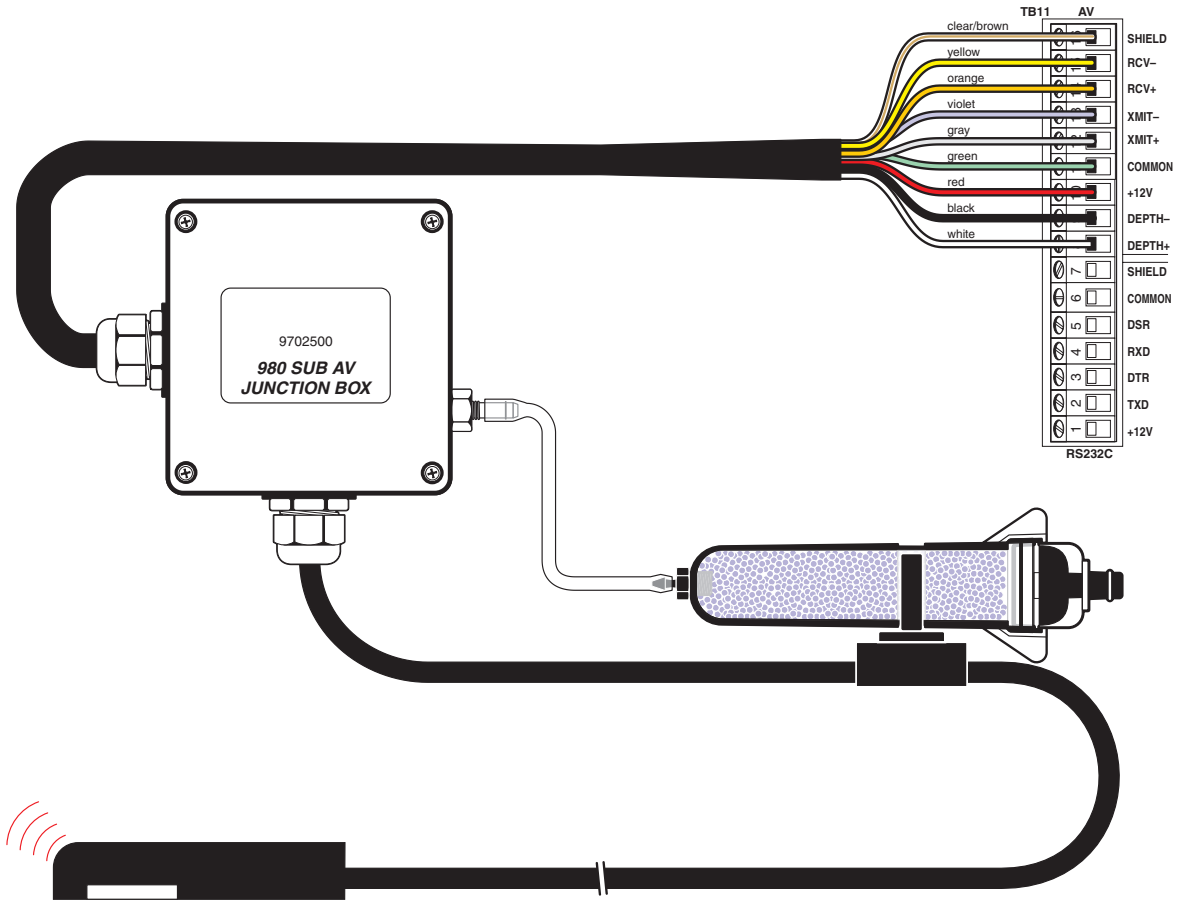
Pin	Signal Description	Wire Color
8	Depth + (pos)	white
9	Depth - (neg)	black
10	+ 12 V dc	red
11	common	green
12	XMIT + (pos)	gray
13	XMIT - (neg)	violet
14	RCV + (pos)	orange
15	RCV - (neg)	yellow
16	shield	clear/brown

Figure 26 Submerged Area Velocity Junction Box Connections



1. Sensor Cable Tubing	**2.** Brass Tubing Nipple	**3.** Cable Clamp Hex Nut

Figure 27 Junction Box, Probe, Cable Connection, and Desiccant Canister



2.19.2 Submerged Area Velocity Sensor Cable Quick-Connect

The quick-connect hub allows easy installation and removal of the submerged area velocity sensor. Connect the submerged area velocity sensor cable to the quick-connect hub:

1. Remove the rubber cap on the quick-connect hub. See Figure 25.

2. Place the connector-end of the cable to the quick-connect hub and tighten the connection by turning the cable connector securement ring clockwise.

2.19.2.1 Desiccant Cartridge

Make sure vinyl tubing is securely fastened at both fittings (Figure 27). Failure to do so will allow fluid or moisture to pass down or block the pressure transducers reference port. This will result in faulty readings and could lead to sensor failure.

During installation, arrange the sensor so that the desiccant cartridge hangs down as shown in the Figure 27.

OPERATION

DANGER

Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.

DANGER

La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.

PELIGRO

La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.

GEFAHR

Das Arbeiten mit chemischen Proben, Standards und Reagenzien ist mit Gefahren verbunden. Es wird dem Benutzer dieser Produkte empfohlen, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.

PERICOLO

La manipolazione di campioni, standard e reattivi chimici può essere pericolosa. La preghiamo di prendere conoscenza delle Schede Techniche necessarie legate alla Sicurezza dei Materiali e di abituarsi con tutte le procedure di sicurezza prima di manipolare ogni prodotto chimico.

3.1 Initial Power-Up of Meter

After power is applied, the flow meter performs a complete diagnostic self-test and displays the menu shown when the unit was last turned off. Set the instrument programming features when the Main Menu is displayed. The Main Menu is the starting point for all programming operations. The Main Menu offers four choices:

- Setup—Basic programming
- Status—Lists all currently measured readings
- Display Data—Shows graphs and tables of logged data (See Displaying Data on page 101)
- Options—Advanced programming

Setup and Options functions lead to sub-menus and will configure the basic and advanced features of the flow meter. Refer to the 980 Quick-Start Guides on page 133. The Display Data and Status lead to sub-menus and will provide information only. Press **STATUS** to display any data channels that have enabled logging (flow, pH, temp., etc.).

3.2 Basic Programming

Note: *To make changes to the program entries after the basic programming setup, press the* ***MAIN MENU*** *key and select* ***SETUP>MODIFY SELECTED ITEMS.*** *Highlight the program entry using the* ***UP*** *and* ***DOWN*** *keys.*

Basic programming setup must be performed, in its entirety, after the instrument is installed. Refer to the 980 Quick-Start Guides on page 133 for more information. The basic program setup will modify all items:

- Flow Units
- Primary Devices
- Program Lock
- Sampler Pacing
- Site ID
- Velocity Direction
- Velocity Units
- Velocity Cutoff/Velocity Default

Step 1 - Setup

1-A. Press **SETUP** from the Main Menu to prepare the flow meter for use.

1-B. Press **MODIFY ALL ITEMS** and press **ACCEPT** to begin setting up the flow units.

11:00 AM 21 - APR - 01	* Main Menu*
DISPLAY DATA	SETUP
OPTIONS	STATUS
READY TO START	

11:00 AM 21 - APR - 01	* Main Menu*
LOGIN	MODIFY ALL ITEMS
REVIEW ALL ITEMS	MODIFY SELECTED ITEMS
READY TO START	

Step 2 - Flow Units

Note: *Different flow units can be selected in the Sampler Pacing programming section (see section 4.6.1 on page 68).*

2-A. From the Modify All Items screen, highlight Flow Units using the **UP** and **DOWN** keys. Press **SELECT**.

2-B. Press **CHANGE CHOICE** to cycle through the flow unit choices. Refer to Table 17 for flow unit choices. The flow unit will be used whenever a flow reading is displayed or logged.

2-C. When the desired choice is displayed press **ACCEPT** to continue and set level units.

11:00 AM 21 - APR - 01		FLOW UNITS
ACCEPT	FLOW UNITS mdg	CHANGE CHOICE CANCEL
	SELECT APPROPRIATE UNITS	

Table 17 Flow Unit Choices

Abbreviation	Flow Unit	Abbreviation	Flow Units
gps	Gallons per second	cfs	Cubic feet per second
gpm	Gallons per minute	cfm	Cubic feet per minute
gph	Gallons per hour	cfh	Cubic feet per hour
lps	Liters per second	cfd	Cubic feet per day
lpm	Liters per minute	cms	Cubic meters per second
lph	Liters per hour	cmm	Cubic meters per minute
mgd	Million gallons per day	cmh	Cubic meters per hour
afd	Acre-feet per day	cmd	Cubic meters per day

Step 3 - Level Units

3-A. From the Modify All Items screen, highlight Level Units, using the **UP** and **DOWN** keys. Press **SELECT**.

3-B. Select the units of measure to use when displaying level readings (Table 18). Level units of measure are used whenever a level reading is displayed or logged.

Table 18 Level Units Choices

Abbreviation	Level Unit
in.	inches
ft	feet
cm	centimeters
M	meters

3-C. Press **CHANGE CHOICE** to cycle through each of the level unit choices. Press **ACCEPT** to continue to primary device setup.

Step 4 - Primary Device

4-A. From the Modify All Items screen, highlight Primary Device using the **UP** and **DOWN** keys, and press **SELECT**.

4-B. Select the desired primary device, enter the calculation method, shape, and pipe diameter for that primary device.

4-C. Press **CHANGE CHOICE** to cycle through the primary device choices (See Table 19). Table 20, Table 21, and Table 22 show the size and details required for each. Press **ACCEPT** to continue to Program Lock.

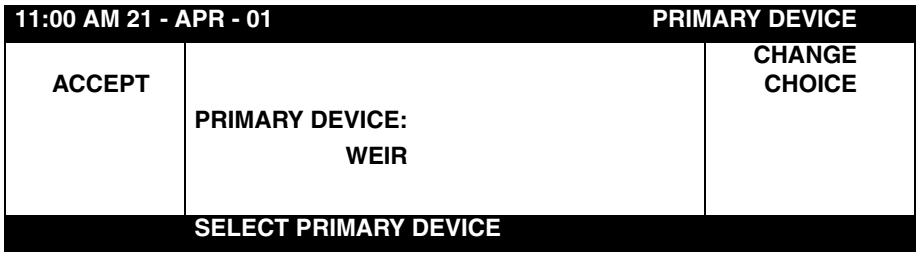


Table 19 Primary Device Choices

Primary Device	Description
None—Level Only	No primary device installed. Level measurement only.
Weir	Compound, Cipolletti, Contracted rectangular, Non-contracted rectangular, Thel-mar, V-Notch (22.5-120°), Compound V-Notch (See Table 20)
Flume	Parshall, Trapezoidal, H-type, HL-type, HS-type, Leopold-Lagco, Palmer Bowlus (See Table 21)
Nozzle	California pipe
Power Equation	Enter variables K_1, K_2, n_1 and n_2 $Q = K_1H^{n1} + K_2H^{n2}$ K_1 (0–9999.99), K_2 (+/- 0–9999.99), n_1 and n_2 (1–9.99)
Head vs. Flow	Two independent user–entered look up tables of up to 100 points each (See Table 22)
Manning Equation	Rectangular channel, U-shaped channel, or Circular pipe (See Table 22)

Table 19 Primary Device Choices (Continued)

Primary Device	Description
Area Velocity	Circular pipe, U-shaped channel, Trapezoidal channel, Rectangular channel (See Table 22)

Table 20 Weir Choices

Weir	Description
Cipolletti	Crest width is in. or cm (1–960 in. or 2.54– 2438 cm)
Contracted Rectangular	Crest width is in. or cm (1–960 in. or 2.54– 2438 cm)
Non-Contracted Rectangular	Crest Width is in. or cm (1–960 in. or 2.54– 2438 cm)
Thel-mar	Size in inches. (6, 8, 10, 12 or 15 in.)
V-Notch	Angle of notch in degrees (22.5 to 120°)
Compound V-Notch	Angle of notch in degrees (22.5–120°), notch depth in inches, rectangular width in inches (0–120 in. or 0–304 cm), Contracted or non-contracted.

Table 21 Flume Choices

Flumes	Description
Parshall	Flume size in inches (1, 2, 3, 6, 9, 12, 18, 24, 30, 36, 48, 60, 72, 84, 96, 108, 120 or 144 in.)
Trapezoidal	Flume size (60° S, 60° L, 60° XL, 45° 2", 45° 12")
H - Type	Flume size in feet (0.5, 0.75, 1.0, 1.5, 2.0, 2.5, 3.0 or 4.5 ft)
HL - Type	Flume size in feet 3.5', 4.0'
HS -Type	Flume size in feet (0.4, 0.6, 0.8 or 1.0 ft)
Leopold-Lagco	Flume size in inches (4, 6, 8, 10, 12, 15, 18, 20, 21, 24, 27, 30, 36, 42, 48, 54, 60, 66 or 72 in.)
Palmer-Bowlus	Flume size in inches (4, 6, 8, 10, 12, 15, 18, 21, 24, 27, 30, 36, 42, 48, 60 or 72 in.)

Table 22 Other Primary Devices

Device or Equation	Description
Head Vs. Flow (two head vs. flow tables are provided)	Enter up to two tables of up to 100 user-defined head vs. flow points. Head: 0– 99.99 in feet or centimeters Flow: 0–99999.99 in any desired units
Manning Equation	Enter pipe diameter, slope & roughness coefficient. Pipe dia.: 4–240 in. or 101–6096 cm Percent Slope: 0.001–1.00 [1 unit per hundred units = 0.01 slope] Example: 1 m of decline every 100 m = 0.01 slope. Manning Roughness
Area Velocity	Circular Pipe: Enter pipe dia., 4–240 in.(10–610 cm) Rectangular Channel: Enter width, 4–999.99 in. (10– 2540 cm). Trapezoidal Channel: Enter width of channel bottom, width of channel top and channel depth, range for all: 4–999.99 in. (10– 2540 cm) U-Shaped Channel: Enter channel width, 4–999.99 in. (10–2540 cm)
Level vs. Area Table (two level vs. area tables are provided)	Enter up to two tables of up to 100 user-defined level vs. area points; Level: 0–999.9 in ft, in., m or cm Area: 1–99999.99 in ft^2, $in.^2$, m^2 or cm^2
Nozzle	Enter nozzle diameter

Step 5 - Program Lock

Program Lock provides a protective passcode to keep unauthorized personnel from tampering with the keyboard. When enabled and a user attempts to change the program, a screen will ask them to enter a password. The Program Lock password is set at the factory as **9800** and cannot be changed.

The meter can also be password locked to prevent remote access via RS232 or modem. InSight® software allows you to change this password.

5-A. From the Modify All Items screen, highlight Program Lock using the **UP** and **DOWN** keys. Press **SELECT**.

5-B. Press **CHANGE CHOICE** to Enable or Disable the program lock. Press **ACCEPT** to continue to Sampler Pacing.

Step 6 - Sampler Pacing

6-A. From the Modify All Items screen, highlight Sampler Pacing, using the **UP** and **DOWN** keys. Press **SELECT**.

6-B. Press **CHANGE CHOICE** to Enable Sampler Pacing.

6-C. Refer to Table 23 for flow unit choices for sampler pacing.

Table 23 Flow Unit Choices for Sample Pacing

Abbreviation	Volume
gal	gallons
ltr	liters
m^3	cubic meters
af	acre-feet
cf	cubic-feet

6-D. Press **ACCEPT** to continue with Site ID.

11:00 AM 21 - APR - 01		SAMPLER PACING
ACCEPT	SAMPLER PACING	CHANGE UNITS
CLEAR ENTRY	500 gal	CANCEL
	(USE NUMERIC KEYPAD)	

Step 7 - Site ID

Creates an 1–8 digit site identification number. The site ID will appear on all data printouts. This feature is useful when multiple sites are monitored using a single flow meter or if data readings from multiple flow meters are collected.

7-A. From the Modified All Items screen, highlight Site ID using the **UP** and **DOWN** keys. Press **SELECT** to continue.

7-B. Enter the site ID using the numeric keypad.

7-C. Press **ACCEPT** to continue to total flow units.

Step 8 - Total Flow Units

8-A. From the Modify All Items screen, highlight Total Flow Units using the **UP** and **DOWN** keys. Press **SELECT** to continue.

8-B. Set the Total Flow Units using the **CHANGE CHOICE** soft key. Total flow units of measure are used whenever a total flow unit is displayed or logged. Refer to Table 24.

Table 24 Total Flow Unit Choices

Abbreviation	Flow Unit
gal	gallons
ltr	liters
m^3	cubic meters
af	acre-feet
cf	cubic feet

8-C. Press **ACCEPT** to continue with velocity direction.

Step 9 - Velocity Direction (only when logging velocity)

9-A. From the Modify All Items screen, highlight Velocity Direction using the up and down arrow soft keys. Press the **SELECT** soft key to continue.

9-B. Set the Velocity Direction the **CHANGE CHOICE** key.

The Velocity Direction feature adapts to a number of difficult sites that would otherwise not be able to measure velocity properly (Upstream, Downstream, and Always Positive).

9-C. Press **ACCEPT** to move to velocity units setup.

9-D. Set the velocity units using the **CHANGE CHOICE** key. Refer to Table 25.

Table 25 Velocity Unit Choices

Abbreviation	Velocity Unit
fps	feet per second
m/s	meters per second

9-E. Read the Velocity cutoff warning on the screen. Press any key to continue.

9-F. Enter the Velocity Cutoff, using the numeric keypad. Press **ACCEPT**.

9-G. Enter the Velocity Default using the numeric keypad. Press **ACCEPT** to end the basic programming setup.

Example 1:

Velocity Cutoff = 0.20 fps
Velocity Default = 0 fps

If the velocity falls below 0.20 fps, the meter will store a value of 0 fps until the velocity increases above 0.20 fps.

Example 2:

Velocity Cutoff = 0.20 fps
Velocity Default = 0.20 fps

If the velocity falls below 0.20 fps, the meter will store a value of 0.20 fps until the velocity increases above 0.20 fps.

3.3 Starting and Stopping Programs

Note: *When selecting "Start From Beginning", all logged data will be cleared from memory. When saving the logged data, make sure the data is downloaded to a DTU or personal computer prior to pressing* ***START FROM BEGINNING****. If a program is complete, the logger can only be restarted from the beginning (and will clear all logged data).*

When basic programming setup is completed, "run" (or execute) the program selections. Press **RUN/STOP** to run a program, resume a currently halted program, or stop a program.

If a program has been halted (and no changes to the program settings were made while it was stopped), press **RUN**. Select either resume to previously running program (and retain all logged data) or Start From Beginning (and clear all logged data).

Status	Description
Program is Running	
	Data Logging, 4–20 mA outputs, sampler control and alarm checking are active.
Program is Halted	
	Logging stops unit the program is restarted. It continues with the last logged value when restarted.
	4–20 mA outputs remain unchanged
	Sampler control is disabled
	Alarm checking is disabled
Program is Complete or Ready to Start	
	No data logging
	4–20 mA outputs stay at last value
	No sampler interface
	No alarm checking
Program Complete	
	A logger has been off for longer than three hours

After wiring the instrument and other devices and performing the basic programming setup program and, when necessary, calibrate the devices. For each sensor program, calibrate, and install the sensors in a pipe. Refer to the 980 Quick-Start Guides on page 133 for more information on programming and calibration. The following external devices are explained in Section 4:

- 4–20 mA Outputs (section 4.1)
- Analog Connection (section 4.2)
- Mechanical Totalizer (section 4.3)
- Alarm Relays (section 4.4)
- Rain Gauge (section 4.5)
- Sampler (section 4.6)
- RS232 (section 4.7)
- Modem Interface (section 4.8)
- pH Sensor (section 4.9)
- Downlook Ultrasonic Sensor (section 4.10)
- In-Pipe Ultrasonic Sensor (section 4.11)
- Velocity-Only Sensor (section 4.12)
- Submerged AV Sensor (section 4.13)

4.1 4–20 mA Output

4.1.1 Programming the 4–20 mA Output

Two 4–20 mA current loop outputs are available for the 980 Flow Meter. These current outputs typically pace other process equipment, such as a wastewater sampler, in proportion to the flow rate.

The dual isolated 4–20 mA current loop outputs on the 980 Flow Meter are unique, they can be assigned to any of the available channels, not just flow. In addition, the 4 mA and 20 mA current levels are programmed to any desired minimum and maximum value for that channel.

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > 4–20 mA OUTPUTS > SELECT**.

Note: *When the 4–20 mA outputs are disabled and not completely turned off, they will continue to output a steady 4 mA.*

2. Press **CHANGE CHOICE** to enable the 4–20 mA outputs while in the 4-20 mA output menu.
3. When the display shows the outputs as enabled, press **ACCEPT**.
4. Highlight Output A or B using the **UP** and **DOWN** keys and press **SELECT.**

5. Select an Input Channel (e.g., channel 1, 2, 3, or, flow, etc.) to assign to that output. Press **CHANGE CHOICE** to cycle through the channel names. When the desired channel is displayed, press **ACCEPT**.

11:00 AM 21 - APR - 01		4–20 mA OUTPUTS
ACCEPT	INPUT CHANNEL: FLOW	CHANGE CHOICE
CANCEL		
	SELECT APPROPRIATE UNITS	

6. Assign a channel value to the 4 mA current value. This value is typically 0, however any value can be set. In other words, enter the value of the input needed to generate 4 mA of current at the output.

11:00 AM 21 - APR - 01		4–20 mA OUTPUTS
ACCEPT	4 mA INPUT VALUE	
CLEAR ENTRY	0.00 mgd	CANCEL
	SELECT APPROPRIATE UNITS	

7. Assign an input value to the 20 mA current level.

8. Repeat this process to configure the other 4–20 mA output.

4.1.2 Calibrating the 4–20 mA Output

After wiring the 4–20 mA connection perform a 4–20 mA output calibration. The 4–20 mA output calibration requires a multimeter and an interface or access to the 4–20 mA current loop wiring. Two 4–20 mA outputs are available and are designated Output A and Output B. Both outputs are calibrated the same way and are isolated from each other.

Calibration may be performed while the 4–20 mA device is in the current loop, as shown in Figure 28 or disconnected from the current loop as shown in Figure 29. In either case, the multimeter must be set to a 20 milliamp dc range or greater.

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > CALIBRATION > 4–20 mA OUTPUTS.**

2. Connect a multimeter to the 4–20 mA current outputs per Figure 28 or Figure 29.

3. Select the Output A or B to calibrate.

4. Press any key to set the selected output to 4.00 mA dc.

5. Measure the current on the selected output using the multimeter and enter the measured value using the numeric keypad. Press **ACCEPT**.

6. Press any key to set the output to 20.00 mA dc.

7. Measure the current on the selected output using the multimeter and enter the measured value using the numeric keypad. Press the **ACCEPT** to complete the calibration.

8. Make sure that the 4–20 mA output is enabled. If it is not enabled, press **CHANGE CHOICE** until the display shows “ENABLED”. Press **ACCEPT**.

By entering the measured current values, the microprocessor will electronically adjust the outputs to compensate for the difference between the measured values and the expected values.

Figure 28 Calibration with the Meter in the Loop

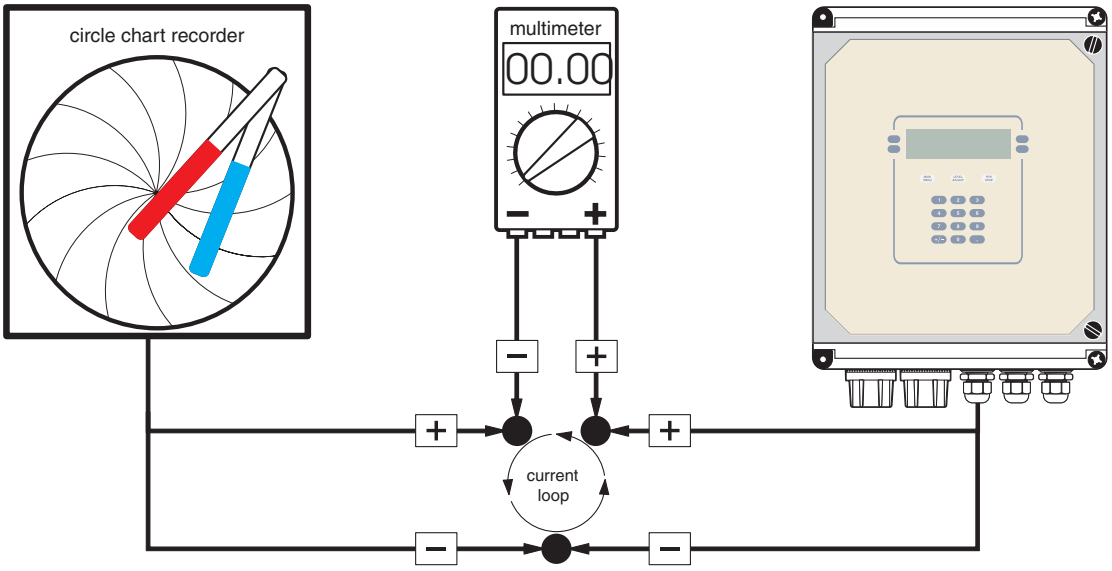
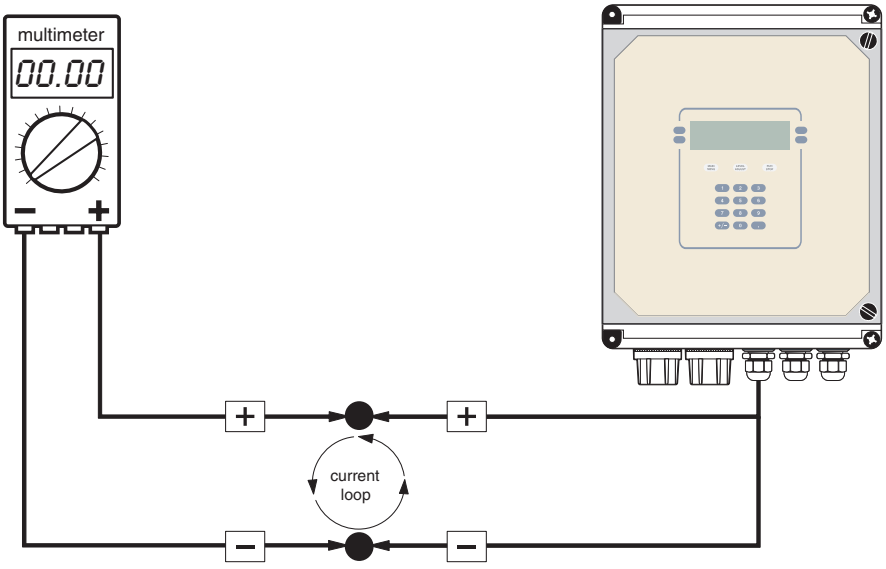


Figure 29 Calibration with the 4–20 mA Device Disconnected from the Loop



4.2 Analog Input

4.2.1 Programming the Analog Inputs

Channels 1 through 7 are analog input channels that can accept a signal from an external device. This signal may range from -4.5 V dc (min.) to +4.5 V dc (max.) or from 4 to 20 mA dc depending on the input selected. In some cases, input signals from certain devices may also fall somewhere within those ranges. For that reason, each analog input channel must be mapped to the minimum and maximum signal limits of the external device.

