APPENDIX D

ARIMETCO HEAP LEACH FLUID MANAGEMENT SYSTEM

OPERATIONS AND MAINTENANCE WORK PLAN

ANACONDA COPPER MINE SITE

INTERIM ADMINISTRATIVE ORDER ON CONSENT

February 5, 2018

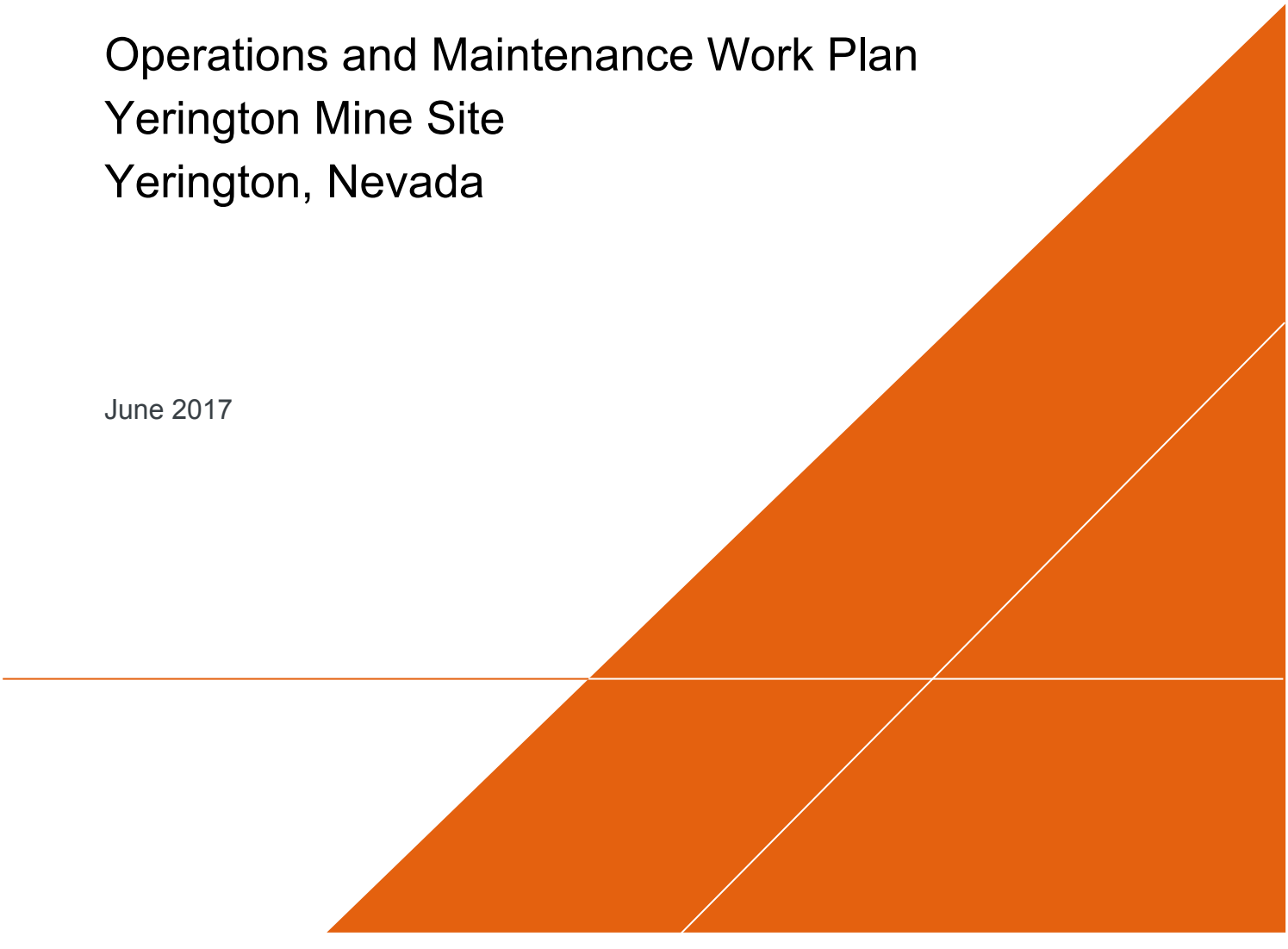
ARCADIS Design & Consultancy for natural and built assets

Atlantic Richfield Company

ARIMETCO HEAP LEACH FLUID MANAGEMENT SYSTEM

Operations and Maintenance Work Plan
Yerington Mine Site
Yerington, Nevada

June 2017



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ACRONYMS AND ABBREVIATIONS

2007 USEPA Order	2007 USEPA Administrative Order for Remedial Investigation and Feasibility Study
ARC	Atlantic Richfield Company
Arcadis	Arcadis U.S., Inc.
EVS	enhanced evaporation system
FMS	fluid management system
FMS O&M Plan	Arimetco Heap Leach Fluid Management System Operation and Maintenance Plan
FMS Work Plan	Arimetco Heap Leach Fluid Management System Work Plan
gpm	gallons per minute
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HLP	Heap Leach Pad
HITRA	Hazard Identification and Task Risk Assessment
MOL	maximum operational level
NDEP	Nevada Department of Environmental Protection
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
OU	operable unit
PPE	personal protective equipment
psi	pounds per square inch
RD/RA	Remedial Design/Remedial Action
Site	Anaconda Copper Mine Site
SPS	Singatse Peak Services
TRA	task risk assessment
USEPA	United States Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
V	volt
VLT	Vat Leach Tailings

1 INTRODUCTION

Atlantic Richfield Company (ARC) has prepared this Arimetco Heap Leach Fluid Management System Work Plan (FMS Work Plan) to specifically address operation and maintenance (O&M) activities associated with drain-down fluids from Arimetco Heap Leach Pads (HLPs) at the Anaconda Copper Mine Site (the Site) under the Administrative Settlement Agreement and Order on Consent for (i) Remedial Design/Remedial Action (RD/RA), (ii) Site-Wide Remedial Investigation/Feasibility Study, and (iii) Fluid Management, entered into between the Nevada Division of Environmental Protection and ARC. The objectives of this FMS Work Plan include the following:

- Discuss the fluid management system (FMS) within the context of regulatory framework.
- Describe the current site settings and FMS components.
- Define the daily work activities, both routine and non-routine, required to manage the FMS.
- Describe FMS monitoring and data management activities.
- Describe the FMS site health and safety requirements.
- Describe site security activities as they relate to the FMS.

The primary objective of FMS activities at the Site is the containment and reduction of the inventory of residual Arimetco HLP drain-down solutions by passive evaporation from a series of ponds. This FMS Work Plan addresses the system in its current configuration. Any future ponds built and closure of existing ponds will be managed under a separate Work Plan as part of the RD/RA Work Plan and RD/RA Design.

1.1 Site Location and Background

The approximately 3,600-acre Site currently consists of an inactive open pit; waste rock piles; sulfide and oxide tailings facilities; spent HLPs; evaporation ponds; and processing facilities that include tanks, buildings, and remnant foundations. There are no current active mining operations at the Site; however, Singatse Peak Services (SPS), a subsidiary of Quaterra Resources Inc., owns a portion of the Site property. SPS has conducted drilling, exploration, and fluid management activities at the Site. Pursuant to a 2007 United States Environmental Protection Agency (USEPA) Administrative Order for Remedial Investigation and Feasibility Study (2007 USEPA Order; Comprehensive Environmental Response, Compensation, and Liability Act Docket No. 9-2007-0005), the USEPA divided the Site into operational units (OUs) as follows:

Arimetco facilities comprise one of the following eight OUs at the Site (OU-8) identified by the USEPA in the 2007 USEPA Order.

- OU-1: Site-Wide Groundwater
- OU-2: Pit Lake
- OU-3: Process Areas
- OU-4: Evaporation Ponds and Sulfide Tailings
- OU-5: Waste Rock Areas
- OU-6: Oxide Tailings Areas

- OU-7: Wabuska Drain
- OU-8: Arimetco Facilities.

1.2 Site Contact and Regulatory Information

ARC is responsible for general site and Arimetco FMS O&M activities. Arcadis U.S., Inc. (Arcadis), its contractor, performs these activities. All contractors and subcontractors who work at the Site are required to be licensed and bonded in accordance with the requirements of Nevada Administrative Code Chapter 624, certified for their equipment, and certified under the Occupational Safety and Health Administration (OSHA) for Hazardous Waste Operations and Emergency Response. The Nevada Department of Environmental Protection (NDEP) is the lead agency for the Site, with responsibilities for directing the Remedial Investigation/Feasibility Study process, including final closure and O&M activities. Cooperating regulatory agencies at the Site include the Bureau of Land Management, USEPA, and U.S Fish and Wildlife Service (USFWS). Site contact information is provided below:

- ARC

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  Project Manager
  Atlantic Richfield Company
  4 Centerpointe Drive
  LaPalma, California 90623-1066
  Tel: (657) 529-4581
  Fax: (714) 670-5195 fax
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- Arcadis

  Assigned Personnel: Ron Hyatt, Will Reves
  Project Manager: Travis Phelps
  Site Safety Officer: Ron Hyatt
  Arcadis Field Office (Weed Heights)
  1 Austin Circle,
  Yerington, Nevada 89447
  Tel: (775) 463-9388
  Fax: (775) 463-9488
  Travis.Phelps@arcadis.com
  Ron.Hyatt@arcadis.com

The following contact information is provided for NDEP (lead regulatory agency at the Site):

- NDEP – Bureau of Corrective Actions

  Abandoned Mines Land Program Manager: Jeryl Gardner (775) 687-9484
  901 S. Stewart Street., Suite 4001
  Carson City, Nevada 89701

2 DESCRIPTION OF FLUID MANAGEMENT SYSTEM COMPONENTS

Arimetco FMS components, depicted on Figure 2-1, are summarized and described below:

- Five lined HLPs and perimeter leachate collection ditches
- Six HLP fluid collection ponds/sumps and transfer pumps
- Drain-down distribution pipeline system consisting of approximately 25,000 feet of pipe
- FMS Evaporation Ponds
- Enhanced evaporation system (EVS) on the Phase IV Vat Leach Tailings (VLT) HLP
- Electrical power supply system consisting of a 300-kilovolt ampere transformer providing 2,400 volt (V) overhead distribution service to FMS components north of Burch Drive, and an NV Energy transformer providing 70 amps of 480 V service at the Slot Pond
- Ultrasonic flow meters on the VLT and Slot Pond pump discharge pipeline; bubble flow meters on the drain-down collection pipeline discharging to the VLT Pond and Evaporation Ponds B and C; a level meter on the Slot Pond HLP drain-down collection ditch weir; and bird deterrents described in further detail in Section 3.1.2.

2.1 Heap Leach Pads

Inactive Arimetco HLPs that continue to produce drain-down fluids include the Phase I/II HLP, two Phase III HLPs, the Phase IV Slot HLP, and the Phase IV VLT HLP. Ultrasonic water level meters in weirs, pressure transducers, and data loggers are installed at the associated ponds to measure drain-down solution volumes and pond water levels. Available drain-down volume and flow data are included in the Arimetco (OU-8) FMS Water Balance Model Update (Brown and Caldwell 2017).

Phase I/II Heap Leach Pad

The Phase I/II HLP occupies approximately 14 acres. The solution ditch that surrounds the Phase I/II HLPs drains to the Phase I Pond. The current average annual drain-down rate is approximately 0.25 gallon per minute (gpm) (Brown and Caldwell 2017).

Phase III Heap Leach Pads

The Phase III South HLP occupies approximately 46 acres, and the Phase III 4X HLP occupies approximately 50 acres. The solution ditches surrounding the Phase III South HLP and the Phase III 4X HLP drain to the North Mega Sump, South Mega Sump, and Phase III-South HLP Sump. The current drain-down rate from the two HLPs is approximately 3.1 gpm (Brown and Caldwell 2017).

Phase IV Slot Heap Leach Pad

The approximate 86-acre Phase IV Slot HLP solution flows down into the Slot Pond. Currently, the annual average drain-down rate has decreased to approximately 2.9 gpm (Brown and Caldwell 2017).

Phase IV VLT Heap Leach Pad

Arimetco constructed the Phase IV VLT HLP on the southern portion of the former finger evaporation ponds and on native alluvial soils north of OU-6. The 54-acre Phase IV VLT HLP solution drainage ditch drains to the VLT Pond and, as needed to improve evaporation efficiency of the FMS, is pumped to one of two FMS Evaporation Ponds (B and C) described below. The current average annual drain-down rate is approximately 2.9 gpm (Brown and Caldwell 2017).

2.2 Fluid Management System Conveyance Components

The FMS components (ponds, pumps, and pipelines) help convey fluids throughout the system to increase storage and evaporation capacity. Solutions from the Phase I Pond are pumped into a 6-inch-diameter pipeline, which then connects to the 12-inch-diameter line that continues west beneath Burch Drive to the eastern corner of the Phase III South HLP. A 12-inch-diameter pipeline from the Phase III-South HLP Sump flows by gravity to this same location, which is where the diameters of the conveyance lines increase from 12 inches to 16 inches (Figure 2-1).

Two parallel 16-inch-diameter lines convey solutions past the former Mega Pond area, where a French drain and two sumps collect drain-down from the Phase III South HLP. Drain-down from the Phase III 4X HLP joins the 16-inch line that conveys flows from the Phase IV Slot, Phase I/II, and the Phase III South HLPs collected by the South and North Mega Sumps. The two pipelines continue to the evaporation ponds, where control valves are used to direct flows to the appropriate ponds. The ponds are shown on Figure 2-1 and summarized in Table 2-1. Pond capacity influences FMS operations under routine (average precipitation) conditions or non-routine or emergency (intense storm events, such as warm rain on snow) conditions.

2.3 Fluid Management System Collection and Evaporation Ponds

Table 2-1 lists each pond and its capacity, which add up to approximately 10.8 million gallons. FMS Ponds in the system are:

- Evaporation Pond B
- Evaporation Pond C
- Slot Pond
- VLT Pond
- Phase I Pond.

Table 2-1. Arimetco FMS Pond Design Specifications

Description	Slot 2 Pond	Slot Sed Pond	Phase I/II Pond	VLT Pond	VLT Sed Pond	Evap. Pond B	Evap. Pond C	Total
Crest Area (square feet)	44,384	6,681	15,368	44,400	~9,000	46,854	46,854	297,514
Crest Area (acre)	0.97	0.15	0.35	1.02	~0.21	1.07	1.07	4.84
Total Depth (feet)	22	6	8	18	NA	10	10	NA
Operational Maximum Water Depth (feet)	18	4	6	13	NA	9.0	9.0	NA
Maximum Operational Capacity (million gallons)	2.6	0.14	0.43	1.9	0.053	2.4	2.4	9.9
Operational High Water Freeboard (feet)	3.0	1	1	2.5	2.5	1	1	NA
Operational High Water Depth (feet)	18	5	7	15.5	NA	9.0	9.0	NA
Highest Operational Capacity (acre-feet)	9.2	0.61	1.53	7.98	~0.16	7.5	7.5	34.5
Highest Operational Capacity (million gallons)	3.0	0.2	0.5	2.6	~0.053	2.4	2.4	11.2
Primary Drain-Down Source(s)	**Slot HLP**	**Slot HLP & Leak Detector**	**Phase I HLP**	**VLT HLP & Leak Detector**	**VLT HLP**	**Phase III HLP**	**Phase III HLP**	**NA**

~ = approximately
NA = not applicable

2.4 Enhanced Evaporation System

A 4-inch high-density polyethylene (HDPE) DR-11 pipeline runs from Evaporation Pond B, up the south side of the VLT HLP, and to a series of 80 standpipes with evaporation nozzles. The nozzles sit in a temporary HDPE-lined evaporation basin, which covers a 150,000-square-foot area. Each nozzle is capable of spraying 2.4 gpm of fluids at 40 pounds per square inch (psi). The system is powered by a pump capable of pumping 192 gpm at 300 feet of pressure head located at Evaporation Pond B.

2.5 Arimetco Leak Detectors

Fifteen leak detectors for the Arimetco FMS (Figure 2-1) include five leak detectors associated with the VLT HLP and Ponds, three associated with the Phase III-4X HLP, four associated with the Phase IV Slot HLP, and two associated with Evaporation Ponds B and C. Currently, two leak detector sumps have permanent pumps, and the other sumps are visually inspected and pumped using a temporary pump. Information and O&M manuals for pumps and flow meters installed in the leak detection sumps is provided in Appendix A.

2.6 Fluid Management System Electrical Power Source

An NV Energy substation provides electrical service to the Site via an overhead distribution line along the northern side of Burch Drive.

2.7 Fluid Management System Bird Deterrence

A variety of tools are setup around the FMS Ponds to assist in deterring birds. These tools may include items such as wind dancers and wetland wailers; however, tools may constantly change to verify that birds do not acclimate to any certain device and to confirm that new methods are deployed for maximum efficiency.

3 ARIMETCO FLUID MANAGEMENT SYSTEM OPERATION AND MAINTENANCE ACTIVITIES

FMS operations are conducted in accordance with this FMS Work Plan. Operational objectives include:

1. Prevention of fluids from escaping containment
2. Deterrence of birds from contacting the solutions
3. Inspection of system components and monitoring of system performance and condition
4. As needed, conveyance of solutions from one location to another to contain and evaporate the solutions
5. Performance of preventive maintenance and system repairs as required
6. Improvement of FMS performance where possible.

Daily inspection of the FMS components (e.g., electrical system, pumps, ditch liners, pipelines, and pond liners) and assessment of available pond capacity provides the basis for daily, weekly, and monthly fluid management and preventive maintenance decisions. O&M technicians also prepare records and annual reports on these FMS activities.

3.1 Routine Activities

Daily O&M occurs during normal business hours (7:00 am to 4:00 pm), Monday through Friday. Bird deterrent occurs within an hour of sunrise and an hour of sunset. Each day begins with a safety meeting (e.g., review of activities and associated task risk assessments (TRA) based on an assessment of work-related risks). Routine Arimetco FMS inspections typically focused on downloading pond water levels and noting the condition of electrical systems, pumps, ditches, pipelines, and pond liners. When levels in the VLT Pond and/or Slot Pond approach maximum operational levels, or when pond solution levels needed to be balanced to optimize evaporation, fluids were diverted and/or pumped to FMS Evaporation Ponds B and C. Routine operational activities are described below.

1. All FMS Ponds are inspected first as part of the bird deterrent program:
   - Wind dancers are turned on.
   - Bird deterrents are checked for operation.
2. At approximately 9:00 am, the EVS is started up and run for approximately 3 hours. Two conditions are monitored throughout operation:
   - Wind speed and overspray are monitored to ensure that no overspray leaves the HLP.
   - Fluid level in the lined evaporation basin is monitored to ensure that fluid depth does not exceed 6 inches.

   The system will be automatically shut down should either of these two conditions be present.
3. FMS Evaporation Ponds B and C are inspected:
   - Staff gauges are checked to obtain the fluid level.
   - Pond surfaces are checked for the buildup of salt precipitate. If the pond not receiving flow has precipitate forming on the surface, flow is switched from the Mega Sumps to that Pond (B or C).

- During the summer evaporation period, Ponds B and C are kept at a minimum of 6 feet.
- In October, pumps are turned off at Ponds B and C to allow fluid levels to drop for winter storage.

4. While driving between the FMS Ponds, the pipelines are visually inspected for leaks.
5. The VLT Pond is inspected:
    - Staff gauges are checked to obtain the fluid level.
    - During the summer evaporation period, fluid is pumped from the VLT to the FMS Ponds B and C as often as needed to maintain the level in Ponds B and C at 6 feet.
6. The Mega Sump area is then inspected (inlet and outlet areas for the French drain).
7. The Slot Ponds are inspected:
    - Staff gauges are checked to obtain the level.
    - Fluids are pumped from the Slot Pond to any of the other ponds according to the fluid levels of those ponds.
8. The Phase I Pond is inspected:
    - One time in the spring, the Pond is pumped dry and a dam is built in the inlet so that any fluid going to the Pond is caught in a reservoir.
    - Fluids are pumped out daily from the reservoir into a portable poly tank and transferred to Ponds B and C.
    - Once temperatures approach freezing in the late fall, the dam is removed, and fluids flow into the Pond.
    - As required, fluids are pumped from the Pond using the portable water tank and transferred to Ponds B and C or where warranted by the current capacity conditions of the entire FMS.
9. Whenever fluids are transferred using pumps, the transfer volume is estimated from the flow rate and the duration of the pumping as well as flow meters at each pumping station.
10. Weekly levels are downloaded from pressure transducers in all Ponds.
11. Inflow weir water level meters, pond level transducers, bubble flow meters, and ultrasonic flow meters are checked, and the collected data are downloaded weekly. The data are analyzed to confirm that all instruments were operating properly.
12. Visual inspections of electrical power components are conducted daily including overhead power lines associated with the FMS, which are inspected while driving between the Ponds.
13. Routine inspections are performed to check leakage from pond liners, collection ditches, and French drains. Local accumulations of drain-down solutions within the ditches, leaks, or seepage areas outside containment (e.g., the observation of moist soils that may be attributed to FMS components) are documented. Leak detection sumps are visually inspected weekly for signs of moisture and the occurrence of chemical precipitates and/or sediments. Areas of exposed liner materials within the ponds are inspected for integrity and any accumulation of chemical precipitates or other solids.

3.2 Emergency Operations

NDEP will be notified in any event of a potential loss of fluid containment resulting from component failure (e.g., liner, pump, conveyance pipe) or extreme weather conditions (i.e., multiple consecutive days of high precipitation). Additionally, NDEP will be notified any time the evaporation ponds reach their maximum operational level (MOLs). Mitigation controls may vary pending time of year and weather forecasting. Each situation will be evaluated and communicated with the NDEP, and a mutually agreed control will be implemented. Some possible controls include:

1. Transfer fluids among FMS Ponds to maximize available storage space.
2. Reconnect the VLT pump to the spray system on top of the VLT HLP and pump to the top of the VLT HLP for short-term containment.
3. Mobilize temporary tanks for emergency storage.

Implemented emergency operations would continue until pond levels drop below approved MOLs. In all such instances, operational measures will be protective of authorized on-site personnel.

3.3 Bird Mitigation and Monitoring Program

ARC conducts bird mitigation and monitoring to prevent birds from landing on the VLT Pond, VLT Sediment Pond, FMS Evaporation Ponds, Slot 2 Pond, and Slot Sediment Pond. These operations comply with Bird Mitigation Protocols adopted for the Yerington Site (Appendix B). Bird observations, reported monthly to the USFWS, include locations, species, and number of individuals. Deterrence used and hours deployed are also reported to the USFWS in the monthly report.

Increased observation/monitoring of ponds and increased numbers of deterrents are deployed during peak bird activity periods, including spring and fall migration, rainy periods that increase water levels in the ponds, and during the winter when other water bodies in the area are frozen. ARC understands that bird deterrent activities are dynamic in nature, subject to: 1) new guidelines provided by the USFWS and 2) changing as site conditions evolve resulting from removal actions or new activities (e.g., mining reuse).

3.4 Fluid Management System Maintenance

O&M technicians perform routine maintenance to confirm that the FMS functions in accordance with system objectives.

3.4.1 Routine Maintenance

Routine maintenance activities include the replacement of gauges, meters, and small pumps. As needed, pipeline leaks may be repaired by O&M technicians, or may require a qualified subcontractor. O&M technicians will not perform any maintenance on the FMS electrical system, which will be maintained by an electrician that is certified and licensed by the State of Nevada.

3.4.2 Non-Routine Maintenance

Non-routine FMS maintenance includes the repair and/or replacement of existing pipes, pumping equipment, and associated electrical systems (as needed) to maintain effective and safe fluid transfer operations. The FMS is not anticipated to generate hazardous waste streams because:

- Pump motors, except the VLT pump, are water-cooled and do not require oil.
- The VLT pump occasionally requires supplemental oil, but does not produce an oil waste.
- Replaced batteries are recycled.

ARC will notify the NDEP of any changing conditions associated with Arimetco facilities (e.g., deterioration, sun or wind damage, broken equipment) that may pose a potential operational issue and/or any health, safety, and environmental hazard.

Repairs to pipelines larger than 4 inches in diameter require a subcontractor (currently Desert Engineering). Such repairs may require that a temporary sump be installed to contain the leak. Malfunctioning pumps are typically repaired or replaced by a subcontractor (currently Owens Brothers Pump).

4 HEALTH AND SAFETY REQUIREMENTS

O&M activities will be conducted in accordance with the Site Health and Safety Plan (HASP; Arcadis 2016) The HASP identifies, evaluates, and prescribes control measures for health and safety hazards and describes emergency response procedures. HASP compliance is the responsibility of Arcadis, with ARC providing oversight and compliance assurance. Copies of the HASP are maintained at the Site and are available to all site workers. The HASP includes the following site-specific requirements and procedures:

- Safety and health risk or hazard analysis
- Employee training requirements
- Personal protective equipment (PPE) requirements
- Daily safety meeting requirements
- Medical surveillance program
- Site control measures (including dust control)
- Decontamination procedures
- Emergency response
- Assigned roles and responsibilities and specific training requirements
- Communications plan
- Simultaneous operations plan
- Identification of control of work-permitted activities
- Evaluating each task for hazards using TRAs in accordance with BP Hazard Identification Task Risk Assessment (HITRA)-Defined Practices.

4.1 Training

All site workers and contractors will receive applicable training, as outlined in 29 Code of Federal Regulations 1910.120(e), and as stated in the HASP. Site-specific training will be covered at the pre-entry briefing, with an initial site tour and review of site conditions and hazards. Records of pre-entry briefings will be maintained on site. Training elements include:

- Persons responsible for site safety
- Site-specific safety procedures
- Site-specific safety and health hazards
- Project- and task-specific work risk assessment and mitigation
- Use of PPE
- Decontamination procedures
- Emergency response procedures.

Other required training, depending on the activity or level of involvement, includes OSHA 24- or 40-hour training (depending on activity or level of involvement) and annual 8-hour refresher courses. Additional

training requirements may include, but are not limited to, first-aid/CPR and driver safety. Copies of training certificates will be maintained at the Site and in employee personnel records.

4.2 Personal Protective Equipment

Minimum PPE requirements while performing FMS O&M tasks include:

- Hardhat
- Steel-toed/steel-shank or equivalent boots (must meet American National Standards Institute Z41.1)
- Safety glasses or goggle with side shields
- High-visibility traffic safety vest (Class II)
- Long-sleeve shirt and long work pants.

Additional PPE may be required depending on the work task and may include, but is not limited to, gloves, hearing protection, face shield, goggles, chemical protective suits, rubber boots, respirators, or fall protection. The specific PPE requirements are identified in the TRA documents and HASP and may be modified based on site conditions.

4.3 Specific Health and Safety Procedures

As identified in the HASP and other project safety documents, some work activities are identified as high hazard potential and require additional safety precautions and approvals before the work commences. The following work procedures are expected or likely to occur during the FMS O&M activities. Additional details should be referenced in the HASP.

- Ground disturbance
- Working around water
- Heavy equipment
- Working at heights.

4.4 Task Risk Assessments

Detailed TRAs have been created for each of the individual tasks that comprise the FMS operation and for all field tasks required for this work. TRAs will be kept at the Site at all times and will be reviewed by site workers prior to and throughout the work activities to identify new hazards or controls. A summary of potential hazards associated with the FMS activities described in this Work Plan is provided in Table 4-1.

Table 4-1. Task Risk Assessment Summary

Field Activities	Potential Hazards
Monitor pond water levels using transducer or visual comparison to painted depth marks	• Walking around ponds with water, potential to slip on liner
Transfer solutions from FMS collection ponds (Slot, VLT, Phase I) to the FMS Evaporation Ponds	• Potential for contact with FMS water that is weakly acidic (pH 2 to 4); could cause minor skin/eye irritation • Possible electrical hazards when turning pumps on/off • Possible contact with insects and spiders in MCC buildings or around ponds
Measure pond inflow rates at v-notch weir using a meter	• Potential contact with FMS water • Walking on uneven ground surface around ponds and ditches; potential slip and fall hazard
Measure pumping rates during solution transfer	• Limited hazards when measured by flow meter on discharge line • Possible contact with FMS water • Potential slip hazard when walking on the pond liner
Inspect and pump leak detectors	• Potential for insects and spiders to be present inside the leak detectors, possible bites or stings • Potential injury when transporting, setting up, or refueling portable generator to run electric pump to purge detector • Possible contact with FMS fluids
Maintenance tasks (pumps, gauges, meters, valves, pipes, liners)	• Potential electrical hazards • May require working with heavy equipment to lift or move pumps • Working on or around pond liners with potential to slip and fall into pond • Possible contact with FMS fluids
EVS and Emergency management of excess fluids by pumping to VLT HLP	• Uneven walking surfaces on top of HLP, potential for slip, fall, or twisted ankle • Infrequently used equipment and valves may be difficult to turn on or adjust • Possible contact with FMS fluids • Noise hazard around large diesel-powered pump
Bird mitigation (observations, pyrotechnics, wind dancers, bird guard towers)	• Noise hazard around bird guard towers • Noise, fire, explosion hazard when handling pyrotechnic equipment • Electrical hazard when working with wind dancers • Walking/driving hazards around ponds

5 REFERENCES

Arcadis. 2016. Health and Safety Plan for the Yerington Mine Site.

Brown and Caldwell. 2010 Arimetco Heap Leach Fluid Management System, Operations and Maintenance Plan, Yerington Mine Site, July 16, 2010.

Brown and Caldwell. 2014 Annual Operations and Maintenance Report, Arimetco Heap Leach Fluid Management System, Yerington Mine Site, March 31, 2015.

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USEPA. 2005. Anaconda/Yerington Mine Site Unilateral Administrative Order for Initial Response Activities. EPA Docket No. 9-2005-0011. April 25.

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FIGURE

rjohnson
Dec 31, 2014 - 12:09pm

VLT POND (DIESEL PUMP WITH DURCO VLTSP BACKUP PUMP)*
149+31.96
4"Ø PIPELINE
PHASE IV- VLT HLP
140+00
4"Ø VLT DISCHARGE PIPELINE
16"Ø PIPELINE OUTLET TO DITCH
130+00
4"Ø PIPELINE
16"Ø PIPELINE
4"Ø DISTRIBUTION LINES W/ SPRINKLERS
FMS EVAPORATION POND A (INACTIVE)
FMS EVAPORATION POND B & C
CONTROL VALVES AT TEE
16"Ø PIPELINE
CONTROL VALVES AT WYE
120+00
110+00
100+00
90+00
16"Ø PIPELINE
PHASE III- 4X HLP
80+00
16"Ø PIPELINE
12"Ø PIPELINE
4"Ø PHASE III-4X COLLECTION LINE
CULVERT
NORTH MEGA SUMP
70+00
END 12"Ø PIPELINE/START 16"Ø PIPELINES
60+00
LINED FRENCH DRAIN
SOUTH MEGA SUMP AND DAM
PHASE III- SOUTH HLP
50+00
PHASE I POND (DIESEL PUMP)*
40+00
12"Ø PIPELINE
LINED FRENCH DRAIN
PHASE III- SOUTH HLP SUMP
12"Ø PIPELINE
6"Ø PIPELINE
PHASE II HLP
30+00
SLOT 2 POND (2 H.P. TRANSFER PUMP)
12"Ø PIPELINE
20+00
10+00
1+00
PHASE I HLP
PHASE IV- SLOT HLP
12"X8" REDUCER
SLOT SEDIMENT POND (25 H.P. PUMP)
8"Ø PIPELINE
SLOT 1 POND

LEAK DETECTOR ID		LOCATION
1	VLT D1	DITCH BY WEIR NORTH
2	VLT D2	DITCH BY WEIR SOUTH
3	VLT SP	SEDIMENT POND
4	VLT P1	VLT POND
5	VLT D3	DITCH BESIDE ROAD
6	III FX	4X HLP
7	II FX	4X HLP
8	I FX	4X HLP
9	SSP I	SLOT SEDIMENT
10	SD 2	DITCH BEHIND SLOT II POND
11	SD 1	DITCH BEHIND SLOT I POND
12	SD 3	DITCH BESIDE ROAD
13	EP "B"	EVAPORATION POND B
14	EP "C"	EVAPORATION POND C

EXPLANATION

- APPROXIMATE PIPELINE ROUTE
- MINE SITE BOUNDARY
- HEAP LEACH PAD (HLP)
- ACTIVE LINED POND
- INACTIVE LINED POND
- INACTIVE POND
- RECLAIMED POND
- FLOW DIRECTION
- COLLECTION/CONVEYANCE DITCH
- VALVE
- SUMP
- WETLANDS WAILER
- FRENCH DRAIN
- LEAK DETECTOR
- * PUMP CAN ALSO BE USED AT THESE LOCATIONS

Brown AND Caldwell

Date: Jan. 2015
Atlantic Richfield Company
Project: 145482

N W E S
400 0 400 800 FEET

Yerington Mine Site, Nevada

Figure 2-1
Active Arimetco Heap Leach Fluid Management Components

P:\Arco-Yerington\Site OandM Activities\145482 - Year 2014 Files\CAD\2015 Arimetco FMS O&M Report\Figure 2-1 - Arimetco Heap Leach FM Facilities.dwg

APPENDIX A

Pump and Flow Meter Manuals

SHENITECH

STUF-300F Series

Wall-Mount Ultrasonic Flowmeter

User's Manual

UM300F-14-02B

November 1, 2010

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The following conventions are used through this manual:

WARNING!

Read the declaration carefully before starting any other action!

Local safety regulations must be applied!

CAUTION!

Attention! Damage could occur to the device if handled inappropriately.

For questions, please call us at +1 781 932 0900 or email us at support@shenitech.com.

Contents

1. Introduction

§1.1 Preface

The wall-mount STUF-300F product family is designed to be installed in a fixed location for long-term flow measurement.

The STUF-300F flowmeter is based on transit-time flow measurement principle. It measures the flow rate of liquid in a closed pipe by using a pair of clamp-on or wetted ultrasonic transducers. In general, the liquid should be full in the pipe, and should contain no or small amount of particles or air bubbles. Examples of applicable liquids are: water (hot water, chilled water, city water, sea water, etc.), sewage, oil (crude oil, lubricating oil, diesel oil, fuel oil, etc.), chemicals (alcohol, acids, etc.), waste water, beverage, liquid food, solvents and other liquids.

The STUF-300F utilizes state-of-the-art technologies such as advanced signal processing, low-voltage transmitting, small signal detection, self-adaptation, the latest SMD electronics, etc. to achieve high accuracy and reliable performance. Besides, the STUF-300F provides versatile output interfaces, both analog and digital, which can be easily used by a host computer or a flow controller. The RS-485 communication interface together with MODBUS support and power surge protection makes STUF-300F the idea device for reliable flowmeter networking.

§1.2 Features

* Repeatability: ±0.2%
* Accuracy: ±1% of velocity reading ± 5mm/s
* Flow range -60 to 60ft/s (-18 to 18m/s), bi-directional
* Positive / negative / net flow totalizers
* Operates with a wide range of Shenitech transducers, including clamp-on, insertion and flow-cell (spool-piece) transducers
* No moving parts, no or minor maintenance
* No pressure drop, no disturbance to the flow
* Excellent long-term stability
* Easy transducer installation
* Proprietary low-voltage transmission and self-adaptation technologies
* Able to measure electrically conductive and non-conductive liquids
* Isolated RS-485 interface with surge protection, support both MODBUS and proprietary protocols
* One isolated 0/4-20mA output
* One isolated OCT output and one Relay output programmable to drive alarm, pulse counter, valve
* Built-in scheduler for leakage detection
* Internal batch process controller
* Real-time clock for calendar
* 2x20 letters backlight LCD display, 4x4 tactile-feedback membrane keypad
* Menu-driving program, easy to use
* Optional GPRS/GSM module
* Optional RTD interface and thermal energy measurement capability
* Low-power consumption, <1W
* NEMA 4X (IP65) weather-resistant enclosure

§1.3 Flow Measurement Principle

The STUF-300F ultrasonic flowmeter is designed to measure the velocity of liquid within a closed conduit. It uses the well-know transit-time measurement principle plus our proprietary signal processing and ultrasonic transceiving technologies.

As shown in Figure 1.1, the STUF-300F utilizes a pair of ultrasonic transducers which are mounted on the pipe upstream and downstream respectively. Each transducer functions as both ultrasonic transmitter and receiver. The STUF-300F main unit operates by alternately transmitting and receiving a coded burst of sound energy between the two transducers. The transit-times in the upstream direction as well as in the downstream direction are measured. The difference of the two transit times is directly and exactly related to the velocity of the liquid in the pipe,

$$V = \frac{MD}{\sin 2} \times \frac{\Delta T}{T_{up} \bullet T_{down}}$$

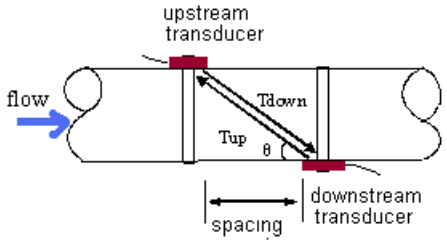


Figure 1.1: Transit-time flow measurement principle

Where:

θ is the angle between the sound path and the flow direction
M is the number of times the sound traverses the flow
D is the pipe diameter
T_{up} is the time for the beam traveling from upstream the transducer to the downstream transducer
T_{down} is the time for the beam traveling from the downstream transducer to the upstream transducer
$\Delta T = T_{up} - T_{down}$

The flow rate is then computed by combining the velocity information with pipe parameters and a scale factor. The scale factor is normally determined by calibration in factory.

