

4210 Ultrasonic Flow Meter

Installation and Operation Guide



Part #60-3213-285 of Assembly #60-3214-110
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Foreword

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

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

If the problem persists, call or e-mail the Teledyne Isco Technical Service Department for assistance. Simple difficulties can often be diagnosed over the phone.

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

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

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

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General Warnings

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

 **WARNING**

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

 **AVERTISSEMENT**

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

Hazard Severity Levels

This manual applies *Hazard Severity Levels* to the safety alerts. These three levels are described in the sample alerts below.

 **CAUTION**

Cautions identify a potential hazard, which if not avoided, may result in minor or moderate injury. This category can also warn you of unsafe practices, or conditions that may cause property damage.

 **WARNING**









Warnings identify a potentially hazardous condition, which if not avoided, could result in death or serious injury.

 **DANGER**

DANGER – limited to the most extreme situations to identify an imminent hazard, which if not avoided, will result in death or serious injury.

Hazard Symbols

The equipment and this manual use symbols used to warn of hazards. The symbols are explained below.

Hazard Symbols	
Warnings and Cautions	
	The exclamation point within the triangle is a warning sign alerting you of important instructions in the instrument's technical reference manual.
	The lightning flash and arrowhead within the triangle is a warning sign alerting you of "dangerous voltage" inside the product.
Symboles de sécurité	
	Ce symbole signale l'existence d'instructions importantes relatives au produit dans ce manuel.
	Ce symbole signale la présence d'un danger d'électocution.
Warnungen und Vorsichtshinweise	
	Das Ausrufezeichen in Dreieck ist ein Warnzeichen, das Sie darauf aufmerksam macht, daß wichtige Anleitungen zu diesem Handbuch gehören.
	Der gepfeilte Blitz im Dreieck ist ein Warnzeichen, das Sie vor "gefährlichen Spannungen" im Inneren des Produkts warnt.
Advertencias y Precauciones	
	Esta señal le advierte sobre la importancia de las instrucciones del manual que acompañan a este producto.
	Esta señal alerta sobre la presencia de alto voltaje en el interior del producto.

4210 Ultrasonic Flow Meter

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4210 Flow Meter

Section 1 Introduction

The following section provides a general introduction to the 4210 Ultrasonic Flow Meter. It includes a description, an explanation of how the unit operates, and technical specifications.

1.1 Manual Organization

This manual provides the information necessary to operate, maintain, and perform minor service on the 4210. The manual is organized into five sections:

Section 1 – Introduction, operation, and technical specifications for the flow meter.

Section 2 – Keypad operation and programming.

Section 3 – Installation and options application-specific to this flow meter.

Section 4 – Options and accessories for all 4200 Series Flow Meters.

Section 5 – Routine maintenance procedures and minor servicing information.

Following Section 5 are appendices covering replacement and accessory parts, safety information, and material safety data sheets.

1.2 Description

The 4210 uses ultrasonic reflection to measure level in flow stream. The flow meter is normally used with some type of primary measuring device to measure flow in an open channel. The 4210 has built-in level-to-flow conversions that cover the vast majority of open channel flow measurement situations.

Additionally, the flow meter lets you enter an equation, or data points. The 4210 supports the Isco data storage, acquisition, and retrieval system with the use of optional Flowlink software. The 4210 has enough memory to store 40,000 data readings. An optional 4200T Modem, with speech capability, is available to transmit stored data over standard dial-up telephone lines and call out on alarms.

1.3 Compatible Equipment

The 4210 Flow Meter may be used with the following equipment:

Manufactured by Teledyne Isco

- 6700 Series Portable and Refrigerated Samplers
- 3700 Series Sequential, Composite, and Refrigerated Samplers
- 4 - 20 mA Output Interface
- 674 Tipping Bucket Rain Gauge
- High Low Alarm Relay Box

Manufactured by Others

- IBM Personal Computer or compatible clone with Isco Flowlink software
- Laptop Computer with Isco software
- YSI 600 Multi-Parameter Sonde

Optional Accessories

- 4200T Modem - Speech-capable, with connector and cable
- Parameter Modules (pH and D. O.)
- Ultrasonic level sensor extension cable in length of 25 feet
- Isco Flowlink Software
- Cable stiffener for the level sensor
- Mounting bracket for the level sensor
- Ultrasonic Sunshade
- Calibration Target
- Cable Clamp
- Floor Mount

1.4 Operating Principles

The 4210 normally measures flow rate with a primary measuring device (weir or flume) or other open-channel flow arrangement where there is a known relationship between liquid level and flow rate. The 4210 can also measure flow in round pipes by using the Manning equation. The level-sensing device is an ultrasonic transducer. The flow meter electronically converts the level reading into a properly scaled flow rate. The flow meter also provides standard or optional flow-related output signals to be used for:

- Flow-proportional sampler pacing
- Transmitting level and flow data to an external device on a serial communication loop
- Data transfer through a modem
- Control of a 4 - 20 mA device
- Data transfer by a laptop computer

The flow meter contains a microprocessor that calculates level and flow rates from the signals produced by the ultrasonic level sensor, stores programming instructions and operates the display and internal printer. An alphanumeric liquid crystal display (LCD) shows total flow, level, and flow-rate. It also assists in programming the flow meter during initial set up or subsequent changes. An internal printer provides a “hard copy” printout of the information computed by the flow meter, plots level or flow rate, and generates reports. Connectors for other equipment used with the 4210 are on the side of the case.

1.5 The Ultrasonic Level Sensor

The ultrasonic level sensor (USLS) mounts directly over the flow stream. The flow meter measures level by transmitting an ultrasonic pulse toward the liquid surface and then measuring the time it takes for the echo to return. The ultrasonic level sensor consists of an enclosure with a single transducer acting both as pulse transmitter and echo receiver. Since the speed of the pulse through the air varies with temperature, compensation is built-in. A temperature sensor inside the enclosure measures ambient temperature. The microprocessor program automatically compensates for speed-of-sound changes caused by air-temperature changes.

1.5.1 Transducer Operation

Several times a second, the ultrasonic level sensor emits a pulse. Between pulses the transducer becomes a receiver or microphone, ready to sense the echo reflected from the surface of the liquid. When the transducer receives the echo, the sound energy changes into a small electrical pulse, that is amplified and detected by the flow meter to produce an echo-received signal. The time between the transmitted pulse and echo-received signal is proportional to the distance between the transducer and the liquid surface. This distance determines the liquid level.

1.5.2 Validity Tests and Error Display

The flow meter checks the measured level for validity. If it cannot obtain a valid level, it will repeat the process. If the flow meter cannot obtain a valid reading after about one minute the level reading will drop to zero with an asterisk (*) to indicate there is an error.

1.5.3 Ambient Air Temperature Factor

The ultrasonic measurement technique used in the 4210 Flow Meter is based on the speed of sound in air.



Figure 1-1 Ultrasonic Level Sensor

Since the speed of sound in air varies with temperature (approximately 1% for 10° variation), compensation must be provided. The ultrasonic level sensor uses both air temperature and micro-processor-based compensation to accurately account for air temperature variations.

1.5.4 Return Echo Amplifier Compensation

The strength of the echo depends on several factors, including the distance between the transducer and the water surface. For every 2¹/₂ foot increase in the distance between the transducer and the liquid surface, the strength of the returned echo decreases by half. Consequently, the flow meter must compensate the gain of the return echo amplifier for distance. As the distance increases between the transducer and the liquid surface, the gain of the echo amplifier increases with time to compensate for the decreasing signal strength of the echo. This type of amplifier, whose gain characteristic is based on a repeating time interval, is referred to as a **ramp-gain amplifier**.

1.6 Software Upgrades

4200 Series Flow Meters can be upgraded without being returned to the factory or having the EPROM replaced. With Flash memory, software updates can easily be installed in the field with a disk, a computer, and a cable. Flash update instruction can be found in Section 5 Maintenance. For more information about installing software upgrades in the 4210 Flow Meter, contact your Teledyne Isco representative or call the factory.

1.7 Controls, Indicators, and Connectors

The controls, indicators and connectors of the 4210 Flow Meter are listed in Table 1-1, with brief descriptions. Refer to Figure 1-2 for a view of the connectors and their pin functions.

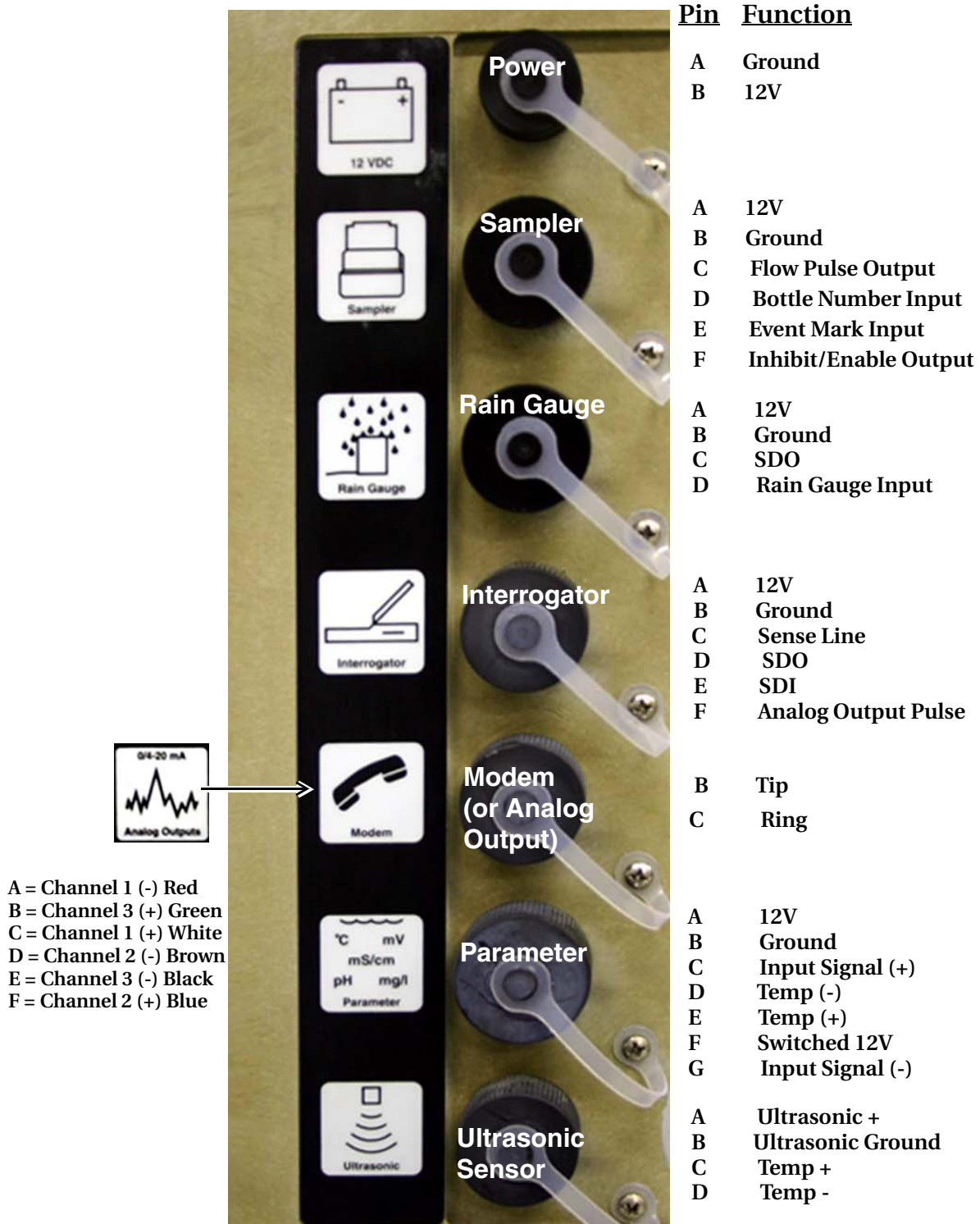


Figure 1-2 4210 Side View Showing Connectors and Pin Functions

Table 1-1 4210 Controls, Indicators, and Connectors

CONTROLS	SETTINGS	FUNCTION
ON/OFF	On - Off	Turns the flow meter on and off. Internal memory is protected with a standby battery. See Section 2 .
Keypad	Momentary Switches	24-key, 4 column matrix - Program flow meter through series of keystrokes prompted by messages on the display. Certain keys perform specific functions, (printing reports or entering program choices into memory). Arrow keys move through menus. Number keys enter numeric values. See Section 2 .
INDICATOR	READING	FUNCTION
Display	Multi-function	2-line, 40 characters per line, liquid crystal display (LCD.) Prompts you through program procedure; displays total flow, present flow rate and level. May also display parameter readings, if sensors present.
Internal Printer	Various	Provides printout of total flow, level or flow rate variation over time; provides sampling information and a printout of the program. Prints reports. Generates up to 3 different linear data plots. Chart characters and plots are generated on plain paper roll with an ink ribbon.
CONNECTOR	TYPE	FUNCTION
12 VDC	2-pin male M/S	Connects 12 VDC power to flow meter
Sampler	6-pin male M/S	Connects flow meter to sampler. Provides 12V flow pulse to sampler (pulse width 78 ms). Receives sampler bottle number, composite sample, and event mark signal.
Ultrasonic Level Sensor	4-pin, male M/S	Connects ultrasonic level sensor to flow meter.
Rain Gauge/ YSI 600 Sonde	9-pin female M/S (Custom)	Connects flow meter to an Isco Rain Gauge or YSI 600 Multi-Parameter Sonde. Also provides output to High Low Alarm Relay Box.
Interrogator	6-pin female M/S	Provides serial data in/out and power. Can also be used with 4-20 mA Output Interface.
Modem (optional)	5-pin male M/S	Connects flow meter to telephone line for remote data transmission. This connector will only be present on units that have the optional modem installed.
Analog Output (optional)	6-pin male M/S	Provides analog data output from the flow meter to external, non-Isco control and recording devices.
Parameter	7-pin female M/S	Connects flow meter to parameter sensor: temperature, pH, or D. O. Note that you can only have temperature and one parameter (pH or D. O.) at the same time.

1.8 Technical Specifications

The technical specifications for the 4210 are found in Table 1-2. Chart longevity for the 4210 internal printer is found in Table 1-3. Battery life expectancy is in Table 1-4, followed by a section on making battery calculations.

Table 1-2 4210 Technical Specifications	
Physical and Electrical	
Size	16" high × 11 1/2" wide × 10 1/2" deep (41.9 cm × 29.2 cm × 26.7 cm) without power source.
Weight	17 lb. 4 oz. (7.84 kg)
Material	High-impact molded polystyrene structural foam.
Type	Self-certified NEMA 4X Enclosure.
Display Type	2-line, 40 character/line alphanumeric dot matrix liquid crystal.
Power	12 -14 VDC, 16 mA average at 12.5 VDC (Printer set at 1" per hour).
Typical Battery Life	7-10 days with printer at 1" per hour and 4 Ampere-hour Ni-Cd battery. 14 days with printer turned <i>off</i> , and 1 <i>minute</i> level reading intervals.
Operating Temperature	0 to 140°F (–18 to 60°C).
Storage Temperature	–40 to 158°F (–40 to 70°C).
Additional Power Required for Optional Equipment	
Modem	60 mA maximum during operation; 0.1 mA maximum standby.
High-Low Alarm Relay Box	10 mA standby, typical; 190 mA - maximum.
Internal Printer	
Chart Speeds	Off, 1/2, 1, 2, or 4 inches per hour.(1.27, 2.54, 5.08 or 10.16 cm/h). See Table 1-3 for longevity in days.
Ribbon	19.7 ft. (6 m) black nylon - replaceable.
Operating Speed	1.5 lines per second at 68°F. (20°C).
Character Size	0.09" high × 0.07" wide (2.4mm × 1.7 mm), 12 pitch.
Printer Recording Span (for level, other plots possible)	User-selected from 1/4 ft. (3.6 cm) to over 30 ft. (9.1 m) with multiple over-ranges.
Chart Resolution	1/240 of selected recording span
Display Resolution	0.001 ft. (0.3 mm)
Paper	4.5" wide × 58 ft. (11.4 cm × 17.7 m) plain white paper, replaceable.
Printer Reliability	2.5 million lines MCBF (mean cycles before failure).

Table 1-2 4210 Technical Specifications (Continued)

Reports Printed	Program selections, interval activity reports, flow meter history.
Printer Recording Modes	Level over time, flow rate over time; includes totalized flow, sampler events, rainfall, temperature, pH (or) D. O. (dissolved oxygen).
Plotted Linear Data	3 different linear plots can be printed at the same time.
Isco Flowlink Data Storage and Retrieval System	
Memory Partitions	Maximum of 6 user-defined memory partitions for level or event storage
Data Storage	Rate for data storage user-selected in 1, 2, 5, 10, 15, 30, 60, or 120 minute intervals.
Baud Rates	Serial connection - 300, 1200, 2400, 4800, or 9600 baud Serial connection with the optional internal modem - 2400 baud
Storage	80,000 bytes, apportioned per reading as follows: flow = 4 bytes, level = 2 bytes, sample = 4 bytes, pH or D. O. = 1 byte)
Level Data	Level readings are stored as a 16-bit number representing $\frac{1}{10,000}$ meter. (0.0394 inch); effective range is 0–65279 meters.
Ultrasonic Level Sensor	
Dimensions	3.63" diameter × 4" long (9.1 × 10.2 cm)
Weight (including cable)	2.2 lbs (1 kg)
Body Material	Housing: glass filled polyester Acoustic window: glass reinforced epoxy
Cable Length	25 ft. (7.6 m). PVC Jacket
Operating Temperature	–22 to 140°F (–30 to 60°C)
Storage Temperature	–40 to 158°F (–40 to 70°C)
Level Measurement Specifications	
Measurement Range	Minimum: 1 ft. (0.3 m) from sensor to liquid surface Maximum 11 ft. (3.3 m) from sensor to liquid at minimum level
Measurement Accuracy	1 ft. (0.3 m) or less: ±0.02 ft. at 72°F (22°C). 1 to 11 ft. (0.3 - 3.3 m): ±0.03 ft. at 72°F (22°C)
Maximum Temperature Error Over Compensated Temperature Range	±0.000085 × D per degree C (Where "D" is the distance from the ±0.000047 × D per degree F transducer to the liquid surface.)
Beam Angle	12 degrees.
Level Resolution	0.004 ft. (0.12 cm).
Optional	Extension cable of 25 ft. (7.6 m) Custom lengths available by special order. Maximum distance is 1,000 ft. (304.8 m) if unit is AC-powered; 250 ft. (76.2 m) if unit is battery-powered.

Table 1-2 4210 Technical Specifications (Continued)

Miscellaneous	
Flow Rate Calculations	The flow meter creates a table of level-versus-flow rate from program selections; this table divides the level span into 256 equally spaced level increments. Each level increment corresponds to a specific flow rate. During data collection, if the measured level falls between two table values, the flow meter will perform a linear interpolation to calculate the flow rate value.

Table 1-3 4210 Chart Longevity

Chart Speed, Inch/Hour		Time to Empty Roll	
<input checked="" type="checkbox"/> Note Report Generator is turned off.			
4		7 ¹ / ₄ Days	
2		14 ¹ / ₂ Days	
1		29 Days	
0.5		58 Days	

Table 1-4 Battery Life Expectancy

Flow Meter Settings	Minimum	Default	Maximum
Reading Interval	5 Minutes	30 Seconds	Continuous
Printer	Off	Off	4" per Hour
Report Generator	Off	Off	Every Hour
Average Current	12 mA	40 mA	125 mA
Nickel-Cadmium ³	12.5 Days ⁵	3.7 Days	1.2 Days

Table 1-4 Battery Life Expectancy

Flow Meter Settings	Minimum	Default	Maximum
Lead-Acid ⁴	20.3 Days	6 Days	1.9 Days
<ol style="list-style-type: none"> 1. These figures are approximations based on calculations; actual times for your flow meter may vary due to factors of battery age, charge condition, operating temperatures, and component differences. “Minimum” settings are those providing the lowest average current draw. “Maximum” settings are those requiring the highest current draw. Your program should draw somewhere between the two. 2. The default settings are the program entered at the factory. You can reset the flow meter to the default program at any time by pressing the 1 and CLEAR ENTRY keys at the same time. 3. The nickel-cadmium battery has a capacity of 4.0 ampere-hours at 20° C. 4. The lead-acid battery has a capacity of 6.5 ampere-hours at 20° C. (Both batteries are assumed to be fully-charged with at least 95% of rated capacity and in good condition. These calculations also assume a 5% safety factor at the end of discharge. Lead-acid batteries should never be completely discharged.) 5. All fractional times are rounded down, rather than up. 			

1.9 How to Make Battery Calculations

To calculate battery life expectancy for an installation, you must know two things:

- The **capacity** of the battery you are using
- The **average current draw** of the flow meter or (other device) powered

Battery capacity is expressed in **ampere-hours**. The battery manufacturer provides this information for each battery. This value is the product of a load current times an arbitrary time period, ten hours for nickel-cadmium batteries, and twenty hours for lead-acid types. The terminal voltage of the battery at the end of this time period is the discharged cell voltage, 10 volts for nickel-cadmium and 10.5 volts for lead-acid types. Note that batteries are fully discharged well before the terminal voltage drops to zero volts.

Isco batteries are rated at **4** ampere-hours for the nickel-cadmium and **6.5** ampere-hours for lead-acid types. Convert the battery current capacity into milliamperes and then divide this figure by the average current drawn by the unit. This will give you a number in hours. Divide that figure by **24**, and you will have the number of days.

The published ampere-hour figures do not mean that you can expect to draw 4 amperes from the nickel-cadmium battery (or 6.5 amperes from the lead-acid battery) for one hour. At the one-hour rate, discharges are typically less than half the ten- or twenty-hour rate.

To convert ampere-hours to milliamperes, multiply by 1,000. Examples:

$$4 \text{ ampere-hours} \times 1,000 = 4,000 \text{ mAh}$$

$$6.5 \text{ ampere-hours} \times 1,000 = 6,500 \text{ mAh}$$

If you divide this figure by the average current of the flow meter, say **15 mA**, you will have:

$$4,000 \div 15 = 266.67 \text{ hours}$$

Divide this number by twenty-four to get days:

$$266.67 \text{ hours} \div 24 = 11.1 \text{ days}$$

For considerations of safety, we suggest you subtract 10% from this number (100% – 5% for 95% capacity and 5% for a reserve at the end of discharge).

$$11.1 - 1.1 = 10 \text{ days}$$

This is the battery expectancy for a nickel-cadmium battery with a 15 mA continuous average drain, with a 10% derating factor. You can use the same method to calculate for lead-acid batteries, except the current will be 6,500 mA, and the period correspondingly longer, in this case a little over 16 days. You can run the full number of days calculated without derating if your batteries are new and at 100% capacity, but you will leave yourself no safety factor if you are in error on either of these assumptions. Remember, if the battery fails, there will be a period of time during which no measurements will be taken, (and no data stored, if you are also using Flowlink® software).

Batteries lose capacity as they age. Capacity also drops off as temperature falls. Low temperatures make less capacity available due to the slowing of the chemical reactions, while high temperatures accelerate the deterioration of battery plate separators, particularly if they are aged. Nickel-cadmium batteries show fairly rapid rates of self-discharge. A battery that is fully charged and then placed in storage will lose some capacity each day. In a week, this could easily be 5% or more.

When using lead-acid batteries, you must be careful to avoid complete discharge, as this may cause cell reversal, which will ruin the battery. Also, complete discharge in low temperature ambients may cause the battery to freeze, which can deform the plates or even crack the case. **Always operate these batteries with a reserve factor.**

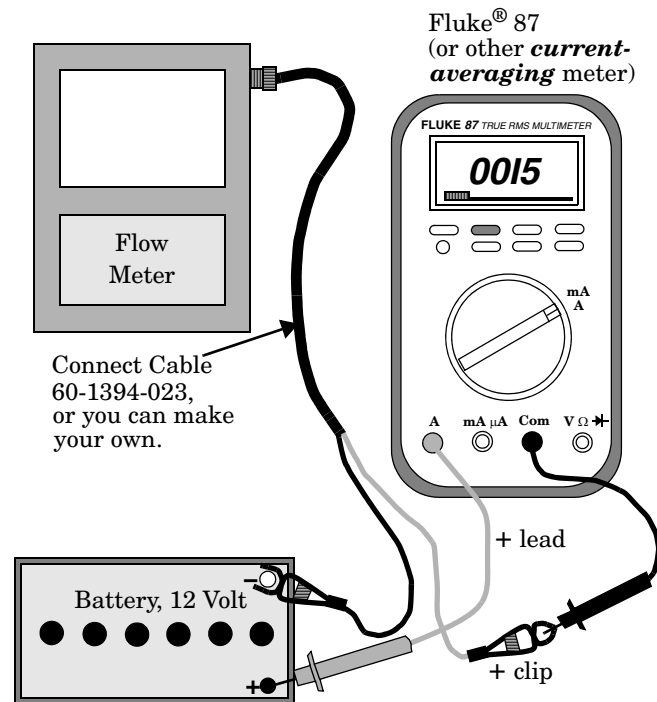
1.9.1 Calculating Current Draw

Calculating current draw for a 4210 Flow Meter is somewhat more difficult than calculating the battery capacity. You cannot simply measure the idle current of the unit unless the printer and report generator are turned off in the program. These functions require power periodically, but not all the time. If the figures given in the previous table are not satisfactory for your application, you can use the following procedure (shown in Figure 1-3) to measure the actual current draw.

 Note

Do not attempt this procedure unless you have the proper equipment available and know how to make electrical measurements.

To measure current for a varying load requires a more-sophisticated type of multimeter, one that is capable of averaging high and low readings over a period of time. The Fluke® 87 Multimeter is one example of this type of meter. You should set the meter on MIN/MAX and let it run with your program for several hours or more. Other manufacturers' meters are also acceptable, but only if they are capable of averaging current draw. You should run the test for at least eight hours, longer if necessary, or until the flow meter has exercised the entire program. The longer you run the test, the more accurate the average will be.



A good quality, adjustable, regulated DC power supply can be substituted for the 12-volt battery. The power supply should have at least 3 Amperes output, preferably more, and capable of overcurrent surges.

Figure 1-3 Measuring Flow Meter Current

More information about batteries used to power Isco equipment is available from the **Isco Power Products Guide**, which is shipped with this manual and any flow meter order.

4210 Flow Meter

Section 2 Programming

Teledyne Isco ships the flow meter with a program already installed called the default program. You can use this program as an example to see the flow meter's capabilities. Note that the default program is just to test the unit at the factory. The flow meter's internal computer must always have something programmed into the unit, so that becomes the default program. Your flow situation will usually require other programming choices. The text provided with each screen explains the reasons for the various menu options.

2.1 Display

The display is a two-line, forty character-per-line liquid crystal (LCD). It has a backlight feature for easy viewing in low light situations. The display has three different operating modes: normal, programming, and messages. In the normal mode, the display shows such things as level, flow rate, total flow, parameter measurement, etc. In the programming mode, the top line of the display shows each step as you work through the program while the bottom line shows the choices available for that step. In the message mode, the display provides instructional information, such as how to leave programming, or what to do if you have entered a number that is out-of-range. Following is a "normal" display on the flow meter. This is typical of what the flow meter will display when it is in the normal operating mode and you are not programming it.

0000004.78 CF	1.13 FT	16-MAR-94
1.03 CFS	(X X)	8:25:37

An interpretation of the numbers on this display would be as follows: Time and date will be replaced by pH/D.O. and temperature if you are using parameter sensing. The (X X) to the right of the time indicates letters that may appear from time to time on the 4210 Flow Meter.

The letter C will appear when the flow meter is communicating with a remote computer (Flowlink applications only). The letters E or D will appear (Enable or Disable) when the sampler enable function (step 6) is programmed by condition. (Programmed by condition means that the flow meter will enable the sampler only when a certain condition or set of conditions, sensed by the flow meter, are met.)

<i>Total Flow</i>	<i>Current Level</i>	<i>Date (or pH/D.O.)</i>
<i>Flow Rate</i>		<i>Time (temperature)</i>

Following is a typical programming display on the flow meter: (One of the items in the second line will be flashing. The item flashing is the selection currently held in memory.).

TOTALIZED VOLUME UNITS • CF •• GAL •• M3 •• AF •• L •• MGAL •
--

Following is a typical display providing instructional information:

CHANGES HAVE BEEN MADE IN STEP PRESS '0' TO CONTINUE, PRESS '1' TO DISCARD

 Note

If you stop programming for more than two minutes, the flow meter will time out, and whatever is on the display, (message or program step) will revert to the “normal” display, shown previously.

The program consists of steps and substeps. The steps are listed on the flow meter front panel. Most steps contain several substeps. Generally, you need to complete all the substeps before stopping, or the flow meter will reject the changes you made for that step after it times out. There are some exceptions.

The flow meter keeps in memory any changes that you made for the finished steps (all substeps completed before stopping). Most steps not finished when you stop will return to the previous selection.

2.2 Keypad Functions

Programming is done on the flow meter's keypad with prompts from the display. The following sections describe the function of each key.

OFF and ON – These turn the flow meter off and on.

Go To Program Step – Pressing this key lets you go directly to a particular program step without passing through the all the steps of the entire program. The display will ask you to enter the number of the step you want to program. Enter the number by pressing one of the number keys. There are nine program steps, so numbers from one to nine are valid.

Exit Program – Press this key when you want to leave the programming mode and return to the normal operating mode.

Clear Entry – This key lets you return to the previous entry for a program step if you have changed the entry, but not yet pressed Enter.

Enter/Program Step – This key has two functions. One is to enter a program selection into the flow meter's memory (Enter). The other is to step through the program (Program Step).

Print Program – Pressing this key will make the flow meter print out a complete list of the current program choices retained in memory.

Print Report – One function of the flow meter is to print reports of activity recorded on the flow meter at regular intervals. The contents of these reports are defined in step 1. If you set up the flow meter to generate these reports, you can have a report printed any time by pressing this key. The report will cover the time interval from the last scheduled report up to the time you press this key.

The flow meter will print the next report at the next scheduled time. Note that if power fails for five minutes or more, the flow meter will print a report when power is restored that will cover the interval between the last report and the time that the power failed. The next report will cover the time from the power failure to next scheduled report time.

Chart Advance – Pressing this key causes the paper chart to advance through the printer at the fastest possible speed. Nothing will be printed while you are holding this key.

Chart Reroll – It is possible to unroll the chart from the take-up roll on the flow meter by pulling it out with your hands. Pressing this key lets you rewind the chart onto the take-up roll.

Number keys – These keys let you enter numeric values into the flow meter when programming.

Decimal Point – This key lets you enter a decimal point into a numeric value when programming. On flow meters equipped with the optional modem only, you can use this character as a comma (delay) when entering dialout numbers.

Arrow keys – These keys, referred to as the left and right arrow keys let you select a programming option by moving across the menus shown on the second line of the display.

+/- key – This key lets you enter a plus or minus to a quantity entered. Its most common use is in entering values for the equation, a method of flow conversion. On flow meters equipped with the optional modem only, you can use this character as a dash when entering dialout numbers.

2.3 Programming Procedure

You press various keys on the keypad to select items from a menu appearing on the flow meter's display. To start programming, turn on the flow meter and wait for the display to settle. Then either press the Enter/Program Step key (generally referred to as **Enter**) or the **Go To Program Step** key.

The display will change to two lines of text; the first line describes the step you are programming and the second line shows the menu choices available. One of the choices shown will be flashing. The flashing indicates that this choice is the current one held in the flow meter's memory. If you are satisfied with this choice, just press **Enter**, and the flow meter will advance to the next step. If you want a different choice from the one flashing, you can move across the display by using the **left** and **right arrow** keys. Each time you press the **right arrow** key, the flashing selection will move one position to the right. This will continue until the flashing cursor is over the last display.

From time to time you will notice an arrow pointing to the edge of the display. This indicates that additional choices are available beyond what you can see on the display. By continuing to press the **right arrow** key you can view these unseen menu options. After reaching the furthest option, the arrow will move to the left side of the display, indicating that there are options unseen to the left. These will be the options you started with. If you want to go back to one of them, use the **left arrow** key until the option you need reappears. When the desired selection is flashing, just press Enter. The display will then automatically advance to the next step of the program.

All of the program steps contain several “substeps” that must all be completed before you advance to the next program step. Other steps, like Reset Totalizer, contain only a few substeps. Some steps will require the entry of a numeric value. Program these steps by using the number and decimal keys to enter the appropriate value.

Note that it is possible to program the flow meter in the shop, rather than at the job site, with the exception of step 3, Adjust Level/Parameters. To set level you must make an accurate measurement of the level in the flow stream and then enter that value. This can only be done at the job site.

If you are programming the flow meter for the first time, press **Enter**, start with step 1, and go on from there. If the flow meter has been in use and you need to change only part of the program, you would more likely use the **Go To Program Step** key. With this key you can go directly to the program step you need to change, which saves time.

If you change an entry and do not like it you can make the display revert to the original entry by pressing **Clear Entry**. If you have already pressed **Enter**, however, the new value will be in memory. To change it, press **Exit Program**. If you are in the middle of a program step with multiple substeps, the flow meter will display, “Changes have been made in step; press 0 to continue or 1 to discard.” If you press 1, the display will return to normal and the last step you were working on will revert to its previous selection. (Any program step you completely change before exiting will remain changed.)

You can re-enter the program with either **Enter** or the **Go To Program Step** keys. If you become confused while programming, the best suggestion is to press **Exit Program** and start over. Also remember that you can have the flow meter print a complete list of your program choices by exiting the program and by pressing the **Print Program** key as soon as the display returns to the normal operating condition, displaying level and total flow, etc.

2.4 Description of Program Steps

The programming steps are as follows:

1. Operating Mode
2. Flow Conversion
3. Adjust Level/Parameters
4. Reset Totalizer
5. Sampler Pacing
6. Sampler Enable
7. Alarm Dialout
8. Printer
9. Reports/History

2.4.1 Step 1 - Operating Mode

OPERATING MODE determines how you set up the flow meter. In this step, there are two choices, **Program** and **Setup**. Program advances you to **step 2**, and from there on you correlate the flow meter to the flow stream. Setup selects various basic housekeeping features for the flow meter. Here, you determine the internal clock, site identification, measurement setup, hysteresis (see page 2-14), report contents, operation of the display backlight, and program lock. In Program you select the units of measure the flow meter will use for the display, calculations, and reports.

Note

If you choose NOT MEASURED for any selection, the flow meter will make no further reference to that value or function for the rest of the program, and you will not be able to activate that process or function later on unless you reprogram step 1. If there is a feature or option you need that does not appear on your display when the manual says it should, return to step 1 and make sure you have not inadvertently left it turned off in either the Program or Setup menus.

Note that selecting some features automatically excludes others. For example, selection of pH or D. O. excludes the other parameter, unless you use the YSI 600 Multi-Parameter Sonde, which measures pH, D.O., and conductivity at the same time.

This method keeps program size manageable and makes programming more efficient. By turning off unneeded features of the program early, you do not have to keep de-selecting those features over and over as you work through the program.

Consequently, you should choose carefully from the first step. We suggest you study the program first, then fill out the Programming Worksheets (in the back of the manual), and program the flow meter last, if you are unfamiliar with the unit.

2.4.2 Step 2 - Flow Conversion Type

FLOW CONVERSION TYPE determines how the flow meter calculates flow rate and total flow. For the 4210, flow rate is calculated by knowing the measured level and (usually) the characteristics of a **primary measuring device**.

A primary measuring device is a structure placed in a flow stream through which the entire stream must flow. These devices are made in a number of styles and sizes, but they all have one thing in common: For any type of primary measuring device there is a known relationship between the level in the flow stream ahead of the device and flow rate through the device. Consequently, after you measure level with the flow meter, it can calculate flow rate and total flow from the measured level, by consulting built-in look-up tables.

Detailed information about many commonly-used primary measuring devices is provided in the *Isco Open Channel Flow Measurement Handbook*. This useful book provides formulas, flow rates at various levels, and values for maximum head, as well as much interesting descriptive material. This book is available from Teledyne Isco, upon request, with each flow meter. If your installation uses a nonstandard primary device, you should consult the manufacturer of the device for flow rates at given levels. The flow meter will then calculate a flow conversion for such a device on the basis of the manufacturers' data you enter as data points or an equation. In some instances, a nonstandard primary device could be supplied with a flow equation; you can enter that equation into the flow meter and the flow meter will calculate the flow rate from that equation.

Flow Calculations Without Primary Devices

It is not always necessary to have a primary measuring device. The 4210 Flow Meter can measure level and calculate flow without having any primary device installed in the flow stream. Sometimes the shape of the flow stream itself forms the primary device. The **Manning** formula uses the shape of a pipe or channel and its slope to calculate flow in open (non-pressurized) pipe situations.

The conversion types available are **WEIR/FLUME, MANNING, DATA POINTS, and EQUATION**.

Use a Weir/Flume flow conversion when your primary measuring device is a weir or a flume. A **weir** is a wall or dam across the flow stream. Water must rise to the point where it flows over the top of the wall. The measured level upstream behind the wall is used to calculate the flow rate. **Flumes** differ from weirs in that there is no wall or barrier, but instead a restriction, typically a sharp narrowing or change in the slope of the channel that restricts the flow. Again, the measured level of the stream at some point ahead of the restriction is used by the flow meter to calculate flow. In this flow conversion mode, the flow meter uses internal look-up tables for many common primary measuring devices.

An Equation – is used when you have a non-standard primary device, or want to use different values from those programmed into the look-up tables of the flow meter. Equation flow conversion uses the standard flow equation:

$$Q = k1HP1 + k2HP2$$

...where Q equals flow rate; k1 and k2 are constants; H is level (or head), and P1 and P2 are the powers to which the two H terms are raised. (Your equation may not have the second term, in which case you would enter 0 for the second constant, k2.) Most common primary devices are supported in the flow meter's software, so generally you will not need this option. But it is available for those needing to enter their own values, or for those who have a nonstandard primary device for which an equation can correlate level and flow.

MANNING Flow Conversion – uses the Manning formula to calculate flow in open or closed (non pressurized) gravity-flow situations based on slope, diameter, and roughness of the pipe. The Manning formula is named for its developer, Robert Manning, a 19th-century Irish civil engineer. There is no primary measuring device as such. Instead the pipe, with considerations for its slope and internal roughness, serves as the primary device. The 4210 can calculate flow in round pipes, rectangular, U-shaped, or trapezoidal channels based on this formula.

Data Point Flow Conversion (DATA POINTS) – calculates flow based on a set of user-entered data points for a flow stream. Data consist of correlated level and flow measurements for the stream. Like the Equation method of flow conversion, this flow conversion is most commonly used where the primary measuring device is nonstandard, but where tables of level and flow rate data are available from the device manufacturer. The 4210 has space for four sets of data with as many as fifty points per set. The flow meter then calculates flow from these data tables using a three-point interpolation.

2.4.3 Step 3 - Adjust Level, Parameters

ADJUST LEVEL, PARAMETERS calibrates the measuring sensors that provide the flow meter with level and other information. In this step you set the level that the flow meter measures. First you measure, as accurately as possible, the level in the flow stream. Then you enter this value with the numeric keys. Accuracy is important. Remember that measured level provides the basis for calculated flow in the flow meter.