To map an external device to an analog input channel:

Select an analog input channel (1, 2, and 3 are current inputs and 4 through 7 are voltage inputs).

1. Select Data Log from the Advanced Options menu.
2. Highlight Select Inputs using the **UP** and **DOWN** keys. Press **SELECT**.
3. Highlight the analog channel to log using the **UP** and **DOWN** keys, then press **SELECT**.
4. Press **CHANGE CHOICE** to cycle between Logged and Not Logged, then press **ACCEPT**.
5. Enter a Logging Interval.
6. Select Unit of measurement (pH, ft, °C, °F, mV, gal, m^3, cf, ltr, in., m, cm,$\%_{02}$, 5 H_2S,%lel, V dc, cfh, ppm, ppb, afd, cfs, cfm, cfd, cms, cmm, cmh, cmd, gps, gpm, gph, lps, lpm, lph, or mgd).
7. Enter Low Point.
8. Enter High Point.
9. Select another channel to configure, or press **RETURN** to back up one step, or press **MAIN MENU** to return to the Main Menu.

Note: *If logging is enabled on any channel, that channel will have an arrow in front of the channel name to signify that the channel is logged.*

Example:
A dissolved oxygen meter has an analog output signal that will connect to the 980 Flow Meter analog input channel 4. The DO meter puts out an analog signal which ranges from +1 V dc to +3 V dc, which is equivalent to 0 to 500 ppm. The DO meter is connected to Channel 4 and logs readings from the DO meter occur once per minute.

To configure data logging for this example, follow the steps below.

1. Select Data Log from the Advanced Options menu.
2. Highlight Select Inputs using the **UP** and **DOWN** keys. Press **SELECT**.
3. Highlight the analog channel to log (Channel 4) using the **UP** and **DOWN** keys, then press **SELECT**.
4. Press **CHANGE CHOICE** to select Logged, then press **ACCEPT**.
5. Enter a 1-minute logging interval, then press **ACCEPT**.

6. Press **CHANGE CHOICE** to cycle through the units of measure until ppm is displayed. Press **ACCEPT**.

7. Apply a voltage to the desired analog input which corresponds to 0 ppm (or +1 V dc). Enter 0 ppm and press **ACCEPT**.

8. Apply a voltage to the same analog input that corresponds to 500 ppm or +3 V dc. Enter 500 ppm using the numeric keypad and press **ACCEPT** to complete the analog channel setup.

4.3 Mechanical Totalizer

4.3.1 Programming the Mechanical Totalizer

The Mechanical Totalizer consists of two numeric counters that keep track of the total flow being measured. The totalizers consist of a resettable totalizer and a non-resettable totalizer. Both totalizers are set to zero upon program start.

Scaling multipliers are provided to allow tailoring of the totalizer response to meet the requirements of the application. Some applications with high flow rates will require a high scaling factor, while low flow rates will require a low scaling factor.

The scaling factor is displayed whenever a total flow number is displayed. As indicated in the Status Screen below, the total flow is displayed as “TOTAL (x1000): 465 gal.” Multiplying the displayed total flow by the scaling factor (1000) gives an actual total flow of 465,000 gallons.

11:00 AM 21 - APR - 01	STATUS SCREEN
LEVEL:	8.688 in.
FLOW:	71.39 mgd
TOTAL (X1000):	465 gal
pH:	7.2 pH
BATTERY:	16.9 volts
RUNNING	

1. From the Main Menu, select **OPTIONS> ADVANCED OPTIONS > FLOW TOTALIZER to display the Modify Setup, Reset, and View Total screen.**

4.3.1.1 Modify Setup

Modify Setup selects a totalizer scaling factor and a flow unit of measure.

1. Highlight Modify Setup using the **UP** and **DOWN** keys. Press **SELECT**.

2. Set the Totalizer Scaling factor using **CHANGE CHOICE** key. All three totalizers are scaled with one of seven scaling factors: X1, X10, X100, X1000, X10,000, X100,000 or X1,000,000. The selected scaling factor always applies to all totalizers. Press **CHANGE CHOICE** to cycle through the available scaling choices. Press **ACCEPT**.

3. Set the Total Flow Units using the **CHANGE CHOICE** key to cycle through the choices. Total Flow Units are independent of the flow units selected in the Setup Menu. Flow units of measure include acre-feet, cubic feet, liters, cubic meters, and gallons. Press **ACCEPT** to continue.

4.3.1.2 Reset (Totalizer)

Note: *The mechanical totalizer cannot be reset manually.*

The non-resettable totalizer will only reset if one of these conditions occur:

- Change in totalizer scaling
- Change in totalizer units of measure
- Change in primary device
- Start of new program

Note: *If any type of condition occurs, both the resettable and the non-resettable totalizers are reset. The resettable totalizer can be used to total flow over a finite period and can be reset as often as desired without affecting the other totalizers.*

1. Select Reset from the Totalizer menu. A confirmation message will appear. Press **YES** to reset or press **NO** not to reset the totalizer.

To reset both software totalizers at once, start a program with **RUN/STOP**.

View Totals
To view the current totals of both the resettable and non-resettable totalizers, press **VIEW TOTALS** from the Totalizer menu. Both totalizer values will appear.

4.4 Alarm Relays

4.4.1 Programming the Alarm Relays

Trouble and set point alarms can be programmed to activate based on certain conditions (low battery, low memory, etc.). Refer to 980 Quick-Start Guides on page 133. When an alarm is tripped, an action is initiated (report via modem, dial a pager, or set a relay).

4.4.1.1 Trouble Alarms

Trouble Alarms initiate an action when a trouble condition occurs.
For example, a relay may close when the memory is full.

1. From the Main Menu, select **OPTIONS> ADVANCED OPTIONS > ALARMS.**
2. Select an action to occur when the alarm is activated. Table 26 shows each Trouble Condition and its cause.
3. Enable one of the trouble conditions.

Table 26 Trouble Alarms

Trouble Condition	Cause
Low Memory Battery	Internal memory battery voltage is too low. Change batteries.
U-Sonic Echo Loss (A pulse of sound was sent but no echo was received back)	The echo has been temporarily deflected by a change in site conditions such as floating debris or foam in the channel, wind, etc.
Transducer Ringing	Transducer is operating within the deadband.
U-Sonic Failure	Transducer not plugged in. Cable damaged. Transducer thermal sensor damaged.
Modem Failure	Unable to initialize modem
RS485 Timed Out	Problem with communications between the flow meter and a remote ultrasonic sensor. May indicate open thermal sensor.
Alarm Action(s):	
Set Relay #1	
Set Relay #2	
Set Relay #3	
Set Relay #4	
Report via Modem	

4.4.1.2 Set Point Alarms

Set point alarms look for trip points to be reached (high, low, or both) before initiating an action. For example an initiated action may be closing a relay when the water level exceeds 24 in. (60 cm) or drops below 4 in. (10 cm).

1. Select an action to occur when the alarm is activated.
2. Enable one of the alarm conditions.
3. Set either a High trip point or a Low trip point.
4. Enter the deadband value. The deadband is the area between the alarm “turn on” and “turn off”. Refer to section on page 104.

Set Point Alarm Conditions:

- Level
- Flow Rate of Change
- Rainfall
- Temperature
- Flow
- pH
- Analog Channels 1–7
- Velocity

4.5 Rain Gauge

4.5.1 Programming the Rain Gauge

Note: *If logging is enabled on any channel, that channel will have an arrow in front of the channel name to signify that the channel is logged.*

1. From the Main Menu Select **OPTIONS>ADVANCED OPTIONS>DATALOG.**
2. Highlight Select Inputs using the **UP** and **DOWN** keys. Press **SELECT**.
3. Highlight Rainfall using the **UP** and **DOWN** keys, then press **SELECT**.
4. Press **CHANGE CHOICE** to cycle between Logged and Not Logged, then press **ACCEPT**.
5. Enter a logging interval using the numeric keypad, then press **ACCEPT**. Valid logging intervals are shown on the status bar along the bottom edge of the display.
6. Select Rainfall Units (in. or cm). Press the **ACCEPT.**
7. Select another channel to configure, press **RETURN** to back up one step, or press **MAIN MENU** to return to the Main Menu.

4.6 Sampler

4.6.1 Programming a Sampler Connection

1. From the Main Menu, select **SETUP>MODIFY SELECTED ITEMS.**
2. Scroll down and highlight Sampler Pacing using the **UP** and **DOWN** keys. Press **SELECT** to continue.
3. Enable Sampler pacing using the **CHANGE CHOICE** key. Press **ACCEPT**.
4. Set the Sampler Pacing using the numeric keypad and Change Units using the **CHANGE UNITS** key. Press **ACCEPT**.

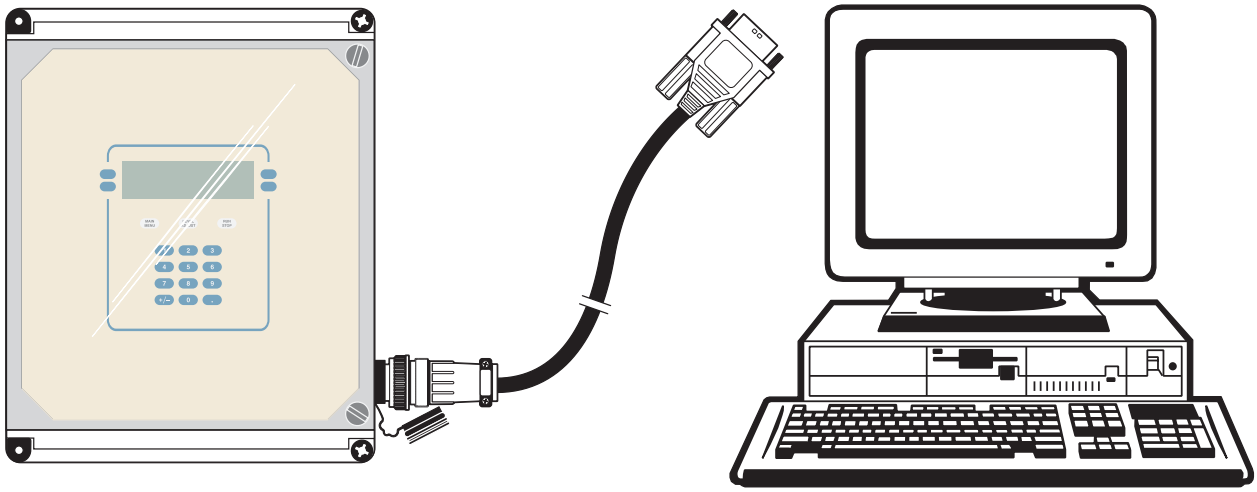
4.7 RS232

4.7.1 Programming the RS232

Note: *Long runs of cable, especially if they are near large motors or fluorescent lights, can cause communication errors and may require a slower baud rate. If errors develop at high baud rates, try lowering the baud rate one step at a time until error-free communications are achieved.*

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > COMMUNICATIONS SETUP > RS232 SETUP**.
2. Select a baud rate for data communications by pressing **CHANGE CHOICE** to cycle through the possible choices; 1200, 2400, 4800, 9600, or 19,200 baud. The higher the baud rate setting, the faster data will transfer. Set the baud rate to the highest setting allowed by the computer. Press **ACCEPT**. The cable connection is shown in Figure 30.

Figure 30 PC to Flow Meter Cable Connection



4.8 Modem Interface

4.8.1 Programming the Modem

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > COMMUNICATIONS SETUP > MODEM POWER.**

2. To enable the modem power, press **CHANGE CHOICE** until “ENABLED” is displayed. Press **ACCEPT**.

11:00 AM 21 - APR - 01		MODEM SETUP
ACCEPT	MODEM POWER: ENABLED	CHANGE CHOICE
RETURN		
CHOICES: ENABLED, DISABLED		

3. Use **CHANGE CHOICE** to set the dial method, Tone or Pulse. Press **ACCEPT**.

4. Enter the phone number of the PC that the unit will call if alarms are enabled. Press **ACCEPT**.

5. Press **CHANGE CHOICE** to enable or disable the pager option. Press **ACCEPT**.

6. Enter the Pager Service Number. Press **ACCEPT**.

7. Enter the amount of pagers. Press **ACCEPT**.

8. Enter up to three pager numbers. Press **ACCEPT**.

9. Use **CHANGE CHOICE** to set the Reporting Order (Modem only, pager only, pager then modem, modem then pager). Press **ACCEPT** .

Modem power must be enabled and the unit must be in running mode before the meter can answer calls from InSight® or VISION software to download data, access remote program, etc.

4.9 pH Sensor

pH sensor function degrades over time, even under ideal conditions, and therefore require periodic replacement. The pre-amplifier junction box is provided to allow for fast, easy replacement of the pH sensor. For extra strain relief the pH cable that leads to the instrument should pass through the water-tight strain relief adapter.

Since the pH reading must be compensated for temperature variations, a temperature sensor is built into every pH electrode. After installation, the pH sensor must be programmed and calibrated.

4.9.1 Programming the pH Sensor

1. From the Main Menu Select **OPTIONS>ADVANCED OPTIONS>DATALOG.**
2. Highlight Select Inputs using the **UP** and **DOWN** and press **SELECT**.
3. Highlight pH/mV using the **UP** and **DOWN** keys, then press **SELECT**.
4. Select pH in the Item to Edit menu using the **pH** key.
5. Press **CHANGE CHOICE** to cycle between Logged and Not Logged, then **ACCEPT**.
6. Enter a logging interval and press **ACCEPT**. Valid logging intervals are shown on the status bar along the bottom edge of the display.
7. Select another channel to configure or press **RETURN** to back up one step or press **MAIN MENU** to return to the Main Menu.

Note: *If logging is enabled on any channel, an arrow in front of the channel name will appear to signify that the channel is logged.*

4.9.2 Calibrating the pH Sensor

Once the pH sensor is wired and programmed, calibrate the pH sensor. Calibrating the pH sensor requires a thermometer and any two of the following buffer solutions: 4, 7, or 10 pH.

The pH probe is an application sensitive device. When used in harsh environments, the accuracy and life expectancy of pH probes can decrease considerably.

Probes must be calibrated to the flow meter each time they are cleaned or replaced. Regular inspection and comparison to a hand-held pH meter can help determine the optimum cleaning and calibration schedule for your application.

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > CALIBRATION > pH.**
2. Place the pH probe into the first buffer solution. Press any key to continue.
3. Enter the temperature of the first buffer solution. Press **ACCEPT**.

Note: *Before calibrating the pH probe make certain the probe and buffers are at ambient temperature.*

4. Select the pH for the first buffer solution (4, 7, or 10 pH) using **CHANGE CHOICE**, then press **ACCEPT**.

5. Remove the probe from the first buffer solution, rinse it under distilled water and place it into the second buffer solution (4, 7, or 10 pH, different from the first buffer used). Press any key to continue.

6. Select the pH for the second buffer solution using **CHANGE CHOICE**, then press **ACCEPT**. If the pH probe is damaged and cannot be calibrated or if the buffer solutions do not fall within an acceptable range, an error message will be displayed as shown below.

11:00 AM 21 - APR - 01	ERROR MESSAGE
pH CALIBRATION FAILED-GAIN AND/OR OFFSET OUT OF RANGE TRY AGAIN (PRESS ANY KEY TO CONTINUE)	

Another attempt at reading the second buffer solution will be made after pressing a key. If this fails, it is likely that you have a bad pH probe or bad buffer solutions. Try a new set of buffer solutions and if that fails try a different pH probe.

4.10 Downlook Ultrasonic Sensor

Downlook ultrasonic level sensors are available with different beam angles and deadbands. The 980 Flow Meter uses a 75 kHz Downlook Ultrasonic Sensor. See Figure 31.

The ultrasonic transducer is mounted over the flow stream at the proper location for head measurement. To determine the proper location for head measurement refer to Working with Primary Devices on page 99. The transducer emits a pulse of sound at a high frequency and awaits for the echo to return from the surface of the water. The time it takes for this echo to return is directly related to the distance between the transducer and the surface water. As the level in the flow stream increases, the time it takes for the echo to return to the transducer decreases (distance is shorter).

By continuously transmitting these pulses and timing the returning echoes, the sensor measures the level of the liquid on the flow stream. After measuring the level, the microprocessor converts the level reading to a flow rate based on the user-defined characteristics of the primary device.

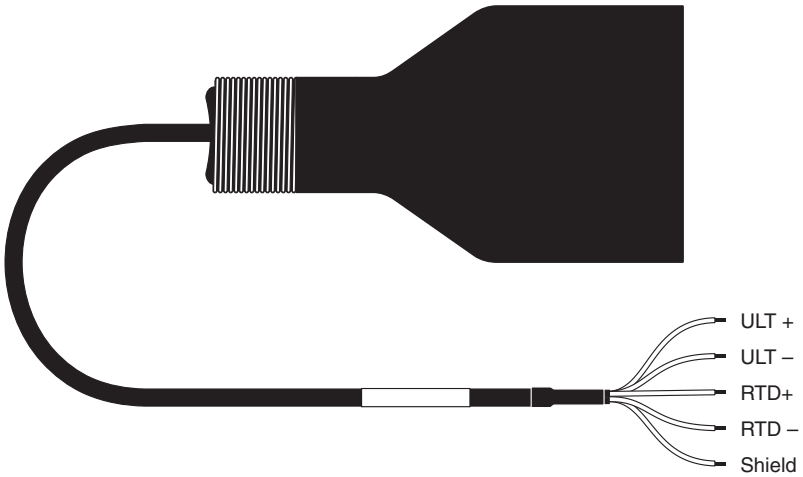
4.10.1 Installing an Ultrasonic Sensor at a Primary Device

Site selection can greatly enhance system performance. Several important factors should be considered when installing the ultrasonic sensor at any primary device. Refer to Appendix A for more information on primary devices.

Note: *Do not suspend the sensor by the cable. Only use appropriate mounting hardware.*

- Locate the ultrasonic sensor at the proper head measurement point for that primary device.
- Determine the appropriate sensor height. Refer to Figure 33 on page 73.
- Suspend the ultrasonic sensor over the center of the flow stream where there is the least surface turbulence.
- Mount the sensor to a stable, secure location, isolated from vibration.

Figure 31 Ultrasonic Sensor



4.10.1.1 Choosing the Appropriate Sensor Height

The beam angle is half the band width at -10 dB. The beam angle from the bottom of the ultrasonic sensor spreads out at an angle of 12° for the 75 kHz sensor as it travels away from the sensor. Therefore, if you mount the sensor too high above a narrow channel, the beam may be wider than the channel when it reaches it. This can cause false echoes from the tops of the channel walls rather than from the water surface. To prevent false echoes, determine the appropriate sensor height so that the entire beam falls within the channel and does not strike any obstructions

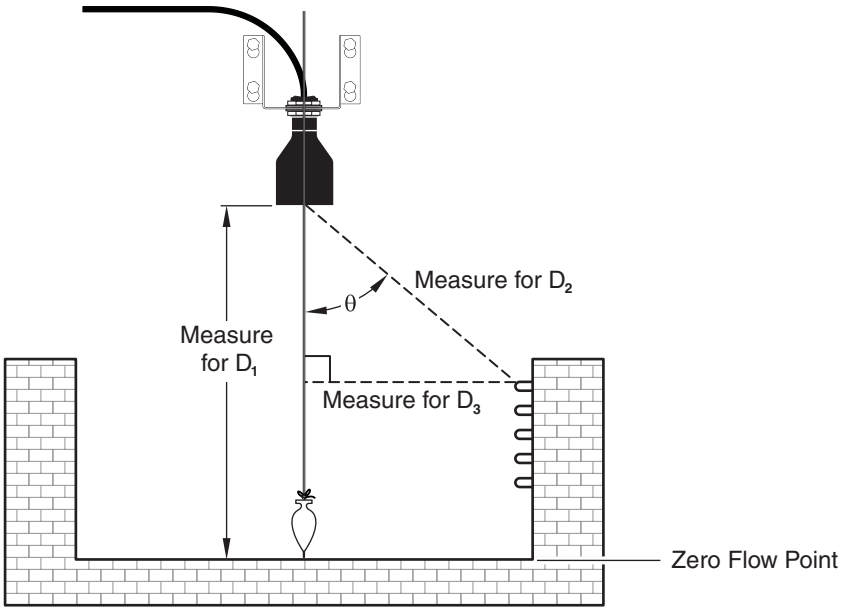
To determine the appropriate sensor mounting height

1. Take the measurements described in Figure 32.
2. Calculate the angle of obstruction from the axis.

$$\theta = \arcsin\left(\frac{D_3}{D_2}\right) \approx \frac{57.3\ D_3}{D_2}$$ is accurate within one degree.

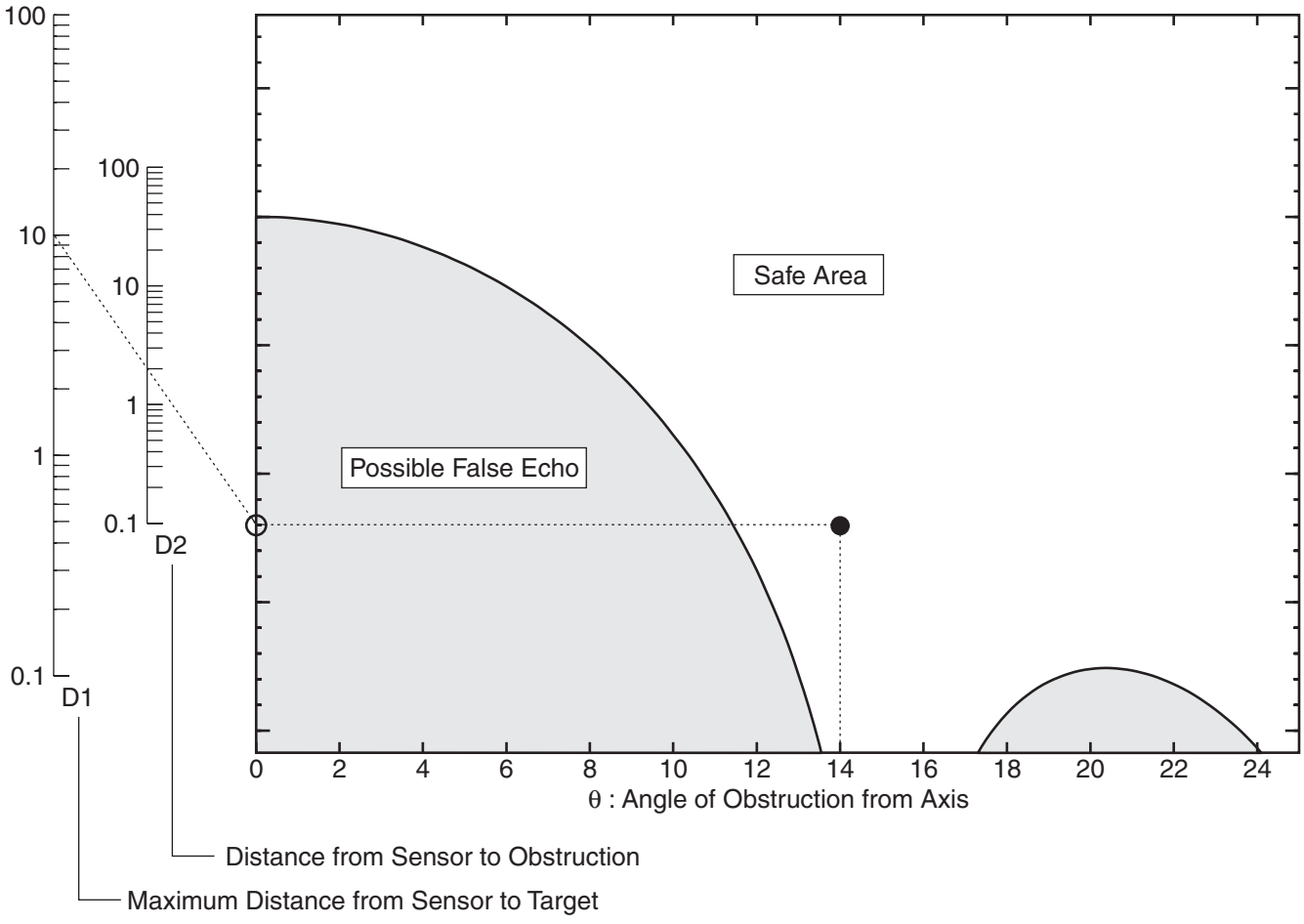
3. Plot the measurements on the graph in Figure 33 to determine if the beam width falls within the possible false echo or safe area.