Three types of transducers can be used with the STUF-300F main unit: clamp-on transducer, insertion wetted transducer and flow-cell transducer. All of them do not block the flow, thus, do not generate pressure drop. None of them has moving parts, thus, needs no or very minor maintenance. The transducers can be mounted in V-method where the sound transverses the pipe fluid twice, or in W-method where the sound transverses the pipe fluid four times, or in Z-method where the transducers are mounted on opposite sides of the pipe and the sound crosses the pipe

fluid once. The selection of the mounting methods depends on pipe and liquid characteristics. Please refer to the related Appendix for more details.

§1.4 Packaging List (Standard)

1. STUF-300F1 main unit – standard version	1 unit
2. Transducers	
(1) For clamp-on installation:	
M1-type clamp-on transducer for 2”~28” pipe	1 pair
Clamp-on fixture	1 set
Acoustic couplant	1 unit
(2) For insertion installation:	
Insertion transducer for pipes of 3” and larger	1 pair
Hot-taping tool for metal pipe installation	1 set
(3) For inline flow-cell installation:	
Flow-cell transducer	1 piece
3. Transducer cable, 15ft	1 pair
4. User’s Manual	1 unit

§1.5 Optional Parts

Clamp-on transducers:

S1-type clamp-on transducer for small pipe (1”~4”, -40°C~90°C)

S1HT-type high-temperature clamp-on transducer for small pipe (1”~4”, -40°C~150°C)

M1-type clamp-on transducer for medium size pipe (2”~28”, -40°C~90°C)

M1HT-type high-temperature clamp-on transducer for medium size pipe (2”~28”, -40°C~150°C)

L1-type clamp-on transducer for large pipe (11”~240”, -40°C~90°C)

Clamp-fixtures

Insertion transducers:

Insertion transducer for pipe size of 3” or larger

Hot-tapping tool for insertion transducer installation

Mounting saddle for non-metal pipes

Flow-cell transducers:

-type flow-cell transducer for small pipe (3/8”~2”)

Standard flow-cell transducer for large pipe (2”~40”)

Dedicated shielded transducer cable

Data logger module

GPRS/GSM module
PT100 temperature sensor, surface-mount type
PT100 temperature sensor, insertion-mount type
PT100 signal conditioning module
Dual-channel analog input module
RS485-USB converter
StufManager ™ PC software

§1.6 Typical Applications

The STUF-300F flowmeter can be applied to a wide range of pipe flow measurements. Applicable liquids include pure liquids as well as liquid with small quantity of tiny particles. Examples are:

Water (hot water, chilled water, city water, sea water, waste water, etc.);
Sewage with small particle content;
Oil (crude oil, lubricating oil, diesel oil, fuel oil, etc.);
Chemicals (glycol, alcohol, acids, etc.);
Plant effluent;
Beverage, liquid food;
Ultra-pure liquids;
Solvents and other liquids.

Applications sorted by industry / process are:

Water and waste water management;
Water and waste water treatment plants;
Power plants, such as nuclear power plants and hydraulic power plants;
Mining and metallurgy plants;
Petroleum process monitoring and control;
Chemical process monitoring and control;
Pulp and paper process monitoring and control;
Food and beverage processing;
Marine maintenance and operation;
Pipeline leakage detection;
Energy supply and production systems, such as geothermal system, HVAC, BMS, etc.
Flow measurement networking.

§1.7 Product Identification

Each set of the STUF-300F series flowmeter has a unique product identification number or ESN (electronic serial number) written into the software that can only be modified with a special tool by the manufacturer. In case of any hardware failure, please provide this number which is located on menu window M61 when contacting the manufacturer.

§1.8 Specifications

Main Unit	Linearity	Better than ±1%.
	Accuracy	±1% of velocity reading, plus ± 5mm/s. Could be better when in-situ calibration is conducted. Amount the three types of transducers, flow-cell is most accurate, next to it is insertion type, followed by clamp-on type. For clamp-on transducer, the accuracy may vary on small pipes (1”~1.5”).
	Repeatability	±0.2%.
	Velocity	-60 ~ 60 ft/s (-18 ~ 18 m/s), bi-directional
	Measurement Period	0.5s. Can be set to 0~99s.
	Display	LCD with backlight. 2x20 letters.
	Keypad	4x4-key membrane keypad with tactile feedback
	Units	English (U.S.) or metric.
	Output	Analog output: one isolated 4-20mA or 0-20mA current output. Impedance 0~1kΩ. Accuracy 0.1%.
		OCT output: one isolated OCT output, 0.2A@24VDC. Can be programmed to drive an alarm, a pulse counter, a relay, an ON/OFF device, etc. Relay output (optional): one Form C relay, SPDT, 1A@125VAC or 2A@30VDC. Can be wired as Normally Open or Normally Closed for alarm, ON/OFF control, totalizer output, etc.
		Internal Alarm (Buzzer): user programmable. External alarm driver: can be connected to the Relay or OCT output terminals directly.
		RS-485 communication: isolated 2-wire half-duplex, with power surge protection, supports MODBUS and proprietary flowmeter protocols. GPRS / GSM module (optional): for remote monitoring and remote control (for model STUF-300FNx only).

	Input	Analog input: 1 channel of 4-20mA current input for signal such as temperature, pressure, or, liquid level. Accuracy 0.1%. Additional analog input channels are available upon request. RTD signal conditioning module (optional): accommodating two PT100 sensors for hot and cold liquid temperature measurement (for model STUF-300FRx only)
	Others	Self-diagnosis. RTC (real-time clock) for calendar. Built-in scheduler Data logger (optional). Capable of offline compensation for flow totalizer, automatic / manual selectable. Automatically record the following information: · The totalizer data of the last 64 days / 64 months / 5 years; · The power-on time and corresponding flow rate of the last 64 power on and off events. Allow manual or automatic flow loss compensation · The instrument working status of the last 64 days
	Enclosure	Protection Class: IP65 (NEMA 4X), weather-resistant. Explosive Proof Class: ExdIIBT4 (for model STUF-300F2x only) Size: 9.1"x5.9"x3" (230x150x75mm^3) for standard version
Transducer	Clamp-on	S1-type: for pipe size 1"~4" (DN25~DN100mm) S1HT-type: for pipe size 1"~4" (DN25~DN100mm), high temperature (to 150˚C) M1-type: for pipe size 2"~28"(DN50~DN700mm) M1HT-type: for pipe size 2"~28"(DN50~DN700mm) , high temperature (to 150˚C) L1-type: for pipe size 11"~240"(DN300~DN6,000mm)
	Wetted - Insertion	Used for pipe size of 3" (DN80mm) or larger. Optional hot-tapping installation tool available.
	Wetted - Flow-cell	-type flow cell transducer: for pipe size 3/8"~ 2" (DN10~DN50mm). Standard flow cell transducer: for pipe size 2"~40" (DN50~DN1,000mm).
Liquids	Liquid Types	Virtually all commonly used clean liquids. Liquids with small quantity of tiny particles may also be applicable. Particle size should be less than 75um, particle concentration less than 20,000ppm (2%). Liquids should contain no or very minor air bubbles. Examples are chilled/hot water, sea water, waste water, chemical liquids, oil, crude oil, alcohol, beer, etc.
	Liquid Temp	32˚F ~ 212˚F (0˚C ~ 100˚C) for standard clamp-on transducers 32˚F ~ 302˚F (0˚C ~ 150˚C) for high-temperature clamp-on transducers, as well as wetted transducers (insertion type and flow-cell type).
	Suspension concentration	< 20,000ppm and particle size less than 75um. May contain very small amount of air bubbles.
Pipe	Pipe Size	3/8" ~ 240" (DN10mm ~ DN6,000mm), depending on transducer type.
	Pipe Material	All metals, most plastics, fiber glass, etc. Allow pipe liner.

	Pipe Straight run	15D in most cases, 30D if a pump is near upstream, where D is pipe diameter.
Cable	Shielded transducer cable. Standard length 15' (5m). Can be extended to 1640' (500m). Contact the manufacturer for longer cable requirement. Cable should not be laid in parallel with high-voltage power line, neither should it be close to strong interference source such as power transformers.	
Environment	Temperature	Main unit: 14˚F ~ 158˚F (-10˚C ~ 70˚C).
		Clamp-on transducer: -22˚F ~ 212˚F (-30˚C ~ 100˚C) for standard type (S1/M1/L1), -22˚F ~ 302˚F (-30˚C ~ 150˚C) for high-temperature type (S1HT/M1HT). Insertion and flow-cell transducer: -22˚F ~ 302˚F (-30˚C ~ 150˚C).
	Humidity	Main unit: 85% RH
		Transducer: water-immersible (IP67), water depth less than 10' (3m)
Power	AC: 90V ~ 260VAC or DC: 12 ~ 32VDC Power consumption: < 1W	
Weight	Standard main unit: 6.6lb (3kg) Network main unit: 7.6lb (3.5kg)	

2. Installation and Measurement

§2.1 Unpacking

Please unpack the shipping box and check the parts and documents against the packing slip. If there is something missing, the device is damaged, or something is abnormal, please contact us immediately and do not proceed with the installation.

WARNING!

The STUF-300F can be used to measure the flow of many kinds of liquids. Some of the liquids may be hazardous. It is very important that you comply with local safety codes and regulations in installing and using electronic devices in your area.

§2.2 Installation Considerations

This section provides guidelines for installing the STUF-300F main unit (electronics box) and its transducers.

§2.2.1 Mounting the Main Unit

The STUF-300F main unit electronics (standard version) are housed in an IP65 (NEMA 4X) weather-resistant and dust-tight enclosure. Therefore, the main unit can be installed indoor and outdoor. Usually, it is mounted in a meter shed or on a location where one can easily access for meter testing and servicing. Please refer to Appendix §9.1 for the enclosure dimensions.

Note: because the unit is not water-proof, be sure it is not exposed to rain or water when it is installed outdoor.

§2.2.2 Installing Transducers

First, you need to select a proper installation site. For this, one usually needs to consider the accessibility of the location, operating space needed for the installation, safety code compliance, etc. In addition, flow and pipe conditions near the installation site are also very important. Please refer to section §2.8 for site selection details.

Then, follow the installation guidelines given in Appendix §9.2 for installing clamp-on transducers.

If you ordered wetted transducer, either insertion type or flow cell type, please refer to Appendix §9.3 and §9.4 for installation instructions.

Distance from Main Unit to Transducers

In general, the closer the transducers to the main unit, the better the signals. Shenitech can supply

up to 1640ft (500m) long transducer cable.

Transducer Cables

STUF-300F utilizes a double-balanced driving technique for high performance ultrasonic transimision and receiving. It requires twisted shielded cable for the transducer. We recommend using the cable supplied by the manufacturer. If you want to do the transducer cabling yourself, please consult the manufacturer in advance.

Try not to route the transducer cable along with high current AC lines. Aviod strong interference sources. Make sure the cables and cable connections are protected from weather and corrosive conditions.

WARNING!

The transducers may have static charges accumulated during transportation. Before connecting the transducers to the main unit, please do discharge the transducers in a safe area by shorting the center conductor of the transducer cable connectors to the metal shield of the connector.

§2.2.3 Power Supply Wiring

Two types of power supply can be used, 90-260VAC and 12-32VDC.

Open the flowmeter enclosure, on the lower right corner (refer to the figures in Appendix §9.1), you should see five terminal blocks which are labeled as DC+, DC-, N, L and E.

If AC power supply is used, connect N, L and E to your power system's Neutral, Line and Earth, respectively. Make sure your Earth ground is good.

If DC power source is used, its positive lead and negative lead should be connected to DC+ and DC-, respectively.

Please refer to Appendix §9.1 for more wiring information.

WARNING!

Be careful about the power supply type of your flowmeter and the power supply wiring! Connecting to a wrong type power source or improper connection of line power could damage the flowmeter. It may also cause hazardous voltage at enclosure, the transducer, flow cell, and associated piping.

Backup Battery

There is a 3V coin cell battery, CR2032, on the main board which is used to backup the calendar real-time clock (RTC). When the main power is off, this battery will keep RTC running. Its lifetime is normally about 3 years. Replace the battery with the same type when necessary. Please disconnect the main power and wear an anti-static wrist strap to prevent electro-static damage to the main board electronics.

If time stamping is not needed for data recording, you may remove this battery from the board.

WARNING!

There might be risk of explosion if the battery is replaced with an incorrect type. Batteries should be recycled where possible. Disposal of used batteries must comply with local environmental regulations.

§2.2.4 Other Electrical Connections

Wiring RS-485

Refer to sections §6.2 and Appendix §9.1 for details.

Wiring 0/4-20mA Output

Using standard twisted-pair wiring. Refer to §3.16 for details.

Wiring 0/4-20mA Input

The analog input channel can be wired to terminal block pins AI3 and AGND using standard twisted-pair wiring. Please refer to section §3.28 and Chapter 7 for more information.

Wiring Alarms

You may use the OCT output or the relay output to drive alarms. The maximum electrical ratings for the OCT and relay are listed in the §1.8 *Specifications*. Using standard twisted-pair wiring. Refer to sections §3.21 and §3.22 for details.

§2.3 Power Up

The STUF-300F does not have power ON/OFF switch. When it is connected to power, it will start to run automatically.

After the power is turned on, the flowmeter will run a self-diagnostic program, checking first the hardware and then the software integrity. If there is any abnormality, corresponding error messages

will be displayed. (Please refer to chapter 5 for error code explanations.)

WARNING!

Before connecting the device to power source, please do a final check to make sure all the wirings are correct and all the local safety codes are followed.

After successful internal checks, the STUF-300F will display menu window #01 (short for M01), or the menu window which was active at last power off. It will also start the measurements by using the parameters configured and saved last time by the user or by the initial program.

The flow measurement program always operates in the background of the user interface. This means that the flow measurement will keep running regardless of any user menu window browsing or viewing. Only when the user enters new pipe parameters will the flowmeter change measurement to reflect the new parameter changes.

When the power is turned on or new pipe parameters are entered, the flowmeter will enter into a self-adjusting mode to adjust the gain of the receiving circuits so that the signal strength will be within a proper range. By this step, the flowmeter finds the best system gain which matches the pipe material and fluid type. The user will see the progress by the number s1, s2, s3 and s4, located on the upper left corner of the LCD display. If the self-adapting process is completed successfully, letter "#R" will be displayed.

When the user adjusts the position of the installed transducers, the flowmeter will re-adjust the signal gain automatically.

Any user-entered configuration value can be stored in the NVRAM (non-volatile memory) by using M26, until it is modified by the user.

§2.4 Keypad

The keypad of the flowmeter has 16 keys (Figure 2.1).

Keys [0] ~ [9] and [.] are keys to enter numbers.

Key [↑/+] is the going UP key when the user wants to go to the upper menu window. It also works as + key when entering numbers.

Key [↓/-] is the going DOWN key when the user wants to go

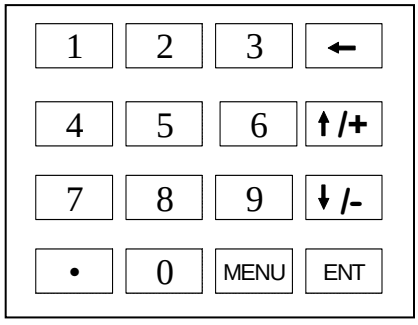


Figure 2.1 Keypad layout

to the lower menu window. It also works as the – key when entering numbers.

Key [←] is the backspace key when the user wants to go left or wants to backspace the left character that is located to the left of the cursor.

Key [ENT] is the ENTER key for any input or selections.

Key [MENU] is the key for the direct menu window jump over. Whenever the user wants to proceed to a certain menu window, the user can press this key followed by a 2-digit number.

The [MENU] key is shortened as the 'M' key hereafter when referring to menu windows.

Key-pressing induced beep sound can be enabled / disabled in menu window M77.

§2.5 Menu Windows

The STUF-300F user interface comprises about 100 independent menu windows that are numbered by M00, M01, M02, …, M99, M+0, M+1, etc.

There are two methods to visit a menu window:

(1) Direct jump in. Simply press the [MENU] key followed by a 2-digit number. For example, if you want to visit menu window M11 for pipe outer diameter, press the following three keys consecutively, [MENU] [1] [1].

(2) Press the [↑/+] or [↓/-] key. Each time of the [↑/+] key pressing will lead to the lower-numbered menu window. For example, if the current window is on M12, the display will go to window M11 after the [↑/+] key is pressed once.

You do not need to remember all the menu windows. Just remember the most commonly used window numbers and the approximate window number of some uncommonly used windows would be sufficient. You can always use [↑/+] or [↓/-] key to find the right window.

There are three different types of menu windows:

(1) Menu windows for number entering, e.g., M11 for setting up pipe outer diameter.

(2) Menu windows for option selection, e.g., M14 for the selection of pipe materials.

(3) Results display windows, e.g., window M00 for displaying flow rate, etc.

For number entering windows, the user can directly press the digit keys if the user wants to modify the value. For example, if the current window is on M11, and the user wants to enter 219.2345 as the pipe outer diameter, then, the flowing keys should be pressed: [2] [1] [9] [.] [2] [3] [4] [5] [ENT].

For option selection windows, the user should first press the ENT key to get into option selection mode. Then, use ↑/+, ↓/- , or digit key to select the right option. Consequently, press the ENT to make the selection.

For example, assume your pipe material is stainless steel and you are currently on menu window M14 which is for the selection of pipe materials (if you are on a different window, you need to press MENU 1 4 first in order to enter into the M14 window.) You need to press the ENT key to get into the option selection mode. Then, either press the ↑/+ or ↓/- key to make the cursor on the line that displays "1. Stainless Steel", or press the 1 key directly. At the end, press ENT again to make the selection.

Generally, the ENT key must be pressed to get into the option selection mode for option modifications. If the "Locked M47 Open' message is indicated on the bottom line of the LCD display, it means that the modification operation is locked out. In such cases, the user should go to M48 to have the instrument unlocked before any further modification can be made.

§2.6 Menu Window List

M00~M09 windows for the display of the instantaneous flow rate, net totalizer value, positive totalizer value, negative totalizer value, instantaneous flow velocity, date time, current analog input values, current working status, etc.

M10~M29 windows for entering system parameters, such as pipe outer diameter, pipe wall thickness, liquid type, transducer type, transducer installation method, etc. Transducer installation spacing is then calculated according to those parameters and displayed on one of the windows. .

M30~M38 windows for flow rate unit selection and totalizer configuration. User can use these windows to select flow rate unit, such as cubic meter or liter, as well as to turn on / off each totalizer, or to reset the totalizers.

M40~M49 windows for setting response time, zeroing / calibrating the system, locking / unlocking keypad, changing network address ID, password, etc.

M50~M89 windows for digital and analog outputs, such as scheduled output, RS-485 output, relay output, analog current loop output, LCD, frequency output, alarm output, analog inputs. Besides, there are also windows for configuring analog inputs, date / time, and day/month/year accumulator.

M90~M94 windows for displaying diagnostic data, including the installation triplet. Those data are very useful when doing a more accurate measurement.

M95 Upon entering into this window, the circular display function is started automatically. The following windows will be displayed one by one, each window will stay for about

4 seconds: M95 ->M00 -> M01 -> M02 -> M03 -> M04 -> M05 -> M06 -> M07 -> M08 -> M09 -> M90 -> M95.

M+0~M+9 windows for some additional functions, including a single precision calculator, display of the total working time, and display of the time and the flow rate when the device is turned on and turned off.

Other menu windows are used for factory debugging.

For detailed explanation of the above windows please refer to chapter 3 “How to” and chapter 4 “Menu Window Details”.

§2.7 Steps to Configure the Parameters

In order to make the STUF-300F work properly, one must program the flowmeter with application information and installation information properly, so that the flowmeter is able to lock to the right signal. The flowmeter will also automatically calculate the transducer spacing which is useful for you to install the transducers.

If you are using flow-cell transducer, however, most of the parameters may have already been programmed in the factory. You may only need to verify the fluid information (M20-M21), make sure the liquid type in M20 is what is in your pipe. Note that the pipe information (M11-M19) should be those of the flow-cell, not that of your pipe.

If you are using clamp-on or insertion type transducer, please follow these steps to configure the system:

(1) Pipe size and pipe wall thickness

For standard pipe, please refer to Appendix §9.4 for outer diameter and wall thickness data. For non-standard pipe, the user has to measure these two parameters.

Enter OD and wall thickness in M11 and M12. The flowmeter will calculate the ID and put it into M13.

(2) Pipe materials
For standard pipe material, select the proper type from the list in M14. The sound speed value of that material, which was pre-stored in the memory, will be used automatically.
For non-standard pipe material, the sound speed of the material must be entered. Please refer to Appendix §9.5 for sound speed data.

(3) Liner material, its sound speed and liner thickness
If liner exists, enter the liner parameters in M16-M18.

(4) Liquid type
For standard liquid material, select the proper type from the list in M20. The sound speed and viscosity values of that material, which were pre-stored in the memory, will be used automatically.

For non-standard liquid material, the sound speed and viscosity of the material must be entered. Please refer to Appendix §9.5 for sound speed and viscosity data.

(5) Transducer type
Transducer type selection is in M23.
For S1/M1/L1 type, select Standard S1/ Standard /M1/ Standard L1.
For insertion type, select Insertion B
For flow-cell transducer, select Pi-Transducer for Pi-type and Insertion B for standard type.

(6) Transducer mounting method
V-method and Z-method are the common methods. Make selection in M24.
Refer to Appendix §9.2 on which method to use.

(7) Transducer spacing
Write down the transducer spacing in M25. You will use it later when install the transducers.

(8) Save configuration

Example: For standard (commonly used) pipe materials and standard (commonly measured) liquids, the parameter configuration steps are as following:

(1) Press keys MENU 1 1 to enter into M11 window. Input the pipe outer diameter through the keypad and press ENT key.

(2) Press key ↓/- to enter into M12 window. Input the pipe thickness through the keypad and press ENT key.

(3) Press key ↓/- to enter into M14 window. Press ENT key to get into the option selection mode. Use keys ↑/+ and ↓/- to scroll up and down to the proper pipe material, and then press ENT key.

(4) Press key ↓/- to enter into M16 window. Press ENT key to get into the option selection mode. Use keys ↑/+ and ↓/- to scroll up and down to the proper liner material, and then press ENT key. Select “No Liner”, if there is no liner.

(5) Press key ↓/- to enter into M20 window. Press ENT key to get into the option selection mode. Use keys ↑/+ and ↓/- to scroll up and down to the proper liquid, and then press ENT key.

(6) Press key ↓/- to enter into M23 window. Press ENT key to get into the option selection mode. Use keys ↑/+ and ↓/- to scroll up and down to the proper transducer type, and then press ENT key.

(7) Press key ↓/- to enter into M24 window. Press ENT key to get into the option selection mode. Use keys ↑/+ and ↓/- to scroll up and down to the proper transducer mounting method, and then press ENT key.

(8) Press key ↓/- to enter into M25 window. The transducer installation distance will be displayed on the window. Based on this distance and the transducer installation method selected above, install the transducers on the pipe (refer to Appendix §9.2 for more installation details.)

(9) After installation is completed, check if the triplet (signal strength S, signal quality Q and transit-time ratio R) are in the right range. Press keys MENU 9 0 to enter into M90 window to read the value for S and Q and press MENU 9 1 to read the value for R.

(10) Press MENU 2 6 to enter into window M26, press ENT 1 ENT to save the above configuration results into non-volatile memory.

(11) Press MENU 0 1 to enter into window M01 to read the measurement result.

§2.8 Transducer Mounting Allocation

The first step in the installation process is to select an optimal location for installing the transducers in order to make the measurement reliable and accurate. Prior to installation, having a basic knowledge about the piping and its plumbing system is recommended.

An optimal location would be defined as a long straight pipe line full of liquid that is to be measured. The piping can be in vertical or horizontal position. The following shows examples of optimal locations.

Principles to select an optimal location:

(1) Pipe must be full of liquids at the measurement site.

(2) No heavy corrosion of deposition inside of the pipe.

(3) Must be a safe location.

(4) The straight pipe should be long enough to eliminate irregular-flow-induced error. Typically, the length of the straight pipe should be 15 times of the pipe diameter, the longer the better. The transducers should be installed at a pipe section where the length of the straight pipe at upstream side is at least 10D and at downstream side is at least 5D, where D stands for pipe outer diameter.

(5) If there are flow disturbing parts such as pumps, valves,

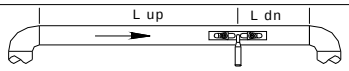
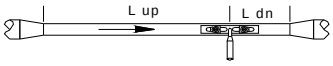
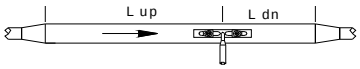
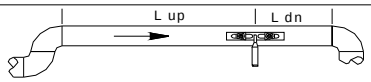
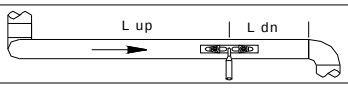
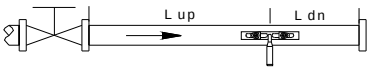
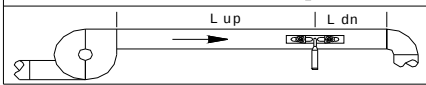
Piping Configuration and Transducer Position	Upstream Dimension L up x Diameters	Downstream Dimension L dn x Diameters
	10D	5D
	10D	5D
	10D	5D
	12D	5D
	20D	5D
	20D	5D
	30D	5D

Figure 2.2 Installation site selection.

etc. on the upstream, the straight pipe length should be increased (refer to the table on the right for more details.) The disturbance strength are in the following order (low to high): *Single Bend -> Pipe Reduction / Enlargement -> Outflow Tee -> Same Plane Multiple Bends -> Inflow Tee -> Out of Plane Multiple Bends -> Valve -> Pump.*

(6) Make sure that the temperature on the location does not exceed the range for the transducers. Generally speaking, the closer to the room temperature, the better.

(7) Select a relatively new straight pipe line if it is possible. Old pipe tends to have corrosions and depositions, which could affect the results. If you have to work on an old pipe, we recommend you to treat the corrosions and depositions as if they are part of the pipe wall or as part of the liner. For example, you can add an extra value to the pipe wall thickness parameter or the liner thickness parameter to take into account the deposition.

(8) Some pipes may have a kind of plastic liner which creates a certain amount of gaps between liner and the inner pipe wall. These gaps could prevent ultrasonic waves from direct traveling. Such conditions will make the measurement very difficult. Whenever possible, try to avoid this kind of pipe. If you have to work on this kind of pipe, we recommend you to use our insertion type transducers that are installed permanently on the pipe by drilling holes on the pipe wall. Refer to Appendix §9.3 for details.

(9) When select the measurement site, you may need to consider where to mount the flowmeter main unit. Normally, the STUF-300F electronics are housed in a weather-resistant enclosure. It can be mounted in a meter shed, or a location that allows easy access to the flowmeter for programming and servicing.

(10) When select the measurement site, you may also need to consider how to install the transducers. Make sure you have enough space for easy operation.

§2.9 Transducers Wiring

Since the STUF-300F utilizes balanced topology for high-performance ultrasonic transmitting and receiving, it is recommended to use high-frequency twisted cable with shielding as the transducer cable in order to guarantee the signal quality. Please refer to section §2.2 and Appendix §9.1 on how to wire transducers to the flowmeter terminals.

§2.10 Transducers Installation

The transducers used by the STUF-300F series ultrasonic flowmeter are made of piezoelectric crystals both for transmitting and receiving ultrasonic signals through the wall of liquid piping system. The measurement is realized by measuring the traveling time difference of the ultrasonic signals. Since the difference is very small, the spacing and the alignment of the transducers are critical factors to the accuracy of the measurement and the performance of the system. Meticulous care should be taken for the installation of the transducers.

Clamp-on transducer installation steps:

(1) Locate an optimal position where the straight pipe length is sufficient (see the previous section), and where pipes are in a favorable condition, e.g., newer pipes with no rust and ease of operation.

(2) Calculate the transducer spacing. Just enter the pipe, fluid and transducer information through menu M11 to M24, the flowmeter will calculate the transducer spacing automatically. The value will be shown in M25. Marking the transducer installation spots on the pipe according to this spacing value.

(3) Clean any dust and rust on the spot where the transducers are to be installed. For a better result, polishing the pipe outer surface with a sander is strongly recommended.

(4) Apply adequate ultrasonic couplant (grease, gel or Vaseline) onto the transducer surface as well as to the installation area on the pipe surface.

(5) Strap on the transducers using clamp fixture. If the pipe is metal, no need to use clamp fixture since the transducer has magnetic built-in. Make sure there is no gap between the transducer surface and the pipe surface.

(6) Fine tune transducer position until the triplet, signal strength S, signal quality Q and transit-time ratio R, have the best readings and those reading are in their *operational ranges* (S≥60, Q≥60 and 97%≤ R ≤103%). It is even better if you can tune those readings into their *optimal ranges* (S≥80, Q≥80 and 99%≤ R ≤101%). Note, for large velocity flow, the R values may exceed this range to some degree.
You may also need to check the measured liquid sound speed (M92) to see if it is close to the theoretic one of the liquid (you may find this info from a physical handbook if you know the liquid material).

For more details on clamp-on transducer installation, please refer to Appendix §9.2.

For wetted transducer installation, please refer to Appendix §9.3.

§2.11 Installation Checkup

After the completion of transducer installation, the user should check the following three parameters (the **triplets**): signal strength S, signal quality Q and transit-time ratio R. The triplet values should fall into their range. One may also need to check delta time (traveling time difference between the upstream and the downstream signals), estimated liquid sound speed, and etc. As such, one can be sure that the flowmeter is working properly and the results are reliable and accurate.

§2.11.1 Signal Strength

Signal strength S indicates the amplitude of receiving ultrasonic signals by a 3-digit number. [00.0]

means there is no signal detected, and [99.9] refers to the maximum signal strength that can be received. Note that sometimes when no confusion will be introduced, S value is expressed by two digits (00-99) for simplicity.

Although the instrument works well when the signal strength ranges from 60 to 99, stronger signal strength should be pursued, because a stronger signal means a better result. The following methods are recommended to obtain strong signals:

(1) If the current location is not good enough for a stable and reliable flow reading, or if the signal strength is lower than 60, relocate to a more favorable location.

(2) Try to polish the outer surface of the pipe, and apply more couplant to increase the signal strength.

(3) Tenderly adjust the position of the two transducers, both vertically and horizontally, while checking the signal strength. Stop at the position where the signal strength reaches to maximum. Then, check the transducer spacing to make sure it is the same as or very close to what window M25 shows.

(4) If the installation method is V-method and the pipe is big, you may need to try Z-method in order to get stronger signals.

§2.11.2 Signal Quality

Signal quality is indicated as the Q value in the instrument. A higher Q value would mean a higher Signal to Noise Ratio (SNR), and accordingly a higher degree of accuracy able to be achieved. Under normal pipe condition, the Q value is in the range of 60-99, the higher the better.

Causes for a lower Q value could be:

(1) Interference from other instruments and devices nearby, such as a power frequency transverter which could cause strong interference. Try to relocate the flowmeter to a new place where the interference can be reduced.
(2) Bad sonic coupling between the transducers and the pipe. Try to polish the pipe surface again, clean the surface and apply more couplant, etc.
(3) The selected pipe section is difficult to conduct the measurement. Relocate to a more favorable pipe line.

§2.11.3 Total Transit Time and Delta Time

The total transit time (or traveling time) and the delta time are displayed on menu window M93. They are the primary data for the instrument to calculate the flow rate. Therefore, the measured flow rate will vary as the total transit time and delta time vary.

The total transit time should remain stable or vary in a very small range.

The delta time normally varies less than 20%. If the variation exceeds 20% in either positive or

negative direction, there could be certain kinds of problems with the transducer installation. The user should check the installation for sure.

§2.11.4 Transit Time Ratio

Transit-time ratio R is usually used to check whether the transducer installation is good and whether the entered pipe parameters are in consistency with their actual values. If the pipe parameters are correct and the transducers are installed properly, the transit time ratio should be in the range of 100±3%. Particularly, when the flow is stand-still, the ratio should be very close to 100%. If this range is exceeded, the user should check:

a) If the entered pipe parameters are correct?
b) If the actual spacing of the transducers is the same as or close to what shown on window M25?
c) If the transducer are installed properly in the right direction?
d) If the mounting location is good, if the pipe has changed shape, or if the pipe is too old (i.e., too much corrosion or deposition inside the pipe)?
e) If there is any interference source inside the pipe?
f) If there are other aspects which do not meet the measurement requirements as recommended earlier?

For more tips, please visit our technical support site:
http://www.shenitech.com/support/support_stuf200h_QnA.htm

3. How To

§3.1 How to check if the instrument works properly

Switch to menu M08 by entering MENU 0 8 keys. If 'R' is displayed on the screen, the instrument is working properly.

If 'E' is displayed, the current loop output is over-ranged. Increasing the range setting in M57 will make the 'E' letter disappear. If you do not use current loop output, you may ignore this error.

If 'Q' is displayed, the frequency output is over-ranged. Increasing the range setting in M69 will make the 'Q' letter disappear. If you do not use frequency output, you may ignore this error.

If 'G' is displayed, the flowmeter is adjusting system gain. This is normal as long as it does not last long.

If 'I' is displayed, there is no signal received. Check if the transducer cables are connected properly and transducers are clamped firmly.

If 'J' is displayed, there is hardware problem. Turn off the power, then, turn on the power again. If the problem remains, refer to Chapter 5 for diagnosis details.

If an 'H' flashes instead, the received signal is poor.

Please refer to Chapter 5 for diagnosis information.

§3.2 How to check the liquid flowing direction

Assume that transducer A is connected to the upstream terminals and transducer B is connected to the downstream terminals.

First, make sure that the instrument works properly.

Then, check the flow rate reading. If the value is positive, the direction of the flow will be from transducer A to B. Otherwise, the flow is from B to A.

§3.3 How to change units systems

Use menu window M30 for the selection of units systems, either English (option 0) or in Metric (option 1).

§3.4 How to select a flow rate unit

Use menu window M31 to select the flow rate unit, use menu window M32 to select the flow totalizer unit.

§3.5 How to use the totalizer multiplier

Use window M33 to select a proper multiplying factor for the totalizers (POS, NEG and NET). Make sure that the rate of the totalizer pulse is not too fast, neither too slow. A speed of several pulses per minute is preferable.

If the totalizer multiplying factor is too small, the output pulse will be very fast and there could be a loss of pulses. The designed minimum pulse period is 500 milliseconds.

If the totalizer multiplying factor is too large, the output pulse will be very slow, which might be a problem if the master device requires fast response.

§3.6 How to turn on / off the totalizers

Use M34, M35 or M36 to turn on or turn off the POS, NEG or NET totalizer, respectively.

§3.7 How to reset the totalizers

Use M37 to reset the flow rate totalizers.

§3.8 How to restore the factory default setups

Go to window M37. Press the [.] [←] Keys. This operation will erase all the parameters entered by the user and setup the instrument with factory default values.

§3.9 How to use the damper to stabilize the flow rate

The damper acts as a filter for a stable reading. Its damping constant is entered in window M40. Its unit is in second. If '0' is entered, that means there is no damping. A bigger constant number brings a more stable effect. But bigger numbers will prevent the instrument from acting quickly.

A constant from 5 to 30 is commonly used for the damper value.

§3.10 How to use the low-flow cutoff function

The value displayed in window M41 is the low-flow cutoff. When the absolute value of the measured flow velocity is below this value, the measured velocity as well as flow rate will be replaced with '0'. This is to avoid any invalid accumulation when the actual flow is below the low-flow cutoff value.

Application example: when a pump is shut down, the liquid will not stop immediately. It will keep moving (may be backward) for a little while. During this period, the totalizer should be prevented

from accumulating. This can easily be done by setting the low-flow cutoff velocity to a certain value, such as 0.1ft/s (0.03m/s)

The low-flow cutoff operation does not affect the flow measurement when the actual flow is greater than the low-flow cutoff value.

§3.11 How to conduct Zero calibration

When the flow in a pipe is absolutely stopped, the flowmeter could still give a small non-zero flow rate reading due to transducer installation or pipe-sensor mismatching. In order to make the measurement accurate, it is necessary to remove this "Zero Point" reading.

Window M42 allows us to take care of this issue. At first, the user should make sure that the liquid in the pipe is totally stopped (no velocity). Then, go to window M42 and press the ENT key to start the zero calibration (or zero point setup) function. Wait until the counter reading goes down to '00'.

You must then save the Zero Point into the flowmeter non-volatile FLASH memory so that it will not get lost when power is off. This can be done by simply pressing keys MENU . 2.

§3.12 How to change the scale factor

You may change the scale factor in menu window M45. After the change, we recommend you to save the value to the non-volatile FLASH memory. Press keys MENU 2 6 to enter into window M26, then, press ENT 1 ENT to save.

A scale factor is the ratio between the 'actual flow rate' and the flow rate measured by the flowmeter. It can be determined by calibration with a standard flow calibration equipment. Please go to our technical support site http://www.shenitech.com/support/stuf300 to see the instructions.