The flow meter also has an input port for measurements other than level. This is the Parameter Port. Here the meter can sense such variables in the flow stream as temperature, pH (the acidity or alkalinity of a solution) and D.O. (dissolved oxygen). You can have either pH with temperature, D.O. with temperature, or temperature alone. The port is not dedicated to a particular sensor, except through programming. For example, you can change from a pH probe to a D.O. sensor if you change the programming. Selection of one parameter will keep the other from showing up on the menus. Note, however, that it is possible to measure several different stream conditions (including pH and D.O.) at the same time with the YSI 600 Sonde.

The YSI 600 Sonde – The YSI 600 Sonde is a multi-purpose, water quality measurement device. It is intended for use in research, assessment, and regulatory compliance. The sonde attaches to the modified RAIN GAUGE connector on the 4210.

Flow meters having only a 4-pin rain gauge connector will not support the YSI Sonde. If you wish to upgrade your flow meter to use this system, contact the factory. Note that you can have both the YSI 600 Sonde and the Rain Gauge connected to the flow meter at the same time by using a special Y-connect cable.

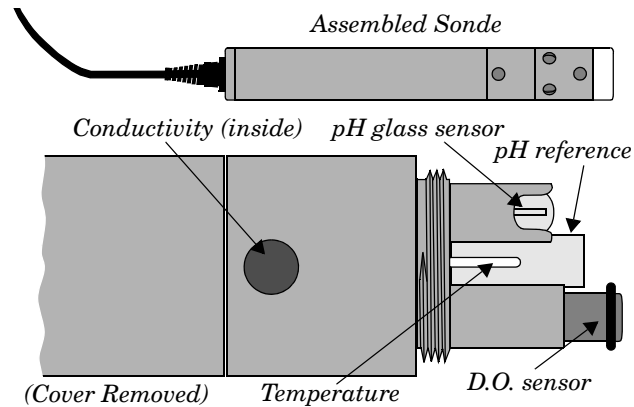


Figure 2-1 The YSI 600 Sonde

The YSI 600 can measure the following water qualities: **dis-solved oxygen (D.O.)**, **conductivity**, **temperature**, and **pH**. Conductivity measurements made by the sonde can be used to calculate specific conductivity, salinity, and total dissolved solids. A brief description and specifications for the YSI 600 are printed in Appendix A. You may also contact the factory or your Teledyne Isco representative. More information on the sonde is found in the YSI 600 Manual, shipped with each YSI 600 Sonde.

2.4.4 Step 4 - Reset Totalizer

RESET TOTALIZER determines whether you reset the flow meter's internal flow totalizers. If the installation is permanent you generally won't reset the totalizer. If you are using the flow meter as a portable recording unit and are moving it from one site to another, you would generally reset the totalizer between sites.

2.4.5 Step 5 - Sampler Pacing

It is common to use a flow meter with an Isco Automatic Waste-water Sampler. Typically the flow meter signals the sampler to take a sample after a certain volume has passed. It might also occur after a certain condition or set of conditions has either changed or been met. SAMPLER PACING allows you to determine that control. There are several possible options—**DISABLE**, **CONDITIONAL**, **VOLUME**, and **Flowlink**. **DISABLE** will keep the sampler from receiving a flow pulse from the flow meter. **VOLUME** allows the flow meter to signal the sampler whenever a specific flow volume has passed by. **Flowlink** (this option will only appear if you are using Flowlink software), allows the sampler to be signalled from the flow meter as a result of conditions determined by Flowlink.

Flowlink is Teledyne Isco's proprietary data acquisition and management software. Flowlink works with personal computers, modems, and laptop computers to monitor flow meters from a distance. Consult the factory for more details about Flowlink.

VOLUME causes the flow meter to pace the sampler after a specific volume has passed through the flow stream.

CONDITIONAL allows pacing of the sampler by the flow meter when a condition has been met, or has changed. Among these conditions are changes in level, flow rate, temperature, rainfall, (if you are using the rain gauge), dissolved oxygen, or pH. You can also use a combination of conditions. D.O. (dissolved oxygen), or pH, or if you are using the YSI 600 sonde, you can select multiple conditions from its sensors.

 **Note**

If you choose CONDITIONAL for sampler pacing and it doesn't seem to work properly for you, read the section on hysteresis (page 2-14). Then check the hysteresis setpoints for your conditions. (The defaults are all zero.)

You must have the appropriate sensors attached to the flow meter to measure temperature, D.O., pH, conductivity, etc.; the flow meter cannot do this by itself, nor does it occur automatically.

2.4.6 Step 6 - Sampler Enable

SAMPLER ENABLE means that in a combination flow meter/sampler pair, the flow meter controls the sampler's ability to run its own program. The difference between step 5, sampler pacing, and step 6, sampler enable is that in sampler pacing, the flow meter merely sends flow pulses to the sampler from time to time. The sampler counts these flow pulses to determine when to take a sample (according to its own programming).

With sampler pacing, the sampler is always enabled. With sampler enabling, the flow meter can actually stop operation of the sampler. The sampler is still set up to run its own program, but the inhibit/enable line from the flow meter will determine when and whether the sampler runs its program. This feature is useful for storm water runoff monitoring applications, where it may be necessary for the flow meter/sampler pair to have to wait a long time between storm intervals.

Again, changing or meeting a condition or set of conditions triggers the enabling. The conditions that can be used for sampler enabling are similar to those used for sampler pacing: level, flow rate, rainfall, temperature, dissolved oxygen, pH, or a combination of these conditions. The YSI 600 Sonde provides several measurements at the same time. (You must have the appropriate sensors for rainfall, temperature, D. O., pH and the YSI outputs.)

2.4.7 Step 7 - Alarm Dialout Mode

ALARM DIALOUT MODE allows you to program a 4210 Flow Meter to signal a remote location through a telephone line. This feature is useful for transmitting alarm conditions or other essential information to a remote location.

 **Note**

You must have the optional modem installed to make use of this program step. The menus will not even appear unless the flow meter has a modem installed.

The Alarm Dialout feature is useful if you need to signal a remote location when there is a change of condition in the flow stream that could constitute an alarm. You can program as many as five different eighteen-digit telephone numbers into the flow meter in decreasing order of importance. The modem is capable of speech.

DISABLE inhibits this function altogether. CONDITIONAL lets you program the flow meter to signal these alarms for a variety of reasons. You can use rainfall, time, level, flow rate, dissolved oxygen, pH, rate-of-change, a combination of conditions, or define the operation through Flowlink software from another computer. STORM lets you set the alarm through a combination of rainfall and time. You can also program the interval between calls and set up the system to reset the alarm condition by dialing back from the remote telephone.

2.4.8 Step 8 - Printer

The 4210 Flow Meter has a built-in printer. The printer is capable of plotting linear data along with printing alphanumeric (letters and numbers) messages. In this step you set the speed for the chart to advance, from $\frac{1}{2}$ " to 4" per hour.

Chart speed is set according to the amount of resolution you want to see on the chart. If there is a great deal of activity on the chart, you would generally choose a faster speed so the marks are more "spread out" and are easier to interpret. If there is little activity on the chart and you want the flow meter to run for long periods without having to change the roll, you would pick a slower speed.

The flow meter is capable of plotting three separate data lines on the chart in addition to the alphanumeric messages. These lines may indicate such things as level, flow rate, pH, dissolved oxygen, or temperature. Note that you must have the appropriate sensors for pH, DO, and temperature to take advantage of the availability of these plots.

The printer is capable of plotting over-ranges for the data lines it plots. You can tell when the printer is in over-range if a data line goes off the chart on the right side and then immediately starts over again plotting on the left side.

2.4.9 Step 9 - Reports/History

REPORTS/HISTORY lets you program the flow meter to print regular reports on the internal printer. The reports the flow meter prints are a summary of activity recorded over time. Typically included are such items as maximum and minimum flow rates, the time they were reached, sample records, etc.

The flow meter lets you create two separate reports, and define what appears on them to a great extent. Note that the contents of the reports are defined in Setup in step 1. Step 9 merely lets you turn them off and on and set the timing. You can define the start time, the interval between reports and other aspects of the report.

History provides a record of changes made to the flow meter's program or operation events. As many as 50 changes can be stored in the flow meter's memory at a time. The memory can store up to 50 history items and 200 sample events at a time.

2.5 Interpreting The Program Screens

Following are the program screens as they appear on the display of a 4210 Flow Meter. Explanations for most of the screens will be provided.

Note

Some items that appear in the following menu will have parentheses (...) around them. This means that the item **may or may not** appear on your flow meter's display. Choices made early in the program can render other choices unavailable later.

An example of this is the pH/D.O. option. Selection of one in Step 1 will keep the other from appearing in all subsequent menus.

Some of the diagnostic and error screens will be covered in Section 5.

2.6 Step 1: OPERATING MODE

Turn on the machine. Wait for the display to settle. Then press the **Enter/Program Step (Enter)** key. The following will appear. If the following menu does not appear, press **Exit Program**, then **Go To Program Step**, then press **1**.

```
SELECT OPTION
• PROGRAM •• SETUP •
```

PROGRAM is always the default. If you press **Enter**, the display will automatically advance to the next screen, which will ask you to select units of measurement. If you select SETUP, the following will appear:

```
SETUP OPTIONS: 'EXIT' TO QUIT
• SET CLOCK •• SITE ID •• MEASUREMENT SETUP •
```

If you press the **right arrow** key, the following options will appear on the display:

```
SETUP OPTIONS: 'EXIT' TO QUIT
• STATUS ENABLE/ALARM HYSTERESIS •
```

Then:

SETUP OPTIONS: 'EXIT' TO QUIT
• OPTIONAL OUTPUTS •• REPORT SETUP •

And:

SETUP OPTIONS: 'EXIT' TO QUIT
• LCD BACKLIGHT •• (LANGUAGE) •• PROGRAM LOCK •

Finally:

SETUP OPTIONS: 'EXIT' TO QUIT
• (LANGUAGE) •• PROGRAM LOCK •• PROGRAM •

If you select SET CLOCK, the following will appear:

YEAR MONTH DAY HOUR MIN
XXXX XX XX XX XX

Enter the year (four digits), the month (01-12), the day (01-31), the hour (01-24), and the minute (01-59).

If you select SITE ID, the following will appear:

SITE ID: XXX

You can select any suitable three-digit number for the site identification.

If you select MEASUREMENT SETUP, the following will appear. You will have to use the right arrow key to bring all the options on screen:

MEASUREMENT SETUP
• LEVEL READING INTERVAL •• DO/PH READING INT-

MEASUREMENT SETUP
• DO/PH READING INTERVAL •• VARIABLE BLANKING •

LEVEL READING INTERVAL refers to how often the flow meter takes a level reading. LEVEL refers to the level in the flow stream.

DO/PH READING INTERVAL refers to the measurement of specific aspects of the flow stream other than amount. The 4210 supports measurement of three different characteristics: **temperature**, **pH** (the relative acidity or alkalinity of a solution), and **D.O.**, dissolved oxygen.

MEASUREMENT SETUP
• VARIABLE BLANKING •• YSI 600 READING INTERVAL •

VARIABLE BLANKING refers to the ability of the flow meter to ignore certain measurements of the ultrasonic transducer to reduce the possibility of error.

YSI 600 READING INTERVAL refers to the frequency of measurements made by the YSI 600 Sonde.

If you select LEVEL READING INTERVAL, the following will appear:

LEVEL READING INTERVAL
• CONTINUOUS •• 15 SEC •• 30 SEC •• 1 MIN •• 2 MIN •• 5 MIN •

The LEVEL READING INTERVAL option is a way to conserve power in battery-powered installations. If your installation is AC-powered, you can simply select CONTINUOUS.

The 4210 expends considerable power generating the ultrasonic pulses.

With this unit, select the longest acceptable interval between readings, if you are operating on battery power. If you need a faster response time, select one of the shorter intervals. If you are operating on battery power, you may have to seek a compromise between short reading intervals and battery life expectancy.

Select VARIABLE BLANKING and the following will appear:

VARIABLE BLANKING DISTANCE = XX.XX FT (or meters)
--

You can determine this distance approximately by measuring from the face of the (installed) ultrasonic level sensor to the surfaces of the channel just above the maximum expected liquid level. This value tells the flow meter to **ignore** any echo reflected from this distance or less.

The purpose of this selection is to let you fine-tune the reflection cone beneath the ultrasonic level sensor. If the level sensor is mounted too high above the flow stream, there is a good chance echoes will be reflected from the channel walls, tops, sides, or other solid surfaces, that have nothing to do with the actual liquid level. Proper selection of a value here will ensure that echoes selected by the flow meter as valid will only come from the surface of the flow stream, not the walls of the channel.

If you select DO/PH READING INTERVAL, the following will appear:

DO/PH READING INTERVAL •CONTINUOUS••15 SEC••30 SEC••1 MIN••2 MIN••5 MIN•

Again, this selection is offered as a means of saving battery power. After selecting the appropriate parameter reading interval, press **Enter**.

This time, select YSI 600 READING INTERVAL from the menu. The following display will appear:

YSI 600 READING INTERVAL •CONTINUOUS••15 SEC••30 SEC••1 MIN••2 MIN••5 MIN•

YSI 600 READING INTERVAL refers to the YSI 600 Sonde. The flow meter can measure several different aspects of the stream at the same time, including pH, D.O., temperature, plus conductivity.

<input checked="" type="checkbox"/> Note

If you are using the Isco D.O. sensor or are sensing D.O. with the YSI 600 Sonde, select as long a measurement interval as is practical for your application. The reasoning is that the D.O. sensor is turned off between measurement intervals and this turned-off period prolongs the life of the sensor.

The Setup menu will reappear. This time select STATUS from the Setup menu. Press **Enter**. The following will appear:

```
MODEL 4210 HW REV: XXXXXX SW REV X.XX  
ID XXXXXXXXXXXXX
```

HW REV refers to the hardware revision number. SW REV refers to the software revision number. ID is an internal identification number.

Press **Enter** again and you will see the following:

```
SIGNAL STRENGTH X%
```

The flow meter will read continuously when this screen is displayed. This value indicates the functioning of the ultrasonic sensor. This display exists primarily as a diagnostic tool for telephone troubleshooting. There is no specific number you should expect to see. If the flow meter is displaying valid level/flow readings, you do not need to worry about the numbers. The numbers become important when you **cannot** get valid level readings. If there is a number greater than zero displayed for **signal strength**, the following is generally indicated:

1 = a very weak return signal. 100 = a very strong return signal. Numbers from 10 to 90 are normal, and numbers of 50 to 90 are typical for sewers.

The important thing to remember when interpreting this number is that the number should be fairly consistent from one reading to the next. This number indicates the strength of the ultrasonic return echo. A number of 1 indicates a very weak return echo. A number of 100 indicates a very strong return echo; generally speaking, the higher the number the better. Numbers from 10 to 90 are normal, and numbers of 50 to 90 are typical for sewers. Again, this number is important only if you doubt the accuracy of the reading, or if the value itself is unstable from one reading interval to the next.

If you press **Enter** again, the flow meter will display the system voltage:

```
SUPPLY VOLTAGE: XX.X
```

This value should be from 10.5 to 13.5 (volts DC). If you do not press **Enter** after the first diagnostic menu appears, the flow meter will automatically advance the display through the next two screens and finally revert to the Setup menu after a short time-out.

```
YSI SOFTWARE REV: XX.X
```

Return to the SETUP menu if the unit has not already done so. This time select ENABLE/ALARM HYSTERESIS from the menu. Press **Enter**. The following will appear:

```
LEVEL ENABLE/ALARM  
HYSTERESIS X.XXX FT (or meters)
```

The HYSTERESIS menu lets you set the range over which the level (or other condition) can vary before the flow meter responds to the change.

In the PROGRAM section of the software there are several steps that require a change in a condition to make the flow meter carry out certain actions. For example, step 6 programs the flow meter to enable (activate) a sampler. In that step, you select a condition (or set of conditions) that must occur before the sampler is enabled. You enter a value (level is an example) that must be met before the enabling occurs.

But what if this value is met and then falls away? It is possible for a condition to vary rapidly over a narrow range. Without hysteresis, the flow meter will turn the sampler off and on repeatedly, causing a condition known as **chattering**, that would result in very erratic operation of the sampler.

With hysteresis, you can enter a value that will keep the flow meter from responding to insignificant changes in the enabling condition. You should select a value for hysteresis that is narrow enough to allow the flow meter to respond to any serious change, but broad enough to ignore minor changes that could cause chattering. Press **Enter** and the following will appear:

```
FLOW RATE ENABLE/ALARM
HYSTERESIS X.XXX CFS (or other units of measure)
```

The next several menus may or may not appear, depending on selections you make in PROGRAM. They concern alarm/enable hysteresis set points for parameter sensing—temperature, pH, and D.O.

If you want to set hysteresis for any of these items, you should enable them when you work through the program section, then re-enter the SETUP section (Hysteresis) and they will appear. Note that you can have temperature alone, or temperature with either pH or D. O. You must have temperature with either pH or D. O.

 **Note**

The 4210 cannot measure pH and D.O. at the same time unless you use the YSI sonde. Selection of one will prevent the other from appearing on the menus later.

The following will appear if you are measuring temperature:

```
TEMPERATURE ENABLE/ALARM
HYSTERESIS XX.XXX DEG F (or C)
```

The following will appear if you are measuring pH:

```
pH ENABLE/ALARM
HYSTERESIS X.XXX pH
```

The following will appear if you are measuring D. O:

```
DO ENABLE/ALARM
HYSTERESIS X.XXX PPM
```

(or mg/l depending on units selected in PROGRAM.)

A set of menus similar to those shown above for pH, D.O., and temperature will then appear for the YSI 600 Sonde, if you have selected it. You can set hysteresis for YSI-pH, YSI-D.O., YSI-Conductivity, and YSI-temperature, if these parameters have been turned on in previous program selections.

2.6.1 Optional Outputs

After all the HYSTERESIS menus have been set, press **Enter**. The display will return to the Setup menu. This time select OPTIONAL OUTPUTS with the arrow key. Press **Enter**.

```
OPTIONAL OUTPUTS
•ANALOG OUTPUT••SERIAL OUTPUT••ALARM BOX•
```

ALARM BOX – refers to an external accessory used to signal alarms from the flow meter. See Section 4 for more information about the High-Low Alarm Box. Note that choice of SERIAL OUTPUT will eliminate ALARM BOX as an option. Likewise, choice of ALARM BOX will eliminate SERIAL OUTPUT as an option.

If you select any of these OPTIONAL OUTPUTS, the flow meter will request that you turn them on or off. If you are running on battery, select OFF for all unused outputs.

ANALOG OUTPUT – refers to the flow meter’s capability of managing associated equipment through a 4-20 mA current loop. The 4-20 mA current loop is a common method used to control industrial processes that are variable (rather than just fully off or on). At the lower value (4 mA) the control is turned off (0%); at 20 mA the control is completely turned on (100%). In between, rates range from 1 to 99%. A typical application is a chlorinator, which must vary in application of the chlorine gas as the amount of water passing through the system increases or decreases. Current ranges other than 4-20 mA are also in use, although they are less common than 4-20 mA. Examples are 0-20 mA (supported by the flow meter on the internal card only) and for longer current loops, 10-50 mA (not supported by the flow meter).

Teledyne Isco offers two different arrangements for the 4-20 mA control circuit. You can have either or both with the same flow meter. One arrangement requires the use of an external accessory, the 4-20 mA Output Interface (see Section 4). This module connects to the flow meter and a source of AC power and contains the circuitry necessary to create the 4-20 mA current loop. This accessory connects to the flow meter through the Interrogator connector.

The other 4-20 mA option is a board installed inside the flow meter that contains circuitry for up to three separate, isolated 4-20 mA current loops. This option can also be ordered with one or two current loops supplied. If you use both the external converter and the internal board, you can have a total of four current loops controlled by the same flow meter. The internal current loops are brought out to a 6-pin M/S connector in the slot where the Modem connector is usually mounted. Additional information for the internal analog output board, including specifications for the loops, is found in Section 4.

 **CAUTION**

Each 4-20 mA output represents a constant drain on the flow meter of at least 16 mA whether activated or not. While 4-20 mA applications are generally made in installations with commercial power available, Teledyne Isco suggests the following for those who have a 4-20 mA output in a battery-powered installation.

Use with battery powered flow meters only:

- If the battery is continuously on charge (for example with a Solar Panel Battery Charger)
- If the battery is very large, such as a deep-cycle or marine type battery, or a Teledyne Isco 35 Ampere-hour lead-acid battery.
- Use only one 4 - 20 mA output.
- Keep in mind that programming choices also affect power consumption. Use “minimum” settings on the flow meter wherever possible. (See Section 1, Table 1-4.)

Even with these circumstances, you may expect significantly shorter charge life from your battery. To determine the effect of this extra current draw on battery life, please refer to the section How to Make Battery Calculations, at the end of Section 1.

The following menus determine the behavior of the 4-20 mA current outputs. If you select ANALOG OUTPUT (another name for the 4-20 mA Output) and the flow meter is equipped with the optional internal board or the 4-20 mA external accessory has been turned on, RANGE, SMOOTHING, and MANUAL CONTROL will appear:

ANALOG OUTPUT
• EXTERNAL 4-20 MA •• (RANGE) •• (SMOOTHING) ••

 **Note**

If you know for certain that you have the proper installed hardware for internal 4-20 mA outputs and you do not see the proper displays, return to the “normal” flow meter display and press 4 - 2 - 0.

 **CAUTION**

If you do not have the proper hardware installed and you press 4 - 2 - 0 and the number of analog outputs is not zero, the external 4-20 mA converter will not work properly. If this occurs, return to the 4 - 2 - 0 option, and at the prompt, enter 0 for the number of outputs activated. This will restore the external 4-20 mA converter capability.

MANUAL CONTROL will appear if you continue moving to the right. "RANGE" will appear with the ANALOG OUTPUT menu if the optional internal 4-20 mA converter is present in the flow meter. If you select RANGE, the following will appear:

OUTPUT RANGE • 0 - 20 mA • • 4 - 20 mA •

This menu lets you select the current value for zero percent (baseline) compatible with your equipment (internal 4-20 mA board only).

If you select SMOOTHING from the ANALOG OUTPUT menu the following will appear:

SMOOTHING • NONE • • 15 SEC • • 30 SEC • • 1 MIN •

The SMOOTHING option lets you stabilize operation of the outputs by preventing a rapid reaction to sudden sharp changes in the condition being monitored that quickly return to normal (transients). Selection of a smoothing interval will prevent the equipment controlled by the 4-20 mA loop from reacting too quickly, too much, or operating erratically. A low-pass filter algorithm is incorporated in the software.

If you select the MANUAL CONTROL option from the ANALOG OUTPUT menu the following will appear:

MANUAL CONTROL (OUTPUT 0 = EXTERNAL) OUTPUT 0 = 0.0 MA

This option lets you control the operation of a 4-20 mA loop to check the operation of equipment controlled by the loop at any level from 0 to 100%. After connecting a 4-20 mA output to a controlled device, you can program the flow meter to put a specified current on a specific analog output. If you are using the external 4-20 mA converter, the Analog Output number will be zero.

<input checked="" type="checkbox"/> Note

Selecting the MANUAL CONTROL option and programming any one of the ports will prevent the values transmitted by the other active 4-20 mA ports from being updated until the test is completed. The other ports will continue to transmit whatever value they held at the start of the test. Exiting from the MANUAL CONTROL menu at the end of the test will return all active 4-20 mA ports to normal operation.

Programming for the conditions and values that determine the operation of the 4-20 mA loop(s) is done in **step 2**.

SERIAL OUTPUT – Returning to the OPTIONAL OUTPUTS menu, you will see the SERIAL OUTPUT option. This feature lets the flow meter transmit the most recent values for all currently enabled ports as ASCII text. You can then write a simple program to retrieve this data periodically, or you can do it interactively using a terminal program.

2.6.2 Serial Output Codes

✓ Note

The information in the following section is provided for those who can write their own software programs to process the data transmitted from the Serial Output (INTERROGATOR) port. An Interrogator cable may be required. Contact Teledyne Isco technical support for more information.

Command Line – The lines of text contain the port values for each port that is turned on. The DATA command will use a special command response protocol. The following table provides the ASCII codes for port types and standard units of measure.

Table 2-1 ASCII Output Codes		
Code	Parameter	Units
DE	Description	String
ID	Unit specific identifier	Unsigned long
MO	Model	String
TI	Time since 1900	Days
BV	Battery Voltage	Volts
LE	Level	Meters
LSI	Level Signal Strength	0 - 100%
VE	Velocity	Meters per second
VSI	Velocity Signal Strength	0 - 100%
VSP	Velocity Spectrum Strength	0 - 100%
FL	Flow	Cubic meters per second
VO	Volume	Cubic meters
FV	Forward volume	Cubic meters
RV	Reverse volume	Cubic meters
SV	Sampler Enabled Volume	Cubic Meters
RA	Rain (rolls over every 255 tips)	Tips
CR	Current day's rain (tips since midnight)	Tips
PR	Previous day's rain (tips since midnight)	Tips
PH	pH	pH units
DO	Dissolved Oxygen	Milligrams per liter
TE	Temperature	Degrees Celsius
YPH	YSI 600 pH	pH units
YDO	YSI Dissolved Oxygen	Milligrams per liters

Table 2-1 ASCII Output Codes (Continued)

Code	Parameter	Units
YCO	YSI 600 Conductivity	Millisiemens per centimeter
YSP	YSI 600 Specific Conductance	Millisiemens per centimeter
YSA	YSI 600 Salinity	Parts per thousand
YTD	YSI 600 Total Dissolved Solids	Milligrams per liter
YTE	YSI 600 Temperature	Degrees Celsius
YSP	YSI 600 Specific Conductance	Millisiemens per centimeter
YCO	YSI 600 Conductance	Millisiemens per centimeter
YSA	YSI 600 Total Salinity	Parts per thousand
YTD	YSI 600 Total Dissolved Solids	Milligrams per liter
YTE	YSI 600 Sonde Temperature	Degrees Celsius
SS	Sampler Enable Status	Logical
B?	Bottle Number and Time	Days
CS	Check sum (does not include the check sum, carriage return, and line feed)	Unsigned long

Note: The output string for a given flow meter will have values only for those parameters it is currently measuring. The order of the fields in this table is subject to change. Additional data types may be inserted anywhere in the list. Parsing routines for this output string should search by type identifier instead of depending on the position in the string. If an active port has an error flag set, the serial output will insert ERROR for the value.

You can enter the command line by connecting the interrogator cable with the interrogator sense line shorted to ground. Then send a series of '?' (question marks) until the flow meter transmits the unit's banner and prompt. The number of question marks necessary is a function of the baud rate auto detection. At the prompt, enter DATA<CR> and the flow meter will respond with the appropriate ASCII output string. You can send the DATA command as often as you want. Type 'Q' to leave the command response interface.

In addition to the port values, the data includes the flow meter's current time, the bottle number and time stamp of the three most recent sample events, the previous day's rainfall total (midnight to midnight), the current day's rainfall total since midnight, and a rainfall bucket tips counter that rolls over every 255

tips. (See **Rain Gauge**, page 2-26.) The port values appear in a comma-separated values format. Each data field is preceded by a two or three-character type identifier. The table lists the type identifiers. Note that the flow meter's current time and the sample event time stamp appear as a number in standard spreadsheet format (days since 1900). The supported baud rates are 9600, 4800, 2400, and 1200 (no parity, eight bits and one stop bit).

2.6.3 Periodic Output

(Use a special RAIN GAUGE connector cable—contact the factory for assistance.) Note that the periodic output will terminate during phone connection and when the interrogator cable is connected.

 **CAUTION**

It is important to use CHECKSUM if you plan to use internal modems or the interrogator. The UART is shared with these devices.

If you select SERIAL OUTPUT from the OPTIONAL OUTPUTS menu, the following display will appear:

PERIODIC SERIAL OUTPUT
• ON •• OFF

Selection of OFF from this menu will disable this feature, and there will be no further references to it. The Serial Output data appears on the Interrogator connector of the flow meter. You should not use a standard interrogator cable for this application, as the sense line in the standard cable is shorted to ground.

Selection of ON from this menu will enable the feature and cause the following display to appear:

SELECT BAUD RATE (N81)
• 9600 •• 4800 •• 2400 •• 1200 •

After you select the appropriate baud rate, the program will advance to the following menu:

SERIAL OUTPUT INTERVAL
• 15 SEC •• 1 MIN •• 5 MIN •• 15 MIN •

This menu lets you select how often the flow meter transmits the ASCII text string.

Following is an example of a string showing all options: (Note that three lines are shown here; this is due to the confines of the text column. In actual practice, there are no carriage returns in the text string.)

```
DE,"TheresaStreet",4250ALPHA4,ID,0721577657,MO,4250,TI,35317.343715,BV,12.3,LE,0.1000,VE,  
0.1225,FL,0.001555,VO,2.199325,FV,2.199325,RV,0.000000,SV,2.195539,SS,1,B0,35317.307384,B0,35  
317.269907,B0,35317.232593,CS,10819
```

If you select any of these outputs, the flow meter will request that you turn them on or off. If you are running on battery and do not need these options, select OFF. Otherwise, select ON. After the OPTIONAL OUTPUTS menus have been set, press Enter. The display will return to the SETUP menu.

If you select any of these outputs, the flow meter will request that you turn them on or off. If you are running on battery and do not intend to use either of these options, select OFF. Otherwise, select ON. After the OPTIONAL OUTPUTS menus have been set, press **Enter**. The display will return to the SETUP menu.

2.6.4 Report Setup

This time, select REPORT SETUP with the arrow key. Press **Enter**:

```
REPORT SETUP
• REPORT A •• REPORT B •
```

This step lets you determine the contents of the reports generated by the flow meter. The flow meter's report generator is capable of creating two different reports (A and B) that can be identical or quite different. The reason for two reports is to allow the summary of events occurring over different time periods. For example you might generate report "A" weekly, and report "B" monthly. At this point, we are only interested in selecting the items the flow meter will include in each report. Press **Enter** and the following will appear:

```
REPORT SETUP
• FLOW •• DO/PH •• YSI 600 •• SAMPLE HISTORY •
```

FLOW METER HISTORY is just off the screen, to the right. If you select FLOW, the following will appear:

```
LEVEL IN REPORT
• YES •• NO •
```

Select YES if you want LEVEL to appear in the report. The following will appear:

```
FLOW RATE IN REPORT
• YES •• NO •
```

Select YES if you want FLOW RATE to appear in the report. Then:

```
RAINFALL IN REPORT
• YES •• NO •
```

Select YES if you want RAINFALL to appear in the report. Note that you must have a rain gauge connected to the flow meter to sense rainfall occurrence. The following will appear:

```
REPORT SETUP
• FLOW •• DO/PH •• YSI 600 •• SAMPLE HISTORY •
```

FLOW METER HISTORY is off the screen to the right.

This time select DO/PH. The following will appear:

```
PH OR DO IN REPORT
• YES •• NO •
```

Select YES if you want DO/PH to appear in the report. You must have the appropriate sensor connected to the flow meter. It is capable of sensing temperature, pH and temperature, and D.O. (dissolved oxygen) and temperature. The following will appear:

```
TEMPERATURE IN REPORT
• YES •• NO •
```

Select YES if you want TEMPERATURE to appear in the report. Press **Enter** again and the display will return to the REPORT SETUP menu:

```
REPORT SETUP
• FLOW •• DO/PH •• YSI 600 •• SAMPLE HISTORY •
```

FLOW METER HISTORY is just off the screen.

This time, select YSI 600. The following will appear:

```
YSI DATA IN REPORT
• YES •• NO •
```

Press **Enter** again and the display will return to the REPORT SETUP menu.

```
REPORT SETUP
• FLOW •• DO/PH •• YSI 600 •• SAMPLE HISTORY •
```

This time, select SAMPLE HISTORY. The following will appear:

```
SAMPLE HISTORY IN REPORT
• YES •• NO •
```

Select YES if you want SAMPLE HISTORY to appear in the report. Press **Enter** again and the display will return to the REPORT SETUP menu:

```
REPORT SETUP
• DO/PH •• SAMPLE HISTORY •• FLOW METER HISTORY •
```

This time, select FLOW METER HISTORY. The following will appear:

```
FLOW METER HISTORY IN REPORT
• YES •• NO •
```

Select YES if you want HISTORY to appear in the report. HISTORY is a list of the changes that have been made to the flow meter's program.

Press **Exit** to leave the program.

2.6.5 Other Setup Options

Enter and reselect SETUP. The Setup menu will reappear:

```
SETUP OPTIONS: 'EXIT' TO QUIT
• STATUS •• REPORT SETUP •• LCD BACKLIGHT •
```

SET CLOCK, SITE ID, MEASUREMENT SETUP, PROGRAM LOCK, PROGRAM are off-screen and can be accessed with the arrow keys.

LCD Backlight – Select LCD BACKLIGHT. The following will appear:

```
LCD BACKLIGHT MODE
• KEYPRESS TIMEOUT •• CONTINUOUS •• OFF •
```

KEYPRESS TIMEOUT will cause the backlight to be turned on whenever you press a key on the keypad. An internal timer is started that will keep the backlight on for approximately two minutes after you press a key. Each time you press a key, the timer is restarted, so the backlight will never go off as long as you continue to program the flow meter, with keystrokes less than two minutes apart. At the end of programming, the backlight will go out, and will stay off until you start to program again. This feature is designed to conserve battery power by de-energizing the backlight when it is not needed. The backlight is still available if it is necessary to program in a dark environment, such as in a manhole. We recommend using this selection if the flow meter is battery-powered, but installed in an environment where the lighting is poor.

CONTINUOUS will light the backlight continuously. Where the flow meter is powered by an AC power supply, battery life considerations do not intervene. If the backlight makes the display easier to read, use it. Do not use CONTINUOUS in any installation that is battery-powered, as it will cause rapid discharge of the battery.

OFF will keep the backlight feature turned off under all circumstances. Select this option for maximum battery life in installations where there is sufficient ambient light to read the display without the backlight feature. The SETUP menu will return.

Language – This time, move the flashing cursor from LCD BACKLIGHT to LANGUAGE.

When LANGUAGE appears on your display, you may select an alternate language to program the flow meter. The other language depends on how the flow meter was ordered. The following display will appear:

LANGUAGE • ENGLISH • • (second language, as ordered) •

Select the language appropriate for your application. The menus and the printed reports will appear in the selected language. The SETUP menu will reappear.

Program Lock – This time, select PROGRAM LOCK from the menu.

PROGRAM LOCK • ON • • OFF •

PROGRAM LOCK prevents the program from being changed. Select OFF while you are programming, and then go back and select ON if you need to lock the program. We suggest using the lock only if there are compelling security reasons. Further changes will require entry of the password, which is the model number for whatever flow meter you are using, for example, enter 4-2-1-0 for the 4210. If you select ON, there is a time-out before the lock engages. If you continue to work through the rest of the program, the lock will not engage until you are done. But if you stop programming longer than two minutes, the lock will engage, and you will not be able to make any further program changes.

Press **Enter** and the SETUP menu will reappear.

```
SELECT OPTION
• PROGRAM •• SETUP •
```

PROGRAM will be flashing. (Note that PROGRAM is always the default choice. That is because you are more likely to need to make changes in the PROGRAM section of the software than in the SETUP section.)

Note

If you choose NOT MEASURED for any selection, the flow meter will make no further reference to that function for the rest of the program, and you will be unable to activate that function later. If there is a feature you need that does not appear when the manual says it should, return to **step 1** and make sure you have not accidentally left it turned off.

If you program a parameter value as a condition for sampler enabling, pacing, dialout, etc., and then turn that parameter sensor off, the flow meter will also remove that condition from the program.

Consider all aspects of your program before you make any changes.

Press **Enter**. The following will appear:

```
UNITS OF LEVEL MEASUREMENT
• FT •• IN •• M •• MM •• NOT MEASURED •
```

Selection of feet, inches, meters, or mm depends on your situation. You would select NOT MEASURED if you were using the flow meter for some other form of sensing only, such as pH or temperature. Press **Enter**. The following will appear. You will have to press the **right arrow** key several times to see all of the options displayed below:

```
FLOW RATE UNITS OF MEASURE
• GPS •• GPM •• GPH •• MGD •• CFS •• CFM •• CF •
```

Pressing the **right arrow** key several times will move other units onto the display:

```
FLOW RATE UNITS OF MEASURE
• CFH •• CFD •• LPS •• M3S •• M3M •• M3H •• M3D •• AFD •
```

NOT MEASURED will also appear if you keep moving with the **right arrow** key. This step establishes the units of measure the flow meter will use in all subsequent displays and calculations.

GPS = gallons per second; GPM = gallons per minute; GPH = gallons per hour; MGD = millions of gallons per day; CFS = cubic feet per second; CFM = cubic feet per minute; CFH = cubic feet per hour; CFD = cubic feet per day; LPS = liters per second; M3S = cubic meters per second; M3M = cubic meters per minute; M3H = cubic meters per hour; M3D = cubic meters per day; AFD = acre-feet per day.

```
TOTALIZED VOLUME UNITS
• GAL •• MGAL •• CF •• L •• M3 •• AF •
```

This step determines the units value the flow meter will use to record the totalized flow volume that passes by. GAL = gallons; MGAL = millions of gallons; CF = cubic feet; L = liters; M3 = cubic meters; AF = acre-feet.

2.6.6 Additional Parameters

For the next several substeps you must have the appropriate sensor attached to the flow meter's **Parameter Port** or **Rain Gauge Port** (for the Rain Gauge or YSI 600 Sonde) to take advantage of the capabilities. You can only have D.O./temperature, pH/temperature or temperature alone on a given flow meter, unless you use the YSI 600 Sonde. The YSI 600 Sonde provides multiple outputs simultaneously. You can use the Rain Gauge with the YSI 600 sonde if you use a Y-connect cable.

Remember that programming for one type of sensor will prevent the display of any references to the other in later program steps. All sensors but the rain gauge are mounted fully submerged in the flow stream. The pH and D.O. probes must be kept **constantly wet** or they can be damaged.

Note

The pH or D. O. probes do not attach directly to the flow meter, as their output signals are quite low. You must also have the appropriate amplifier box connected between the probes and the flow meter.

Their use in streams with intermittent flow (such as storm drainage) is not recommended. Even in normal use, the pH probe becomes contaminated over time and exposure, and will eventually need replacement in any case.

RAIN GAUGE
• INCHES • • MM • • NOT MEASURED •

You must have an **Isco 674 Rain Gauge** (or approved equivalent) connected to the flow meter through the Rain Gauge Port to sense rainfall. MM = millimeters. The rain gauge is factory-calibrated. See Section 4 (Accessories) for more information about the rain gauge. If you are not using a rain gauge, you would select NOT MEASURED for this step.

- If you choose not to measure rainfall, no more references to rainfall will appear in the rest of the program.

pH UNITS OF MEASURE
• pH • • NOT MEASURED •

pH measurement determines the relative acidity or alkalinity of a solution. You must have an **Isco pH Probe** (or approved equivalent) connected to the flow meter through the parameter port to sense pH. pH measurements range from 0 to 14 pH units, with solutions below 7 considered acidic and solutions above 7, alkaline. (Pure water has a pH of 7.)

These devices require periodic calibration for accurate sensing of pH. See Section 4 (Accessories) for more information about the pH probe. If you are not using a pH probe you would select NOT MEASURED for this step.