Figure 32 Ultrasonic Sensor Beam Angle



This drawing is not to scale.

Figure 33 Choosing the Appropriate Sensor Height



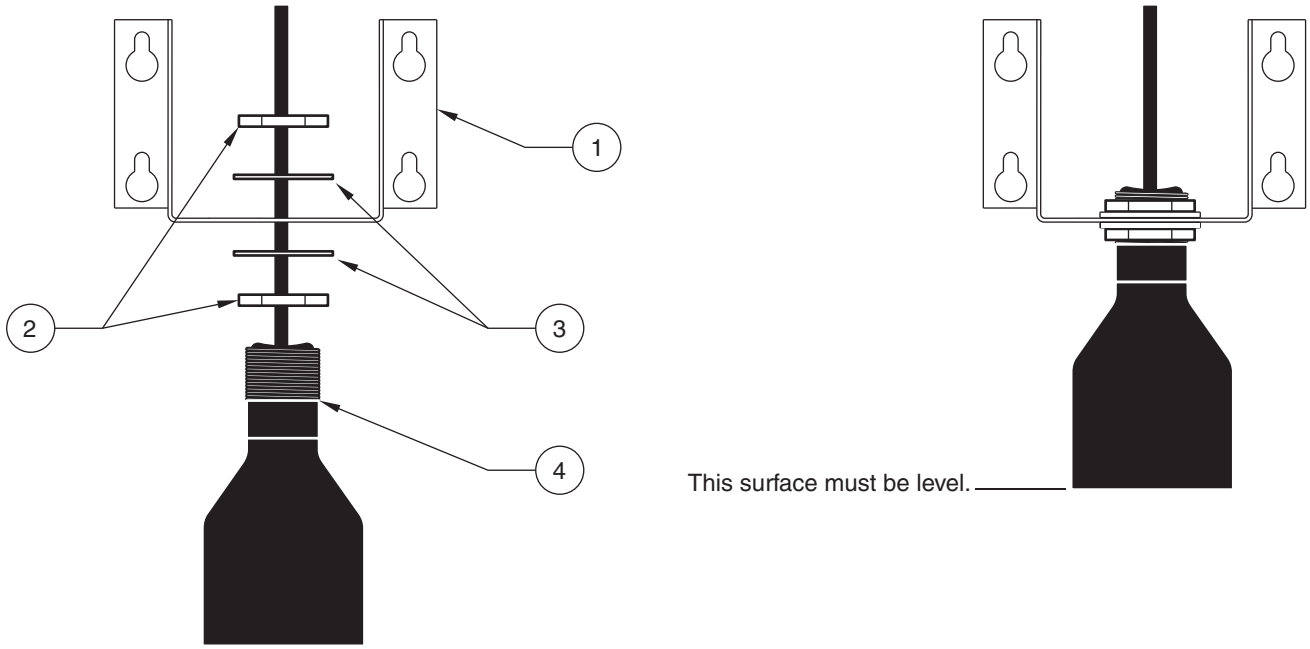
4.10.1.2 Mounting the Ultrasonic Sensor

Note: *To prevent mechanical vibration ensure that the supplied isolation washers are installed as shown in Figure 34.*

Several brackets are available for mounting the sensor to a fixed location such as a wall or floor. See Figure 34 and Figure 35. For mounting options see Parts and Accessories on page 137. Each bracket utilizes the ¾ in. (1.9 cm) NPT connector on the sensor to secure the sensor to the bracket. Always level the sensor using a level. The maximum water level must be below the deadband to ensure accurate readings.

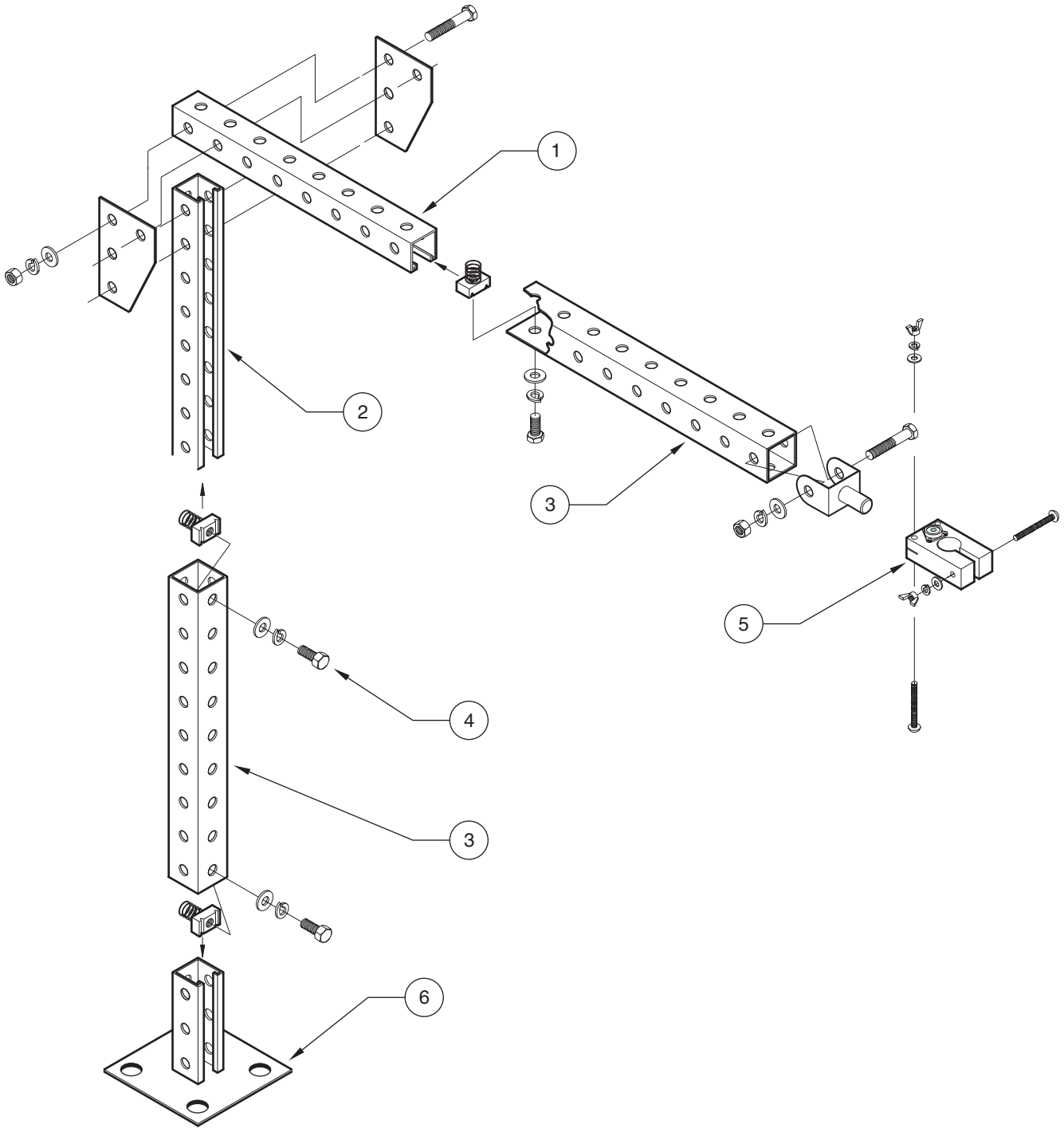
The sensor is “blind” to anything closer than the deadband and will stop reading level when the distance is shorter than that.

Figure 34 Bracket and Isolation Washers



1. Wall/Rail Mount Bracket (Cat. No. 2974)	**3.** Isolation Washers (Cat. No. 6820)
2. 1 inch x 0.25 Hex Nuts (Cat. No. 1429)	**4.** Ultrasonic Sensor

Figure 35 Assembling the Mounting Bracket (Cat. No. 2904)



1. 14.75 inches (Cat. No. 3047)	**4.** Horizontal and vertical sections are fully adjustable*.
2. 15.25 inches (Cat. No. 3046)	**5.** Sensor Mounting Clamp
3. 16.625 inches (2) (Cat. No 3048)	**6.** 5.5 inches tall (Cat. No. 3108)

* Loosen the bolt, slide the section to the desired distance and re-tighten the bolt.
Sensor Mounting Clamp (with built-in bubble level) Sensor adjusts to any required level.

4.10.2 Ultrasonic Senor (Downlook) Installation Troubleshooting

Convection Currents
Convection components between the sensor and target will change the velocity of sound. If these conditions are present, install a shield around the sound beam to eliminate temperature variation due to convection currents. The system is designed with averaging routines to help mitigate this problem.

The acoustical impedance of foam and oil is low relative to air. While the 980 is designed with an AGC (Automatic Gain Control) scheme to reduce these factors it is recommended that sites without these anomalies be selected.

Obstructions
Through the use of an Invisible Range, the 980 Flow Meter can select targets beyond peripheral obstructions. In establishing this exclusion zone, care must be taken to set the exclusion zone higher than the maximum expected level.

Echo Loss
It is normal to report some temporary echo loss due to environmental effects mentioned above. The 980 will determine if the sound intensity is below recommended values and automatically initiate subsequent measurements to provide an accurate reading. If echo loss events are in excess of two per hour, site conditions should be reexamined for convection currents caused by sunlight or thermal gradients at the water ambient interface. Foam on the liquid's surface may also cause echo loss.

Transducer Ringing
Ringing can occur if the transducer is operating within the deadband. Transducer ringing means that the transducer may not have finished transmitting a pulse of sound when the echo returned. Sufficient distance between the sensor and the target will eliminate transducer ringing.

Problem/Error Message	Possible Causes and Solutions
Ultrasonic Failure (No signal from sensor)	Check the connection between the flow meter and the sensor.
	Check the sensor cable. The cable may be cut or broken.
	Recalibrate the sensor. Look for unusual temperature or the inability for a new calibrated level to be read.
	Try a different sensor on the same flow meter to rule out instrument problems and try a different flow meter with the same sensor to rule out sensor problems.
Echo Loss (Flow meter is not getting a return signal from the sensor)	Check for excessive foam on the water surface. Foam may cause sound waves to be absorbed rather than reflected.
	Check the sensor cable for cuts or nicks.
	Check the connection between the flow meter and the sensor.
	Make sure that the sensor is level. The sensor must be level for proper return of the signal.
	Try shielding the transducer from convection currents.
	Repeat the temperature calibration procedure. If the unit reads extreme high or low temperatures, the sensor may have a bad temperature sensor.
	Try a different sensor on the same flow meter to rule out instrument problems and try a different flow meter with the same sensor to rule out sensor problems.

Problem/Error Message	Possible Causes and Solutions
Transducer Ringing (False return echoes mask “real” echoes)	Try moving the transducer farther from the liquid.
	Check the area under the transducer for obstructions. This includes the area in front and to the sides of the transducer.
	Check the face of the transducer for a coating. This is rare, but cleaning the transducer face may correct the problem. If this is a constant problem due to site conditions, coat the face of the sensor with a thin film of silicone grease to keep debris from clinging.
	Make sure that you are using the proper rubber isolation washers on the mounting bracket. The transducer can resonate against steel mounting rails. See Mounting the Ultrasonic Sensor on page 74.
RS485 Time Out (Flow meter did not receive data within the specified time)	If the CPU is having trouble communicating with the velocity board, RS485 time outs may occur. Wait a few minutes and see if it goes away. If it continues, a problem with the ultrasonic, velocity, or CPU board may exist.
	May be caused by difficulty getting a good velocity reading. If the logging interval is 1 or 2 minutes, conditions are poor, and the problem continues indefinitely, try increasing the logging interval to capture more signals.
	This condition may occur occasionally. When using a combination of area velocity and ultrasonic sensors, this condition may occur more frequently if site conditions are less than ideal. This is not necessarily an indication of a defective sensor.
	Check to see if wires were shorted. Check the RS485 fuse.

4.10.3 Programming the Downlook Ultrasonic Sensor

The downlook ultrasonic sensor does not require specific programming, unless more than one sensor option is connected to the 980 Flow Meter.

When more than one sensor option is connected to the 980 Flow Meter:

1. From the Main Menu, select **OPTIONS** > **LEVEL SENSOR**
2. Select Ultra-Sonic Sensor using **CHANGE CHOICE**, then press **ACCEPT**.

4.10.4 Calibrating the Downlook Ultrasonic Sensor

Calibrate the current water level via one of two methods; Liquid Depth or Sensor Height. An Invisible Range can also be set which allows the transducer to ignore reflections from obstructions between the sensor and the water surface, such as ladder rungs, channel side walls, etc. Each method has its own advantages and disadvantages; selecting the proper method will depend upon the site conditions. Calibrate the ultrasonic sensor each time the sensor is installed at a new site.

4.10.4.1 Liquid Depth

This method requires the “head” or depth of liquid in the channel that is contributing to flow. In a round pipe, the entire depth typically contributes to flow. In a weir, only the depth that is flow over the weir plate contributes to flow. Many flumes have specific requirements, refer to Working with Primary Devices on page 99. Level Depth calibration is primarily is used when:

- Access is available to the primary device for a physical measurement of the liquid depth, and
- When water is flowing during installation of the 980 Flow Meter (channel is not dry).

Note: *Always re-check the Level Adjust when re-installing the flow meter.*

1. From the Main Menu, select **OPTIONS>ADVANCED OPTIONS>CALIBRATION>ULTRASONIC SENSOR.**

2. Select Calibrate U-Sonic using the **UP** and **DOWN** keys. Press **SELECT**.

3. Select Standard as the type of Ultrasonic Transducer using **CHANGE CHOICE**. Press **ACCEPT**.

Temperature Time Constant
The speed of sound in air varies with the temperature of the air. The ultrasonic sensor is equipped with temperature compensation to help eliminate the effect of temperature variation under normal site conditions. The transducer must be equal to the ambient air temperature at the site prior to calibration for optimum results. The manufacturer also recommends that sensors be shielded from direct sunlight for this reason.

4. Enter the ambient air temperature at the transducer location. For optimum results, allow enough time (100 minutes) to ensure that the sensor is at equilibrium with the surrounding ambient temperature. Press **ACCEPT**.

5. Select the Liquid Depth method and enter the new level.

6. Take a physical measurement of the liquid depth (head) and enter the value. Press **ACCEPT**.

4.10.4.2 Sensor Height

This method requires you to enter the distance between the face of the ultrasonic sensor and the zero flow point in the primary device. The zero flow point in a primary device is the level at which flow ceases. In a round pipe the zero flow point would typically be the invert or bottom of the pipe. In a V-notch weir the zero flow point occurs when the liquid behind the weir is level with the bottom of the ‘V’. (There would still be liquid behind the weir plate but it would not be contributing to flow). Sensor Height calibration is generally used when:

- Access to the primary device is difficult (such as confined space entry in a manhole) or
- There is no liquid flowing during installation of the flow meter

1. From the Main Menu, select **OPTIONS>ADVANCED OPTIONS>CALIBRATION>ULTRASONIC SENSOR.**

2. Select Calibrate U-Sonic using the **UP** and **DOWN** keys. Press **SELECT**.

3. Select Standard as the type of Ultrasonic Transducer using **CHANGE CHOICE**. Press **ACCEPT**.

   The speed of sound in air varies with the temperature of the air. The ultrasonic sensor is equipped with temperature compensation to help eliminate the effect of temperature variation under normal site conditions.

4. Enter the ambient air temperature at the transducer location. For optimum results, allow enough time (100 minutes) to ensure that the sensor is at equilibrium with the surrounding ambient temperature. Press **ACCEPT**.

5. Select the Sensor Height method and enter the new level.

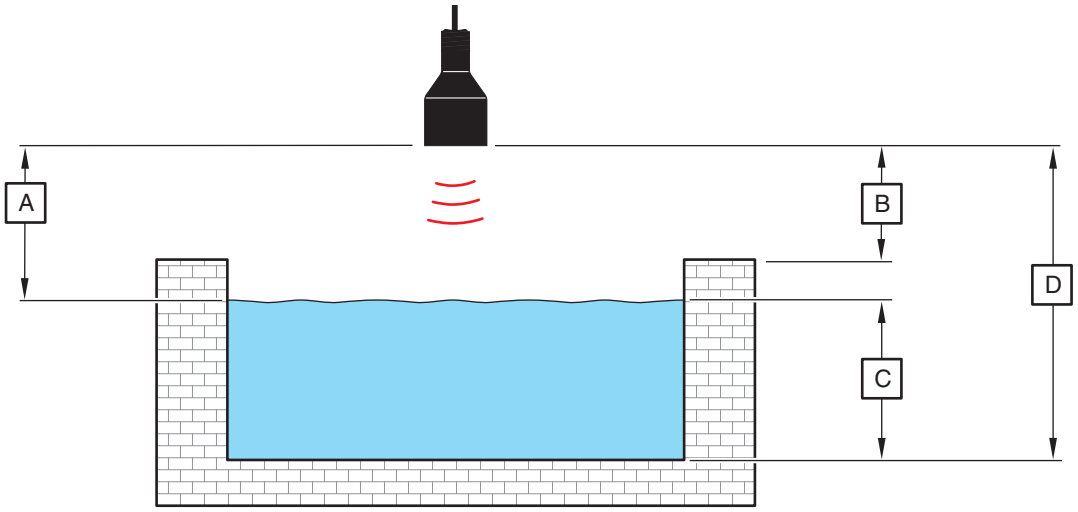
6. Enter the distance from the face of the transducer to the zero flow point of the primary device. Press **ACCEPT**.

4.10.4.3 Setting the Invisible Range

The 980 Flow Meter is equipped with an Invisible Range feature (adjustable deadband) to prevent false echoes from tops of channel walls, ladder rungs, shelves, etc. Refer to Figure 36. A user-selected range is defined which is invisible to the flow meter. Extend the invisible range to where it meets or overlaps the highest expected level in the channel. A gap of at least 2 in. (5 cm) should be left between the invisible range and the highest expected level. Only objects beyond the invisible range can be detected.

1. From the Main Menu, select **OPTIONS>ADVANCED OPTIONS>CALIBRATION>ULTRASONIC SENSOR.**
2. Select the Invisible Range using the **UP** and **DOWN** keys. Press **SELECT**.
3. Enter the Distance to End of the Invisible Range.
4. Press **CHANGE UNITS** to select either inches or centimeters. The distance must be greater than the minimum deadband of 11.5 in. (29 cm) for the 75 kHz transducer. Refer to Figure 36. Press **ACCEPT**.

Figure 36 Setting the Invisible Range



A. Minimum Distance (must be at least 11 inches (29 cm)	**C.** Highest expected water level
B. Invisible Range (set to ignore tops of channel walls)	**D.** Maximum Range

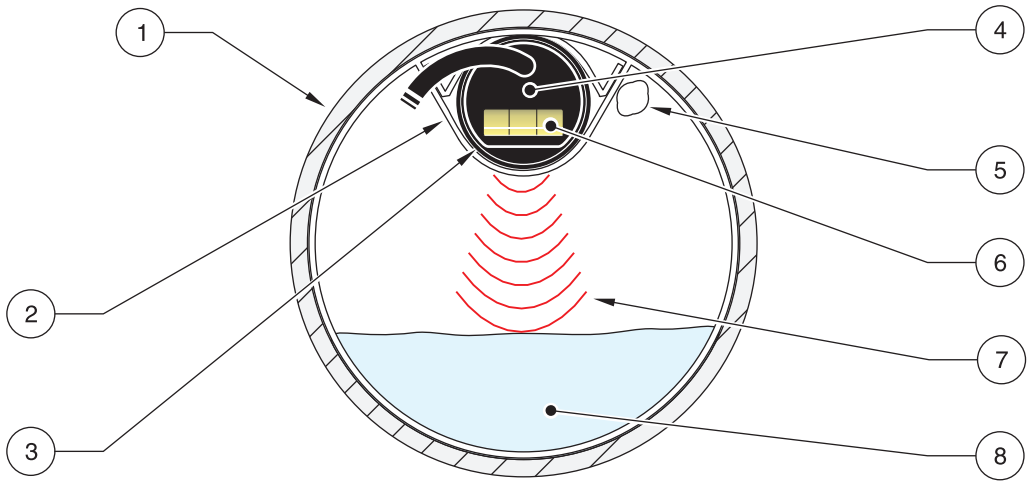
4.11 In-Pipe Ultrasonic Sensor

4.11.1 Mounting the In-Pipe Sensor

- Mount the sensor over the center of the flow stream where the surface turbulence is minimized (Figure 37).
- Mount the sensor 2 m (82 in.) away from obstructions located in front of the in-pipe senor to prevent inaccurate liquid level readings (Figure 38).
- Level the sensor using the built-in bubble level.

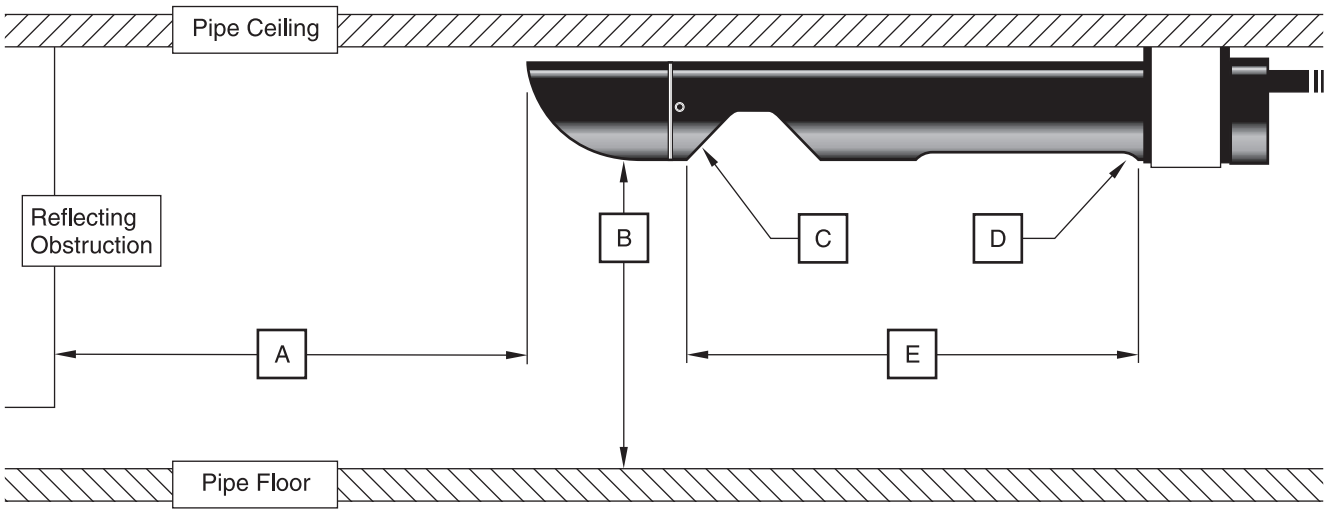
- Ensure the isolation gasket is in place and the mounting bracket thumbscrews are finger-tight to avoid sensor ringing.
- Install the sensor within 4.12 m (13.5 ft) of the lowest expected level (the maximum range of the sensor). The intensity of the echo decreases with distance at a maximum of 1.31 dB/m (0.4 dB/ft)

Figure 37 End View of In-Pipe



1. Pipe (size may vary)	**5.** Bracket Thumbscrew (3.17 cm (1.25 in.) long)
2. Mounting Clip	**6.** Bubble Level
3. Vibration Isolation Gasket	**7.** Sound Waves
4. Sensor	**8.** Flow

Figure 38 Side View of In-Pipe



A. Minimum distance to reflecting obstruction (2 m (82 in.))	**D.** Ultrasonic Sensor
B. Distance from Sensor (Range: 1.6 cm (0.64 in.) to 4.11 m (13.5 ft))	**E.** Internal Deadband (18.21 cm (7.17 inches))
C. 45° Deflector	

4.11.2 Beam Angle

The narrow beam of sound that emanates from the bottom of the in-pipe ultrasonic sensor spreads out at an angle of ±12° (-10 dB) as it travels away from the sensor. This means that if the sensor is mounted too high above a narrow channel, the beam may be too wide when it reaches the bottom of the channel. This may cause false echoes from the sides on the channel walls.

4.11.3 Programming the In-Pipe Ultrasonic Sensor

The in-pipe ultrasonic sensor does not require operator programming, unless more than one sensor option is connected to the 980 Flow Meter. When more than one sensor option is connected:

1. From the Main Menu, select **OPTIONS > LEVEL SENSOR**

2. Press **CHANGE UNITS** to select Ultra-Sonic Sensor, then press **ACCEPT**.

4.11.4 Calibrating the In-Pipe Ultrasonic Sensor

Calibrate the in-pipe sensor each time the sensor is installed at a new site. Calibrate the in-pipe via one of two methods; Liquid Depth or Sensor Height. Each method has its own advantages and disadvantages. Liquid Depth calibration is the recommended calibration method, use the sensor height method **only** when Liquid Depth calibration is not an option. An Invisible Range can also be set which allows the transducer to ignore reflections from obstructions between the sensor and the water surface, such as ladder rungs, channel side walls, etc.

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS.**

2. Highlight Calibration, using the **UP** and **DOWN** keys. Press **SELECT**.

3. Highlight Ultra-Sonic Sensor, using the **UP** and **DOWN** keys. Press **SELECT**.

4. Highlight Calibrate U-Sonic Sensor and press **SELECT**.

5. Press **CHANGE UNITS** to select the type of ultrasonic transducer (In-Pipe). Press **ACCEPT**.

6. Enter the ambient air temperature at the transducer location. For optimum results, allow enough time (100 minutes) to ensure that the sensor is at equilibrium with the surrounding ambient temperature. Press **ACCEPT** to continue.