The scale factor is transducer dependent. Prior to shipment from the factory, the scale factor of a transducer pair is calibrated on a pipe with water flow. If you ordered multiple pairs of transducers, be sure you enter the scale factor of the transducer pair you are using. Also, we recommend you to do a Zero calibration (refer to the above section) each time after the transducer change.

The scale factor is also affected by other factors such as pipe size, fluid viscosity, installation variation, etc. It is therefore recommended to do on-site calibration when accuracy is of crucial importance.

§3.13 How to use the password locker

The password locker provides a means of preventing inadvertent configuration changes or totalizer resets. When the system is locked, the user can still browse menu windows, but cannot make any modifications on the windows.

The password locking / unlocking is done in window M47. The system can be locked without a

password or with a password consisted of 1 to 4 digits.

For no-password locking / unlocking, just press ENT key in window M47.

If the password is forgotten, please contact the manufacturer.

§3.14 How to use the keypad locker

First, switch to the menu window which will be displayed after the keypad is locked.

Then, press MENU 4 8 to switch to menu M48. Press ENT and enter a 1-8 digit long password. Password should be numerical only. Press ENT again to set the password. The system will return to the previously selected window automatically.

To unlock keypad, press ENT, enter the password, and press ENT again.

§3.15 How to use the built-in scheduler

STUF-300F has a built-in scheduler which allows user to set a specific period of time to conduct one of the following activities:

- Send data to the internal serial port
- Start to monitor the flowrate, and trigger an alarm if it is over a preset threshold
- Start to accumulate flow, and trigger an alarm if the flow total is over a preset threshold

The first activity is reserved for 4-20mA output, printer and other future extended functions. Data items to be sent to the internal serial port are selected in M50.

The last two activities can be used for leakage detection and scheduled dosing or batching.

The scheduler parameters are set in M51. They include the starting time, time interval and number of times to repeat the activity.

For example, if you want to start the activity at 9.30pm, stop at 11.00pm, and repeat this 50 times, you need to enter the following parameters in M51:

Start Time	21:30:00
Interval	01:30:00
Last	50

The scheduler can be used for leakage detection and timed batch delivery. Please refer to sections §3.32 and §3.35 for more details.

§3.16 How to use 4-20mA current loop output

Stuf-300F has one channel of isolated 4-20mA analog output. The accuracy of this output is better

than 0.1%. It can be configured to different mode, such as 4-20mA mode, 0-20mA mode, etc. Mode selection can be made in menu M55. Refer to the next chapter for details on M55.

In order to use the 4-20mA output function, you need to not only select the mode to be 4-20mA in M55, but also set the flow rate values which correspond to the minimum current (4mA) and the maximum current (20mA). Enter the two values in M56 and M57.

Example A: flow rate range is 0-500m3/h. Just enter 0 in M56 and 500 in M57.

Example B: flow rate range is -500-0-1000m3/h. If flow direction is not an issue for you, you may select 20-4-20mA mode in M55. Then, enter 500 in M56 and 1000 in M57. If flow direction is an issue, you may select 0-4-20mA mode in M55. This means that the current loop will output 0-4mA when flow rate is negative and 4-20mA when flow rate is positive. Enter -500 in M56 and 1000 in M57.

You may need to calibrate and test the current loop output before using it. Just go to menu M58 and do the following:

First, connect an ammeter to the current loop output.

Press MENU 5 8, then, ENT to enter into menu M58.

Use ↑/+ and ↓/- to display “0mA”, “4mA”, “8mA”, “16mA”, “20mA” orderly, record the corresponding reading on the ammeter. Calculate the differences between the readings and the selected ones. For instance, when 4mA is selected, the actual output current shown on the ammeter is 4.01mA. Then, the difference is 0.01mA.

If the differences are not within tolerance, calibrate the current loop (see section §3.33.)

The present current loop output is displayed in Window M59. It changes along with flow rate change.

Wiring:

There are two ways to wire this analog output to an external load (i.e., your device which uses the flowmeter 4-20mA output): loop-powered method and non-loop powered method.

First, you need to check your load to see whether it is a “source” or a “sink”. A source will provide DC power to the 4-20mA interface. A sink draws current, thus, will need an external power supply for the 4-20mA interface.

If your load is a source type, check what voltage it provides for the 4-20mA interface. If the voltage is between 12VDC and 20VDC, you may use the loop-powered method (Figure 3.1a) to wire your load to the 4-20mA output. Otherwise, please contact Shenitech for support.

If your load is a sink type, you may use either loop-powered method (Figure 3.1a) or non loop-powered method (Figure 3.1b).

(1) Loop-powered method

This method requires an external power supply, either 12VDC or 15VDC. However, if your load is a “source”, which means it has a DC power for the 4-20mA interface already, you do not need to provide external power anymore.
The flowmeter 4-20mA output circuit functions as a sink in this case. The minimum sink current is about 3mA.
This wiring method ensures that the 4-20mA output is isolated from the flowmeter electronics.
The flowmeter power could be either DC power (12VDC ~ 24VDC) or AC power (90VAC ~ 240VAC.
Figure 3.1 (a) shows how to wire the 4-20mA output to a load using loop-powered method. Here RL is the load, the 12VDC/15VDC power next to RL is the external power supply.

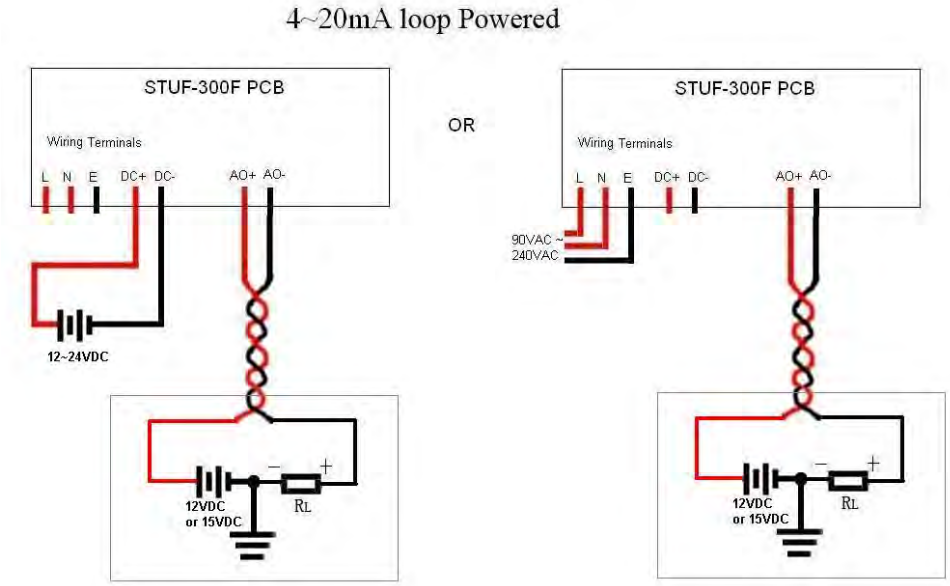


Figure 3.1a. 4-20mA wiring diagram - loop-powered method

(2) Non loop-powered method

This method uses the internal power supply of the flowmeter. Therefore, the flowmeter will function as a source, and your load must be a sink. If your load is a source, you cannot use this wiring method.

This wiring method connects the 4-20mA ground to the flowmeter ground. As such, the 4-20mA output is not isolated output anymore.

As showing in Figure 3.1b, the two output terminals in the flowmeter are AO- and DC-. The AO+ terminal is not used. No external power supply is needed.

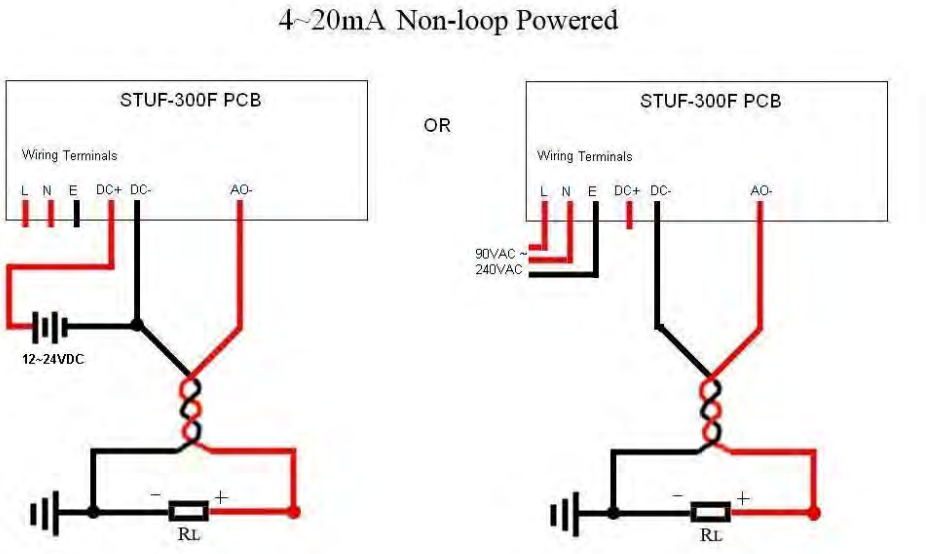


Figure 3.1b. 4-20mA wiring diagram - non Loop-powered method

§3.17 How to output analog voltage signal

Replace the load RL shown in Figure 3.1 with a 250Ohm/0.25W resistor. This resistor will convert the 4-20mA output current into 1-5V voltage signal. In other words, the voltage across the resistor will be 1-5V.

§3.18 How to use the Frequency Output

When Frequency Output Module is equipped, the STUF-300F flowmeter can output a frequency signal which represents the instantaneous flow rate. This output is totally user-configurable. Usually, four parameters should be configured: frequency minimum and frequency maximum (M67), as well as corresponding flow rate lower limit and higher limit (M68 and M69).

For example, assume that the flow rate varies in a range from 0m3/h to 3000m3/h, and the required output signal frequency should be in a range from 200Hz to 1000Hz. The user should enter 0 in M68 and 3000 in M69, and enter 200 and 1000 in window M67.

Please note that the user needs to select the frequency output option (the 13th option, “FO output”) in window M78. The user must also make the OCT hardware connection to the device which is supposed to use the frequency output signal. Refer to Appendix §9.1 for wiring information.

§3.19 How to use the Totalizer Pulse Output

The flowmeter is able to produce a pulse output every time when it reaches a unit flow of liquid. This pulse could be used by an external pulse counter to accumulate the flow rate.

Refer to §3.4 and §3.5 for the setup of the totalizer units and multiplier.

The totalizer pulse output can only be transmitted through OCT or relay devices. Therefore, it is necessary to configure the OCT or relay. This can be done in menu M78 and M79. Refer to the next chapter for detail on M78 and M79.

For example, assume that we need to output the POS totalizer through the relay in pulse form, and every pulse represents 0.1cubic meter of liquid flow. The following steps must be performed:

(1) Select the Cubic Meter (m3) unit in window M32.

(2) Select the Multiplier factor as '2. X0.1' in window M33.

(3) Select the output option '9. POS INT Pulse' in window M77. (INT stands for integrated or totalized)

Note that the totalizer pulse must be set properly. It should be neither too large nor too small. If it is too large (e.g., long period), the output pulse will be very slow. If it is too small (e.g., short period), the relay may activate too frequently and its lifetime may be shortened. Besides, pulse loss error may occur. It is recommend to be within 1-60 pulse/minute. You can adjust the pulse period by selecting different totalizer multiplier factor in M33.

§3.20 How to produce an alarm signal

There are two types of hardware alarms that are available with this instrument. One is the audible alarm, and the other is the ON/OFF output signal which can drive an alarm. The audible alarm is also called Buzzer. It is generated internally and can be configured in M77. The ON/OFF output signal is generated through the OCT or relay output which is connected to an external alarm circuitry.

The triggering sources of the alarming events for both the Buzzer and the ON/OFF alarm signal could be:

(0) No Signal - There is no receiving signal.

(1) Poor Signal - The signal received is too weak.

(2) Not Ready - The flowmeter is not in normal measurement mode.

(3) Reverse Flow - The flow direction is reversed.

(4) AO Over 120% - Overflow occurs at the analog outputs by 120% or more.

(5) AO Over 120% - Overflow occurs at the frequency output by 120% or more.

(6) Alarm #1 - The flow rate is out of the specified upper and lower limits specified in Alarm#1

settings (windows M73 and M74).

(7) Alarm #2 - The flow rate is out of the specified upper and lower limits specified in Alarm#2 settings (windows M75 and M76).

(8) Batch Controller – Batching started.

(9) POS Int Pulse – Positive totalizer pulse output.

(10) NEG Int Pulse – Negative totalizer pulse output.

(11) NET Int Pulse – Net totalizer pulse output.

(12) Energy POS Pulse – Thermal energy positive totalizer pulse output.

(13) Energy NEG Pulse – Thermal energy negative totalizer pulse output.

(14) Energy NET Pulse – Thermal energy net totalizer pulse output.

(15) MediaVel => Thresh – Liquid sound speed becomes bigger, over the preset threshold.

(16) MediaVel <= Thresh – Liquid sound speed becomes smaller, lower than the preset threshold.

(17) ON/OFF Via RS485 – RS485 is the trigger source, providing ON/OFF control.

(18) Timer (M51 Daily) –Daily scheduler programmed in M51 is the trigger source.

(19) Timer Alarm #1 – Alarm#1 is the trigger source during the time period specified in M51.

(20) Timer Alarm #2 – Alarm#2 is the trigger source during the time period specified in M51.

(21) Batch Total Full – The totalizer in the batch controller is full.

(22) Key Stroking ON – Key stroke is the trigger source.

(23) Disable BEEPER – the BEEPER will not be activated.

Example A: assume we need the Buzzer to start beeping when the flowmeter is not ready in normal measurement. Switch to M77, select item “2. Abnormal Measurement State”

Example B: assume we need the Buzzer to start beeping when the flow rate is less than 300 m3/h and greater than 2000m3/h. The following setup steps would be recommended:

(1) Enter flow rate lower limit 300 in M73 for #1 alarm,

(2) Enter flow rate upper limit 2000 in M74 for #1 alarm,

(3) Select item ‘6. Alarm #1’ in M77.

Example C: assume we need the OCT output to activate when flow rate exceeds 100~500m3/h and the relay output to activate when flow rate exceeds 600~1000m3/h. The following setup steps would be recommended:

(1) Enter flow rate lower limit 100 in M73

(2) Enter flow rate upper limit 500 in M74

(3) Enter flow rate lower limit 600 in M75

(4) Enter flow rate upper limit 1000 in M76

(5) Select item ‘6. Alarm #1’ in M78

(6) Select item ‘6. Alarm #1’ in M79.

§3.21 How to use the OCT output

The OCT output is an ON/OFF type, electrically isolated collector open circuit output. It is user-configurable. You can program it to be an ON/OFF type alarm signal or a totalizer pulse signal.

Notice that the Frequency Output shares the same OCT hardware. When used as Frequency Output, the OCT cannot be used for other purpose (neither alarm signal nor totalizer pulse signal).

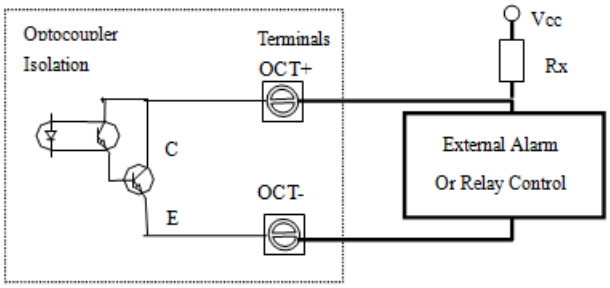


Figure 3.2 Wire the isolated OCT output to an external alarm device .

The OCT has two wiring terminals, terminals OCT+ and OCT-. Terminal OCT+ is collector and terminal OCT- is emitter. Be careful of the polarity. An external DC power supply Vcc and an external pull-up resistor Rx are needed for using the OCT (Figure 3.2). Vcc can be from +12VDC to +24VDC. Rx can be from 1KOhm to 10KOhm. The maximum current the OCT can take should be less than 0.2A. The OCT can drive an alarm, pulse counter, frequency counter, etc. It can also be used to drive a relay, which operates a valve system, for instance.

Refer to the next chapter on menu M78 for OCT configuration.

§3.22 How to use the relay output

The relay output is a single-pole single-throw (SPST). It has two terminals, R+ (normally open, NC) and R- (common, C). Its maximum operating frequency is 1Hz. Its load current is 1A at 125VAC, or, 2A at 30VDC.

The relay output is user-configurable and can be configured as an ON/OFF type signal to drive an alarm or a valve, or, as a totalizer pulse signal to drive a remote counter or totalizer.

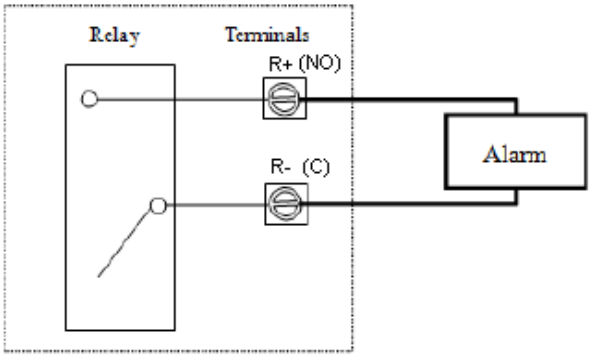


Figure 3.3 Wire the relay to an alarm device with Normally Open configuration.

When wiring the relay to an external device, you can wire it as normally open only. Figure 3.3 illustrates how to wire the relay to an external alarm with normally open configuration.

Please refer to the next chapter on menu M79 for more details.

§3.23 How to use the built-in Buzzer

The built-in buzzer is user-configurable. It can be used as an alarm. Use M77 for setups.

§3.24 How to modify the built-in calendar

The current date and time is displayed in menu M04 in format “yy-mm-dd hh:mm:ss”. If this is the first time you run the flowmeter, please do make sure that the date and time are correct. If not, please make correction. In addition, if “daylight saving” applies in your area, you may also need to change the time accordingly.

To make changes on the date and time, press MENU 6 0 ENT to switch to menu M60 and modify the settings. Use the dot key to skip over these digits that need no modifications.

The calendar can also be modified through the serial port. Please refer to Chapter 6.

§3.25 How to adjust the LCD

Use M70 to adjust the LCD backlight. Press MENU 7 0 ENT. You should see “>” on the screen, which indicates that the system is ready for modification. Use ↑/+ and ↓/- to select the desired option. “Always On” means that the backlight will remain on always. “Always Off” means that the backlight will remain off always. “Time=” means that the backlight will keep on for “x” seconds which should be keyed in after selecting “Time=”.

Use M71 to adjust the LCD contrast. This is necessary when the letters on the screen are not clear and the viewing angle is offset. Press MENU 7 1 ENT. You should see “>” on the screen. Use ↑/+ and ↓/- to increase or decrease the contrast.

§3.26 How to use the RS-485 interface

The STUF-300F family flowmeters are equipped with a standard half-duplex RS-485 serial interface. The terminals for this port are Tx and Rx, therefore, only two wires are needed to connect a STUF-300F flowmeter to a RS-485 bus. The data rate of the RS-485 port can be set to 75-115,200 Baud in M62.

Please refer to Chapter 6 and Appendix §9.1 for more details.

§3.27 How to view and reset the yearly/monthly/daily totalizers

In addition to the POS, NEG and NET totalizers shown in M34-M36, there are 128 DAILY totalizers, 64 MONTHLY totalizers and 5 YEARLY totalizers for net flow and energy totalization. In other words, the flowmeter records the net flow total and net energy total of the last 128 days, the last 64 months and the last 5 years.

To view those records, go to M82, select item 0 for “Day”, 1 for “Month” or 2 for “Year”. In the display window, the first line will be the data or the total working time. The second line will be the net flow or net energy total. You may also see “----” on the upper right corner, which indicates that the system was normal during that day, or, you may see “G”, “H” or other characters, which indicates errors occurred in that day. Please refer to chapter 5 for error code explanations and solutions.

Use M37 to reset the yearly/monthly/daily totalizers.

§3.28 How to connect analog input signals

The Stuf-300F could be expanded to support up to 5 analog channels, AI1-AI5. AI1 and AI2 channels are assigned to temperature measurement by using PT100 RTD sensor. The remaining three channels, AI3-AI5, are current input channels which can be connected to any standard 0/4-20mA transmitters, such as temperature transmitter, pressure transmitter, level transmitter, etc.

In the standard Stuf-300F model, however, only one analog channel, AI3, is available. More input channels may be added upon request. In a thermal energy model, e.g., Stuf-300FRx, the two temperature channels are enabled.

The input signal is digitized and acquired by the flowmeter. The data can then be sent to a remote computer or controller through RS-485 upon request. Refer to chapter 6 for communication details.

AI3 input terminal blocks are labeled AI3+ and AGND. Menu window M07 displays the input current values and their corresponding physical values. The terminals assigned to the two temperature inputs are TX1+, T1, TX2+, T2 and GND. Menu window M06 displays the input RTD resistances and their corresponding temperature values.

§3.29 How to compensate the flow not measured during offline

When the power is down, the flowmeter will not be able to conduct flow measurement. In order to compensate the flow uncounted during the offline period, you need to enable Automatic Amending function before the flowmeter is offline.

To enable the Automatic Amending function, switch to M83, press ENT key, then, select YES and press ENT again.

To disable this function, just select OFF in menu M83.

Please note that there are many factors which could impact the reliability of this function in a complicate application. We do not recommend you to use this function. Instead, try to find an uninterruptible power supply (UPS).

Refer to the next chapter for M83 details and how the uncounted flow is estimated.

§3.30 How to use the Working Timer

Use the working timer to check the time that has passed with a certain kind of operation.

The working timer value is displayed in M72. To reset the timer, press ENT key and select YES.

§3.31 How to use the manual totalizer

Use M38 to use the manual totalizer. Switch to M38. Press ENT key to start, and press ENT key again to stop the totalizer.

This function is useful for conducting flowmeter calibration.

§3.32 How to use the batch process controller

The STUF-300F has a built-in batch process controller. It can be used for flow quantity control or the batching of specific volumes.

This batch controller utilizes the keypad or the rising edge or falling edge of an analog input signal as its control signal input (or triggering signal). It utilizes the OCT as its output. When using analog as the input signal, the input current must be larger than 2mA to indicate a logic “1” and 0mA to indicate a logic “0”.

The user needs to select the type of input control signal in menu M80. The user also needs to select the output type to be item 8 “output as batch controller” in M78 for OCT output or in M79 for relay output.

Use M81 to enter batch value. After completion, the display will be in batch control mode and the batch controller is waiting for triggering signal. If you selected “0. Key Input” as the triggering source in M80, you may press the ENT key to start the batch process. Otherwise, just wait the specified triggering event is detected.

By combing the batch function with the built-in scheduler, one can do batch delivery at a specific period of time for a certain number of times.

Example: assume one wants to deliver 5 m^3 of water to a client’s pipe, and repeat this every 2 hours until 50 m^3 has been delivered. After the completion of this process, the flowmeter should trigger an alarm which is connected to its OCT output. Assume the starting time is 9am (should be ahead of

the current time). You may program the flowmeter as following:

In M51: Start Time 9:00:00; Interval 02:00:00; Repeat 10

In M78: select 8. Batching Controller

In M80: select option 8. Timer-periodical

In M81: enter 5

§3.33 How to calibrate the analog output

In general, there is no need to calibrate the analog output since it has been calibrated in factory. However, if you find the current value shown in M58 differs from the actual current shown in the ammeter, you do need to recalibrate the analog output.

Calibration steps:

First, put the flowmeter into calibration mode. Press MENU - 0 ENT, enter password "4213068", and press ENT again.

Then, connect a precise ammeter to the current output loop.

Press MENU - 0 ENT to calibrate the current loop 4mA output. Read the ammeter. If the reading is not 4mA, use ↑/+ or ↓/- to adjust the output current until the ammeter reads 4.00mA.

Press ENT again to calibrate 20mA output, similar to the above step.

Press MENU 2 6 to enter into window M26, press ENT 1 ENT to save the above configuration results into non-volatile memory.

§3.34 How to check the ESN

Each product of the STUF-300F series has a unique electronic serial number (ESN) to identify itself. The user can use the ESN for instrumentation management.

The ESN is displayed in window M61.

Use M+1 to view the total working time since the instrument left the factory. Use M+4 to view the total number of times the instrument has been turned on and off since the instrument left the factory.

§3.35 How to implement leakage detection

STUF-300F has powerful functions designed for leakage detection applications. By configuring menus M51, M73-M81, one can make the flowmeter enter into leakage detection mode at a specified period of time in a day, every day. When a leakage is detected, the flowmeter will trigger an alarm, or a relay which can be used by your security system.

Example: assume one wants to monitor a water pipe during night from 11pm to 5am daily. Under normal condition, there should have no flow in the pipe during this period of time. However, if the pipe is broken due to frozen, leakage happens. If the leakage flowrate is over $0.1m^3$/hour, one wants the flowmeter to send a signal to close his valve. Assume the valve is connected to a relay which is then connected to OCT2 output. The flowmeter should be programmed as following:

In M51: Start Time 23:00:00; Interval 06:00:00; Repeat 9999

In M73: enter -0.1 for the lower threshold of Alarm#1

In M74: enter 0.1 for the upper threshold of Alarm#1

In M79: select 19. Timer Alarm#1

For advanced leakage detection solution, such as dialer-based or GSM/GPRS-based leakage detection, please contact the manufacturer for more information.

For more application tips and help, please visit our technical support site at

http://www.shenitech.com/support/stuf300.htm.

4. Menu Window Details

Note 1: It is recommended to practice those menu windows on your flowmeter while reading this chapter for easy understanding.

Note 2: To quickly switch to a menu window, just press MENU followed by the window number (a two digit number). To move from one window to the next, use ↑/+ or ↓/- key.

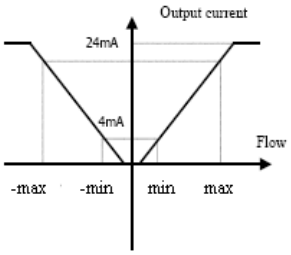
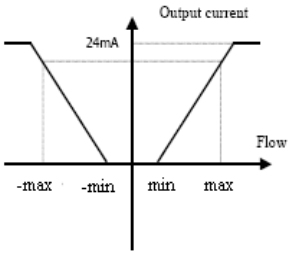
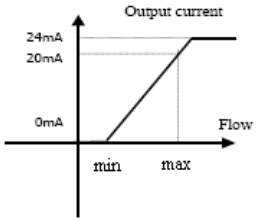
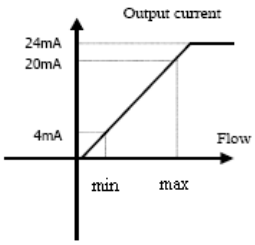
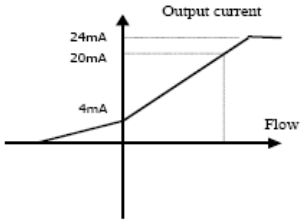
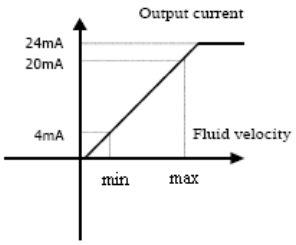
Note 3: After making changes to the flowmeter configuration parameters, please use M26 to save the changes into the non-volatile FLASH memory. The flowmeter will automatically load those parameters every time when power is up.

The FLASH memory can save and recall 9 groups of pipe parameters.

Menu Window No.	Function
M00	Display flow rate and net totalizers
M01	Display flow rate, velocity
M02	Display flow rate and positive totalizer
M03	Display flow rate and net totalizer
M04	Display date and time, flow rate
M05	Display total energy and energy rate
M06	Display temperatures, T1 and T2
M07	Display analog inputs AI3 and AI4
M08	Display all the detailed working status
M09	Display today's total flow
M10	Window for entering the outer perimeter of the pipe
M11	Window for entering the outer diameter of the pipe. 0 to 18000mm allowed
M12	Window for entering pipe wall thickness
M13	Window for entering the inner diameter of the pipe
M14	Window for selecting pipe material Standard pipe materials (users do not need to know the speed) include: (0) carbon steel (1) stainless steel (2) cast iron (3) ductile iron (4) copper (5) PVC (6) aluminum (7) asbestos (8) fiberglass (9)others
M15	Window for entering the pipe material speed, only for non-standard pipe materials
M16	Window for selecting the liner material, select none for pipes without any liner. Standard liner materials that the user does not need to know the speed include: (1) Tar Epoxy (2) Rubber (3) Mortar (4) Polypropylene (5) Polystryol (6)Polystyrene (7) Polyester (8) Polyethylene (9) Ebonite (10) Teflon (11) others
M17	Window for entering the liner material speed, only for non-standard liner materials
M18	Window for entering the liner thickness, if there is a liner
M19	Window for entering the ABS thickness of the inside wall of the pipe
M20	Window for selecting fluid type

	For standard liquids that the user does not need to know the liquid speed include: (0) Water (1) Sea Water (2) Kerosene (3) Gasoline (4) Fuel oil (5) Crude Oil (6) Propane at -45C (7) Butane at 0C (8)Other liquids (9) Diesel Oil (10)Caster Oil (11)Peanut Oil (12) #90 Gasoline (13) #93 Gasoline (14) Alcohol (15) Hot water at 125C
M21	Window for entering the fluid sonic velocity, only for non-standard liquids
M22	Window for entering the viscosity of the non-standard liquids
M23	Window for selecting the proper transducers There are 16 different types of transducers for selection. If the user-type-transducer is selected, system will prompt another 4 user-type-wedge parameters to be inputted. If the PI-type transducer is selected, the system also needs another 4 PI type transducer parameters.
M24	Window for selecting the transducer mounting methods Four methods can be selected: (0) V-method (1) Z-method (2) N-method (3) W-method
M25	Display the transducer mounting spacing
M26	(0) Save the current configuration parameters into RAM. Not recommended for general users (1) Save the current configuration parameters into the non-volatile FLASH memory. **Recommended to use this function every time after you make changes on the flowmeter configurations**
M27	Entry to store or restore configuration parameters from the internal Flash memory. Up to 9 sets of configuration parameters are allowed.
M28	Select YES or NO for the instrument to determine whether or not to hold (or to keep) the last correct value when poor signal condition occurs (Q less than what is set in M.5). YES is the default setup.
M29	Pipe empty setup. Enter a value ranging from 00 to 99. 0 is the default value. When signal strength is below this value, the flowmeter will assume the pipe is empty and will not count the measuring results. It is recommended to set to 40 if you want to turn on this function. When pipe is empty, ultrasound may still travel from one transducer to another through pipe wall. The flowmeter may treat this as good signal and work as under normal condition. Using this menu setting will avoid this situation.
M30	Window for selecting unit system. Default value is 'Metric'. The change from English to Metric or vice versa will not affect the totalizer unit.
M31	Window for selecting flow rate that will be used by the instrument afterwards. Flow rate can be in 0. Cubic meter short for (m3) 1. Liter (l) 2. USA gallon (gal) 3. Imperial Gallon (igl) 4. Million USA gallon (mgl) 5. Cubic feet (cf) 6. USA oil Barrels (OB) 7. Imperial Oil Barrels (IB) The flow unit in terms of time can be per day, per hour, per minute, or per second. Thus there are 32 different flow rate units in total for selection.
M32	Window for selecting the totaliziers' working unit
M33	Select totalizer multiplier The multiplier ranges from 0.001 to 10000
M34	Turn on or turn off the NET totalizer
M35	Turn on or turn off the POS totalizer
M36	Turn on or turn off the NEG totalizer
M37	(1) Totalizer reset (2) Restore the instrument to the default parameters as the manufacturer did by pressing the dot key followed by the backspace key. Take note of the parameters before doing the restoration
M38	Press a key to run or to stop totalizer
M39	Language selection
M40	Flow rate damper for a stable value. The input range is 0 to 999 seconds.