- If you choose NOT MEASURED for pH, no further references to pH will appear.
- If you select pH, you will be unable to measure D. O. and no more references to D.O. will appear in the program.
- If your situation requires the measurement of both parameters (pH and D.O.) at the same time, or if you also need to measure conductivity, use the YSI 600 Multi-Parameter Sonde.

If you select NOT MEASURED and press **Enter**, the following will appear:

```
D. O. UNITS
• MG/L •• PPM •• NOT MEASURED •
```

Measurement of dissolved oxygen is conducted in studies of water quality in lakes and streams. Some dissolved oxygen is necessary for the survival of aquatic life in these waters.

You must have an **Isco Dissolved Oxygen Probe** (or approved equivalent) to sense dissolved oxygen. The probe attaches to the Parameter Port. These devices require periodic calibration for accurate sensing. See Section 4 (Accessories) for more information about the dissolved oxygen probe. PPM = parts per million; MG/L = milligrams per liter.

If you are not using the D. O. probe, you would select NOT MEASURED for this step.

- Selection of NOT MEASURED will keep D. O. from appearing on subsequent programming menus.

Selection of PPM or MG/L will keep references to pH from showing up on subsequent menus.

```
TEMPERATURE UNITS
• DEG F •• DEG C •• (NOT MEASURED) •
```

This step sets up temperature measurement of the flow stream. You must have an **Isco Temperature Probe** attached to the flow meter's Parameter Port. The temperature probe contains a thermistor and needs no further calibration.

Measurement is in degrees Celsius or degrees Fahrenheit. If you are not using the temperature probe, you would select NOT MEASURED for this step.

- Selection of NOT MEASURED will keep TEMPERATURE from appearing in subsequent programming menus.

If you are using either the pH or D. O. probe, temperature *must* be measured; the NOT MEASURED option will not even appear.

2.6.7 The YSI 600 Multi-Parameter Sonde

The following series of menus concerns the use of the **YSI 600 Multi-Parameter Sonde**. This probe, allows you to measure several different characteristics of a flow stream at the same

time. The YSI 600 Sonde attaches to the Rain Gauge connector on the 4210. Note that this connector must be a special, modified connector with nine pins.

 **Note**

4210 Flow Meters with **4-pin Rain Gauge connectors** cannot support the YSI 600. It is necessary to return the flow meter to the factory for modifications if you wish to use a YSI 600 Sonde. In addition to the connector, significant internal modifications to the flow meter's electronics and software are required.

You can use both the YSI Sonde and a Rain Gauge on flow meters that support the YSI with a special Y-connect cable. Note that the YSI 600 Sonde differs from the previously-mentioned pH and D.O. probes. The YSI 600 can measure pH and D.O. at the same time, as well as temperature and conductivity.

If you are not using the YSI 600 sonde, select NO in the following display and the flow meter will advance to the next step. Otherwise, select YES.

YSI 600 CONNECTED
• YES •• NO •

- If you select NO, you will be unable to activate the YSI Sonde later in the program.

If no communication has been confirmed, the following display will appear:

YSI COMMUNICATIONS CHECK
• YES •• NO •

NO is the default. If you select YES, the following display will appear:

WARNING – DO NOT DISCONNECT POWER
YSI COMMUNICATION CHECK. PLEASE WAIT...

 **CAUTION**

The reason you should not disconnect either the sonde or flow meter power during a communications check is that the memory in the sonde can be damaged by a power failure during an update.

If the communication check is bad, the following display will appear:

COMMUNICATIONS CHECK FAILED
PRESS ENTER TO CONTINUE

Note

The flow meter cannot communicate at 600 baud. If your sonde has been set up for 600 baud, you will get a communications failure. Consult the YSI 600 Manual for what to do in this case.

If the communications check is good, the following display will appear:

```
COMMUNICATIONS RATE SET AT 2400 BAUD
PRESS ENTER TO CONTINUE
```

After you press Enter, the flow meter will advance to the following display:

```
YSI 600 pH UNITS OF MEASURE
• pH • • NOT MEASURED •
```

- Selection of NOT MEASURED from any of the YSI menus will prevent you from activating that function later in the program.

If you wish to make use of the YSI 600 sonde's pH measurement capability, select pH. If you do not, select NOT MEASURED.

```
YSI 600 D.O. UNITS OF MEASURE
• MG/L • • NOT MEASURED •
```

If you wish to make use of the YSI 600 sonde's D.O. measurement capability, select MG/L. Otherwise, select NOT MEASURED.

```
YSI 600 CONDUCTIVITY PARAMETER
• YSI SP COND • • YSI SALINITY • • YSI CONDUCTIVITY • >
```

For any of the YSI CONDUCTIVITY options, if you press **Enter**, the following display will appear:

```
TEMPERATURE COEFFICIENT
1.91%
```

This value is provided because conductivity rises (~2%/ °C) with temperature. The default setting is 1.91%. This value is the temperature coefficient for pure KCl (potassium chloride) in water. For other salts this value will be somewhat inaccurate, but it does provide a close approximation for solutions of many common salts, such as NaCl (sodium chloride), NH₄Cl (ammonium chloride) and sea water. If you use the value of 1.91, in most cases you will be able to identify that gross changes are occurring in the ionic content of the stream. If you move with the right arrow, the following options will appear on the display:

```
YSI 600 CONDUCTIVITY PARAMETER
• YSI T.D.S. • • NOT MEASURED •
```

T.D.S. stands for "total dissolved solids." T.D.S. are measured in parts per thousand (ppt).

```
TDS SCALE FACTOR
0.75
```

Total dissolved solids are estimated by multiplying conductivity by an empirical factor. This factor can vary between 0.55 and 0.9 depending on the solubility of the ionic components in the water and its temperature.

YSI 600 TEMPERATURE UNITS
• °F • °C • • NOT MEASURED •

Select the temperature units that are appropriate for your application.

2.7 Step 2 - Flow Conversion (Level-to-Flow)

If you select **step 2**, the following will appear:

FLOW CONVERSION TYPE
• WEIR/FLUME • • EQUATION • • MANNING • • DATA POINTS •

WEIR/FLUME = weir or flume; EQUATION = equation; MANNING = Manning; DATA POINTS = data points.

2.7.1 Weir/Flume Conversions

Select WEIR/FLUME and the following will appear:

TYPE OF DEVICE:
• WEIR • • FLUME •

For detailed information on weirs and flumes, refer to the *Isco Flow Measurement Handbook* that was shipped with your flow meter. Consulting the manufacturer of the specific weir or flume is also worthwhile. Note that for weirs and flumes, there is a preferred location for installing the level measuring device. Proper mounting of the level measurement device and accurate measurement of the level in the flow stream at the calibration point are essential for accurate flow calculation by the flow meter.

If you select WEIR, the following will appear:

SELECT TYPE OF WEIR:
• V-NOTCH • • RECTANGULAR • • CIPOLLETTI •

If you select V-NOTCH, the following will appear:

SELECT V-NOTCH WEIR ANGLE (IN DEGREES)
• 22.5 • • 30 • • 45 • • 60 • • 90 • • 120 •

If you select RECTANGULAR for of weir, the following will appear:

END CONTRACTIONS ON RECTANGULAR WEIR:
• YES • • NO •

If you select YES, the following will appear:

RECTANGULAR WEIR WITH END CONTRACTIONS
ENTER CREST LENGTH XX.XXX FEET (or meters)

If you select CIPOLLETTI for the type of weir, the following will appear:

CIPOLLETTI WEIR
ENTER CREST LENGTH XX.XXX FEET (or meters)

If you selected FLUME for the type of standard device, the following display will appear:

SELECT TYPE OF FLUME
• PARSHALL • • PALMER-BOWLUS • • LEOPOLD-LAGCO •

:Also available with the **arrow** key:

SELECT TYPE OF FLUME
• HS • H • HL • TRAPEZOIDAL

If you select PARSHALL for the type of flume, the following will appear:

SELECT PARSHALL SIZE:
• 1" • 2" • 3" • 6" • 9" • 1.0' • 1.5' • 2.0'

If you press the **right arrow** key several times, the sizes shown below will move onto the screen:

SELECT PARSHALL SIZE:
• 3' • 4' • 5' • 6' • 8' • 10' • 12'

If you select PALMER-BOWLUS for the type of flume, the following will appear:

SELECT PALMER-BOWLUS SIZE
• 4" • 6" • 8" • 9" • 10" • 12" • 15" • 18" • 21"

If you press the **right arrow** key several times, the sizes shown below will move onto the screen:

SELECT PALMER-BOWLUS SIZE
• 24" • 27" • 30" • 48"

If you select LEOPOLD-LAGCO for flume, the following will appear:

LEOPOLD-LAGCO FLUME SIZE
• 4" • 6" • 8" • 10" • 12" • 15" • 18" • 21"

If you press the **right arrow** key several times, the sizes shown below will move onto the screen:

LEOPOLD-LAGCO FLUME SIZE
• 24" • 30"

If you select HS for the type of flume, the following display will appear:

HS FLUME SIZE
• 0.4' • 0.5' • 0.6' • 0.8' • 1.0'

Select H for flume and the following will appear:

H FLUME SIZE
• 5' • .75' • 1' • 2' • 2.5' • 3' • 4.5'

Select HL for flume and the following will appear:

HL FLUME SIZE
• 2.0' • 2.5' • 3.0' • 3.5' • 4.0'

If you select TRAPEZOIDAL for the type of flume, the following will appear:

TRAPEZOIDAL SIZE
• LG 60 V • 2" 45 WSC • 12" 45 SRCRC

2.7.2 Equation

Returning to **step 2**, SELECT FLOW CONVERSION: If you select EQUATION, the following will appear:

```
ENTER EQUATION UNITS
Q = XXX.XXXH^X.XX + XXX.XXXH^X.XX
```

This step allows you to enter an equation that is appropriate for your flow situation. The equation is expressed in the general form of $Q = k_1H^{P_1} + k_2H^{P_2}$, where Q = flow rate, k1 = a constant, H = level or head, and P1 is the power to which H is raised. k2 and P2 are a second constant and power found in some equations. If your equation has only one term, you should enter 0 for the second constant.

2.7.3 Manning Conversion

Again returning to **step 2**, SELECT FLOW CONVERSION, if you select MANNING, the following display will appear:

```
SELECT MANNING TYPE
• ROUND PIPE •• U-CHANNEL •• RECTANGULAR •• T-
```

TRAPEZOIDAL is also available, if you move to the right with the right arrow key.

If you select ROUND PIPE for the Manning flow conversion, the following displays will appear:

```
MANNING ROUND PIPE
SLOPE = X.XXXXXX ROUGH = X.XXXX
```

Slope is entered as a dimensionless quantity, delta Y/ delta X, not as percent slope. Or, as otherwise expressed:

$$\frac{\Delta X}{\Delta Y} = \frac{\text{Rise}}{\text{Run}}$$

For example:

$$\frac{1}{100} = 0.01$$

Roughness coefficients are published in the *Isco Open Channel Flow Measurement Handbook*. You must know the material the pipe is made of. The roughness coefficients are published for all common materials in three grades: minimum, normal, and maximum. Then:

```
MANNING ROUND PIPE
DIAMETER = X.XXX FEET (or meters)
```

If you select U-CHANNEL for the Manning flow conversion, the following displays will appear:

```
MANNING U-CHANNEL
SLOPE = X.XXXXXX ROUGH = X.XXX
```

(Slope and roughness are entered as for ROUND PIPE.) Then:

```
MANNING U-CHANNEL
WIDTH = X.XXX FEET (or meters)
```


If you select RECTANGULAR for the Manning flow conversion, the following displays will appear:

```
MANNING RECTANGULAR
SLOPE = X.XXXXXX ROUGH = X.XXX
```

(Slope and roughness are entered the same as for ROUND PIPE.) Then:

```
MANNING RECTANGULAR
WIDTH = X.XXX FEET (or meters)
```

If you select TRAPEZOID for the Manning flow conversion, the following displays will appear:

```
MANNING TRAPEZOID
SLOPE = X.XXXXXX ROUGH = X.XXX
```

(Slope and roughness are entered as for ROUND PIPE.) Then:

```
MANNING TRAPEZOID
TOP WIDTH = X.XXX FEET (or meters)
```

Then:

```
MANNING TRAPEZOID
BOTTOM WIDTH = X.XXX FEET (or meters)
```

2.7.4 Data Points

Returning to **step 2**, FLOW CONVERSION TYPE, if you select DATA POINTS, the following will appear:

```
SELECT DATA SET
• ONE • TWO • THREE • FOUR • (NONE) •
```

Then:

```
LEVEL UNITS FOR DATA POINT ENTRY
• FT • IN • M • MM •
```

This allows you to enter data points that are in different units than you are using. Then:

```
FLOW RATE UNITS
• GPM • GPS • MGD • CFS • CFM • M3S • M3H • M3D •
```

If you press the **right arrow** key several times, the following units will appear on the display:

```
FLOW RATE UNITS
• LPS • CFD • GPH • AFD • CFH • CFM • M3M •
```

GPM = gallons per minute; GPS = gallons per second, MGD = million gallons per day, CFS = cubic feet per second; CFM = cubic feet per minute, M3S = cubic meters per second; M3M = cubic meters per minute; M3H = cubic meters per hour; M3D = cubic meters per day; LPS = liters per second; CFD = cubic feet per day; GPH = gallons per hour; AFD = acre-feet per day; CFH = cubic feet per hour.

Data Point flow conversion allows you to enter measured level and flow rate values for a number of different points. The 4210 Flow Meter can accept up to four sets of data points with each set containing as many as fifty points.

The flow meter then performs a three-point interpolation to calculate a flow rate appropriate for the data entered. The common use of data point flow conversion is with unusual primary measuring devices, specifically devices that the 4210 does not support in the WEIR/FLUME flow conversion set.

The level-to-flow rate data for such devices is usually available from the manufacturer. From this data, the flow meter can create a flow conversion based on the relationship between the level and flow rate.

After the FLOW RATE UNITS menu, the next menu is:

```
SET X (1-4): (0) POINTS ENTERED
• ADD POINT •• (UNITS) •
```

Then:

```
SET 1 DATA POINT 1
ENTER: 0.00 (level units) 0.000 (units of volume)
```

After you have entered the data point set, the following will appear:

```
SET X (1-4): XX (1-50) POINTS ENTERED
• (USE) •• EDIT POINT •• ADD POINT •• CLEAR •• PRINT •
```

UNITS, SAVE will also appear if you move the flashing cursor with the **right arrow** key. USE will only appear after four points have been entered. USE tells the flow meter that the set is complete and can be used for the flow rate calculation.

Select EDIT POINT if you need to change either the level or the flow value for a particular data point.

Select ADD POINT if you want to add another point to a data set.

CLEAR will erase an entire set of data points from the flow meter's memory.

PRINT will make the flow meter print out the entire data set.

UNITS allows you to set or change the units of measure used in the data set. Note that you can only set UNITS if the set is empty, or you have cleared it. You cannot change the units once you have entered data points into a set unless you clear it and start over.

SAVE tells the flow meter to save the data set as it is.

If you select either EDIT POINT or ADD POINT, the following display will appear:

```
SET X (1-4) DATA POINT XX (1-50)
ENTER: XX.XX (level units) XXX.XXX (volume)
```

2.7.5 Maximum Head

Before advancing from **step 2** (Flow Conversion) to **step 3** (Adjust Parameters), the flow meter will request that you enter a value for Maximum Head (Level) for the device or flow conversion you are using.

For most standard measuring devices, this information is published or is available from the device manufacturer. However, you should not arbitrarily use the largest value available. Instead,

use the value that is the largest *expected* level for your actual situation, even if this is less than the published maximum.

The flow meter's internal resolution and its accuracy are based on the value you enter for Maximum Head. The flow meter will display:

```
FLOW RATE AT MAXIMUM HEAD
X.XXX CFS (or other units of measure)
```

2.7.6 Programming the 4-20 mA Outputs

If you turn on any of the 4-20 mA outputs (ANALOG OUTPUTS) in **step 1 - Setup**, programming the actual operation of the output appears in **step 2 - Select Flow Conversion**.

Note

If you do not turn on the 4-20 mA output(s) in **step 1**, the menus determining its (their) operation will not even appear later in the program. If you need this function and cannot find the appropriate menus in **step 2**, return to **step 1, Setup** and check to see that you have not inadvertently switched the option off.

For each 4-20 mA output port turned on, the flow meter will request entry of the type of data that will drive the output, along with minimum and maximum values. Here is an example of what you might see for programming analog output 1.

```
DATA TYPE FOR ANALOG OUTPUT 1
• (OFF)•(LEVEL)•(FLOW RATE)•(pH)•
```

TEMPERATURE, DISSOLVED OXYGEN, CONDUCTIVITY, SPECIFIC CONDUCTANCE, SALINITY, and TOTAL DISSOLVED SOLIDS may also appear as driving conditions.

The actual choices available to you will depend on what ports you have turned on previously and what accessories (YSI, pH, DO probes, rain gauge, etc.) you are using with your flow meter. After you select one of the available choices, the flow meter will request that you enter minimum and maximum values for that choice:

```
ANALOG OUTPUT PORT 1
4 MA = X.X (units)
```

Note that 4 MA in the second line of the display could also be 0 MA if that is what you selected for the current loop minimum in Setup. The units available are the units of measure appropriate for the option you selected; for example, feet or meters for level, degrees F or C for temperature, mg./l for dissolved oxygen, etc. After you have set the minimum value for the port, the flow meter will request you to enter a value for full-scale, or 100%:

```
ANALOG OUTPUT PORT 1
20 MA = X.X (units)
```

This value causes the port to transmit 100% or 20 mA. For example, if the data type selected for this output were level, and the unit is measuring level in a four-foot pipe, you would enter a full-scale value of four feet. If the actual level reading is cur-

rently two feet, the analog output would read 12 mA (50% if the 4-20mA current range is selected) or 10 mA (50% if the 0-20 mA current range is selected).

The flow meter will then request that you repeat the process of defining the data type and setting the minimum and maximum values for any of the other analog ports you activated previously in Setup.

2.8 Step 3 - Parameter to Adjust

This step lets you enter the measured level in the flow stream. It also lets you calibrate the pH (acidity or alkalinity), D.O. (dissolved oxygen) parameter sensors, and the YSI 600 Multiple Parameter Sonde. There is no calibration step for the temperature sensor because it does not need calibration. When you select **step 3** the following will appear:

```
PARAMETER TO ADJUST
• NONE •• (LEVEL) •• (pH) •• (D. O.) •• (YSI 600) •
```

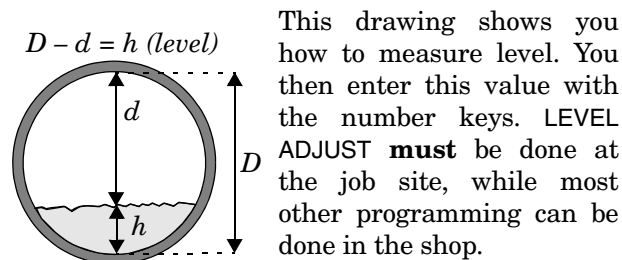
LEVEL will not show up if you are using the flow meter only for *parameter sensing*. Likewise, pH and/or D. O. and YSI 600 will not show up on the display if you have locked them out by programming selections you made in **step 1**.

Remember that selection of *either* pH or D. O. in **step 1** will keep the other from appearing on the display in this or subsequent programming steps. If the parameter you want does not appear in this menu, exit the program and return to Setup. Check to see that you have not accidentally locked your choice out with selections you made in the early section of the program.

If you select NONE, the flow meter will advance to the next step. If you select LEVEL, the following will appear:

```
ENTER CURRENT LEVEL
X.XXX FEET (or meters)
```

First, measure the level in the flow stream. This is usually done with a measuring stick, or you read the level from a scale that may be painted or printed on the side of the primary measuring device.



Note

It is *very important* to enter accurate measurements for both the level in the stream and the dimension(s) of the channel, as all calculations of flow will be based on these measurements. If the values entered are incorrect, even by relatively small amounts, all subsequent flow calculations will also be incorrect.

For example, an error of only $\frac{1}{4}$ " for a 3" level and $\frac{1}{4}$ " for a 10" diameter round pipe can result in a combined error of over 14%!

Errors in level measurement have a greater effect on flow calculations at low liquid levels. Dimensional errors tend to be more significant at higher levels.

Unless you have reliable information about the size of the channel, you should measure it.

If you select pH for port to adjust, the following display will appear. (pH will not appear as an option unless you have selected it in **step 1**.) If you want to measure pH and pH does not appear in this step, you must go back to **step 1** and select pH instead of NOT MEASURED.

```
pH CALIBRATION
• pH 4 & 7 •• pH 7 & 10 •• pH 4, 7, & 10 •
```

You can perform a two- or three-point calibration for pH with the pH sensor. Select the calibration that best suits your stream's profile. If the pH in your stream is generally below 7, you would probably select pH 4 & 7. If the pH is generally above 7, you would probably select pH 7 & 10. If your stream's pH varies a great deal, for example from 3 to 12, your best choice would be pH 4, 7, & 10. Then:

```
RINSE PROBE AND PLACE IN 4.0 pH SOLUTION
PRESS ENTER WHEN STABLE X.XX pH
```

The flow meter will direct you to repeat this process with the other standard buffers (7 and/or 10) to calibrate the pH sensor. If the probe fails to provide the correct output with any of the buffer solutions, you will receive the following message:

```
pH BUFFER/PROBE OUT OF RANGE
PRESS ENTER TO CONTINUE
```

If you select D. O. for port to adjust, the following display will appear:

```
DISSOLVED OXYGEN CALIBRATION
•D.O. STANDARD••ABS BAROMETRIC PRESSURE•>
```

ALTITUDE is just off screen to the right. If you select D.O. STANDARD for the calibration method, the following display will appear:

```
D.O. STANDARD
0.00 MG/L
```

If you select ABS (absolute) BAROMETRIC PRESSURE the following will appear:

ABS BAROMETRIC PRESSURE
X.XX mmHg

Absolute barometric pressure is barometric pressure *not* corrected to sea level. The barometric pressure published by the U.S. Weather Bureau is corrected to sea level. If you use their value, you must convert it to the absolute pressure for your altitude. You should use Weather Bureau barometric pressure only if you are at sea level, or are able to correct the Weather Bureau figure to absolute pressure at your location. Enter the value for barometric pressure.

WRAP D. O. PROBE IN MOIST CLOTH
PRESS ENTER WHEN STABLE: X.XX MS/CM:

Then the display will advance to the following:

CALIBRATING...
PLEASE WAIT...

If you select ALTITUDE for D.O., the following will appear:

UNITS FOR ALTITUDE ENTRY
• FT •• M •

Select the appropriate units and press **Enter**.

ALTITUDE
ALTITUDE = X.XX FT (*or meters*)

Enter the altitude for your location. Then:

WRAP D. O. PROBE IN MOIST CLOTH
PRESS ENTER WHEN STABLE: X.XXX MG/L

For more detailed information on the pH and D. O. probes, see Section 4.

Returning to **step 3**, Parameter to Adjust, the following display will appear:

PARAMETER TO ADJUST
• NONE •• (LEVEL) •• (pH) •• (DO) •• (YSI 600) •

NOTE

If you are using the YSI Sonde and YSI 600 does not appear on your display, return to step 1, Program, and make sure you have selected YES from the YSI CONNECTED menu.

If you select YSI 600, the following display will appear:

YSI 600 PARAMETER TO CALIBRATE
• NONE •• pH •• DO •• CONDUCTIVITY •

If you select pH for the parameter to calibrate, the following display will appear:

YSI 600 pH CALIBRATION
• pH 4 & 7 •• pH 7 & 10 •• pH 4, 7, & 10 •

You can perform a two- or three-point calibration for pH with the YSI sonde. The menus that follow are similar to those in the preceding section for the Isco pH sensor. Select the calibration that best suits your stream's profile. When you complete the pH calibration successfully, the following display will appear:

```
CALIBRATING...  
PRESS ENTER TO CONTINUE
```

Returning to the YSI menu, if you select D.O:

```
YSI 600 DISSOLVED OXYGEN CALIBRATION  
• D.O. STANDARD • • ABS BAROMETRIC PRESSURE •>
```

ALTITUDE is just off screen to the right. Programming for YSI 600 D.O. is essentially the same as that described for the Isco D.O. sensor on the preceding section, with the exception that you always place the sensor in a cup, rather than wrap a moist cloth around it, as is done for the Isco D. O. sensor.

If you select CONDUCTIVITY for the parameter to calibrate, the following display will appear:

```
CONDUCTIVITY CALIBRATION UNITS  
• MS/CM • • PPT •
```

MS/CM is milli-siemens per centimeter. The *siemen* is the S.I. (*Système Internationale*) name for the unit of conductance, which is also the reciprocal of the ohm. The siemen was formerly called the *mho* (*ohm* spelled backwards), and that term is more familiar to some. PPT is *parts per thousand*. Select the standard most suitable for your application.

```
CONDUCTIVITY STANDARD  
X.XX MS/CM
```

Then:

```
PLACE PROBE IN X.XX MS/CM  
PRESS ENTER WHEN STABLE: X.XX MS/CM
```

Then:

```
CALIBRATING...  
PLEASE WAIT...
```

If you select PPT for the conductivity standard:

```
CONDUCTIVITY STANDARD  
X.XX PPT
```

Then:

```
PLACE PROBE IN X.XX PPT  
PRESS ENTER WHEN STABLE: X.XX MS/CM
```

Then:

```
CALIBRATING...  
PLEASE WAIT...
```

There is no need to calibrate the YSI 600 temperature sensor, as it is self-calibrating.

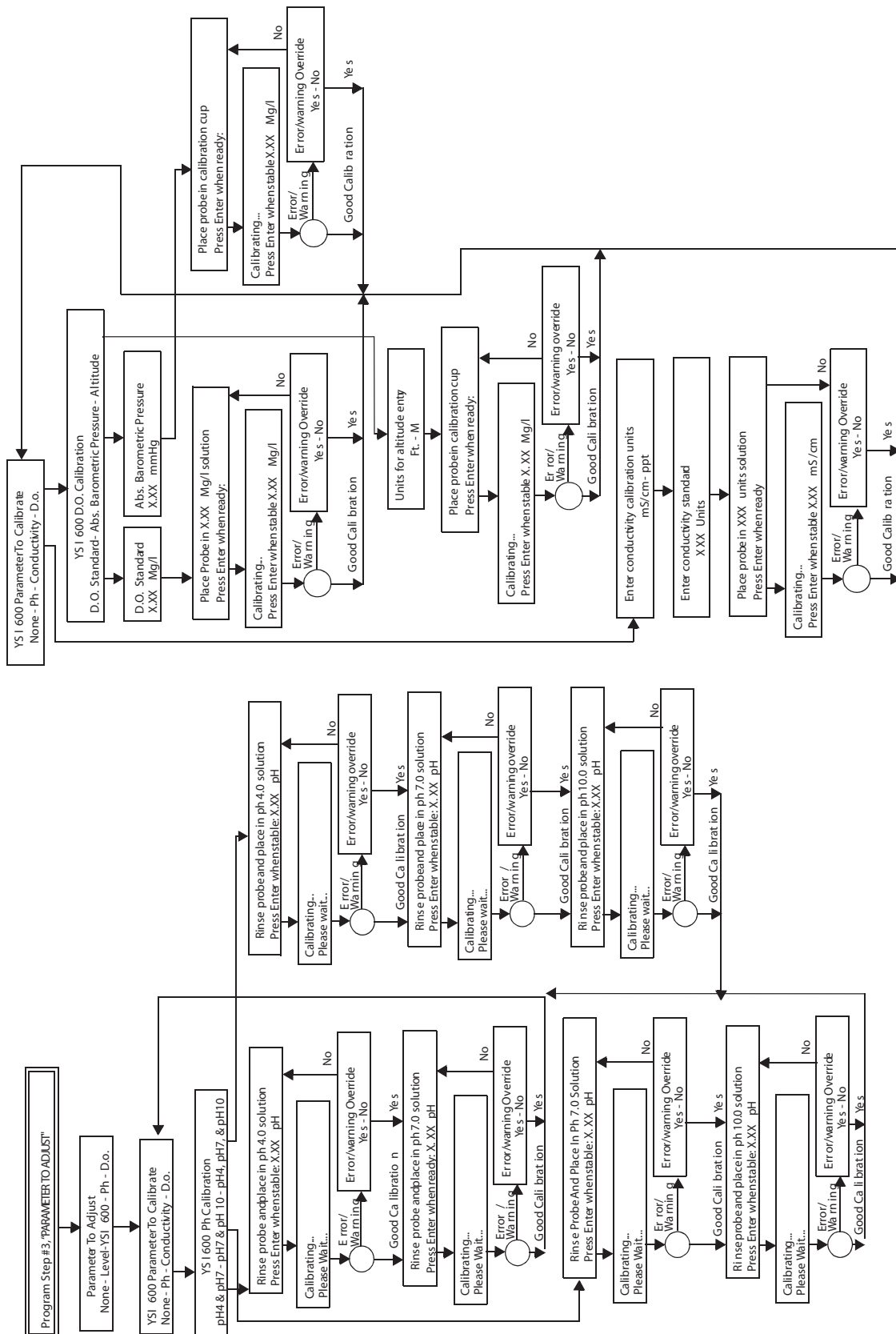


Figure 2-2 YSI 600 Sonde Calibration Flow Chart

2.9 Step 4 - Reset Totalizer

This step allows you to reset the flow meter's internal flow totalizer. The 4210 can *also* maintain a separate totalizer for the time the sampler is enabled through the sampler enabling feature (**step 6**). If you select **step 4**, the following screen will appear. If you select NO, the flow meter will advance to the next step. If you select YES, the flow meter will reset the internal totalizer to zero.

```
RESET TOTALIZER
• YES •• NO •
```

Then, if you have sampler enabling turned on (**step 6**), the flow meter will ask you whether you want to reset the totalizer for the total flow during the time the sampler was enabled. (See **step 6** for an explanation of sampler enabling.)

```
ENABLE TOTALIZER XX CF (or other units of measure)
PRESS 'ENTER
```

Then:

```
RESET SAMPLER ENABLE TOTALIZER
• YES •• NO •
```

2.10 Step 5 - Sampler Pacing

This step determines how the flow meter will signal an associated automatic wastewater sampler to take a sample. The flow meter and sampler must be connected together with a cable. The flow meter sends flow pulses to the sampler. The sampler uses these flow pulses as counts. When an appropriate number of flow pulses has been received by the sampler, it will take a sample. If you select **step 5**, the following will appear:

```
SAMPLER PACING
• DISABLE •• (VOLUME) •• (Flowlink) •• CONDITIONAL •
```

VOLUME will not appear if the flow meter is measuring level only, or is being used for parameter monitoring. The Flowlink menu option will not appear unless Flowlink software is installed and pacing has been downloaded from Flowlink.

If you select DISABLE for sampler pacing, the flow meter will be effectively disconnected from the sampler. The sampler will run its program independent of the flow meter. Selection of DISABLE will also cause the flow meter to advance to the next program step. If you select VOLUME for sampler pacing, the following will appear:

```
SAMPLER PACING
ENTER PACING VOLUME XX.XXXX CF
```

Other units of measure, as previously selected, may appear here. The range for pacing is max. flow ÷ by 100 (minimum) or 10,000 × max. flow (maximum.)

If Flowlink appears for sampler pacing, the operation of sampler pacing has been determined by choices made in Flowlink, Teledyne Isco's proprietary data acquisition and storage software. Flowlink controls the flow meter remotely, via phone lines and a modem, or locally with a laptop computer and cable. If the sampler pacing definition is controlled by Flowlink, it can only be changed through Flowlink.

If you select CONDITIONAL for sampler pacing, the following will appear:

CONDITION •(LEVEL)••(FLOW RATE)••(RAINFALL)••(D. O.)••(pH)•
--

(TEMPERATURE), (YSI pH), (YSI DO), (YSI CONDUCTIVITY) and (YSI TEMP) may also appear. Note that all the conditions shown above are in parentheses. Your previous programming selections determine which ones will actually appear. At least one of these menu options will be available to you. Pressing the **right arrow** key may be necessary to bring all items onto the display.

LEVEL will only appear if the flow meter is set up to measure level or flow.

RAINFALL, D. O., pH, and TEMPERATURE measurement require the appropriate sensor probe be used with the flow meter. Remember that only one parameter condition (D. O. or pH) can be measured by the flow meter at a time.

RAINFALL can appear if you have a rain gauge attached to the flow meter.

TEMPERATURE can be measured alone, or with either parameter probe.

D. O. and/or pH may not appear on the menu, depending on selections made in **step 1**. If you do not see the item you need, return to **step 1**, and recheck your programming. If you did not make the proper selections there, certain menu options will not appear here, as they would have been locked out.

The YSI 600 conditions of pH, DO, CONDUCTIVITY, and TEMPERATURE will only appear on the menu if you have turned them on in **steps 1 and 3**.

For any of these conditions, you can set the point at which change in the selected condition causes the flow meter to send a flow pulse to the sampler. The following menu will appear:

CONDITION •GREATER THAN••LESS THAN••RATE OF CHANGE•
--

If you select GREATER THAN, the flow meter will ask you to enter a maximum value for the selected condition which, if exceeded, will trigger the flow pulse.

If you select LESS THAN, the flow meter will ask you to enter a minimum value for the selected condition. If the condition falls below that value later, the flow meter will send a flow pulse to the sampler.

If you select RATE OF CHANGE, the flow meter will ask you to enter two values, one for the condition, and the other for a period of time over which the change occurs. After you have determined what condition will signal the sampler and under what circumstances, the following menu will appear:

SELECT OPERATOR •DONE••OR••AND•

SELECT OPERATOR allows you to trigger the sampler from a single condition or from two conditions. Suppose you wanted to trigger the sampler from only one condition, *level*. You would select LEVEL as the condition, and then identify what change in LEVEL would be the trigger. Then you would select DONE for the SELECT OPERATOR step. Selection of DONE will advance the flow meter to the next program step.

However, suppose you wanted to select *two* conditions, *either* of which would trigger the sampler. In this case, you would select OR for the SELECT OPERATOR step. The menu will return to the one listing the conditions. This will let you define the second condition. Now the flow meter will trigger the sampler when either condition changes.

Finally, suppose you had a situation where you wanted changes in *two* conditions to occur before you signalled the sampler. In this case, you would select AND for the SELECT OPERATOR step. Then you would define the second condition. Now the flow meter will signal the sampler only after *both* conditions have changed.

The next screen on the flow meter (after you have established the conditions for sampler pacing) will request the following. (Entering 0 sends no pulses):

```
CONDITION TRUE PACING INTERVAL
PACE EVERY X MINUTES
```

This option allows you to send flow pulses periodically to the sampler during the time the conditions you established for sampler pacing are being met. Then:

```
CONDITION FALSE PACING INTERVAL
PACE EVERY X MINUTES
```

This option allow you to send flow pulses periodically to the sampler during the time the conditions you established for sampler pacing are *not* being met. Again, entering 0 sends no pulses.

2.11 Step 6 - Sampler Enable

The operation of **step 6** Sampler Enable is similar to **step 5**, Sampler Pacing. The menus and options are similar. The difference is that where sampler pacing only causes the flow meter to send a momentary signal (flow pulse) to the sampler, sampler enabling actually controls an inhibit line to the sampler that can keep the sampler from running its program. Sampler enabling is useful where the sampler needs to remain idle for long periods of time, such as storm water runoff applications. When you select or advance to **step 6**, the following display will appear:

```
SAMPLER ENABLE MODE
• DISABLE •• ENABLE •• CONDITIONAL •• (STORM) •
```

(Flowlink) may also appear. The Flowlink menu option will not appear unless Flowlink software is installed.

DISABLE means that the sampler will be permanently inhibited by the flow meter. This condition will remain until you change it in this program step, or if you are using Flowlink, until it is over-

ridden by a command from Flowlink. Select the DISABLE option with care; it will make the sampler appear to be inoperative, and that could easily be misinterpreted as an equipment failure by someone not familiar with the programming of the flow meter.

ENABLE means that the sampler is permanently enabled, free to run its own program without any control from the flow meter. This condition will remain until you change this menu option, or until it is overridden by a command from Flowlink.

The STORM option will not appear unless you turned on rainfall measurement in **step 1**. STORM selection is what you use when you want to monitor storm water runoff.

STORM enabling is really a combination of conditions. First, enter a value for LEVEL in the flow stream. Second, enter a value for RAINFALL. Third, enter an amount of time over which the rainfall occurs. Finally, you enter a time since the last rainfall. You must have an Isco Rain Gauge, or approved equal, to measure rainfall. The following menus are the STORM sequence:

LEVEL GREATER THAN X.XXX FT (or other units of measure)
--

Followed by:

RAINFALL AMOUNT X.XX INCHES (or other units of measure)
--

Then:

RAINFALL TIME PERIOD • 15 MIN •• 30 MIN •• 1 HR •• 2 HR •• 4 HR •
--

If you press the **right arrow** key several times, the following times will appear:

RAINFALL TIME PERIOD • 6 HR •• 8 HR •• 12 HR •• 24 HR •• 48 HR •• 72 HR •
--

The intervals above are the periods of time over which the rainfall occurs. The amount of rain entered in the previous step and detected by the rain gauge must fall during the time interval chosen from this menu before the flow meter recognizes the event as a storm.

The next menu defines the interval that must pass *between* storm events.

TIME SINCE LAST RAINFALL DAYS: X (allowable entry of 1-7)
--

If you select CONDITION from SAMPLER ENABLE, the following will appear:

CONDITION • (LEVEL) •• (FLOW RATE) •• (D. O.) •• (pH) •
--

(TEMPERATURE), (RAINFALL), (YSI pH), (YSI DO), (YSI CONDUCTIVITY) and (YSI TEMP) may also appear. These conditions are all shown in parentheses, because they may or may not be available to you by the time you reach this menu. The

menus that do appear will depend on the flow meter type and selections made earlier in the program. At least *one* of the conditions will be available to you.

If you select LEVEL from CONDITION the following will appear:

```
LEVEL
• GREATER THAN • • LESS THAN • • RATE OF CHANGE •
```

After you select one of these options, the flow meter will request that you enter a value, for example if you selected GREATER THAN:

```
LEVEL
GREATER THAN X.XX FEET (or other units of measure)
```

Enter a maximum value for the selected condition, which if exceeded, will enable the sampler.

If you select LESS THAN, the flow meter will ask you to enter a minimum value for the selected condition. If the condition falls below that value later, the flow meter will enable the sampler.

If you select RATE OF CHANGE, the flow meter will ask you to enter two values, one for the condition, and the other for a period of time over which the change occurs.

After you have determined what condition will signal the sampler and under what circumstances, the following menu will appear:

```
SELECT OPERATOR
• DONE • • OR • • AND •
```

This step allows you to trigger the sampler from a single condition or from two conditions. Suppose you wanted to trigger the sampler from only one condition and that condition was LEVEL. You would select LEVEL as the condition, and then identify what change in level would be the trigger. Then you would select DONE for the SELECT OPERATOR step. Selection of DONE will advance the flow meter to the next program step. Selection of OR or AND will allow you to select another condition, and then determine whether both conditions are necessary for enabling (AND) or whether either condition will enable the sampler (OR).

If you select FLOW RATE:

```
FLOW RATE
• GREATER THAN • • LESS THAN • • RATE OF CHANGE •
```

You would select one of these options, and then enter a value, as for LEVEL, previously.