The speed of sound in air varies with the temperature of the air. The ultrasonic sensor is equipped with temperature compensation to help eliminate the effect of temperature variation under normal site conditions.

4.11.4.1 Liquid Depth

Liquid depth requires knowing the level or depth of the liquid in the channel that is contributing to flow. Liquid depth calibration is the recommended calibration method for the in-pipe ultrasonic sensor.

Continue from Step 6, above:

1. Select the Liquid Depth method.

2. Take a physical measurement of the liquid depth (head) and enter the value. Press **ACCEPT** when finished.

4.11.4.2 Sensor Height

Sensor height calibration is generally used when access to the primary device is difficult (such as confined space entry in a manhole) or when there is no liquid flowing during installation of the flow meter. This calibration method requires compensation for the internal deadband in the sensor housing. Measurement uncertainty increases to 0.85 m (0.028 ft) for a 60 cm (2 ft) change in level from the calibration point. Use this method only if the Liquid Depth method is not an option.

Continue from Step 8, above:

1. Measure the distance from the bottom of the sensor to the zero flow point. Add 18.2 cm (7.17 in.) to the measured distance to obtain the total zero flow distance for the in-pipe sensor.

2. Select the Sensor Height calibration method and enter the total zero flow distance from Step 1. Press **ACCEPT** when finished.

4.11.4.3 Setting the Invisible Range

Note: *When programming the invisible range, 18.21 cm (7.17 in.) must be added to the desired range to compensate for the internal deadband distance between the sensor, the reflector, and the bottom of the sensor housing.*

The 980 Flow Meter is equipped with an invisible range feature to prevent false echoes from tops of channel walls, ladder rungs, shelves, etc. A user-selected range is defined that is invisible to the flow meter. Extend the invisible range to where it meets or overlaps the highest expected level in the channel. Have a gap of at least 2 in. (5 cm) between the invisible range and the highest expected level. Only objects beyond the invisible range can be detected.

1. From the Main Menu, select **OPTIONS>ADVANCED OPTIONS> CALIBRATION> ULTRASONIC SENSOR.**

2. Select the Invisible Range option using the **UP** and **DOWN** keys. Press **SELECT** to continue.

3. Enter the Distance to End of the Invisible Range.

4. Select either inches or centimeters using **CHANGE UNITS**. Press **ACCEPT.**

4.11.5 Protecting the In-Pipe Ultrasonic Sensor

Keep the sensor and the reflector free of grease and dirt. Since the logger “listens” for the relatively faint sound of the returning echo, a heavy coated sensor will not be able to detect the echo well and may not provide accurate level measurement.

4.11.6 In-Pipe Ultrasonic Sensor Troubleshooting

During surcharged conditions, the ultrasonic level will give random depth readings that will need to be edited in the application software.

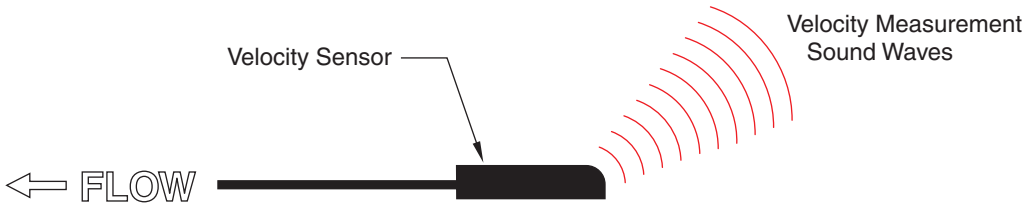
Symptoms of this hydraulic condition occur when the level appears erratic within 5.7 cm (2.25 in.) of the pipe diameter. The readings will first appear to flat-line. Then the erratic readings (that in some cases exceed the pipe diameter) will occur.

If the hydraulics are frequently in surcharge conditions, use a submerged level sensor instead of an in-pipe ultrasonic sensor.

4.12 Velocity-Only Sensor

The Velocity-Only Sensor is an extremely low-profile velocity sensor. It does not measure level. The streamlined shape of the wafer probe allows velocity measurement in very low-flow conditions. When used in conjunction with a level sensor (such as the In-pipe Ultrasonic Level Sensor), the meter can calculate flow. Refer to Figure 39.

Figure 39 Velocity-Only Sensor



4.12.1 Programming the Velocity-Only Sensor

1. From the **MAIN MENU**, select **SETUP>MODIFY SELECTED ITEMS**
2. Highlight Velocity Direction using the **UP** and **DOWN** keys. Press **SELECT**.
3. Set the velocity direction (upstream, downstream, or always positive) using the **CHANGE CHOICE** key. Refer to Compensating for Velocity Direction on page 86 for more information on velocity direction. Press **ACCEPT**.
4. Highlight Velocity Units using the **UP** and **DOWN** keys. Press **SELECT**.
5. Set the Velocity Units (fps or m/s), using the **UP** and **DOWN** keys. Press **ACCEPT**.
6. Highlight Velocity Cutoff, using the **UP** and **DOWN** keys. Press **SELECT**.
7. Read the Velocity Cutoff information screen. Press any key to continue.
8. Set the Velocity Cutoff using the numeric keypad. Press **ACCEPT**.
9. Set the Velocity Default, using the numeric keypad. Press **ACCEPT**. Press **RETURN** to go back to the Setup Menu or **MAIN MENU** to return to the beginning.

4.12.2 Calibrating the Velocity-Only Sensor

No calibration is required for the velocity sensor. The transmit frequency is fixed with a highly accurate quartz crystal-controlled frequency generator that cannot be adjusted.

4.12.3 Installing the Velocity-Only Sensor in a Pipe

4.12.3.1 Important Guidelines for Velocity-Only Sensor Installation

- Do not install more than one probe at a time in pipes less than 24 inches in diameter (61 cm). Multiple probes in smaller pipes can create turbulent or accelerated flows near the probes that may cause inaccurate measurements.
- Mount the sensor as close as possible to the bottom of the pipe invert to most accurately measure low velocity levels.
- Locate monitoring sites as far from inflow junctions as possible to avoid interference caused by combined flows.
- Avoid any sites that contain flow obstacles within 2 to 4 pipe diameters in front of the probe installation (rocks, stones, pipe joints, valve stems, etc.) as these will contribute to turbulence and generate high speed flows in the immediate vicinity of the obstruction.
- Avoid any sites with slow moving flows that will encourage the buildup of silt in the invert or channel. Excessive silting around the probe may inhibit the Doppler signal and decrease sensor accuracy, and may affect depth measurement accuracy.
- Avoid sites with deep, rapid flows that will make it physically difficult or dangerous to install the probe.
- Avoid sites with high velocity, low-depth flows. Splash-over and excessive turbulence will be present around the probe and data may be inaccurate.

4.12.3.2 Choosing a Mounting Band

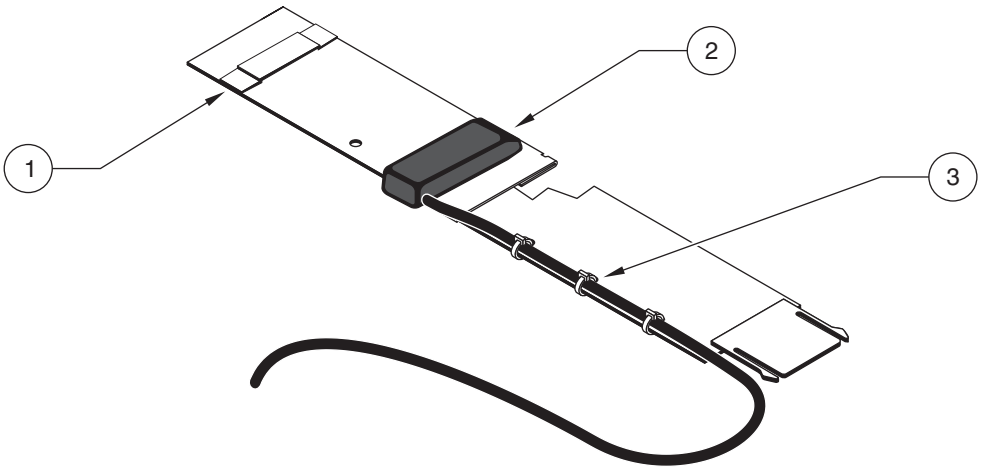
Mounting bands and rings for depth/velocity and velocity sensors are listed in Parts and Accessories on page 137. A complete mounting band assembly for pipe sizes less than 12 ft also requires one Depth/Velocity Sensor Mounting Clip (Cat. No. 3263) and one Scissors Jack Assembly (for band set only) (Cat. No. 1533).

4.12.3.3 Connecting the Sensor to the Mounting Bands

Note: *If there is a large amount of silt in the bottom of the pipe, rotate the band until the sensor is out of the silt (Figure 41), assuring that the sensor remains below the minimum expected water level at all times. Silt should not be disturbed and must be measured frequently if entered into InSight® software. A Level Adjust is required to offset level sensors.*

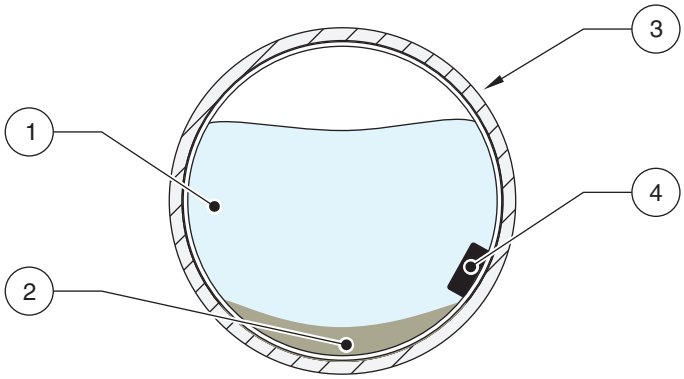
1. Attach the sensor to the sensor mounting clip using the two screws provided. See Figure 40.
2. Attach the clip to the mounting band. Mounting Rings come with pre-drilled holes for direct mounting of the sensor to the ring.
3. To reduce the likelihood of debris collecting on the cable and mounting band, route the cable along the edge of the band and fasten the cable to the mounting band with nylon wire ties. See Figure 40. The cable should exit the tied area at, or near, the top of the pipe to keep it out of the flow stream.

Figure 40 Attaching the Sensor Mounting Band



1. Receptacle for Spring Clip	**2.** Velocity Sensor	**3.** Nylon Wire Ties

Figure 41 Avoiding Silt when Mounting the Sensor



1. Water	**2.** Silt	**3.** Pipe	**4.** Sensor

4.12.3.4 Compensating for Velocity Direction

When programming the velocity sensors you may select one of three Velocity Direction options and the velocity cutoff/velocity default:

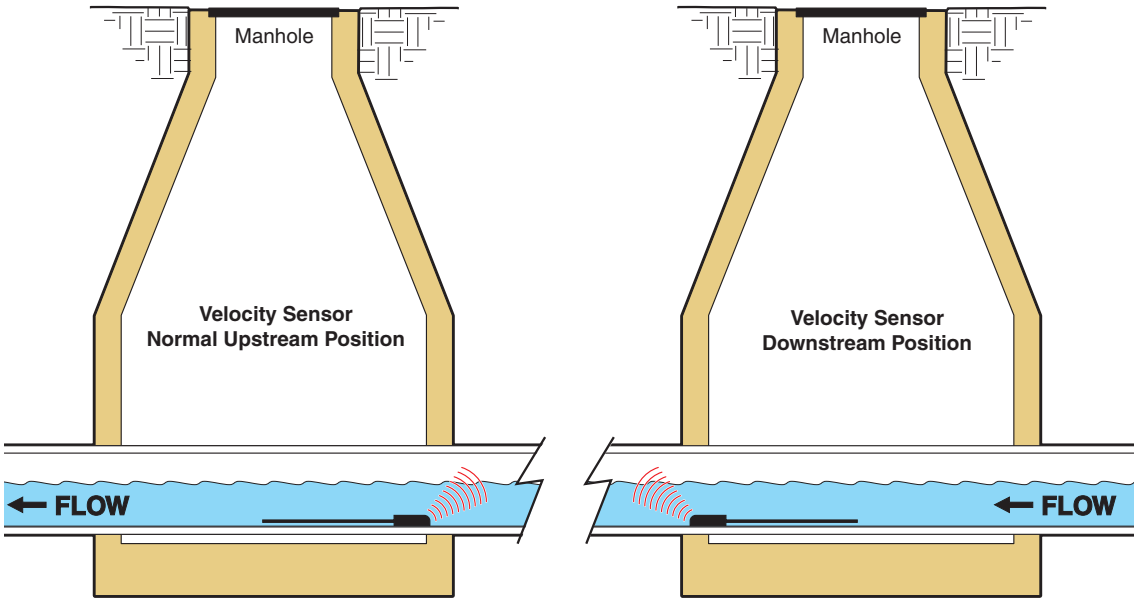
Direction	Description
Upstream	Use this option at sites with fairly consistent velocities, and low to medium turbulence. The flow stream over the sensor should be relatively straight, with no drops or turns near the measurement point.
	Mount the sensor in the pipe, beveled edge facing into the flow, where the flow stream enters the measurement area. (See Figure 42.)
Downstream	Use this option when the sensor is installed downstream of the measurement point (where the flow stream exits the site). This option is useful when more than one flow stream enters a site and the combined flow of all streams at a single exit point is measured.
	Mount the sensor in the downstream direction rather than the typical, upstream direction. Mounting the sensor 'backwards' in this manner (see Figure 42) causes the velocity direction readings to be the opposite of actual stream flow. By selecting the Downstream choice when programming, the logger reverses the measured signal to show actual flow direction (beveled edge downstream). ***Note:*** *The maximum velocity obtained in this type of installation is 5 fps.*
Always Positive	Extremely turbulent conditions can make it difficult to detect the flow direction. Particles in the flow stream (particularly near the surface of the stream) may travel in several different directions, even though most of the flow is moving in one general direction. Although the velocity magnitude is generally consistent in these cases, reflections from the particles moving in a positive direction (same direction as the flow stream), are so mixed up with those from particles moving in a negative direction (opposite direction as flow stream) that determining actual direction is difficult.
	The Always Positive option logs all readings as positive, regardless of the measured signal direction. Do not select this option at sites where negative flows normally occur, such as tidal effects on ocean outfalls.
Velocity Cutoff/ Velocity Default	The Velocity Cutoff option compensates for problems encountered at sites with very low velocities and extremely clean water. Flow is difficult to measure in these conditions because clean water contains very few reflecting particles, and extremely low velocities lack the turbulence to add air bubbles (which also make good reflecting targets) to the flow stream.
	The Velocity Cutoff allows you to enter a default velocity value that is used when the Velocity Cutoff set-point is reached, rather than report erratic velocities.

4.12.3.5 Placing the Sensor and Mounting Band into the Pipe

Point the front of the sensor (the side opposite the cable entrance) into the flow. See Figure 42.

Slide the mounting band as far into the pipe as possible to eliminate drawdown effects near the end of the pipe. Locate the sensor at the bottom-most point, in the channel. If excessive silt is present on the bottom of the pipe, rotate the band in the pipe until the sensor is out of the silt.

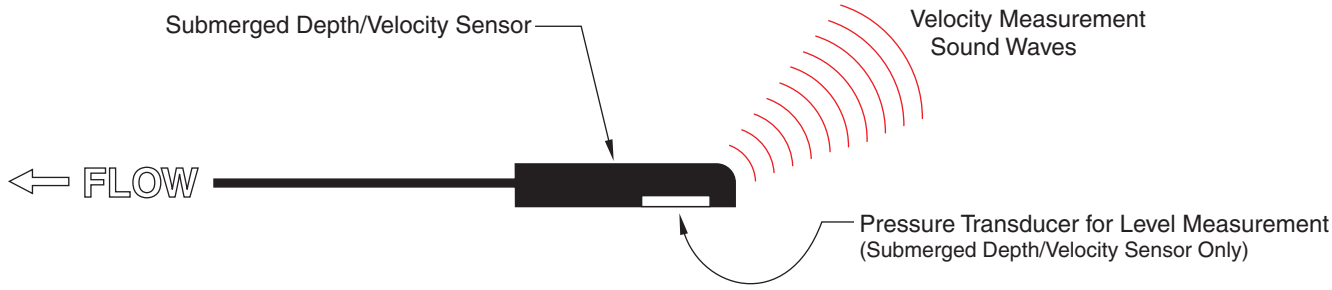
Figure 42 Placing the Sensor into the Flow



4.13 Submerged Area Velocity Sensors

Submerged Area Velocity sensors can measure level and velocity simultaneously. A submerged pressure transducer measures level. Velocity is measured with sound waves, using the Doppler principle. Refer to Figure 43.

Figure 43 Submerged Area Velocity Sensor



4.13.1 Programming the Submerged Area/Velocity Sensor

1. From the Main Menu, select **OPTIONS > LEVEL SENSOR**
2. Select Submerged Xducer using the **CHANGE CHOICE** soft key, then press the **ACCEPT** soft key.
3. Follow Steps1-11 in section 4.12.1 on page 83.

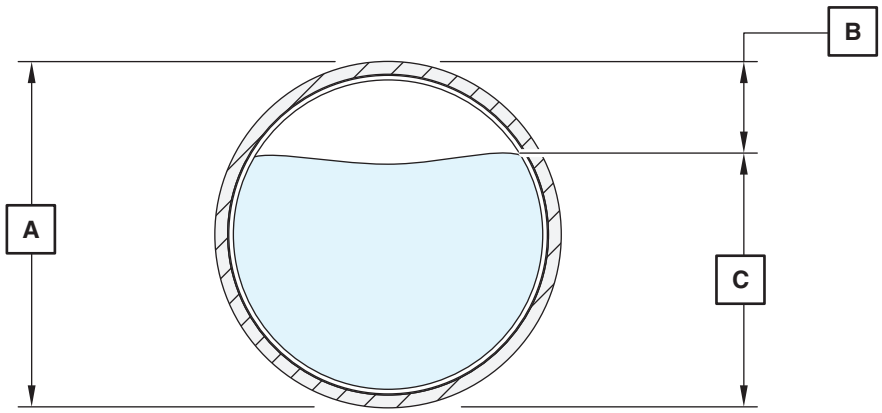
Setting the Water Level

1. Take a physical measurement of the water level and enter the number using the Level Adjust function on the instrument display.

2. Measure from the surface water to the top of the pipe (B in Figure 44), then subtract this from the pipe diameter (A in Figure 44) to get the water level in the pipe (C in Figure 44).

3. This method prevents disturbances to the flow stream that might affect the measurement and keeps the tape measure or ruler clean.

Figure 44 Measuring the Water Level



4.13.2 Calibrating the Submerged Area/Velocity Sensor

Note: *The data is constant if the difference between the level reading of the flow meter and the independent verification is constant; recalibration is not required.*

Note: *Errors can occur with the level reading of the flow meter and the independent verification. Errors are caused by variation in site conditions and measurement abilities. These errors may cause slight variations in the difference, therefore, not indicating a true change in the difference.*

Calibrating the submerged area/velocity sensor synchronizes the meter electronics with the unique characteristics of each individual probe. In addition, the calibration compensates for a drift in the output of the sensor that may occur as the materials in the sensor age. To ensure optimum accuracy, the manufacturer recommends calibrating the submerged area/velocity sensor when:

- The sensor is first used.
- Installing a new or different sensor on a flow meter or input receptacle.
- The difference between the level reading of the flow meter and the independent verification (measurement with a dipstick and ruler) is increasing.

This calibration requires a bucket with at least 7 in. (20 cm) of water and a ruler.

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > CALIBRATION > SUBMERGED PROBE.**

2. Place the sensor flat on a table top or floor with the sensor (the plate with holes) facing down onto the surface (Figure 45).

3. Press any key.

4. Place the sensor face up in the bucket or liquid. Tap lightly to remove air bubbles. If these bubbles are not removed you can receive false readings from the sensor during calibration (Figure 45).

Note: *Always check the Level Adjust when reinstalling the flow meter following a calibration. (See Keypad Description on page 15.)*

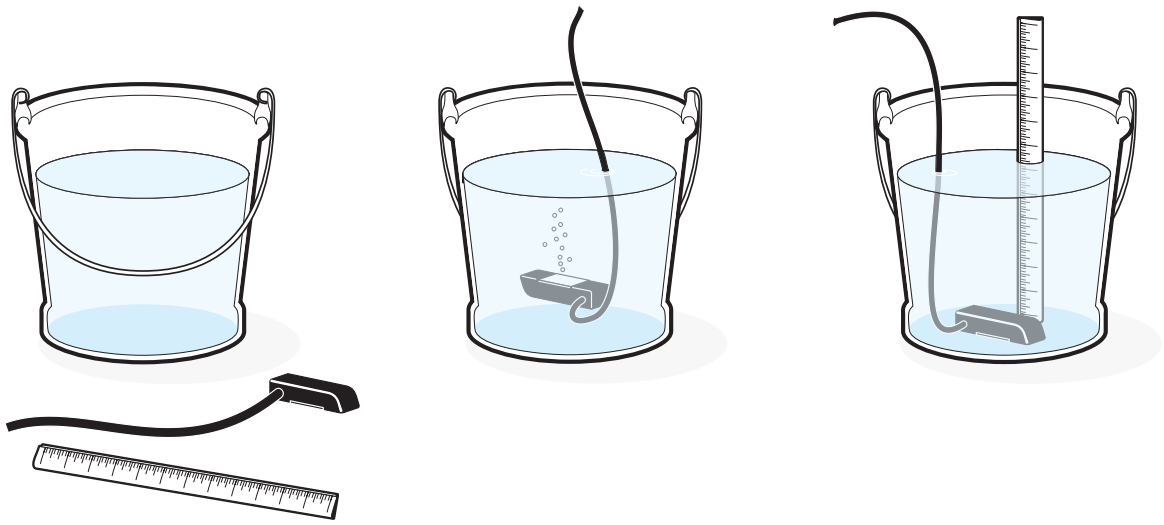
5. Place the sensor face down under at least 7 in. (20 cm) of water. Make sure the water surface is calm and the probe is stable.

6. Press any key.

7. Measure the depth from the bottom of the bucket to the surface of the water and enter the value using the numeric keypad (Figure 45).

8. Press the **ACCEPT** soft key.

Figure 45 Calibrating the Submerged Area/Velocity Sensor



4.13.3 Installing a Submerged Area/Velocity Sensor in a Pipe

4.13.3.1 Important Guidelines for Submerged Area/Velocity Sensor Installation

Installing the submerged area/velocity sensor follows the same instruction as the velocity-only sensor. Refer to Installing the Velocity-Only Sensor in a Pipe on page 84.

MAINTENANCE

DANGER

Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the installation/maintenance tasks described in this portion of the manual.

DANGER

Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détérioration de l'appareil. Les tâches d'installation et d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire.

PELIGRO

Algunos de los capítulos del manual que presentamos contienen información muy importante en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de instalación y mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas.

GEFAHR

Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vermeiden. In diesem Abschnitt beschriebene Installations- und Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.

PERICOLO

Alcune parti di questo manuale contengono informazioni sotto forma d'avvertimenti, di precauzioni e di osservazioni le quali richiedono una particolare attenzione. La preghiamo di leggere attentivamente e di rispettare quelle istruzioni per evitare ogni ferita corporale e danneggiamento della macchina. Solo gli operatori qualificati per l'uso di questa macchina sono autorizzati ad effettuare le operazioni di manutenzione descritte in questa parte del manuale.

Section 5 Maintenance

This chapter explains how to maintain, repair, and upgrade the 980 Flow Meter. It describes how to open the case, inspect and replace fuses, and perform operating system software upgrades.

5.1 Routine Maintenance

Routine maintenance of the 980 Flow Meter consists of calibrating input channels, cleaning the case, and maintaining the sensors as needed.

5.1.1 Calibration

Calibration should be performed on all channels at the proper interval for that type of input. (See Section 4).

5.1.2 Cleaning the Case

Clean the outside of the case with a damp cloth and mild detergent. Use a non-abrasive plastic cleanser on the front cover if necessary. Avoid harsh chemicals or solvents because they may harm the case or fog the front cover.

5.2 Upgrades, Repairs, General Maintenance

Only a qualified technician should service the 980 Flow Meter. For example, steps that require knowledge of CMOS electrostatic discharge precautions and advanced electronics training should only be performed by a qualified technician. If you need assistance in performing any of the following service steps, please contact the manufacturer.

5.2.1 Internal Maintenance Items

The following items require access to the inside of the case for service:

- Interface connectors
- RAM memory batteries
- Fuses

5.2.2  Opening the Front Panel

DANGER
Always disconnect external power sources to the flow meter before opening the front panel.

To open the front panel, loosen the two hold-down screws with a flat-blade screwdriver.

5.3  Fuse Replacement

DANGER
Internal power switch does not remove power from the fuses. Remove power from all external power sources when installing a fuse.

DANGER
For continued protection against fire, replace fuses with only fuses of specified type and current rating.