	0 means there is no damping. Default value is 10 seconds
M41	Lower flow rate cut-off to avoid invalid accumulation.
M42	Zero Point setup or Zero calibration. Should be conducted when the flow in the pipe is totally stopped (zero flow velocity), but the pipe should still be full of liquids **After Zeroing, you need to save the Zero Point by visiting M.2 menu.** Please refer to M.2 item at the end of this table for details.
M43	Clear the zero point set by the user, and restore the zero point set by the manufacturer
M44	Set up a manual flow trend. In general this value should be 0.
M45	Scale factor for the instrument of certain transducer pair. If you ordered more than one pair of transducers, you need to change the value to the scale factor of the transducer pair in use. You are also recommended to do a Zero when change the transducer pair.
M46	Network Environment Identification Number. Any integer can be entered except for 13 (0DH, carriage return), 10 (0AH, line feeding), 42 (2AH), 38, 65535. Every set of the instrument in a network environment should have a unique ID number. Please refer to the chapter on communication.
M47	System locker to avoid modification of the parameters by mistake
M48	Entry to linearity correction data. As many as 12 data points can be entered.
M49	Display the input contents for the serial port.
M50	Turn on/off the data logging port Select the item to be logged or to be output through the 0/4-20mA analog output channel. Not recommended to change.
M51	The built-in Scheduler Three parameters: start time, interval and number of times to be repeated.
M52	(1) Data logging direction control. If 'To RS-485' is selected, all the data will be transmitted to the RS-485 port (2) If 'To the internal serial BUS' is selected, the data will be transmitted to the internal serial bus. If you flowmeter is equipped with a thermal printer or a 4-20mA analog output module, this selection must be chosen. Not recommended to change.
M53	Display the input current value and the converted value of analog input AI5.
M54	Pulse width setup for the OCT output.
M55	Select the current loop (CL) mode. Available options: 0. 4-20mA (set up flowrate output range from 4-20mA) 1. 0-20mA (set up flowrate output range from 0-20mA) 2. RS232 controls 0-20mA (set up to control by serial port RS-485) 3. 4-20mA vs. Sound (set up sound speed output range from 0-20mA) 4. 20-4-20mA (set up flowrate output range from 20-4-20mA) 5. 0-4-20mA (set up flowrate output range from 0-4-20mA) 6. 20-0-20mA (set up flowrate output range from 20-0-20mA) 7. 4-20mA vs. Vel (set up velocity output range from 4-20mA) 8. 4-20mA vs. Energy (set up thermal energy output range from 4-20mA) The output current value is controlled by sending a parameterized command to the flowmeter through its RS-485 serial port. The command formats are explained in chapter 6. Example, if you want to output a 6mA current through the current loop, you need to select mode "0-20mA Via RS232/485" in menu M55 and send command "A06 (CR)" to the flowmeter. This function allows the flowmeter to control valve openness. Other different current output characteristics are illustrated in the following figures. The user can select one of them according to his actual requirements. The minimum and maximum values indicated

	in the figure are those set in menu windows M57 and M58. In the 4-20mA and 0-20mA modes, the minimum and maximum can be a positive or negative flow value as long as the two values are not the same. In the 20-4-20mA and 20-0-20mA modes, the polarity of the actual flow reading is ignored. In 0-4-20mA mode, the minimum must be negative, and the maximum must be positive. The last one in the following figures is for velocity output. The output current represents flow velocity.  **20-4-20mA Mode**  **20-0-20mA Mode**  **0-20mA Mode**  **4-20mA Mode**  **0-4-20mA Mode**  **4-20mA Mode - Flow Velocity**
M56	4mA or 0mA output value Set the flow rate value which corresponds to 4mA or 0mA output current (4mA or 0mA is determined by the settings in M55). The flow unit options are the same as those in M31. If “velocity 4-20mA” is selected in M55, the unit should be set to m/s.
M57	20mA output value Set the flow rate value which corresponds to 20mA output current. Refer to M31 for flow unit options.
M58	Current loop verification. Check if the current loop has been calibrated before leaving the factory. Press ENT, and use ▼/+ or ▼/- to display 0mA, 4mA - 24mA one after another. For each one, check with an ammeter to verify that current loop output terminals agree with the displayed values. It is necessary to re-calibrate the current loop if over the permitted tolerance. For more information, refer to section §3.29 for analog output calibration.
M59	Display present output of the current loop circuit. Re-calibration is needed if the displayed value differs significantly from the actual output value measured with an ammeter.
M60	Set up system date and time. Press ENT for modification. Use the dot key to skip the digits that need no modification.
M61	Display Version information and Electronic Serial Number (ESN) that are unique for each STUF-300

	series flow meter. Users can employ the ESN for instrumentation management
M62	RS-485 serial communication setup. Baud rate can be 75 to 115200 bps
M63	Communication protocol selection. Default is MODBUS_ASCII plus TDS7 (EFCP) protocol.
M64	Lower and upper values represented by the lower current (4mA) and upper current (20mA) of input channel AI3
M65	Lower and upper values represented by the lower current (4mA) and upper current (20mA) of input channel AI4
M66	Lower and upper values represented by the lower current (4mA) and upper current (20mA) of input channel AI5
M67	Input the frequency range for the frequency output. The biggest range is 0Hz-9999Hz. Default value is 0-1000 Hz
M68	Enter a flow rate value that corresponds to lower frequencies
M69	Enter a flow rate value that corresponds to higher frequencies
M70	LCD display backlight control. The entered value indicates how many seconds the backlight will be on with every key press.
M71	LCD contrast control. The LCD becomes darker or brighter when a value is entered.
M72	Working timer. It can be cleared by pressing ENT key, and then select YES.
M73	Enter lower flow rate value that will trigger the #1 Alarm. There are two virtual alarms in the system. By “virtual” we mean that the user must redirect the output of the alarms by setting up the output hardware in M78 and M77.
M74	Enter the higher flow rate value that will trigger the #1 Alarm.
M75	Enter the lower flow rate value that will trigger the #2 Alarm.
M76	Enter the higher flow rate value that will trigger the #2 Alarm.
M77	Buzzer setup. If a proper input source is selected, the buzzer will beep when the trigger event occurs. The valid trigger sources are: 0. No Signal 1. Poor Signal 2. Status Error 3. Reverse Flow 4. AO Over 120% 5. FO Over 120% 6. Alarm #1 7. Reverse Alarm #2 8. Batch Controller 9. POS Int Pulse 10. NEG Int Pulse 11. NET Int Pulse 12. Energy POS Pulse 13. Energy NEG Pulse 14. Energy NET Pulse 15. MediaVel => Thresh 16. MediaVelo<Thresh 17. ON/OFF Via RS485 18. Timer(M51 Daily) 19. Timer Alarm #1 20. Timer Alarm #2 21. Batch Total Full 22. Key Stroking ON 23. Disable BEEPER
M78	OCT (Open Collector Transistor) output setup By selecting a proper input source, the OCT hardware will close when the trigger event occurs 0. No Signal 1. Poor Signal 2. Status Error 3. Reverse Flow 4. AO Over 120% 5. FO Over 120% 6. Alarm #1 12. Energy POS Pulse 13. Energy NEG Pulse 14. Energy NET Pulse 15. MediaVel => Thresh 16. MediaVelo<Thresh 17. ON/OFF Via RS485 18. Timer(M51 Daily)

	7. Reverse Alarm #2 8. Batch Controller 9. POS Int Pulse 10. NEG Int Pulse 11. NET Int Pulse 19. Timer Alarm #1 20. Timer Alarm #2 21. Batch Total Full 22. OCT NET Using
M79	Relay (or OCT2) output setup Select a proper input source. The triggering sources are similar to those for OCT. When the trigger event of the selected source occurs, the relay output will change status, i.e., the C (Common) pin will be disconnected from NC (Normally Closed) pin and be connected to the NO (Normally Open) pin.
M80	Signal selection for the built-in batch controller 0. Key Pressing 1. Serial Port 2. AI3 Rising Edge 3. AI3 Falling Edge 4. AI4 Rising Edge 5. AI4 Falling Edge 6. AI5 Rising Edge 7. AI5 Falling Edge 8. Timer-periodical 9. Timer-daily
M81	The built-in batch controller
M82	Date totalizers by day, by month and by year. Use M37 to reset There are seven totalizers: Daily-totalizer for flow, Monthly-totalizer for flow, Yearly-totalizer for flow, Daily-totalizer for heat, Monthly-totalizer for heat, Yearly-totalizer for heat, and the Working-time-totalizer. The last one is the number of hours of continuous working under normal condition (no error condition) in the past day
M83	Automatic total flow correction switch
M84	Energy unit selection.
M85	Temperature selection
M86	Specific Heat selection
M87	Energy totalizer switch
M88	Energy multiplier
M89	Displays the current temperature difference (T1 - T2)
M90	Display signal strength and signal quality UP – upstream direction; DN – downstream direction; Q – signal quality
M91	Displays the Time Ratio between the Measured Total Transit Time and the Calculated time. If the pipe parameters are entered correctly and the transducers are properly installed, the ratio value R should be in the range of 100±3%. Otherwise the entered parameters and the transducer installation should be checked.
M92	Displays the estimated fluid sound velocity. If this value has an obvious difference from the actual fluid sound speed, pipe parameters and the transducer installation should be checked again.
M93	Displays total transit time and delta time (transit time difference)
M94	Displays the Reynolds number and the pipe factor used by the flow rate program.
M95	(1) Display the positive and negative energy totalizer values and other menus in a loop fashion: M95->M00-M01->…M09->M90->95. Each menu is displayed for 8seconds. The loop-displaying will stop when any key is pressed.
M96 none	Reserved for printer
M97 none	Reserved for printer
M98 none	Reserved for printer
M99	Reserved for printer

none	
M+0	Browse the 128 recorded instrument power-on and power-off dates and times with the flow rate at the time of power on and off
M+1	Displays the total work time of the instrument
M+2	Displays the last power-off date and time
M+3	Displays the last power-off flow rate
M+4	Displays how many times the instrument has been powered on
M+5	Calculator for the convenience of field working. All the values are in single accuracy.
M+6	MediaVel Threshhold setup
M+7	Displays total flow for this month (up to today)
M+8	Displays total flow for this year (up to today)
M+9	Total time the flowmeter has not been in normal working mode. It includes the time when power is off.
M.2	Save Zero Point to the non-volatile FLASH memory. When a Zero calibration is done, you are recommended to save the Zero Point results by visiting this menu. You need to press ENT key, select YES and press ENT key again to save.
M.5	Set minimum quality Q for status “R”. When Q is less than this value, system status will be “Poor Signal”. Refer to M28.
M.8	The maximum flow rates for today and for the current month.
M-0	Entry to hardware adjusting windows only for the manufacturer

5. Troubleshooting

§5.1 Introduction

The STUF-300F series flowmeters utilized high-reliability design, thus, their malfunction probability is quite low. However, due to improper settings, harsh environment or misusage, problem could occur. Therefore, STUF-300F is equipped with a complete set of self-diagnosis functions. The errors are displayed in the upper right corner of the menu window via identification code in a timely order. Hardware self-diagnosis is conducted every time when power is on. Some errors can even be detected during normal operation. For those errors undetectable due to incorrect settings or improper testing conditions, the flowmeter will also display useful information to help the user to quickly debug the error and solve the problem.

There are two types of errors, one is hardware error, and the other is operational error. Details are presented in the following sections.

§5.2 Power-on Errors

When powered on, the STUF-300F series ultrasonic flowmeter automatically starts the self-diagnosis process to find if there are any hardware and software problems. If a problem is identified, an error message will be displayed. The following table shows the possible error messages, the corresponding causes and their solutions.

Table 5.1 Hardware self-diagnosis errors and solutions

Error message	Causes	Solutions
ROM Parity Error	ROM operation illegal / error	(1) Reboot the system (2) Contact the manufacturer.
Stored Data Error	User-entered parameters lost.	(1) Reboot the system (2) If problem persists, press ENT key to restore the factory default configuration.
SCPU Fatal Error	SCPU hardware fatal error	(1) Reboot the system (2) Contact the manufacturer.
System Clock Slow or Fast Error	Problem with the system clock or the crystal oscillator.	
CPU or IRQ Error	Problem with CPU or IRQ hardware	
System RAM Error	Problem with RAM chip	

Time Date Error	Problem with date/time chip	(1) Initialize the calendar in menu window M61. (2) Contact the manufacturer.
No Display. Erratic or Abnormal Operation	Problem with wiring	Double check wiring connections.
No response to key pressing	Keypad is locked Bad plug connection	Unlock the keypad.
Reboot repetitively	Hardware problems	Contact the manufacturer

§5.3 Working Status Errors

The STUF-300F series ultrasonic flowmeter will show an Error Status Code (a single letter like I, R, etc.) in the upper right corner on menu windows. When any abnormal Error Code shows, counter-measures should be taken.

Table 5.2 Working status errors and solutions

Error code	Message on window M08	Causes	Solutions
R	System Normal	No error	
I	No Signal	(1)Unable to receive signal (2)Transducers installed improperly (3)Loosen contact or not enough couplant between transducer and pipe surface. (4)Pipe liners are too thick or the deposition inside of the pipe is too thick. (5)Transducer cables are not properly connected	(1)Polish the pipe surface and clean the spot. Remove paint. (2)Make sure the couplant is adequate (3)Make sure the transducer is in tight contact with pipe surface (4)Check the transducer cables (5)Check installation parameter settings (6)Find a better measurement site. Newer pipe, no corrosion, no deposition
J	Hardware Error	Hardware problem	Contact the manufacturer
H	Poor Sig. Detected	Poor signal detected Similar to error code I	Similar to error code I
E	Current Loop Over 20mA	4-20mA loop output over 120% Improper settings for current loop output	(1) Ignore it if current loop output is not used (2) Check current loop settings in M56. (3) Confirm if the actual flow rate is too high.
Q	Frequency Output Over	(1) The frequency output is 120% over. (2) Improper settings for	(1) Ignore it if frequency output is not used (2) Check the values entered in window M66, M67, M68 and M69.

		frequency output (3) The actual flow rate is too high	(3) Use a larger value in M69 if needed. (4) Confirm if the actual flow rate is too high.
F	System RAM Error Date Time Error CPU or IRQ Error ROM Parity Error	(1) Temporary problems with RAM, RTC (2) Permanent problems with hardware	(1) Reboot the system (2) Contact the manufacturer Refer to Table 5.1 as well
G	Adjusting Gain >s1 Adjusting Gain >s2 Adjusting Gain >s3 Adjusting Gain >s4 (shown in M00-M03)	Instrument is in the progress of adjusting the gain for the signal, and the number indicates the progressive steps	No need for action
K	Empty pipe	(1) No liquid inside the pipe (2) Incorrect setup in M29	(1) If the pipe is not full, relocate the meter to where the pipe is full of liquid (2) If the pipe is full, enter 0 in M29

§5.4 Other Problems and Solutions

(1) Q: Why the instrument displays 0.0000 flow rate while the liquid in the pipe is actually flowing? The signal strength is checked to be good (the working status is "R") and the signal quality Q has a satisfactory value.

A: The problem is likely to be caused by the incorrect "Zero Point" setting. The user may have conducted the "Zero Point" setup while the flow was not standstill. To solve this problem, use the 'Reset Zero' function in menu window M43 to clear the zero point.

(2) Q: The displayed flow rate is much lower or much higher than the actual flow rate in the pipe under normal working conditions. Why?

A: The entered offset value might be wrong. Enter '0' offset in window M44.

(a) Incorrect transducer installation. Re-install the transducers carefully.

(b) The 'Zero Point' is wrong. Go to window M42 and redo the "Zero Point" setup. Make sure that the flow inside the pipe is standstill. No velocity is allowed during this setup process.

(3) Q: Why there is no signal? The installation requirements are met, pipe is new and pipe material is in good quality.

A: Check the following:

(a) Is the installation method suitable for your pipe size?

(b) Are the entered installation parameters correct?

(c) Are the wirings correct?

(d) Adequate couplant? Are the transducers in good contact with pipe?

(e) Is pipe full?

(f) Is the transducer distance in consistency with the one shown in M25?

(g) Is transducer head/tail in the right direction?

(4) Q: How to conduct measurement on an old pipe? Heavy scale inside, no signal or poor signal detected.

A: (a) Check if the pipe is full of liquid.

(b) Try Z method. If the pipe is close to a wall and it is hard to do Z-method installation, you may work on a vertical or inclined pipe with flow upwards.

(c) Carefully select a good pipe section and fully polish/clean the installation area of the pipe surface. Apply a wide band of couplant on each transducer face. Install the transducer properly.

(d) Slowly and slightly move each transducer with respect to each other around the installation point until the maximum signal is found. Be careful that the new installation location is free of scale inside the pipe and that the pipe is concentric (not distorted) so that the sound waves do not bounce outside of the proposed area.

(e) For pipe with thick scale inside or outside, try to clean the scale off, if it is accessible from the inside. (Note: Sometimes this method might not work and sound wave transmission is not possible because of the layer of scale between the transducers and pipe inside wall).

(5) Q: Why no current in the current loop output?

A: Check if the current output mode is set correct in M55. You need to turn the current loop on in M55. Check the hardware connection: open the electronics enclosure, check to see if wires are properly connected to terminals AO+ and AO-.

(6) Q: Why is the current output not correct?

A: (a) Check if the current output mode is set correct in M55.

(b) Check the upper and lower current settings in M56 and M57.

(c) Re-calibrate the current loop. Verify the output with M49.

(7) Q: Can the flowmeter work normally for a few years without stop under harsh environment where power supply voltage varies widely?

A: Yes. STUF-300F flowmeter employed intelligent signal processing algorithms to handle strong interference coming from either power line or radiation. It also automatically adjusts itself to the optimal operation status when sound wave strength varies due to changing environment.

For more tips, please go to http://www.shenitech.com/support/support_stuf200h_QnA.htm.

6. Communication Protocol

§6.1 General

The STUF-300F series ultrasonic flowmeter has integrated a standard isolated RS-485 communication interface to allow the flowmeter to be easily connected to a RS-485 network bus. The RS-485 interface is a two-wire, half-duplex serial interface, supporting MODBUS protocol as well as Shenitech Extended Flowmeter Communication Protocol (EFCP). MODBUS is a common industrial communication protocol. It comes with two formats, MODBUS-ASCII and MODBUS-RTU. Both are supported by STUF-300F.

You may also use our GSM/GPRS module to transmit flow data to a remote computer, or, to check the flow data and flowmeter status from your cell phone.

When using the flowmeter for networking, you may use the flowmeter's ID as its network address, and use [W]-extended command set as the communication protocol. The 4-20mA current loop output and OCT output can be used to control analog-based or stepper-based valve openness, and the relay output can be used to turn on and off other devices. The analog inputs can be used to input pressure, temperature and other signals. In brief, a STUF-300F is a complete flow measurement RTU or thermal energy measurement RTU.

The maximum transmission distance is 1000m for RS-485. If longer distance is needed, current loop, MODEM, GSM/GPRS can serve the purpose.

All the flowmeter operations can be made on a remote computer, except the modification of ID which can only be done locally through the flowmeter's keypad. The communication protocol is based on master-slave principle. Master (remote computer) sends a command, slave (the flowmeter) responses the command.

You may use the Hyper Terminal utility in your computer to send commands to and view responses from the flowmeter. Please refer to your computer's manual on how to configure the Hyper Terminal utility. Note that the COM port settings of your computer need to match those in the flowmeter (M62.)

By default, the RS485 will be setup with 9600, none, 8, 1 (9600 Baud， none parity, 8 data bits，1 stop bit).

You may also use Shenitech's software for the same purpose. Please check our website for latest software release.

§6.2 RS-485 Wiring

If your master unit (a computer, a PLC or other controllers) does not have a RS-485 port, you need to buy a RS-232/RS-485 converter or a USB/RS-485 converter in order to connect your Stuf-300F main unit to the master unit.
Figure 6.1 illustrates an example of a flowmeter network based on RS-485 bus. The 120Ohm resistor is recommended to be connected at the end of the bus if the length of the wires is long. If you simply connect the flowmeter to your PC though a 485 converter, you do not need to have this resistor.

To complete the wiring, follow those steps:

- Disconnect the main power to the unit and remove the cover.
- Install the required cable clamp in the chosen conduit hole on the bottom of the electronics enclosure.
- Feed one end of the cable through the conduit hole, wire it to terminal pins Tx and Rx , then, secure the cable clamp. Connect the other end of the cable to the 485 converter.
- Wire the 485 converter according to the its instructions
- Reinstall the rear cover on the enclosure and tighten the set screw.

Please refer to Appendix §9.1 for more information.

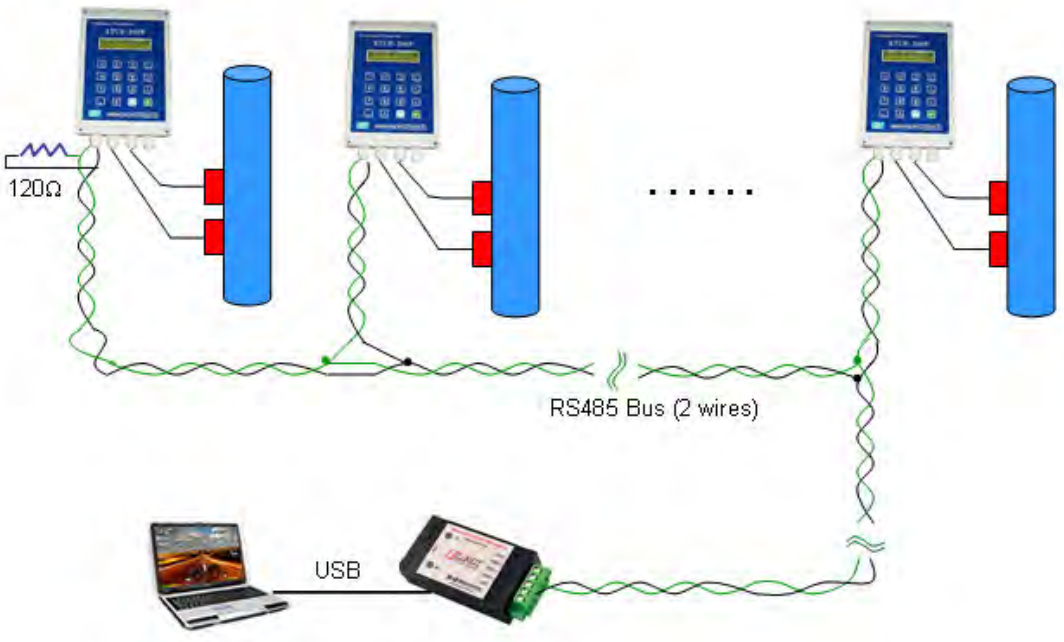


Figure 6.1 Flowmeter network based on RS-485 bus

§6.3 MODBUS Protocol

Both MODBUS -ASCII and MODBUS -RTU protocols are supported. You may use menu window 63 (M63 hereafter) to select which protocol to use. The default is MODBUS-ASCII protocol.

Amount all the MODBUS functions, only function code 03, code 06 and code 16 are supported. Code 03 and code 06 are used to read from and write to a single register, and code 16 is used to write a block of registers. With RTU protocol, the maximum number of registers can be read at one time is 125, but with ASCII protocol, this maximum number is 61 only.

Example 1: we want to use MODBUS –RTU protocol to read flow velocity (REG 5 and REG 6) from flowmeter unit #1.

Select MODBUS-RTU in M63. Send the following command to RS485 bus where flowmeter unit#1 is connected:

01	**03**	**00 04**	**00 02**	**85 CA (Hex)**
Unit#	Function Code	Start REG	# of REGs	Check-sum

Here 85 CA is the hex value of the check-sum, which is calculated according to CRC-16 (BISYNCH, polynomial $x^{16} + x^{15} + x^2 + 1$, logical exclusive word 0A001H). Please refer to MODBUS standards for details.

The response to the above command will be (assume velocity is 1.2345678m/s):

01	**03**	**04**	**06 51 3F 9E**	**3B 32 (Hex)**
Unit#	Function Code	# of bytes	Velocity Data	Check-sum

Here 3F 9E 06 51 represents velocity data 1.2345678, single-precision float format.

Example 2: we want to use MODBUS –RTU protocol to read net flow total (REG 25 and REG 26) from flowmeter unit #1.

Select MODBUS-RTU in M63. Send the following command to RS485 bus where flowmeter unit#1 is connected:

01	**03**	**00 18**	**00 02**	**44 0C (Hex)**
Unit#	Function Code	Start REG	# of REGs	Check-sum

The response to the above command will be (assume the net total is 802609, i.e., 00 0C 3F 31 in hex):

01	**03**	**04**	**3F 31 00 0C**	**A7 ED (Hex)**
Unit#	Function Code	# of bytes	Velocity Data	Check-sum

Please pay attention to the order of data.

Example 3: we want to use MODBUS –ASCII protocol to read REG 1 to REG 10 from flowmeter unit #1.

Select MODBUS-ASCII in M63. Send the following command to RS485 bus where flowmeter unit#1 is connected:

:01030000000AF2 (CR and LF)

Here ":" is the lead character of the MODBUS-ASCII protocol, "F2" is a two bytes checksum, computed by binary summing the ASCII code of all the characters before the checksum byte but not include the lead character.

Note: When debug the MODBUS protocol code, you may use MODSCAN tool which is free and can be downloaded from website.

For MODBUS REGISTERS TABLEs, Please refer "STUF300 - ModbusReg.pdf"

§6.4 Extended Flowmeter Communication Protocol (EFCP)

The STUF-300F uses an Extended Flowmeter Communication Protocol compatible with our previous version ultrasonic flow meter, except for the commands in Italic in the following table.

Command	Meaning	Data format
DQD(cr) note 0	Returns flow rate per day	±d.dddddE±dd(cr) note 1
DQH(cr)	Returns flow rate per hour	±d.dddddE±dd(cr)
DQM(cr)	Returns flow rate per minute	±d.dddddE±dd(cr)
DQS(cr)	Returns flow rate per second	±d.dddddE±dd(cr)
DV(cr)	Returns fluid velocity	±d.dddddE±dd(cr)
DI+(cr)	Returns positive totalizer	±ddddddE±d(cr) note 2
DI-(cr)	Returns negative totalizer	±ddddddE±d(cr)
DIN(cr)	Returns net totalizer	±ddddddE±d(cr)
DIE(cr)	Returns net energy totalizer	±ddddddE±d(cr)
DIE+(cr)	Returns positive energy totalizer	±ddddddE±d(cr)
DIE-(cr)	Returns negative energy totalizer	±ddddddE±d(cr)
DIT(cr)	*Returns net total flow for today*	*±ddddddE±d(cr)*

DIM(cr)	*Returns net total flow for this month*	*±ddddddE±d(cr)*
DIY(cr)	*Returns net total flow for this year*	*±ddddddE±d(cr)*
DID(cr)	Returns the ID number/address	ddddd(cr) 5 bytes long
E(cr)	Return energy flow rate per hour	±d.ddddddE±dd(cr)
DL(cr)	Returns the signal strength	UP:dd.d,DN:dd.d,Q=dd(cr)
DS(cr)	Returns percentage of AO output	±d.ddddddE±dd(cr)
DC(cr)	Returns current error code	Note 3
DA(cr)	OCT and RELAY output	TR:s,RL:s(cr)note 4
DT(cr)	Returns the current date and time	yy-mm-dd,hh:mm:ss(cr)
Time@TDS1=(cr)	*Set date and time yy-mm-dd,hh:mm:ss*	
M@(cr)	Mimic key input. @ presents a key	M@(cr)note 5
LCD(cr)	Returns current window display	
LOCK0(cr)	*Unlock the system*	*Has nothing to do with the original password.*
LOCK1(cr)	*Lock the system*	*Can be opened by pressing the ENT key*
MENUXX(cr)	*Go to window XX*	
C1(cr)	OCT turns on	
C0(cr)	OCT turns off	
R1(cr)	RELAY(OCT2) turns on	
R0(cr)	RELAY(OCT2) turns off	
FOdddd(cr)	Output n Hz at frequency output	Fdddd(cr)(lf)
AOa(cr)	Output a mA current at AO output	AOa(cr)(lf)Note 6
BA1(cr)	Return the resistance for T1	±d.ddddddE±dd(cr)(lf)
BA2(cr)	Return the resistance for T2	±d.ddddddE±dd(cr)(lf)
BA3(cr)	Returns the current (0~20mA) at AI3	±d.ddddddE±dd(cr)(lf)
BA4(cr)	Returns the current (0~20mA) at AI4	±d.ddddddE±dd(cr)(lf)
BA5(cr)	Returns the current (0~20mA) at AI5	±d.ddddddE±dd(cr)(lf)
AI1(cr)	Returns the temperature at T1 input	±d.ddddddE±dd(cr)(lf)
AI2(cr)	Returns the temperature at T2 input	±d.ddddddE±dd(cr)(lf)
AI3(cr)	Returns the value for AI3	±d.ddddddE±dd(cr)(lf)
AI4(cr)	Returns the value for AI4	±d.ddddddE±dd(cr)(lf)
AI5(cr)	Returns the value for AI5	±d.ddddddE±dd(cr)(lf)
ESN(cr)	Returns the ESN number	ddddddd(cr)(lf) note 7
N	Prefix for single byte addressing network	Note 8
W	Prefix for ID string addressing network	Note 8
P	Prefix to returns with check-sum	
&	Command connector to make a super	Result commands should not exceed

	command in one line.	253 bytes long.
RING(cr)(lf)	Command for modem handshake	ATA(CR)(lf)
OK(cr)	Output by a modem	
	Output by flow meter to handshake a modem	AT(CR)(LF)
GA(cr)	Special command for GSM network.	note 9
GB(cr)	Special command for GSM network.	note 9
GC(cr)	Special command for GSM network	note 9

Notes:

0．(cr) is carriage return. Its ASCII value is 0DH. (lf) is line feed, and its ASCII value is 0AH.

1．'d' stands for digit 0~9. A value of 0 is presented by +0.000000E+00

2．'d' stands for digit 0~9. There is no dot before 'E'.

3．1~6 characters present the current state of the flow meter. See the meaning of the characters in the chapter Diagnostics.

4．'s' presents one of ON, OFF or UD

For example 'TR:ON,RL:ON' stands for that the OCT and RELAY are in ON state.

'TR:UD,RL:UD' stands for that the OCT and RELAY are not assigned.

5．@ is the key value. For example, 30H stands for the '0' key. The command 'M4(cr)' acts just like the number 4 key on the keypad.

6． 'a' stands for the output current. The maximum value should not exceed 20. For example AO2.34567, AO0.2

7． 'ddddddd' stands for the Electronic Serial Number

8． If there are more than one flow meter or other kinds of meters in a network, a prefix like 'N' or 'W' must be added before the basic command in the above table, otherwise the system might be confused.

9. The returns by the special command for GSM networks contain Chinese characters.

§6.4.1 Command prefixes and the command connector

(1) The P prefix

The P prefix can be added before every basic command to make the returned message with a check-sum. The check-sum is obtained by a binary addition. For example, if the command DI+(CR) (44H,49H,2BH,0DH in binary numbers brings a return like +1234567E+0m3 (CR) (2BH, 31H, 32H, 33H, 34H, 35H, 36H, 37H, 45H, 2BH, 30H, 6DH, 33H, 20H, 0DH, 0AH in binary numbers), then the PDI+(CR) will bring a return like +1234567E+0m3 !F7(CR). After the exclamation point '!' are the check-sum in ASCII format (2BH+31H+32H+33H+34H+35H+ 36H+37H+45H+2BH+30H+6DH+33H+20H=(2)F7H)

Please note that there may be no characters or only spaces before the exclamation point'!'.

(2) the N prefix

The use of prefix N goes like: N + single byte address + basic command.

For example, if the address number 88 flow meter is going to be addressed, the command should be: NXDV(CR), the decimal value of X being 88.

The prefix W is strongly recommended for new users.

（3） The W prefix

Usage: W + character string address + basic command

The value of the character string should have a value in the range of 0~65535, except for the value of 13（0DH carriage return）, 10（0AH line feed ）, 42（2AH *）, 38（26H&）.

For example, if the velocity of number 12345 flow meter is wanted, the command can be like: W12345DV(CR), (57H, 31H, 32H, 33H, 34H, 35H, 44H, 56H, 0DH in binary numbers)

（4） The command connecter &

The command connecter '&' adds several basic commands into a one-line super command. The super command should not exceed 253 characters. The prefix P should be added before every basic command for the returned results to have a check-sum.

For example, if the 1) flow rate 2) velocity 3) positive totalizer 4) net energy totalizer 5) the AI1 input 6) the AI2 input of the address number 4321 flow meter are required to return with check-sum, the one-line command should be:

W4321PDQD&PDV&PDI+&PDIE&PBA1&PAI2(CR)

The returned data are:

+0.000000E+00m3/d!AC(CR)
+0.000000E+00m/s!88(CR)
+1234567E+0m3 !F7(CR)
+0.000000E+0GJ!DA(CR)
+7.838879E+00mA!59
+3.911033E+01!8E(CR)

§6.4.2 Key Value Table

The key values are used in a network application. By use of the key value and a command 'M', we can operate the flow meter through the network on a computer or other kinds of terminals. For example, the command 'M0 (cr)' acts just like the Zero key on the keypad.

key	Key value (hexadecimal)	Key value (decimal)	ASCII value	key	Key value (hexadecimal)	Key value (decimal)	ASCII value
0	30H	48	0	8	38H	56	8
1	31H	49	1	9	39H	57	9
2	32H	50	2	.	3AH	58	:
3	33H	51	3	◄	3BH	59	;
4	34H	52	4	MENU	3CH	60	<
5	35H	53	5	ENT	3DH	61	=
6	36H	54	6	▲/+	3EH	62	>
7	37H	55	7	▼/-	3FH	63	?

§6.4.3 Programming Examples

Example 1: VB requests the instantaneous (in second) flow rate.

VB Code: mscom1.input = “dqs” + vbcrlf;

Example 2: VB requests the 4321 flowmeter to return the following data with checksum: (a) instantaneous flow rate; (b) instantaneous flow velocity; (c) Positive totalizer value; (d) Heat totalizer value; (e) AI1 input current; (f) AI2 input current.

VB Code: mscom1.input = “W4321PDQD&PDV&PDI+&PDIE&PBA1&PAI2” + vbcrlf;

Example 3: VB requests to change the pipe OD to 345mm.

VB Code: mscom1.input = “M<” +VBCRLF +“M1” +VBCRLF +“M1” +VBCRLF+“M3” +VBCRLF +“M4” +VBCRLF +“M5” +VBCRLF +“M=” +VBCRLF

Note that “M<” represents the MENU key, “M=” represents the ENT key, “M1” represents the “1” key.

7. Measurements of Thermal and Other Physical Parameters

§7.1 Introduction

The STUF-300F flowmeter can be equipped with a maximum of two temperature measurement channels and three analog input channels.

The two temperature channels, which are available in model STUF-300FRx, can accommodate two PT100 RTD sensors directly. They are used for thermal energy measurement as will be introduce in the next section.

There is only one analog input channel in standard STUF-300F model, but can be extended to three channels upon request. These channels can be connected to analog sensors which output is in standard 4-20mA current to measure physical quantities, such as temperature, pressure, concentration, sulfa, etc. By combining the flow rate information, STUF-300F can provide very valuable information for resources management and process control.

All the results can be sent to a master computer through the RS-485 serial port. This means that a STUF-300F can be used as a RTU in a flow monitoring network. It helps to reduce the cost and complexity while improving the reliability of a monitoring network.

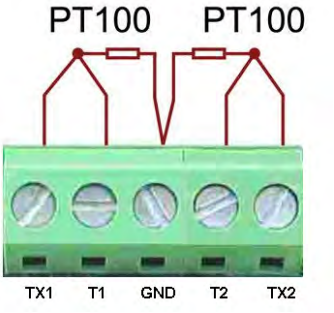
Note that the analog-to-digit conversion resolution of these analog channels is 12-bit, and there is no electrical isolation for those input channels. If the working environment is subjected to strong interference, it is recommended to add external isolation to protect the flowmeter device.

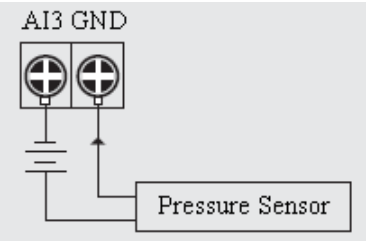
§7.2 Wiring Analog Inputs

The two temperature channels designed for thermal measurement function are wired to terminal block pins TX1, T1, TX2, T2 and GND. They can work with a 3-wire PT100 sensor without any extra parts.

AI3 is a standard 4/0-20mA analog input channel, which can be used to accommodate temperature sensor, pressure sensor or other physical sensor. It is wired to terminal block pins AI3 and AGND

The wiring diagram is shown in the figure below.





Menu window M06 and M+8 display the temperature measurement results. M07 displays the analog input current and its corresponding pressure or temperature value.

§7.3 Thermal Energy Measurement

There are two methods for thermal energy calculation:

(1) Qt = Q x (T2 – T1) x Ct,

(2) Qt = Q x (TC2 – TC1)

Where Qt is the thermal energy (or caloric) consumed, Q is the flow rate, T1 and T2 are the temperature at supply and return points, respectively. Ct is the specific heat (or the thermal capacity coefficient) of the fluid, which can be entered in menu M86. For water, it is normally about 0.0041868GJ/m3°C. TC1 and TC2 are the thermal capacities corresponding to temperature T1 and T2, which are calculated by the flowmeter according to international standards and displayed in M05.

The following menu windows might be used when performing thermal energy measurement:

Menu window M05: display energy and totalized energy.

Menu window M06: display the two temperature measurement results.

Menu window M07: display the values of input current AI3 and AI4 and their corresponding physical values.

Menu window M84: thermal unit selection.
KCAL/s - Kilocalories/second, GJ/s – Giga Joules/second

Menu window M85: temperature source selection: 0. temperature from input AI1 and AI2; 1. fixed difference. When selecting fixed difference, enter the difference in this menu.

Menu window M86: specific heat (or thermal capacity coefficient) input

Menu window M87: thermal totalizer on/off switch

Menu window M88: thermal totalizer multiplier factor

Menu window M89: thermal totalizer reset

Note that, if the fluid temperatures at both supply and return points are stable, you may choose not to use temperature transmitters. Instead, you can directly enter the temperature difference of the two points on menu window M85.

§7.4 Configure Analog Measurement Ranges

Temperature, pressure and other physical signals can be entered into the flowmeter through analog

channels AI3-AI5, if these sensors provide standard 4-20mA signals. Their measurement ranges can be set on windows M64-M66. The first number of these windows is the minimum of the measurement range, corresponding to an analog input of 4mA. The second number is the maximum, corresponding to 20mA input current.

Example: assume a pressure transmitter outputs current 4mA at 0.98kg pressure and 20mA at 10.5kg pressure. The transmitter is connected to channel AI3. Then, you need to enter 0.98 and 10.5 in window M65. The present values of input current and corresponding temperature are shown in M07.

If you find the current value from the transmitter is different from the one shown in M07, you need to calibrate the corresponding analog channel. Please see section §3.16 for calibration detail.

§7.5 Read Input Analog Values from a Network Computer

When the flowmeter is networked, all the analog data can easily be visited from a remote computer.

Use command BA1, BA2, BA3, BA4 and BA5 to read analog input current values of channel T1, T2, AI3, AI4 and AI5. Use command AI1, AI2, AI3 AI4 and AI5 to read the corresponding physical quantities of the five analog channels.

8. Warranty and Service

§8.1 Warranty

The products manufactured by Shenitech are warranted to be free from defects in materials and workmanship for a period of one year from the date of shipment to the original purchaser. Shenitech's obligation should be limited to restoring the meter to normal operation or replacing the meter, at Shenitech's choice, and shall be conditioned upon receiving written notice of any alleged defect within 10 days after its discovery. Shenitech will determine if the return of the meter is necessary. If it is, the user should be responsible for the one-way shipping fee from the customer to the manufacturer.

Shenitech is not liable to any defects or damage attributable to misusage, improper installation, out-of-spec operating conditions, replacement of unauthorized parts and acts of nature. Besides, fuses and batteries are not part of this warranty.

THE FOREGOING WARANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES (INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND WARRANTIES ARISING FROM DEALING, TRADE OR USAGE.)

§8.2 Service

The manufacturer provides instrument installation for its customers, and the charge will depend on the complexity of the installation.

For operational problems, please contact the technical support department by telephone, fax, email or internet. In most cases, problems could be solved immediately.

For any hardware failure of the instrument, we recommend our customers to send back the instrument for service. Please contact the technical support department with the model number and serial number of the unit before sending the unit back to us. Both numbers can be found on the product label. For each service or calibration request, we will issue a Return Materials Authorization (RMA) number.

Take notice that the cost for repairing can only be determined after receipt and inspection of the instrument. A quotation will be sent to the customer before proceeding with the service.

Important Notice for Product Return

Before returning the instrument for warranty repair or service, please read the following carefully:

1. If the return item has been exposed to nuclear or other radioactive environment, or has been in contact with hazardous material which could pose any danger to our personnel, the unit cannot be serviced.

2. If the return item has been exposed to or in contact with dangerous materials, but has been certified as hazard-free device by a recognized organization, you are required to supply the certification for the service.