The rest of the menus will appear the same as they did for LEVEL and FLOW RATE. D. O., pH, TEMPERATURE, and RAINFALL all require activation in **step 1** and use of the appropriate sensor. Only one parameter condition (pH, D. O.) can be measured by the flow meter at a time. pH and D. O. cannot appear on the display at the same time.

It is possible to program the Sampler Enable option so that it operates in two different modes, **latching** and **non-latching**. To explain this, in the nonlocking mode the sampler will be enabled only as long as the condition that caused the enabling remains

outside of “normal.” If the enabling condition returns to “normal,” the sampler enable will turn off until the next time the condition goes outside of “normal.”

In the latching mode, the sampler will be enabled the first time the condition goes outside of normal and the sampler will remain enabled, regardless of any subsequent changes to the enabling condition. If this is the case, the following menu will allow you to reset the sampler enable feature. Note that this menu will not appear unless the condition necessary to enable the sampler has been met and the sampler is currently enabled.

WHEN ENABLE CONDITION IS NO LONGER MET
• DISABLE SAMPLER • • KEEP ENABLED •

Or.

ENABLE CURRENTLY LATCHED, RESET
• NO • • YES •

Select YES to reset the sampler enable feature; select NO to leave the sampler enabled.

PRINTER ON/OFF WITH ENABLE
• YES • • NO •

This selection allows you to turn the flow meter's internal printer on or off when the sampler is enabled from the flow meter. This allows you to conserve battery power and only print a chart when the sampler is enabled. This feature is useful for monitoring storm water runoff.

2.12 Step 7 - Alarm Dialout Mode

This step lets you signal an alarm to a remote location from the flow meter. The conditions that can cause an alarm are the same as described previously for sampler enabling.

Note

You must have the optional internal modem installed and connected to a telephone network to make use of this feature. This menu will not even appear if you do not have a modem. The flow meter will automatically advance to the next step.

More information about the modem can be found in Section 4.2. If you have the modem installed and select **step 7**, the following will appear:

ALARM DIAL OUT
• DISABLE • • CONDITIONAL • • STORM • • Flowlink •

If you select DISABLE, this option will be deactivated until you change the selection later. The program will advance to the next step. If you select STORM, the flow meter will request definitions similar to those for STORM in sampler enable. The following will appear:

LEVEL
GREATER THAN X.XXX FT (or other units of measure)

Followed by:

RAINFALL AMOUNT
X.XX INCHES (or other units of measure)

Then:

RAINFALL TIME PERIOD
• 15 MIN •• 30 MIN •• 1 HR •• 2 HR •• 4 HR •

If you press the right arrow key several times, the following times will appear:

RAINFALL TIME PERIOD
• 6 HR •• 8 HR •• 12 HR •• 24 HR •• 48 HR •• 72 HR •

The intervals above are the periods of time over which the rainfall occurs. The amount of rain entered in the previous step and detected by the rain gauge must fall during the time interval chosen from this menu before the flow meter recognizes the event as a storm. The next menu defines the interval that must pass *between* storm events.

TIME SINCE LAST RAINFALL
DAYS: X (allowable entry of 1-7)

If you select CONDITIONAL for alarm dialout, the following will appear:

CONDITION
• (LEVEL) •• (FLOW RATE) •• (D. O.) •• (pH) •

(TEMPERATURE), (RAINFALL), (YSI pH), (YSI DO), (YSI CONDUCTIVITY), and (YSI TEMP) may also appear. As mentioned previously, some of these menu options may not appear, depending on selections you made earlier in the program. At least *one* of the options will be available to you.

D.O., pH, TEMPERATURE, the YSI outputs, and RAINFALL all require activation in **step 1** and connection of the appropriate sensor to the flow meter. D. O. and pH will never appear together, as only one can be used at a time. When you have selected the condition you want, the display will advance to the following:

CONDITION
• GREATER THAN •• LESS THAN •• RATE OF CHANGE •

For these conditions, you enter an amount which if exceeded (GREATER THAN), or if dropped below (LESS THAN), or if changed too quickly (RATE OF CHANGE), will activate the alarm dialout. For RATE OF CHANGE, you enter two values: **amount** and **time over which change occurs**. Then the display will advance to the following:

SELECT OPERATOR
• DONE •• OR •• AND •

As described for sampler enabling previously, this step allows you to combine conditions to produce an alarm dialout signal. Select DONE if you do not need more than one condition to trigger the alarm.

If you want *either* of two conditions to trigger an alarm, select OR.

If you want *both* of two conditions to be met before signalling an alarm, select AND. Selection of DONE will advance you to the next display menu. Selection of OR or AND will return you to the CONDITION menu to select the other condition.

The flow meter will then request that you enter the telephone numbers for the remote alarms. There are five possible telephone numbers, in decreasing order of importance. You can enter as many as eighteen digits for each phone, so the remote targets need not necessarily be local. You can also use the decimal key (.) to insert a comma into the number, which enters a two-second delay. Entering multiple commas will increase the delay.

```
ALARM DIALOUT NUMBERS
• DONE •• NUM 1 •• NUM 2 •• NUM 3 •• NUM 4 •• NUM 5 •
```

If you select DONE, the flow meter will advance to the next step. If you select one of the NUM entries, such as NUM 1, the following will appear:

```
FIRST PHONE NUMBER
XXXXXXXXXX
```

You can enter the phone numbers as straight seven or ten-digit numbers, or you can use the +/- key to enter a dash as telephone numbers are often written.

If you want to signal more than one remote number at a time, the numbers are arranged in decreasing priority. NUM 1 carries the highest priority, followed by NUM 2 and so on. After you have entered the numbers, the flow meter will request:

```
DELAY BETWEEN DIALOUTS
XX MINUTES
```

This is the time delay between calling the first number and calling the second, etc. This option gives you time to respond to an alarm before the flow meter dials the next number. Select a value between 1 and 99 minutes. Then the display will advance to the following:

```
CALLBACK TO DISABLE ALARM
• YES •• NO •
```

Select YES if you want to be able to acknowledge the alarm condition in the flow meter by calling back. No message is spoken on this callback.

When the flow meter's modem detects the ring, it will answer and automatically reset the alarm. If there is no one available to answer an alarm, you can have the flow meter dial a paging service and then someone with a pager can call back to acknowledge the alarm.

To acknowledge an alarm from a touch tone phone; wait for the spoken message to complete; then press *-X-X-X. The X-X-X is the three digit site ID number.

2.13 Step 8 - Printer Setup

This step sets up the operation of the flow meter's internal printer. This printer also functions as a plotter. Note that the printer/plotter is capable of printing alphanumeric information (words and numbers), and at the same time, plotting linear data like flow, level, pH, etc.

The unit can print as many as three different data lines (named A, B, and C) at the same time it regularly records other printed information supplied from the flow meter. Program selections made in this step will determine the appearance of the printer/printer's chart.

The first menu will request the speed of the chart.

```
ENTER PRINTER SPEED
• OFF •• 1/2"/HR •• 1"/HR •• 2"/HR •• 4"/HR •
```

If you select OFF, the printer will be disabled. No data will be printed on the chart. The flow meter will, however, still print reports if you activate that function in **step 9**. The choice made from the other speeds depends on the amount of data you need to record on the chart.

If you are recording from a stable situation and are using only one data line, and you want to achieve maximum life for the roll of chart paper, you would select a lower speed for chart advance.

On the other hand, if there is a great deal of activity in your flow stream, and you need to use all three data lines, selection of a faster chart speed will probably produce a chart that is more easily read and interpreted.

After you select the printer speed, the flow meter will ask you to define what parameter input you want represented by **Printer Line A**. The following display will appear:

```
INPUT FOR PRINTER LINE A
• (LEVEL) •• (FLOW RATE) •• (pH) •• (D. O.) •• OFF •
```

(TEMPERATURE), (YSI pH), (YSI D.O.), (YSI CONDUCTIVITY), and (YSI TEMP) can also appear. Remember that menus in parentheses may or may not appear due to previous program selections. Either pH or D. O. may appear, but not both.

The various YSI options will only appear if you have enabled the YSI 600 option in **step 1**. You must have the appropriate probes to sense these conditions for the flow meter. Select OFF if you do not wish to use this line.

If you select pH, D. O., TEMPERATURE, or any of the YSI options, the flow meter will request that you set limits that will serve as the bottom of the chart and the chart full-scale.

```
PRINTER LINE A BOTTOM SCALE
X.XX pH (or other condition, as selected previously)
```

You would enter here the lowest pH value you expect to see in your flow stream:

```
PRINTER LINE A FULL SCALE
X.XX pH (or other condition, as selected previously)
```

Here, enter the highest pH value you expect to see in your flow stream. Selection depends on the range that you would normally see. If your stream varies from 6 to 8 pH units, you would not want to enter 0 and 14 as limits. The chart resolution would be poor. You could enter 5 and 9 pH and still have good resolution if there were sharp deviations because of the availability of **over-ranges**.

Selection of OFF from the INPUT FOR PRINTER LINE menu will cause the printer to leave this line blank. Selection of conditions other than pH, D.O., TEMPERATURE, or YSI-functions will result in a request that you enter the full-scale value for the condition being plotted. For example, if you selected LEVEL as a condition, the following would appear:

```
PRINTER LINE A FULL SCALE
X.XXXX FEET (or other units of measure, as selected)
```

The flow meter will automatically go into **over-range** if the data goes higher than the full-scale value you have selected. You can easily recognize over-range operation by the plotted line running off the right side of the chart and then immediately reappearing on the left side of the chart. Because of the over-range feature, you can set a full-scale value that gives you good resolution on the chart.

At the same time, the automatic over-range will prevent the loss of recorded data if the plotted line rises past the full-scale point. For the other parameters, the full-scale units will be appropriate for what is being measured (D.O., pH, temperature, etc.) the flow meter is capable of multiple over-ranges.

```
INPUT FOR PRINTER LINE B
•(LEVEL)••(FLOW RATE)••(pH)••(D.O.)••OFF•
```

(TEMPERATURE), (YSI pH), (YSI D.O.), (YSI CONDUCTIVITY), and (YSI TEMP) may also appear.

Again, just as for line A, you can select another parameter to plot on the chart. The flow meter will request a full-scale value. The full-scale value can be different than that entered for line A.

```
INPUT FOR PRINTER LINE C
•(LEVEL)••(FLOW RATE)••(D.O.)••(pH)••OFF•
```

(TEMPERATURE), (D. O.), (YSI pH), (YSI D.O.), (YSI CONDUCTIVITY), and (YSI TEMP) may also appear.

For line C, you can select a third parameter to plot on the chart. The flow meter will also request entry of a full-scale, or bottom and full-scale values.

```
PLOT RAINFALL ON CHART?
•NO••YES•
```

You must have an **Isco 674 Rain Gauge** or equivalent connected to the flow meter to measure rainfall. Output is recorded in either inches or millimeters. Note that there is only one over-range for rainfall.

2.14 Step 9 - Reports/History

This step lets you set up the flow meter to print periodic reports. The typical report contains such information as the period of time covered in the report, maximum and minimum levels, and when they occurred. You can define two different reports in this step. For example, this is used to provide weekly and monthly reports. You can choose the content of the reports by working through the menus in **step 1**. When you go to **step 9** the following will appear:

```
REPORT GENERATOR A
• ON •• OFF •• (PRINT) •
```

If you select OFF, the program will advance to the next step, and there will be no report A generated. If you select YES, the following will appear:

```
REPORT A DURATION TO BE IN
• HOURS •• DAYS •• MONTHS •
```

After you select the units of time, the following will appear:

```
ENTER REPORT A DURATION
XX HOURS
```

DAYS or MONTHS could also appear, depending on what you selected for the previous step. The time selected becomes the time interval that will be covered in the report. Then, the flow meter will ask you when you want the first report printed:

```
PRINT REPORT A AT
YR: XXXX MONTH: XX DAY: XX HR: XX MIN: XX
```

Then:

```
REPORT GENERATOR B
• ON •• OFF •• (PRINT) •
```

The second report generator lets you program the flow meter to print another report at a different time interval. This is useful, for example, if you needed both a weekly and a monthly summary of flow meter activity.

If you select OFF for this step, the program will advance to the next step, and there will be no report B generated. If you select YES, the following will appear:

```
REPORT B DURATION TO BE IN
• HOURS •• DAYS •• MONTHS •
```

Select the appropriate interval for this second report. After you select the units of time, the following will appear:

```
ENTER REPORT B DURATION
XX HOURS
```

DAYS or MONTHS could also appear, depending on what you selected for the previous step. The time selected becomes the time interval that will be covered in the report. Then, the flow meter will ask you when you want the first report printed:

```
PRINT REPORT A AT
YR: XXXX MONTH: XX DAY: XX HR: XX MIN: XX
```

After you have entered the desired date and time for the first report, the program will advance to the following:

```
PRINT FLOW METER HISTORY
• YES •• NO •
```

The final programming choice is HISTORY. This presents a record of the programming activity on the flow meter that you can have printed by the plotter. The flow meter keeps a record of certain programming changes and prints them out. If you select YES, the following will appear:

```
PRINT FLOW METER HISTORY
• PRINT SINCE LAST •• PRINT ALL •
```

If you press PRINT SINCE LAST, the flow meter will only print the changes that have occurred since the last print request. If there were no changes, there will be no print. If you select PRINT ALL, the flow meter will print all the changes it has in memory, as far back as fifty entries.

If you selected NO from PRINT FLOW METER HISTORY, the flow meter will advance to CLEAR HISTORY - YES/NO.

If you select NO again, the flow meter will exit programming and return to the normal display. If you clear the memory, previous programming changes will be erased, but the flow meter will begin tracking changes again the next time you change the program.

Flow Meter History Contents:

D. O. ADJUSTED
pH ADJUSTED
LEVEL ADJUSTED
FLOW CONVERSION CHANGED
PLOTTER SPEED CHANGED
PLOTTER TURNED ON
PLOTTER TURNED OFF
TIME CHANGE FROM
TIME CHANGE TO
REPORT A CHANGED
REPORT B CHANGED
REPORT A TURNED ON
REPORT B TURNED ON
REPORT A TURNED OFF
REPORT B TURNED OFF
TOTALIZER RESET
INTERROGATED
SAMPLER ENABLED
SAMPLER DISABLED
ALARM ACKED BY #X
ALARM NOT ACKNOWLEDGED
YSI pH ADJUSTED
YSI D.O. ADJUSTED
YSI CONDUCTIVITY ADJUSTED

4210 Flow Meter

Section 3 Installation

This section of the manual tells you how to install the 4210 Flow Meter. There is also information on mounting methods, interconnection wiring, and the setup procedure.

3.1 Preparation for Use

Teledyne Isco ships the flow meter with a roll of paper installed and a default program entered into memory. You should familiarize yourself with the programming procedure and practice working through the program steps, so you become comfortable with programming the unit. With the exception of setting the level, you can program the unit in the shop, rather than on the job site, if you want. This is a good idea as it will minimize the possibility of dirt and contamination getting inside the flow meter.

3.1.1 Opening the Case

To access the flow meter keypad and internal plotter, you must open the case. Do this by unlatching the two catches on the right side of the flow meter cabinet (as you face it) and opening the lid. Keep the flow meter lid closed and latched whenever possible. This will protect the internal components from dirt and moisture, and will prolong the life of the desiccator.

3.1.2 Desiccant Canister Installation

If the unit is new, at this time you should install the desiccant canister. It is provided in the accessory package and looks like a small, flat can with little holes in it. Open the flow meter case lid. Note the small clamp that resembles a bottle cap opener located near the bottom right-hand corner of the case lid. Install the desiccant canister by pressing it under this bracket, with its viewing window lined up with the circular hole in the bracket. Make sure the clamp is fully engaged over the canister. The particles inside the desiccant window should be blue. If the particles are pink, the desiccant is saturated and you will need to regenerate the canister before using it. If the unit has been in use and has been returned for reprogramming, you should clean it and inspect it as outlined in Section 5 of this manual.

CAUTION

Do not operate the flow meter with a saturated desiccant canister or with the door left open. Dust and moisture will settle inside and cause damage that can eventually damage the unit seriously. For maximum equipment life, inspect the desiccant canister regularly and regenerate it when necessary. Keep the lid closed and latched unless you are programming or servicing the flow meter.

The case and door have a seal between them and you should keep the door closed and latched to protect the flow meter mechanism. A case left open will defeat the purpose of the seal by causing the desiccant canister to quickly saturate with moisture. Dust will also begin to settle inside the case. Dust will wear the moving parts of the plotter prematurely. Many flow meters are installed in damp environments. Moisture and fumes dispersed inside the case can form acids that will corrode the electronics, causing unreliable operation and eventual circuit failure.

3.2 Connection to a Power Source

The 4210 requires a 12 volt, direct current (12 VDC) power input. This power may come from various sources.

- Isco Automatic Wastewater Sampler
- Isco rechargeable battery attached to the flow meter (nickel-cadmium or lead-acid)
- Isco AC Power Supply attached to the flow meter
- From an external 12 VDC battery, such as a deep-cycle marine, or RV type

3.2.1 Low Power Indication

When power to the flow meter falls too low for the unit to operate properly, the message POWER LOST/LOW BATTERY will appear on the top line of the display. When power is lost or falls below operating limits, the flow meter will stop accumulating data, and the internal printer will not print, but the internal battery-backed RAM will save stored data (if any) and the program selections for the flow monitoring program you have entered into memory.

3.2.2 Isco Sampler

If you are using the 4210 Flow Meter with an Isco Wastewater Sampler in a flow-proportional sampling system, you can power the flow meter from the sampler's battery or power supply. Connect the flow meter to the sampler with the 6-pin flow meter-to-sampler cable. Use the connectors marked "Flow Meter" on the sampler and "Sampler" on the flow meter. The flow meter will then receive power from the sampler. Keep in mind that under certain conditions, such as a "fast" setting on the internal printer's chart speed, the flow meter will draw a significant amount of power from the sampler. While this is no problem for samplers and flow meters powered by an AC power pack, there could be problems when you are using a battery. In that case, it would be preferable for the flow meter to have its own battery.

Note

Do not attempt to run a sampler from a power source installed on a flow meter. The sampler's pump draws heavy current, particularly on start-up. The connect cable cannot carry such currents. If you are using a single power source, always install it on the sampler.

3.2.3 Isco Nickel-Cadmium Battery

Teledyne Isco offers a 4-ampere-hour 12-volt rechargeable nickel-cadmium battery to power the flow meter. Teledyne Isco packages this battery specifically for use with Teledyne Isco flow

meters and samplers. Refer to the *Power Products Guide* accompanying this manual for detailed information about this battery and the procedure for charging it.

Install the battery on the top of the flow meter case, and attach its connector to the 12 VDC connector on the side of the flow meter. Place the battery with its cable pointing toward the right side of the cabinet. Secure the battery by stretching the two rubber draw catches on top of the flow meter until they slip over the two metal “U” brackets mounted on the ends of the battery case. Then screw the battery connector into the top mating connector on the right side of the flow meter case.



Figure 3-1 Battery Installed on Flow Meter

3.2.4 Isco Lead-Acid Battery

Teledyne Isco also offers a 6.5 ampere-hour 12-volt rechargeable lead-acid battery to power the flow meter. This battery is similar in size to the nickel-cadmium battery, except somewhat taller, reflecting its 50% greater capacity.

The lead-acid battery installs the same way as the nickel-cadmium battery. Place the battery on top of the case and secure it with the rubber draw catches. Attach the connector to the flow meter. If your flow meter is permanently installed, you may need to allow extra clearance above the flow meter for the slightly greater height of this battery.

For those familiar with nickel-cadmium batteries, operation and maintenance of lead-acid batteries differs somewhat. Fewer charge-discharge cycles are possible, and a single deep discharge can ruin a lead-acid battery. While nickel-cadmium batteries show essentially the same voltage throughout discharge, there is a linear voltage decrease as the lead-acid battery discharges. Failure to recharge promptly can also ruin the battery. Proper operation is necessary for normal service life. For detailed information, on these batteries, refer to the *Power Products Guide*. Read the *Guide* if you intend to use lead-acid batteries on your flow meter.

 **CAUTION**

Do not test either battery for its charge condition by “sparking” the output (shorting the terminals together with a screwdriver or other tool), as serious damage to the batter can occur.

3.2.5 AC Power Supplies

Teledyne Isco also offers two different AC power supplies: the High Capacity Power Pack and the Battery-Backed Power Pack to power the flow meter. These power supplies are designed for operation from 120 VAC, 50/60 Hz commercial power sources. Alternate versions, designed for operation from 240 VAC, 50/60 Hz, are also available and are intended primarily for export. Both are supplied with a line cord for convenient attachment to the AC power source, and are capable of operating the flow meter. The Battery-Backed Power Pack provides 12 VDC at 5 Amps, and is backed up by a 1.2 Ampere-hour nickel-cadmium battery. This is built in a package the same size as the standard power supply, and is intended for use where short-term power interruptions are frequent but unacceptable for flow meter operation.

Mount the power supply on top of the flow meter cabinet the same as described for the battery. Secure the power supply with the two rubber draw catches pulled over the brackets on the ends of the case. Attach the short cable with the smaller connector to the top connector on the right side of the flow meter case. Connect the longer cord with the plug on it to an AC outlet. Refer to the *Power Products Guide* for details concerning charging the batteries with the power pack.

3.2.6 External 12 Volt Direct Current Source

You can also power the flow meter from an external 12 VDC source, such as an automotive, motorcycle, or marine battery. Many people have found that a deep-cycle marine/RV battery is particularly well-suited to this application. However, you will have to mount batteries of this type separately, as they are too large to fit on top of the flow meter. Teledyne Isco offers a special optional connect cable to power the flow meter from a separate battery.

Mount the battery securely in an upright position, so it will not tip over, or have its cable easily pulled off. As advised previously for the nickel-cadmium battery, do not check the charge condition of lead-acid batteries by “sparking” the output cables (momentarily shorting the wires together).

 **CAUTION**

Be sure of proper polarity before attaching clips to the battery. Never connect the flow meter to a source of unknown polarity or voltage. If in doubt, check with a reliable DC voltmeter. Never connect the flow meter directly to an AC power source of any voltage under any circumstances. Charge the battery in accordance with the manufacturer's instructions.

3.3 Flow Meter Mounting and Installation Procedures

Because the 4210 Flow Meter is a portable device, it may or may not be permanently installed. You can suspend the flow meter in temporary installations, such as sewers, or mount it permanently in other installations, such as treatment plants.

3.3.1 Carrying Handle

To assist in transporting or suspending the flow meter, a handle is provided in the instrument's accessory package. To install the handle, snap the handle latches into the two brackets at the top of either side of the flow meter case.



Figure 3-2 4210 Suspended by Handle (handles may vary)

3.3.2 Installation Location

Because it uses an ultrasonic level sensor, the 4210 Flow Meter does not have to be mounted directly above the primary device, or even close to the flow stream. You can install the flow meter itself at a convenient, protected location and route the sensor cable to the place where the level sensor is mounted. For example, the flow meter may be mounted above the surface of the ground for protection and easy accessibility, and then the manhole has to be entered only once, for ultrasonic level sensor installation and calibration.

The standard cable length for the ultrasonic level sensor is 25 feet. A 25-foot extension cable is available that will extend this distance to 50 feet. You can order an extension cable that will be custom-built in lengths up to 1,000 feet. This is not a standard product. Operation of the ultrasonic level transducer beyond 1,000 feet is not recommended.

The 4210 does not have any special requirements for mounting. It may be located on any relatively flat surface either horizontally, supported by the two mounting pads and the stainless steel mounting bracket, or vertically, supported by the two plastic rails on the bottom of the case. The flow meter may also be panel mounted, using the mounting bracket on the top rear of the case or suspended from a ladder rung or hook using the optional suspension harness. To use the suspension harness, the carrying handle should first be installed on the flow meter as described above. Then slip the loops on the ends of the harness cables onto the handle hooks. The flow meter may now be suspended using the harness.

3.3.3 Safety Considerations

In field installations of 4210 Flow Meters and associated equipment, the safety of the personnel involved should be the foremost consideration. No project is so important or deadline so critical as to justify the risk of human life. Refer to the sections on working safely in manholes and avoiding hazardous gases; these sections are found at the back of this manual.

 WARNING
--

The 4210 Flow Meter has not been approved for use in “hazardous locations” as defined by the National Electrical Code.

3.4 Error Factors

It is possible for the ultrasonic measurement system to be in error due to the influence of various factors on both the initial pulse and reflected sound wave. It is important that you understand these factors and take them into consideration when planning an installation. Proper installation will result in more accurate measurement.

The factors affecting the ultrasonic system may be grouped broadly into two classes:

3.4.1 Velocity Errors

These errors occur when the flow meter is unable to accurately calculate the velocity of sound. Without going into the cause, it may be said that they are proportional errors, in that the error increases as the distance between the ultrasonic level sensor and the liquid surface increases.

3.4.2 Echo Detect Errors

These errors come from problems the flow meter may have measuring the time between transmitting the ultrasonic pulse and receiving the echo. Anything that can absorb the sound causes these errors. This makes the echo amplifier detect the returned signal either later or earlier than intended by the design of the ramp-gain amplifier. These errors will generally be of an absolute nature; they will not be affected to any extent by the distance between the transducer and the water.

3.4.3 Error Factors and Flow Meter Compensation

Following are specific factors affecting the accuracy of the 4210 Flow Meter and the measures provided for compensation of the more significant factors.

Beam Angle – The flow meter must only respond to surfaces within a specific area. The transducer can only “see” items inside a cone whose apex (point) is the ultrasonic transducer. The beam angle is the angle across this cone. If the beam angle is too wide, the flow meter will detect unwanted surfaces, such as the walls of the channel. If the beam angle is too narrow, setup of the installation is difficult and the flow meter may never detect an echo. The 4210 uses a beam angle of 12°.

Humidity – The velocity of sound varies only slightly with humidity (maximum 0.35% at 68° F). Because the effect is small, the 4210 does not provide any compensation for humidity. Humidity, however, does have an effect on the reduction of the sound. Under conditions of extremely high or low humidity, the reduction of the sound wave may be inconsistent with the characteristics of the ramp-gain amplifier. This can cause an echo detect error.

Noise – Background noise can interfere with the operation of the flow meter. You must filter this noise out, or the flow meter may trigger on noise rather than the echo. The 4210 uses a tuned circuit to filter unwanted noise outside the operating frequency. Noise in the operating frequency range (around 40 kHz) can render the system unstable. Software algorithms eliminate most sporadic noise pulses occurring within the flow meter's operating frequency range.

Surface Objects – Objects or foam floating on the surface of the flow stream can absorb or weaken the ultrasonic pulses. If the pulses are reduced enough there will be no echo. In less severe cases, the flow meter may experience an echo detection error.

Temperature – The velocity of sound at a given temperature may be approximated by the following equation:

$$\text{Velocity} = \sqrt{1050 \times (1 + \text{Temperature} / 459.67)}$$

...Where Velocity is in feet per second and Temperature is in degrees F.

Temperature changes have a significant effect on the velocity of sound (approximately 7% between 32° and 104° F). Consequently, the 4210 provides temperature compensation. There is a temperature sensor embedded in the housing of the ultrasonic level sensor. However, the temperature of the transducer, level sensor, and air may not be exactly the same, and the temperature sensor cannot measure temperature perfectly. As a result, the equations used to calculate the velocity of sound in air are approximations, including the equation shown above.

Waves – Waves on the surface of the flow stream can deflect the sound energy so it does not return to the transducer. Waves can also cause the sound to return to the transducer by an indirect path. In the first case, the flow meter will not receive an echo; in the second case, the additional time lapse will cause an echo error, indicated by an incorrect level reading. The 4210 employs a

software algorithm to reject occasional readings that deviate substantially from normal. However, if the waves are severe, the flow meter will not function and will indicate a “no echo” condition.

Wavelength – You can determine the wavelength of sound by dividing the velocity of the sound by the frequency. The frequency of the 4210 is about 40 kHz. The length of a 40 kHz sound wave is found by dividing 1,125 by 40,000 which is 0.02815 feet or 0.3378 inches.

Under ideal conditions it is possible to detect the same wave front of the returning echo. However, any noise or abnormal attenuation (excessive decrease) may cause the flow meter to detect an earlier or a later wave. When the attenuation of the returned echo does not match the gain slope of the amplifier, the circuit will eventually detect a different cycle of the returned echo as the distance changes. The impact of this wave-detect error is determined by the wavelength. Higher frequencies (shorter wavelengths) produce smaller echo-detect errors. However, higher frequencies are absorbed more rapidly, decreasing the maximum distance that you can measure with the same amount of power. The frequency of 40 kHz was selected for the 4210 as a suitable compromise.

Since the sound travels the distance twice (going and coming), the observed error is one-half of the wavelength or 0.014 foot. The 4210 uses a rectified detect circuit that can detect either the positive or negative peak. This allows the flow meter to limit the error of proper wave detection to increments of one-half wavelength. This error is 0.007 foot.

Wind – Wind can blow the sound away or significantly reduce the intensity of the returned echo. Narrow beam angles, advantageous for measuring small flow streams, are a disadvantage in this situation. Likewise, greater distances to the surface of the flow stream are more affected by wind.

Obviously, some of these factors have significant impact on the accuracy of the 4210 Flow Meter. You should make installations with care.

3.5 Accessories

Accessories used in sensor installation are described below. For ordering information, see Appendix A.2.

Spreader Bar – The Spreader Bar is an expandable pipe for suspending equipment inside a manhole. Outward spring pressure secures it against the manhole walls, like a shower curtain rod. You then suspend the 4210 from the bar.

Ultrasonic Cable Clamp – The cable clamp is used with the Spreader Bar to secure the mounting of the sensor.

Ultrasonic Wall Mount Bracket – This device lets you install the ultrasonic level sensor on a convenient nearby wall over a flow stream, such as the side of a bridge, or other structure.

Ultrasonic Floor Mount – The Ultrasonic Floor Mount is a collapsible metal stand that you set up at the bottom of a manhole over a flow stream. This device provides a stable mounting for the level sensor for temporary or permanent installations.

Ultrasonic Cable Straightener – The cable straightener is designed for use in installations where the transducer is suspended by its cable only, such as from the Spreader Bar. The straightener helps hold the transducer vertically plumb, thereby stabilizing alignment.

Ultrasonic Calibration Target – This option is designed to make calibration of the level sensor more accurate during the installation process by letting you calibrate the level sensor from outside the manhole.

Ultrasonic Sunshade – The ultrasonic sunshade is a white plastic cap that fits over the top of the ultrasonic transducer. Its purpose is to keep sunlight from heating the body of the level transducer and introducing temperature errors to the internal temperature compensation.

Extension Cable – Teledyne Isco offers a 25 foot (7.6 m) extension cable to connect to the ultrasonic level sensor. Do not attempt to cut or splice cable lengths. Coil any extra cable neatly by the flow meter. The level sensor is supplied with a 25 foot cable, so with the extension you can mount the level sensor as far as 50 foot (15.2 m) from the flow meter. Other lengths of cable can be ordered, up to 1,000 feet, but this is a custom product. For special lengths of cable, consult the factory. The maximum distance between the level sensor and the flow meter is 1,000 feet.

3.6 Ultrasonic Level Sensor: Mounting Considerations

The location of the ultrasonic level sensor depends on the method of level-to-flow rate conversion you are using. The 4210 is usually installed with some type of primary measuring device, such as a weir or flume. The location of the ultrasonic level sensor over the primary device depends on the type of primary device used. Most primary devices have a specific place intended for the head (level) measurement device. For example, the head measuring point of a weir is at least three times the expected maximum head upstream from the weir plate. For Parshall flumes, the measuring point is $\frac{1}{8}$ of the way into the converging section. For Palmer-Bowlus flumes, the measuring point is at least $\frac{1}{2}$ pipe diameter upstream from the entrance to the flume. Refer to the

Isco Open Channel Flow Measurement Handbook or to information provided by the manufacturer of the primary device for more details about the location of the head measuring point.

3.6.1 Mounting Location

If you intend to measure flow by some other means, such as a gravity flow equation (Manning) or by calibrating a section of the flow channel, you will have to determine the location of the ultrasonic level sensor. You should base this location on the hydraulic characteristics of the site and the method of level-to-flow rate conversion used.

Note

In open channel installations, where flow may exceed one-half of full pipe, you must place the transducer as close as possible to the midpoint between the pipe entrance and exit of the U-Channel to ensure sensing over the least turbulent flow.

3.6.2 Dead Band

Mount the ultrasonic level sensor as close to the maximum expected level as possible. This minimizes many of the undesirable characteristics of ultrasonic distance measurement. However, you must mount the ultrasonic level sensor at least one foot higher than the maximum expected level. This is a result of the one foot *dead band* directly below the level sensor where no measurements can be taken.

Note

4210 flow meters shipped June 2004 and later have a dead-band of **1 foot**. 4210 flow meters shipped before June 2004 have a deadband of **2 feet**, unless they have been modified.

3.6.3 Accidental Submersion

Since both ends of the ultrasonic level sensor are completely sealed, temporary submersion in the flow stream should not cause any harm, if that should accidentally happen. However, you should avoid prolonged submersion. You should also realize that submersion will keep the level sensor from working, even if it is not damaged. Prolonged submersion or submersion in dirty or greasy flow streams may cause the surface of the transducer to become coated with solid matter. This could cause it to malfunction until it is cleaned. If possible, mount the ultrasonic level sensor high enough above the flow stream to avoid submersion under normal circumstances.

3.6.4 Mounting the Sensor

You can mount the ultrasonic level sensor over the flow stream in various ways. It is up to you to determine which method best fits the application. Mounting examples are shown in the illustrations. The ultrasonic level sensor has a $\frac{3}{4}$ " male pipe thread with a conduit lock nut to connect it to a mounting bracket or cable stiffener. An optional mounting bracket is available from Teledyne Isco to mount the ultrasonic level sensor. You can also run the ultrasonic level sensor cable through conduit to the flow meter.

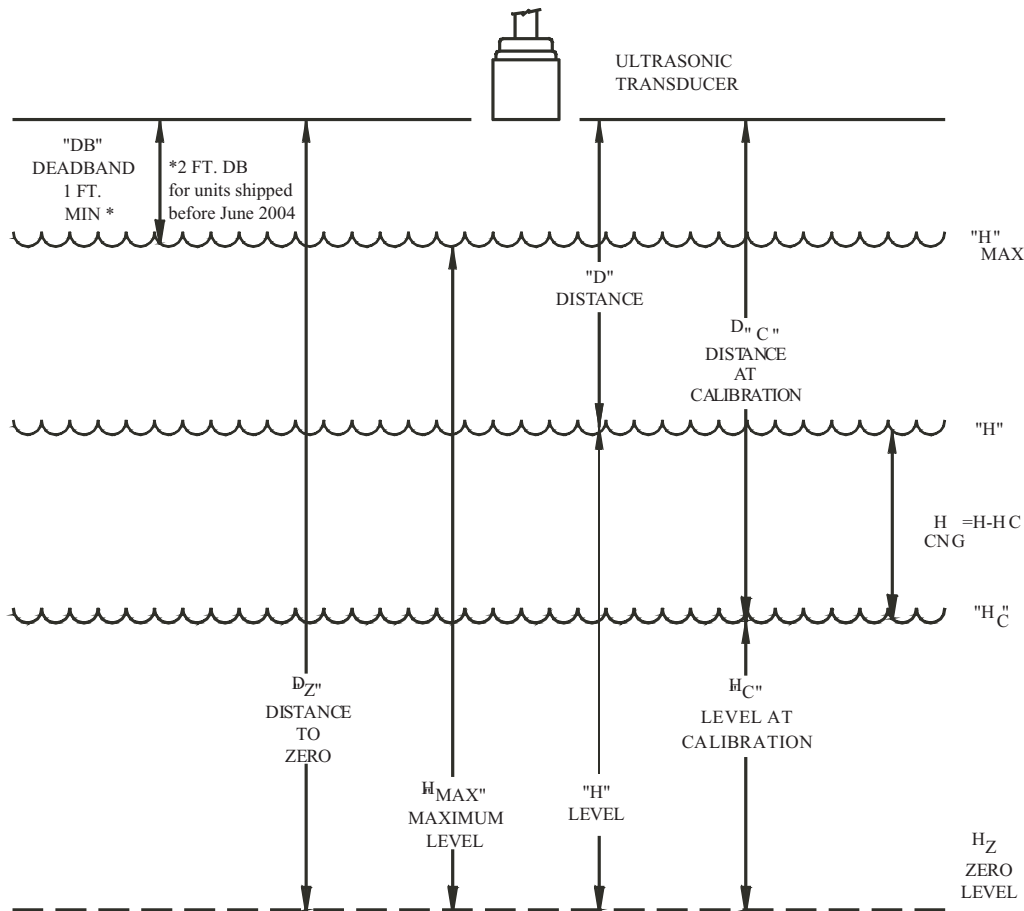


Figure 3-3 Ultrasonic Level Sensor Dead Band

DEAD BAND: The non-usable distance (1 foot) between the level sensor and the liquid surface. This requires that at maximum level the liquid surface be at least 1 foot from the level sensor (or 2 feet for units shipped before June 2004).

DISTANCE "D" is the distance from the level sensor to the liquid surface. For the 4210, distance can be from 2 to 12 feet.

"Dc" is the distance from the level sensor to the liquid surface at the time that the level "H" was calibrated.

"Dz" is the distance from the level sensor to the zero level "Hz" of the primary device. Note that errors caused by the velocity of sound will be multiplied by the distance from the level sensor to the liquid surface "D." As the distance "D" increases, the possibility of error increases.

LEVEL: The depth of water above the primary device's zero level "Hz" point. May also be referred to as **HEAD**. In the manual, "level" and "head" are interchangeable terms. The 4210 calculates level using the following formula: $H = Dz - D$.

"Hc" is the level when the flow meter was calibrated.

"H" is the level at the present time. "H" is shown above "Hc." However, if the level had dropped after calibration, "H" would be below "Hc."

LEVEL CHANGE "Hcng": is the change in level over time. The maximum change in level that the 4210 can detect is 10 feet. $Hcng = H - Hc$.

MAXIMUM HEAD "Hmax": is the maximum level that the flow meter can measure. For the 4210, this is limited to 21 feet or less. Since the largest level change the 4210 can sense is 10 feet, the unit will have a minimum level of greater than 0 feet if the maximum level is greater than 10 feet.

TEMPERATURE: Since temperature significantly affects the velocity of sound, temperature measurement is made by the 4210 Flow Meter to provide compensation.

CALIBRATION TEMPERATURE "Tc": is the temperature at the level sensor at the time the system is calibrated. (Not shown on drawing.)

TEMPERATURE CHANGE "Tcng": is the change in the temperature after the head was calibrated. $Tcng = T - Tc$. Note that the temperature is used to calculate the velocity of sound in air, which is used to calculate the distance "D" to the liquid surface, and the head. Any error in the temperature "T" causes an error that is proportional to the distance "D."