The ac main fuses are located in the customer wiring area. Replace the fuses as follows:

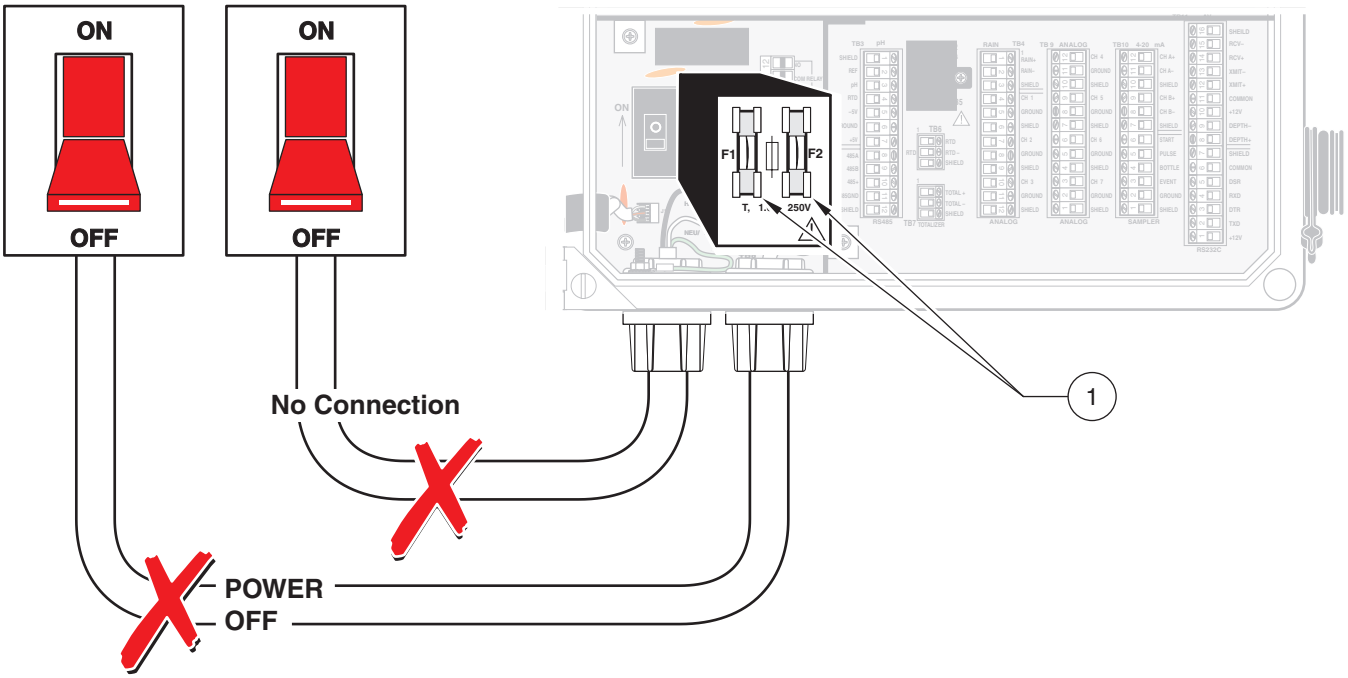
1. Disconnect all power to the instrument (including relay power).

2. Open the front cover of the instrument by loosening the two corner screws.

3. To remove a fuse, pull it straight out of the clips that hold it in place. A typical blown fuse will have a noticeable broken wire strand inside the tube. Occasionally it may take an ohmmeter to verify if a fuse is good or not.

4. Replace the fuses (F1 and F2) with the same type and amperage (T, 1A, 250V) (Cat. No. 015804). Over-rating or bypassing a fuse could result in fire or electrical safety hazards.

Figure 9-1 Locating the Fuses (F1 and F2)



1.	F1 and F2 (T, 1A, 250V)

5.4 Memory Batteries

RAM (random access memory) is a very reliable data storage medium for microprocessor applications. Random Access Memory requires power at all times to store its data, however. If power is removed, the data stored in the RAM chip is lost. Therefore, it is not feasible to power the RAM chips from the meter power supply because you would lose your data and program settings every time power is disconnected. A separate battery pack located inside the flow meter powers the RAM chips and the real time clock.

The memory batteries consist of three AA alkaline cells. They are located on the rear panel assembly and are easy to replace. Use only good quality alkaline AA battery cells as replacements.

The memory batteries (Cat. No. SE 989) keep the program entries and logged data stored in RAM memory when the main power fails or is removed for transport or replacement.

If the memory battery voltage falls too low to properly maintain the program settings, a warning: “MEMORY BATTERY” will flash in the lower right corner of the display to alert you to replace the batteries. The meter uses a very small amount of energy from the memory batteries during normal operation.

5.5 Ultrasonic Sensor Maintenance

One of the key features of the Ultrasonic method of flow measurement is the low maintenance requirements for the level sensor (transducer). Clean the face of the transducer if it is coated by dirt and grease. To clean the Ultrasonic Transducer housing, wipe with a mild soap and water. Strong solvents may damage the transducer housing.

5.6 Cleaning and Maintaining Submerged Area/Velocity Sensors

CAUTION:
When handling materials, samples, and waste wear goggles and latex gloves to avoid illness or infection.

Clean the transducer port when:

- Upward-drift occurs in your readings
- Level data are missing or incorrect but velocity data are valid
- Silt has deposited between the transducer and its protective cover

Do not clean the transducer unless it shows signs of drift or malfunction. Do not clean it just because it appears dirty.

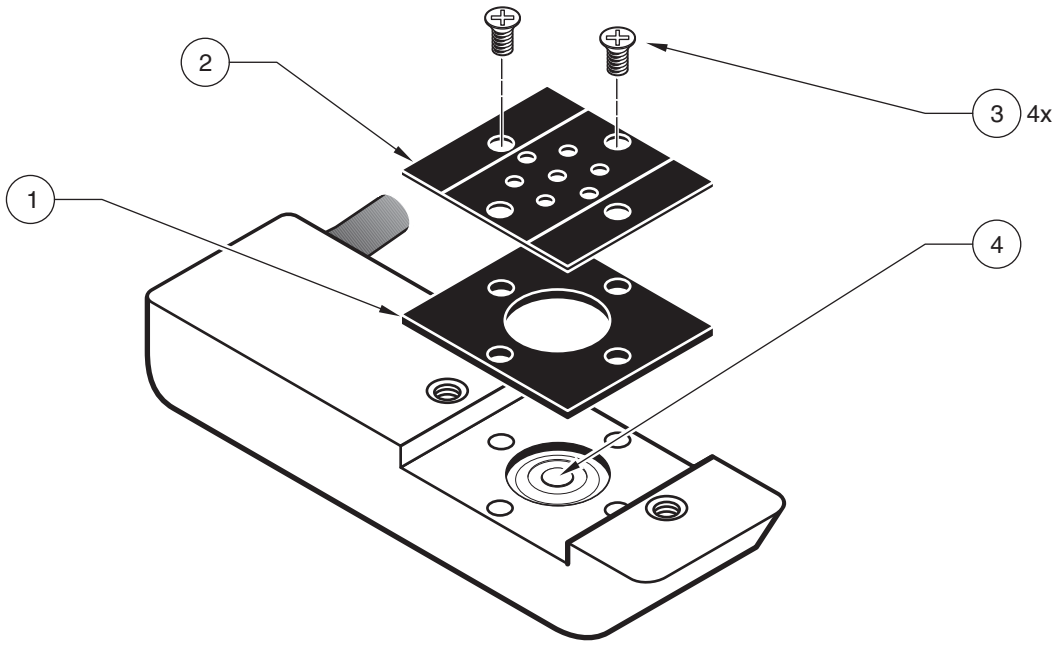
5.6.1 Submerged Area/Velocity Sensor Cleaning Procedure

When cleaning the transducer, use the most gentle technique possible. Do not use any type of object to remove sediment from the face of the transducer. Foreign object damage to the transducer will void the warranty!

1. Soak the sensor in soapy water for 24 hours.
2. Remove the screws from the protective cover (Figure 9-2).
3. Remove the cover and gasket.
4. Carefully swirl the sensor in soapy water to remove soil. For stubborn deposits, use a spray or squeeze bottle.
5. Clean the gasket and cover.
6. Reattach the gasket and cover. Tighten the screws to 10 inch-pounds or until the gasket starts to expand out from under the cover.

Note: *Do not soak the sensor in bleach. Bleach will permanently damage the sensor.*

Figure 9-2 Removing the Protective Cover



1. Gasket	**3.** Screws (#6–32 x 5/16)
2. Protective Cover	**4.** Transducer

5.6.2 Changing the Desiccant

Your sensor contains a tube that equalizes the air pressure in the transducer and the outside air pressure. Moisture may become trapped in this tube. A desiccant-filled canister helps remove moisture from this tube and from the sensor. The canister contains beads of silica gel. When the beads are blue, they can remove moisture from the air. When they are pink, they cannot absorb any more moisture from the air.

When the beads begin to turn pink, you must replace or rejuvenate (dry out) the beads. You can permanently damage the sensor if the desiccant is not maintained. Never operate the sensor without the proper desiccant.

5.6.3 Desiccant Replacement Procedure

Note: *If you are rejuvenating the beads, remove them from the canister and heat at 100–180 °C (212–350 °F) until the beads turn blue again. If the beads do not turn blue, replace them with new beads. Do not heat the canister. It will melt.*

Note: *Applying O-ring grease (beryllium grease) to new or dry O-rings improves the ease of insertion, sealing, and life span of the O-ring.*

1. Use a slight twisting motion to twist the bottom end-cap until its slots align with the retaining clips.
2. Gently remove the end cap by grasping it and pulling it straight out.
3. Pour the desiccant beads out of the canister.
4. Remove the tubing at the top of the canister (Figure 9-3).
5. Remove the canister from its clip.
6. Hold the canister up to the light and inspect the hydrophobic filter for tearing or obstruction.

- If you see a small, dim light spot while looking through the hole, the filter is in good condition. If you see a bright light spot, the filter if probably torn. Replace the filter.
- If the desiccant beads were completely saturated with water or the filter may have been saturated with water or grease, replace the filter.

If you need to replace the filter, complete the Hydrophobic Filter Replacement Procedure on page 97, then continue with step 8.

7. Refill the canister tube with blue desiccant beads (Cat. No. 3624). Inspect the O-ring (Cat. No. 5252) on the bottom cap for cracking, pits, or evidence of leakage. Replace if necessary.

8. Make sure that the O-ring is clean and free of dirt or debris before replacing the end cap.

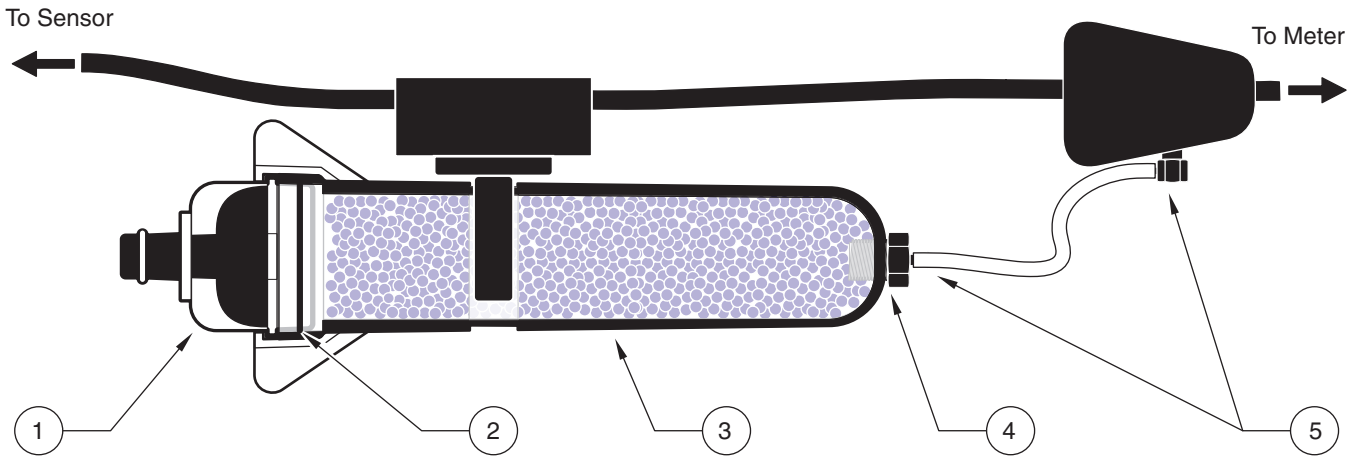
9. Reinstall the end cap and check to make sure that the vinyl tubing is securely fastened at each fitting.

5.6.4 Hydrophobic Filter Description

A single Teflon® hydrophobic filter (Cat. No. 3390) is installed in the top of the canister to prevent liquid from entering the vent tube. This filter is very reliable.

For best performance and to avoid grease buildup on the filter during submergence or surcharge conditions, hang the canister vertically so that the end facing the sensor points downward.

Figure 9-3 Removing the Tubing



1. End Cap	**4.** Teflon® Hydrophobic Filter (Cat. No. 3390)
2. O-ring	**5.** Vinyl Tubing
3. Desiccant Container	

5.6.5 Hydrophobic Filter Replacement Procedure

1. Using a deep-well hex socket (11 mm), unscrew the hex-head tubing nipple from the top of the canister and discard the old filter.

2. Discard any remnants of Teflon tape from the nipple's threads. Reapply two turns of Teflon tape (Cat. No. 10851-45) to the threads, pulling the tape into the threads until it conforms to the shape of the threads.

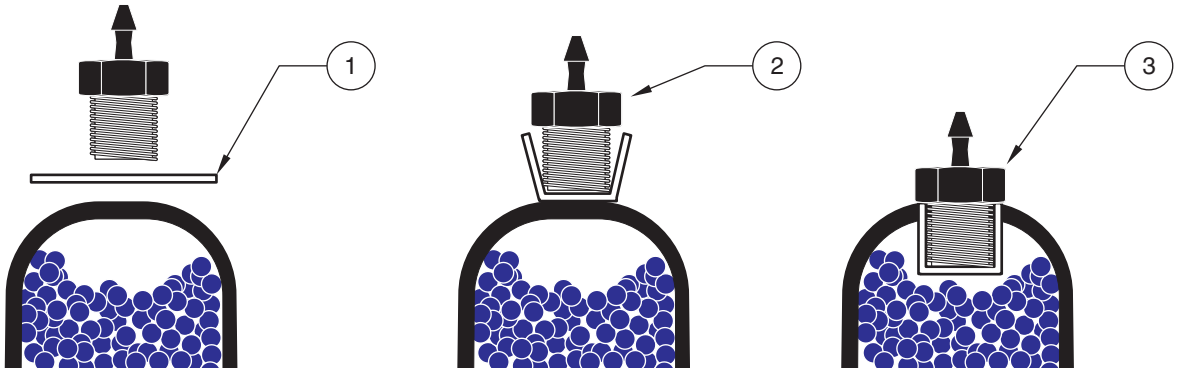
3. Place a new filter (Cat. No. 3390) over the hole. Make sure that the smooth side of the filter faces the inside of the canister. See Figure 9-4.

4. Place the threaded nipple on top of the filter.

5. With a slight pressure, press the filter into the hole with the nipple threads and begin threading the nipple into the hole. The filter will deflect upward and feed completely into the thread until it disappears. The filter must rotate with the nipple as it is threaded into the cap. If it does not, it is torn. Start over with a new filter.

6. Inspect the installation. In the upper cap, a small, dim light spot should be visible when held up to the light. A bright spot indicates a torn filter. Start over with a new filter.

Figure 9-4 Replacing the Hydrophobic Filter



1. Filter, smooth side down	**2.** Hex-head tubing nipple	**3.** Finished assembly.

Troubleshooting Measurement Errors From Electromagnetic Fields

Measurement inaccuracy can be affected by numerous factors, one of these factors is Radio Frequency (RF). The 980 Flow Meter is designed to be resistant to RF fields and other Electromagnetic Interference (EMI), however, RF fields at certain frequencies (at or above 10 Volt/per meter level) can cause disturbances to measurement circuits causing inaccurate measurements. If RF is causing measurement errors, the tranmitter(s) are usually located near the 980 Flow Meter. When the transmitter(s) are too close to the instrument, remove or move the transmitter farther away from the 980 Flow Meter.

The following tables provide RF frequencies and levels that can cause measurement errors. Compare any local transmitters and its transmitting frequency to the tables listed below.

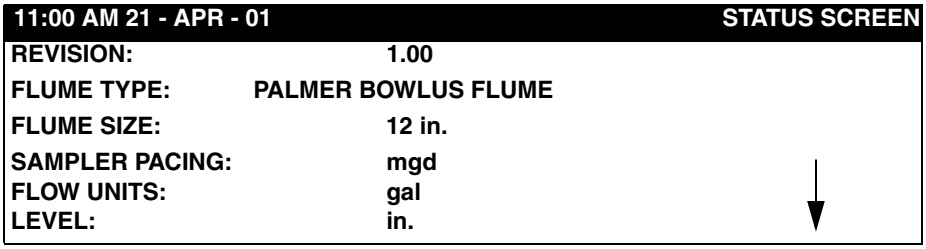
Analog Input		
Offending Frequency (mega Hz)	**Measurement Error (milli V)**	**Specification (milli V)**
90.5	28	not specified
119	12	not specified
141	11	not specified
392	9	not specified

Temperature		
Offending Frequency (mega Hz)	**Measurement Error (°C)**	**Specification (°C)**
84	1.9	not specified
93.7	2.1	not specified
105	5.6	not specified
125	3.6	not specified
127	2.2	not specified
131	3.8	not specified
150	2.3	not specified
324	1.9	not specified
382	7.5	not specified

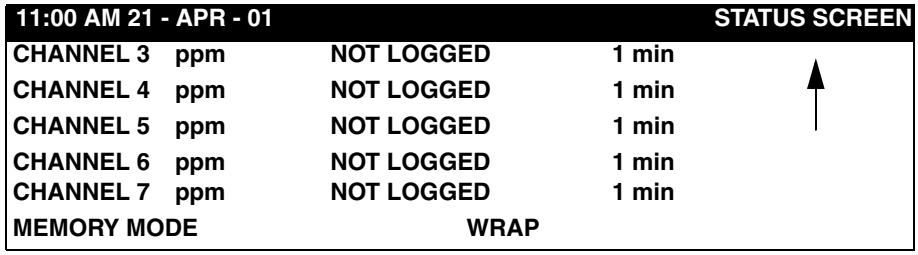
Level Accuracy		
Offending Frequency (mega Hz)	**Measurement Error (inch)**	**Specification (inch)**
31.43	1.300	0.36
44.94	0.430	0.36
374.00	0.780	0.36

Review All Items

To view programmed entries without accidently changing any of the information, select the Review All Items from the Setup menu. This information fills more than one screen, scroll through the setup information one page at a time with the arrow keys. Press the **MAIN MENU** key to exit.



.



Displaying Data

The Display Data function provides the recorded data for any channel being logged in a tabular report or a graph.

In addition, for tabular reports, the data can be viewed from the beginning, from the end, or from a specific point in time. A graph can display any 24-hour period, zoom in to any portion of the 24-hour period for finer detail, or center the graph on a specific point in time.

Selecting the Channel

Note: *Only the channels for which logging has been enabled will be listed.*

1. Press **DISPLAY DATA** from the Main Menu to display a list of logged channels.
2. Highlight the desired channel with the **UP** and **DOWN** keys. Press **SELECT**.

Tabular or Graph Format

1. Highlight the display method with the **UP** and **DOWN** keys. Press **SELECT**.

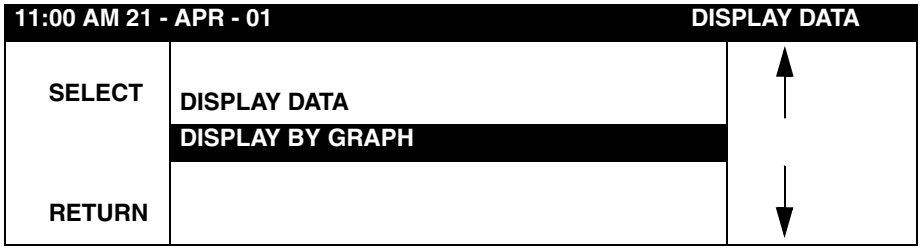


Table 27 Display Data Functions and Descriptions

Function	Description
Display Data by Table	
	View from start: Displays the data for the selected channel beginning with the first (oldest) data point in memory.
	View from end: Displays the data for the selected channel beginning from the most recent point in memory.
	View from time/date: Displays the data for the selected channel beginning from any desired time and date. Enters a new desired time and date.
	Note: *Totals displayed are calculated by summing the logged data. If the date selected precedes available logged data (memory has wrapped), the total will be incorrect.*
Display Data by Graph	
	Graph day: Displays data for a specified date. Data for the selected date is graphed from midnight to midnight.
	Graph point in time: Displays data for a specified time and date. The graph displays three hours of data with the selected point in the time at the corner of the graph.
	Graph partial day: Zooms in on a portion of the logged data.

Graph Manipulation

Table 28 Graphing Functions and Descriptions

Function	Description
Status Bar	
	Displays the time, date, measured value, and unit of measure at the intersection of the data cursor. Placing the cursor data on the status bar eliminates the need for X or Y axis labels and provides a larger graph viewing area.
Moving the Data Cursor with the Arrow Keys	
	The data cursor appears as a vertical line in the center of the graph. Moves the data cursor to the left or right by using the soft keys or the numeric keypad.
Moving the Data Cursor with the Numeric Keypad	
	The keys 0–9 represent a percentage of full scale. Pressing a numeric key while a graph is displayed causes the data cursor to jump to the location on the graph that is represented by that key. For example, pressing 0 moves the data cursor to the far left or 0% position on the graph. Pressing 5 moves the data cursor to the middle or 50% position of the graph. Pressing 9 moves the cursor to the 90% position.
Next Channel	
	Graphs data from the next logged channel. For example, if the 980 is logging Level, Flow, and pH and the Level graph is currently displayed, **NEXT CHANNEL** causes the flow channel to be graphed. Pressing **NEXT CHANNEL** again will create a graph for pH channel. Pressing **NEXT CHANNEL** again returns to the Level graph, selects a time period of interest and compares different graphs.

Graphic Display Averaging

The 980 Flow Meter can display a graph that consists of a maximum of 180 individual dots. Since a 24-hour period could contain as many as 1,440 data points (assuming a one-minute recording interval, one reading each minute) it would be impossible to plot every data point on the graph.

When more than three hours (more than 180 minutes worth) of data is graphed the data points must be averaged. When graphing a partial day of three hours or less, all data points are graphed with no averaging.

When viewing a graph with more than 180 data points zoom in to the area of interest (using the Graph Partial Day option) before all of the individual data points are displayed.

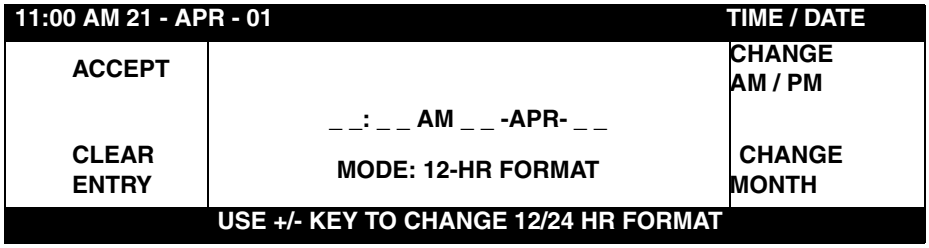
Options Features

The Options menu can set the:

- Time and Date for the real time clock in the 980 Flow Meter.
- Program the advanced features of the flow meter.
- Select level sensor when multiple sensors are installed.

Setting the Time and Date

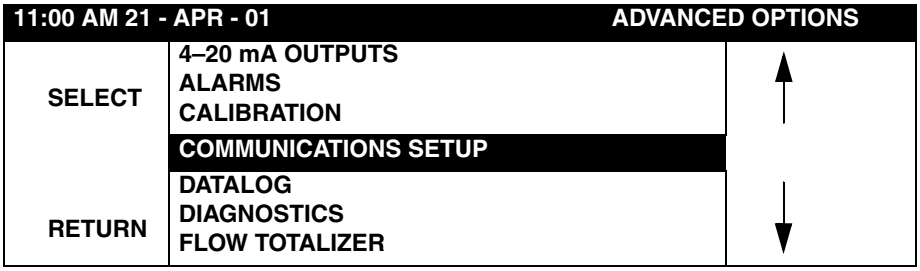
From the Main Menu, select **OPTIONS > TIME/DATE**.



Starting with the hours and minutes, use the numeric keypad to enter numbers in the flashing cursor. Use the **+/-** keys to toggle between 12-hour and 24-hour formats. Use the soft keys on the right of the display to toggle the AM/PM and month fields to the desired selection. Press **CLEAR ENTRY** to clear all numeric fields. When complete, press **ACCEPT** to save the changes.

Advanced Options

1. From the Main Menu, select **OPTIONS** > **ADVANCED OPTIONS**.



2. Use the **UP** and **DOWN** keys to highlight the choice, then press **SELECT**.

3. Proceed through the series of screens to configure the parameters for the selected item.

Advanced Options include:

- 4–20 mA Outputs (section 4.1.1.)
- Alarms (section 4.4.1.)
- Calibration (Section 4)
- Flow Totalizer (section 4.3.1.)
- Diagnostics (Diagnostics on page 107.)
- Data Log (Data Log on page 105.)
- Storm Water (Storm Water on page 110.)
- Set Point Sampling (Set Point Sampling on page 109.)
- Languages (English, Czech, Danish, French, German, Italian, Portuguese, and Swedish, Dutch, and Spanish.
  (The 980 supports English and one other selected language).

Alarms

Setting the Deadband

Note: *Rainfall and Flow Rate of Change alarms are High Set Point conditions; they take no deadband, and they are time dependent.*

After entering the trip point, enter a “Deadband” value. The deadband is the area between alarm “turn on” and “turn off.”

The purpose of setting a Deadband is to eliminate alarm relay chatter which may occur if the turn-on and turn-off values are too close together. Small fluctuations that occur when the reading is at or near the trip point can toggle an alarm relay on and off very rapidly.