3. If the return item does not have a RMA# associated, it will be sent back without any service conducted.

§8.3 Software Upgrade Service

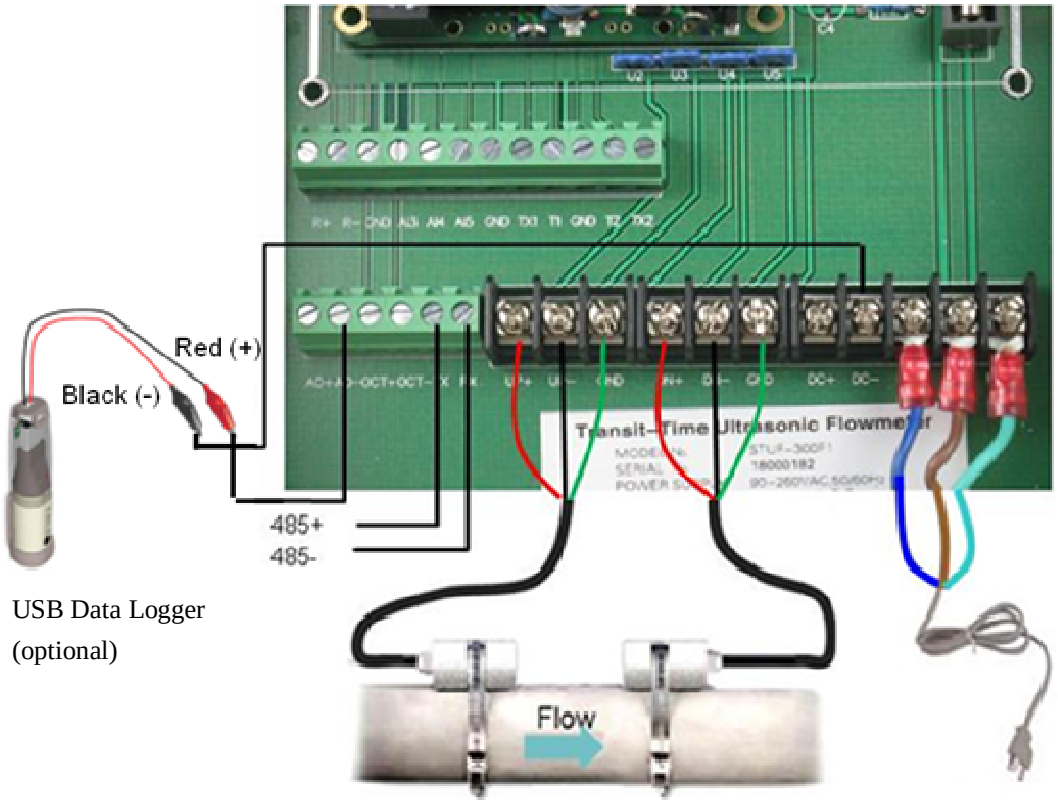
We provide free-of-charge software upgrade services. Please contact the manufacturer for the software upgrade information. You may also go to our technical support website at http://www.shenitech.com/support/stuf300.htm for the latest download.

9. Appendix

§9.1 Wiring Diagram and Outline Drawings

The terminal blocks are labeled in the following figure. Please identify them correctly before starting wiring.

WARNING!
Disconnect power before wiring. Otherwise, the on-board electronics may be damaged by misconnecting or static discharge!



Wire Transducer
Up Positive (Red)
Up Negative (Black)
Up Ground (Green)
Down Positive (Red)
Down Negative (Black)
Down Ground (Green)

USB Data Logger
(optional)

**Note: If you have ordered USB data logger, you need to program the data logger with your computer first before wiring it to the flowmeter unit. Otherwise, the data logger will not log data.*

Line Voltage and Fuse Ratings:

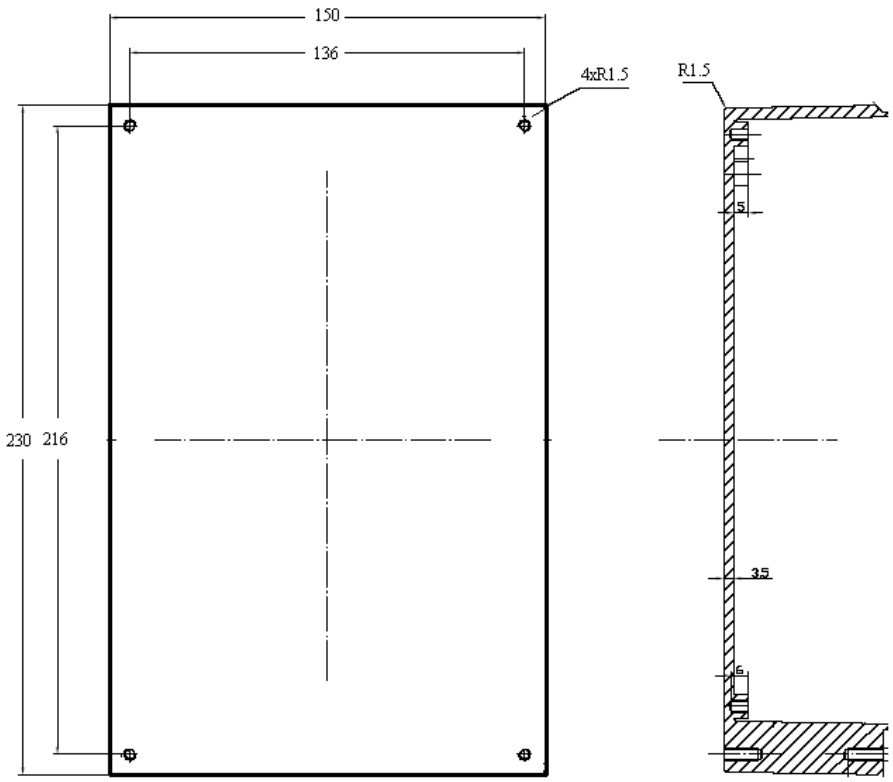
Line voltage is 90VAC~260VAC.
Fuse rating is 0.5A/250VAC, Slo-Blo.

Instead of AC power supply, you may also use 12VDC~32VDC power supply.

WARNING!
Disconnect power before removing fuse.
Be careful not to touch the on-board electronic parts when you replace the fuse. Otherwise, they may be damaged by static discharge!

Enclosure Outline

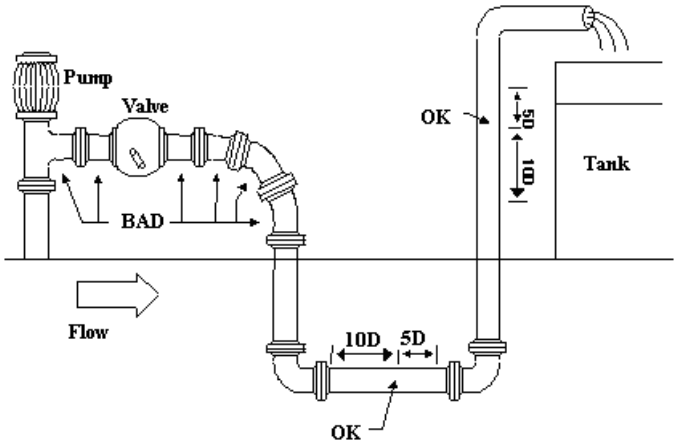
Standard version


150
136
4xR1.5
R1.5
230
216
5
3.5
6

§9.2 Clamp-on Transducer Installation Guide

§9.2.1 Find the mounting site

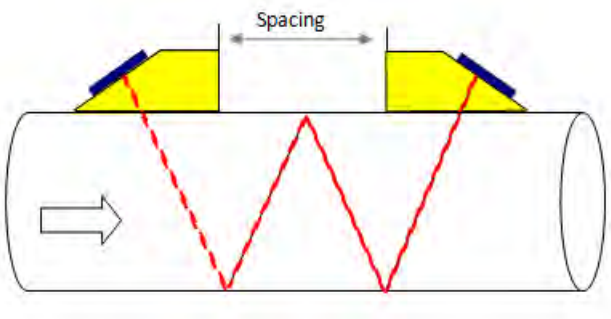
(A) Pipe must be full of liquids at the measurement site.
(B) No heavy corrosion of deposition inside of the pipe.
(C) Must be a safe location.
(D) The straight run of the pipe must not be shorter than 15D as a general guideline, where D is the pipe diameter. Insufficient straight pipe length will degrade the accuracy of the results.
(E) The transducer mounting site should be 10D straight run upstream and 5D straight run downstream (see the following drawing.)
(F) If there are flow disturbing parts such as pumps, valves, etc. on the upstream, the straight pipe length should be increased. The disturbance strength of those flow conducting parts will be (low to high):
Single Bend -> Pipe Reduction / Enlargement -> Outflow Tee -> Same Plane Multiple Bends -> Inflow Tee -> Out of Plane Multiple Bends -> Valve -> Pump



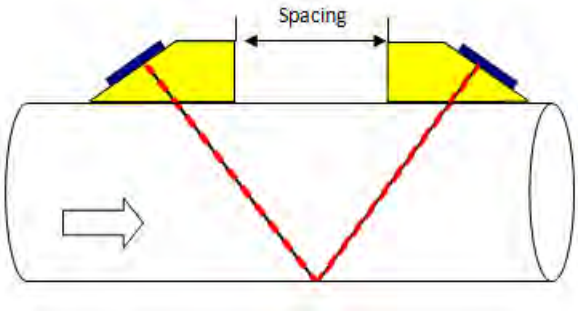
§9.2.2 Transducer Configuration Method

There are three configurations can be used when installing the transducers, W-method, V-method and Z-method.

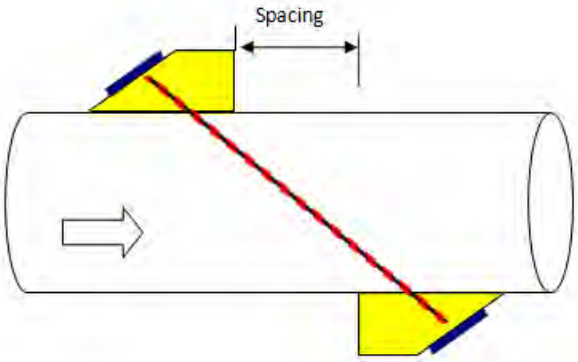
W-method is not commonly used. In some cases it can be used on small pipes, such as pipe size less than 32mm.



V-method is most commonly used configuration. It is applicable for pipes which size is between 25mm and 500mm. However, for old pipes and other difficult pipes, you may try Z-method if V-method does not work.



Z-method is commonly used when the pipe diameter is between 300 millimeters and 5,000 millimeters.



§9.2.3 Configure the Main Unit

Enter the pipe, fluid and transducer information in menus M11-M24. The flowmeter will calculate the transducer installation spacing for you and display the result in M25. This spacing will be used later.

Please note that, if your pipe material is PVC or other plastics, DO NOT select "5. PVC" in M14. Instead, select "9. Others". Then, enter the shear-wave sound speed of that material in M15. Normally, this sound speed is around 1060m/s (3478ft/s).

§9.2.4 Prepare the Pipe Surface

Clean the pipe surface where the transducers will be mounted. Remove rust and paint. Sand the surface if not smooth. Use wet cloth to wipe off the powder after sanding. Dry up the surface. A dry, clean surface will ensure a good acoustic bond between transducer and pipe.

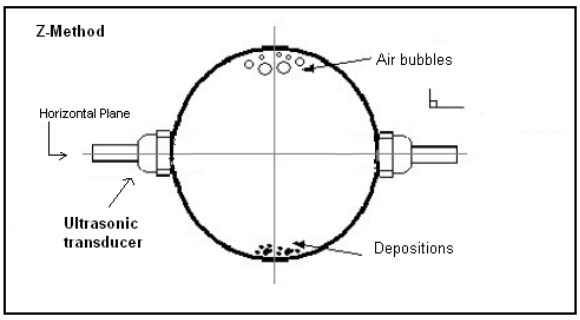
§9.2.5 Prepare the Transducer

Clean the transducer surface. Keep the surface dry.

Put couplant on transducer surface as shown in the right figure. Do not put couplant more than necessary, especially for small pipe.

Note: Ultrasonic couplant can be grease, gel, and Vaseline, silicon or epoxy. Please read the instructions on those products carefully before using them. Shenitech will not be responsible for any consequences caused by these products.

§9.2.6 Install the Transducers



Notice: For horizontal pipe line, it is recommended to install the transducers on the side instead of on the top or bottom of the pipe. This is to avoid air bubbles on the top and sediments on the bottom of the pipe.

First, mark the transducer installation location on the pipe surface according to the mounting spacing given in menu M25. You may need to make a paper template to help you accurately and quickly locate the transducer positions as well as to center the transducers, especially if you plan to use Z-method for the installation.

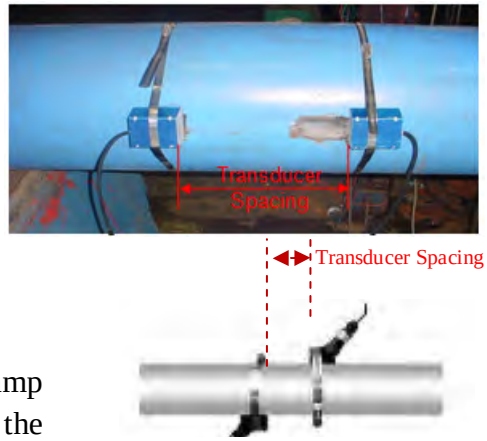
Then, connect the mounting fixture around the pipe. Leave the chain loose so you can slip the transducer underneath.

Apply a small amount of couplant in the prepared area of the pipe where transducers will be in contact.

Slip the transducer under the clamp fixture. Tighten the screw. Do the same thing for the other transducer. Use the figure on the right as a reference.

If the pipe material is metal, you do not need the clamp fixture. The transducers will automatically attach to the pipe by magnetic force.

Finally, connect the transducer cables to the main unit.



Z-method clamp-on installation for high–temperature transducers (S1HT/M1HT)

§9.2.7 Fine Tune the Installation

Check the readings of the triplet (signal strength S, signal quality Q and transit-time ratio R) in menu window M90 and then M91. Make sure they are at least in the operational ranges:

***Operational Ranges*:** **$S \geq 60$, $Q \geq 60$, $97\% \leq R \leq 103\%$.**

***Optimal Ranges*:** **$S \geq 80$, $Q \geq 80$, $99\% \leq R \leq 101\%$[*].**

[*] *Note that when flow velocity is very high, the range for R may extend.*

In ideal case where pipe condition and fluid condition are favorable for sound propagation, the triplet readings could be fine turned into the optimal ranges. If your triplet readings are not close to their optimal ranges, or, even not in their operational ranges, you need to adjust your transducer installation slightly and slowly, until you get the best readings.

If you are unable to get the triplet into their operational ranges, no mater how hard you try, then, you may need to check all the parameters you entered in menu windows M11 to M24. Make sure those values are correct. Whenever you make a change to those parameters, you need to check the transducer spacing reading in menu M25. If the spacing is changed, you need to reinstall the transducers accordingly.

If you still cannot get the right triplet readings, check the following:

Is the pipe too old?
Too much deposition inside of the pipe?
Too much corrosion? Too much air bubble?
Too thick liner? Empty or half-full pipe?
Too close to pump / valve / elbow?

Please refer to section §2.11 for more suggestions. Please also check on our technical support website for more tips, http://www.shenitech.com/support/stuf300.

§9.3 Insertion Transducer Installation Guide

A separate installation instruction should have been shipped with the product. If not, please contact the manufacturer at support@shenitech.com.

§9.4 Flow-cell Transducer Installation Guide

A separate installation instruction should have been shipped with the product. If not, please contact the manufacturer at support@shenitech.com.

§9.5 Standard Pipe Dimensions

Please refer to the following website for standard pipe dimensions:
http://www.shenitech.com/support/support_pipesize.htm

§9.6 Sound Speed Tables

Table 9.6.1: Sound Speed in Water at atmosphere pressure. Unit：t (□) v (m/s)

t	v	t	v	t	v	t	v
0	1402.3	25	1496.6	50	1542.5	75	1555.1
1	1407.3	26	1499.2	51	1543.5	76	1555.0
2	1412.2	27	1501.8	52	1544.6	77	1554.9
3	1416.9	28	1504.3	53	1545.5	78	1554.8
4	1421.6	29	1506.7	54	1546.4	79	1554.6
5	1426.1	30	1509.0	55	1547.3	80	1554.4
6	1430.5	31	1511.3	56	1548.1	81	1554.2
7	1434.8	32	1513.5	57	1548.9	82	1553.9
8	1439.1	33	1515.7	58	1549.6	83	1553.6
9	1443.2	34	1517.7	59	1550.3	84	1553.2
10	1447.2	35	1519.7	60	1550.9	85	1552.8
11	1451.1	36	1521.7	61	1551.5	86	1552.4
12	1454.9	37	1523.5	62	1552.0	87	1552.0
13	1458.7	38	1525.3	63	1552.5	88	1551.5
14	1462.3	39	1527.1	64	1553.0	89	1551.0
15	1465.8	40	1528.8	65	1553.4	90	1550.4
16	1469.3	41	1530.4	66	1553.7	91	1549.8
17	1472.7	42	1532.0	67	1554.0	92	1549.2
18	1476.0	43	1533.5	68	1554.3	93	1548.5
19	1479.1	44	1534.9	69	1554.5	94	1547.5
20	1482.3	45	1536.3	70	1554.7	95	1547.1
21	1485.3	46	1537.7	71	1554.9	96	1546.3
22	1488.2	47	1538.9	72	1555.0	97	1545.6
23	1491.1	48	1540.2	73	1555.0	98	1544.7
24	1493.9	49	1541.3	74	1555.1	99	1543.9

Table 9.6.2: Sound Speed and Viscosity Data of Liquids

Liquids	Sound Speed @ 25□ (77°F)		Kinematic Viscosity X 10^{-6}	
	m/s	ft/s	m^2/s	ft^2/s
Acetone	1,174	3,851.7	0.399	4.293
Acetaldehyde Alcohol	1,180	3,870		
Alcohol	1,207	3,960	1.396	15.02
Aviation kerosene	1,298	4,257		
Benzene	1,306	4,284.8	0.711	7.65
Carbine	1,121	3,677		
Ethanol	1,207	3,690	1.39	14.956
Ethyl benzene	1,586	4,389.8 (68°F)	0.797 (17□)	8.575 (63°F)
Ethylene chloride	1,193	3,914	0.61	6.563
Ethylene trichloride	1,050	3,444		
Gasoline	1,250	4,100	0.8	0.1980
Gasoline 66#	1,171	3,841		
Gasoline 80#	1,139	3,736		
Glycol	1658	5,439.6		
50%Glycol / 50%H2O	1,578	5,177		
Glycerin	1,904	6,246.7	757.1	8,081.8
Ketone	1,310	4,297		
Kerosene	1,420	4,658	2.3	24.7
Oil (Castor)	1,477	4,854.8	0.670	7.209
Oil (Diesel)	1,250	4,101		
Oil (Peanut)	1,458	4,783.5		
Petroleum	1,290	4,231		
Tetrachlor-Methane	926	3,038.1	0.607	6.531
Toluene	1,328 (20□)	4,357 (68°F)	0.644	6.929
Water, distilled	1,498	4,914.7	1.0	10.76

Table 9.6.3: Sound Speed Data of Solids

Material	Sound Speed Shear Wave (25□)		Sound Speed Long. Wave (25□)	
	m/s	ft/s	mm/us	in/us
Steel, 1% Carbon, hardened	3,150	10,335	5.88	0.2315
Carbon Steel	3,230	10,598	5.89	0.2319
Mild Steel	3,235	10,614	5.89	0.2319
Steel,1% Carbon	3,220	10,565		
302 Stainless Steel	3,120	10,236	5.690	0.224
303 Stainless Steel	3,120	10,236	5.640	0.222
304 Stainless Steel	3,141	10,306	5.920	0.233
304L Stainless Steel	3,070	10,073	5.790	0.228
316 Stainless Steel	3,272	10,735	5.720	0.225
347 Stainless Steel	3,095	10,512	5.720	0.225
Aluminum	3,100	10,171	6.32	0.2488
Aluminum (rolled)	3,040	9,974		
Copper	2,260	7,415	4.66	0.1835
Copper (annealed)	2,235	7,628		
Copper (rolled)	2,270	7,448		
CuNi (70%Cu 30%Ni)	2,540	8,334	5.03	0.1980
CuNi (90%Cu 10%Ni)	2,060	6,759	4.01	0.1579
Brass (Naval)	2,120	6,923	4.43	0.1744
Gold (hard-drawn)	1,200	3,937	3.24	0.1276
Inconel	3,020	9,909	5.82	0.2291
Iron (electrolytic)	3,240	10,630	5.90	0.2323
Iron (Armco)	3,240	10,630	5.90	0.2323
Ductile Iron	3,000	9,843		
Cast Iron	2,500	8,203	4.55	0.1791
Monel	2,720	8,924	5.35	0.2106

Table 9.6.3 (continued): Sound Speeds in Solids

Material	Sound Speed Shear Wave（25□）		Sound Speed Long Wave（25□）	
	m/s	ft/s	mm/us	in/us
Nickel	2,960	9,712	5.63	0.2217
Tin,rolled	1,670	5,479	3.32	0.1307
Tintanium	3,125	10,253	6.10	0.2402
Tungsten,annealed	2,890	9,482	5.18	0.2039
Tungsten,drawn	2,640	8,661		
Tungsten,carbide	3,980	13,058		
Zinc,rolled	2,440	8,005	4.17	0.1642
Glass,Pyrex	3,280	10,761	5.61	0.2209
Glass,heavy silicate flint	2,380	7,808		
Glass,Iight borate crown	2,840	9,318	5.26	0.2071
Nylon	1,150	3,772	2.40	0.0945
Nylon,6-6	1,070	3,510		
Polyethylene（LD）			2.31	0.0909
Polyethylene（LD）	540	1,772	1.94	0.0764
PVC,CPVC	1,060	3,477	2.40	0.0945
Acrylic	1,430	4,690	2.73	0.1075
Asbestos Cement			2.20	0.0866
Tar Epoxy			2.00	0.0787
Mortar			2.50	0.0984
Rubber			1.90	0.00748

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- Flexible Heaters
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- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments

M-4463/0707

User's Guide

OMEGA
An OMEGA Technologies Company

http://www.omega.com
e-mail: info@omega.com

LVU800 Series
Ultrasonic Transmitter

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit should malfunction, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

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RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. P.O. number to cover the COST of the repair,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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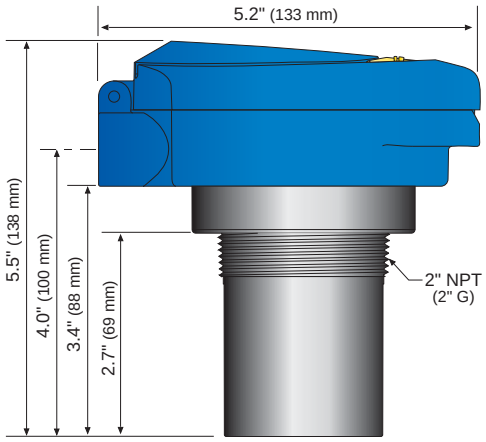
ISO 9002 Certified

SPECIFICATIONS

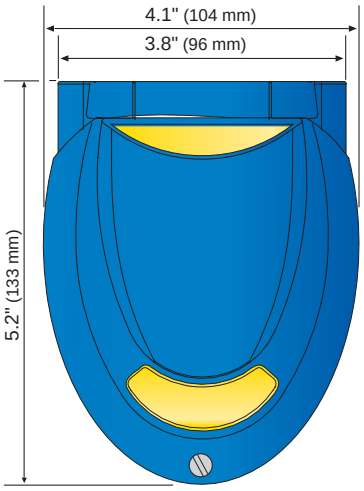
Step One

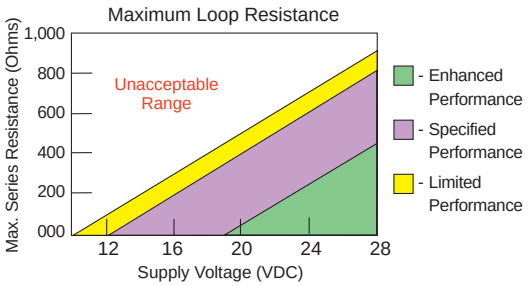
Range:	LVU816: 8” to 16.4’ (10 cm to 5 m) LVU826: 8” to 26.2’ (20 cm to 8 m) LVU832: 12” to 32.8’ (30 cm to 10 m)
Accuracy:	+/- 0.2% of span in air
Resolution:	LVU816: 0.039 (1 mm) LVU826: 0.039 (1 mm) LVU832: 0.078: (2 mm)
Beam width:	3” (7.6cm) dia.
Dead band	LVU816: 8” (10cm) LVU826: 8” (20cm) LVU832: 12” (30cm)
Display type:	LCD, 6-digit
Display units:	Inch, cm or percentage
Display mode:	Air gap or liquid height
Memory:	Non-volatile
Supply voltage:	12- 28 VDC
Loop resist,:	500 Ohms @ 24 VDC
Signal output:	4 - 20 mA, two -wire
Signal invert:	4-20 mA, 20-4 mA
Calibration:	Push button
Fail-safety:	Selectable: 4 mA, 20 mA, 21 mA, 22 mA or hold last value
Process temp.:	F: -4° to 140° C: -20° to 60°
Temp comp,:	Automatic
Electronics temp.:	F: -40° to 160° C: -40° to 71°
Pressure:	30 psi (2 bar) @ 25 °C., derated @ 1.667 psi (113 bar) per °C, above 25 °C
Enclosure rating:	NEMA 4X (IP65)
Enclosure vent:	Water tight membrane
Encl. material:	PC/ABS FR
Trans. material:	PVDF
Process mount:	2” NPT (2” G)
Mount. gasket:	Viton®
Conduit entrance:	Dual, 1/2” NPT
Classification:	General purpose
CE compliance:	EN 61326 EMC

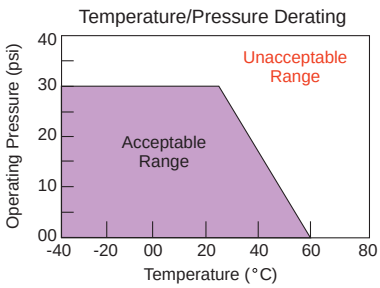
Side View

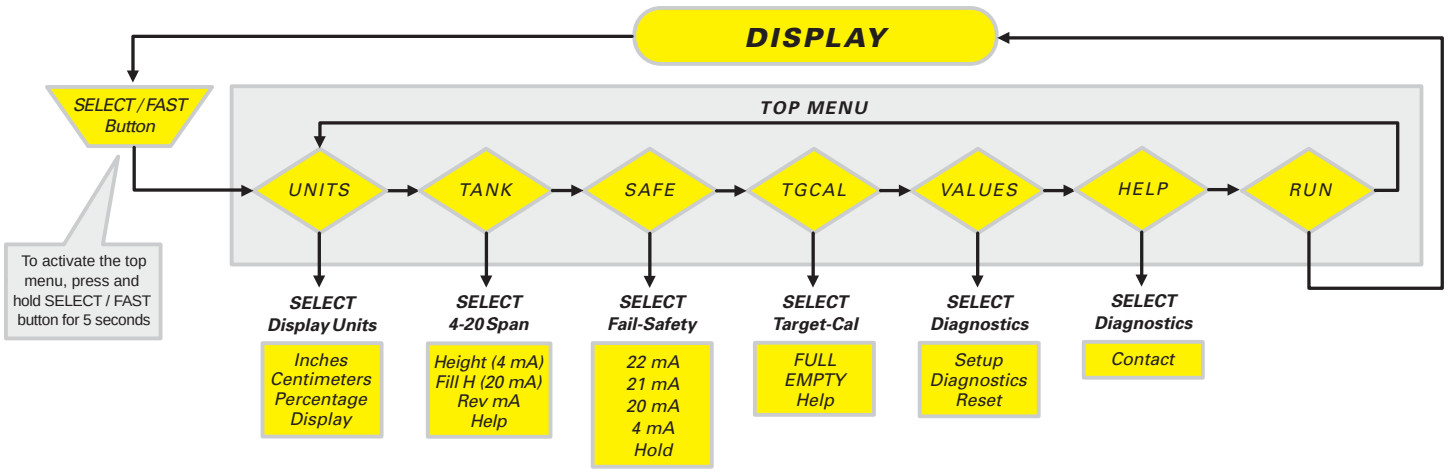


Top View









SAFETY

Step Two

⚠ **About this Manual:** PLEASE READ THE ENTIRE MANUAL PRIOR TO INSTALLING OR USING THIS PRODUCT. This manual includes information on then LVU800 Ultrasonic Level Transmitter from OMEGA. Please refer to the part number located on the transmitter label to verify the exact model configuration which you have purchased.

⚠ **User's Responsibility for Safety:** OMEGA manufactures a broad range of level sensing technologies. While each of these sensors is designed to operate in a wide variety of applications, it is the user's responsibility to select a sensor model that is appropriate for the application, install it properly, perform tests of the installed system, and maintain all components. The failure to do so could result in property damage or serious injury.

⚠ **Proper Installation and Handling:** Only properly trained staff should install and/or repair this product. Install the transmitter with the Viton gasket and never overtighten the transmitter within the fitting. Always check for leaks prior to system start-up.

⚠ **Wiring and Electrical:** A supply voltage (loop power) of 12 -28 VDC is used to power the LVU800 series. The sensor circuit should never exceed a maximum of 28 volts DC. Electrical wiring of the sensor should be performed in accordance with all applicable national, state, and local codes.

⚠ **Material Compatibility:** The LVU800 series enclosure is made of a flame retardant Polycarbonate (PC/ABS FR). The transducer is made of Polyvinylidene Fluoride (PVDF). Make sure that the model which you have selected is chemically compatible with the application media and it's environment.

⚠ **Enclosure:** While the transmitter housing is liquid-resistant the LVU800 series is not designed to be operational when immersed. It should be mounted in such a way that the enclosure and transducer do not come into contact with the application media under normal operational conditions.

⚠ **Make a Fail-Safe System:** Design a fail-safe system that accommodates the possibility of transmitter and/or power failure. OMEGA recommends the use of redundant backup systems and alarms in addition to the primary system.

⚠ **Flammable, Explosive or Hazardous Applications:** Do not use the LVU800 series of general purpose transmitters within classified hazardous environments.

⚠ ***Warning*** ⚠

Always use the Viton gasket when installing the LVU800 series transmitter in its fitting, and always connect the shield wire to the common ground.

OVERVIEW

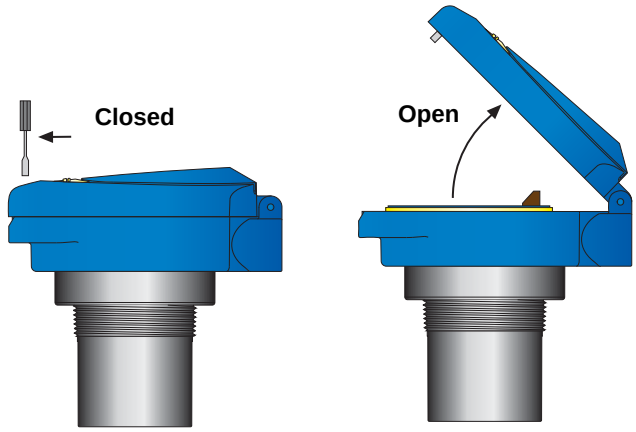
Step Three

A. Application: The general-purpose ultrasonic transmitter provides non-contact level detection up to 32.8' or 10m. The transmitter is well suited for a wide range of corrosive, waste and slurry type media, and is broadly selected for atmospheric bulk storage, day tank and waste sump applications.

B. Part Number: The part and serial numbers are located on the wrench flat. Check the part number on the product label and confirm which of the below model configurations you have purchased:

Part Number	Range	Supply	Mount
LVU816	16.4' (5 m)	12-28 VDC	2" NPT
LVU816G	16.4' (5 m)	12-28 VDC	2" G
LVU826	26.2' (8 m)	12-28 VDC	2" NPT
LVU826G	26.2' (8 m)	12-28 VDC	2" G
LVU832	32.2' (10 m)	12-28 VDC	2" NPT
LVU832G	32.2' (10 m)	12-28 VDC	2" G

C. NEMA 4X Enclosure: The NEMA 4X (IP65) enclosure has a flip cover with two 1/2" NPT female conduit ports and an internal terminal strip for wiring. To open the enclosure, you will need a small small screwdriver. Insert the tool into the hole located at the top edge of the enclosure and turn counter-clockwide. Rotate the hinged cover up for 135° access to the faceplate screen and terminal strip.



Before closing the enclosure, make sure that the enclosure gasket is properly seated, and that any conduit fittings, liquid tight cable connectors and/or plugs are properly installed and sealed.

Handling Static-Sensitive Circuits/Devices

When handling the transmitter, the technician should follow these guidelines to reduce any possible electrostatic charge build-up on the technicians body and the electronic part.

1. *Always touch a known good ground source before handling the part. This should be repeated while handling the part and more frequently after sitting down from a standing position, sliding across the seat or walking a distance.*
2. *Avoid touching electrical terminals of the part unless making connections.*
3. *DO NOT open the unit cover until it is time to calibrate.*

PREPARATION

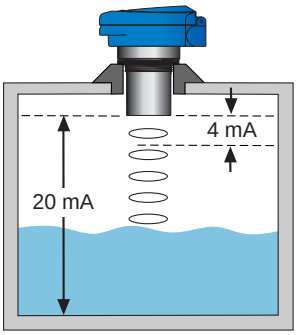
Step Four

A. Supply Voltage: The transmitter power supply voltage should never exceed a maximum of 28 VDC. Omega controllers and meters have built-in 24 VDC power supplies for use with the transmitter. Alternative controllers and/or power supplies with a minimum output of 12 VDC may also be used with the transmitter for calibration and/or operation.

B. Cable Length: The cable length between the transmitter and it's point of termination may be extended up to a maximum of 1000 feet, using a well-insulated, shielded wire from 14 to 18 gauge.

C. Factory Span: All transmitter models are factory calibrated with 4 mA at their maximum range (tank empty) and 20 mA at their minimum range (tank full). The 4 and 20 mA span set points can be reverse calibrated on all models.

LVU800 Series Reverse Mode

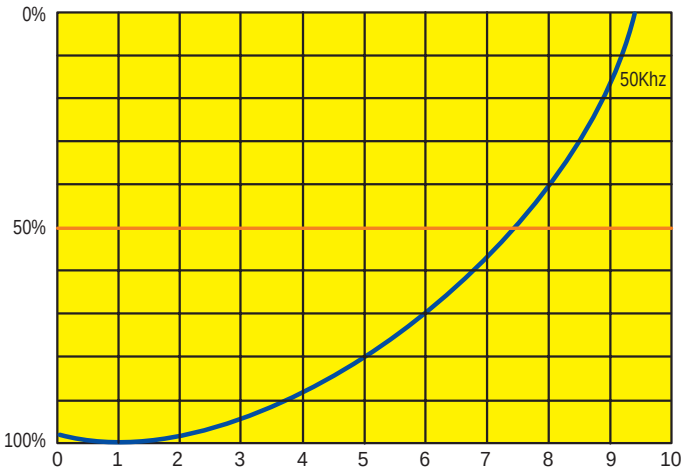


D. Maximum Applied Range: The Individual or cumulative effects of agitation, vapor or foam can reduce the overall quality of signal return and shorten the maximum applied range of the transmitter. To determine the maximum applied range of the transmitter in your application, refer to the below derating chart.

Maximum Applied Range Derating Chart

LVU800

Agitation = 1-3 @ 50 kHz
Vapor = 3-5 @ 50 kHz
Foam = 4-6 @ 50 kHz



MENU ITEMS

Step Five

A. WARMUP: This is the initial power up mode. When this message is displayed, the transmitter is going through its power up routine, and validating the target value. After a short period of time, this message will disappear and be replaced by a numeric value.

B. FULL: Level has reached the programmed FULL set point.

C. EMPTY: Level has reached the programmed EMPTY set point

D. UNITS: Selectable in Inches Centimeters or Percent. The factory default is Inches.

E. INCHES: Inch units of measurement.

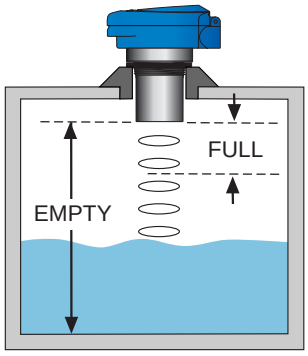
F. CM: Centimeters units of measurement.

G. PERCNT: 0-100% units of measurement. Percent is the calculated value based on the 4mA and 20mA set points.

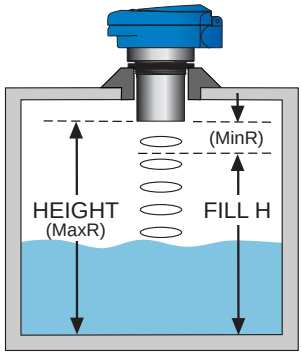
H. DISPLAY: Allows the user to select if the display will read in units of air or units of liquid. Factory default is units of air.

H. TANK: Menu through which the 4-20 mA span is adjusted.

I. HEIGHT: The point in inches or centimeters from the transducer face where the output will be 4 mA (generally the bottom of the tank). Factory default is the same as the unit's maximum range. Example: LVU816 = 197" maximum range which is also the same 4 mA set point under factory default.



J. Fill H (Fill Height): The point in inches or centimeters from the bottom of the tank to the high level where the output will be 20 mA (generally the straight wall distance from the bottom of the tank). NOTE: The transmitter dead band is automatically subtracted from the FILL H. Example: LVU816 = 8" dead band. Therefore the maximum FILL H is 197" [maximum range] - 8" [dead band] = 189".



K. REV mA (Reverse mA): Allows the user to select 20 mA at the bottom and 4 mA at the top of the tank (20-4 mA). Factory default is 4 mA (MaxR) at the bottom and 20 mA (MinR) at the top.

L. SAFE: The FAIL-SAFE current output of the transmitter if the acoustic signal is LOST. Selectable at 4 mA, 20 mA, 21 mA, 22 mA or HOLD. (HOLD is the last 4-20 mA value prior to LOST).