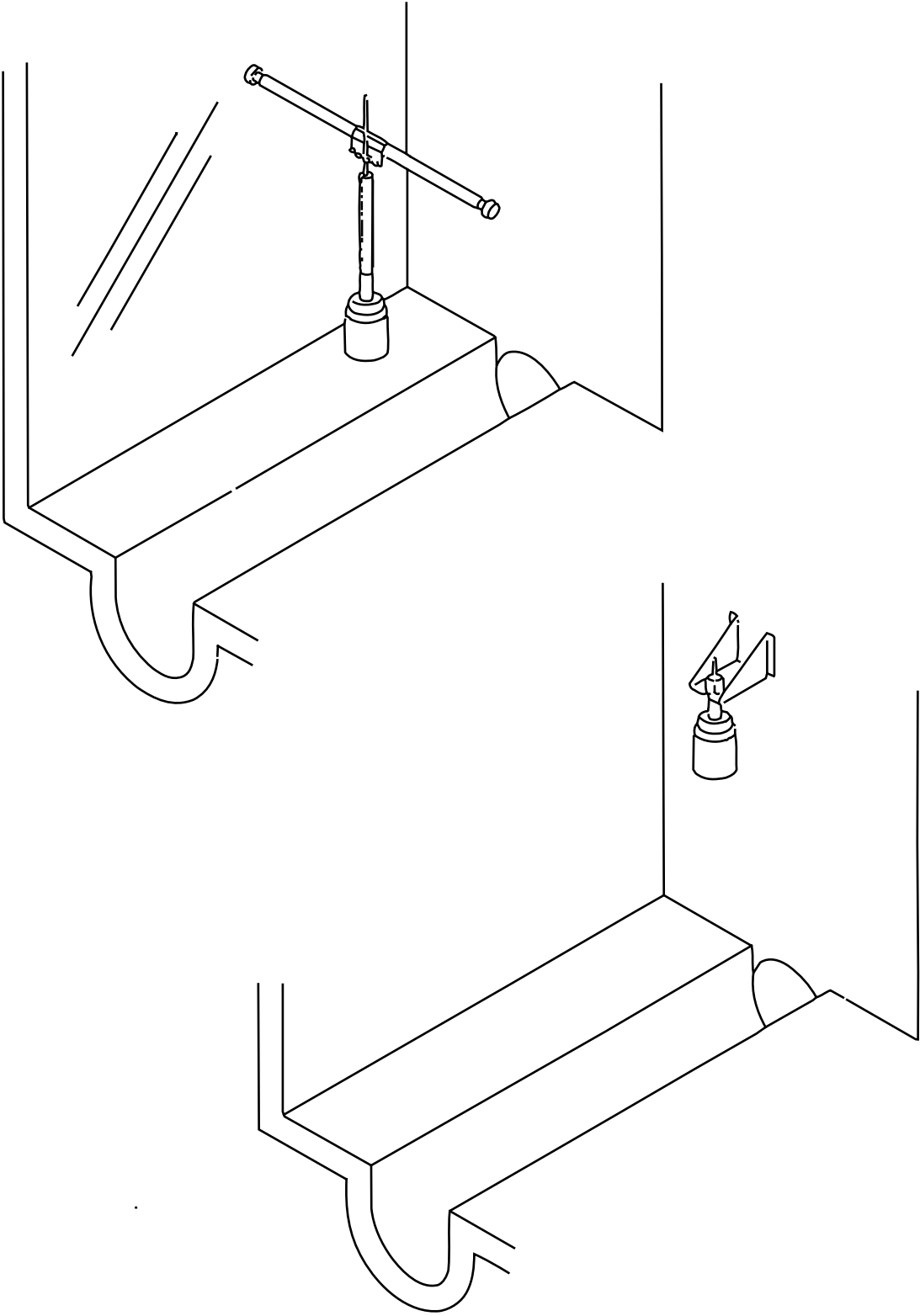


Figure 3-4 Mounting the Ultrasonic Level Sensor

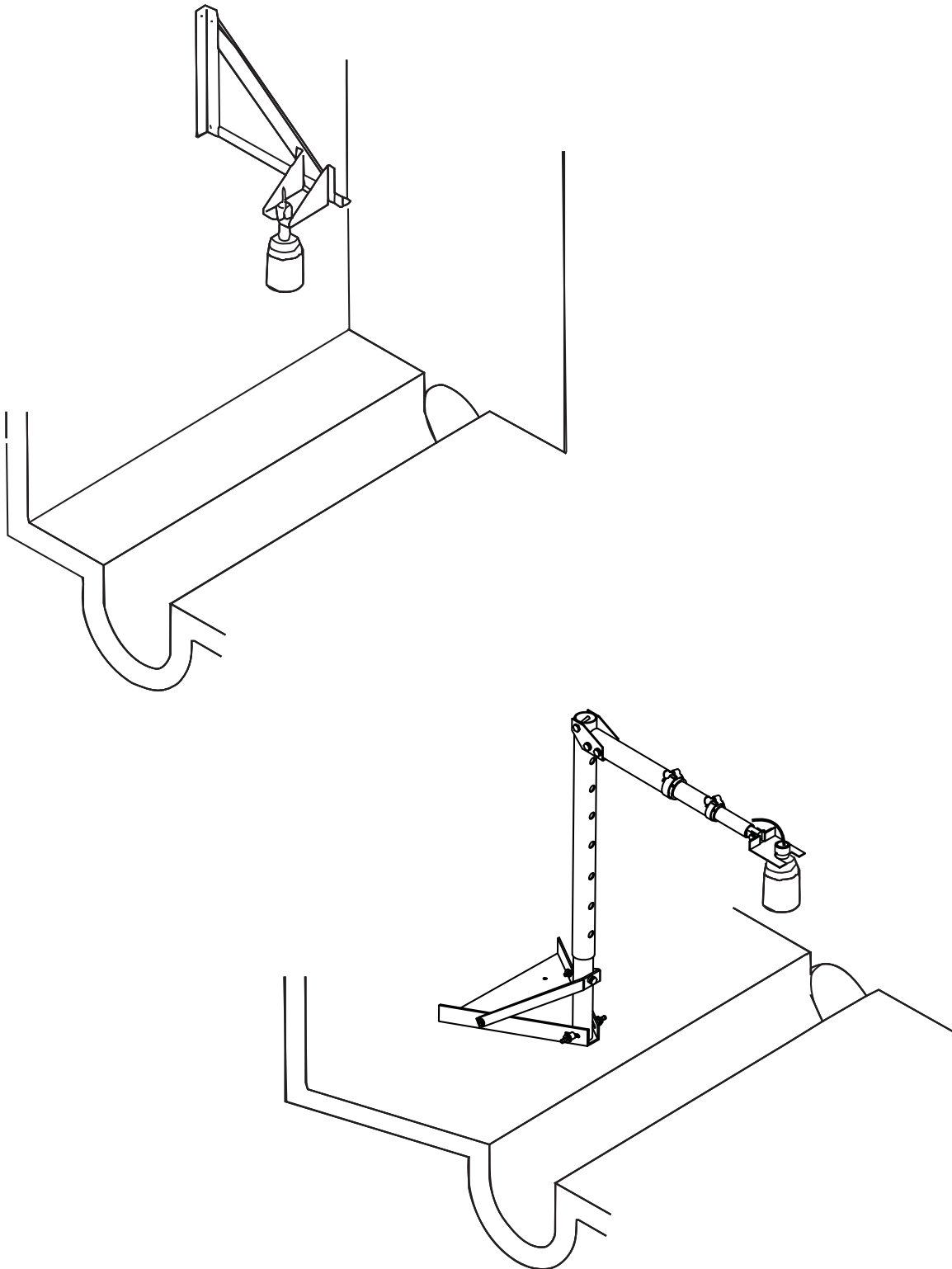


Figure 3-5 Mounting the Ultrasonic Level Sensor (Continued)

3.6.5 Suspension of the Sensor

In addition, in stable, indoor environments, you can simply suspend the ultrasonic level sensor from its cable. The previously-described Cable Straightener, which is weighted, and which forces the ultrasonic level sensor to hang plumb, is available to help in this mounting method.

3.6.6 Using a Level

When you mount the ultrasonic level sensor, place it over the center of the flow stream and use a circular bubble level to align it vertically. This is very important, since misalignment may result in erratic or erroneous level readings, resulting from the echo bouncing off the walls of the channel.

3.6.7 Use the Variable Blanking Feature

In **step 1** of the program, select **SETUP**, then under setup, select **Measurement**. Under **MEASUREMENT**, there is a menu called **VARIABLE BLANKING**. If you select **VARIABLE BLANKING**, the following will appear:

VARIABLE BLANKING DISTANCE = XX.XX FT (or meters)
--

You can determine this distance approximately by measuring from the face of the (installed) ultrasonic level sensor to the surface of the channel just above the maximum expected liquid level. This value tells the flow meter to ignore any echo reflected from this distance or less.

The purpose of this selection is to let you fine-tune the reflection cone beneath the ultrasonic level sensor. If the level sensor is mounted too high above the flow stream, there is a good chance echoes will be reflected from the channel walls, tops, sides, or other solid surfaces, that have nothing to do with the actual liquid level.

Proper selection of a value here will ensure that echoes selected by the flow meter as valid will only come from the surface of the flow stream, not the walls or sides of the channel.

3.6.8 Use the Signal Strength Reading

In **step 1**, **SETUP**, there is a menu called **STATUS**. If you select this menu, the flow meter will display the number, software revision, etc. If you press **Enter** again, the following will appear:

SIGNAL STRENGTH X%

This number indicates the strength of the ultrasonic return echo. A number of 1 indicates a very weak return echo. A number of 100 indicates a very strong return echo; generally speaking, the higher the number the better. Typical values will range from **10** to **90**. You should adjust the ultrasonic level sensor for the highest number here. If the flow meter and the level sensor are installed a considerable distance from each other, you will need an assistant to either watch the reading on the flow meter or adjust the level sensor.

3.6.9 Minimizing Level Measurement Errors

In order to minimize measurement errors with the 4210 Flow Meter, the following precautions should be observed in the installation of the ultrasonic level sensor. These are listed in the

approximate order of their significance. Factors affecting accuracy of the ultrasonic technique were discussed in the beginning of this section.

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

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

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

$$\text{LevelError} = 0.001 \times 35 \times 2 = 0.070\text{foot}$$

(about 1 inch)

Temperature differences between the ultrasonic level sensor and the flow stream surface will lead to velocity errors because the ultrasonic level sensor is at a different temperature than the air. Also, air layers of different temperatures between the level sensor and the flow stream surface will cause an abnormal reduction in the strength of the ultrasonic pulse. (The flow meter is designed to interpret the normal pulse correctly, not an abnormal one.) This may lead the flow meter to detect the wrong wave and introduce a wave detect error.

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

Avoid Excessive Distances – Although the ultrasonic level sensor cannot be mounted closer than two feet from the maximum level of the flow stream, it is recommended that the mounting be kept as close to the twelve inch limit as possible. The reason is that the error made by the flow meter in calcu-

lating the velocity of sound in the air is multiplied by the distance from the level sensor to the surface of the flow stream. Minimizing the distance will minimize the error.

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

Avoid Water Condensate – The ultrasonic level sensor will not operate properly if the bottom surface collects water droplets. This may occur if water condenses on the transducer surface as a result of high ambient humidity. Some users have found that mounting the ultrasonic level sensor horizontally and aiming it at a 45° angled reflector will keep water from collecting on the level sensor's radiating surface.

Avoid Foam, Oil, and Turbulence – If the flow stream surface is absorbent (such as with foam) or very irregular (such as highly turbulent water), the ultrasonic echo may not be correctly reflected back to the ultrasonic level sensor. This can result in a false measurement or no measurement at all. If the foam is reflective, the system will detect the top of the foam rather than the liquid surface. Also, if grease or oil is floating on the flow stream surface, it will be detected rather than the liquid surface. (See Figure 3-6.)

Small Pipes and Channels – Small circular pipes, narrow channels, and small flumes may also cause problems with ultrasonic distance measurement. Since the ultrasonic pulse expands outward at a beam angle of approximately 12° as it travels away from the ultrasonic level sensor, it may strike the sides of a channel or the sloping sides of a circular pipe with low flow. (See Figure 3-7). This can result in false echoes and incorrect level readings. The term “small channels” generally refers to “U” shaped channels and pipe inverts 10" in diameter and less. The term “small flumes” generally refers to 1" and 2" Parshall flumes. It should be noted that the level measuring point for many types of flumes (Palmer-Bowlus, Leopold-Lagco, etc.) is not in the flume, but upstream in the invert of the pipe; for these types of flumes the section of interest is in the pipe invert, not in the flume itself. Thus, care should be exercised in the use of 10" or smaller Palmer-Bowlus and Leopold-Lagco flumes.

Determining Suitability – The channel to be measured can be pre-qualified by a simple equation to determine whether or not the channel is wide enough to allow correct positioning of the ultrasonic sensor. Since the beam angle is 12°, the equation is:

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

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

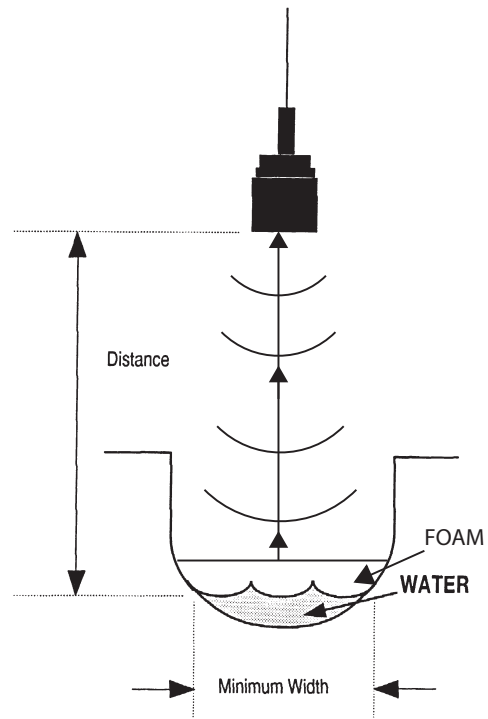


Figure 3-6 Foam and Oil on the Surface of the Stream

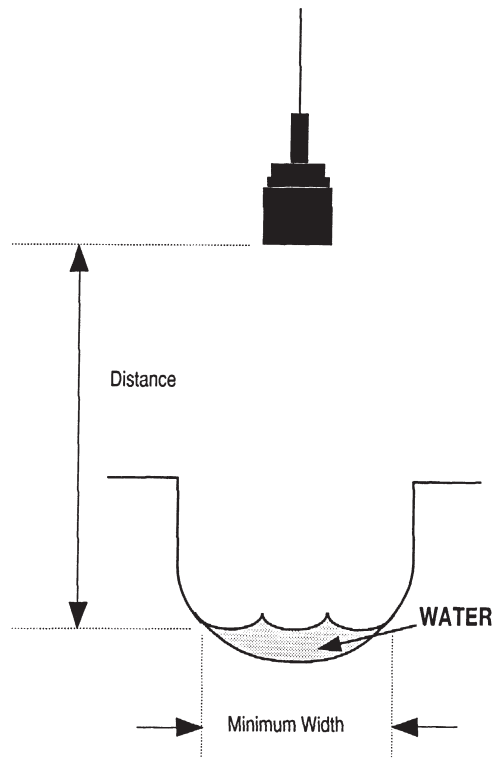


Figure 3-7 Small Pipes and Narrow Channels

3.6.10 Alternative Flow Measurement Systems

Because of the characteristics of ultrasonic liquid measurement, there may be some installations where the ultrasonic method is either unreliable or inaccurate. In these instances, it is worthwhile to consider use of the submerged probe level sensor (Isco 4220 Flow Meter) use of the bubbler technique (Isco 4230 Flow Meter), or use of the area-velocity technique (4250 Flow Meter). Information on these companion units to the 4210 is available from their respective manuals or from the factory. Call for more information.

3.7 Associated Equipment

You can use the 4210 Flow Meter with a variety of other equipment. The following sections give instructions for connecting other equipment to the 4210.

3.7.1 Isco Sampler

One of the uses of the 4210 Flow Meter is to control a sampler in a **flow-paced sampling mode**. Flow-paced sampling means that the flow meter is programmed to signal the sampler to take a sample after a specific volume of flow has passed through the flow stream, rather than after a period of time. In this way, the sampler and flow meter are able to compensate for varying flow rates. You can use the 4210 Flow Meter with any of the Teledyne Isco Samplers listed in Section 1.

An optional 25 foot (7.6 m) connect cable is available to connect the flow meter to the sampler. Attach the six-pin female connector on the cable to the SAMPLER connector on the side of the flow meter. (This is the second connector from the top.) Attach the connector on the other end of the cable to the FLOW METER socket on the sampler. The flow meter will then be connected to the sampler's power supply, and the sampler will be able to receive flow-proportional signals from the flow meter. Refer to the sampler manual for further details.

Note

The flow meter-to-sampler connect cable has been changed. It now has six wires. This new cable must be used if it is desired to use the software "Sampler Enable" feature. Previously available cables will not allow this feature to work. Pin "F" is not connected; this pin may be checked with an ohmmeter. A "new" cable will show continuity (zero ohms) between the two "F" pins; an "old" cable will show open.

3.7.2 Connection to Other Isco Equipment

Teledyne Isco manufactures a variety of accessories for use with the 4210 Flow Meter. Among these options are: two different types of modems, single and multiple parameter sensors, an alarm relay box, a tipping bucket rain gauge, a 4-20 mA output device, software, and a mechanical totalizer.

Descriptions of each of these options, as well as information about their use, is provided in Section 4.

4210 Flow Meter

Section 4 Optional Equipment

This section describes accessories available for use with 4200 Series Flow Meters. There are two groups of accessories. One group of options you can use with any of the 4200 Series. The other group are accessories for a specific type of level sensing and can only be used with one flow meter of the series. This section covers the accessories that are usable with any 4200 Series Flow Meter. Application-specific options are covered in the *Installation* sections of each type of flow meter.

Teledyne Isco offers the following options for use with all 4200 series flow meters:

- 4200T Modem
- Internal and external 4-20 mA Outputs
- 674 Tipping Bucket Rain Gauge
- Flowlink® Software (used with the modem or a laptop computer)
- Parameter Probes - Temperature, pH (acidity/alkalinity) and D.O. (dissolved oxygen)
- Mechanical Totalizer
- High-Low Alarm Relay Box
- YSI 600 Multi-Parameter Sonde

4.1 User-Installed Options The 4-20 mA Output Interface, alarm box, rain gauge, and parameter probes are options you can field-install any time. The modems require factory modification to the flow meter, and you should specify these options when you order. If you want to add any of these later, you will need to return the flow meter to the factory.

4.2 4200T Modem The 4200T Modem is a circuit board installed inside the flow meter that transmits flow meter data over standard telephone lines. The modem also makes it possible for the flow meter to receive data from compatible equipment at the other end of the phone line. Modems allow digital equipment to “talk” and “listen” to other remotely-located digital equipment over telephone lines.

4.2.1 How the Modem Works The analog phone system cannot transmit digital signals through repeaters; digital machines cannot communicate directly over phone lines. Modems convert the data into tones and transmit them over phone lines. The equipment on the other end of the line answers with tones through its modem. The first modem converts these tones back to digital data and interprets it. The 4200T Modem is full duplex and works in the auto-answer

mode. It operates at 300/1200/2400 baud. This modem has speech and tone capabilities and comes with a connect cable to attach to the telephone line.

 **Note**

The modem is disabled when an interrogator cable is connected to the flow meter's interrogator port. It cannot receive incoming calls, and the alarm dialout will be rendered inoperable, while this cable is connected. **Disconnect the interrogator cable in order to use the 4200T Modem.**

4.2.2 Modem and Flowlink Software

The 4200T Modem communicates with Teledyne Isco's Flowlink data storage and acquisition software, setting up the flow meter to collect blocks of data. Flowlink allows storage and interpretation of flow meter data. Other Flowlink software packages can write reports with this collected data.

4.2.3 Connection to a Line

The FCC (Federal Communications Commission) governs communications over telephone lines. Your local telephone company will provide you with the line between the flow meter and the computer. Call them for connection information. *The FCC requires the following information be published for connecting the modem to the phone line:*

“This equipment complies with part 68 of the FCC rules. On the case of this equipment is a label that contains, among other information, the FCC registration number and ringer equivalence number for this equipment. If requested, this information must be provided to the telephone company.”

“This equipment uses the following USOC jacks: USOC RJ11C.

“The REN is used to determine the quantity of devices that may be connected to the telephone line. Excessive REN's on the telephone line may result in the devices not ringing in response to an incoming call. In most, but not all areas, the sum of REN's should not exceed five (5.0). To be certain of the number of devices that may be connected to the line, as determined by the total REN's, contact the telephone company to determine the maximum REN for the calling area.

“If this equipment causes harm to the telephone network, the telephone company will notify you in advance that temporary discontinuance of service may be required. If advance notice isn't practical, the telephone company will notify the customer as soon as possible. Also, you will be advised of your right to file a complaint with the FCC if you believe it is necessary.

“The telephone company may make changes in its facilities, equipment, operations, or procedures that

could affect the operation of the equipment. If this happens, the telephone company will provide advance notice in order for you to make the necessary modifications in order to maintain uninterrupted service.

“If trouble is experienced with this equipment, please contact the Teledyne Isco Customer Service Department, (800) 465-3022 or outside the U.S.A., call (402) 464-0231, 4700 Superior Street, Lincoln Nebraska, 68504, for repair and (or) warranty information. If the trouble is causing harm to the telephone network, the telephone company may request you remove the equipment from the network until the problem is resolved.

“The following repairs can be done by the customer: None.

“This equipment cannot be used on telephone company-provided coin service. Connection to Party Line Service is subject to state tariffs.

“When programming and/or making test calls to emergency numbers:

“Remain on the line and briefly explain to the dispatcher the reason for making the call.”

“Perform such activities in the off-peak hours, such as the early morning or late evenings.”

4.2.4 Types of Service

The 4200T Modem is compatible with standard telephone lines and comes with a 12-foot cable. The cable connects the flow meter's MODEM connector to a standard telephone jack, type USOC RJ11C, supplied by the phone company. You must mount the flow meter within 12 feet of this jack.

We are required by the FCC to provide the following notice:

“This equipment generates and uses radio frequency energy and if not installed and used properly, in strict accordance with the manufacturer's directions, may cause interference with radio and television reception. There is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures.”

- Reorient the receiving antenna on the television.
- Relocate the unit with respect to the receiver.
- Plug the unit into a different outlet so the unit and receiver are on different branch circuits.
- If necessary, consult the manufacturer or an experienced radio-television technician for additional suggestions.

You may find the following booklet, prepared by the FCC, helpful: *How to Identify and Resolve Radio-TV Interference Problems*. This book is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No. 004-00-00345-4.

4.3 Connection to an External Serial Device

Teledyne Isco offers two serial outputs from 4200 series flow meters. There is a software-enabled output that is transmitted on the RAIN GAUGE connector. This signal also appears on the INTERROGATOR connector. This feature lets the flow meter transmit the most recent values for all currently enabled ports as ASCII text. You can select the baud rate and the frequency of transmission. You can then write a simple program to retrieve this data periodically, or you can do it interactively using a terminal program. This option (SERIAL OUTPUT) is discussed in detail in Section 2.6.2.

Teledyne Isco still offers the older 300 baud output for the 2312 Plotter (no longer sold), also on the RAIN GAUGE connector. This port provides ASCII level and flow rate data for remote transmission to any ASCII-compatible equipment. Every 15 seconds, the flow meter transmits a line of data that includes level, units of level measurement, percentage of maximum flow rate, maximum flow rate, a total flow value, units of flow, sample number, bottle number, text, time, and date.

If you are using the flow meter with an Isco sampler, the data line also includes an indication of a sampling event.

You can transmit this data line to a computer, or to a locally-connected (within 250 feet) device capable of interpreting serial data, such as a video display terminal or a printer. The specifications for this serial data output are as follows: 300 baud, 7 data bits, 2 stop bits, even parity. The printed (or displayed) line contains 110 characters and will appear similar to the following:

```
+01.409F 100.00% 2.500+0 CFS    0001533+0 CF    00 00 90  
DEGREE V-NOTCH WEIR  
000 0 90 04 04 02 31 48
```

The last two characters (not displayed) are a 'CR' (carriage return) and an 'LF' (line feed). The large gaps between some of the words indicate extra character spaces which are not used in this particular text, but which are available for use if needed.

<input checked="" type="checkbox"/> Note

You cannot use both serial outputs at the same time. You must select one or the other.

The serial output is paralleled with the Interrogator Port and the Internal Modem. Use of either the Interrogator Port or the Internal Modem will cause non-standard data to be transmitted.

4.4 4 to 20 mA (Analog) Outputs (External and Internal)

These outputs provide connection between a 4210 Flow Meter and non-Isco process-control equipment, such as chlorinators, or any other type of equipment that you can control with a 4-20 milliampere current loop. Analog outputs convert digital information from the flow meter to a variable analog output current ranging from 4 to 20 milliamperes. When a condition measured by the flow meter is converted into an analog output, 4 mA becomes the 0%, or baseline for the condition, while 20 mA becomes the 100%, or full-scale of the condition. Teledyne Isco offers two different arrangements for providing the 4-20 mA outputs. One is an external box that converts the signals from the flow meter to a 4-20 mA current loop. The other is an internal circuit board containing from one to three separate analog output circuits on the same board.

The 4 to 20 mA current is an industrial standard current loop for process control equipment that must respond to changing conditions by varying output rates.



Figure 4-1 4-20 mA Output Interface

4.4.1 Connecting the 4-20 mA Output Interface

The 4-20 mA Output Interface has its own case and AC power supply. Commercial power (120 VAC) must be available for this device. Battery operation (12 VDC) is not feasible due to voltage and current demands. It comes with a line cord, connectors, and two interconnect cables. One cable has 6-pin M/S connectors on both ends. This cable connects the input of the 4-20 mA Output Interface to the flow meter Interrogator connector. The other cable has a three-pin plug on it that connects to the output connector of the 4-20 mA Output Interface. This cable ends in three pigtailed wires you connect to the equipment you want to control with the 4-20 mA Output Interface.

Table 4-1 External 4-20 mA Specifications

Power	120 VAC 1/8 Amp.
Output Connector	3-pin male plug Pin A: + current out Pin B: – current out Pin C: not used
Output Accuracy At 72° F (22°C) Full Oper. Range	±0.25% of full-scale ±0.5% of full scale
Operating Range	0° to 140°F (–18° to 60°C)
Resolution	0.1% of full-scale
Input Connector	6-pin male M/S Pin B: – pulse input Pin F: + pulse input Pins A, C, D, E: NC
Isolation	Output current optically isolated from flow meter.
Fusing	1/4 Amp. internal on AC line.
Adjustments/Calibration	Factory-calibrated; when used within range, no adjustment needed,
Maximum Distance	1,500 ft. (457.3 m) using 18 AWG wire.

4.5 The Internal Analog Output Board

For those needing more than one analog output, Teledyne Isco offers the **Multiple Analog Output Board**, which is installed inside the flow meter. This board provides from one to three isolated analog outputs. The board is compatible with the existing external 4-20 mA output box (60-1784-039). A flow meter can use either the internal board, the external box, or both, for a maximum number of four analog outputs.

 **Note**

If your flow meter has both the multiple analog output board and the external analog converter, the internal ports will be designated Analog Outputs 1, 2, and 3. The external converter will be designated either “External” or “Analog Output 0.”

The Multiple Analog Output Board consumes a minimum of 16 mA per output; consequently, the flow meter should be AC-powered. If you must use battery power, you should consider the following to extend battery life:

- Use a Solar Panel Battery Charger
- Use a larger battery: either a commercial deep-cycle/marine type, or an Isco 35 Ampere-hour lead-acid battery.
- Order and use only one analog output.

- Flow meter program choices also affect power consumption. Use “minimum” settings, if possible. (See Section 1, Table 1-4.)

The outputs from the analog output board are electrically isolated from the flow meter and from each other by internal DC-DC converters. The board uses the opening for the modem connector for its outputs. Normally, a flow meter will not need both the analog and modem boards. If your installation does, however, you should contact the factory.

The analog board terminates in a 6-pin male M/S connector on the flow meter case. Flow meters built with the analog board option are also supplied with an output cable. This cable connects to the wiring that runs to the equipment controlled by the 4-20 mA current loop and to the 6-pin M/S connector on the flow meter. The cable has a 6-pin female M/S connector and is provided with stripped pigtail ends for convenient wiring.

Table 4-2 Internal 4-20 mA Specifications

Temperature (operating)	0 to 140° F (–18 to 60° C)
Output Accuracy	±0.5% of full-scale
Resolution	0.1% of full-scale (0-20 mA)
Electrical Isolation	Isolated from each other and from the flow meter.
Calibration	Factory-calibrated; no further adjustments necessary.
Maximum output distance	1500 feet (457.3 m) using 18 AWG wire.
Current Range (per loop)	0 to 20 mA
Maximum Load (per loop)	750 ohms
Analog Output 1 Terminations	Pin A (Red wire –) Pin C (White wire +)
Analog Output 2 Terminations	Pin D (Brown wire –) Pin F (Blue wire +)
Analog Output 3 Terminations	Pin E (Black wire –) Pin B (Green wire +)
Note: If you must strip the cable further back to facilitate wiring, you will expose an orange, yellow, and purple wire. You may disregard these wires, as they are not connected in this application.	

4.6 Pacing Non-Isco Equipment

For applications requiring the conversion of the flow meter's flow proportional output signal to a fixed duration contact closure, Teledyne Isco offers the Type 'E' Interface.



Figure 4-2 Type 'E' Interface for pacing non-Isco equipment

To allow connection to a second device simultaneously, you must connect using the special Isco Y cable, part #60-5314-278. A connected sampler must have its own external power. **NEVER** connect the sampler and flow meter to the same power source.

 **CAUTION**

Do not use the standard Isco Y cable (60-3704-081) with the Type 'E' Interface. This cable is designed for Isco sampler connection only.

Use of this device requires a factory modification to the flow meter. If you are connecting the Type 'E' Interface to a previously purchased flow meter, prepare the unit by performing the steps described in this section, or contact the factory to return the unit for modification by Technical Service.

 **DANGER**

Risk of electrocution. Disconnect the flow meter from power before performing any modification or repair.

 **CAUTION**

Always protect your equipment by observing anti-static precautions when exposing internal components. Turn to Section 5.5.1 for recommended precautions.

1. Remove the four Phillips screws on the front panel. Carefully pull the panel away from the case to access the interior.
2. Remove the lower metal shield by sliding it downward, freeing the tabs from their slots. This exposes the power supply PCB.

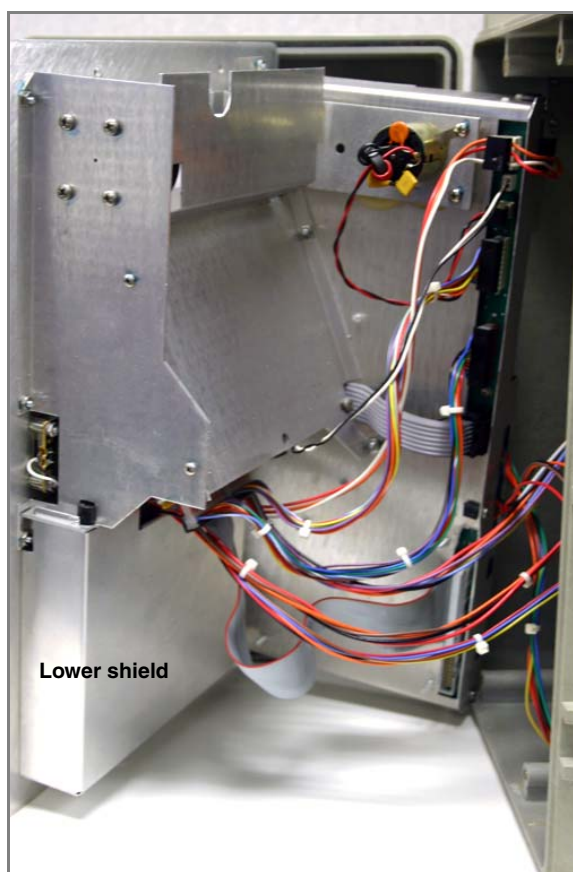


Figure 4-3 Flow meter with front panel removed

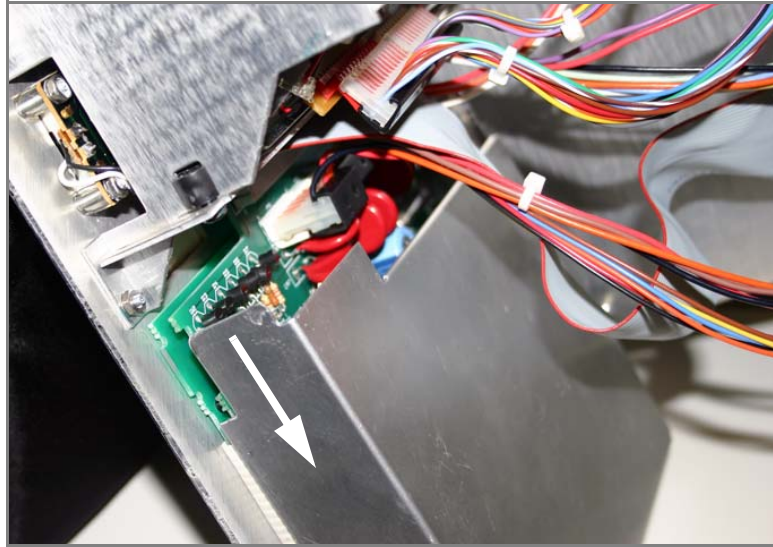
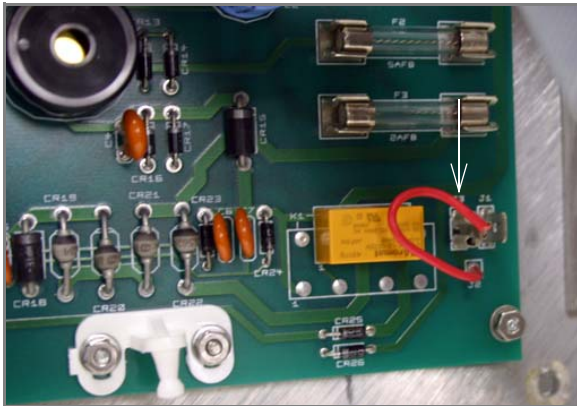
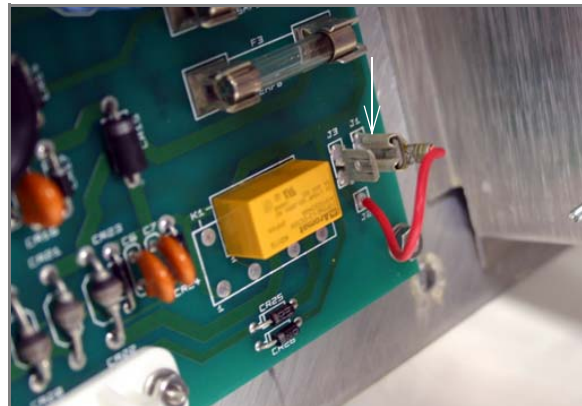


Figure 4-4 Removing the lower shield

3. In the lower right hand corner of the power supply PCB, disconnect the red wire's spade connector from J3 and connect it to J1.



Disconnect from J3.



Connect to J1.

Figure 4-5 Type 'E' modification

4. Replace the metal shield and carefully reattach the front panel to the flow meter case.

4.7 Tipping Bucket Rain Gauge

A Tipping Bucket Rain Gauge is available from Teledyne Isco for use with 4200 Series Flow Meters. The gauge connects to the flow meter by a cable terminated in an M/S connector. This connector plugs into the Remote Printer/Rain Gauge connector on the case. A Y-connect cable is available that allows use of both the rain gauge and a YSI 600 Multi-Parameter Sonde at the same time. You can connect extra cable (user-supplied) between the rain gauge and the factory-supplied cable as long as you do not exceed a maximum total length of 1,000 feet. Use 18 AWG wire or larger. Do not cut the M/S connector from the cable.

The rain gauge is factory-calibrated to provide a contact closure to the flow meter for every hundredth of an inch (0.01") [or 0.1 mm] of rainfall. Software in the flow meter stores this information in memory and prints the accumulated data as a text line on the printer chart. It also allows the printout to be expressed in metric.

You may, if you wish, provide a rain gauge of your own choice, but to ensure compatibility with the flow meter's operating environment, it must conform to the following specification:

- It must provide an isolated, dry contact closure.
- It must be a normally open contact configuration.
- It must close for 100 ms (-25 ms +150 ms) with less than 2 ms contact bounce.
- It must provide a contact closure for every 0.01" (or 0.1 mm) of rainfall

A cable assembly is available to connect a user-supplied rain gauge to the flow meter. Further information about the rain gauge is available from the factory or its manual.



Figure 4-6 Isco 674 Rain Gauge

4.8 Isco Flowlink Software

Teledyne Isco offers a proprietary software system for data acquisition, storage, retrieval, and analysis. This software system, Flowlink, contains programs that allow 4200 series flow meters to store blocks of level and other data readings in the flow meter's memory. You retrieve this stored data with either a laptop computer or central computer connected to the flow meter by modem. You can use other programs in the package to process the retrieved data for further analysis. In addition to storing data, this software makes it possible to divide part of the flow meter's memory into partitions. These partitions may be formatted in "rollover" or "slate" mode of data storage. You can also set up the flow meter to store data as a result of some sort of "triggering" event, such as level rising to a predetermined point, the passage of a predetermined time interval, or the occurrence of a storm event, such as rainfall.

Consult the factory. A detailed explanation of the Flowlink Software is beyond the scope of this manual. Information on Flowlink Software is available from its manual or from the factory.

4.9 High-Low Alarm Relay Box

Teledyne Isco offers a control box that monitors flow rate data available from any 4200 Series Flow Meter. Alarm relays trip when the flow rate exceeds or falls below pre-selected limits. High and low set points are user-set and range from 0% to 99% in 1% increments. Output from the unit is the switching of form C (SPDT) relay contacts. The unit has 2 relays; one for high alarm and the other for low. The availability of form C contacts (both NO [normally open] and NC [normally closed] contacts) means you can switch loads either on or off. Relay contacts are rated 3 Amperes at 24 volts AC or DC. The alarm box operates on 12 VDC supplied from the flow meter. Current consumption in standby condition is approximately 10 mA. In alarm, current increases to 190 mA. You can connect as many as four alarm boxes to a flow meter, if the flow meter is powered from the AC line.

Note

Do not use the alarm box if your flow meter has a modem or uses Flowlink software (through either a modem or laptop computer).

Use the alarm box with caution in battery-powered installations, as it will significantly increase power consumption.

In standby condition, an alarm box consumes about one ampere-hour of battery capacity in four days (or reduces capacity approximately 25%). In alarm condition, one alarm box will completely discharge a fresh (4 Ah) battery in 21 hours. Teledyne Isco recommends using only one alarm box in a battery - powered installation, and you can expect to change the battery more often.

4.9.1 Installation

The High-Low Alarm Relay Box is enclosed in a high-strength plastic box and is easily installed. Mount the unit with corrosion-resistant hardware through the 2 holes in the stainless steel mounting plate attached to the case. Two threaded holes in the case allow the use of either 1/2" conduit fittings or compression bushings. While the alarm box is suitable for use in damp locations, do not install it where there is any possibility of submersion. Where temperatures are expected to fall below freezing, Teledyne Isco recommends installation of the alarm box indoors or in a heated location, as the manufacturer of the micro-processor does not specify its operation below 32° F (0° C).

 **WARNING**

Hazard of electric shock! Use the relay contacts for low voltage (24 V) pilot duty only. Do not wire 120 VAC or higher voltages to the relay contacts.