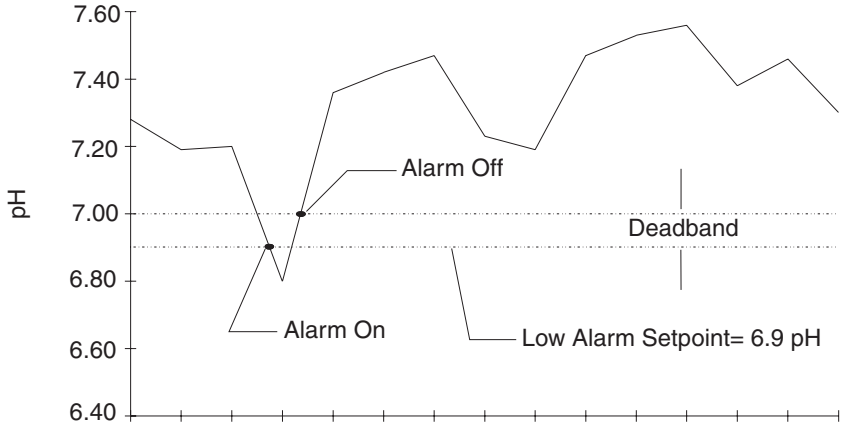
In the pH example (Figure 11-5) the Deadband is set to 0.10 pH. When the pH reached 6.9 (lower dashed line), the alarm tripped, but the alarm did not turn off until the pH came back up to 7.00. This difference is the Deadband setting which should be set according to the characteristics of the item being measured.

Note: *You must log rainfall to use an alarm on a rainfall condition; likewise, you must log flow in order to implement an alarm on a flow rate of change. If you forget, you are reminded when the program begins.*

Four alarm relays are provided with SPDT (Form C) contacts. The normally open, normally closed, and common contacts are on the terminal wiring board.

Multiple alarms can be enabled one at a time. Multiple alarms can be assigned to individual trouble conditions, to individual relays, or assign to all the same relay.

Figure 11-5 Deadband Concept



Data Log

From the Main Menu, select **SETUP > ADVANCED OPTIONS > DATA LOG.**

The 980 Flow Meter can record up to 115,630 readings from any or all input channels and store them in solid state, battery-backed memory for later viewing or retrieval.

This option selects logged input channels, the frequency of logged channels (Logging Interval), and explains what to do when the memory becomes full.

Logging Intervals

Logging Intervals are designed to optimize the available memory so that readings can be logged for a longer period of time. A Logging Interval is the time period over which readings are taken and then averaged.

Note: *The Review All Items selection from the Setup menu indicates the maximum available logging hours for the channels and recording intervals you selected. The flow meter calculates this information when the program is run using the* **RUN/STOP** *key.*

Logging Interval—Continuous Mode
When a one-minute logging interval is selected, a reading will be taken approximately every second but no data are logged until the logging interval ends. At that time, the readings are averaged over the logging interval; that average is logged.

When a five-minute logging interval is selected, readings are still taken every second but the data are not logged until the five-minute logging interval ends. At that time, the readings are averaged over the previous five minutes; that average is logged.

Longer logging intervals result in a longer total recording time. Lower resolution also occurs since more averaging is done at higher logging intervals. Choose the shortest logging interval possible, while still making data

collection convenient. Pick a logging interval that almost fills memory over the course of one month if data will be collected monthly.

Table 29 Logging Intervals vs. Total Recording Time for Each Memory Configuration*

Logging Interval	Total Recording Time (days) before memory is full with 512K Bytes of RAM (approx. 115,630 readings)
1	80
2	160
3	240
5	401
6	481
10	803
12	963
15	1204
20	1606
30	2409
60	4818

* Assuming **one** logged channel.

Data Logging Memory Allocation Options

The 980 Flow Meter uses a management scheme called “Dynamic Memory Allocation.” All readings are logged in battery-backed Random Access Memory (RAM). RAM memory is allocated to each channel dynamically during operation. If one channel is logging at 5-minute intervals and a second channel logging at 1-minute intervals, the meter automatically configures memory so that both channels fill memory at the same time. Five times as much memory is assigned to the channel that is logging at 1-minute intervals than the channel that is logging at 5-minute intervals.

Wrap Memory Mode

The 980 Flow Meter uses wrap memory. In Wrap mode, when memory becomes full, the oldest reading is discarded each time a new reading is taken. When memory becomes full, the flow meter continues to operate and log data. This mode is best used to receive the most recent data readings.

Datalogging Configurations

To configure the 980 Flow Meter for data logging:

1. From the Main Menu, select **OPTIONS>ADVANCED OPTIONS> DATA LOG**.
2. Highlight Select Inputs using the **UP** and **DOWN** keys, then press **SELECT**.
3. Highlight the channel to log using the **UP** and **DOWN** keys.
4. Select Logged or Not-Logged using **CHANGE CHOICE**. Press **ACCEPT**.
5. Enter a logging interval, then press **ACCEPT**. Valid logging interval are shown on the status bar along the bottom edge of the display.

6. Select another channel to configure or press **RETURN** to back up one step or press **MAIN MENU** to return to the Main Menu.

Table 30 Setup Parameters for Specific Channels

Channel Name	Configuration Options
Process Temperature	1. Select Logged or Not Logged using **CHANGE CHOICE**. Press **ACCEPT**. 2. Enter the Logging Interval using the numeric keypad. 3. Select Temperature Units, °F or °C (this is the only place in the software where temperature units can be changed)
Rainfall	section 4.5.1 on page 68
pH/mV	section 4.9.1 on page 70
Level / Flow	Flow Units on page 54 and Level Units on page 55
Analog Inputs	section 4.2.1 on page 64

Diagnostics

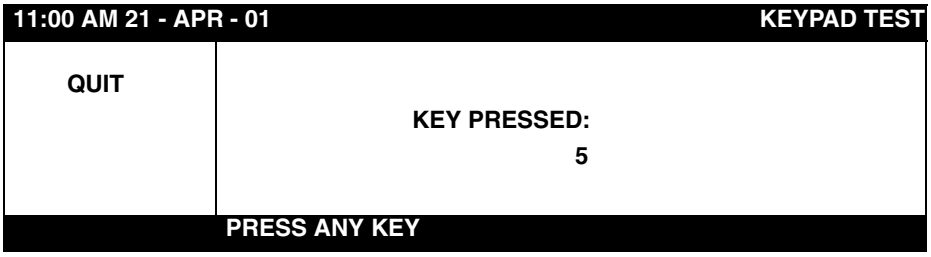
From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > DIAGNOSTICS.**

In addition to the automatic diagnostics that are performed upon power up, the following manual diagnostics are available:

- Keypad Test
- LCD Test
- Demonstration Graph
- Velocity Analysis (only meters with area-velocity capability)
- Events (log)

Keypad Test

Keypad Test provides a simple means of verifying the operation of all front panel keys. Selecting **KEYPAD TEST** from the diagnostics menu will bring up the following screen:



Pressing any key on the front panel (except for the upper left soft key) will cause that key label to appear in the center of the display.

All numeric keypad keys, soft keys, and function keys may be tested in this manner.

To end, press **QUIT** (this also verifies the upper left soft key operation).

LCD Test

Display Test verifies all the pixels in the Liquid Crystal Display (LCD) are functional. The LCD is made up of 14,400 pixels that are turned on and off as needed to create the display of graphics and text. Each individual pixel is turned on and off by its own transistor. If a transistor fails, the pixel will not turn on, potentially causing an unreadable or confusing display.

Select **LCD TEST** from the Diagnostics Menu. The display will become black for 3 seconds. To verify that all pixels are functional. A defective pixel will stand out as a white dot in the field of black dots. A message, “THE DISPLAY WILL REMAIN INVERTED FOR 3 SECONDS” is shown for 2 seconds followed by a 3-second period with all dots turned on.

Demonstration Graph

The demonstration graph provides a small portion of demonstration data to use when learning how to use the graphing screen for the first time or for training others on its operation. No data logging is required to use the demonstration graph.

Velocity Analysis

A velocity sensor must be installed in the flow stream and must be connected to the meter in order for this diagnostic to work. This diagnostic allows the viewing of ‘real time’ readings directly from the Submerged Area/Velocity Sensor. It shows the current velocity Signal Strength (percentage of Doppler signal returning to the sensor) and a ‘real time’ velocity measurement of the flow stream. Use this diagnostic to determine that the sensor is mounted for optimal velocity measurement. The closer to 100% the Signal Strength is, the more stable the velocity reading will be. If the signal seems low (50% or less), it may be due to improper installation of the sensor or a lack of particulate in the flow stream.

Event Log

The Event Log diagnostic provides a time/date stamped list of significant events occurring in the flow meter. Review these events to find out when an event occurred and what events preceded or followed the event of interest. Events may be viewed in chronological order from the beginning or end of the event list by selecting **VIEW FROM START** or **VIEW FROM END** respectively.

Fixed Alarms

Fixed alarms (Table 31) show the On/Off status associated with the alarm. For instance, U-sonic Echo Loss On at some time/date will appear. When the condition ends, U-sonic Echo Loss Off will appear.

Table 31 Event Log Fixed Alarms

Event	Explanation
MEMORY BATTERY	Internal memory battery is low.
MODEM FAILURE	Modem chip/modem board failure.
U-SONIC ECHO LOSS	No return signal detected.
XDUCER RINGING	The return signal is detected too soon.
U-SONIC FAILURE	Ultrasonic board detects an error.
RS485 TIMED OUT	Communication problem with RS485.

Channel Alarms

Channel alarms show the value that caused the alarm to occur or go away, and show a status ON/OFF to indicate if the alarm occurred or went away at that time/date. Event log channel alarms include:

- Level
- Flow Rate Of Chg
- Rainfall
- CH1
- CH2
- CH3
- CH4
- Flow
- pH
- CH5
- CH6
- CH7
- Velocity
- Temperature

Set Point Sampling

In the 980 Flow Meter, set point sampling allows the control of an automatic liquid sampler from up to 14 different sources individually or simultaneously.

Upon reaching a user-defined set point trigger, the flow meter provides an output signal at the Sampler interface (see Wiring the Sampler on page 38) for details on the sampler interface). This signal can be used to tell a sampler such as the Model 900 Sampler that a set point condition has been reached and samples should be taken.

Set Point sampling defines a set of limits that inhibit sampling until an upset condition occurs, causing the limits to be exceeded. In this manner, time and money and collecting and testing samples that are within limits is not wasted, because sampling is enabled only when the waste stream falls outside the set points.

Table 32 shows all possible sampling triggers and appropriate settings.

Table 32 Sampling Triggers

Sampling Trigger	Settings
Level	High and/or Low condition, deadband
Flow	High and/or Low condition, deadband
Flow Rate of Change	High condition within time interval
Temperature	High and/or Low condition, deadband
pH	High and/or Low condition, deadband
Rainfall	High condition within time interval
Analog Input Channel 1	High and/or Low condition, deadband
Analog Input Channel 2	High and/or Low condition, deadband
Analog Input Channel 3	High and/or Low condition, deadband
Analog Input Channel 4	High and/or Low condition, deadband
Analog Input Channel 5	High and/or Low condition, deadband
Analog Input Channel 6	High and/or Low condition, deadband
Analog Input Channel 7	High and/or Low condition, deadband

To enable Set Point Sampling:

1. From the Main Menu, select **OPTIONS> ADVANCED OPTIONS > SETPOINT SAMPLING.**
2. Highlight **SETPOINT SAMPLING** using the **UP** and **DOWN** keys on the Advanced Options Menu, then press **SELECT**.
3. Highlight the desired sampling trigger (see Table 32), then press **SELECT**.
4. Highlight **SAMPLE ON HIGH CONDITION** or **SAMPLE ON LOW CONDITION.**
5. Press **CHANGE CHOICE** to enable or disable the sampling trigger for this condition.
6. Enter the desired high or low trigger point, then press **ACCEPT**.
7. Enter a deadband value (see Setting the Deadband on page 104) or, if programming for Flow Rate Of Change or Rainfall, enter a time interval within which the flow or rainfall change must take place.

Note: *You must log rainfall to use set point sampling on a rainfall condition; likewise, you must log flow in order to implement set point sampling on a flow rate of change. If you forget, you are reminded when the program begins.*

Sample on High Condition and Sample on Low Condition can be enabled at the same time. There is no limit to the number of sampling triggers that can be enabled at one time.

Storm Water

A special Storm Water monitoring program designed specifically to meet the NPDES storm water requirements is built in to the 980 Flow Meter. Rainfall is monitored with an optional Rain Gauge. A connection is then made from the 980 Flow Meter Sampler Interface to an automatic liquid sampler.

A typical storm water program might be configured to activate when a storm causes a level of at least 3 in. (7.6 cm) in the outfall channel and 0.10 in. (2.5 mm) of rainfall within 30 minutes. Or, it might be desirable to activate the

program if either the rainfall occurs or the channel level exceeds the limit. Any combination of rainfall and level conditions can be used to activate a storm water program. Specific requirements can vary, however, from state to state. Consult state regulatory groups for recommendations on storm water permit requirements for specific applications.

To configure the Storm Water program in the flow meter, proceed as follows:

1. From the Main Menu, select **OPTIONS > ADVANCED OPTIONS > STORM WATER.**
2. Highlight Storm Water on the Advanced Options Menu. Press **SELECT.**
3. Press **CHANGE CHOICE** to enable Storm Water, then press **ACCEPT**.
4. Select a Start Condition:
   - Rain
   - Level
   - Rain and Level (both conditions must be met to begin program)
   - Rain or Level (either condition must be met to begin program)
5. Enter the Start Condition limits:
   - For Rain, enter the amount of rainfall and the time period within which it must fall.
   - For Level, enter the level limit.
   - For Rain and Level and Rain or Level enter the amount of rainfall and the time period within which it must fall, and the desired level limit.

Appendix C Programming Worksheet

Name:		Date:	Serial No.:	ID No.:
Program Software Versions for:				
Flow Meter:	DTU:	InSight:	Vision	StreamLog

Basic Programming Guidelines

- Go through all items in the Setup menu and configure each one.
- Review items in the Advanced Options menu and configure any items
- Always check Data Logging and Totalizer Setup. Data logging channels must be enabled if you want to record the data in memory. Also, the totalizer should be configured with an acceptable scaling factor for the flow rate at each site.
- Go to the options menu and set the time and date if they have not already been set.
- When finished, press **RUN/STOP** to start the program.
- Photocopy the following worksheets to record your program settings at each site for easy reference.

SETUP MENU

From the Main Menu, select **SETUP**, **MODIFY ALL ITEMS.**

1. Select FLOW unit of measure (gps, gpm, gph, lps, lpm, lph, mgd, afd, cfs, cfm, cfh, cfd, cms, cmm, cmh, cmd): _____

2. Select LEVEL unit of measure (cm, m, in., ft): _____

3. Select a PRIMARY DEVICE:_____

Flume: Type_____, Size_____

Weir: Type_____, Size_____

Nozzle: Type_____, Size_____

Manning Formula:

Slope_____, Roughness_____, Pipe Diameter_____

Power Equation:

K_1=_____, n_1=_____, K_2=_____, n_3=_____

Head vs. Flow

4. Enable PROGRAM LOCK password: (Y / N)

(Password is always 9800)

5. Enable SAMPLER PACING: (Y / N):

   Flow interval:_____, Flow unit of measure:_____

6. Enter a SITE IDENTIFICATION:_____

7. Enter unit of measure for TOTAL FLOW (acre-feet, cubic feet, gallons, liters, cubic meters):_____

Applies to velocity models only:

8. Enter the VELOCITY DIRECTION (Upstream (normal), Downstream or Always Positive):_____

9. Enter the VELOCITY UNITS (fps or m/s):_____

10. Enter the VELOCITY CUTOFF:

    Cutoff value = _____, Default Value = _____

OPTIONS MENU
From the Main Menu, select **OPTIONS**.

1. Set Time & Date: _____

2. Level Sensor (Ultrasonic or Submerged Sensor): _____

ADVANCED OPTIONS MENU
From the Main Menu, select **OPTIONS > ADVANCED OPTIONS**.

1. Setup 4–20 ma Outputs (if desired):_____

2. Setup ALARMS (if desired):_____

Alarm Name	High Trigger	Low Trigger	Deadband	Time Interval	Relay # Set
Low Mem Battery					
Level					
Flow					
Flow Rate of Change					
pH					
Temperature					
Rainfall					
Channel 1					
Channel 2					
Channel 3					
Channel 4					
Channel 5					
Channel 6					
Channel 7					

3. Calibrate inputs (as needed): _____chk

4. Communications Setup: (If modem is enabled) ACCEPT any baud rate displayed. [Modem will independently establish actual baud rate between 1200 and 14,400.]

   Pager Phone Numbers (if enabled): Pager Service:_____

   Pager #1: _____ Pager #2: _____ Pager #3: _____

   Select Baud Rate for RS232 (1200, 2400, 4800, 9600, 19200):_____

5. Configure DATA LOGGING for each desired channel:

Channel Name	Analog Channel Signal Description	Logged (Y/N)	Units	Logging Interval (min)
Process Temperature				
Rainfall				
pH				
Level / Flow				
Analog Channel 1				
Analog Channel 2				
Analog Channel 3				
Analog Channel 4				
Analog Channel 5				
Analog Channel 6				
Analog Channel 7				

6. Configure Flow Totalizer:

   Scaling: _____ (X, X1, X10, X100.... X1,000,000)

   Flow Units (Acre-feet, cubic feet, gallons, liters, cubic meters):_____

7. Configure SETPOINT SAMPLING if it is desired to trigger a sampler based on one of the following conditions:

Channel Name	High Trigger	Low Trigger	Deadband	Time Interval
Level				
Flow				
Flow Rate of Change				
pH				

Channel Name	High Trigger	Low Trigger	Deadband	Time Interval
Temperature				
Rainfall				
Channel 1				
Channel 2				
Channel 3				
Channel 4				
Channel 5				
Channel 6				
Channel 7				

8. Configure STORM WATER if desired:

Start Condition:_____ (Rain, Level, Rain & Level, Rain or Level)

Rain Trigger: _____, Rain Time Limit:_____

Level Trigger_____

Check one:

____ Head Vs Flow Worksheet

____ Level Vs Area Worksheet (velocity units only)

Head / Level (units =_____)	Flow / Area (units =_____)

Appendix D SCADA-Modbus® System Guidelines

Introduction to SCADA - Modbus Communications

Use this section as a guide when using the Modbus ASCII protocol to communicate directly with the 980 Flow Meter via an RS232 or modem connection.

This guide assumes that the user has a working knowledge of Supervisory Control and Data Acquisition (SCADA), its components, and the different topologies used to construct the communications network. Because a basic understanding of the Modbus ASCII protocol is necessary, a description of key pieces of the protocol will be described.

This section will guide you through the setup process by describing key points that need to be addressed for successful communication. This section will not outline specific implementation details of any particular Man Machine Interface (MMI) or controller, although examples may reference certain manufacturers for illustrative purposes. The description of the Modbus ASCII protocol is provided for reference only and is not intended as a tutorial. The scope of this section is limited to the description of Modbus ASCII as it pertains to the 980 Flow Meter.

Modbus, an open protocol, determines how each instrument will know its device address, recognize a message addressed to it, determine the type of action to be taken, and extract any data or other information contained in the message. The flow meter and Man Machine Interface (MMI) communicate using a master-slave technique in which only the master can initiate queries to a slave (980). The 980 will always be considered the slave, never a master. The master can address individual 980 Flow Meters or can broadcast a message to instruments within its scope. Responses are never returned to broadcast queries from the master. The Modbus protocol establishes the format for the master's query by placing into it the device address, a function code defining the requested action, any data to be sent, and an error-checking field. The flow meter's response message is constructed using the Modbus format which confirms the action to be taken, any data to be returned, and an error checking field.

ASCII Transmission Mode

The 980 Flow Meter is designed to communicate on standard Modbus networks using Modbus ASCII. In ASCII mode, messages start with a colon ':', and end with a 'carriage return-line feed' pair. The allowable characters transmitted for all fields are hexadecimal 0–9, and A–F. When a message is transmitted over a Modbus ASCII communication link, each character or byte is sent in the order of Least Significant Bit to Most Significant Bit. A typical message frame looks like the following:

START	ADDRESS (HEX)	FUNCTION (HEX)	DATA (HEX)	LRC (HEX)	END (HEX)
1 Char ':'	2 Chars	2 Chars	n Chars	2 Chars	2 Chars 'CRLF'

Address Field

The address field of an ASCII message frame, ranging from 0 to 247 decimals, consists of two characters that represent the slave address. Individual slaves are assigned values between 1 and 247. A master addresses a slave by putting the slave's address in the address field of the message frame. When the slave sends its response, it places its own address

in the address field of the message frame to let the master know which slave is responding.

The device address of the 980 Flow Meter is set via the front keypad in the 980 Communications menu.

1. From the Main Menu select **OPTIONS > ADVANCED OPTIONS > COMMUNICATIONS SETUP > MODBUS SETUP**

2. Enter a value between 0 and 247.

Function Field

The function code field of an ASCII message frame, ranging from 1 to 255 decimals, consists of two characters that represent the type of action the master is requesting from the slave. Of these functions, the 980 Flow Meter currently supports function 3 (Read Holding Registers). When a message is sent from the master to a slave device, the function field tells the slave what kind of action to perform. For example, this may include reading the channel values of Level and Velocity. When the slave responds to the master, it echoes the function code field to indicate a normal response. In the event of an error, such as parity error, LRC error, or a request that cannot be handled, the slave will not respond and the master will eventually process a time-out condition.

Data Field

The data field of an ASCII message frame consists of *n* pairs of ASCII characters that represent data sent to or from a slave device (flow meter). The data field contained in the master request contains additional information that is required by the slave before any action takes place. This may include channel register addresses, the number of registers to read, and the actual byte count in the data field. For example, if a master requests that the flow meter read the current status of a group of channels (function code 03), the data field specifies the starting register and how many registers are to be read. If no error occurs, the data field of the response from the meter to the master contains the data requested.

LRC Field

The LRC field of an ASCII message frame consists of two ASCII characters that provide an additional level of error checking to verify the integrity of the communication media. The LRC field is one byte that contains an 8-bit binary value. The LRC value is calculated by the transmitting device, which appends the LRC to the end of the message. The receiving device recalculates the LRC and compares it against the LRC value of the incoming message. If the two values are not equal, an error condition occurs. The LRC is calculated by adding together successive 8-bit bytes of the message, discarding any carries, and then complementing the result. The LRC is calculated by summing all values in the ASCII message except for the leading ‘colon’ and ending <CR><LF>.

Communication Parameters

To successfully communicate with the 980 Flow Meter using Modbus ASCII, the communication parameters of the master device must be set at 7 bits, Even Parity, and 1 Stop bit. The baud rate may be configured to any value offered by the 980 Flow Meter. With the exception of baud rate, the communication parameters must not vary from this format.

User Memory Customizing

The most familiar component of existing SCADA networks today is the Programmable Logic Controller (PLC). Because the network integrator is most familiar with this type of device, the flow meter emulation of an existing PLC simplifies the process of integrating the manufacture's instrumentation into the SCADA network. Modbus ASCII uses a referencing system to identify the various types of memory inputs and outputs. Each reference number has a leading digit that identifies its data type (discrete input, discrete output, register input, register output) followed by a string of digits that indicates its location in RAM (Table 33).

Table 33 Modbus ASCII Memory Input/Output Referencing System

Reference Indicator	Reference Type	Meaning
0xxxx	discrete output or coil	binary
1xxxx	discrete input	binary
3xxxx	input register	real
4xxxx	output holding register	real
6xxxx	extended memory register	real

The memory data is stored in 16-bit words. Within the predefined function codes of the Modbus ASCII protocol, the data fields are subject to interpretation by the device manufacturer. For example, the 980 Flow Meter places temperature information in registers 40001-40002.

Modbus ASCII Function Codes Supported

Currently, the 980 Flow Meter is capable of a read-only function to retrieve channel and total flow information. All data addresses in the Modbus ASCII message are referenced to zero. Therefore, a reference to holding register 40001 is addressed as register 0000. The function code field specifies the type of register accessed; therefore, the 4XXXX is implicit.

Function 03: Read Holding Registers
Reads the register (4X reference) contents of the 980 Flow Meter as defined in the tables that follow.

Table 34 Channels' Read Holding Register Addresses

Name	Type	Size (bits)	# of Registers	Start Address Hi	Start Address Lo	Registers
Temperature	Float	32	2	00	00	40001-40002
Rainfall	Float	32	2	00	02	40003-40004
pH (or ORP)	Float	32	2	00	04	40005-40006
Level 1	Float	32	2	00	06	40007-40008
Velocity 1	Float	32	2	00	08	40009-40010
Channel 1	Float	32	2	00	0A	40011-40012
Channel 2	Float	32	2	00	0C	40013-40014
Channel 3	Float	32	2	00	0E	40015-40016
Channel 4 (D.O.)	Float	32	2	00	10	40017-40018
Channel 5 (D.O. Temp.)	Float	32	2	00	12	40019-40020
Channel 6 (Conductivity)	Float	32	2	00	14	40021-40022
Channel 7 (Cond. Temp.)	Float	32	2	00	16	40023-40024
Flow 1	Float	32	2	00	20	40033-40034
Power	Float	32	2	00	26	40039-40040

Table 35 Channels' Units of Measure Read Holding Register Addresses*

Name	Type	Size (bits)	# of Registers	Start Address Hi	Start Address Lo	Registers
Temperature	Integer	16	1	00	31	40050
Rainfall	Integer	16	1	00	32	40051
pH (or ORP)	Integer	16	1	00	33	40052
Level 1	Integer	16	1	00	34	40053
Velocity 1	Integer	16	1	00	35	40054
Channel 1	Integer	16	1	00	36	40055
Channel 2	Integer	16	1	00	37	40056
Channel 3	Integer	16	1	00	38	40057
Channel 4 (D.O.)	Integer	16	1	00	39	40058
Channel 5 (D.O. Temp.)	Integer	16	1	00	3A	40059
Channel 6 (Conductivity)	Integer	16	1	00	3B	40060
Channel 7 (Cond. Temp.)	Integer	16	1	00	3C	40061
Flow 1	Integer	16	1	00	41	40066

* The addresses shown above return a code that represents the appropriate unit of measure.