M. TG CAL: Allows the user to use an unknown distance for setting of the 4 mA and 20 mA span.

MENU ITEMS

Step Six

N. FULL: Target calibration technique that allows the user to enter the present distance from the transducer face to the liquid or a reflective target as the 20 mA (FULL) set point

O. EMPTY: Target calibration technique that allows the user to enter the present distance from the transducer face to the liquid or a reflective target as the 4 mA (EMPTY) set point.

P. WAIT: Indicates that you have selected either FULL or EMPTY and the transmitter is calculating the distance value.

Q. VALUES: Allow the user to view the present calibration settings that are programmed in the transmitter.

R. SETUP: Displays the present calibration settings such as UNITS, MinR, MaxR, and SAFE.

S. MINR: The lesser distance from the transducer to the full tank height of liquid.

T. MAXR: The greater distance from the transducer to the empty tank height of liquid.

U. RESET: Allows the user to reset the transmitter to its original factory default settings.

V. DIAG (Diagnostics): Allows the user to view the present values of LEVEL, TEMP, ECHO, POWER, MOUNT and VER.

W. LEVEL: Displays the current Inch, Centimeter or Percent measured value.

X. TEMP: Displays the temperature in the vessel at the transducer.

Y. ECHO: Displays the present acoustic signal strength.

Z. POWER: Displays the present acoustic power level

AA. MOUNT: Displays either QUIET (no fitting noise) or NOISY (potential fitting noise), If NOISY with transmitter performance issues, please contact Omega to discuss your installation.

BB. VER (VERSION): Displays the transmitter software version.

CC. DONE: Indicates that the new value has been saved in memory (after depressing the SELECT/FAST key).

DD. ERROR: Indicates that the new value has NOT been saved in memory (after depressing the SELECT/FAST or EXIT key).

EE. RUN: When displayed, if the user depresses the SELECT/FAST key, the transmitter will exit the programming mode and return to the RUN mode for normal operation.

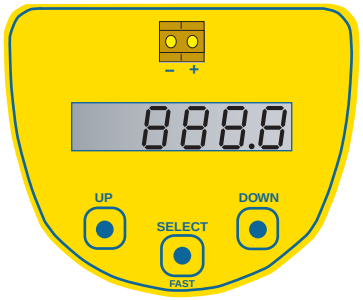
FF. UP / DOWN: Increases or decreases the SET 20 and SET 4 display values in the programming mode. NOTE: Simultaneously holding down the SELECT/FAST button while pressing the UP or DOWN button will increase the speed of the display.

PROGRAMMING

Step Seven

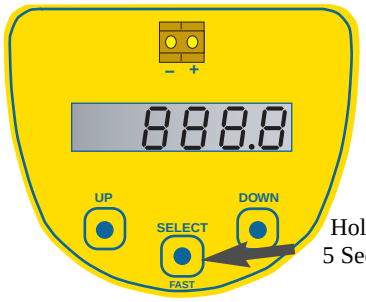
A. Introduction: The transmitter has two modes, RUN and PROGRAM. In the RUN mode, the transmitter is operational and the display will indicate the liquid height in inches, centimeters or percent.

In the PROGRAM mode, the display will indicate the selected mode of calibration. The transmitter arrives from the factory with its settings at 4 mA = maximum range and 20 mA = minimum range (defined by the dead band or minimum measurement distance). The transmitter is programmed with it's built-in display and three button keyboard. **Under normal application circumstances, users typically program the HEIGHT distance value, FILL H distance value and FAIL-SAFE mode.**



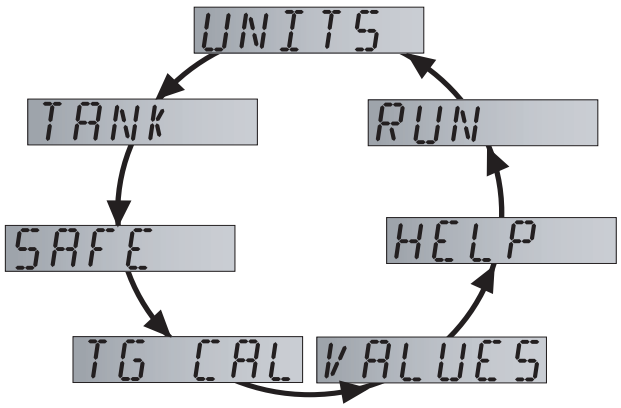
B. Entering the Program Mode: Press and hold the SELECT/FAST button for approximately 5 seconds until the display changes from a numeric value to PROG, indicating that you have entered the PROG mode.

Note: *When PROG mode is active, the sensor will hold the last current value. The value will not change until the transmitter is returned to RUN Mode.*



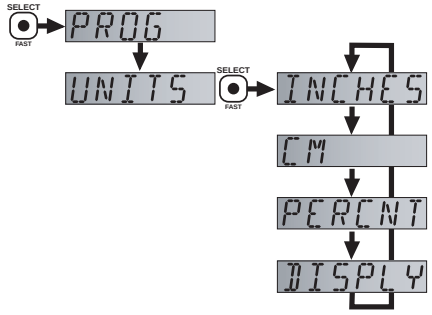
After entering the PROG mode, the display will scroll through the top menu, alternately flashing UNITS, TANK, SAFE, TG CAL, VALUES, HELP and RUN.

Top Menu



Step Eight

C. Programming UNITS: To change UNITS from INCHES to CM or PERCENT.

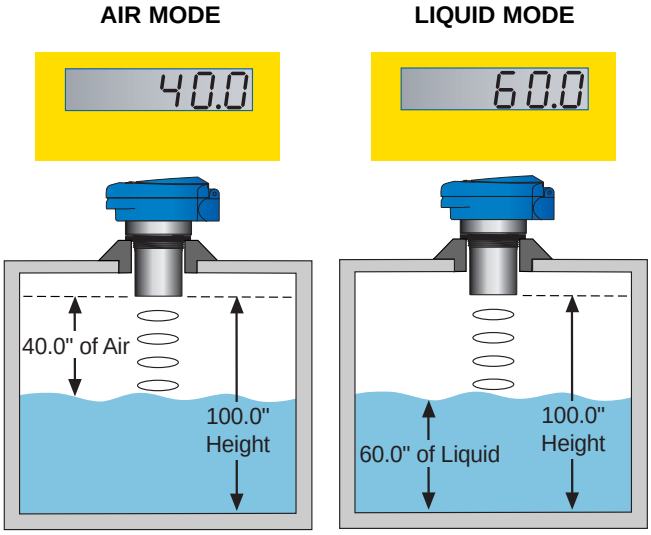


1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When UNITS appears, press the SELECT/FAST button. The display will rotate between INCHES, CM, PERCENT and DISPLAY.
3. Press the SELECT/FAST button when the UNITS you want (INCHES, CM or PERCENT) appear. The display will then display SAVED.

You have successfully changed the UNITS function.

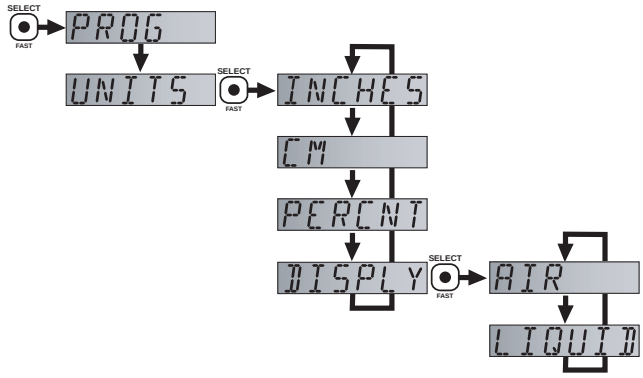
Note: *Percent units can only be selected after the transmitters Height (4 mA) and Fill H (20 mA) set points have been programmed. Therefore initial programming should always be done in INCH or CM UNITS.*

D. Display Mode: The transmitter is factory set such that the display reads the distance from the bottom of the transmitter to the liquid surface. This is also referred to as the Air distance (Air Mode). As the level of liquid increases, the display will decrease and vice versa. Conversely, the transmitter may be set to read the actual height of liquid in the tank (Liquid Mode). Below, a tank height of 100” will display 40.0, which represents 40.0” of air in the AIR Mode. In the Liquid Mode, the display will change to 60.0, which represents 60.0” of liquid.



Step Nine

E. Change Display Mode: To change the display to indicate the height of liquid, follow the instructions below:



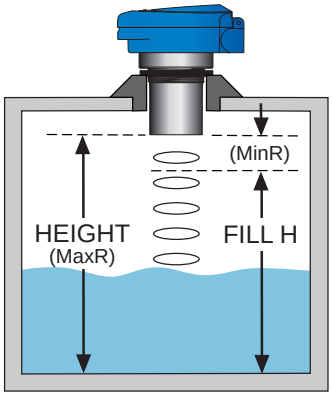
1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When UNITS appears, press the SELECT/FAST button. The display will rotate between INCHES, CM, PERCENT and DISPLAY.
3. When DISPLAY appears, press the SELECT/FAST button. The display will rotate between AIR or LIQUID.
4. When LIQUID appears, press the SELECT/FAST button.

You have successfully programmed the LIQUID mode.

F. Programming Off Tank: If you know the dimensions of your tank, you may input the 4 mA and 20 mA set points manually without performing target calibration (requiring you to raise and lower the liquid level). To do so, review the following:

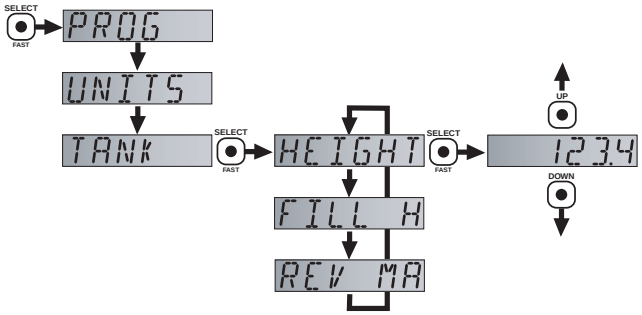
HEIGHT: The point in inches or centimeters from the transducer face where the output will be 4 mA (generally the bottom of the tank). Factory default is the same as the unit’s maximum range. Example LVU816 = 197” maximum range which is also the same 4 mA set point under factory default.

FILL H: The point in inches or centimeters from the bottom of the tank to the high level where the output will be 20 mA (generally the straight wall distance from the bottom of the tank). NOTE: The transmitter dead band is automatically subtracted from the FILL H. Example: LVU816 = 8” dead band. Therefore the maximum FILL H is 197” [maximum range] - 8” [dead band] = 189”.



Step Ten

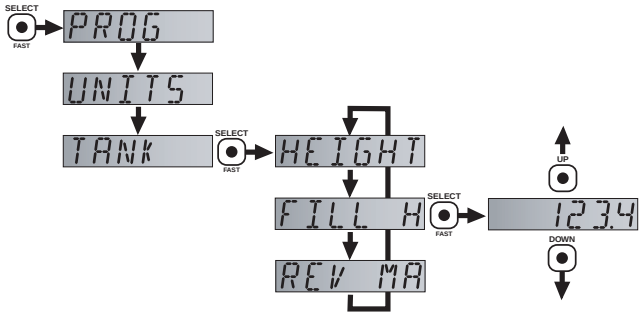
G. Programming HEIGHT: To change HEIGHT 4 mA value.



1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When TANK appears, press the SELECT/FAST button. The display will rotate between HEIGHT, FILL H and REV mA.
3. When HEIGHT appears, press the SELECT/FAST button. The display will show a decimal reading in the selected UNITS.
4. Press the UP/DOWN buttons to increase or decrease this value to the distance from the transducer face to the bottom of the tank. NOTE: Simultaneously holding down the SELECT/FAST button while pressing the UP or DOWN button will increase the speed of the display.
5. When you have reached the desired value, press SELECT/FAST to SAVE.

You have successfully programmed the HEIGHT or 4 mA value.

H. Programming FILL H: To change FILL H 20 mA value.



1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When TANK appears, press the SELECT/FAST button. The display will rotate between HEIGHT, FILL H and REV mA.
3. When FULL H appears, press the SELECT/FAST button. The display will show a decimal reading in the selected UNITS.
4. Press the UP/DOWN buttons to increase or decrease this value to the distance from the bottom of the vessel to the full point (typically the straight wall height).
5. When you have reached the desired value, press SELECT/FAST to SAVE it.

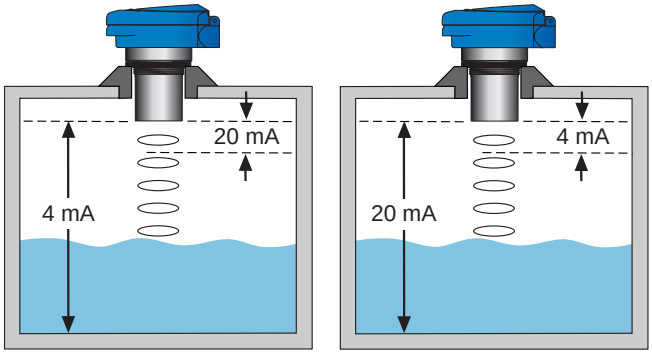
You have successfully programmed the FILL H or 20mA value.

NOTE: *You can increase the speed at which the display changes by pressing the SELECT/FAST button while simultaneously holding down the UP or DOWN button.*

PROGRAMMING

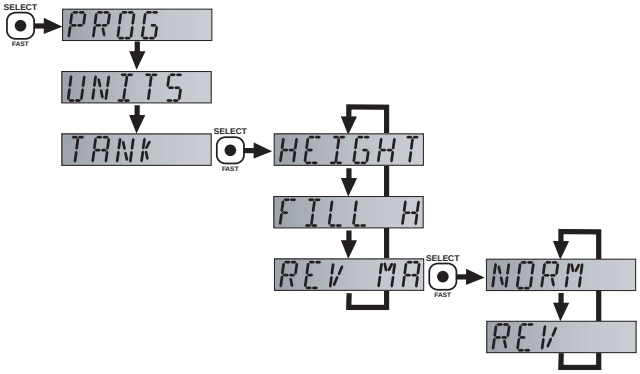
Step Eleven

I. Programming REV mA (Optional): In factory default, the transmitter operates with 4 mA at the maximum range (MaxR), and 20 mA at the dead band (MinR). Using the menu item REV mA, you can change the unit to reverse this to 20 mA at the furthest distance (MaxR) and 4 mA at the closest distance (MinR).



Normal mA Mode
MaxR (4 mA) set at empty tank and MinR (20 mA) set at full tank.

Reverse mA Mode
MaxR (20 mA) set at empty tank and MinR (4 mA) set at full tank.

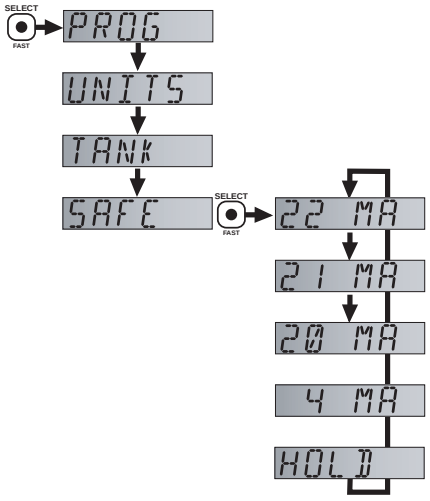


NOTE: *You must set HEIGHT and FULL R prior to reversing the 4 and 20 mA. Regardless of which mode you are in (Norm or Rev), changes to the HEIGHT or FULL R are always with respect to the original settings programmed.*

NOTE: *Any changes to the HEIGHT will effect the FULL R value. The FULL R will stay at the same physical level in the tank. An increase to the HEIGHT value will result in an equal increase to the FULL R value. A decrease to the HEIGHT value will result in an equal decrease to the FULL R value.*

Step Twelve

J. Programming SAFE Mode: To change SAFE mode.



1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When SAFE appears, press the SELECT/FAST button.
3. The display will now rotate through 22mA, 21mA, 20mA, 4mA and HOLD. When you reach the desired setting, press the SELECT/FAST button to SAVE it..

You have successfully programmed the SAFE mode.

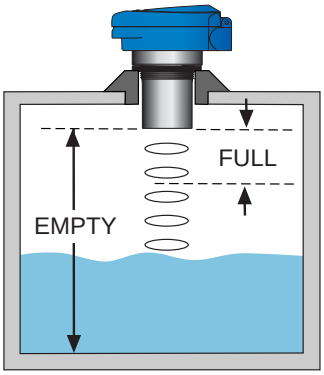
K. Programming Target Calibration (Optional): The transmitter's 4 mA and 20 mA set points can be target calibrated ON the tank by raising and lowering the liquid level, or OFF the tank using the distance to a flat reflective target such as a wall. Generally, target calibration is done ON the tank. To do so, follow the EMPTY and FULL tank programming steps on the next page.

NOTE: *A transmitter installed on a tank operating in the factory default RUN mode will display the distance from the bottom of the sensor to the liquid surface. The value will decrease as the tank is filled or increase as the tank is emptied. Make sure that you do not overflow the tank or completely empty the tank while moving the liquid level to the desired high or low set point distance for target calibration.*

TG CAL: Allows the user to use an unknown distance for setting of the 4 mA and 20 mA span.

FULL: Target calibration technique that allows the user to enter the present distance from the transducer face to the liquid or a reflective target as the 20 mA (FULL) set point

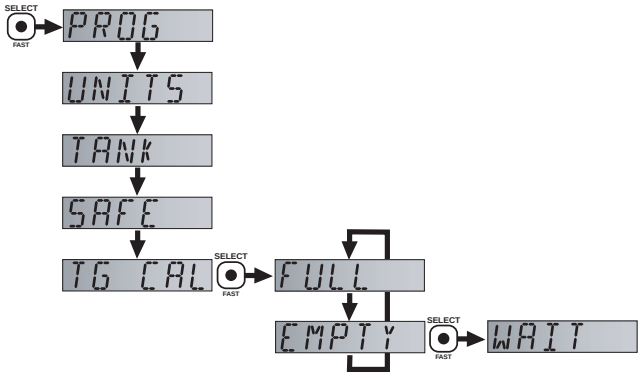
EMPTY: Target calibration technique that allows the user to enter the present distance from the transducer face to the liquid or a reflective target as the 4 mA (EMPTY) set point.



PROGRAMMING

Step Thirteen

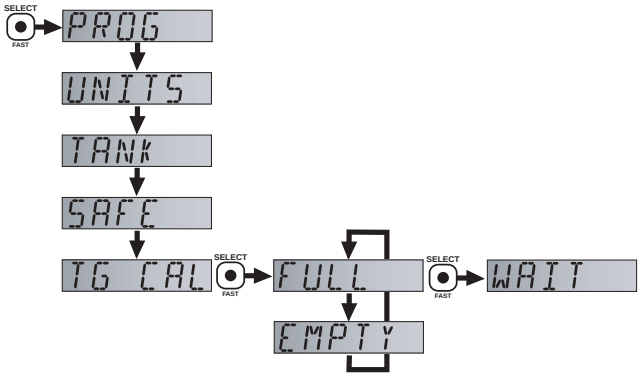
L. Programming TG CAL EMPTY Tank: With the tank EMPTY or the liquid in a low level state, apply power to the transmitter. Begin programming after WARMUP.



1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When TG CAL appears, press the SELECT/FAST button. The display will rotate between FULL and EMPTY.
3. When EMPTY appears, press the SELECT/FAST button. WAIT will be displayed followed by SAVED.

You have successfully programmed the EMPTY or 4 mA value.

M. Programming TG CAL FULL Tank: With the tank FULL, or the liquid in a high level state, apply power to the transmitter. Begin programming after WARMUP.



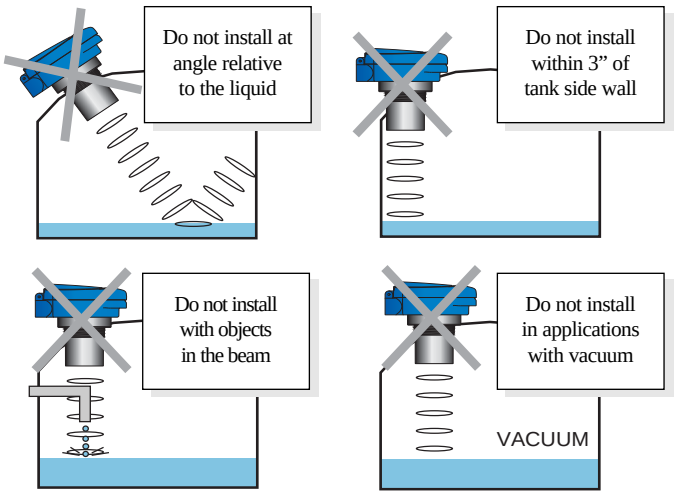
1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When TGCAL appears, press the SELECT/FAST button. The display will rotate between FULL and EMPTY.
3. When FULL appears, press the SELECT/FAST button, WAIT will be displayed followed by SAVED.

You have successfully programmed the FULL or 20 mA value.

Note: *The display will now indicate LEVEL height in the RUN mode.*

INSTALLATION

Step Fourteen

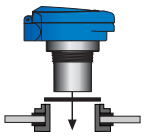


⚠ Warning ⚠

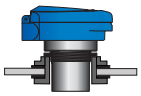
Omega ultrasonic transmitters have been optimized for use in non-metallic fittings. For best performance, avoid the use of metal fittings.

Install the appropriate installation fitting. Make sure that the fitting and transmitter threads are not damaged or worn. Install the transmitter with the included Viton mounting gasket. Hand tighten the transmitter within the fitting. Perform an installed leak test under normal process conditions prior to system start up.

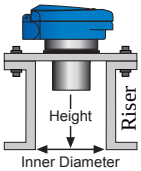
Gasket



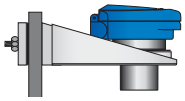
Adapter



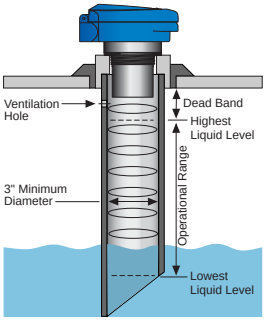
Flange



Bracket



Stand Pipe



A. Fitting Selection: Check the transmitter part number to determine the required 2" fitting thread type. The transmitter is commonly installed in tank adapters, flanges, brackets or stand pipes.

1. **Adapter:** Select a tank adapter fitting with minimal height so as to ensure that the installed transducer will not be substantially elevated into the fitting. Avoid tank adapter styles with threads and/or pipe stops forward of the installed transducer.

2. **Flange:** Tall flanges with narrow risers impede the acoustic signal. Select a fitting with the right riser height versus inner diameter geometry. The transmitter may be elevated up to 12" (30 cm) in a 6" (15 cm) riser, 8" (20 cm) in a 4" (10 cm) riser and 3" (7.6 cm) in a 2" (5 cm) riser.

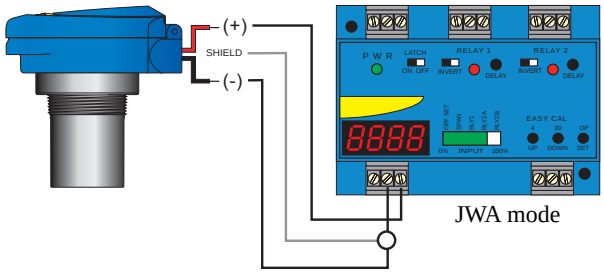
3. **Bracket:** The LVM-30 bracket or equivalent can be used for open tank top installations against the side wall.

4. **Stand Pipe:** A stand pipe may be used to dampen turbulence or separate surface foam. Select a minimum 3" pipe for the stand pipe. The pipe length should run the measurement span. Cut a 45° notch at the bottom of the pipe and drill a 1/4" pressure equalization hole high in the dead band.

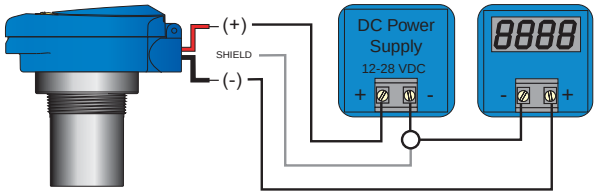
WIRING

Step Fifteen

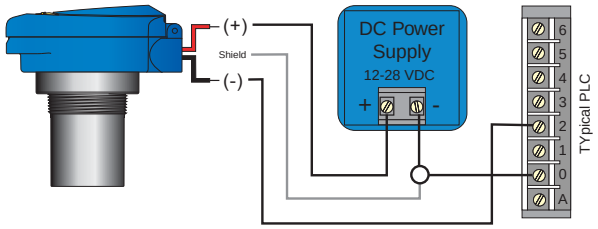
A. Wiring to a Omega LVCN-51 Controller



B. Wiring to a Typical Two-Wire Loop Powered Indicator



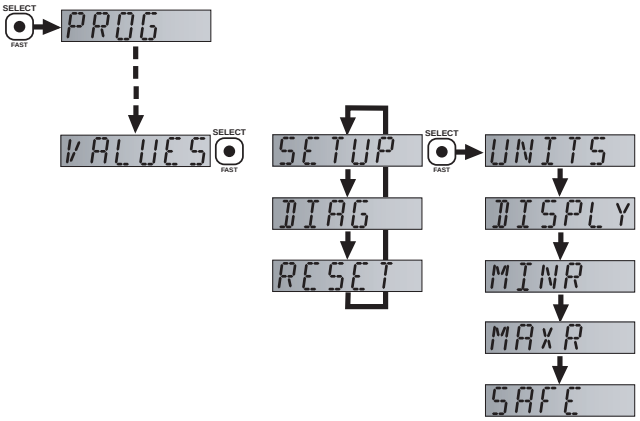
C. Wiring to a Typical Programmable Logic Controller



TROUBLESHOOTING

Step Sixteen

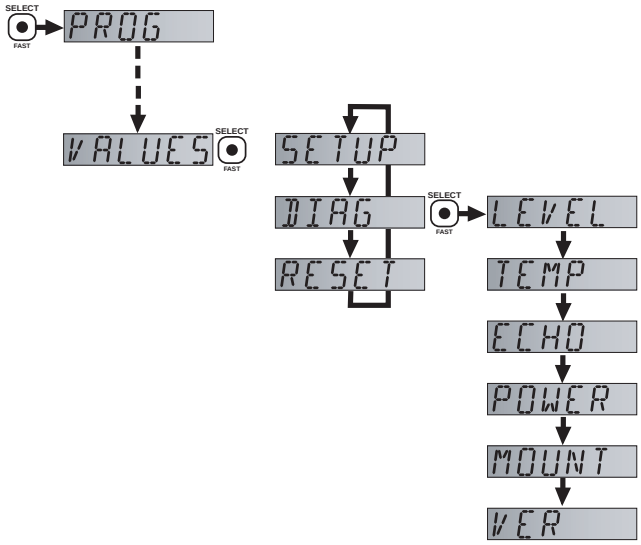
A. Viewing Programmed VALUES:



1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When VALUES appears, press the SELECT/FAST button. The display will rotate between SETUP, DIAG and RESET.
3. When SETUP appears, press the SELECT/FAST button. You will now begin viewing calibration settings (UNITS, Display, MinR, MaxR and SAFE) that are programmed in the transmitter.

When complete the display will revert back to the VALUES menu.

B. Viewing DIAGNOSTICS:



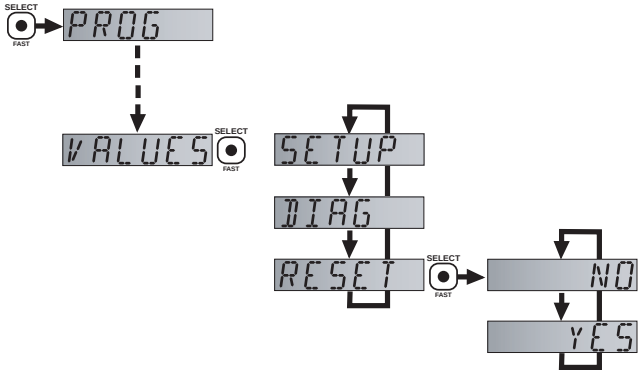
1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When VALUES appears, press the SELECT/FAST button. The display will rotate between SETUP, DIAG and RESET.
3. When DIAG appears, press the SELECT/FAST button. You will now begin viewing diagnostic values (LEVEL, TEMP ECHO, POWER, MOUNT and VER) that may be relevant to the transmitter and it's performance in your application.

When complete the display will revert back to the VALUES menu.

TROUBLESHOOTING

Step Seventeen

C. Factory RESET:



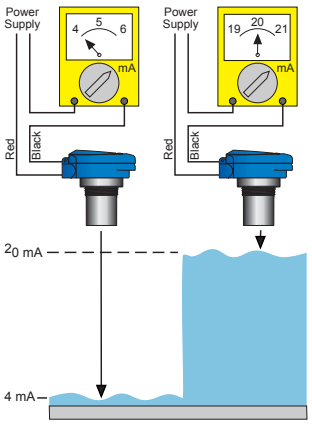
1. Press the SELECT/FAST button and hold it for 5 seconds until PROG appears.
2. When VALUES appears, press the SELECT/FAST button. The display will rotate between SETUP, DIAG and RESET.
3. When RESET appears, press the SELECT/FAST button. The display will rotate between YES or NO.
4. When YES appears, press the SELECT/FAST button.

Note: *FACTORY RESET resets the transmitter back to its original factory default settings: (20 mA = Minimum Range, 4mA = Maximum Range and SAFE = 22mA).*

D. Testing the Transmitter

Factory Set Points		
Transmitter	**4 mA Setting**	**20 mA Setting**
LVU816	16.4' (5m)	8" (10 cm)
LVU826	26.2' (8m)	8" (20 cm)
LVU832	32.8' (10m)	12" (30 cm)

1. Connect a multimeter in series with the black wire to read the current output.
2. Verify that the current increases (tank filling) and decreases (tank emptying) appropriately in the calibrated span.
3. If not, carefully observe and attempt to correlate any installation, level or application event for more specific troubleshooting.



4. Write down the information in DIAGNOSTICS (LEVEL, TEMP ECHO, POWER, MOUNT and VER) and have it ready when you contact your Flowline representative.

In-Situ Inc.

Level **TROLL**®

OPERATOR'S MANUAL

Level ***TROLL*** *300*
Level ***TROLL*** *500*
Level ***TROLL*** *700*
Baro ***TROLL***

March 2010

Revision history
Beta draft June 10, 2005 (Level TROLL 500)
Initial release, June 27, 2005
Rev. 001, August 17, 2005
Rev. 002, April 2006 (Level TROLL 300, 500, 700, BaroTROLL)
Rev. 003, September 2006
Rev. 004, March 2007
Rev. 005, September 2007
Rev. 006, March 2010

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(US & Canada)

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Images in this manual have been selected for illustration; actual images may vary from those shown.

In-Situ Inc.

Contents

1 INTRODUCTION

SYSTEM DESCRIPTION

Your new Level TROLL is a compact, modular system for measuring level and temperature in natural groundwater and surface water, as well as industrial, waste, and other installations. Components include the instrument body, vented and non-vented cables, communication cables, external power accessories, desiccants and other installation accessories, and software.

HOW TO USE THIS MANUAL

This operator's manual is designed as both a start-up guide and a permanent reference for the Level TROLL's features and applications.

Section 1: Introduction to the Level TROLL Operator's Manual and to In-Situ Inc. — Warranty Provisions — Instrument Repair & Return Recommendations

Section 2: Components and features of the Level TROLL system — Accessories — Product Specifications

Section 3: Getting Started — Select a TROLL Com — Install the Software — Connect the Hardware

Section 4: Using Win-Situ — Connecting for the First Time — Setting the Clock — Setting a Device Site — Preparing to Log Data —Disconnecting

Section 5: About the Pressure (Level) Sensor: The two basic types of pressure sensors — Factory and field calibration

Section 6: Field Installation — Guidelines and Precautions for Long-Term Deployment of the Level TROLL

Section 7: The BaroTROLL

Section 8: Connecting for use with SDI-12, Analog (4-20 mA), and Modbus loggers and controllers

Section 9: Care & Maintenance

Section 10: Troubleshooting

CONVENTIONS

Throughout this operator's manual you will see the following symbols.

The check mark highlights a tip about a convenient feature of the Level TROLL

The exclamation point calls your attention to a requirement or important action that should not be overlooked

CERTIFICATION

The Level TROLL complies with all applicable directives required by CE and the FCC and found to comply with EN 61326, ICES-003, and FCC Part 15 specifications. Declarations of conformity may be found at end of this manual.

UNPACKING AND INSPECTION

Your Level TROLL was carefully inspected before shipping. Check for any physical damage sustained during shipment. Notify In-Situ and file a claim with the carriers involved if there is any such damage; do not attempt to operate the instrument. Accessories may be shipped separately and should also be inspected for physical damage and the fulfillment of your order.

TIP: *Please save packing materials for future storage and shipping of your Level TROLL. The shipping boxes have been performance-tested and provide protection for the instrument and its accessories.*

SERIAL NUMBER

The serial number is engraved on the body of the Level TROLL. It is also programmed into the instrument and displayed when the instrument is connected to a computer running Win-Situ 5 or Win-Situ Mobile. We recommend that owners keep a separate record of this number. Should your Level TROLL be lost or stolen, the serial number is often necessary for tracing and recovery, as well as any insurance claims. If necessary, In-Situ maintains complete records of original owner's names and serial numbers.

TO OUR CUSTOMERS . . .

Thank you for your purchase of an In-Situ product. We are glad you chose us and our products to help you with your environmental monitoring needs. In-Situ Inc. has been designing and manufacturing world-class environmental monitoring instrumentation for over 25 years in the Rocky Mountains of the United States. As it was in the beginning, our expectation is that this product will provide you with many trouble-free years of use. To that end, we pride ourselves on delivering the best customer service and support possible—24 hours a day, 7 days a week. We believe that this level of commitment to you, our customer, is imperative in helping you ensure clean, safe groundwater and surface water resources across the globe. We also understand the need for accurate, reliable assessments and we continue to make significant investments in Research and Development to ensure that we deliver the latest product and technological innovations to support your needs.

Whether you are gathering information about your body of water for a few moments, or over a period of years, you can rely upon us to provide you with a quality product and outstanding customer support at a fair price and have that product delivered to you when and where you need it.

We want your experience with In-Situ Inc. to be pleasant and professional, whether you are renting from us, or purchasing from us. We would be pleased to hear from you and learn more about your needs, and your experiences with our products. Again, we thank you for choosing In-Situ Inc. and we look forward to serving your needs now, and in the future.

Bob Blythe, President and CEO
In-Situ Inc.
bblythe@in-situ.com

WHAT WE PROVIDE

WARRANTY PROVISIONS

In-Situ Inc. warrants the Level TROLL and BaroTROLL for one year from date of purchase by the end user against defects in materials and workmanship under normal operating conditions. To exercise this warranty contact Technical Support at the phone or e-mail address listed below for a return material authorization (RMA) and instructions. Complete warranty provisions are posted on our web site at www.In-Situ.com.

FIRMWARE & SOFTWARE UPGRADES

The Level TROLL is upgradable. Contact In-Situ Inc. for details.

TIP: *Maintenance & calibration plans as well as extended warranties are available for U.S. customers. Contact your In-Situ representative for more information.*

HOW TO CONTACT US

Technical Support:	800 446 7488
	Toll-free 24 hours a day in the U.S. and Canada
Address:	In-Situ Inc. 221 East Lincoln Ave. Fort Collins, CO 80524 USA
Phone:	970 498 1500
Fax:	970 498 1598
Internet:	www.in-situ.com
e-mail:	support@in-situ.com

TO OBTAIN REPAIR SERVICE (U.S.)

If you suspect that your Level TROLL is malfunctioning and repair is required, you can help assure efficient servicing by following these guidelines:

1. Call or e-mail In-Situ Technical Support (support@in-situ.com). Have the product model and serial number handy.

2. Be prepared to describe the problem, including how the instrument was being used and the conditions noted at the time of the malfunction.

TIP: *Please keep your RMA number for future reference.*

3. If Tech Support determines that service is needed, they will ask that your company pre-approve a specified dollar amount for repair charges. When the pre-approval is received, Tech Support will assign an RMA (Return Material Authorization) number.

4. Clean the Level TROLL and cable. Decontaminate thoroughly if it has been used in a toxic or hazardous environment. See the Cleaning Guidelines and form on page 13.

5. Carefully pack your Level TROLL in its original shipping box, if possible. Include a statement certifying that the instrument and cable have been decontaminated, and any supporting information.

6. Mark the RMA number clearly on the outside of the box with a marker or label.

7. Send the package, shipping prepaid, to

   In-Situ Inc.
   ATTN: Repairs
   221 E. Lincoln Ave.
   Fort Collins, CO 80524

The warranty does not cover damage during transit. We recommend the customer insure all shipments. Warranty repairs will be shipped back prepaid.

Outside the U.S.

Contact your international In-Situ distributor for repair and service information.

GUIDELINES FOR CLEANING RETURNED EQUIPMENT

If an instrument returned for servicing shows evidence of having been deployed in a toxic or hazardous environment, Customer Service personnel will require written proof of decontamination before they can service the unit.

Please help us protect the health and safety of our employees by cleaning and decontaminating equipment that has been subjected to any potential biological or health hazards, and labeling such equipment. Unfortunately, *we cannot service your equipment without such notification*. Please complete and sign the form on page 13 (or a similar statement certifying that the equipment has been cleaned and decontaminated) and send it along to us with each downhole instrument.