4.9.2 Wiring to a 4200 Series Flow Meter

Connecting the High-Low Alarm Relay Box to a 4200 Series Flow Meter requires a cable and an M/S connector. A special cable, 25 feet long, is available from Teledyne Isco. On one end of the cable is a 4-pin, male M/S connector. Plug this connector into the Remote Plotter/Rain Gauge connector on the flow meter. The other end of the cable has 3 stripped wires. Attach them to the alarm box according to the instructions in the alarm box instruction manual.

BLACK	+12 VDC
GREEN	-12 VDC
WHITE	DATA

4.10 Parameter Sensing

The Isco 4210 Flow Meter has the capability of displaying, recording, and (if Flowlink software is used) storing data provided from parameter sensors. The parameter sensors available for the 4210 Flow Meter are for temperature, dissolved oxygen (DO), pH, (concerned with the acidity or alkalinity of a solution), and the YSI 600 Multi-Parameter Sonde. See Section 4.14 for information on the YSI 600 Sonde. This section covers the Isco pH, D.O., and temperature sensors.

4.10.1 Installation of Parameter Probes

The parameter probes, as well as other Isco probes such as the submerged probe and area-velocity probe, require complete, continuous submersion in the flow stream for proper operation. Dry operation can damage the pH and D.O. probes. The YSI Sonde (only) may be suspended vertically in the stream. Teledyne Isco offers a series of rings that provide mounting for the probes in round pipes.

- Each probe snap-mounts to a specialized sensor carrier.
- The sensor carrier then attaches to the rings or mounting straps.
- The probe cable is carefully routed out of the stream.
- Only the temperature probe can connect directly to the flow meter's parameter probe connector.

- The pH and D.O. probes both connect to parameter modules (amplifiers). The pH probe connects to the 201 pH Module and the D.O. probe connects to the 270 D.O. Module. The modules are not interchangeable.

Note

The 270 D.O. module has been discontinued. Probes, service kits, and accessories are still available to maintain existing field units.

Isco flow meters are built with one parameter sensing port, and can only sense temperature plus one parameter at a time, (unless you use the YSI Sonde). You must select temperature, D.O. with temperature, or pH with temperature. If you want to change probes later, you can, but you will need to reprogram the flow meter. Selection of either pH or D.O. in **step 1** (where units of measure are defined) will lock out any mention of the other in the menus for the rest of the program.

The Parameter Modules themselves plug into the Parameter Probe connector on the flow meter.

Note

The pH and D.O. probes require continuous submersion after installation, or they will lose sensitivity. Prolonged dehydration of the sensor bulb may damage or even ruin the pH probe.

4.10.2 The Temperature Probe

The temperature probe is the simplest of the three, consisting of a thermistor inside a metal housing. The thermistor changes resistance with an increase or decrease in temperature. The flow meter converts this resistance change to a temperature reading and displays it, in degrees Celsius or Fahrenheit, as chosen by menu selection.

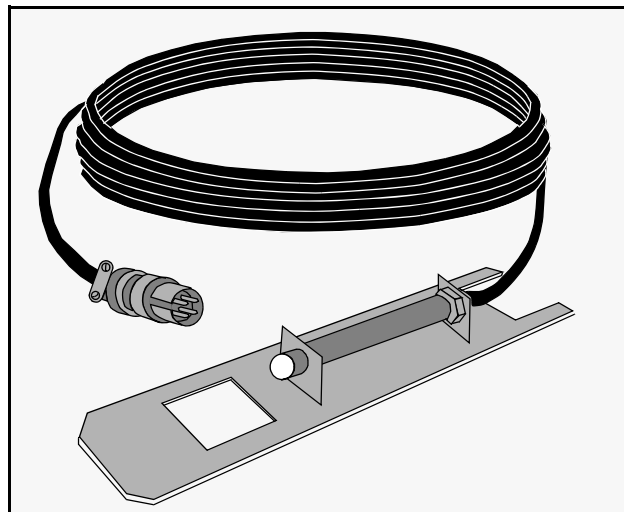


Figure 4-7 Temperature Probe

Note

Use the temperature probe with the 201 pH Module when monitoring temperature **only**. Do not connect a pH probe and temperature probe to the same box. The pH probe contains its own integral temperature sensor, which, if connected in parallel with a temperature probe, will cause erroneous readings.

4.11 The pH Probe

The pH probe measures the acidity or alkalinity of an aqueous solution by determining the relative quantity of dissociated hydrogen ions, H^+ (actually H_3O^+) in the solution. A larger quantity of H^+ ions indicates acidity, while a smaller quantity of H^+ ions indicates alkalinity. The H in pH stands for Hydrogen and the p stands for power.

The normal scale for pH runs from 0 to 14, with 0 being most acidic and 14 being most alkaline. Distilled water at 25° C is neutral at 7, based on the fact that the dissociation constant (number of H^+ and OH^- [hydroxyl] ions present) for pure water at that temperature is 10^{-7} .

The *dissociation constant* is a number indicating the degree of ionic dissociation for a substance after it is dissolved in water. Dissociation constants vary widely for substances, depending on the nature of the substance's chemical bonds. Ionic salts tend to have higher constants.

Each number on the pH scale between 7 and 0 equals a tenfold increase in H^+ ion. Each number between 7 and 14 equals a tenfold decrease of H^+ ion. pH measurements of wastewater are commonly made to monitor the effect of treatment chemicals added to raise or lower the pH.

Water that has been used for various industrial processes may deviate substantially from 7. Chemicals are often added to the water to bring the pH close to that of neutral water, which is 7.

For example, if the effluent has a concentration of heavy metal ions, they must be removed before discharge. Raising the pH of solutions containing transition-metal ions will cause them to precipitate, where they can easily be removed as sludge. The resultant solution will be high in pH and will require acid to neutralize it.



Figure 4-8 pH Probe (With Protective Cap On)

4.11.1 How the pH Probe Works

The pH probe is a combination of two electrochemical half-cells. Together they provide a low-voltage signal that corresponds to the hydrogen-ion concentration of a solution. If you look at the pH probe, you will see a glass bulb on one end. This is called the *glass mono electrode*.

The glass is of special composition, sensitive only to hydrogen ions, and is exposed to the solution to be measured. The specific sensitivity to the hydrogen ion prevents interference from other ions that may be present in the solution. It is essential to prevent grease from fouling this membrane. The glass membrane produces an electrical potential proportional to hydrogen ion activity.

The other electrode, called the *reference electrode*, completes the circuit between the glass electrode and the solution.

The Isco pH probe combines both electrodes in a single housing and also contains an amplifier to reduce the extremely high impedance of the circuit. This improves the reaction of the probe to stray capacitance and reduces interference caused by electrical noise in the vicinity.

pH measurement is affected significantly by temperature, like any other chemical reaction. Consequently, temperature compensation is provided in the flow meter. The Isco pH probe has a built-in temperature sensor that is exposed for faster response.

The pH probe connects to a **201 Module** that plugs into the Parameter Port on the flow meter. The probe has a 25 ft. (7.6 m) cable. For greater distances, contact the factory. The maximum distance between the module and the flow meter is 1,000 ft. (304.8 m).

Note

Do not connect an Isco pH probe and temperature probe to the 201 module at the same time. The "Temperature Probe" input on the 201 module is for use ONLY with non-Isco pH probes that do not have built-in temperature sensing. The Isco pH probe contains its own integral temperature sensor, which, if connected in parallel with a separate temperature probe, will cause erroneous readings.

When the ion-selective electrode and the reference electrode are connected to a high-impedance voltmeter and submerged in solution, ions move to the surface of the membrane. The electrical charge on the ions creates a potential difference across the barrier between the solution and the membrane. This potential, or voltage difference, is proportional to the activity of the ions in solution.

The potential, when read by a sensitive voltmeter, translates into a reading of pH. With an Isco flow meter, the voltage is sent first to a preamplifier inside the probe to reduce the impedance of the circuit and improve the signal-to-noise ratio, and then on to the

parameter module to allow greater operating distance from the flow meter. The flow meter determines the pH value and displays it.

4.11.2 pH Probe Calibration

The 4210 provides a two- or three-point calibration for the pH probes with commercially-prepared calibrated buffer solutions. Calibrations of 4 and 7, 7 and 10, and 4, 7, and 10 are all possible. For accurate readings, you must clean and re-calibrate the probe on a regular basis. How often you need to do this depends on the condition of your flow stream.

Flow streams with a high grease content will coat the sensing surfaces of the probe quickly, clogging them and slowing the response time or stopping it altogether. **Installation in very greasy flow streams is not recommended.**

Note

For pH probe calibration, Teledyne Isco recommends that you use a glass container for the buffer solutions to ensure that the following conditions are met:

The probe must be properly submerged in solution, and there must be no air trapped under the probe membrane, or the reading may become incorrect and/or erratic.

Do not touch the probe until after you have performed step 6.

To calibrate the pH probe with the flow meter:

1. Go to program Step 1: PROGRAM, SETUP and select PROGRAM.
2. Step through the units of measure with the **Enter** key until you reach the menu that says pH UNITS - NOT MEASURED, pH. Select pH. You must do this in step 1 or the pH menu will not appear later.
3. Now go to step 3. PARAMETER TO ADJUST - NONE, LEVEL, pH (other selections may appear.) and select pH. If the pH menu does not appear in step 3, go back to step 1 to make sure you have turned it on. Then the pH selection of calibrations will appear.
4. Place the pH probe in the appropriate buffer solution until the stainless steel body is one inch beneath the surface.
5. If you select 4 & 7, the following screen will appear. Calibration with the other menu options (7 & 10 or 4, 7, & 10) is essentially the same as shown below. For the other menus, see Section 2.

RINSE PROBE AND PLACE IN 4.0 pH SOLUTION
PRESS ENTER WHEN STABLE: X.XX pH

6. Wait for the reading to stabilize (this may take from 30 seconds up to 5 minutes). When the probe has stabilized, press **Enter** and the following display will appear:

RINSE PROBE AND PLACE IN 7.0 pH SOLUTION
PRESS ENTER WHEN STABLE: X.XX pH

When you have entered this second value, the pH probe calibration is complete. You can then install the probe in the flow stream.

 **Note**

An asterisk (*) may occasionally appear next to the pH reading for approximately 30 seconds, during which time the most recent reading will be displayed. This may be normal flow meter operation due to other internal functions, or could indicate pH fluctuation in the stream.

4.11.3 pH Probe Installation Guidelines

Installation of the pH probe is similar to the submerged level sensor, other parameter probes, and the area-velocity sensor.

- Install the probe only in streams that have continuous flow. The sensing end of the probe must always remain wet.
- For proper operation, there must also be enough flow to submerge the sensing end of the probe completely.

If flow in the stream is intermittent (dry for periods of time), the pH sensing bulb will dry out and its response time will slow. This is a problem in situations where pH changes rapidly. If the probe is dry long enough, it will first lose sensitivity, then be slow to respond, and finally be ruined. **Never let the sensing end of the probe dry out completely.**

- Installation in streams with high grease content will result in poor performance and require frequent cleaning and recalibration. Greasy substances, being nonconductors of electricity, weaken the electrical potentials formed between the glass mono-electrode and the solution, slowing or halting the response altogether.
- The pH Sensor operates satisfactorily mounted either horizontally or vertically in the stream. However, horizontal mounting is more secure, and presents less of an barrier to trap debris.
- Simple suspension of the probe is *not recommended*, particularly in streams of high velocity, or those that carry debris.

If you mount the pH probe vertically, mount it securely. Do not just hang it from the top of the pipe by its cable. Suspending the probe in the stream is not stable.

For horizontal mounting, the probe fastens to a sensor carrier that snap-fits to an Isco mounting ring. The mounting rings fit various diameters of round pipes 15" diameter and smaller. For larger pipes, use the *Isco Scissors Ring*. For installation details,

refer to the instruction sheet supplied with the mounting ring. The mounting rings are held in place by the outward force of spring pressure in the smaller sizes and by a scissors arrangement in the larger sizes. After mounting the probe in the ring or strap, route the cable out of the stream so it will not trap debris or clog the sewer.

Mount the 201 Module within 25 feet of the probe, but in a location higher than the highest anticipated level for the flow stream. The amplifier box is sealed and will withstand temporary submersion, but this should be avoided.

 **Note**

When installing the pH probe and its sensor carrier, make sure the mounting slots on the carrier are completely pressed into the mating tabs on the ring. The probe relies on a full engagement between tabs and slots for secure mounting. If the slots are loose against the tabs, the probe may be swept away by the force of the stream.

- Always mount the probe in an easily-accessible location, because you will need to service it (cleaning) from time to time.
Also, you will eventually need to replace it. You can mount the probe facing either upstream or downstream, but Teledyne Isco recommends facing upstream, as there is a stop on the sensor carrier that is not effective when the probe is facing downstream.
- Remember to unscrew the rubber guard cap from the sensing end of the probe when you install it, or the probe will be unable to sense the flow stream.

The guard cap is to protect the probe during shipment and storage and to keep the glass membrane and liquid junction from drying out. If you remove the probe for any reason, clean it and replace the cap after filling with 4.0 buffer solution. **Never store the probe dry or without the cap in place.**

The Isco amplifier box extends the allowable distance between the probe and the flow meter. The probe has a 25-foot cable, so you must mount the amplifier within this distance. The maximum distance between the amplifier box and the flow meter is 1,000 feet.

Table 4-3 pH Probe Specifications

Description	Submersible, horizontal-mounting probe with combination-type electrodes. Porous Teflon [®] liquid junction to resist fouling and coating. Steam-sterilized glass hemi-bulb for long-term stability.
Size	6" long × 3/4 NPT.
Body Material	Stainless Steel
pH Range	0 to 14 pH units.
Temperature	32° to 176° F (0° to 80° C).
pH Accuracy	±0.1 pH units over the full range.
pH Electrode Junction	Double porous junction
Temperature Compensation	Performed by software inside the flow meter. The pH Probe contains an integral temperature sensor.

4.11.4 pH Probe Life

pH probes are consumable items, meaning that they will eventually fail and have to be replaced.

During the life of the probe you will have to clean and recalibrate it periodically. Grease and debris will interfere with the probe's ability to measure pH accurately. Grease, particularly, will coat the end of the probe. Because grease is an insulator, it will keep the ions from reaching the glass membrane and porous liquid junction, thus failing to create a voltage potential.

You can consider the pH probe at its end-of-life when you can no longer calibrate it (after cleaning) to ±0.2 pH with the standard buffers of 4, 7, and/or 10. Another indication of end-of-life is when the probe calibrates satisfactorily, but takes too long to stabilize (more than 10 minutes).

Such a probe could not possibly respond to rapidly-changing pH. If your situation requires fast response, you might consider end-of-life to be when stabilization time reaches five minutes.



Figure 4-9 pH Parameter Module

4.11.5 Storage and Maintenance of pH Probes

If you remove the pH probe from operation, be careful to keep the glass sensor bulb wet. Always store the probe with the rubber cover screwed completely over the threaded end of the sensor. Exposure to air causes the glass membrane on the sensor bulb to dry out. This makes it very slow to respond in solution. Prolonged or repeated dehydration of the bulb will ruin the probe.

The pH-sensitive glass can also become “conditioned” to its environment, especially when it is continuously exposed to high pH (10 and above) solutions. The glass does have a memory and will respond slowly when exposed to a lower pH solution after having been in a high pH solution for any significant period of time.

Storage of a pH probe in a 4.0 buffer solution is recommended as this has a regenerative effect on the glass and does not put a memory on it. Tap water will work if 4.0 buffer solution is not available. Deionized water is good for quick rinses to clean the element, but not for prolonged storage of an electrode. Continuous exposure of the ion-sensitive membrane to a wetted, but non-ionic solution will improperly condition the membrane.

The reference electrode is also adversely affected when allowed to dry out. Salt crystals from the electrolyte or precipitates of the solution measured will form salt bridges either within or on the surfaces of the liquid junction, causing the reference to be less conductive and resulting in a higher reference impedance. This condition will typically worsen until the unit no longer functions. Soaking the reference electrode in a 4.0 pH solution, or tap water if the buffer is not readily available, may bring the reference back to life. Boiling the electrode in 4.0 buffer solution or tap water could revive the electrode in more severe situations. If none of these solutions work, it may be necessary to replace the probe.

4.12 The Dissolved Oxygen (D.O.) Probe

This probe measures the amount of oxygen dissolved in a stream or waterway. Oxygen dissolved in water is necessary for many forms of life that dwell in lakes and streams. Inadequate supplies of dissolved oxygen will cause fish and other aquatic life that depend on them as a food source to die off or be sharply diminished in numbers. The measurement of dissolved oxygen content is of interest to those monitoring the condition of lakes and streams. Fish must have a certain minimum concentration of dissolved oxygen to thrive, typically 4 to 6 mg/l.

Note

The 270 D.O. module has been discontinued. Probes, service kits, and accessories are still available to maintain existing field units.

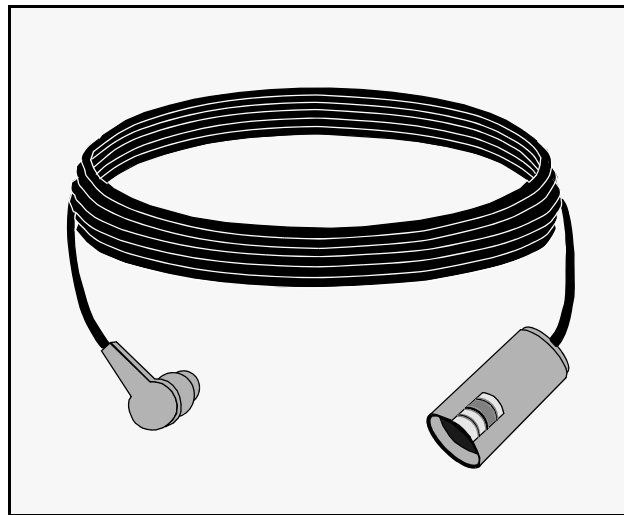


Figure 4-10 The D.O. Probe

Various types of pollution can cause the amount of oxygen dissolved in water to drop sharply, placing the aquatic life forms at serious risk. The D.O. Probe measures the amount of oxygen dissolved in water in a range from 0 to 20 mg/l. The flow meter can display D.O. in either mg/l (milligrams per liter) or ppm (parts per million) depending on your choice in programming.

For effective use of the D.O. Probe, please read and consider the following before making the installation:

- The D.O. Probe requires constantly moving water. The probe consumes oxygen during operation; this will deplete the oxygen available from stagnant or stratified waters, resulting in an inaccurate reading. Do not install it in a stilling well or in any location where water movement is intermittent or very low. As a guideline, a minimum velocity of one foot per second is suggested.

- Frequent maintenance is necessary when the probe is installed in flows with grease or solids content. Tests conducted by Teledyne Isco with probes installed in various waste streams indicate that grease and solids quickly coat the probe's membrane, making it impossible for oxygen to enter the reaction chamber. This will result in an abnormally low reading, or no reading at all. Cleaning the membrane is generally not effective, as it tends to drive the solids further into the membrane pores. You must usually replace both the electrolyte and the membrane to get an accurate reading. In severe cases of fouling it may be necessary to change the membrane very frequently, even as often as every other day.

4.12.1 How the D.O. Probe Works

A thin permeable membrane stretched over the sensor isolates the electrodes from the environment, but allows gases to enter.

When a polarizing voltage is applied across the sensor, oxygen that has passed through the membrane reacts at the cathode, causing a current to flow. The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the absolute pressure of oxygen outside the membrane. As the oxygen partial pressure varies, both the oxygen diffusion through the membrane and the probe current change proportionally.

4.12.2 D.O. Probe Preparation

First, unscrew the sensor guard; remove the O-ring and membrane, then thoroughly rinse the sensor with distilled water. Prepare the KCl electrolyte according to the directions on the bottle. **Use distilled water only.** You install the membranes by hand. The probe is shipped with a small folder containing several replacement membranes. To install a new membrane, follow these steps:

1. Secure the probe body so it is in an upright position. You can use a vise, adjustable wrench, or locking pliers, etc., whatever is satisfactory. Do not apply too much force to the probe body, or you will crack it.
2. Fill the cavity around the silver anode with electrolyte. The liquid should be free of bubbles and should completely cover the tip of the sensor. Fill the cavity to the point where any more electrolyte would spill over.
3. Lightly lay the membrane across the top of the probe. If you do this carefully, there will be no bubbles under the membrane.

 Note

Handle the membrane material with care, touching it at the ends only.

4. Place the O-ring on top of the membrane, generally conforming to the circumference edge of the probe.
5. Place the thumb and index finger from both hands opposite each other on the O-ring at equal distances.
6. Roll the O-ring down over the end of the probe, being careful not to touch the membrane where it covers the probe.
7. Trim off excess membrane with scissors or a sharp knife. Check to see that the stainless steel rod (thermistor) protruding below the liquid cup is not covered by extra membrane.

 **Note**

There must be no bubbles under the membrane and no creases in it for the probe to function correctly.

8. Shake any excess KCl solution from the probe. Reinstall the sensor guard. Keep the sensor in a humid environment when not in use and between measurements. The plastic bottle that was placed over the end of the sensor when it was shipped is ideal for this purpose. Place a piece of moist tissue inside the bottle, and slide the bottle over the probe.

4.12.3 Membrane Thicknesses

Teledyne Isco supplies a 2 mil (.002") thick membrane for use with the D.O. probe. This membrane is recommended for long-term monitoring situations only, typical of our users' applications. Use only this thickness of membrane with D.O. probes connected to Isco flow meters. Do not use other thicknesses of membranes, as the Parameter Module used with the probe is calibrated only for the 2-mil membrane, and cannot be recalibrated in the field. Using other membrane thicknesses will result in inaccuracy. Thinner membranes are also very fragile and difficult to install.

4.12.4 D.O. Probe Installation

The D.O. probe attaches to a sensor carrier bracket that snaps into an Isco mounting ring. Use the specific size of *Spring Ring* for pipes less than 15" in diameter, and the *Scissors Ring* for pipe sizes greater than 15" diameter. Refer to the instruction sheet supplied with the mounting ring.

 **Note**

When installing the D.O. probe and its sensor carrier bracket, make sure the mounting slots on the sensor carrier are *completely pressed* into the mating tabs on the ring. The probe relies on a full engagement between tabs and slots for secure mounting. If the slots are loose against the tabs, the probe may be swept away by the force of the stream.

4.12.5 Probe Operation and Precautions

The following factors determine the life of the D.O. probe and the frequency of service.

- Membrane life depends on use. Membranes will last longer if installed properly and treated with care during use. Contents of the flow stream are also important, as some substances will foul the membrane very quickly. Erratic readings will result from loose, wrinkled or fouled membranes, or from large bubbles in the electrolyte reservoir. If erratic readings or evidence of membrane damage occur, you should replace the membrane and the KCl electrolyte.
- In environments where the membrane becomes rapidly coated with oxygen-consuming or oxygen-evolving organisms, erroneous readings may occur. Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by reacting like oxygen at the probe. If your readings seem unreasonable, you may need to perform analysis to determine whether these gases are the cause. Long-term use, as for monitoring, can magnify the effect of these factors in some applications.
- Avoid any environment containing substances that may attack any of the probe's materials. Some of these substances are concentrated acids, caustics, and strong solvents. The probe materials that come into contact with the sample include FEP Teflon, acrylic plastic, ABS plastic, EPR rubber, stainless steel, epoxy, polyetherimide, and the polyurethane cable covering.
- For correct probe operation, the gold cathode must always be bright. If it is tarnished (which can result from contact with certain gases) or plated with silver (which can result from extended use with a loose or wrinkled membrane), you need to restore its surface. You can return it to Teledyne Isco or clean it yourself with a probe reconditioning kit. (This kit is available from Teledyne Isco.) Never use chemicals or any abrasive not supplied with this kit. It is also possible for the silver anode to become contaminated, which will prevent successful calibration. Try soaking the probe overnight in a 3% ammonia solution; then rinse with deionized water, recharge with electrolyte, and install a new membrane. If you are still unable to recalibrate the probe after several hours, return the probe to Teledyne Isco for service.
- If the sensor O-ring is worn or loose, you should replace it. The probe comes with a kit of O-rings and replacement membranes. Additional replacement O-rings are available from Teledyne Isco in an O-ring replacement pack.
- If the probe is not going to be in constant use, you should store it in the plastic bottle provided in shipping. To keep the electrolyte from drying out, place a small piece of moist towel or sponge in the bottle and insert the

probe into the open end. If you need service for your D.O. probe, Teledyne Isco recommends returning the unit for evaluation. In addition to servicing the probe, we can also provide advice on product applications, and you can also purchase other accessories for use with the D.O. probe. Use only 2-mil membranes with D.O. probes connected to Isco flow meters.

You must use the Isco 270 D.O. Module box between the probe and flow meter; this extends the distance between the probe and the flow meter to 1,000 feet.



Figure 4-11 D.O. Parameter Module

Table 4-4 D.O. Probe Specifications

Cathode	Gold
Anode	Silver
Membrane	FEP Teflon; 2 mil standard
Electrolyte	Half-saturated KCl (Potassium Chloride)
Temp. Range	0 to +45° C
Polarizing Voltage	0.8 Volts (Nominal)
Probe Current in Air at 30° C	19 microamps (nominal)
Probe Current in Nitrogen at 30° C	0.15 microamps or less
Connection	12 ft. (3.2 m) cable with 5-pin male M/S connector
Response Time	Typical response for dissolved oxygen, using supplied membranes, is 90% in 20 seconds. Response at low dissolved oxygen levels is typically 90% in 60 seconds.

4.12.6 Calibrating the D.O. Probe

1. Prepare the probe as described above (fill the probe cavity with electrolyte and seat the membrane).

☑ Note

You must use the Isco Temperature Probe with the D.O. Probe to provide temperature compensation.

2. Wrap both the D.O. Probe and the Temperature Probe in a damp cloth. Wait ten minutes for them to stabilize, then proceed.
3. Go to **step 1** on the flow meter. Select PROGRAM, then step through the units of measure with **Enter** until you reach the menu for pH measurement.
4. Select NOT MEASURED. Press **Enter**. Then D.O. UNITS will appear. Select either MG/L or PPM. Press **Enter**. Exit the program and re-enter, going to **step 3**.

☑ Note

You must select measurement of D.O. in **step 1** or the D.O. menu will not appear in **step 3**. If you cannot get the D.O. menu to appear in **step 3**, recheck your selections in **step 1**. Remember that you must select NOT MEASURED for pH in **step 1** or D.O. will not appear on the menu for the rest of the program.

PARAMETER TO ADJUST
NONE LEVEL D.O.

5. Select D.O. Press **Enter**. The following display will appear:

D.O. CALIBRATION
D.O STANDARD, ABS BAROMETRIC PRESSURE,

ALTITUDE is just off the screen. You can select D.O. STANDARD if this calibration medium is available to you. Do not select ABS (absolute) BAROMETRIC PRESSURE unless you are at sea level or know how to correct for this value. The barometric pressure provided from the Weather Bureau is corrected for altitude. Select ALTITUDE.

ALTITUDE UNITS OF MEASURE
FT, M

Then:

ENTER ALTITUDE
ALTITUDE = XXXXX FEET (or meters)

6. Enter the altitude for your location. This is critical to the probe's accuracy. The following display will then appear:

WRAP D.O. PROBE IN MOIST CLOTH
PRESS ENTER WHEN STABLE: X.XXX MG/L

The reading is in milligrams of oxygen per liter. If you chose PPM in program **step 1** for D.O. units, the reading would be in parts per million.

4.13 Installation of Parameter Probes in Round Pipes

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

The following sections describe sensor installation using the two options available for mounting sensors in pipes or round-bottomed flow streams. For pipes up to 15" (38.1 cm) in diameter, **stainless steel self-expanding mounting rings (Spring Rings)** are available. For pipes larger than 15" in diameter, Teledyne Isco offers the **Scissors Rings (Universal Mounting Rings)**.

4.13.1 Spring Rings

To install a spring ring, you compress the ring, slip it inside the pipe, and then allow it to spring out to contact the inside diameter of the pipe. The inherent outward spring force of the ring firmly secures it in place. A typical self-expanding mounting ring (with a probe mounted on it) is shown in Figure 4-12.

These mounting rings are available for use in pipes with inside diameters of 6" (15.2 cm), 8" (20.3 cm), 10" (25.4 cm), 12" (30.5 cm), and 15" (38.1 cm). The Isco part numbers for the various size mounting rings available are listed in Appendix A. These part numbers include not only the ring, but also the miscellaneous hardware necessary to mount the sensor on the ring.

CAUTION

Always wear leather gloves when handling the rings (either type). The metal is finished, but there is still a possibility of cutting your hands on the edges.

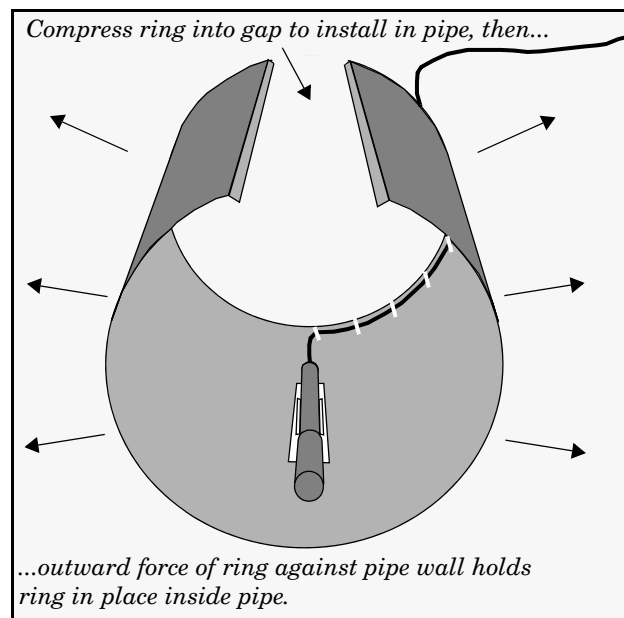


Figure 4-12 Sensor Installed on a Spring Ring

Completing the assembly

To complete the sensor-spring ring assembly procedure, attach the sensor cable to the downstream edge of the ring. Follow the cable routing shown in Figure 4-12. Other routing directions may affect measurement accuracy. The cable can actually create a stilling well downstream from the sensor, causing the level to read low. Use the self-locking plastic ties supplied with the ring. Install the ring in the pipe by compressing it. Press inward on both sides and slide the ring into the pipe.

Route the sensor cable out of the stream and secure it in position by placing the ties through the holes in the mounting ring and then locking them around the cable, as shown. To prevent debris from catching on the cable, it is important to attach the cable to the mounting ring so it offers as little resistance to the flow as possible.

The spring ring may need anchoring. Under conditions of high velocity (greater than 5 feet per second or 1.5 meters per second), the ring may not have sufficient outward spring force to maintain a tight fit inside the pipe. The ring may start to lift off the bottom of the pipe in a waving fashion, or may even be carried downstream.

This problem is more prevalent in the larger diameter pipes (10", 12", and 15", and in pipes with smooth inside surfaces, such as plastic pipes). If any of these conditions are present, or if movement of the mounting ring is detected or suspected, you must anchor the ring in place. You can do this by setting screws through the ring into the pipe, or by other appropriate means. If there is a problem with the smaller diameter rings, it may be sufficient to simply increase the outward spring force of the ring by bending it into a less round configuration.

4.13.2 Scissors Rings

For pipes larger than 15" in diameter, Teledyne Isco offers the adjustable Scissors Ring (also known as the Universal Mounting Ring). This device consists of two or more metal strips that lock together with tabs to form a single assembly. There is a base section where the sensors are mounted, one or more extension sections (usually), and a scissors section at the top that expands the entire assembly and tightens it inside the pipe. The scissors mechanism includes a long screw that increases the width as it is tightened.

The assembled rings fit pipe diameters from 16" to 80". Secure the unit in place by tightening the scissors mechanism with a $\frac{5}{8}$ " socket wrench or other suitable tool. Ring sections are .040" thick half-hard 301 stainless steel sheet. All other parts are also stainless steel, except for the plastic cable ties in the hardware kit.

Each extension, 1, 2, 3, and 4, adds 9.0", 21.5", 31.5", or 41.5", respectively, to the circumference of the ring. Used alone, the base section fits pipe that is approximately 16" to 18" in diameter. The 9.0" (the smallest) extension exists so that in larger pipe sizes, where large variations in circumference can

occur, you can use one or two of these extensions to take up or remove slack, to bring the scissors mechanism into a position where it can be effectively tightened.

Mounting ring kits are available for different pipe sizes. A kit is also available for partial pipe applications (see your Mounting Rings manual). For a listing of part numbers and ordering information, see Appendix A.

To prevent debris from catching on the cable, it is important to attach the cable to the mounting ring so it offers as little resistance to the flow as possible. Attach the sensor cable to the downstream edge of the ring, using the self-locking plastic ties supplied with the ring. Place the ties through the holes in the edge of the mounting ring and then lock them around the cable.

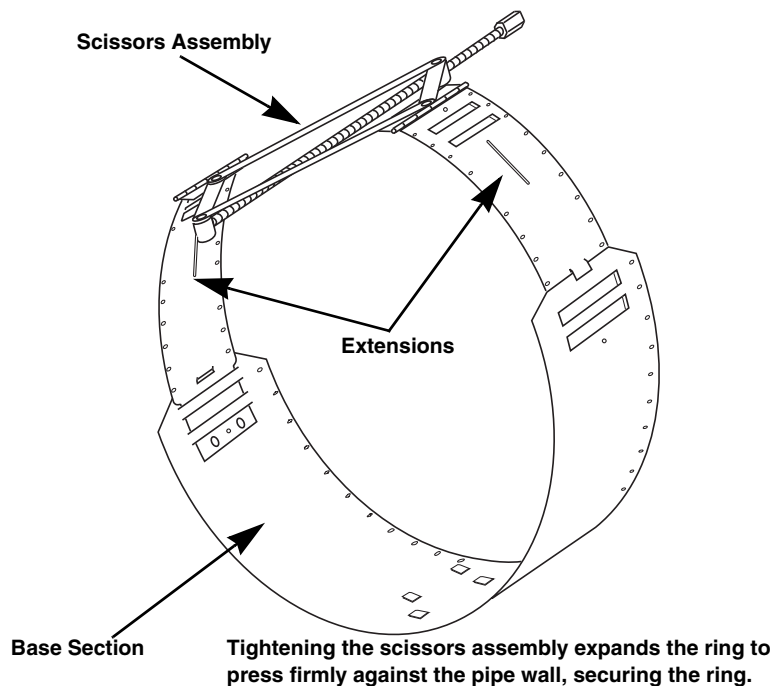


Figure 4-13 Scissors Ring Adjustment

4.14 The YSI 600 Multiple Parameter Sonde

The YSI 600 Sonde is a multi-purpose, water quality measurement and data collection system. It is intended for use in research, assessment, and regulatory compliance. The YSI 600 Sonde can measure the following water qualities:

- Dissolved Oxygen
- Conductivity
- pH
- Salinity
- Total Dissolved Solids
- Temperature

The YSI 600 is ideal for profiling and monitoring water conditions in industrial and wastewater effluents, lakes, rivers, wetlands, estuaries, coastal waters, and monitoring wells. It can be left unattended for weeks at a time with measurement parameters sampled at your selected interval and data transmitted to the flow meter. You can use the 600 as deep as 200 feet below the surface, or in as little as a few inches of water. The fast sensor response of the YSI 600 makes it ideal for vertical profiling. Its small size means it can fit inside two-inch diameter monitoring wells.

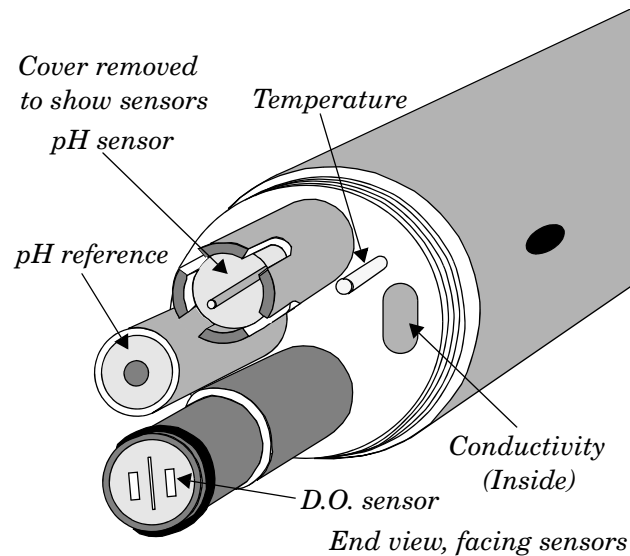


Figure 4-14 The YSI 600 Multiple Parameter Sonde

A “Rapid Pulse Dissolved Oxygen Sensor” eliminates the need for stirring, providing accurate results without an expensive and bulky stirrer. Because no stirring is required, no supplemental power supply or battery is needed, and sensor drift caused by passive fouling is minimized.

The YSI 600 communicates with any 4200 Series flow meter equipped with suitable hardware and software. Data can be exported through Flowlink software for further processing.

The YSI 600 connects to a modified 9-pin Rain Gauge Terminal on any 4200 Series Flow Meter. Operation of the Rain Gauge with YSI 600 is still possible with a special Y-connect cable. Modification of older 4200 Series Flow Meters is possible with changes in connectors and boards. For additional information, contact Teledyne Isco.

The YSI 600 is available with a cable 25 feet long to connect to the flow meter. The cables are waterproof at the sonde and can be used in lab or field.

Information about programming the flow meter to use the YSI 600 is found in Section 2 of this manual. Information about the YSI 600 Sonde is found in the YSI manual.

4.15 Mechanical Totalizer

A mechanical totalizer is available for 4200 series flow meters that consists of a seven-digit, non-resettable mechanical counter mounted in the front panel. It must be ordered with the flow meter. The totalizer advances according to program selections for units of measure and the maximum flow of the primary device used. The totalizer is internally set to advance at $\frac{1}{100}$ of the rate of the display totalizer. Consequently, you must multiply the number shown on the mechanical totalizer by 100 to determine the actual value for total flow.

4210 Flow Meter

Section 5 Maintenance and Service

This section of the 4210 instruction manual provides detailed instructions on the care and routine maintenance necessary to keep the flow meter in top operating condition. Included are sections on cleaning the flow meter, reactivating the desiccator, maintaining the ultrasonic level sensor, and servicing the internal printer.

Teledyne Isco strongly recommends that you become familiar with the maintenance procedures presented here. While the 4210 is ruggedly built to withstand severe field conditions, it will function best and remain most reliable if these simple procedures are learned and followed.

5.1 Routine Maintenance

5.1.1 Care of the Flow Meter Case

If the lid is tightly latched, and all the M/S connectors on the side of the case are tightly capped, you can clean the case by spraying it with a hose or washing it with soapy water. Do not use a hose with a nozzle or a high pressure hose-and-wand such as is found at car washes. Do not immerse the flow meter in a tank of water to wash it. While designed to withstand accidental submersion in water, if that should occur, the flow meter is not intended for routine submersion.

5.1.2 Care of the Case Seal

Periodically inspect the case seal and clean it, if necessary. The ridge extending around the edge of the back half of the flow meter cabinet forms a seal with the groove in the cabinet door. It should be free of dirt, sand, etc. If it isn't, the case may not seal completely when closed. Clean it carefully with a damp cloth. The rubber gasket in the lid should also be clean; if not, clean it with a small brush and a damp cloth.