Table 36 Flow Totalizer Read Holding Register Addresses

Name	Type	Size (bits)	# of Registers	Start Address Hi	Start Address Lo	Registers
Total Flow 1	Float	32	2	00	4A	40075-40076
Total Flow Units	Integer	16	1	00	50	40081
Total Flow Multiplier	Float	32	2	00	51	40083-40084

Table 37 SCADA-Modbus Units of Measure Codes

Unit	Code	Unit	Code
ML	1	GPH	26
AF	2	LPS	27
CF	3	LPM	28
GAL	4	LPH	29
L	5	MGD	30
M3	6	PH	31
IN	7	ORP	32
CM	8	PPM	33
FT	9	PPB	34
M	10	MGL	35
CM2	11	PCTSAT	36
FT2	12	MSIEMENS	37
IN2	13	MICROSIEMENS	38
M2	14	GRAMSPERKG	39
AFD	15	PCTPERDEGC	40
CFS	16	DEGREE_C	41
CFM	17	DEGREE_F	42
CFH	18	MILS	43
CFD	19	VOLTS	44
CMS	20	FPS	45
CMM	21	MPS	46
CMH	22	PCT_O2	47
CMD	23	PCT_H2S	48
GPS	24	PCT_LEL	49
GPM	25	VDC	50

Query

The Modbus ASCII query must take the form shown below that specifies the starting register and number of registers to be read:

Start ':'	Slave Address	Function (03)	Start Address High	Start Address Low	No. of Pts. High	No. of. Pts. Low	LRC	<CR>	<LF>

For example, to read the level channel of the 980 Flow Meter, the query must be as indicated in Table 38.

Table 38 Channel Query to Read Level (Example)

Start	':'
Slave Address	01
Function	03
Starting Address High	00
Starting Address Low	06
No. of Registers High	00
No. of Registers Low	02
LRC	F4
Stop	<CR><LF>

The master queries the flow meter using a Read Holding Registers request, which implies a 4XXXX register reference, to slave device address 01.
The message requests data from holding registers 40007–40008 to obtain the level information, which requires two registers to store the floating point value. Note that registers are referenced from zero in the data field.

Response

The 980 Flow Meter responds with the following transmission reflecting a level reading of 15.0 inches:

Table 39 Transmission Response that Reflects a 15 in. Level Reading

Start	':'
Slave Address	01
Function	03
Byte Count	04
Data High	00
Data Low	00
Data High	41
Data Low	70
LRC	47
Stop	<CR><LF>

The flow meter response echoes the address and function code, which indicates that no problems exist in the communication between the master and 980. The 'Byte Count' field specifies how many 8-bit data items are being returned in the data field. With Modbus ASCII, this is one-half the actual count of ASCII characters transmitted in the data portion of the response.
The contents of 40007 are shown as two byte values of 00 00 hex, and the contents of register 40008 are shown as two byte values 41 70 hex. Together, these values represent the floating point IEEE representation of the level status.

980 Flow Meter Response Time

As a result of time lags associated with data acquisition, instrumentation could conceivably take up to 12 seconds to respond to a SCADA RS232

request. Therefore, the SCADA system must be designed to accommodate this potential communication lag. For example, in a Wonderware® application running a Modbus ASCII DDE server, the com port reply time-out must be set to 12 seconds. This is the amount of time that the meter will be given to reply to Modbus queries via this serial port.

Communication Handshaking
The 980 Flow Meter contains minimal communication handshaking. For the meter to identify an RS232 connection from an outside source, and to keep the RS232 hardware active once communicating, the Data Terminal Equipment (DTE) must assert and hold high the DTR line of the DB9 connector (DSR of meter). The 980 Flow Meter does not support RTS/CTS hardware handshaking. Note that DTE must be capable of handling a 12-second maximum response lag.

Pin	Description	Pin	Description	Pin	Description
Pin 1	Data Carrier Detect (DCD)*	Pin 4	Data Terminal Ready (DTR)	Pin 7	Request to Send (RTS)*
Pin 2	Received Data (RD)	Pin 5	Signal Ground (SG)	Pin 8	Clear to Send (CTS)
Pin 3	Transmitted Data (TD)	Pin 6	Data Set Ready (DSR)	Pin 9	Ring Indicator*

* Not used.

Complications with Floating Point Values

The manufacturer's implementation of the Modbus protocol was based on the idea that we would enable our flow meters to emulate a Modicon®, Compact 984 PLC. Consequently, we follow the exact same format that Modicon uses for the storing and processing of floating point numbers. Additionally, the Modbus protocol does not define how floating point values are packed (stored) into the internal memory addresses or "Registers" of the flow meter. If you are integrating our Modbus-capable flow meters, be aware that these meters store and process floating point numbers in the exact same format as the Modicon Compact 984 PLC.

All current models of Modicon PLCs, including the Compact 984, pack two bytes of data into each register. This alone presents no problems. Unsigned two-byte (16-bit) integer values in the range of 0 to 65535 can be stored and retrieved from these registers without any problems or complications. The complications arise when the stored value is a floating point value, which by IEEE definition, require 4 bytes (32 bits). The IEEE standard for floating point values states in part that the 8 most significant bits represent the exponent and the remaining 23 bits (plus one assumed bit) represent the mantissa and the sign of the value.

Since a data "word" consists of two bytes, a floating point value is represented by two data words. Because a single Modicon register consists of one word (or 2 bytes), two consecutive Modicon registers are needed to store one floating point value.

The representation of a floating point value can be broken down into a "High Order" and a "Low Order" word. Additionally, each word can be broken down into a high order byte and a low order byte.

Table 40 and Table 41 depict how a IEEE floating point value is usually represented and how the Modicon stores a floating-point value.

The complications arise because Modicon doesn't store floating point values in this standard (IEEE) format. Modicon stores floating point values the opposite way with the “Low-order” word in the first register and the “High-order” word in the second register.

Table 40 IEEE Floating Point Representation

First Register (i.e., 4001)		Second Register (i.e., 4002)	
High Word, High Byte	High Word, Low Byte	Low Word, High Byte	Low Word, Low Byte

Table 41 Floating Point Values Representation

First Register (i.e., 4001)		Second Register (i.e., 4002)	
Low Word, High Byte	Low Word, Low Byte	High Word, High Byte	High Word, Low Byte

Since the Modbus protocol doesn't define how floating point values are handled or stored, some Modbus-capable servers incorrectly use the normal, “High word — Low word” format for converting the Modbus message response to the client application. Since Modicon stores the floating point values in the opp0odbus and floating point numbers.

Port Expanders and Protocol Converters

In some situations, there may not be a Modbus ASCII port available for use with the 980 Flow Meter. A good example might be where there is a need to install a flow meter at a remote pump site that already has a single Modbus line connected to a PLC that is used to control the pumps.

Port expanders are available from third party manufacturers; these allow several Modbus slave devices to be connected to a single Modbus Master device. Typically, a single port expander will have 3–5 separate Modbus ports on it. Depending on the manufacturer, the user may be able to configure each of these ports for different communications parameters. In essence, not only does this type of port expander allow multiple slave devices to be connected to a single Modbus master device, but it can also be configured to convert incompatible communications parameters such as Modbus ASCII to RTU (or vice versa), baud rate, parity, stop bits, etc.

In addition to the port expanders mentioned above, other protocol converters from third-party manufacturers, can be used to convert other industrial protocols to Modbus ASCII.

Other Reference Material

SCADA ANSI Specification. ANSI/IEEE Std. C37. 1–1994.

Boyer, Stuart A. *SCADA supervisory control and data acquisition.* Research Triangle Park, NC: Instrument Society of America. 1993.

MODICON. *Modicon modbus protocol reference guide.* North Andover, MA: MODICON, Inc., Industrial Automation Systems. 1996.

AEG Schneider Automation. *Modicon ladder logic block library user guide.* North Andover, MA: AEG Schneider Automation, Inc. 1996.

Troubleshooting Tips

Problem: 980 Flow Meter responds to some Modbus messages but not all

Response: Check the Register Addresses
The flow meter will only respond to valid Modbus message requests. If a Modbus message sent to the flow meter asks for stored register addresses for values that are outside of the address range currently supported by the meter, the meter will ignore the request.

The flow meter currently only supports register addresses 40001 through 40083. Consequently, a request to read the value in any register address greater then 40083 will be ignored. If a range of registers is requested and that range includes register addresses greater then 40083, the entire request will be ignored

Response: Check the number of registers being polled
Additionally, the 980 Flow Meter checks all Modbus messages to see if the correct number of registers is requested for the type of data being returned. The meter will ignore the request if the number of registers requested does not coincide with the correct number of registers needed to accurately display the data. For example, Velocity is a floating point value stored in register 40009–40010. Because all floating point values require two registers, the meter would ignore a request to read just the data in register 40009, yet it would respond correctly to a request to read the data stored in both registers 40009 AND 40010. Consequently, if the meter received a single request to read both Level 40007–40008 and Velocity 40009–40010, the request would have to be for an even number of registers for the meter to respond.

Problem: 980 Flow Meter does not respond to any Modbus message requests

Note: *It is imperative that the DTR be asserted prior to the communication session and that it remains asserted throughout the entire communication session.*

Response: Check the DTR Signal/Line
The 980 Flow Meter will not respond to any Modbus messages until the device connected to the RS232 port asserts (raises) the DTR line (DB-9, Pin 4 on the 1727 cable).

Response: Check the Baud Rate
The baud rate of the 980 Flow Meter is configured from 1200–19,200 and must match the baud rate of the device communicating with the meter.

Response: Check the Communication Parameters
The communications parameters of the 980 Flow Meter meter are fixed (except for the baud rate) and can not be changed. The device communicating with the flow meter must be configured with the exact same communication parameters as the meter. These parameters are as follows:

- 7 Data Bits
- 1 Start bit
- 1 Stop bit
- Even parity

Response: Check the Modbus Device Address assigned to the 980 Flow Meter
Modbus devices, including the 980 Flow Meter, have a unique configured device address in the range of 1 to 247. This address is embedded in the first two characters of the Modbus message. The flow meter will only respond to messages encoded with the same address as the meter. If the meter receives

a valid Modbus message with an encoded device address other than the address the meter is configured for, it will ignore that message.

Response: Check the Modbus mode
There are two different forms of Modbus: ASCII and RTU. Currently the 980 Flow Meter only support Modbus ASCII. Consequently the device communicating with the meter must be setup for Modbus ASCII. The meter will not respond to Modbus RTU messages.

Problem: The data values being returned by polling the meter with Modbus are not the same as the data values displayed in the current status screen of the meter.

Response: Confirm that the correct register addresses are being polled.
Check to make sure the register address being polled corresponds to the correct data channel. For example, if polling for FLOW, make sure the server or MMI is requesting data from registers 40033–40034.

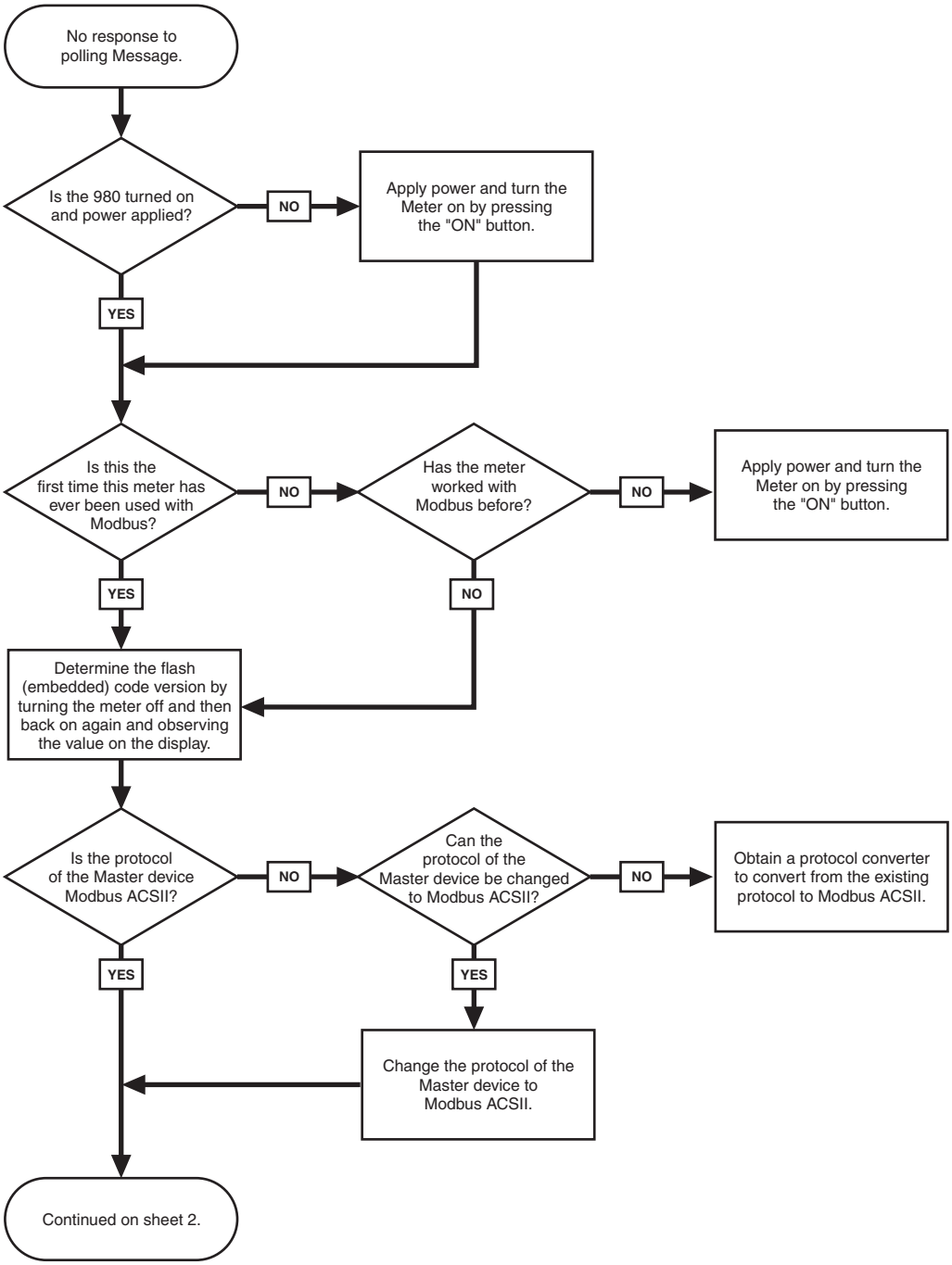
If polling for several values at the same time, try changing the polling so that only one value is polled at a time. Then check to see if the polled value matches a different data channel in the meter. For example, if polling for Level and it appears that you are getting the data for Velocity instead, you probably are polling the wrong registers.

Response: Check the data format of the Modbus server.
When configuring a Modbus server or MMI application to poll a 980 Flow Meter, it is absolutely essential that the correct data format is selected for that particular data channel (register). For example, when polling for Flow, Level or Velocity, which are all floating point values, the Modbus server or MMI must be configured to read these values as floating point values. If the server or MMI is formatting this data as a data type other then floating point, the values will not be read or displayed correctly.

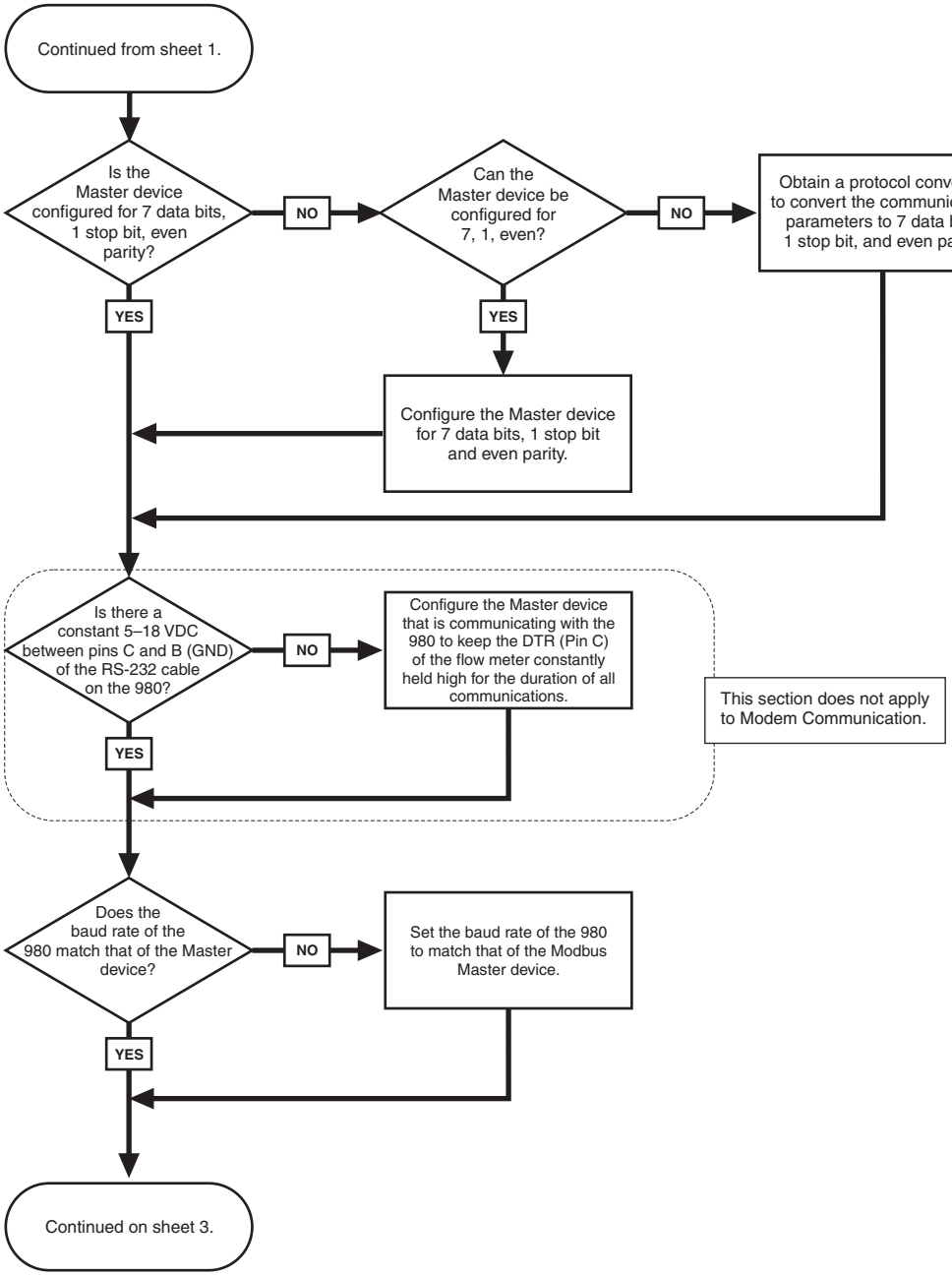
Likewise, if polling the meter for engineering units, which are represented by integer values, such as Flow Units of Measure or Level Units of Measure, the Modbus server or MMI must be configured to read these values as Integers. If the server or MMI is formatting this data as any data type other than Integer, the values will not be read or displayed correctly.

Different Modbus servers and MMI manufacturers have different methods for configuring the application to the appropriate data type contained within the register. Contact the server or MMI manufacturer for details on how to configure the application to read the data in the correct format.

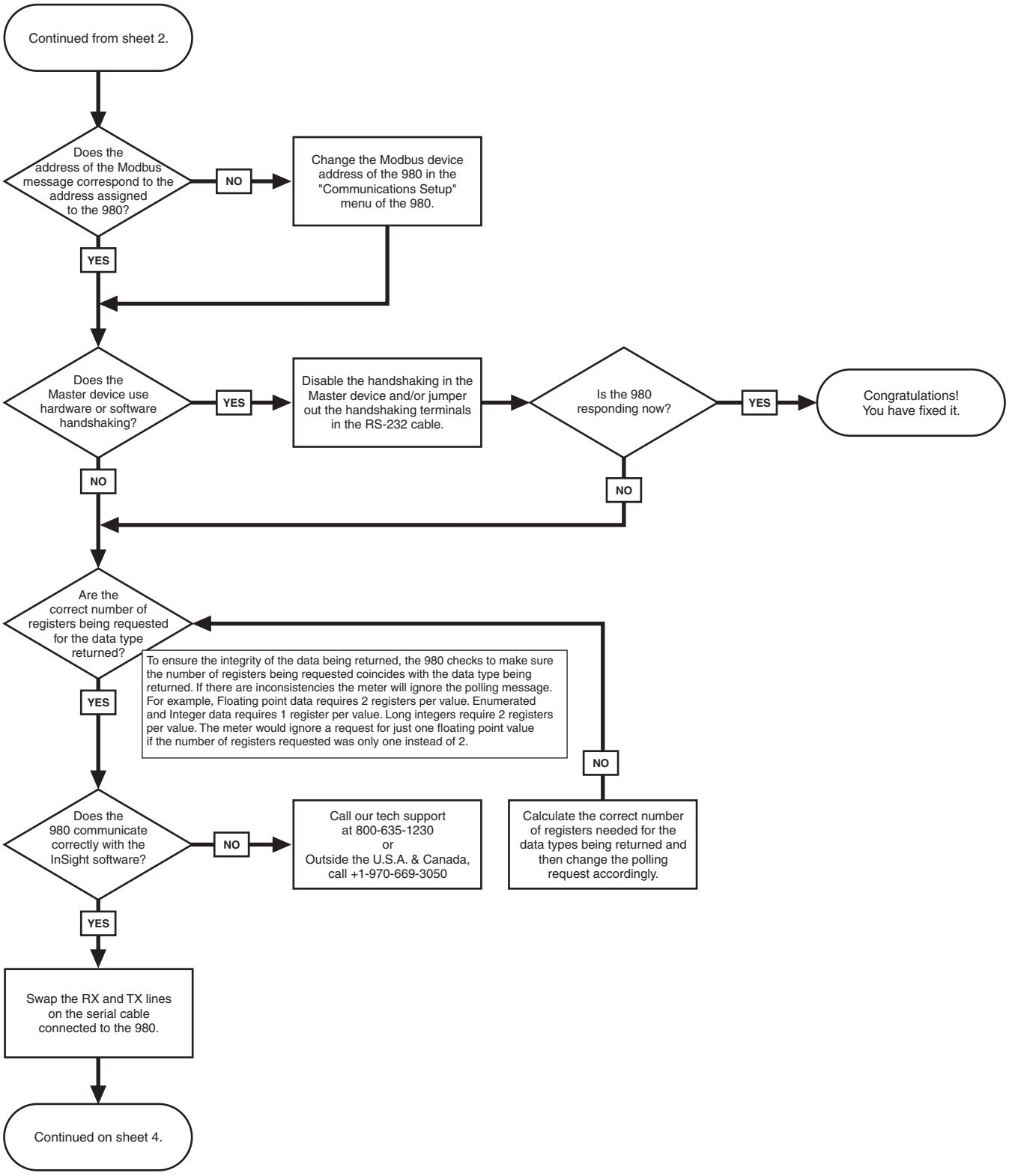
980 SCADA-Modbus “No Response” Troubleshooting Flow Chart (1 of 5)



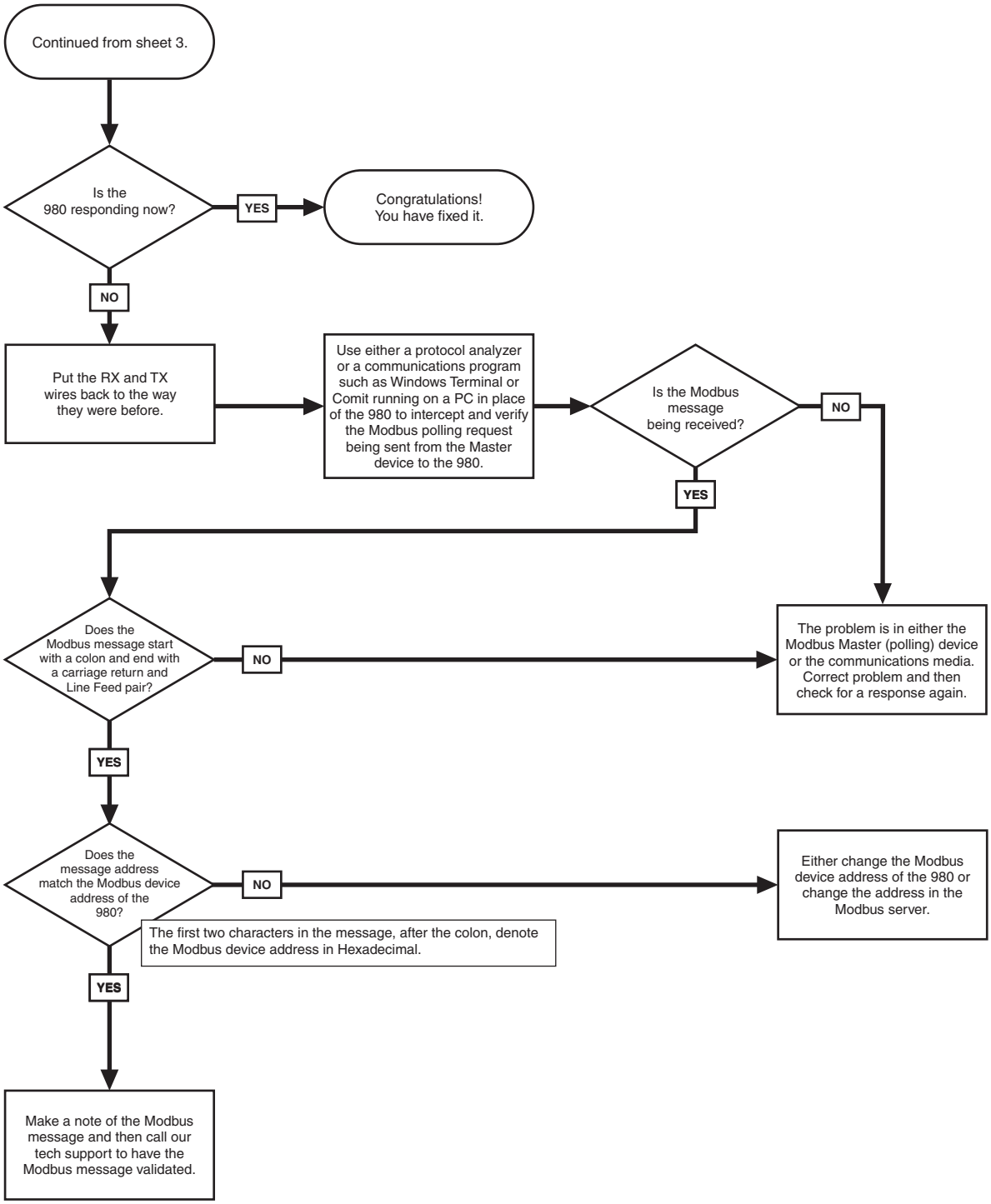
980 SCADA-Modbus “No Response” Troubleshooting Flow Chart (2 of 5)