***TIP:** Alconox® is available from In-Situ Inc. (Catalog No. 29810).*

- We recommend a good cleaning solution, such as Alconox®, a glassware cleaning product available from In-Situ (Catalog No. 0029810) and laboratory supply houses.
- Clean all cabling. Remove all foreign matter.
- Clean cable connector(s) with a clean, dry cloth. Do not submerge.
- Clean the probe body—including the nose cone, cable head, and protective caps. Remove all foreign matter.

If an instrument is returned to our Service Center for repair or recalibration without a statement that it has been cleaned and decontaminated, or in the opinion of our Service Representatives presents a potential health or biological hazard, we reserve the right to withhold service until proper certification has been obtained.

Decontamination & Cleaning Statement

Company Name_____Phone _____

Address _____

City _____ State _____ Zip _____

Instrument Type_____Serial Number_____

Contaminant(s) (if known) _____

_____

Decontamination procedure(s) used _____

_____

Cleaning verified by_____ Title_____

Date_____

In-Situ Inc.

2 SYSTEM COMPONENTS

BODY

The completely sealed Level TROLL contains pressure and temperature sensors, real-time clock, microprocessor, sealed lithium battery, data logger, and memory. Options include a vented or non-vented pressure sensor in a variety of ranges.

There are no user-serviceable parts in the Level TROLL body.

CABLE

Several basic cable types are used in the Level TROLL system.

- RuggedCable® system, TPU-jacketed (Thermoplastic Polyurethane)
  - Vented or non-vented
  - Vented Tefzel®-jacketed cable (ETFE fluoropolymer)
- Poly-coated stainless steel suspension wire for deployment of a non-vented instrument
- Communication cables for programming the device/downloading the logged data

TIP: *Cable markings include VF = vent-free*

RuggedCable® Systems

Cable includes conductors for power and communication signals, a strength member, and a Kellems® grip to anchor the Level TROLL securely. Available in standard and custom lengths.

Uphole and downhole ends are identical “female” bayonet-type Twist-Lock connectors that mate with the Level TROLL body, TROLL Com communication cable, desiccants, and other accessories.

Vented cable is designed for use with vented pressure/level sensors (gauged measurements). The cable vent tube insures that atmospheric pressure is the reference pressure applied to the sensor diaphragm. Vented cable includes a small desiccant cap.

Non-vented cable may be used with non-vented pressure/level sensors (absolute measurements).

RuggedCable "Stripped & Tinned" Systems

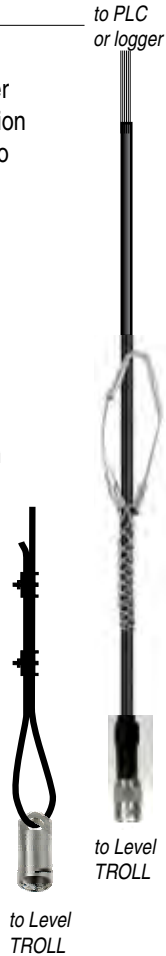
In place of the "uphole" Twist-Lock connector, this cable ends in bare conductors for wiring to a logger or controller using SDI-12, analog (4-20 mA), or Modbus communication protocols. Vented cable includes an outboard desiccant to protect against condensation.

Also available in a shorter length ending in a "male" Twist-Lock connector to mate with RuggedCable.

For connections, refer to wiring diagrams in Section 8.

Suspension Wire

Poly-coated stainless steel suspension cable is ideal for deployment of instruments with non-vented pressure sensors: Level TROLL 300, non-vented Level TROLL 500 or 700, and BaroTROLL.



Small Desiccant

Vented cable includes a clear cap of indicating silica gel desiccant to protect the cable and electronics from condensation. The desiccant is blue when active. It will absorb moisture from the top down and for best results should be replaced before the entire volume has lost its color. Replacements are available from In-Situ Inc. or your distributor.

Large Desiccant

The optional high-volume desiccant pack may last up to 20 times longer than the small desiccant in humid environments. It attaches to vented Level TROLL cable in the same way. Refill kits are also available from In-Situ Inc. or your distributor.

TIP: *Protect new desiccant from moisture until ready to use.*

Outboard Desiccant

Vented “stripped & tinned” cable includes an outboard desiccant pack attached to the cable vent tube. Same size as large desiccant. Replacements and refills are available.

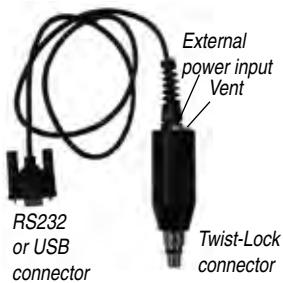
Accessory	Catalog No.
Small desiccant (3)	0052230
Large desiccant, ABS connector	0053550
Large desiccant, titanium connector	0051810
Outboard desiccant (replacement)	0051380
Refill kit for large & outboard desiccant	0029140

COMMUNICATION CABLES

TROLL Coms interface between a Level TROLL and a desktop/laptop PC or handheld PDA for profiling, calibrating, programming, and downloading. Both include 0.9 m (3 ft) vented polyurethane cable, external power input jack, and vent with replaceable membrane.

TROLL Com (Cable Connect)

Connects a Level TROLL's RuggedCable to a serial or USB port. Weatherproof, withstands a temporary immersion (IP67).



The computer connectors are not submersible.

TROLL Com (Direct Connect)

Connects a Level TROLL directly to a serial or USB port. A good choice for permanent connection to a PC, or for programming a non-vented Level TROLL that will be deployed without RuggedCable. Not submersible.

Accessory	Catalog No.
RS232 TROLL Com, Cable Connect	0056140
USB TROLL Com, Cable Connect	0052500
RS232 TROLL Com, Direct Connect	0056150
USB TROLL Com, Direct Connect	0052510

POWER COMPONENTS

INTERNAL POWER

TIP: Win-Situ 5 can display the approximate percentage of internal battery life remaining when the Level TROLL is connected to a computer.

The Level TROLL operates on 3.6 VDC, supplied by a completely sealed, non-replaceable AA lithium battery. Battery life depends on sampling speed. The battery is guaranteed for 5 years or 2,000,000 readings, whichever occurs first.

EXTERNAL POWER

External Battery Pack

The sealed, submersible TROLL Battery Pack (lithium) supplies 14.4 V. When this power source is connected, the Level TROLL will use the external battery source first and switch to the internal batteries when external battery power is depleted. Battery life depends on sampling speed.

0.5 sec sampling interval	1.2 months
1 sec sampling interval	2.3 months
1 min sampling interval or longer	1 year

TIP: When a Level TROLL is used as an Analog (4-20 mA), SDI-12, or Modbus device, power is supplied by the data logger or controller to which the Level TROLL is wired.

AC Adapter

In-Situ's AC adapter provides 24 VDC, 0.75 A, AC input 100-250 V, includes North American power cord. The Programming Cable includes an external power input for connection to this adapter.

Use only In-Situ's AC adapter. Damage to the Level TROLL caused by the use of third-party converters is not covered by the warranty.

Accessory	Catalog No.
External Battery Pack	0051450
AC Adapter 24V	0052440

INSTALLATION ACCESSORIES

NPT Adapter

Twist-Lock Hanger

Cable Extender

Well Dock

- 1/4" NPT Adapter: allows Level TROLL installation in piping
- Twist-Lock Hanger: titanium or stainless steel hanger to suspend a non-vented Level TROLL or BaroTROLL while taking data; no venting, no communication capabilities
- Cable Extender: connects two lengths of RuggedCable
- Well Docks: top-of-well support for 2", 4", or 6" well
- Well caps, locking and vented
- Panel-mounted bulkhead for connection to RuggedCable

Accessory	Catalog No.
NPT Adapter	0051470
Twist-Lock Hanger, titanium for Level TROLL 500, 700, Baro	0051480
Twist-Lock Hanger, stainless steel for Level TROLL 300	0055050
Cable Extender	0051490
Top-of-well installation ring	WELLDOCK2", 4", 6"
Locking Well cap, 2"	0020360
Locking Well cap, 2" vented	0020370
Locking Well cap, 4"	0020380
Locking Well cap, 4" vented	0020390
Bulkhead connector	0053240

Locking Well

Bulkhead connector

CONTROL SOFTWARE

Win-Situ® 5 is easy-to-use software for programming the Level TROLL.

Win-Situ provides instrument control for direct reads and profiling, long-term data logging, data downloads, data viewing, data export to popular spreadsheet programs, choice of units and other display options, battery/memory usage tracking, interface to networks and telemetry.

Minimum system requirements: 400 MHz Pentium® II processor, 128 Mb RAM, 100 Mb free disk space, Internet Explorer® 6.01 or higher, Windows® 2000 Professional SP4 or higher, or Windows XP Professional SP2 or higher, or Windows Vista SP1 or higher, CD-ROM drive, and a serial communications port.

Complete information on using the software is available from Win-Situ's Help menu.

Win-Situ® Mobile (formerly Pocket-Situ 5) provides Win-Situ's features and functions on a field-portable platform. Requirements: In-Situ RuggedReader® with Microsoft Windows Mobile® operating system (yellow RuggedReader, Pocket PC 2003 or later; blue RuggedReader, Windows Mobile 5 or later), serial communications port, and at least 16 Mb for data storage (SD card, CF card, or the device's built-in non-volatile memory). For installation and file exchange, Microsoft® ActiveSync® must be installed on an office desktop or laptop computer.

Accessory	Catalog No.
Win-Situ 5 (no license required)	0051980
Win-Situ Mobile license for RuggedReader	0047520
Win-Situ Mobile license (upgrade from Pocket-Situ 4)	0047550

PRODUCT SPECIFICATIONS

	Level TROLL 300	Level TROLL 500	Level TROLL 700
Operating Temperature	-20 to 80°C (-4 to 176°F)	-20 to 80°C (-4 to 176°F)	-20 to 80°C (-4 to 176°F)
Storage Temperature	-40 to 80°C (-40 to 176°F)	-40 to 80°C (-40 to 176°F)	-40 to 80°C (-40 to 176°F)
Dimensions			
O.D.	20.82 mm (0.82 in)	18.3 mm (0.72 in)	18.3 mm (0.72 in)
Length	22.9 cm (9.0 in)	21.6 cm (8.5 in)	21.6 cm (8.5 in)
Weight	0.24 kg (0.54 lb)	0.197 kg (0.43 lb)	0.197 kg (0.43 lb)
Material			
Housing	316L Stainless steel	Titanium	Titanium
Nose Cone	Black Delrin®	Black Delrin®	Black Delrin®
Output Options	RS232 (with TROLL Com), Modbus (RS485), SDI-12, 4-20mA	RS232 (with TROLL Com), Modbus (RS485), SDI-12, 4-20mA	RS232 (with TROLL Com), Modbus (RS485), SDI-12, 4-20mA
Power			
Internal Battery	3.6V lithium	3.6V lithium	3.6V lithium
Battery Life	5 yrs or 2M readings*	5 yrs or 2M readings*	5 yrs or 2M readings*
External Power	8-36 VDC	8-36 VDC	8-36 VDC
External Battery	14.4 V lithium	14.4 V lithium	14.4 V lithium
Real-Time Reading Rate	1 per second	1 per second	1 per second
Memory/Data Points**	1 MB / 50,000	2 MB / 100,000	4 MB / 350,000
Fastest Logging Rate	1 per second	2 per second	4 per second
Max. no. of logs	2	50	50
Log Types	Linear, Fast Linear, Event	Linear, Fast Linear, Event	Linear, Fast Linear, Event, Linear Average, Step Linear, True Logarithmic
Real-Time Clock	all models: accurate to 1 second per day		

** 1 reading = time plus all available parameters read from device or logged*

*** 1 data point = time plus one parameter in a data log*

	Level TROLL 300	Level TROLL 500	Level TROLL 700
Pressure/Level Sensor			
Type	Silicon strain gauge	Silicon strain gauge	Silicon strain gauge
Material	Stainless steel	Titanium	Titanium
Accuracy*			
@ 15°	± 0.1% FS	± 0.05% FS	± 0.05% FS
0 to +50°C	± 0.1% FS	± 0.1% FS	± 0.1% FS
-20 to 0 & +50 to +80°C	± 0.25% FS typical	± 0.25% FS typical	± 0.25% FS typical
Resolution	± 0.01% FS or better	± 0.005% FS or better	± 0.005% FS or better
Range			
Non-Vented (PSIA)	30, 100, 300	30, 100, 300, 500	30, 100, 300, 500
Vented (PSIG)	—	5, 15, 30, 100, 300, 500	5, 15, 30, 100, 300, 500
Max. pressure	2X range	2X range	2X range
Burst pressure	3X range	3X range	3X range
Temperature Sensor			
Material	Silicon	Silicon	Silicon
Accuracy	± 0.3°C	± 0.1°C	± 0.1°C
Resolution	0.1°C	0.01°C	0.01°C

** FS = full scale. Accuracy with 4-20 mA output option: ± 0.25% FS typical*

Range and Usable Depth

Non-Vented Level TROLL

Range	Effective Range		Usable Depth	
PSIA	PSIA	kPa	Meters	Feet
30	15.5	106.9	0–10.9	0–35.8
100	85.5	589.5	0–60.1	0–197.3
300	285.5	1968	0–200.7	0–658.7
500	485.5	3347	0–341.3	0–1120
1000	985.5	6795	692.9	0–2273
** At sea level (14.5 PSI atmospheric pressure).*				

Vented Level TROLL

Range		Usable Depth	
PSIG	kPa	Meters	Feet
5	34.5	0–3.5	0–11.5
15	103.4	0–11	0–35
30	206.8	0–21	0–69
100	689.5	0–70	0–231
300	2068	0–210	0–692
500	3447	0–351	0–1153

BaroTROLL

Same as Level TROLL 500 specs, **except** Pressure Range: 0 to 16.5 PSIA (1.14 bar, 33.59 in Hg) Max. no. of Logs: 2. Log Types: Linear. Fastest Logging Rate: 1 per minute

Cable

Jacket options	Polyurethane, Tefzel®
Connector	Titanium, 18.5 mm (0.73 in) O.D.
Conductors	6 conductors, 24 AWG, polypropylene insulation
Diameter	6.7 mm (0.265 in)
Break strength	127 kg (280 lb)
Minimum bend radius (vented cable)	2X cable diameter (13.5 mm, 0.54 in)
Weight	Vented: 14 kg/300 m (32 lb/1000 ft) Non-vented: 16 kg/300 m (35.6 lb/1000 ft) Vented Tefzel: 14 kg/300 m (32 lb/1000 ft)]

Suspension Wire

Material	304 stainless steel, 7 x 7 strand
Coating	15 mil polyester elastomer insulation
Weight	0.28 kg /30 m (0.60 lb/100 ft)
Break strength	122 kg (270 lb) with proper tightening of clips

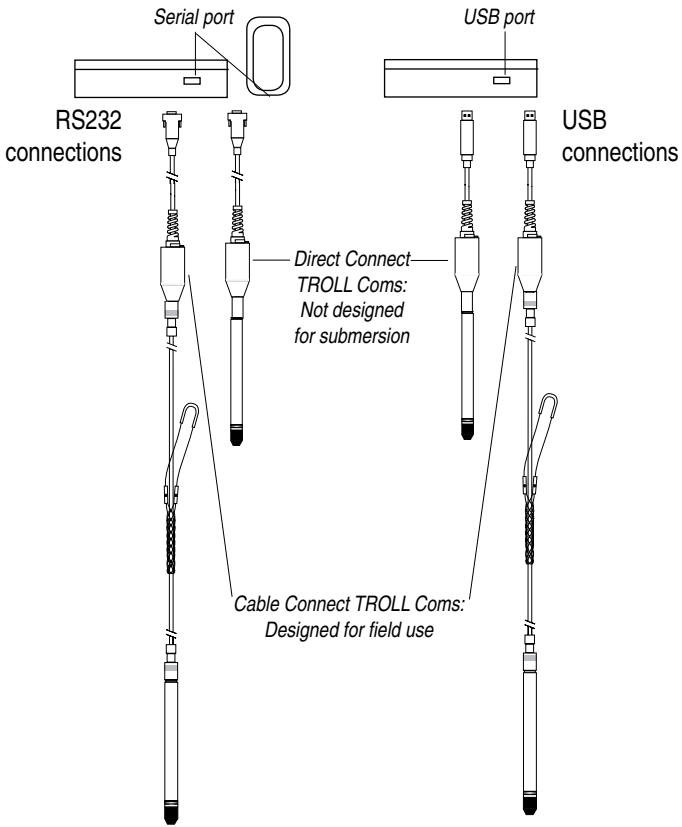
3 GETTING STARTED

This section provides a quick overview of the initial steps necessary to get the instrument ready to log data.

- Select the appropriate TROLL Com for communication. This determines the hardware connections, and may influence the software installation. The drawing on the following page shows the function of the different TROLL Com models.
- Install the software.
- Connect the hardware, based on the selected TROLL Com.
- Launch the software and establish communication with the Level TROLL. See Section 4 of this manual for an overview of Win-Situ operations.

SELECT A TROLL COM FOR COMMUNICATION

The figure below shows the function and connectability of the different models of TROLL Com.



TIPS: *A Direct Connect TROLL Com may be preferred for programming a Level TROLL that will be deployed on wire.*

RuggedCable and a Cable Connect TROLL Com are required for communication with the device while deployed, but programming can be done with any TROLL Com connection.

An RS232 (serial) TROLL Com is needed for use with a RuggedReader.

INSTALL THE SOFTWARE

WIN-SITU 5

TIP: If using a USB TROLL Com, be sure to select the option "Install USB TROLL Com Drivers" when installing Win-Situ 5.

Install Win-Situ 5 from the In-Situ software/resource CD or from the In-Situ web site:

- Click on Win-Situ 5, and follow the instructions to install Win-Situ 5 to your local hard drive.

USB TROLL COM DRIVERS

- If using a USB TROLL Com, be sure to select the option "Install USB TROLL Com Drivers." Two drivers will be loaded to your hard drive, one for the USB TROLL Com, one for the USB TROLL Com serial port.

WIN-SITU MOBILE

TIP: Insure Microsoft ActiveSync is installed on the desktop or laptop PC and a Guest connection or partnership has been established between the computers.

For communication using a RuggedReader handheld in the field, install the desktop component of Win-Situ Mobile on a desktop/laptop PC from the CD or web site: The desktop component is called the Win-Situ Software Manager, and is needed to install Win-Situ Mobile on the RuggedReader.

- Click on Win-Situ Mobile and follow the instructions to install the Win-Situ Software Manager to your local hard drive.

When convenient, connect the RuggedReader to the PC, establish a connection in Microsoft ActiveSync®, launch the Win-Situ Software Manager, and follow the instructions to install Win-Situ Mobile on the RuggedReader.

WIN-SITU SYNC

If you plan to synchronize log files from the RuggedReader to a PC after collecting data in the field, install Win-Situ Sync from the CD or web site.

CONNECT THE HARDWARE

TIP: If you need more information on the twist-lock connectors, refer to the topic Twist-Lock Cable Connections later in this section.

1. Connect the Aqua TROLL to the selected TROLL Com as illustrated earlier in this section.
   - **Direct Connect:** Attach via snap-on connection to the Aqua TROLL back end.
   - **Cable Connect:** Mate the Twist-Lock connectors on the Aqua TROLL and the RuggedCable.
2. Plug the TROLL Com into the computer.

USB TROLL COM

When you plug in a USB TROLL Com, the USB drivers that were downloaded when you installed Win-Situ 5 will be installed as follows:

- **Windows 2000, Windows Vista:** When new hardware is detected, the drivers are installed automatically.
- **Windows XP:** Follow the instructions in the Found New Hardware Wizard. Select the option “Install Software Automatically.”

Remember the COM port number. You will need it when connecting to the Level TROLL in Win-Situ.

After installation, check as follows to find which COM port the connected USB TROLL Com is using:

- **Windows 2000, Windows XP:** Control Panel > System > Hardware tab > Device Manager > Ports. Click the plus sign to display the ports.
- **Windows Vista:** Control Panel > System > Device Manager (Administrator permission required) > Ports. Click the plus sign to display the ports.

After connections are made, you are ready to launch the software and program the Aqua TROLL. Section 4 of this manual is an overview of Win-Situ. For more detailed information, see Win-Situ’s Help menu.

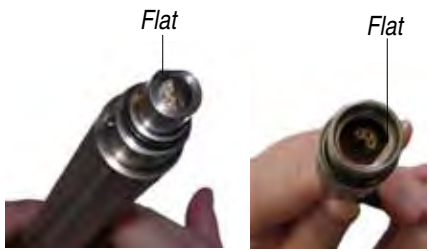
TWIST-LOCK CABLE CONNECTIONS

1. Remove the protective caps from the Level TROLL and cable.

Level TROLL (or TROLL Com) *Cable*

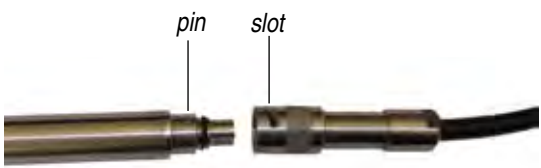
TIP: *Retain the dust caps to protect the pins and o-ring from damage when cable is not attached.*

2. Take a moment to look at the connectors. Each has a flat side.



Level TROLL (or TROLL Com) *Cable*

Note the pins on the body connector (one on each side) and the slots on the cable connector (one on each side).



3. Slide back the sleeve on the cable connector.

4. Orient the “flats” so they will mate up, and insert the Level TROLL connector firmly into the cable connector.

Level TROLL *Cable*

5. Slide the sleeve on the cable toward the Level TROLL body until the pin on the body pops into the round hole in the slot on the cable connector.

Level TROLL *Cable*

6. Grasp the knurled (textured) section of the cable connector in one hand and the Level TROLL body in the other. Push and twist firmly so that the pin on the body connector slides along the slot on the cable connector and locks securely into the other hole.

Be sure you hear the "click." The "click" ensures the cable is securely attached.

Level TROLL *Cable*

To attach a Cable Connect TROLL Com, first remove the desiccant from the free end of cable: Grasp the knurled (textured) section of the cable connector in one hand and the desiccant in the other. Twist in opposite directions to unlock the desiccant from the cable.

Remember to re-install the desiccant before deploying the device.

Orient the "flats" so they will mate up, and insert the TROLL Com connector firmly into the cable connector.

Push, twist, and click to lock.

4 USING WIN-SITU

Win-Situ® 5 software is In-Situ's instrument control software for Level TROLLs. Use Win-Situ software to

- display real-time readings from the connected Level TROLL, in meter, tabular, or graphic format
- program the device to log data; download the logged data
- customize the output of a pressure/level sensor to record drawdown, surface water elevation, gauge height, stage height, etc.
- set communication options in the device—Modbus, SDI-12, analog, IP, telemetry, etc.

TIP: *Win-Situ® Mobile software provides Win-Situ's features and functionality in a convenient field-worthy platform.*

LAUNCH THE SOFTWARE AND CONNECT TO THE LEVEL TROLL

1. Start Win-Situ by double-clicking the shortcut  created on the desktop during installation.

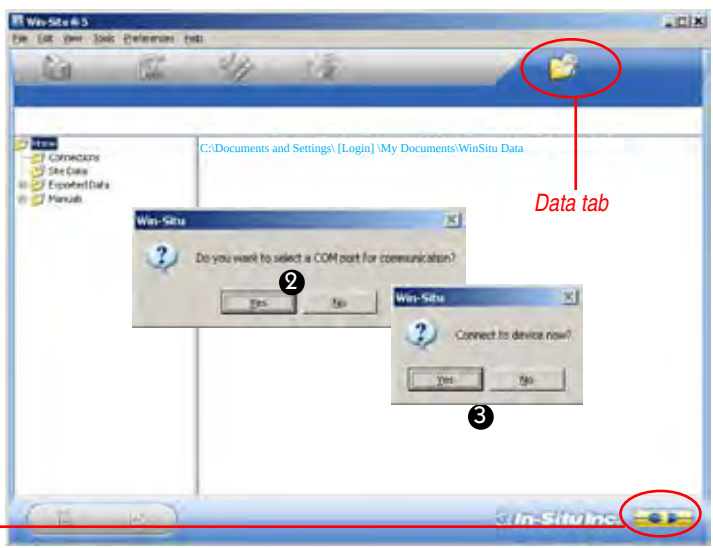
Win-Situ launches and displays the Data area ("tab") shown below.

2. Check the COM port. When you launch for the first time, the software may ask if you want to select a COM port. Do one of the following:
   - Answer Yes to the prompt, then check or change the port in the Comm Settings dialog, and click OK to close it, or
   - Answer No to bypass this step.
3. Win-Situ asks if you want to connect to the Level TROLL (the "device"). If the Level TROLL is connected to your computer as described in the previous section, answer Yes.

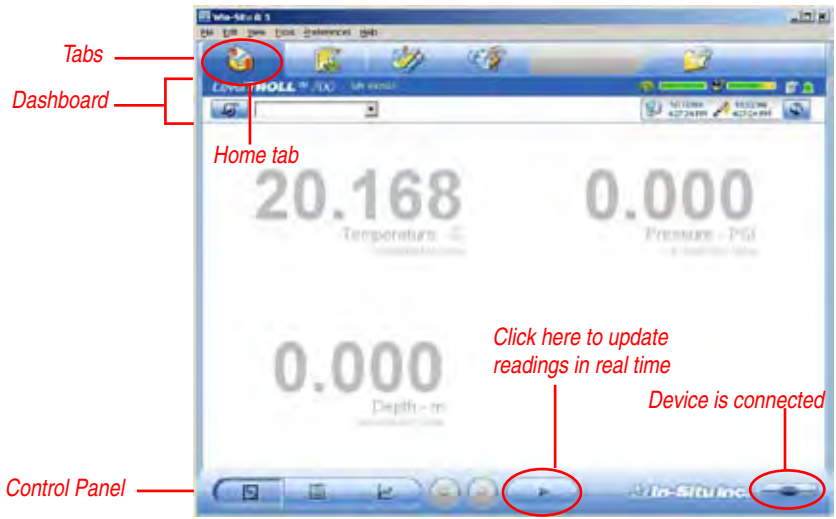
TIP: *For direct serial connection the port is usually COM 1. This is Win-Situ's default.*

For USB communication, be sure to select the correct COM port.

TIP: *You can turn off the "Connect now?" prompt: Select Preferences menu > General Settings, deselect "Prompt for connect at startup," click OK. In this case, connect to the device by clicking the Connect button*



4. Software connects and displays a reading of all supported parameters.



THE HOME SCREEN

- Note the **Tabs** at the top of the screen— this is the Home tab, which displays current readings from the connected device.
- The **Dashboard** (status area) shows device model and serial number, battery and memory usage, clock, alarms, and logging status.
- The **Control Panel** contains action buttons. To update the readings in real time press  .

  Note: When this button looks "pressed in"  , polling is active. Before you can perform certain software tasks, you will need to stop polling by pressing the button again.

CUSTOMIZING THE HOME SCREEN DISPLAY

Changing Units

1. Click the Senors tab  , select the level/pressure sensor.
2. Click the Configure button  in the control panel.
3. In the Sensor Setup screen, select a parameter, then select a unit. Repeat for each parameter as necessary.
4. Click OK  to change the units and return to the Sensors tab.

Changing the Rate at Which the Readings Update

Also called the “poll rate,” this can range from 1 to 30 seconds.

1. Select Preferences menu > Home View Settings.
2. Adjust the Poll Rate. Default: 5 seconds.

Changing the Decimal Places Displayed

To change the number of decimal places displayed for each reading:

1. Select Preferences menu > General Settings.
2. Under Parameter Defaults, select a parameter, then the significant decimal digits for each parameter.

Real-Time Graphing

To view a real-time trend graph: click the graph button 

To view a graph with a data table below it, select Preferences menu > Graph Settings. Check ☑ the Data Panel option. Click OK.

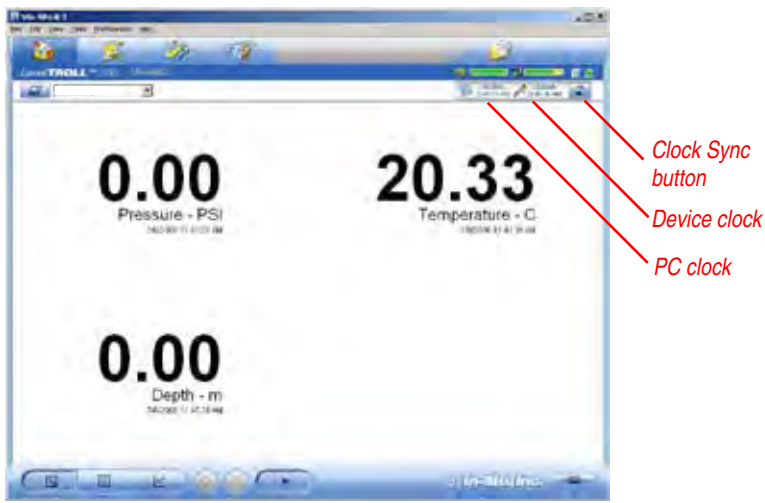
Now you're ready to give the Level TROLL some specific information through the software. Win-Situ provides many options. At a minimum:

- set the Level TROLL clock
- enter a name for the site where the Level TROLL will collect data
- enter data logging instructions

A brief overview is provided here. For more detailed information, see Win-Situ's Help menu.

SET THE CLOCK

Data collection schedules depend on the device's real-time clock. Both the device clock and the system (PC) clock are shown on the dashboard. The clocks update every 2 seconds. If the device clock differs by more than 2 seconds from the system clock, the device clock is displayed in red. To synchronize the clocks, click the Sync button.



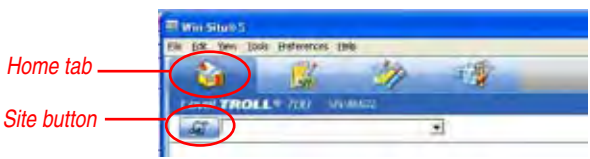
ADD A NEW SITE

TIP: A default site is supplied and may be used, but it does not contain any specific information on the location where the Aqua TROLL collected data. For more information on sites, see Win-Situ's on-line help.

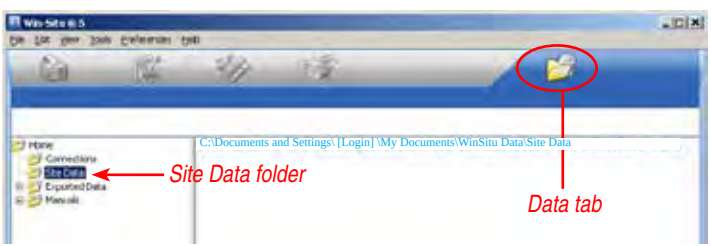
Logged data are organized and filed by the **site** where the data were logged. This feature can help you manage data from multiple sites. You can create as many sites as you like, with or without a Level TROLL connected. Sites are stored in the site database in your Win-Situ working directory and are available to select for any Level TROLL, any log.

You will need a site when setting up a data log. To set up a new site:

1. Do one of the following:
   - With a device connected: On the Home tab, click the Site button on the dashboard. When the Site List is displayed, click the "New"  button.



   - With or without a device connected: On the Data tab, click the Site Data folder, select File menu > New > Site.

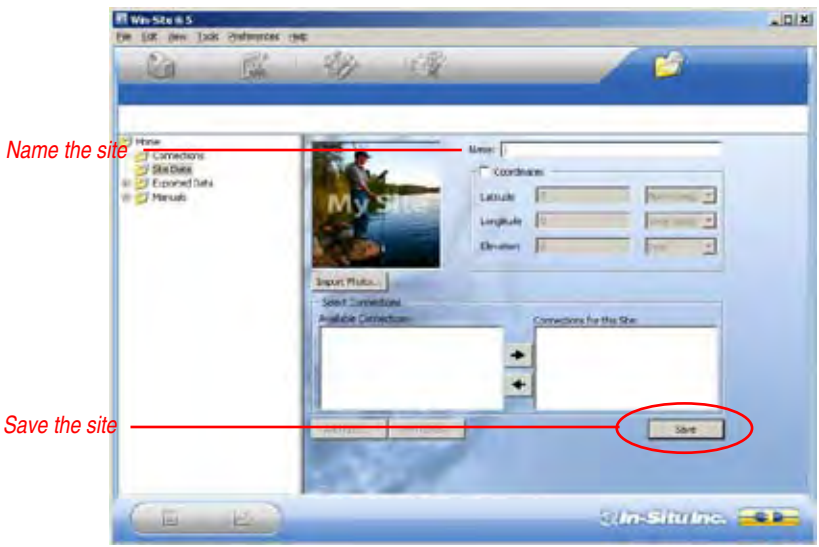


2. In the next screen, enter a short—up to 32 characters—descriptive site name, such as a project, well, water body, gauging station, town, etc.

   A name the only required field, but there are many additional options for identifying a site. To include site Coordinates, check ☑ Coordinates, then enter Latitude (0.00 to 90.00, North or South), Longitude (0.00 to 180.00, East or West), and Elevation (Feet or Meters). You can import a site Photo (bitmap) and/or select a custom Connection, if any have been defined.

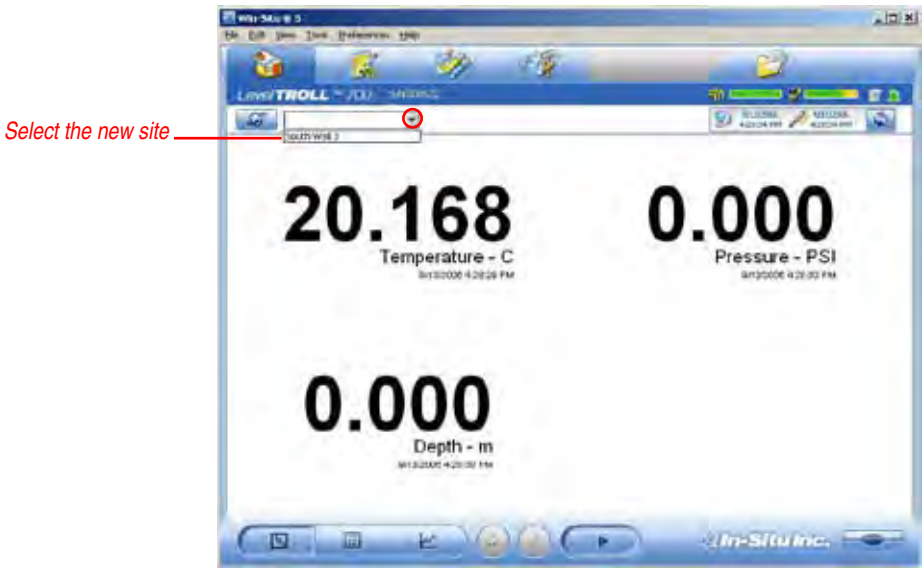
3. When finished, click **Save** or click OK twice to save the site.

TIP: *The site coordinates are optional. They are used to uniquely identify a data site. They are not used elsewhere by the software.*



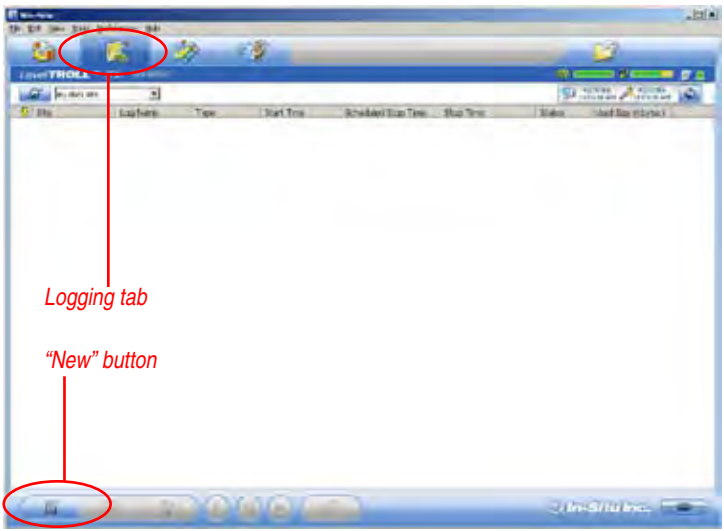
4. In the Home tab, click the down arrow beside the site box, and select your new site.

   This site now becomes the “current” site for the connected Level TROLL, and is available to use in data logs.



PREPARE TO LOG DATA

1. To program the device to log data, first select the Logging tab.
2. Click the "New" button.



TIP: *For more complete information on setting up data logs, see Win-Situ's Help menu.*

TIP: *For a Level TROLL 300 or other non-vented Level TROLL that will be deployed on wire, be sure to select a Scheduled Start so the log will start by itself, without a communication connection.*

The Logging Setup Wizard will prompt you through the configuration of a data log—including the site, log name, parameters to measure, sample schedule, start time, stop time, output (depth or level), and other options. For details on setting the pressure sensor output, refer to Win-Situ's Help menu, or Section 5 in this manual.