If you do any cleaning while the case is open, be careful not to allow any dirt or debris to fall inside the flow meter case; it is best to work on the flow meter with the case standing upright. If the seals are not properly maintained, they may leak, causing damage and eventual failure of the components inside.

5.1.3 Preventing Moisture Damage

To prevent moisture damage to internal components, keep the lid tightly latched at all times, except when you need to access the front panel to change the program or the paper roll. Do not run the flow meter with the case open as a matter of routine. If you do, you will expose the internal components to dirt and moisture; you will also cause the case desiccant canister to prematurely saturate. Inspect the desiccant canister periodically and recharge it as necessary.

It is also important to keep the external connectors clean by keeping the mating connectors or the protective caps tightly screwed down. Under severe operating conditions, you can spray the threads of the connectors with a cleaner/lubricant (such as Jif manufactured by GC Electronics or WD-40 manufactured by the WD-40 Company) to prevent corrosion. Be careful not to spray any of the conductive terminals (pins or jacks) inside the connectors; residue from the sprays could cause intermittent or failed contacts.

5.1.4 Checking and Regenerating the Desiccant

As shown in the picture, the 4210 is equipped with a reusable desiccating canister attached by a spring steel clamp attached to the inside of the flow meter's lid. This canister contains silica gel that attracts moisture trapped inside the flow meter's case when it is closed. This keeps the inside of the case completely dry during shipment, storage, and use. If you leave the case open, the desiccant will attract moisture from the surrounding air. Eventually, its absorption capacity will be reached, and it will no longer be able to protect the internal components of the flow meter.

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

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

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

Important Guidelines to Follow:

- Always use a vented, circulating forced air, convection oven in a well-ventilated room.
- DO NOT use a microwave oven to recharge the desiccant cartridge.
- Always use the recommended temperature. Never heat the desiccant at higher than recommended temperatures.
- Avoid heating the desiccant longer than necessary.

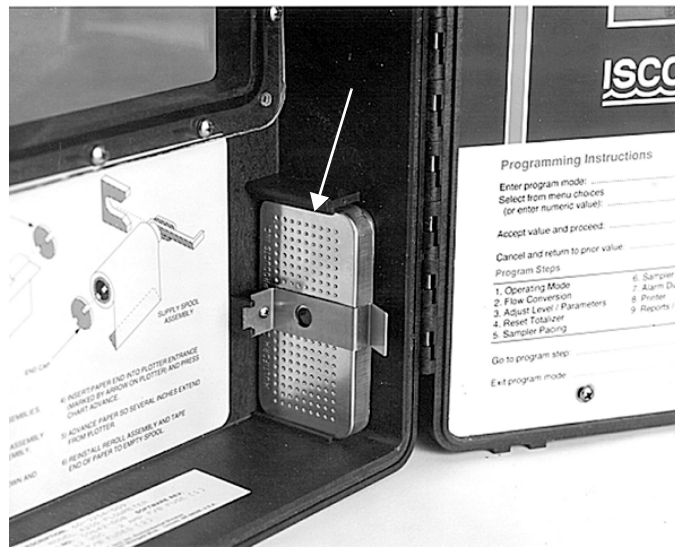


Figure 5-1 Location of the Internal Desiccant Canister

CAUTION

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

5.1.5 Care of the Ultrasonic Level Sensor

The ultrasonic level sensor requires little maintenance. It is encapsulated for protection from the environment. The level sensor's transducer is encapsulated behind the rubber potting material. Do not drop the assembly, nor attempt to take it apart. The ultrasonic level sensor contains no user-serviceable parts. If the transducer's surface becomes contaminated due to long-term use or accidental submersion, operation of the unit may be impaired. If this happens, clean the unit. Clean the case with a brush. Clean the surface of the transducer with a gently flowing stream of water.

5.1.6 Cable Inspection

Inspect the cables connecting the ultrasonic level sensor to the flow meter periodically for deterioration caused by abuse or exposure to the elements. Damaged cables threaten the operation of the ultrasonic level sensor; replace them. Keep connectors clean and dry. In permanent installations, always install cables so they are not at risk of damage resulting from other activity taking place in the area.

Cables repeatedly subjected to physical abuse will fail and should be installed in conduit for protection. In temporary installations, avoid running cables where they may trip someone or be run over by heavy equipment.

5.2 Maintenance of the Printer

The internal printer needs little maintenance beyond changing the chart roll and the ink ribbon. Refer to the pictures provided for each section. Also refer to the label inside the cabinet.

5.2.1 Changing the Roll of Paper

To change the chart paper, you will need:

- new roll of paper
- knife or pair of scissors
- small piece of tape

The printer will shut down when the paper runs out. The roll is nearly empty when a 1-inch wide pink band appears on the left side of the chart.

To change the roll:

Removing Empty Paper Roll

1. Locate the handle on the left side of the take-up roll and pull it straight out until the take-up roll slips off the printer.
2. Remove the paper roll from the take-up spool by holding the handle in one hand with your thumb pressed against one of the slots in the white end cap.

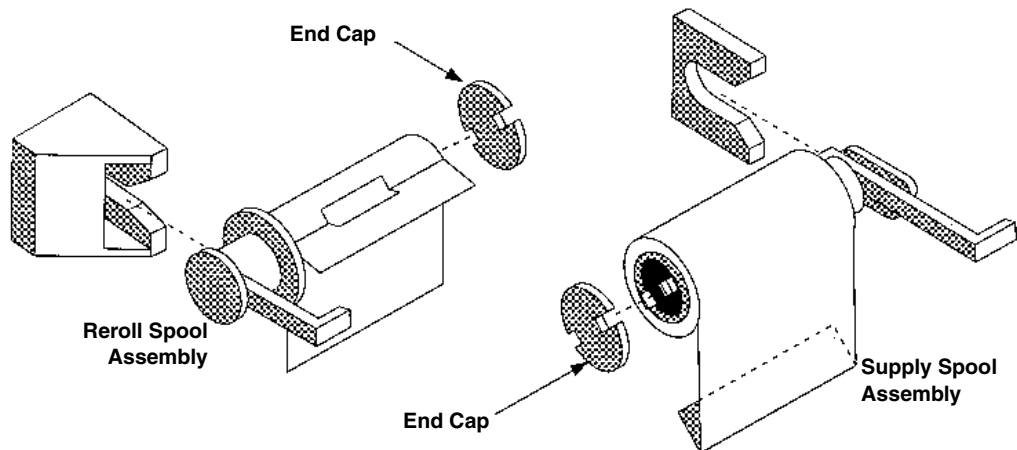


Figure 5-2 Paper Roll and Spool Assemblies

3. Snap the white end cap free from the two black catches on the end of the spool.
4. Pull the paper roll off the spool with your other hand.
5. Remove the feed spool by pulling on the handle extending from the right side of the printer.
6. Snap off the other white end cap as described previously. Save the white end caps; you will reuse them.
7. Remove the empty roll from the spool by holding the handle in one hand and pulling the roll from the spool with the other.
8. Slide the new roll onto the feed spool so it unrolls from the back side - facing away from you.

Installing New Paper Roll

9. Line up the slots in the cardboard tube with the raised guides on the spool.
10. Reattach the white end cap by wedging the two catches on the end of the spool into the two slots on the white end cap.
11. Peel the paper back gently so it will unroll freely. Using the knife or scissors, cut off the end of the roll if it is torn.
12. Fold the paper over on itself so the end is straight and stiffer than a single layer of paper would be.
13. Unroll a few inches of the paper and set the roll on top of the cabinet.
14. Use your fingers to feed the paper down the back of the internal printer to where it touches the roller. Make sure the paper gets past the lever for the paper sensing switch.
15. Press the **Chart Advance** key and hold it until the paper comes through the printer mechanism.
16. When the paper comes through, reinstall the feed spool with the new roll on it by snapping it into the printer assembly.
17. Run a few inches through the printer, using the **Chart Advance** key; then unfold the end.
18. Put the cardboard tube from the empty roll on the take-up spindle and reattach the white end cap by wedging the catches on the end of the spool into the two slots on the white end cap.
19. Use the piece of tape to attach the end of the new paper to the cardboard tube from the old roll.
20. Roll some of the paper onto the spool so that it will wind clockwise, facing away from you. Then reinstall the take-up roll into the top of the printer. Be careful to push it all the way back in, so that the take-up gear on the end of the spool assembly will reengage.
21. When the take-up spool is back in place, again push the **Chart Reroll** key; this will remove any slackness in the paper.

5.2.2 Ink Ribbon Replacement

Ribbon life will vary greatly from one installation to another depending on how often the printer has to print. When the characters on the chart become difficult to read, you should replace the ribbon. If possible, try to replace the ribbon at the same time you change the paper roll, as it is easier to replace the ribbon when the roll of paper is out of the way.

To replace the ribbon:

1. Turn the unit off.
If there is paper in the unit, remove the take-up spool and unroll enough paper to get it out of the way, so you can clearly see the two ribbon spools. Each spool has a ribbon-detecting lever pressing against the ribbon. Note the direction the ribbon leaves the left spool and how it winds onto the right spool.

2. Take hold of one of the spools and rotate it slightly, loosening the ribbon.
3. Lift gently until the spool comes free from its shaft. Do the same with the other spool.
4. Lift the chart and take-up spool out of the way and remove the ink ribbon from the printer mechanism, noting how it threads through the unit.
5. Thread the new ink ribbon through the printer mechanism.
6. Locate the three small pins on each spool of the ink ribbon and turn the spools so the pins face the gears on the two ribbon shafts.
7. Replace the two spools on their respective shafts, pushing the detector levers out of the way so the spools will easily re-engage their gears.
8. Gently rotate each spool to tighten the ink ribbon. Reinstall the paper take-up roll if necessary.

5.2.3 Do Not Lubricate or Disassemble

It is not necessary to provide any periodic lubrication to the internal printer mechanism in the 4210 Flow Meter. The internal printer mechanism has been designed for long life and trouble-free service without special maintenance, if it is not subjected to abuse. Teledyne Isco recommends no attempt be made to oil or disassemble the mechanism should it malfunction. Oil attracts dirt; some oils become gummy over a period of time and may cause parts of the mechanism to bind or stick. Attempts to disassemble the internal printer mechanism may cause the frame or component parts to be bent or distorted. This will certainly cause malfunction. Do not force any part of the mechanism with tools or probes. Other than the roll of paper and the ink ribbon, the internal printer mechanism contains no user-serviceable parts. Teledyne Isco recommends the unit be returned to the factory for service should this become necessary.

5.3 Software Updates

Update Isco Instrument Software installs software in Isco instruments and modules. This application will transfer a binary file from your PC to the instrument's flash memory.

Updated binary files are available from Teledyne Isco when enhancements have been made to the instrument software. Contact the factory for help with obtaining these files.

CAUTION

Updating the instrument software or resetting the instrument may completely erase readings and reports stored in the instrument's memory. Collect the data from the instrument before proceeding.

5.3.1 Updating the Flow Meter Software

The flow meter should be powered and turned on.

Connect your computer to the flow meter using the Computer Connect Cable (Interrogator Cable) and start the program Update Isco Instrument Software.

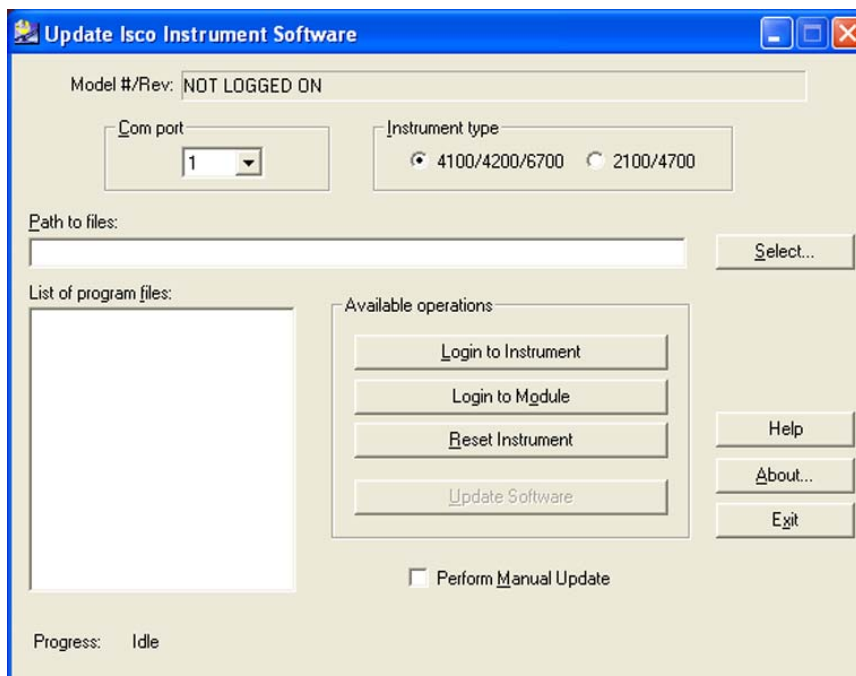


Figure 5-3 Open the software update program

Click the Help button and follow the steps listed under Update Instrument Software. Do not disturb the connection or stop the update while the file transfer is taking place. When the transfer is complete, the program displays an “Operation successful” message. Click OK and close the program.

Your flow meter’s software is now updated and ready for operation.

5.4 Servicing and Troubleshooting

This section of the 4210 instruction manual provides servicing information and a troubleshooting guide to assist you in correcting certain minor malfunctions that might occur. Included are sections describing disassembly of the unit, on fuse replacement, and on the care and repair of CMOS circuitry.

You can remove the flow meter mechanical assembly from the cabinet for inspection and servicing, if necessary. First, remove the four screws, two at the top, and two at the bottom, that hold the flow meter chassis in the cabinet. Then you can lift chassis out by carefully inserting the thumb or index finger from each hand into the upper right and lower left corners of the opening surrounding the printer. Do not try to lift the flow meter out of the case by holding on to any part of the printer. If you do, you could bend or distort part of the printer, possibly damaging it. Once the chassis has cleared the case, you can grip it with both hands by its edges and lift it free of the case.



Figure 5-4 Lifting the Flow Meter from the Cabinet

5.4.1 Fuse Replacement

With the flow meter chassis out of the cabinet, you can locate and change fuses. The fuses are located on the printed circuit board under a cover on the back of the flow meter keyboard assembly. Slide the cover off and you can see the fuses. The fuses are labeled F1, F2, and F3. The proper size for each of these fuses is:

F1 - 5 amp., fast blow

F2 - 5 amp., fast blow

F3 - 2 amp., fast blow

Always replace a blown fuse with one of the same value. Using a larger value fuse may cause serious damage to the flow meter or to its power supply.

5.4.2 Display Warnings

The LCD will show various warnings and error messages to warn of problems in the program, or difficulties inside the flow meter. Some messages request routine maintenance; others point out programming errors; still others indicate serious internal difficulties. Following are typical warning messages displayed on the LCD:

CHECK PRINTER FUSE
PRINTER JAMMED
PAPER OUT

5.4.3 System Reset

If the flow meter does not appear to be operating normally, you can try to restart the processor by turning the unit off, waiting a few minutes, and then turning the unit back on. If that doesn't work, you can (software) reset the system by pressing both the **4** and **Exit Program** keys at the same time while the unit is powering up. Pressing 4 and Exit Program only works when the unit is powering up; it has no effect when the unit is running.

 **Note**

Pressing 4 and Exit Program when powering up will cause most programmed entries to be lost. Accumulated data stored in the 4210 will also be lost. The flow meter will revert to the program originally entered at the factory. If this operation is performed, it will be necessary to reprogram the unit to user specifications.

Pressing 4 and Exit Program may leave some values programmed into the flow meter's computer. If you want to remove all programmed entries, press **1** and **Clear Entry** when the flow meter is powering up.

The following messages describe serious internal problems, indicating service is required:

ROM CHECKSUM ERROR - or -

FOUND BAD RAM - CALL CUSTOMER SERVICE

If these messages appear, call the Teledyne Isco Technical Repair Department for instructions at (866) 298-6174 or (402) 464-0231.

 **CAUTION**

Do not attempt to disassemble or repair the 4210 Flow Meter (other than changing fuses) unless you are skilled in the evaluation and repair of microprocessor-based circuitry. Teledyne Isco recommends no attempt be made to disassemble or repair the printer mechanism or display module.

5.4.4 If Serious Problems Occur

If you suspect an electronic problem, Teledyne Isco strongly recommends that you call the Teledyne Isco Technical Repair Department - (866) 298-6174 or (402) 464-0231 outside the U.S.A., Canada, and Mexico. The service department will advise you on how to return the 4210 to the factory for servicing. Due to the complex nature of microprocessor-based circuitry, specialized

knowledge and instrumentation are required for troubleshooting. The Teledyne Isco service department has trained technicians and specially-designed equipment necessary for timely, efficient repair of the 4210 Flow Meter. If you still wish to attempt repairs, the Teledyne Isco Customer Service Department is available to provide additional advice and information on servicing.

5.4.5 Processor Servicing

When attempting to isolate problems within the unit, the CPU and memory should be assumed to be working properly until attempts to find problems in the peripheral circuitry have been exhausted. This is for two reasons: first, the likelihood of failure is far greater on transistor drive circuits (heavier currents are handled here), than on the CPU or memory. Second, it is unlikely that the repair facility will have the time or equipment to do worthwhile troubleshooting (beyond exchanging components) on the CPU or memory.

5.4.6 Preliminary Troubleshooting Steps

The electronic circuitry of the 4210 is solid-state and highly reliable. If the unit should fail to operate properly, the problem is most likely a mechanical failure. Items such as a broken or intermittent connection in the power cable or wiring harness should be suspected. When the unit does not work, do not automatically assume the CPU is at fault. Telephone consultation with Technical Service is strongly recommended. Following are suggested areas to check before attempting to service the CPU and associated circuitry.

1. Check the ultrasonic transducer and its cable.
The flow meter could be all right and will appear not to work because of a damaged cable or misaligned transducer; check these first.
2. Check to see if any fuses are blown.

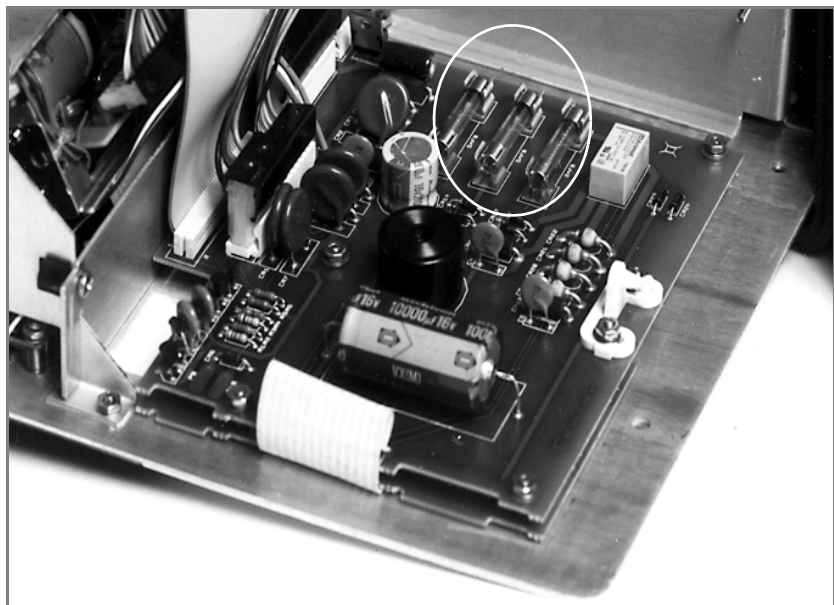


Figure 5-5 Location of the Three Fuses

3. Check the battery or power supply.
Proper voltage to the unit should be from 10.5 to 14.5 VDC. If the unit is powered from the AC supply, make sure the branch circuit is delivering at least 110 VAC to the power supply cord.
4. Check the wiring harnesses, connectors, and solder joints.
Under normal conditions these should stay in good condition. However, abuse, or operation of the unit with the door open or the desiccator saturated could cause corrosion of the connectors in certain atmospheres.
5. Look for physical damage.
Burned or broken components, overly hot components, stuck or inoperative switches, or the evidence of water damage.
6. Look for shorted or open diodes and transistors, especially driver transistors.
7. Check the voltage regulators.
The output voltage from the regulators should be within 5% of their rated value. Check to see that rated voltages are available at various places on the boards.
8. Look for excessive current draw from some or all the circuitry.
This will usually be accompanied by an unusual amount of heat coming from some component or group of components, and the voltage on the power rails may be depressed.
9. Check the input signals to unit and see that they are correct.
This will require the use of an oscilloscope. Consult Technical Service for the appearance of wave forms.
10. Check to see that the crystal oscillator is operating and at the proper frequency.
11. Check the reset circuitry to see that it is working properly.

5.5 Precautions for Servicing CMOS Circuitry

Most of the circuitry in the 4210 Flow Meter is made up of CMOS components. Because of the oxide gate structure of these devices, they are extremely susceptible to destruction caused by the discharge of static electricity through their inputs. Note that many of the driver transistors in the 4210 are power MOS devices; they are susceptible to static damage just as CMOS ICs are. Because of this risk, certain precautions must be taken when working on these circuits.

5.5.1 Hazard of Static Electricity

The voltage levels present from static buildup due to walking over carpeted floors, movement of woolen or synthetic clothes over chair seats, workbenches, etc., are high enough to destroy CMOS circuitry when performing repair work. Ideally, all tools, soldering irons, etc., should be grounded, and work should be conducted on a grounded metal workbench, with grounding straps worn on the wrists of personnel. It is recognized that in most field repair situations, such precautions are impractical. However, certain extreme hazards must be avoided.

- Never perform any work in a room with a carpeted floor.
- Always roll up work clothes' sleeves so that the arms are in contact with the working surface.
- Avoid using a work surface made of an extremely good insulator.
Formica or glass are good insulators and should be avoided. A metal surface is best; a wood surface is acceptable. Conductive grounding mats are available for work stations and are worthwhile if much repair is to be done.
- The degree of hazard depends on the level of humidity. Be particularly careful if the work area is extremely dry, or if the work is being done in the winter, when indoor forced heating and low temperatures outdoors can cause the relative humidity level to be very low.
- Keep yourself grounded when handling disassembled equipment.
When arriving at the work area, after a unit has been opened for repair, make an effort to always be touching the metal chassis before touching any of the circuit components.
- Be especially careful handling the CMOS integrated circuits when they are removed from the rest of the circuitry.
Simply being connected to the rest of the circuitry provides some protection. Most of the circuitry is well-protected from damage caused by static discharge when the unit is powered up. However, an IC should never be replaced when the unit is turned on.
- Individual CMOS semiconductors and built-up printed circuit boards should always be transported in conductive packaging.
Foil is satisfactory; metallized plastic bags are also available and work well. Ordinary plastic bags and pink poly are not satisfactory unless the legs or leads of the semiconductor are also stuck into a block of black conductive foam. Do not accept replacement components that you purchase if they do not come in marked, protective packaging. They may already be destroyed. Do not use them.
- Once assembled and soldered, printed circuit boards are easily damaged by improper repair procedures.
Do not attempt to remove components, particularly ICs, from printed circuit boards unless skilled at this procedure. A defective component may be located, changed, and the unit still not work, if too much heat or pressure has broken the foil traces or pulled the cores from holes on the board.

Contact Customer Service – If trouble symptoms persist and cannot be located, call the Customer Service Department, at (800) 228-4373, or, outside the U.S.A., call (402) 464-0231.

4210 Flow Meter

Appendix A Replacement Parts and Accessories

A.1 Replacement Parts

The following section contains illustrations and corresponding tables of 4210 Flow Meter replacement parts. A list of accessories and optional equipment can be found at the end of this section. Replacement parts can be purchased by contacting Teledyne Isco's Customer Service Department.

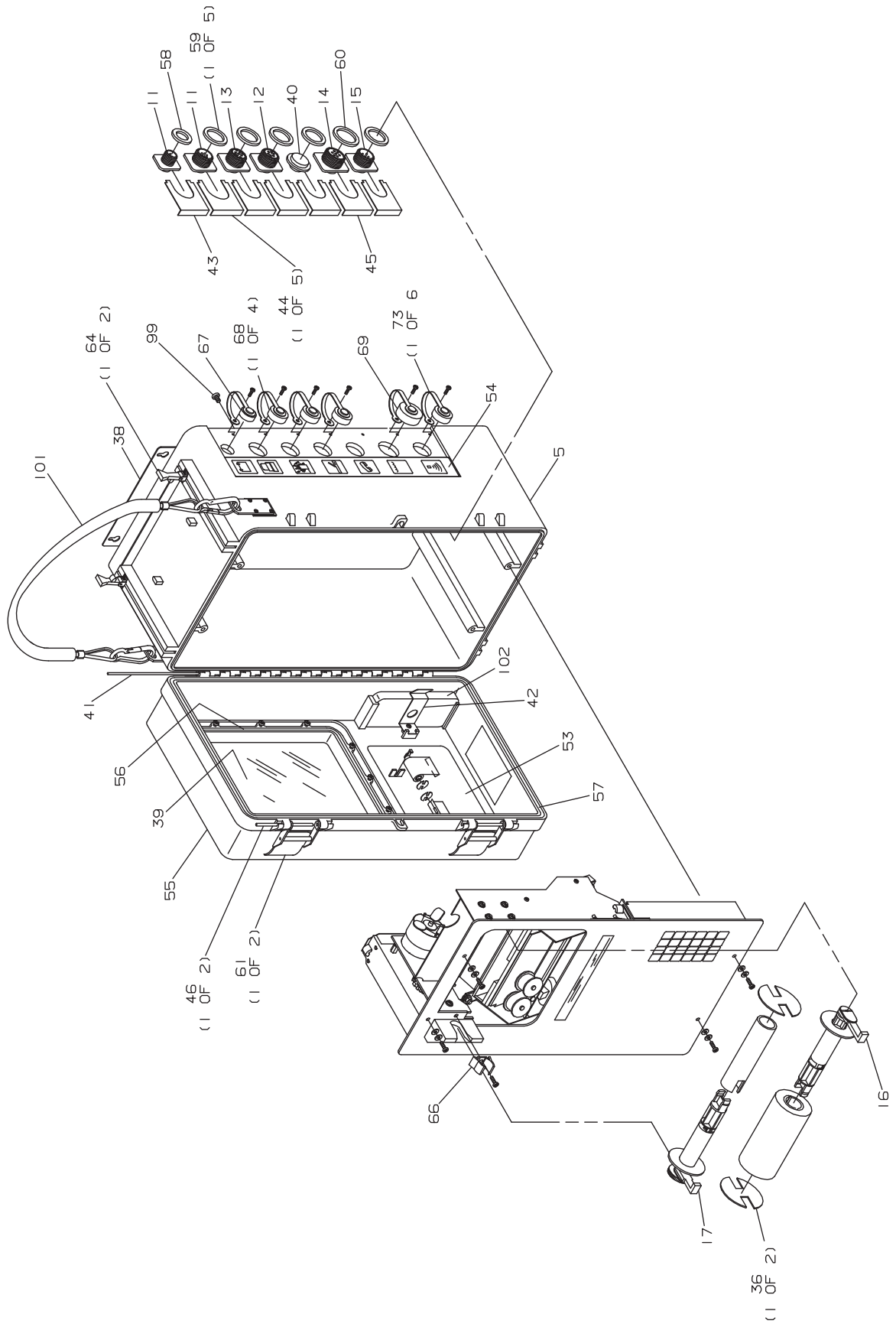
Teledyne Isco

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

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

E-mail: IscoInfo@teledyne.com

4210 Flow Meter
 Appendix A Replacement Parts and Accessories



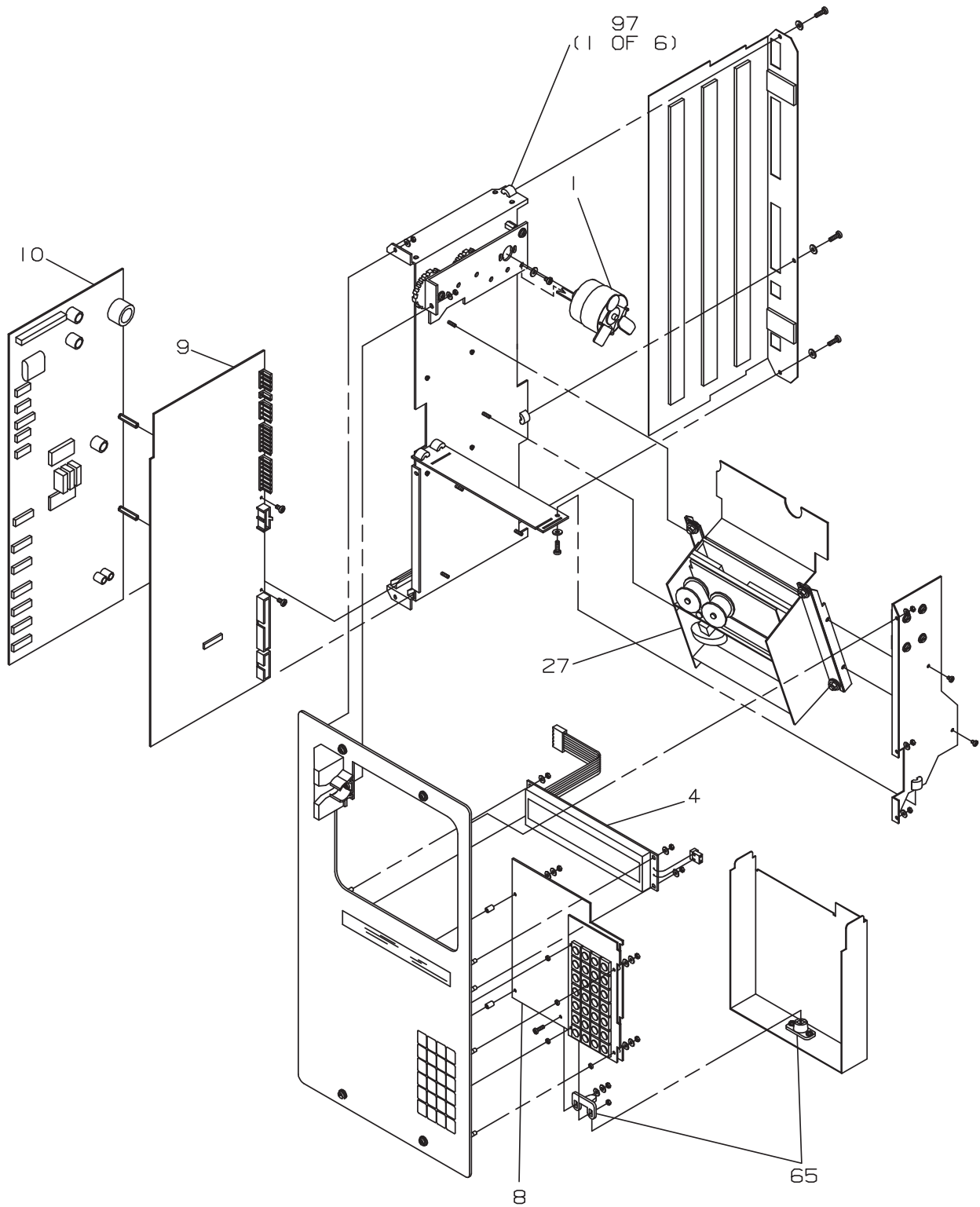


Table A-1 4210 Flow Meter Replacement Parts List

No	Part Number	Complete Parts Description
1	60-3214-139	Motor Assy Chart Drive 4200
4	60-3214-093	LCD Module Assy B/L
5	60-3214-136	Case Bottom Sub Assembly
8	60-3214-098	PCB Assy Keyboard
9	60-3214 -147	PCB Assy 4210 CPU w/Software
10	60-3214-100	PCB Assy 4210 Usonic Amp
11	60-3214-120	Wiring Assy - 12 VDC/Sampler
12	60-3214-122	Wiring Assy - Interrogator
13	60-3214-140	Wiring Assy - Rain Gauge/Com 1
14	60-3214-125	Wiring Assy - Parameter
15	60-3214-126	Wiring Assy - Ultrasonic
16	60-3234-022	Supply Spool Assembly
17	60-3234-023	Reroll Spool Assembly
27	60-3213-098	Printer Mod
36	60-3213-229	Spool End Cap
38	60-3213-255	Wall Mount
39	60-3213-259	Window
40	60-9003-031	Connector Hole Plug
41	60-3233-099	Hinge Pin
42	60-3233-106	Desiccant Can Holder
43	60-3233-115	Connector Clip - .688 Dia.
44	60-3233-116	Connector Clip - .813 Dia
45	60-3233-117	Connector Clip - .938 Dia
46	60-3113-034	Latch Pin
*52	60-3213-214	Label Case Top
53	60-3213-060	Label Printer
54	60-3213-216	Label Connector
55	68-4210-005	Replacement Door
56	60-3213-260	Gasket Window
57	60-3213-261	Gasket Door
58	202-4001-14	O-Ring Silicone #114 .61ID x .1 W
59	202-4001-18	O-Ring Silicone #118 .86ID x .1 W
60	202-4001-20	O-Ring Silicone #120 .99 ID x .1 W
61	60-3214-141	Case Latch Assy
64	109-0605-03	Draw Latch Assy - Small

Table A-1 4210 Flow Meter Replacement Parts List (Continued)

No	Part Number	Complete Parts Description
65	109-0609-00	Cabinet Catch White
66	142-2003-00	Component Clip $\frac{3}{4}$ "
67	149-1000-00	Amp Dust Cover 9760-10
68	149-1001-00	Amp Dust Cover MS9760-14
69	149-1001-01	Amp Dust Cover 9760-16
97	239-0416-32	Sheet Edge Fastener #6-32
99	231-0197-04	Scr SS SST PH P 10-32 $\times \frac{1}{4}$
101	60-1704-017	Carrying Handle Assy
102	099-0012-00	Dri-Can Desiccant Canister
*Not shown		

A.2 Accessories

Accessories and optional equipment are listed below.

Basic Equipment and Accessories

Ultrasonic Transducer	60-3114-012
4210 Flow Meter	60-3214-090
Accessory Package	60-3214-091
Instruction Manual	60-3214-110
Pocket Guide	60-3213-254
Caution Tag	60-3003-256
Dri-Can Desiccant	099-0012-00
Flow Data Handbook.....	60-3003-041
4210 Flow Meter Only.....	60-3214-089
Chart Roller	60-3004-156
Printer ribbon, black	250-0200-00
Plotter paper roll, 58 ft.....	60-2313-019

Optional Equipment

Ultrasonic Transducer Extension Cable, 25 ft. (7.6 m)	60-3114-013
<i>(Other lengths available by special order)</i>	
Spreader Bar.....	60-3004-110
Ultrasonic Sensor Cable Clamp (use with Spreader Bar).....	60-3004-129
Ultrasonic Wall Mount Bracket.....	60-2003-615
Ultrasonic Wall Mount (old style).....	60-2443-092
Ultrasonic Floor Mount.....	60-2004-611
Ultrasonic Cable Straightener.....	60-3213-061
Ultrasonic Calibration Target.....	60-3004-143
Ultrasonic Sensor Sunshade (Includes Adaptor).....	60-3004-142
Interrogator Cable, 9 pin	60-2544-044
Interrogator Cable, 25 pin	60-2544-040
Standard Y Cable for Isco Samplers	60-3704-081
Special Y Cable without diodes	60-5314-278
High-Low Alarm Relay Box	60-3404-028
4-20 mA Output Interface.....	60-1784-039
674 Rain Gauge (0.01")	60-3284-001
pH Probe and Amplifier (25 ft. cable standard).....	68-4200-002
<i>(Includes probe with built-in temperature sensor)</i>	
pH Probe only	60-9004-126
D.O. Probe only.....	472-0000-00
D.O. Membrane Kit	479-0020-02
<i>(Includes 30, 0.002" membranes, electrolyte, sanding tool and disks)</i>	

O-Ring Kit for D. O. Probe	479-0020-00
Temperature Probe only.....	60-3214-130
YSI 600 Sonde with pH, D.O., conductivity, temperature sensors, and 25 ft. cable	68-0600-110
Type 'E' Interface.....	60-1784-024
Flowlink Software	68-2540-200

(Call factory for additional information)

 Note

Item 68-0600-110 includes a YSI-to-Isco 4200/6712 adapter cable, calibration/transport cup, 1# stainless steel nose weight, and YSI instruction manual. Many other configurations of the YSI 600 Sonde are available *without* either the pH and/or D. O. sensors, or supplied with 50, 100, or 200 ft. cables. Also available is a *low ionic strength pH sensor* for use in streams with very low conductivity (10 μ S/cm or less). Call the factory for more information.

YSI 600 Accessories

D.O. Sensor Maintenance Supplies

D.O. Probe membrane and electrolyte kit <i>(30 membranes, 30 mL KCl soln., 2 O-rings)</i>	60-0603-205
D.O. Probe reconditioning kit <i>(Instructions and sanding disks)</i>	60-0603-206

Miscellaneous – for use with the YSI Sonde

YSI 600 Instruction Manual	60-0603-218
YSI 600 to Isco 4200/6712 Adapter Cable.....	60-0604-001
YSI 600 and Isco 674 Rain Gauge Y-Connect Cable.....	60-0604-002

(Allows use of the YSI 600 Sonde and the Isco 674 Rain Gauge at the same time.)

Use the following with Isco Mounting Rings in Round Pipe Installations

Probe Carrier for Temperature probe	60-3204-010
Probe Carrier for pH probe	60-3208-001

Spring Rings

Probe Mounting Ring for 6" pipe	60-3200-007
Probe Mounting Ring for 8" pipe	60-3200-008
Probe Mounting Ring for 10" pipe	60-3200-009
Probe Mounting Ring for 12" pipe	60-3200-010
Probe Mounting Ring for 15" pipe	60-3200-011

**Scissors Mounting Ring
(for pipes 16" diameter and larger)**

Base Section (with tabs for mounting up to five probes)	60-3004-169
Scissors Assembly.....	60-3004-170
Extension 1 (9.0")	60-3004-172
Extension 2 (21.5")	60-3004-173
Extension 3 (31.5")	60-3004-174
Extension 4 (41.5")	60-3004-175

Note that Scissors Mounting Ring Assemblies will require a base and scissors section for all sizes. Sizes from 16" to 80" will also require two or more extension sections.

4210 Flow Meter

Appendix B Programming Worksheet

- Use a photocopy of the worksheet on the following pages to create a hard copy of the program you use in your 4210. Most program steps can be completed in the shop without the flow meter being installed or at the job site. However, please note the following:
- Do not attempt to fill out this form without first studying the manual, especially Section 2. This section describes the program in detail and offers reasons why you might choose one option over another. This is particularly true for those using the flow meter for the first time. Keep this worksheet as a record.
- Some of the menus shown on this sheet may not appear on your flow meter. The reason is that you must make choices from the first step forward that will prevent you from choosing certain other options later on. Options can appear at several points of the program. However, menus pertaining to the options not chosen early on will not appear later. Another example is the alarm dial-out feature. This step requires your flow meter to have the optional modem. If you do not have the modem, no menus concerning dialout will appear.
- If, after filling out this chart, you cannot make some menus appear that you need, recheck your Setup on the flow meter to see that you have not accidentally locked yourself out of a path by an incorrect early selection.
- If you only need to program the flow meter once, you can write on this sheet. If you are doing temporary surveys, or expect the program to change, make copies of these sheets and write on the copies.