980 SCADA-Modbus “No-Response” Troubleshooting Flow Chart (3 of 5)



980 SCADA-Modbus “No-Response” Troubleshooting Flow Chart (4 of 5)



980 SCADA-Modbus “No Response” Troubleshooting Flow Chart (5 of 5)

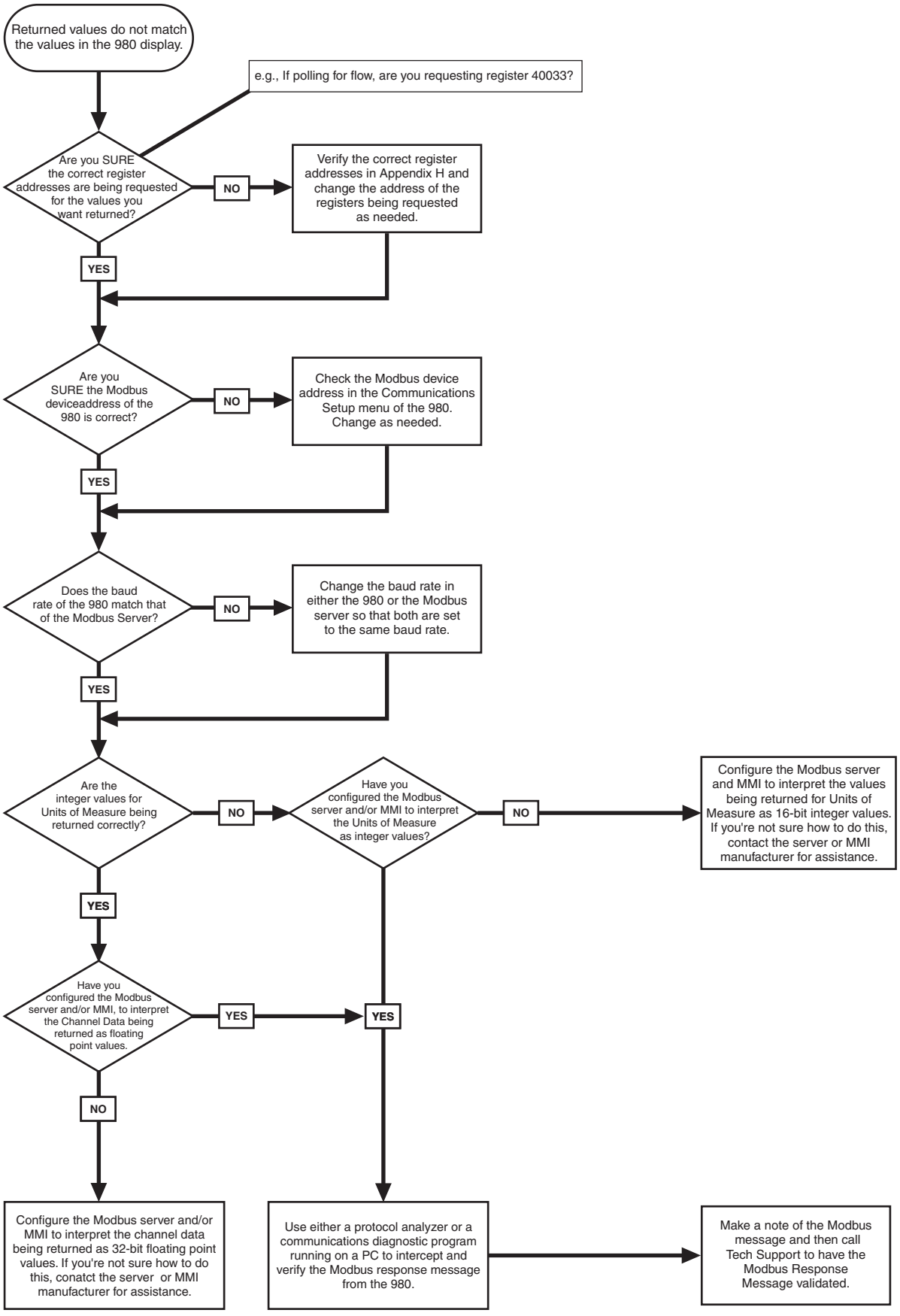


Table 42 Setup Menu

MAIN MENU>SETUP				
Review All Items	Displays all program items (no changes allowed)			
Modify All Items	Steps you through each program item (same item as Modify Selected Items)			
Modify Selected Items	Login			
	Flow Units	Select GPS, GPM, GPH, LPS, LPM, LPH, MGD, AFD, CFS, CFM, CFH, CFD, CMS, CMM, CMH, or CMD		
	Level Units	Select FT, IN, M, or CM		
	Primary Device	Select Area Velocity, Manning Equation, None–Level Only, Weir, Flume, Nozzle, Power Equation, Head vs. Flow		
	Program Lock	Enable/Disable		
	Site ID	Enter Site I.D.#		
	Sampler Pacing	Enable/Disable	Select flow interval and flow units	
	Total Flow Units	Select AF, CF, GAL, LTR, or M^3		
	Velocity Direction	Select Upstream (normal), Downstream, or Always Positive		
	Velocity Units	Select fps or mps		
	Velocity Cutoff	Enter Velocity Cutoff Value	Enter Velocity Default Value	
	Modem	Enable/Disable Modem Power	Enter phone number	Select dial method (tone or pulse)
	RS232	Set baud rate		

Table 43 Advanced Options

MAIN MENU>OPTIONS>ADVANCED OPTIONS						
4–20 mA Outputs	Enable/Disable	Select output A or B	Select a channel to assign to output A or B	Enter 4 mA input value	Enter 20 mA input value	
Alarms	Select one: memory battery, modem failure, U-sonic echo loss, X-ducer ringing, U-sonic failure, RS485 timed out.			Enable/ Disable	Select Report via Modem, Set Relay #1, Set Relay #2, Set Relay #3, Set Relay #4.	
	Select Level, Flow, pH/ORP, Temperature, Ch1, Ch2, Ch3, Ch4, Ch5, Ch6, Ch7			Enable/ Disable	Set trigger point	Set deadband.
	Select flow rate of change/rainfall		Enable/Disable	Set trigger point	Set time interval.	
Calibration	pH	Place sensor in first buffer	Enter temperature of liquid	Enter pH for Buffer #1	Place sensor in second buffer	Enter pH for Buffer #2
	4–20 mA outputs	Select Output A or B	Press a key for 4 mA	Enter actual output current	Press a key for 20 mA	Enter actual output current
	Submerged Area/Velocity Sensor	Place probe on a flat surface and press any key			Submerge sensor to known depth	Enter new depth
	Ultrasonic Sensor	Calibrate U-Sonic	Choose standard or In-pipe Ultrasonic Sensor (75 KHz only)	Enter ambient temperature	Level Adjust	Enter new level
					Sensor Height	Enter sensor height
		Set invisible range		Enter distance to end of invisible range		
Communication Setup	Modbus	Device address				
	RS232	Set baud rate				
Language	Select a second language					
Data log	Select Inputs	Select: rainfall, pH/mV, temp., velocity, level/flow, Ch1, etc.		Select logged or not logged	Set logging interval	Select units
Diagnostics	Select: Keypad test, LCD display test, Demonstration graph, velocity analysis, system events log					
Flow Totalizer	Modify setup	Select scaling factor		Select total flow units (AF, CF, GAL, LTR, M^3)		
	Reset	Reset totalizer (Yes or No)				
	View Totals	Resettable Total=, Non-resettable total=				
Setpoint sampling	Select condition (level, flow, flow rate or change, pH, Temp, etc.)		Select high or low condition	Enable/ Disable	Set high or low trip point, deadband, and time interval	
Stormwater	Enable/Disable	Select: Rain, level, rain or level, rain and level		Enter start conditions (rate of rain and/or level)		

GENERAL INFORMATION

At Hach Company, customer service is an important part of every product we make.

With that in mind, we have compiled the following information for your convenience.

Logger Mounting Accessories

Description	Part Number
Rail / Pole Mounting	9709100
Wall Mounting Bracket	4424700

Sensors and Accessories for Use with the 980 Flow Meter

In-Pipe Ultrasonic Sensor Mounting Accessories

Mounting Band Set for 15–42” pipes	3766
Mounting Clip (for use with Cat. No. 3766)	3868
Mounting Clip, permanent (screws to channel wall)	3875
Mounting Ring, 6”, with integral in-pipe sensor mounting clip and velocity sensor mounting holes	4021
Mounting Ring, 8”, with integral in-pipe sensor mounting clip and velocity sensor mounting holes	4022
Mounting Ring, 10”, with integral in-pipe sensor mounting clip and velocity sensor mounting holes	4023
Mounting Ring, 12”, with integral in-pipe sensor mounting clip and velocity sensor mounting holes	4024

Keppler Submerged Depth/Velocity Sensor

Cable, max length 100’	9702400
Junction Box	9702500
Keppler Submerged Depth/Velocity Sensor, 0-10’ with connector	9701600
Keppler Submerged Depth/Velocity Sensor, 0-10’ with bare leads	9701700
Keppler Submerged Depth/Velocity Sensor, 0-30’ with connector	9701800
Keppler Submerged Depth/Velocity Sensor, 0-30’ with bare leads	9701900

Submerged Depth/Velocity Sensor

Cable, Submerged Depth/Velocity Sensors, max. length 100’	9702400
Junction Box, Submerged Depth/Velocity Sensors	9702500
Submerged Depth/Velocity Sensor, 0-10' with connector	9701200
Quick-Connect Hub	9702700
Submerged Depth/Velocity Sensor, 0-30' with connector	9701400
Quick-Connect Hub	9702700
Submerged Depth/Velocity Sensor, 0-10' with bare leads	9701300
Submerged Depth/Velocity Sensor, 0-30' with bare leads	9701500

Ultrasonic Sensor

Cable, Standard Length 500’	9702300
Ultrasonic Sensor 75 kHz	9701100

Velocity-Only Sensor

Cable, max length 100’	9708000
Velocity Probe w. connector	9707800
Velocity Probe w. bare leads	9707900

Sensor Mounting Hardware

Submerged Area Velocity Sensor Mounting Accessories

Insertion Tool for street-level installation of mounting rings	9574
Mounting Ring for 6" diameter pipe (requires Cat. No. 3263)	1361
Mounting Ring for 8" diameter pipe (requires Cat. No. 3263)	1362
Mounting Ring for 10" diameter pipe (requires Cat. No. 3263)	1363
Mounting Ring for 12" diameter pipe (sensor mounts directly to band)	1364
Mounting Ring for 15" diameter pipe (sensor mounts directly to band)	1365
Mounting Ring for 18" diameter pipe (sensor mounts directly to band)	1366
Mounting Ring for 20–21” diameter pipe (sensor mounts directly to band)	1353
Mounting Ring for 24" diameter pipe (sensor mounts directly to band)	1370
Mounting Plate, wall mount sensor	4939
Mounting Band for 15 in. Pipes	9706100
Mounting Band for 18 in. Pipes	9706200
Mounting Band for 21 in. Pipes	9706300
Mounting Band for 24 in. Pipes	9706400

Mounting Band for 27 in. Pipes 9706500
Mounting Band for 30 in. Pipes 9706600
Mounting Band for 33 in. Pipes 9706700
Mounting Band for 36 in. Pipes 9706800
Mounting Band for 42 in. Pipes 9706900
Sensor Mounting Clip for use with mounting bands 3263

Ultrasonic Sensor Mounting Hardware
Adjustable Mounting Bracket 2904
Permanent Wall Mount Bracket 2974

Description	Part Number
1 AMP, 250 V Fuse	015804
AA Alkaline Batteries, (1) 3 required	SE989
AC Power Cord, 115 V ac (North American Style Plug), includes Heyco Strain Relief	4630600
AC Power Cord, 230 V ac (Continental Style European Plug), includes Heyco Strain Relief	4630800
Cable, Sampler or Flow Meter-to-PC	1727
Conduit Hub, ½ in, sealing style.	16483
Conduit Hub, 1 in, sealing style.	4913600
Desiccant Refill	3624
DTU-to-PC Cable, 115 V ac	3513
DTU-to-PC Cable, 230 V ac	3580
DTU-II with #1726 DTU-to-Sampler/Flow Meter Cable, #3513 DTU-to-PC Cable, 115 V ac	3516
DTU-II with #1726 DTU-to-Sampler/FLow Meter Cable, #3512 DTU-to-PC Cable, 230 V ac	3517
Heyco Fitting, Fits 0.20-0.35 cable O.D.	9711400
Heyco Fitting, Fits 0.23-0.47 cable O.D.	9711300
Locknut, ½ in. Conduit (for Heyco fitting)	10596-12
Multi-Purpose Half Cable, 25', 6-pin connector and opens leads end	9708600
Multi-Purpose Half Cable, 10', 6 pin connector and open leads end	9708700
pH Temperature Probe, 25' cable	9708100
pH Temperature Probe, 50' cable	9708200
Plugs, NEMA ½ in, sealing style.	4221000
Plugs, NEMA 1 in, sealing style.	4052400
Rain Gauge, 25' cable	9708400
Rain Gauge Cable, max length 100'	9708500
Washer, Sealing (for Heyco fitting)	10338-14

Contact Information for U.S.A. and Outside Europe

Ordering Information for the U.S.A.

By Telephone:
(800) 635-4567

By Fax:
(970) 461-3915

By Mail:
Hach Company
P.O. Box 389
Loveland, Colorado 80539-0389
U.S.A

Ordering information by E-mail:
orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

Ordering Information for Outside the U.S.A. and Europe

Hach Company maintains a worldwide network of dealers and distributors. To locate the representative nearest you, send E-mail to intl@hach.com or visit www.hach.com.

Technical Support

Technical and Customer Service Department personnel are eager to answer questions about our products and their use. In the U.S.A., call 1-800-635-4567. Outside the U.S.A. and Europe, send E-mail to intl@hach.com.

Repair Service

Authorization must be obtained from Hach Company before sending any items for repair. Please contact the Hach Company Service Center serving your location.

Hach Company
P.O. Box 389
Loveland, Colorado, 80539-0389 U.S.A.

Telephone: 1-800-635-4567 or (970) 669-3050

Fax: (970) 669-2932

Contact Information for Europe

For technical support, repair service, and ordering information please refer to the contact information below for your specific country.

Belgium
Lange Group
Ragheno Business Center 2
Motstraat 54
B-2800 Mechelen
Tel.: ++32/(0)15 42/ 35 00
Fax: ++32/(0)15 41/ 61 20
email: info@langegroup.be

Germany (TCS & Service)
Dr. Bruno Lange GmbH & CO. KG
Willstätterstr. 11
D-40549 Düsseldorf
Tel.: ++49/(0)211/52 88-0
Fax: ++49/(0)211/52 88-143
email: kundenservice@drlange.de
www.drlange.com

Spain
NEURTEK. M.A-LANGE GROUP
c/ Araba, 45.
Apdo. 220
E-20800 ZARAUZ
Tel.: ++34 943 894.379
Fax: ++ 34 943 130.241
email: info@drlange.com
www.drlange.com

Great Britain
Dr. Lange (UK) Ltd.
Lennox Road
GB-Basingstoke
Hampshire
RG22 4AP
Tel.: ++44/(0)12 56/ 33 34 03
Fax: ++44/(0)12 56/ 33 07 24
email: info@drlange.co.uk
www.drlange.co.uk

Sweden
Dr. Lange AB
LAB Products
Box 9008
S-40091 Götebord
Tel.: ++46-31-28 50 50
Fax: ++46-31-28 50 39
email: info@lange.se
www,lange.se

Denmark
Dr. Lange Danmark A/S
Jernhoolmen 34-40
DK-2650 Hvidovre
Tel.: ++45/(0)36 77/ 2911
Fax: ++45/(0)36 77/ 4911
email: drlange@drlange.dk
www.drlange.de

Germany (Ordering)
Dr. Bruno Lange GmbH & CO. KG
Königsweg 10
D-14163 Berlin
Tel.: ++49/(0)30/80 98 60
Fax: ++49(0)30/80 98 62 70
www.drlange.de

France
Polymetron/Dr. Lange
Division Lab
33 rue du ballon
F-93165 Noisy le Grand
Tel.: ++33/(0)1/ 48 15 68 70
Fax: ++33/(0)1/ 48 15 68 79
email: info@drlange.fr
www.drlange.fr

The Netherlands
Dr. Lange Benelux
Postbus 6299
NL-4000 HG Tiel
Tel.: ++31/(0)344/ 63 11 30
Fax: ++31/(0)344/ 63 11 50
email: info@langegroup.nl
www.langegroup.nl

Sweden
Dr. Lange AB
PROCESS Products
Box 410
S-13525 Tyresö
Tel.: ++46-87-98 05 00
Fax: ++46-87-42 17 24
email: info@lange.se
www.lange.se

Poland
Dr. Lange Sp. z o.o.
ul. Opolska 143a
PL-52-013 Wroclaw
Tel.: ++48/(0)71/ 3 42 10 -81/-83
Fax: ++48/(0)71/ 3 42 10 79
email: mail@drlange.pl
www.drlange.de

Austria
Dr. Bruno Lange Ges.m.b.H.
Industriestraße 12
A - 3200 Obergrafendorf
Tel.: ++43/(0)2747 - 7412
Fax: ++43/(0)2747 - 4218
email: lange@via.at
www.drlange.de

Italy
Dr. Bruno Lange s.r.l.
via Riccione, 14
IT-20156 Milano
Tel.: ++39/(0)2 39 23 14 1
Fax: ++33/(0)2 39 23 14 39
email: info@drlange.it
www.drlange.it

Switzerland
Dr. Bruno Lange AG
Juchstrasse 1
CH-8604 Hegnau
Tel.: ++41/(0)1/ 9 45 66 10
Fax: ++41/(0)1/ 9 45 66 76
email: info@drlange.ch
www.drlange.ch

Hach Company warrants this product to the original purchaser against any defects that are due to faulty material or workmanship for a period of one year from date of shipment.

In the event that a defect is discovered during the warranty period, Hach Company agrees that, at its option, it will repair or replace the defective product or refund the purchase price, excluding original shipping and handling charges. Any product repaired or replaced under this warranty will be warranted only for the remainder of the original product warranty period.

This warranty does not apply to consumable products such as chemical reagents; or consumable components of a product, such as, but not limited to, lamps and tubing.

Contact Hach Company or your distributor to initiate warranty support. Products may not be returned without authorization from Hach Company.

Limitations

This warranty does not cover:

- **Damage caused by acts of God, natural disaster, labor unrest, acts of war (declared or undeclared), terrorism, civil strife or acts of any governmental jurisdiction**
- **Damage caused by misuse, neglect, accident or improper application or installation**
- **Damage caused by any repair or attempted repair not authorized by Hach Company**
- **Any product not used in accordance with the instructions furnished by Hach Company**
- **Freight charges to return merchandise to Hach Company**
- **Freight charges on expedited or express shipment of warranted parts or product**
- **Travel fees associated with on-site warranty repair**

This warranty contains the sole express warranty made by Hach Company in connection with its products. All implied warranties, including without limitation, the warranties of merchantability and fitness for a particular purpose, are expressly disclaimed.

Some states within the United States do not allow the disclaimer of implied warranties and if this is true in your state the above limitation may not apply to you. This warranty gives you specific rights, and you may also have other rights that vary from state to state.

This warranty constitutes the final, complete, and exclusive statement of warranty terms and no person is authorized to make any other warranties or representations on behalf of Hach Company.

Limitation of Remedies

The remedies of repair, replacement or refund of purchase price as stated above are the exclusive remedies for the breach of this warranty. On the basis of strict liability or under any other legal theory, in no event shall Hach Company be liable for any incidental or consequential damages of any kind for breach of warranty or negligence.

Certification

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory. The 980 Flow Meter has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

The 980 Flow Meter was tested with pH, velocity, and ultrasonic sensors connected.

UL 3101-1 (ETL Listing # H0492805390)
CSA C22.2 No. 1010.1 (ETLc Certification # H0492805390)
Certified by Hach to EN 61010-1 (IEC1010-1) per 73/23/EEC, supporting test records by Intertek Testing Services.

Immunity

The 980 Flow Meter and sensors were tested for Industrial level EMC per:

EN 61326 (EMC Requirements for Electrical Equipment for Measurement, Control and Laboratory Use) per 89/336/EEC EMC: Supporting test records by Hach Company, certified compliance by Hach Company.

Standards include:

IEC 1000-4-2:1995 (EN 61000-4-2:1995) Electro-Static Discharge Immunity (Criteria B).
IEC 1000-4-3:1995 (EN 61000-4-3:1996) Radiated RF Electro-Magnetic Field Immunity (Criteria A).
IEC 1000-4-4:1995 (EN 61000-4-5:1995) Electrical Fast Transients/Burst (Criteria B).
IEC 1000-4-5:1995 (EN 61000-4-5:1995) Surge (Criteria B).
IEC 1000-4-6:1996 (EN 61000-4-6:1996) Conducted Disturbances Induced by RF Fields (Criteria A).
IEC 1000-4-11:1994 (EN 61000-4-11:1994) Voltage Dip/Short Interruptions (Criteria B).

Additional Immunity Standard/s include:

ENV 50204:1996 Radiated Electro-Magnetic Field from Digital Telephones (Criteria B).

Emissions

The 980 Flow Meter and sensors were tested for Radio Frequency Emissions as follows:

Per 89/336/EEC EMC: EN 61326:1998 (Electrical Equipment for measurement, control and laboratory use-EMC requirements) Class “A” emission limits. Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01), certified compliance by Hach Company.

Standards include:

EN 61000-3-2 Harmonic Disturbances Caused by Electrical Equipment
EN 61000-3-3 Voltage Fluctuation (Flicker) Disturbances Caused by Electrical Equipment.

Additional Emissions Standard/s include:
EN 55011 (CISPR 11), Class “B” emission limits

Canadian Interference-causing Equipment Regulation, IECS-003, Class A

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

This Class A digital apparatus meets all requirements of the Canadian Interference-causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Equipment Attachment Limitations In Canada

Notice: The Canadian Industry Canada label identifies certified equipment. This certification means that the equipment meets certain telecommunications network protective, operational and safety requirements as prescribed in the appropriate Terminal Equipment Technical Requirements document (s). The Department does not guarantee the equipment will operate to the user's satisfaction.

Before installing this equipment, users should ensure that it is permissible to be connected to the facilities of the local telecommunications company. The equipment must also be installed using an acceptable method of connection. The consumer should be aware that compliance, with the above conditions, may not prevent degradation of service in some situations.

Repairs to certified equipment should be coordinated by a representative of the supplier. Any repairs or alterations made by the user to this equipment, or equipment malfunctions, may give the telecommunications company cause to request the user to disconnect the equipment.

Users should ensure for their own protection that the electrical ground connections of the power utility, telephone lines and internal metallic water pipe system, if present, are connected together. This precaution may be particularly important in rural areas.

FCC PART 15, Class “A” Limits

Supporting test records by Hewlett Packard, Fort Collins, Colorado Hardware Test Center (A2LA # 0905-01) and certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are

designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense. The following techniques of reducing the interference problems are applied easily.

1. Disconnect the 980 Flow Meter from its power source to verify that it is or is not the source of the interference.

2. If the 980 Flow Meter is connected into the same outlet as the device with which it is interfering, try another outlet.

3. Move the 980 Flow Meter away from the device receiving the interference.

4. Reposition the receiving antenna for the device receiving the interference.

5. Try combinations of the above.

FCC Requirements

1. The Federal Communications Commission (FCC) has established Rules which permit this device to be directly connected to the telephone network. Standardized jacks are used for these connections. This equipment should not be used on party lines or coin lines.

2. If this device is malfunctioning, it may also be causing harm to the telephone network; this device should be disconnected until the source of the problem can be determined and until repair has been made. If this is not done, the telephone company may temporarily disconnect service.

3. The telephone company may make changes in its technical operations and procedures; if such changes affect the compatibility or use of this device, the telephone company is required to give adequate notice of the changes.

4. If the telephone company requests information on what equipment is connected to their lines, inform them of:

    a. The telephone number that this unit is connected to,

    b. The ringer equivalence number [1.4B]

    c. The USOC jack required [RJ11C], and

    d. The FCC Registration Number

Items (b) and (d) are indicated on the label. The ringer equivalence number (REN) is used to determine how many devices can be connected to your telephone line. In most areas, the sum of the RENs of all devices on any one line should not exceed five. If too many devices are attached, they may not ring properly.

Numerics

A

B

C

D

E

F

G

H

I

K

L