Step 1 - Setup

1. Select Option: Program, Setup. First, choose Setup and work through the following menus.
2. Year:Month:Day:Hour:Min _____
3. Site I.D. _____ (Any three-digit number)
4. Measurement Setup: Level Reading Interval, Minimum Depth, Do/pH Reading Interval _____
5. Level Reading Interval: Continuous, 15 Sec, 30 Sec, 1 Min, 2 Min, 5 Min
6. Variable Blanking Distance = _____
7. (Job site only) Signal Strength _____ %
8. Do/pH Reading Interval: Continuous, 15 Sec, 30 Sec, 1Min, 2 Min, 5 Min _____
9. YSI 600 Reading Interval: Continuous, 15 Sec, 30 Sec, 1Min, 2 Min, 5 Min _____
10. Level Enable/Alarm: Hysteresis _____ Feet (or Meters)
11. Flow Rate Enable/Alarm Hysteresis _____ Units _____
12. Temperature Enable/Alarm Hysteresis _____ Deg. F (C)
13. pH Enable/Alarm Hysteresis _____ pH units.
14. D.O. Enable/Alarm Hysteresis _____ ppm.
15. YSI-pH Enable/Alarm Hysteresis _____ pH units.
16. YSI-D.O. Enable/Alarm Hysteresis _____ ppm/mg./L
17. YSI-Conductivity Enable /Alarm Hysteresis _____ mS/cm
18. YSI-Temperature Enable/Alarm Hysteresis _____ Deg.
19. Optional Outputs: 4-20 Ma Outputs, Serial Output, Alarm Box, Mechanical Totalizer
20. Report A Setup: Flow, DO/pH, YSI 600, Sample History, Flow Meter History
21. Level In Report: Yes, No _____
22. Flow Rate In Report: Yes, No _____
23. Rainfall In Report: Yes, No _____
24. PH or DO In Report: Yes, No _____
25. Temperature In Report: Yes, No _____
26. YSI 600 Data in Report: Yes, No _____
27. Sample History In Report: Yes, No _____
28. Flow Meter History In Report: Yes, No _____
29. Report B Setup: Flow, DO/pH, YSI 600, Sample History, Flow Meter History
30. Level In Report: Yes, No _____
31. Flow Rate In Report: Yes, No _____
32. Rainfall In Report: Yes, No _____
33. PH or DO In Report: Yes, No _____

34. Temperature In Report: Yes, No _____
35. YSI 600 Data in Report: Yes, No _____
36. Sample History In Report: Yes, No _____
37. Setup Options: Status, Report Setup, LCD Backlight _____
38. LCD Backlight Mode: Timeout, Continuous, Off _____
39. Language: English, _____
40. Program Lock: On, Off _____
41. Select Option: Program, Setup. This time, select *Program* and do the following (Program Section).
42. Units Of Level Measure: Ft., In, M, mm, Not Measured _____
43. Flow Rate Units of Measure: GPS, GPM, GPH, MGD, CFS, CFM, CFH, CFD, LPS, M3S, M3M, M3H, M3D, AFD,
44. Totalized Volume Units: GAL, MGAL, CF, L, M3, AF _____
45. Rain Gauge: Inches, MM, Not Measured _____
46. pH Units Of Measure: pH, Not Measured _____
47. D.O. Units: MG/L, PPM, Not Measured _____
48. Temperature Units: Deg F, Deg. C, Not Measured _____
49. YSI-pH Units Of Measure: pH, Not Measured _____
50. YSI-D.O. Units: MG/L, PPM, Not Measured _____
51. YSI-Conductivity Parameter: Specific Conductivity, Salinity, Conductivity, T.D. S.
_____ Units _____ Coeff. _____
52. YSI-Temperature: Deg F, Deg. C, Not Measured _____

Step 2 - Flow Conversion - Level-to-Flow Rate

1. Flow Conversion Type: Weir/flume, Equation, Manning, Data Points, _____
2. Type Of Device: Weir, Flume _____
3. Select Type Of Weir: V-notch, Rectangular, Cipolletti _____
4. Select V-notch Weir Angle (*In Degrees*): 22.5, 30, 45, 60, 90, 120,
5. End Contractions On Rectangular Weir: Yes, No _____
6. Rect. Weir With End Contractions: Enter Crest Length _____ Feet (*or Meters*)
7. Cipolletti Weir: Enter Crest Length _____ (Ft. / M)
8. Type Of Flume: Palmer-Bowlus, Parshall, Trapezoidal, H, HS, HL, Leopold-Lagco
9. Palmer-Bowlus Size: 4", 6", 8", 9", 10", 12", 15", 18", 21", 24", 27", 30", 48"
10. Parshall Size: 1", 2", 3", 6", 9", 1.0', 1.5', 2.0', 3', 4', 5', 6', 8', 10', 12"
11. Trapez. Size: LG 60 V, 2" 45 WSC, 45 SRCRC, XL 60 _____
12. Flume Size: .5', .75', 1', 2', 2.5' 3', 4.5' _____
13. HS Flume Size: 0.4', 0.5', 0.6', 0.8', 1.0' _____

14. HL Flume Size: 2.0', 2.5', 3.0', 3.5', 4.0' _____
15. Leopold-Lagco Flume Size: 4", 6", 8", 10", 12", 15", 18", 21", 24", 30" _____
16. Enter Equation Units: $Q = \text{___} \cdot \text{H}^{\text{___}} + \text{___} \cdot \text{H}^{\text{___}}$
($Q = kH^{P1} + kH^{P2}$)

(Note that if your equation does not have a second term, (kH^{P2}), just enter 0 (zero) for it.)

17. Manning Types: Round Pipe, U-channel, Rectangular, Trapezoid
18. Mann. Round Pipe: Slope = Rough =
19. Mann. Round Pipe: Diameter = Feet (or meters)
20. Mann. U-channel: Slope = Rough =
21. Mann. U-channel: Width = Feet (or meters)
22. Mann. Rectangular: Slope = Rough =
23. Mann. Rectangular: Width = Feet (or meters)
24. Mann. Trapezoid: Slope = Rough =
25. Mann. Trapezoid: Top Width = Feet (or meters)
26. Mann. Trapez.: Bottom Width = Feet (or meters)
27. Select Data Set: One, Two, Three, Four, (None) _____
28. Level Units For Data Point Entry: Ft., In, M, Mm _____
29. Flow Rate Units: GPM, GPS, MGD, CFS, CFM, M3S, M3H, M3D, LPS, CFD, GPH, AFD, CFH, CFM, M3M
30. Set (1-4): (0) Points Entered: Add Point, (units) _____
31. Set 1 Data Point 1: Enter: (level units) (units of volume) (Enter data points in the table in next column. Additional tables on following pages.)

Enter Maximum Head

32. Maximum Flow: (units of measure) _____

11. Place Probe In _____Ms/cm. (or ppt) Press **Enter** When Stable: _____Ms/cm (job site only)
12. YSI 600 Dissolved Oxygen Calibration: D.O. Standard, Absolute Barometric Pressure, Altitude

Step 4 - Reset Totalizer

1. Reset Totalizer: Yes, No _____
2. Enable Totalizer _____CF (or other units) _____
3. Reset Sampler Enable Totalizer: Yes, No _____

Step 5 - Sampler Pacing

1. Sampler Pacing: Disable, (Volume), (Flowlink), Conditional
2. Sampler Pacing: Enter Pacing Volume __.____ CF _____
3. Condition: Level, Flow Rate, Rainfall, D.O., pH, Temperature, YSI pH, YSI DO, YSI Conductivity, YSI Temperature
4. Condition: Greater Than, Less Than, Rate Of Change
5. Select Operator: Done, Or, And _____
6. Condition True Pacing Interval: Pace Every _____ Minutes.
7. Condition False Pacing Interval: Pace Every _____ Minutes.

Step 6 - Sampler Enable

1. Sampler Enable Mode: Disable, Enable, Conditional, (Storm), (Flowlink)
2. Level: Greater Than __.____ Feet (or meters)
3. Rainfall Amount: __.____ Inches (or other units) _____
4. Rainfall Time Period: 15 Min, 30 Min, 1 Hr, 2 Hr, 4 Hr, 6 Hr, 8 Hr, 12 Hr, 24 Hr, 48 Hr, 72 Hr
5. Time Since Last Rainfall: Days: _____ (enter 1 to 7)
6. Condition: Level, Flow Rate, D. O., pH, Temperature, Rainfall, YSI pH, YSI DO, YSI Conductivity, YSI Temperature
7. Level: Greater Than, Less Than, Rate Of Change _____
8. Level: Greater Than __.____ Feet (or meters)
9. Select Operator: Done, Or, And _____
10. Flow Rate: Greater Than, Less Than, Rate Of Change ____
11. When Enable Condition Is No Longer Met: Disable Sampler, Keep Enabled
12. Enable Currently Latched, Reset: No, Yes _____
13. Printer On/off With Enable: Yes, No _____

Step 7 - Alarm Dialout Mode

(You must have a modem installed in the flow meter for any of these menus to appear.)

1. Alarm Dialout: Disable, Conditional, Storm, Flowlink _____
2. Level: Greater Than __.____ Feet.
3. Rainfall Amount: __.____ Inches (or other units) _____

4. Rainfall Time Period: 15 Min, 30 Min, 1 Hr, 2 Hr, 4 Hr, 6 Hr, 8 Hr, 12 Hr, 24 Hr, 48 Hr, 72 Hr
5. Time Since Last Rainfall: Days: _____ (allowable 1-7)
6. Condition: Level, Flow Rate, D. O., pH, Temperature, Rainfall, YSI pH, YSI DO, YSI Conductivity, YSI Temperature
7. Condition: Greater Than, Less Than, Rate Of Change _____
8. Select Operator: Done, Or, And _____
9. Alarm Dial-out Numbers: Done, Num. 1, Num. 2, Num. 3, Num. 4, Num. 5 _____
10. First Phone Number: _____
11. Second Phone Number: _____
12. Third Phone Number: _____
13. Fourth Phone Number: _____
14. Fifth Phone Number: _____
15. Delay Between Dialouts: _____ Minutes
16. Callback To Disable Alarm: Yes, No _____

Step 8 - Printer

1. Enter Printer Speed: Off, 1 1/2"/hr, 1"/hr, 2"/hr, 4"/hr _____
2. Input For Printer Line A: None, Level, Flow Rate, pH, D.O., Temp, YSI pH, YSI D.O., YSI Cond., YSI Temp.
3. Printer Line A Bottom Scale: ____ pH
4. Printer Line A Full Scale: ____ Feet (or meters)
5. Input For Printer Line B: None, Level, Flow Rate, pH, D.O., Temp, YSI pH, YSI D.O., YSI Cond., YSI Temp.
6. Input For Printer Line C: None, Level, Flow Rate, pH, D.O., Temp, YSI pH, YSI D.O., YSI Cond., YSI Temp.
7. Plot Rainfall On Chart?: No, Yes _____

Step 9 - Reports/History

1. Report Generator A: On, Off, (Print) _____
2. Report A Duration To Be In: Hours, Days, Months _____
3. Enter Report A Duration: _____ Hours
4. Print Report A at Yr: _____ Month: _____ Day: _____ Hr: _____ Min: _____
5. Report Generator B: On, Off, (Print) _____
6. Report B Duration To Be In: Hours, Days, Months _____
7. Enter Report B Duration: _____ Hours
8. Print Report B at Yr: _____ Month: _____ Day: _____ Hr: _____ Min: _____
9. Print Flow Meter History: Yes, No _____
10. Print Flow Meter History: Print Since Last, Print All _____

4210 Flow Meter

Appendix C General Safety Procedures

The safety of the personnel who use the 4210 is a critical consideration. The following procedures, applicable to working in and around manholes and sewers, are those used by Black & Veatch, a respected consulting firm, and are published here by their permission.

Field personnel must keep safety uppermost in their minds at all times. When working above ground, rules of common sense and safety prevail. However, when entering manholes, strict safety procedures must be observed. Failure to do so could jeopardize not only your own life, but also the lives of other crew members.

 **WARNING**

The 4210 Flow Meter has not been approved for use in hazardous locations as defined by the National Electrical Code.

 **CAUTION**

Before you install any flow meter, you must take the proper safety precautions. The following discussion of safety procedures offers only general guidelines. Each situation in which you install a flow meter varies. You must take into account the individual circumstances of each installation.

Additional safety considerations, other than those discussed here, may be required. Check applicable guidelines, codes, and regulations of federal, state, city, and county agencies.

The following procedures are those used by Black & Veatch, a respected consulting firm, and are published here by their kind permission:

“Field personnel must keep safety uppermost in their minds at all times. When working above ground, rules of common sense and safety prevail. However, when entering manholes, strict safety procedures must be observed. Failure to do so could jeopardize not only your own life, but also the lives of other crew members.

C.1 Hazards

There are many hazards connected with entering manholes. Some of the most common hazards are:

C.1.1 Adverse Atmosphere

The manhole may contain flammable or poisonous gases or the atmosphere may be deficient in oxygen. Forced ventilation may be necessary.

- C.1.2 Deteriorated Rungs** Manhole steps may be corroded and not strong enough to support a man. It may be difficult to inspect the rungs because of poor lighting.
- C.1.3 Traffic** Whenever manholes are located in the traveled way, barricades and warning devices are essential to direct traffic away from an open manhole.
- C.1.4 Falling Objects** Items placed near the manhole opening may fall and injure a worker in the manhole. All loose items should be kept away from the manhole opening. This applies to hand tools as well as stones, gravel and other objects.
- C.1.5 Sharp Edges** Sharp edges of items in or near a manhole may cause cuts or bruises.
- C.1.6 Lifting Injuries** Unless proper tools are used to remove manhole covers, back injuries or injuries to hands or feet may result.
- C.2 Planning** Advance planning should include arrangements for test equipment, tools, ventilating equipment, protective clothing, traffic warning devices, ladders, safety harness, and adequate number of personnel. Hasty actions may result in serious injuries. Time spent in the manhole should be kept to a minimum.
- C.3 Adverse Atmospheres** [Refer to the table of *Hazardous Gases* at the end of this appendix.] Before workers enter a manhole, tests should be made for explosive atmosphere, presence of hydrogen sulfide, and oxygen deficiency. Combustible or toxic vapors may be heavier than air, so the tests on the atmosphere must be run at least $\frac{3}{4}$ of the way down the manhole.
- Whenever adverse atmosphere is encountered, forced ventilation must be used to create safe conditions. After the ventilating equipment has been operated for a few minutes, the atmosphere in the manhole should be retested before anyone enters the manhole.
- When explosive conditions are encountered, the ventilating blower should be placed upwind to prevent igniting any gas that is emerging from the opening. When a gasoline engine blower is used, it must be located so that exhaust fumes cannot enter the manhole.
- If testing equipment is not available, the manhole should be assumed to contain an unsafe atmosphere and forced ventilation must be provided. It should never be assumed that a manhole is safe just because there is no odor or the manhole has been entered previously.
- C.4 Entering Manholes** Since the top of the manhole is usually flush with the surrounding surface, there may not be anything for the person who is entering the manhole to grab on to steady himself. Persons who are entering manholes should not be permitted to carry any-

thing in their hands as they enter the manhole, to ensure that their hands will be free to hold on or grab if they slip. A good method for entering a manhole is to sit on the surface facing the manhole steps or ladder, with the feet in the hole and the arms straddling the opening for support. As the body slides forward and downward, the feet can engage a rung, and the back can rest against the opposite side of the opening. If there is any doubt about the soundness of the manhole steps, a portable ladder should be used.

A person should never enter a manhole unless he is wearing personal safety equipment, including a safety harness and a hard hat. Two persons should be stationed at the surface continuously while anyone is working inside a manhole, to lift him out if he is overcome or injured. One man cannot lift an unconscious man out of a manhole.

The persons stationed at the surface should also function as guards to keep people and vehicles away from the manhole opening. To avoid a serious injury, a person should not be lifted out of manhole by his arm unless it is a dire emergency.

“When more than one person must enter a manhole, the first person should reach the bottom and step off the ladder before the next one starts down. When two men climb at the same time, the upper one can cause the lower one to fall by slipping or stepping on his fingers.

C.4.1 Traffic Protection

In addition to traffic cones, markers, warning signs, and barricades, a vehicle or a heavy piece of equipment should be placed between the working area and oncoming traffic. Flashing warning signals should be used to alert drivers and pedestrians. Orange safety vests should be worn by personnel stationed at the surface when the manhole is located in a vehicular traffic area.

C.4.2 Removing the Covers

Manhole covers should be removed with a properly designed hook. Use of a pick ax, screwdriver, or small pry bar may result in injury. A suitable tool can be made from 3/4-inch round or hex stock. Two inches of one end should be bent at a right angle and the other end should be formed into a D-handle wide enough to accommodate both hands. Even with this tool, care must be exercised to prevent the cover from being dropped on the toes. The 2-inch projection should be inserted into one of the holes in the cover, the handle grasped with both hands, and the cover lifted by straightening the legs which have been slightly bent at the knees.

C.4.3 Other Precautions

Other precautions which should be taken when entering a manhole are:

- Wear a hard hat.
- Wear coveralls or removable outer garment that can be readily removed when the work is completed.
- Wear boots or nonsparking safety shoes.
- Wear rubberized or waterproof gloves.

- Wear a safety harness with a stout rope attached.
- Do not smoke.
- Avoid touching yourself above the collar until you have cleaned your hands.

C.4.4 Emergencies

Every member of the crew should be instructed on procedures to be followed in cases of an emergency. It is the duty of each crew chief to have a list of emergency phone numbers, including the nearest hospital and ambulance service, police precinct, fire station, and rescue or general emergency number.

C.4.5 Field Equipment

The following equipment should be available for use:

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

C.4.6 Lethal Atmospheres in Sewers

The following is an article written by Dr. Richard D. Pomeroy, and published in the October 1980 issue of "Deeds & Data" of the WPCF. Dr. Pomeroy is particularly well known for his studies, over a period of nearly 50 years, in the field of the control of hydrogen sulfide and other odors in sewers and treatment plants. He has personally worked in a great many functioning sewers. In the earlier years he did so, he admits, with little knowledge of the grave hazards to which he exposed himself.

"It is gratifying that the subject of hazards to people working in sewers is receiving much more attention than in past years, and good safety procedures are prescribed in various publications on this subject. It is essential that people know and use correct procedures.

"It is less important to know just what the hazardous components of sewer atmospheres are, as safety precautions should in general be broadly applicable, but there should be a reasonable understanding of this subject. It is disturbing to see statements in print that do not reflect true conditions.

"One of the most common errors is the assumption that people have died from a lack of oxygen. The human body is able to function very well with substantially reduced oxygen concentrations. No one worries about going to Santa Fe, New Mexico, (elev. 2,100 meters), where the partial pressure of oxygen is equal to 16.2% (a normal atmosphere is about 21%) oxygen. "When first going there, a person may experience a little 'shortness of breath' following exercise.

“People in good health are not afraid to drive over the high passes in the Rocky Mountains. At Loveland Pass, oxygen pressure is 13.2% of a normal atmosphere. At the top of Mt. Whitney, oxygen is equal to 12.2%. Many hikers go there, and to higher peaks as well. After adequate acclimation, they may climb to the top of Mt. Everest, where oxygen is equal to only 6.7%.

“The lowest oxygen concentrations that I have observed in a sewer atmosphere was 13 percent. It was in a sealed chamber, near sea level, upstream from an inverted siphon on a metropolitan trunk. A man would be foolish to enter the chamber. Without ventilation, he might die, but not from lack of oxygen.

“It seems unlikely that anyone has ever died in a sewer from suffocation, that is, a lack of oxygen. Deaths have often been attributed to ‘asphyxiation.’ This is a word which, according to the dictionary, is used to mean death from an atmosphere that does not support life. The word has sometimes been misinterpreted as meaning suffocation, which is only one kind of asphyxiation.

“In nearly all cases of death in sewers, the real killer is hydrogen sulfide. It is important that this fact be recognized. Many cities diligently test for explosive gases, which is very important, and they may measure the oxygen concentration which usually is unimportant, but they rarely measure H₂S. Death has occurred where it is unlikely that there was any measurable reduction in the oxygen concentration. Waste water containing 2 mg per liter of dissolved sulfide, and at a pH of 7.0, can produce, in a chamber with high turbulence, a concentration of 300 PPM H₂S, in the air. This is considered to be a lethal concentration. Many people have died from H₂S, not only in sewers and industries, but also from swamps and from hot springs. In one resort area, at least five persons died from H₂S poisoning before the people were ready to admit that H₂S is not a therapeutic agent. Hardly a year passes in the US. without a sewer fatality from H₂S as well as deaths elsewhere in the world.

“The presence of H₂S in a sewer atmosphere is easily determined. A bellows-and-ampoule type of tester is very satisfactory for the purpose, even though it is only crudely quantitative. When using a tester of this type, do not bring the air to the ampoule by way of a tube, as this may change the H₂S concentration. Hang the ampoule in the air to be tested, with a suction tube to the bulb or bellows.

“Lead acetate paper is very useful as a qualitative indicator. It cannot be used to estimate the amount of sulfide, but it will quickly turn black in an atmosphere containing only a tenth of a lethal concentration.

“Electrodes or other similar electrical indicating devices for H₂S in air have been marketed. Some of them are known to be unreliable, and we know of none that have proved dependable. Do not use one unless you check it at frequent intervals against air containing known H₂S concentrations. A supposed safety device that is unreliable is worse than none at all.

“Remember that the nose fails, too, when it comes to sensing dangerous concentrations of H₂S.

“Various other toxic gases have been mentioned in some publications. It is unlikely that any person has been asphyxiated in a sewer by any of those other gases, except possibly chlorine. The vapor of gasoline and other hydrocarbons is sometimes present in amounts that could cause discomfort and illness, but under that condition, the explosion hazard would be far more serious. The explosimeter tests, as well as the sense of smell, would warn of the danger. Pipelines in chemical plants might contain any number of harmful vapors. They, too, are sensed by smell and explosimeter tests if they get into the public sewer. Such occurrences are rare.

“The attempt to instill a sense of urgency about real hazards is diluted if a man is told to give attention to a long list of things that in fact are irrelevant.

“Be very careful to avoid high H₂S concentrations, flammable atmospheres, and hazards of physical injuries. Remember that much H₂S may be released by the stirring up of sludge in the bottom of a structure. Obey your senses in respect to irritating gases, such as chlorine (unconsciousness comes suddenly from breathing too much). Be cautious about strange odors. Do not determine percent oxygen in the air. There is a danger that the result will influence a man's thinking about the seriousness of the real hazards. Most important, use ample ventilation, and do not enter a potentially hazardous structure except in a good safety harness with two men at the top who can lift you out.”

Table C-1 Hazardous Gases

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air = 1	Physiological Effect*	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air.) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Ammonia	NH ₃	Irritant and poisonous. Colorless with characteristic odor.	0.60	Causes throat and eye irritation at 0.05%, coughing at 0.17%. Short exposure at 0.5% to 1% fatal.	300 to 500	85	16 25	Near top. Concentrates in closed upper spaces	Sewers, chemical feed rooms.	Detectable odor at low concentrations
Benzene	C ₆ H ₆	Irritant, colorless anesthetic	2.77	Slight symptoms after several hours exposure at 0.16% to 0.32%. 2% rapidly fatal.	3,000 to 5,000	25	1.3 7.1	At bottom.	Industrial wastes, varnish, solvents.	Combustible gas indicator
Carbon Bisulfide	CS ₂	Nearly odorless when pure, colorless, anesthetic. Poisonous.	2.64	Very poisonous, irritating, vomiting, convulsions, psychic disturbance.	—	15	1.3 44.0	At bottom	An insecticide	Combustible gas indicator

Table C-1 Hazardous Gases (Continued)

Carbon Dioxide	CO ₂	Asphyxiant, Colorless, odorless. When breathed in large quantities, may cause acid taste. Non-flammable. Not generally present in dangerous amounts unless an oxygen deficiency exists.	1.53	Cannot be endured at 10% more than a few minutes, even if subject is at rest and oxygen content is normal. Acts on respiratory nerves.	40,000 to 60,000	5,000	— —	At bottom; when heated may stratify at points above bottom.	Products of combustion, sewer gas, sludge. Also issues from carbonaceous strata.	Oxygen deficiency indicator
Carbon Monoxide	CO	Chemical asphyxiant. Colorless, odorless, tasteless. Flammable. Poisonous.	0.97	Combines with hemoglobin of blood. Unconsciousness in 30 min. at 0.2% to 0.25%. Fatal in 4 hours at 0.1%. Headache in few hours at 0.02%.	400	50	12.5 74.0	Near top, especially if present with illuminating gas.	Manufactured gas, flue gas, products of combustion, motor exhausts. Fires of almost any kind.	CO ampoules.
Carbon Tetra-Chloride	CCl ₄	Heavy, ethereal odor.	5.3	Intestinal upset, loss of consciousness, possible renal damage, respiratory failure.	1,000 to 1,500	100	— —	At bottom.	Industrial wastes, solvent, cleaning	Detectable odor at low concentrations.
Chlorine	Cl ₂	Irritant. Yellow-green color. Choking odor detectable in very low concentrations. Non-flammable.	2.49	Irritates respiratory tract. Kills most animals in a very short time at 0.1%.	4	1	— —	At bottom.	Chlorine cylinder and feed line leaks.	Detectable odor at low concentrations.
Formaldehyde	CH ₂ O	Colorless, pungent suffocating odor.	1.07	Irritating to the nose.	—	10	7.0 73.0	Near bottom.	Incomplete combustion of organics. Common air pollutant, fungicide.	Detectable odor.
Gasoline	C ₅ H ₁₂ to C ₉ H ₂₀	Volatile solvent. Colorless. Odor noticeable at 0.03%. Flammable.	3.0 to 4.0	Anesthetic effects when inhaled. Rapidly fatal at 2.4%. Dangerous for short exposure at 1.1 to 2.2%.	4,000 to 7,000	1,000	1.3 6.0	At bottom.	Service stations, garages, storage tanks, houses.	1. Combustible gas indicator. 2. Oxygen deficiency indicator**
Hydrogen	H ₂	Simple asphyxiant. Colorless, odorless, tasteless. Flammable	0.07	Acts mechanically to deprive tissues of oxygen. Does not support life.	—	—	4.0 74.0	At top.	Manufactured gas, sludge digestion tank gas, electrolysis of water. Rarely from rock strata.	Combustible gas indicator.
Hydrogen Cyanide	HCN	Faint odor of bitter almonds. Colorless gas	0.93	Slight symptoms appear upon exposure to 0.002% to 0.004%. 0.3% rapidly fatal.	—	10	6.0 40.0	Near top.	Insecticide and rodenticide.	Detector tube
Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air = 1	Physiological Effect*	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air.) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Hydrogen Sulfide	H ₂ S	Irritant and poisonous volatile compound. Rotten egg odor in small concentrations. Exposure for 2 to 15 min. at 0.01% impairs sense of smell. Odor not evident at high concentrations. Colorless. Flammable.	1.19	Impairs sense of smell, rapidly as concentration increases. Death in few minutes at 0.2%. Exposure to 0.07 to 0.1% rapidly causes acute poisoning. Paralyzes respiratory center.	200 to 300	20	4.3 45.0	Near bottom, but may be above bottom if air is heated and highly humid.	Coal gas, petroleum, sewer gas. Fumes from blasting under some conditions. Sludge gas.	1. H ₂ S Ampoule. 2. 5% by weight lead acetate solution.

Table C-1 Hazardous Gases (Continued)

Methane	CH ₄	Simple asphyxiant. Colorless, odorless, tasteless, flammable.	0.55	Acts mechanically to deprive tissues of oxygen. Does not support life.	Probably no limit, provided oxygen percentage is sufficient for life.	—	5.0 15.0	At top, increasing to certain depth.	Natural gas, sludge gas, manufactured gas, sewer gas. Strata of sedimentary origin. In swamps or marshes.	1. Combustible gas indicator 2. Oxygen deficiency indicator.
Nitrogen	N ₂	Simple asphyxiant. Colorless, tasteless. Non-flammable. Principal constituent of air. (about 79%).	0.97	Physiologically inert.	—	—	— —	Near top, but may be found near bottom.	Sewer gas. sludge gas. Also issues from some rock strata.	Oxygen deficiency indicator.
Nitrogen Oxides	NO	Colorless	1.04	60 to 150 ppm cause irritation and coughing.	50	10	— —	Near bottom.	Industrial wastes. Common air pollutant.	NO ₂ detector tube.
	N ₂ O	Colorless, sweet odor.	1.53	Asphyxiant.						
	NO ₂	Reddish-brown. Irritating odor. Deadly poison	1.58	100 ppm dangerous. 200 ppm fatal.						
Oxygen	O ₂	Colorless, odorless, tasteless. Supports combustion.	1.11	Normal air contains 20.8% of O ₂ . Man can tolerate down to 12%. Minimum safe 8 hour exposure, 14 to 16%. Below 10%, dangerous to life. Below 5 to 7% probably fatal.	—	—	— —	Variable at different levels.	Oxygen depletion from poor ventilation and absorption, or chemical consumption of oxygen.	Oxygen deficiency indicator.
Ozone	O ₃	Irritant and poisonous. Strong electrical odor. Strong oxidizer. Colorless. At 1 ppm, strong sulfur-like odor.	1.66	Max. naturally occurring level is 0.04 ppm. 0.05 ppm causes irritation of eyes and nose. 1 to 10 ppm causes headache, nausea; can cause coma. Symptoms similar to radiation damage.	0.08	0.04	— —	Near bottom.	Where ozone is used for disinfection.	Detectable odor at 0.015 ppm.
Sludge Gas	—***	Mostly a simple asphyxiant. May be practically odorless, tasteless.	Variable	Will not support life.	No data. Would vary widely with composition.		5.3 19.3	Near top of structure.	From digestion of sludge.	See components.
Sulfur Dioxide	SO ₂	Colorless, pungent odor. Suffocating, corrosive, poisonous, non-flammable.	2.26	Inflammation of the eyes. 400 to 500 ppm immediately fatal.	50 to 100	10	— —	At bottom, can combine with water to form sulfurous acid.	Industrial waste, combustion, common air pollutant.	Detectable taste and odor at low concentration.
Toluene	C ₅ H ₁₂ to C ₉ H ₂₀	Colorless, benzene-like odor.	3.14	At 200-500 ppm, headache, nausea, bad taste, lassitude.	200	100	1.27 7.0	At bottom.	Solvent.	Combustible gas indicator.
Turpentine	C ₁₀ H ₁₆	Colorless, Characteristic odor.	4.84	Eye irritation. Headache, dizziness, nausea, irritation of the kidneys.	—	100		At bottom.	Solvent, used in paint.	1. Detectable odor at low concentrations. 2. Combustible gas indicator.
Xylene	C ₈ H ₁₀	Colorless, flammable	3.66	Narcotic in high concentrations. less toxic than benzene.	—	100	1.1 7.0	At bottom.	Solvent	Combustible gas indicator.
<p>* Percentages shown represent volume of gas in air. ** For concentration over 0.3%. ***Mostly methane and carbon dioxide with small amounts of hydrogen, nitrogen, hydrogen sulfide, and oxygen; occasionally traces of carbon monoxide.</p>										

4210 Flow Meter

Appendix D Material Safety Data Sheets

Material Safety Data Sheets for the desiccants used in the 4210 flow meter can be found on the following pages. For more information about these chemicals, contact the manufacturers listed on the Material Safety Data Sheets.

Distributed by: Rainbow Technology Corp.
1.800.637.6047 or 205.733.0333
Product #: 79355

Page 1 of 5



MATERIAL SAFETY DATA SHEET

Effective Date February 14, 2009
MSDS Number M75

Section 1 – Product and Company Information

Product Name: Silica gel, indicating
Product Use: Desiccant, absorbent
Grades: Silica gel indicating
Synonyms: Amorphous silica gel, SiO₂, silicon dioxide (amorphous)
Company: Multisorb Technologies, Inc.
Street Address: 325 Harlem Road
City, State, Zip, Country: Buffalo, NY 14224-1893 USA
Telephone Number: (716) 824 8900 [USA] Monday - Friday (8:00 - 5:00 EDT)
Fax Number: (716) 824 4091 [USA]
Website / E-Mail : multisorb.com

Section 2 – Hazard Identification

Emergency Overview: A blue to pink granular material that poses little or no immediate hazard. This material is not combustible.

Potential Health Effects:

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

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

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

Inhalation: Slight irritation is possible but none is expected.

Medical Effects Generally Aggravated by Exposure: Respiratory ailments.

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

Section 3 – Composition / Information on Ingredients

Component Name	CAS Number	% by Weight
Synthetic amorphous silica gel (SiO ₂)	112926-00-8	100
Cobalt Chloride	7646-79-9	.5

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

Section 4 – First Aid Measures

Eyes: Rinse eyes well with water while lifting eye lids. If irritation persists, consult a physician.

Skin: Wash affected area with soap and water.

Ingestion: Ingestion is unlikely, this material will pass through the body normally.

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

Multisorb Technologies, Inc Silica gel, Indicating February 14, 2009 Page 2 of 5
Notes to Physician: Not applicable

Section 5 – Fire Fighting Measures

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

Section 6 – Accidental Release Measures

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

Section 7 – Handling and Storage

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

Section 8 – Exposure Controls/Personal Protection

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

Exposure Limits

Component Name	OSHA PEL	ACGIH TLV	Other Recommended Limits
Silica gel	TWA 20 mppcf (80 mg / m ³ % SiO ₂)	Not Applicable	NIOSH REL TWA 6 mg / m ³ IDLH 3000 mg / m ³
Cobalt chloride	TWA .1 mg / m ³ (cobalt metal fume & dust)	TWA .02 mg / m ³ (as cobalt)	NIOSH REL TWA .05 mg / m ³ Cobalt metal dust and fume as cobalt IDLH 20 mg / m ³ (as metal dust & fume) (as Co)

Section 9 – Physical and Chemical Properties

Appearance:	Pink to blue granules	Vapor Density:	Not applicable
Odor:	None	Boiling Point:	4046° F (2230° C)
Physical State:	Solid granule	Melting Point:	3110° F (1710° C)
PH:	Not applicable	Solubility:	Insoluble in water
Vapor Pressure:	Not applicable	Specific Gravity:	2.1
Evaporation Rate	Not applicable	Odor Threshold	Not applicable
Coefficient of water / oil distribution	Not applicable	Auto-ignition Point:	Not applicable
Flammable:	Not applicable	Flammable Limits:	Not applicable
Flash Point:	Not applicable		

Section 10 – Stability and Reactivity

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

Section 11 – Toxicological Information

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

Animal Toxicology Tests for DOT Hazard classification
 (Tests Conducted on finely ground silica gel)

1 - hour LC₅₀ (rat) > 2 mg / l
 48 - hour oral LD₅₀ (rat) est. > 31,600 mg / kg
 48 - hour dermal LD₅₀ (rabbit) est. > 2,000 mg / kg
 Considered an ocular irritant

Multisorb Technologies, Inc Silica gel, Indicating February 14, 2009 Page 4 of 5

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

Section 12 – Ecological Information

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

Section 13 – Disposal Information

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

Section 14 – Transportation Information

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

Transport Canada Product Identification Number Not classified as a hazardous material. Not regulated.

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

TSCA Listed: Yes

OSHA: See section 8 above.

NIOSH: See section 8 above.
Animal tests conducted in 1976 - 1978. 18 month exposure at 15 mg / m³ showed silica deposition in respiratory macrophages and lymph nodes, minimum lung impairment, no silicosis.

ACGIH: See section 8 above.

DOT: Not classified as a hazardous material.

Canadian Hazardous Products Act This product is not classified as a controlled product under the regulations pursuant to the Federal Hazardous Product Act (e.g. WHMIS).

Canadian Environmental Protection Act All ingredients of this product are notified to CEPA and on the DSL(Domestic Substances List).

Section 16 – Other Information

HMIS – Hazardous Materials Identification System

HMIS Rating	
Health	1
Flammability	0
Physical	0

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

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

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

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

4210 Flow Meter

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产品中有毒有害物质或元素的名称及含量

Name and amount of Hazardous Substances or Elements in the product

部件名称 Component Name	有毒有害物质或元素 Hazardous Substances or Elements					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二联苯 (PBDE)
线路板 Circuit Boards	X	O	O	O	O	O
显示 Display	X	O	O	O	O	O
接线 Wiring	O	O	O	O	X	O
小键盘 Keypad	O	O	O	O	X	O
直流电机 DC Motor	X	O	O	O	X	O
接头 Connectors	O	O	X	O	O	O

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

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

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

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

(企业可在此处，根据实际情况对上表中打“X”的技术原因进行进一步说明。)

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

(Manufacturer may give technical reasons to the “X”marks)

环保使用期由经验确定。

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

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

A 为一月，B 为二月，等等。

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

NOTICE

Disregard the following “Declaration of Conformity” and Radio Interference Statement” if your instrument does not have a CE label on its rear panel

Radio Interference Statement

FCC

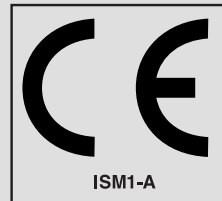
This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates,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

Canada

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

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

DECLARATION OF CONFORMITY



Application of Council Directive: 89/336/EEC – The EMC Directive
73/23/EEC – The Low Voltage Directive

Manufacturer's Name: Teledyne Isco, Inc.
Manufacturer's Address: 4700 Superior, Lincoln, Nebraska 68504 USA
Mailing Address: P.O. Box 82531, Lincoln, NE 68501

Equipment Type/Environment: Laboratory Equipment for Light Industrial/Commercial Environments
Trade Name/Model No: 4200T Modem
Year of Issue: 2001

Standards to which Conformity is Declared: EN 55024-1998 EMC Requirements for Information Technology Equipment
EN 60950 Safety Requirements for Information Technology Equipment
FCC Part 68

Standard	Description	Severity Applied	Performance Criteria
EN61000-4-2	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	B B
EN61000-4-3	Radiated RF Immunity	80 MHz to 1000MHz 80% AM at 1kHz Level 1 – 10V/m	A
EN61000-4-4	Electrical Fast Transient	Level 2 - 2kV on ac lines	B
EN61000-4-5	Surge on AC Lines	2kV common mode, 1kV differential mode	B
EN61000-4-6	Conducted RF on AC lines	150 kHz to 80 MHz, 3V rms, 80% modulated	B
EN61000-4-11	Voltage Dips/Short Interruptions	0.5 cycle, each polarity/100%	B
EN 55022	RF Emissions	Group 1, Class A, Information Technology Equipment	
EN61000-3-2, 3-3	Harmonic, Flicker		

We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of July 5, 2001.

William Foster
USA Representative



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

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

60-3212-049
Rev. A

Teledyne Isco One Year Limited Factory Service Warranty*

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

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

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

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

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

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

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

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

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

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

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

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

Mailing Address: Teledyne Isco
PO Box 82531
Lincoln, NE 68501 USA

Phone: Repair service: (800) 775-2965 (lab instruments)
(866) 298-6174 (samplers & flow meters)
Sales & General Information: (800) 228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: IscoService@teledyne.com



October 11, 2013 P/N 60-1002-040 Rev H