To Start logging:

- A “Pending” (scheduled) log will start at its programmed time
- You can start a “Ready” (manual) log at any time while connected by selecting the log and pressing “Start”

To Stop logging:

- Select the log and press the “Stop” button
- Or suspend (temporarily stop) it with the “Pause” button

To Download the log to the connected PC:

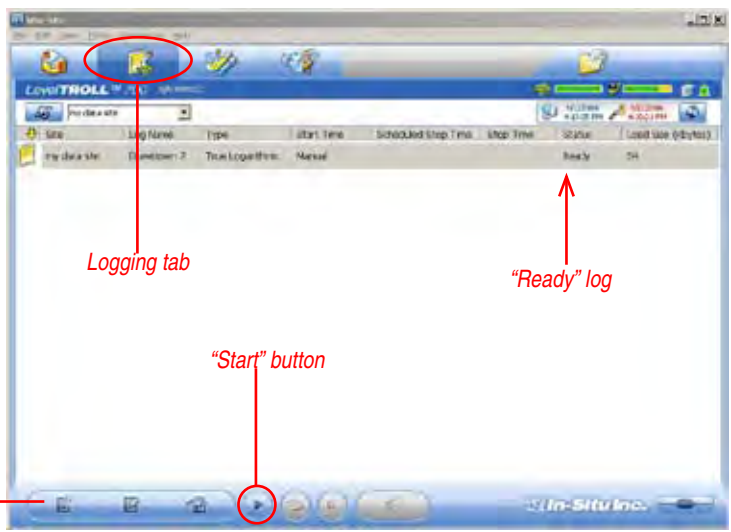
- Select the log and press the “Download” button

To View the log after downloading:

- Go to the Data tab and select the log; for a graph press

TIP: *As an alternative to the log control buttons, right-click a log to display a short context menu of available actions.*

TIP: *The available log control buttons will vary depending on the status of the log selected.*



DISCONNECT

After the Level TROLL is programmed to log data, you're ready to

- Exit the software (File menu > Exit).
- Disconnect the TROLL Com from the cable connector, by grasping the knurled (textured) section of the cable connector in one hand and the TROLL Com in the other. Twist in opposite directions to unlock the TROLL Com from the cable.

Be sure to remove the desiccant dust cap (if present) before deployment to allow air to reach the cable's vent tube.

- Vented cable: Attach desiccant to the cable connector—line up the flat sides of the connectors, push, twist, and click to lock the desiccant to the cable. Remove red dust cap (if present) from the desiccant's vent.
- Non-vented Level TROLL or BaroTROLL: Attach a Twist-Lock hanger to prevent flooding, and suspension wire (if using).
- Install the instrument in its field location. See Section 6 for guidelines.

5 ABOUT THE PRESSURE/ LEVEL SENSOR

A pressure transducer senses changes in pressure, measured in force per square unit of surface area, exerted by water or other fluid on an internal media-isolated strain gauge. Common measurement units are pounds per square inch (PSI) or newtons per square meter (pascals).

NON-VENTED (ABSOLUTE) VS. VENTED (GAUGED) SENSORS

A non-vented or “absolute” pressure sensor measures all pressure forces exerted on the strain gauge, including atmospheric pressure. Its units are **PSIA** (pounds per square inch “absolute”), measured with respect to zero pressure.

Non-vented pressure measurements are useful in vacuum testing, in short-term testing when atmospheric pressure would not be expected to change, in very deep aquifers where the effects of atmospheric pressure are negligible, and in unconfined aquifers that are open to the atmosphere.

TIP: *For more on the differences between Absolute (non-vented) and Gauged (vented) sensors, see the technical note on the In-Situ software/ resource CD, or the Downloads section of the In-Situ web site at www.In-Situ.com.*

With vented or "gauged" pressure sensors, a vent tube in the cable applies atmospheric pressure to the back of the strain gauge. The basic unit for vented measurements is **PSIG** (pounds per square inch "gauge"), measured with respect to atmospheric pressure. Vented sensors thus exclude the atmospheric or barometric pressure component.

This difference between absolute and gauged measurements may be represented by a simple equation:

$$P_{gauge} = P_{absolute} - P_{atmosphere}$$

PRESSURE, DEPTH, AND LEVEL

Output options for pressure measurement are completely software-selectable. Each log configuration presents the following choices:

- Pressure in PSI or kPa
- Depth in feet or meters
- Water Level with a reference (an "offset")
  - Surface Elevation reference
  - Depth to Water (drawdown) reference

Pressure is a simple check box. For depth or level, the software presents additional options:

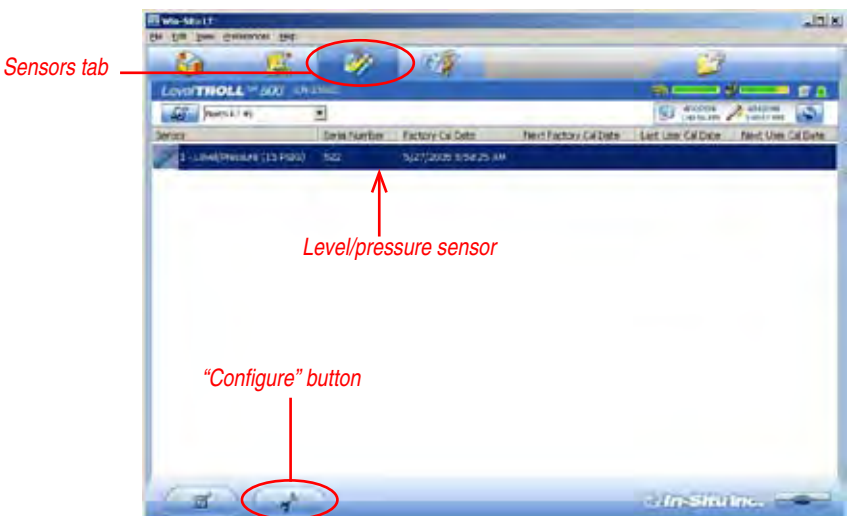
- The type of Level measurement you wish to log
- The Level Reference you wish to use
- The type of water you will be monitoring in (fresh, brackish, or saline). Or choose the **Advanced** button for a pressure-to-level conversion that compensates pressure readings for fluid density, latitude, and elevation

CONFIGURING DEPTH AND LEVEL

TIP: When you configure level using the Sensors tab, the settings are stored in the Level TROLL and are available for use in Modbus, SDI-12, and analog communications, as well as in Win-Situ. Different configuration may be selected when setting up a log.

This procedure stores the configuration settings in the Level TROLL. When setting up a log, the same options are presented.

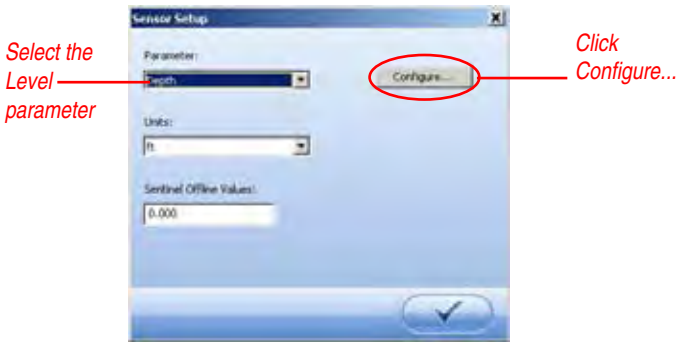
1. While connected to the Level TROLL in software, click the Sensors tab.
2. Select the level/pressure sensor and click the "Configure" button  . (Not available for a BaroTROLL.)



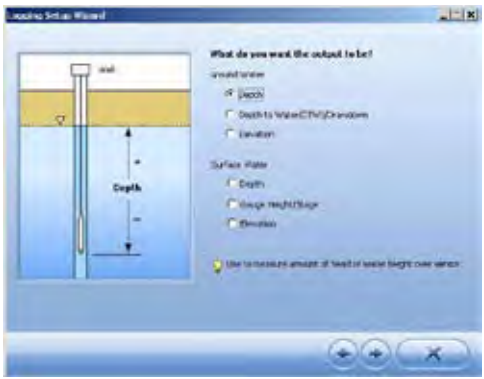
TIP: *The Level TROLL measures three parameters—Pressure, Temperature, and Level—on one sensor. A BaroTROLL does not measure Level, so the Configure option is not available.*

3. In the Sensor Setup window, select the Level parameter, then click **Configure...**

   The Level parameter shown is the one currently stored in the device (device's default or the most recent choice). You will have a chance to change this in a moment.



4. In the Level Setup Wizard, select the options you want. Each choice includes an illustration. For more information, see Win-Situ Help.



PRESSURE SENSOR CALIBRATION

FACTORY RECALIBRATION

Pressure sensor accuracy can be adversely affected by improper care and handling, lightning strikes and similar surges, exceeding operating temperature and pressure limits, physical damage or abuse, as well as normal drift in the device's electronic components. Aside from damage to the sensor, the need for factory recalibration is dependent upon the amount of drift a customer is willing to tolerate. Factory calibration every 12-18 months is recommended. Contact In-Situ Customer Service for information on the factory maintenance and calibration plan.

FIELD RECALIBRATION

The following procedure may be used, **with caution,** to "zero" the offset of a vented pressure sensor to correct for electronic drift. The drifted offset is visible when the sensor is in air and reading other than zero.

TIP: *Field recalibration is not available for a BaroTROLL.*

It is recommended you **do not** zero the offset if it is outside the specified accuracy of your pressure sensor, as shown in the table below. If the reading in air deviates from zero by more than the amounts shown, you may want to consider a factory recalibration.

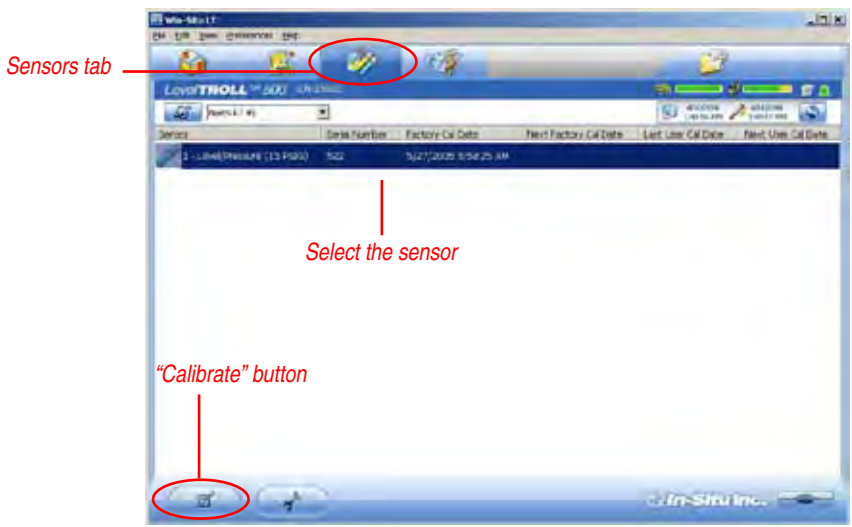
Sensor range	Accuracy (-5°C to +50°C)	Acceptable Offset from zero
5 PSI	± 0.1% FS	± 0.005 PSI
15 PSI	± 0.1% FS	± 0.015 PSI
30 PSI	± 0.1% FS	± 0.03 PSI
100 PSI	± 0.1% FS	± 0.10 PSI
300 PSI	± 0.1% FS	± 0.30 PSI
500 PSI	± 0.1% FS	± 0.50 PSI

Field Recalibration Procedure

1. With the Level TROLL connected in software, select the **Sensors** tab.
2. Select the pressure sensor and click the **Calibrate** button.

   You will be prompted to ensure the device is in air.
3. With the device in air, click **Calibrate**.

The current pressure reading will be set to zero.



BAROMETRIC COMPENSATION OF NON-VENTED PRESSURE/LEVEL DATA USING BARO MERGE™

Win-Situ Baro Merge can post-correct absolute (non-vented) level sensor data to eliminate barometric pressure from the measurements. Or it can be used with gauged (vented) level sensor data to calculate barometric efficiency.

Baro Merge provides 3 options:

- Fixed Correction – A single offset value is applied to all selected log data. Use this option if you know what the barometric pressure was during the log, and it did not change
- Manual Entry – Specify 2 or more correction values to apply to the log data. Use this option if you know that barometric pressure changed during the log
- BaroTROLL log file – Absolute level sensor data are corrected by barometric pressure values logged by an In-Situ BaroTROLL during the same general time period

Launching Baro Merge

Baro Merge may be launched as a stand-alone application from the program group In-Situ Inc., or accessed from Win-Situ's Tools menu when both are installed on the same system.

Input

In the Fixed Correction and Manual Entry options, it is important to know the barometric pressure for the general time period covered by the log or logs you want to correct.

Baro Merge uses a Wizard-like interface consisting of three main steps:

1. First, choose the type of compensation/correction that you wish to use.
2. Then, choose the absolute (non-vented) log file or files that you wish to correct. Baro Merge displays these automatically.
3. Click OK and the barometric compensation is applied.

Output

Your original log file is not changed. A new, corrected log file with the same name and path is created. The original ".wsl" extension is replaced by "-BaroMerge.wsl".

For help on using Win-Situ Baro Merge, press F1 at any Baro Merge screen.

For more detailed information on barometric compensation see the technical notes on the In-Situ software/resource CD, or the Downloads section of the In-Situ web site at www.In-Situ.com.

6 FIELD INSTALLATION

POSITION THE LEVEL TROLL

Lower the Level TROLL gently to approximately the desired depth. Position the instrument below the lowest anticipated water level, but not so low that its range might be exceeded at the highest anticipated level. Refer to the tables below for usable depth.

Note that a BaroTROLL is not designed for submersion. Position it above water level near a submerged Level TROLL.

Non-Vented Level TROLL

Range	Effective Range		Usable Depth	
PSIA	PSIA	kPa	Meters	Feet
30	15.5	106.9	0–10.9	0–35.8
100	85.5	589.5	0–60.1	0–197.3
300	285.5	1968	0–200.7	0–658.7
500	485.5	3347	0–341.3	0–1120
1000	985.5	6795	692.9	0–2273
** At sea level (14.5 PSI atmospheric pressure).*				

Vented Level TROLL

Range		Usable Depth	
PSIG	kPa	Meters	Feet
5	34.5	0–3.5	0–11.5
15	103.4	0–11	0–35
30	206.8	0–21	0–69
100	689.5	0–70	0–231
300	2068	0–210	0–692
500	3447	0–351	0–1153

Kellems grip

CHECK THE INSTRUMENT'S DEPTH

At this point, if convenient, you can connect the Level TROLL to a PC, launch the software, and take a reading. If the instrument is at the desired depth, secure it in position as suggested below. If not, reposition the Level TROLL as necessary.

If you requested the software to "Remind me later" to set a Level Reference, enter the level reference after installation when prompted.

SECURE THE CABLE

The RuggedCable has a handy device called a Kellems® grip near the surface end. You can slide it along the cable to the desired position by compressing it. When you pull on it, it tightens and stops sliding. You may need to pull on both ends of the Kellems grip to properly tighten it and keep it from slipping.

Use the loop of the Kellems grip to anchor the cable to a convenient stationary object. It works well with In-Situ's "well dock" installation ring. Simply insert the loop into the locking clip on the well dock, and position the assembly on the top of a well.

INSTALLATION TIPS

- Never let a probe "free fall" down a well. The resulting shock wave when it hits the water surface can damage the strain gauge (the "waterhammer" effect).
- It is always wise to check the level of water above the probe, then move it and read again to be sure that the probe is giving a reasonable reading and showing change. It might not

be located where you think it is — for example, it could be wedged against the casing with a loop of cable hanging below it. A probe in such a position might become dislodged and move while logging, giving a false change in level. *A secure placement is critical to accurate measurements.*

The minimum bend radius for vented cable is 13.5 mm (0.54 in).

- Do not allow the vented cable to kink or bend. If the internal vent tube is obstructed, water level measurements can be adversely affected. The recommended minimum bend radius is 13.5 mm (0.54 in), which is twice the cable diameter.

Do not submerge the connector at the uphole end of the cable.

- For accurate measurements, the instrument should remain immobile while logging data.

***TIP:** Be sure to replace the desiccant when it appears pink. Expired desiccant can allow water build up in the vent tube, causing a blockage resulting in inaccurate data.*

- Be sure the "uphole" cable end is capped—desiccant cap on the vented cable connector, soft dust cap on non-vented cable—and positioned above the highest anticipated water level. Avoid areas that may flood.
- Do not deploy pressure transducers in such a way that ice may form on or near the sensor or cable connections. Ice formation is a powerful expansive force and may over-pressurize the sensor or otherwise cause damage. Any damage associated with ice formation is not covered by the warranty.

STABILIZATION TIME

Allow the Level TROLL to stabilize to the water conditions for *about an hour* before logging data. A generous stabilization time is always desirable, especially in long-term deployments. Even though the cable is shielded, temperature stabilization, stretching, and unkinking can cause apparent changes in the probe reading. If you expect to monitor water levels to the accuracy of the probe, it's worth allowing the extra time for the probe to stabilize to its environment.

INSTALLATION OF A LEVEL TROLL 300 OR OTHER NON-VENTED LEVEL TROLL

All Level TROLL 300 and non-vented Level TROLL 500 and 700 instruments include non-vented (absolute, PSIA) pressure sensors and do not require vented cable for proper operation. They may be deployed on non-vented RuggedCable or with a Twist-Lock Hanger and economical stainless steel suspension wire while logging data.

- Because the Twist-Lock Hanger has no communication capabilities, program the Level TROLL in advance, and download the data the same way
- Logged pressure data will show the effects of changes in barometric pressure (unlike vented Level TROLLs). However, post-processing tools such as Win-Situ Baro Merge may be used to eliminate the effects of barometric pressure changes from the data, if required.

TIP: *Be sure to program a non-vented Level TROLL or BaroTROLL before attaching the Twist-Lock Hanger, as this accessory has no communication capability.*

DO NOT submerge a non-vented Level TROLL 500 or 700 without first attaching a Twist-Lock Hanger, or a cable, as the unit could be damaged by flooding.

Although the Level TROLL 300 is completely sealed from flooding, a Hanger is recommended.

7 BAROTROLL

TIP: For more detailed information on barometric compensation see the technical notes on the In-Situ software/ resource CD, or the Downloads section of the In-Situ website at www.In-Situ.com.

In-Situ's BaroTROLL® is a special model of non-vented Level TROLL designed to log barometric pressure from 0 to 16.5 PSIA (1.14 bar, 33.59 in Hg) at the surface near a submerged non-vented Level TROLL. BaroTROLL data may then be used to correct the Level TROLL data for barometric pressure fluctuations.

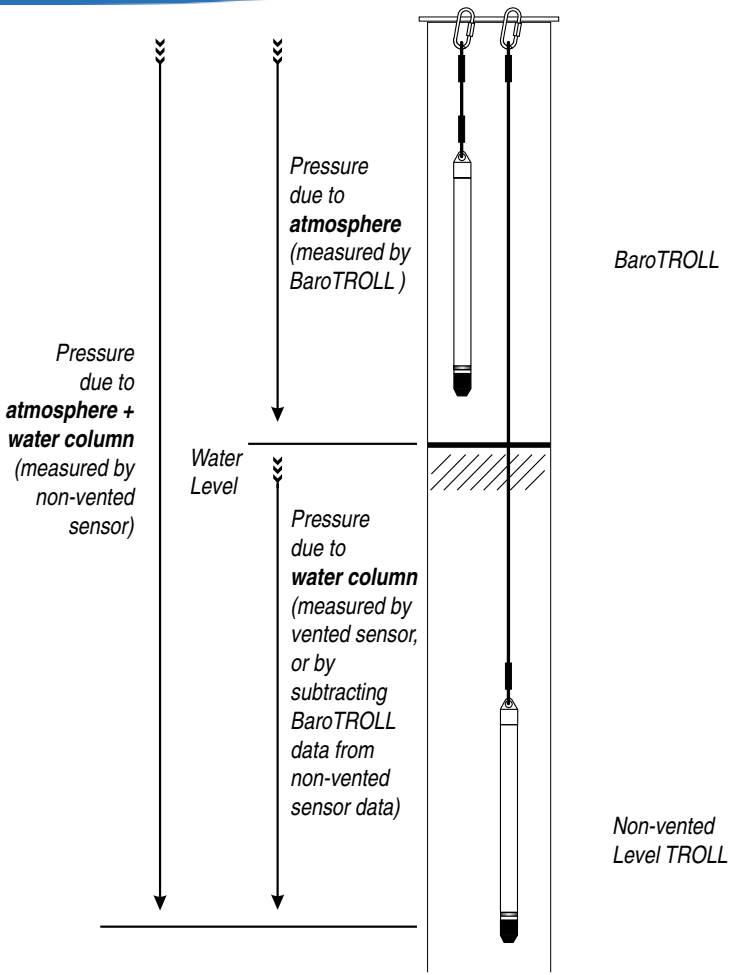
PROGRAMMING

- Program before installation. Be sure to sync the clock.
- Schedule a log with the same start time as that in the paired non-vented Level TROLL. Select the same sample interval.

INSTALLATION

After programming, install the BaroTROLL in a protected location above water level. Install the BaroTROLL near the submerged non-vented unit. One possibility is shown below, using a Twist-Lock Hanger and suspension wire.

- Be sure to attach the Twist-Lock Hanger before installation to prevent flooding.


Pressure due to **atmosphere** (measured by BaroTROLL)
BaroTROLL
Pressure due to **atmosphere + water column** (measured by non-vented sensor)
Water Level
Pressure due to **water column** (measured by vented sensor, or by subtracting BaroTROLL data from non-vented sensor data)
Non-vented Level TROLL

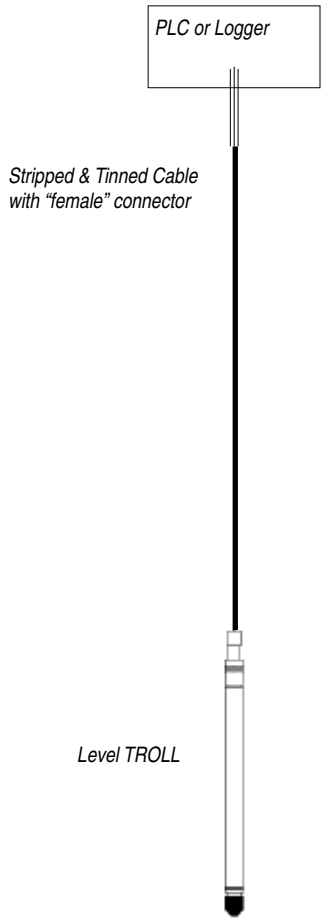
8 ANALOG, SDI-12 & MODBUS CONNECTIONS

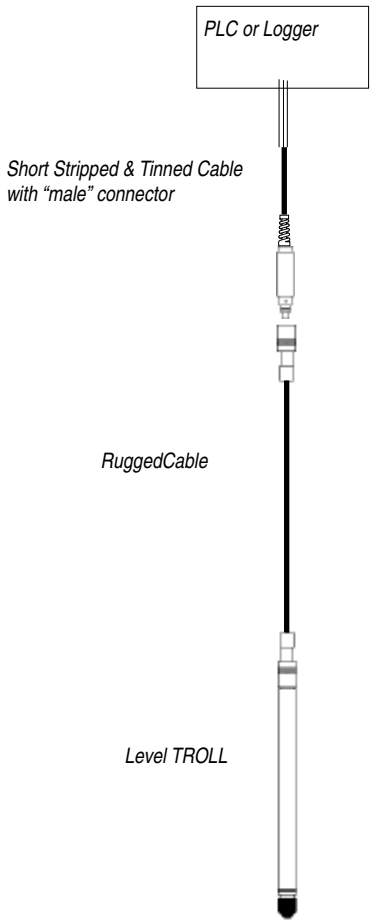
The Level TROLL may be connected to a controller or logger for communication via:

- Analog (4-20 mA)
- SDI-12
- RS485 Modbus
- RS232 Modbus (with a customer-supplied converter)

RuggedCable® stripped & tinned cables have a “female” Twist-Lock connector on one end to mate with the Level TROLL body. The uphole end terminates in bare wires for connection to a PLC or data logger.

Also available in a shorter length ending in a “male” Twist-Lock connector to mate with RuggedCable systems.

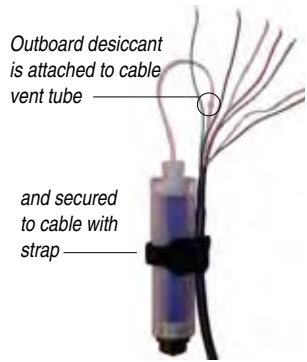

PLC or Logger
Stripped & Tinned Cable
with “female” connector
Level TROLL


PLC or Logger
Short Stripped & Tinned Cable
with “male” connector
RuggedCable
Level TROLL

DESICCANT

Vented cable includes removable outboard desiccant to protect the cable vent tube and Level TROLL electronics from condensation in high-humidity environments.

The desiccant may be removed from the vent tube, if needed, to trim the conductor wires. Pull the vent tube extender off the cable vent tube to remove, replace desiccant after trimming and connecting wires.

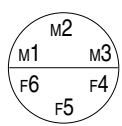


WIRING

Refer to diagrams on the following pages. Trim back and insulate unused wires. The shield should be wired to a chassis ground or earth ground.

RuggedCable (TPU)

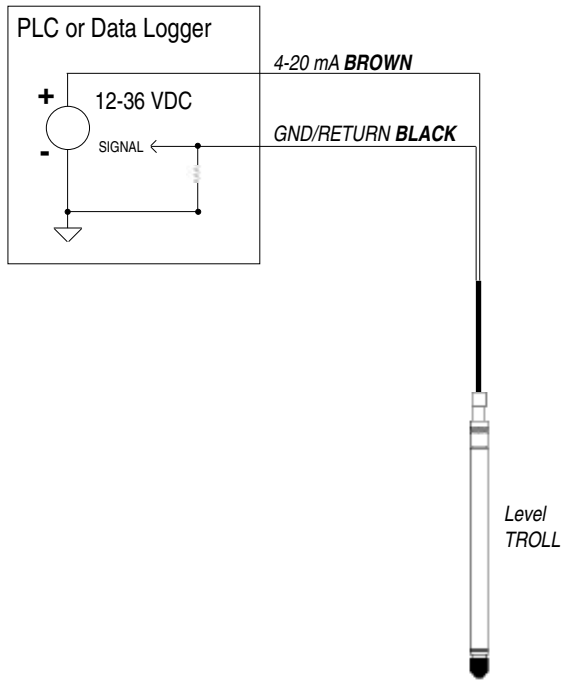
Signal	Color	Pin
Gnd/Return	BLACK	6
Ext Power	RED	5
4-20 mA	BROWN	4
RS485(–)	GREEN	3
RS485(+)	BLUE	2
SDI-12	WHITE	1



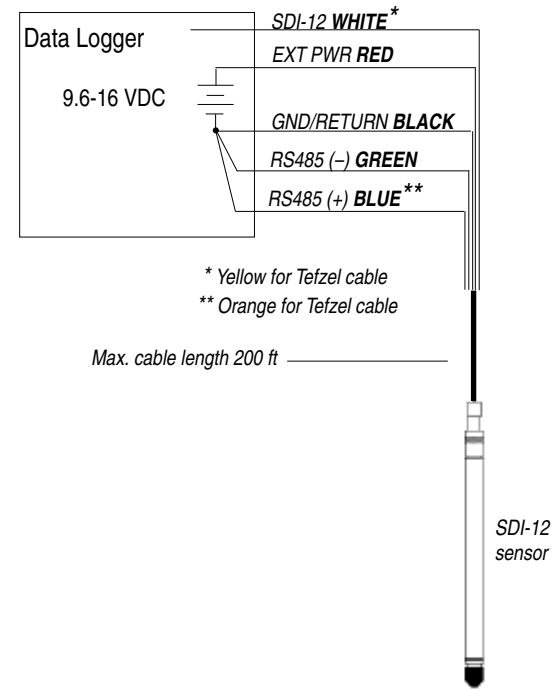
Tefzel Cable

Signal	Color
Gnd/Return	BLACK
Ext Power	RED
4-20 mA	BROWN
RS485(–)	GREEN
RS485(+)	ORANGE
SDI-12	YELLOW

ANALOG (4-20 mA) 2 WIRE

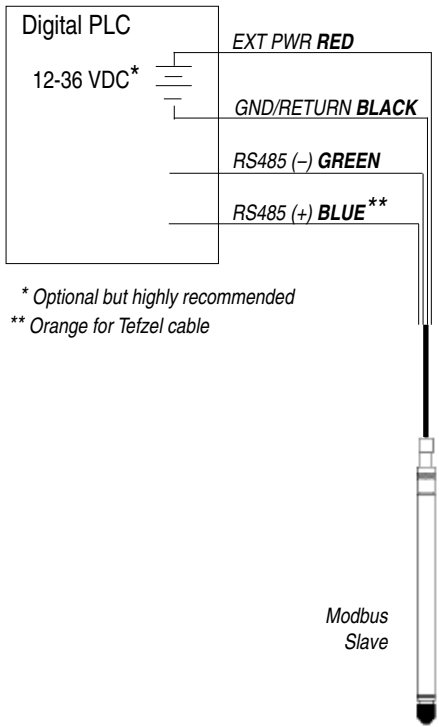


SDI-12 3 WIRE


Data Logger
9.6-16 VDC
SDI-12 WHITE*
EXT PWR RED
GND/RETURN BLACK
RS485 (–) GREEN
RS485 (+) BLUE**
* Yellow for Tefzel cable
** Orange for Tefzel cable
Max. cable length 200 ft
SDI-12 sensor

MODBUS MASTER

with RS485 built in

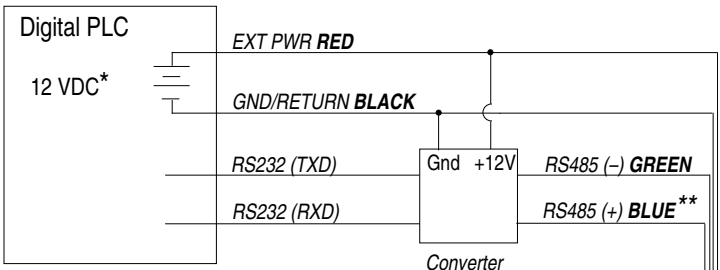


* Optional but highly recommended

** Orange for Tefzel cable

MODBUS MASTER

with RS232 built in (converter required)

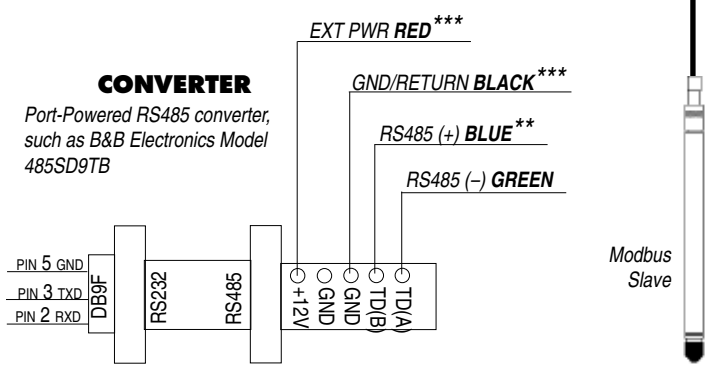


* Voltage limited by converter

** Orange for Tefzel cable

CONVERTER

Port-Powered RS485 converter, such as B&B Electronics Model 485SD9TB



***Required if port power is not available

POWER CONNECTIONS

The Red wire provides power for Modbus and SDI-12 modes. The Brown wire provides power for the 4-20 mA mode. If power is present on the Brown wire and not on the Red wire, the device enters the 4-20 mA mode automatically and stays in the 4-20 mode until power is removed from the Brown wire or is applied to the Red wire. The Red wire has priority — if power is applied to both wires at the same time, the device will operate in Modbus or SDI-12 modes but not in 4-20.

COMMUNICATIONS

The device automatically switches between Modbus and SDI-12 modes depending on which of the two interfaces has activity. Modbus and SDI-12 cannot be used at the same time — whichever one is currently in use will block communication on the other.

USING WIN-SITU

Win-Situ provides options for configuring analog/SDI-12 communications (Setup tab) and Modbus communications (File menu > Settings). In addition, the Level TROLL is capable of internal logging (programmed in Win-Situ) while participating in a Modbus, SDI-12 or analog network. However, Win-Situ cannot communicate with the Level TROLL while it is transmitting Modbus, SDI-12 or analog data, and conversely, the instrument cannot receive or respond to Modbus, SDI-12 or analog commands while connected to a PC serial port.

This “redundant logging” feature means

- if the PLC or recorder somehow “loses” data, the Level TROLL data can be retrieved using Win-Situ.

- if the PLC or recorder ceases to function due to power loss, the Level TROLL will continue to collect data using its own internal batteries and clock.

A port-powered RS485 converter like that shown for Modbus connections may be used for temporary connection of the Level TROLL to a serial port on a PC.

FOR MORE INFORMATION

For additional information on Modbus and SDI-12 communications, including the SDI-12 commands and Modbus registers, see these In-Situ technical notes:

SDI-12 Commands and Level TROLL Responses. November 2006.

In-Situ Modbus Communication Protocol. Bill Bonner, Senior Software Engineer, In-Situ Inc., version 6, January 2007.

They are available on the In-Situ software/resource CD, and in the Downloads section of the In-Situ web site at www.In-Situ.com.

9 CARE & MAINTENANCE

OPERATING CONSIDERATIONS

The Level TROLL has been designed to withstand harsh field conditions. However, as with any electronic instrument, it can be permanently damaged if used outside its operating specifications.

Do not deploy pressure transducers in such a way that ice may form on or near the sensor or cable connections. Ice formation is a powerful expansive force and may over-pressurize the sensor or otherwise cause damage that is not covered by the warranty.

TEMPERATURE

The Level TROLL and BaroTROLL instruments operate within a temperature range of -20°C to +80°C (-4°F to 176°F).

PRESSURE RANGE

The Level TROLL can withstand pressures of up to two times (2X) the rated range of the pressure sensor without damage, although it may not read correctly at such pressure. If the pressure range is exceeded by 3X, the sensor will be destroyed.

FACTORY RECALIBRATION

Accuracy can be adversely affected by improper care and handling, lightning strikes and similar surges, exceeding operating temperature and pressure limits, physical damage or abuse. Factory calibration every 12-18 months is recommended. Contact In-Situ Customer Service for information on the factory maintenance and calibration plan.

STORAGE

Store the Level TROLL clean and dry. Place the protective red dust cap on the cable end, or store with cable attached to protect the connector pins and o-ring.

Store the instrument where it will be safe from mechanical shocks that may occur, such as rolling off a bench onto a hard surface.

Protect the instrument from temperature extremes. Store within a temperature range of -40°C to +80°C (-40°F to +176°F).

GENERAL MAINTENANCE

CLEANING—BODY AND FRONT END

When the nose cone is removed, the sensitive pressure sensor diaphragm is completely exposed. Do not touch this area with any object! Replace the nose cone as soon as possible.

Nose cone in place

Nose cone removed

Clean the Level TROLL body with water and a soft brush or plastic scouring pad, or soak overnight in a mild acidic solution, such as household vinegar.

If the ports in the front end are clogged with silt or mud, try the following:

- Swish the instrument vigorously in a bucket of clean water
- Apply a gentle squeeze of water from a wash bottle
- In severe cases, remove the nose cone and clean out the holes with a soft brush or pipe cleaner

To avoid damage to the pressure sensor diaphragm, *do not insert any object into the sensor opening or attempt to dig out dirt or other materials.*

Damage caused by digging or scraping in the pressure sensor opening to remove silt, mud, etc. is not covered by the warranty.

If contamination cannot be removed using the recommendations above, please contact In-Situ Inc. for cleaning.

TWIST-LOCK CONNECTORS

Do not submerge the cable connector; do not immerse in any fluid.

Keep the pins on all connectors free of dirt and moisture by using the soft protective dust cap when cable is not attached.

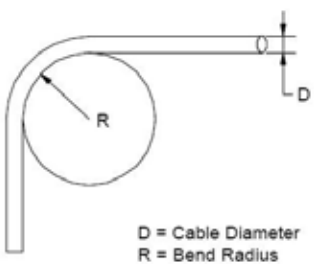
CABLE VENT TUBE (VENTED CABLE)

Vented cable assures that atmospheric pressure is the reference pressure to the vented pressure sensor diaphragm. *The vent tube should not be blocked, kinked, or otherwise obstructed.* Such obstructions will cause barometric pressure to appear in measurements, and errors will be introduced due to thermal expansion and contraction of air within the vent tube and probe body.

The minimum bend radius for vented cable is 13.5 mm (0.54 in).

The recommended minimum bend radius is 13.5 mm (0.54 in), which is twice the cable diameter.

***TIP:** Be sure to replace the desiccant when it appears pink. Expired desiccant can allow water build up in the vent tube, causing a blockage resulting in inaccurate data.*



BATTERIES

***TIP:** If batteries are completely exhausted, remember that external power and battery pack options are available.*

Internal batteries in the Level TROLL are not user-replaceable. The approximate percentage remaining is displayed on the Dashboard when the Level TROLL is connected in software.

10 TROUBLESHOOTING

TROUBLESHOOTING CONNECTIONS

Problem: Win-Situ cannot connect to the Level TROLL

Probable Cause: Wrong COM port selected, incompatible Communication settings, loose or dirty cable connections, low batteries

Suggested Remedy: Check the following:

- all cable connections are tight, connectors are clean and dry
- the cable is securely attached to the instrument
- the correct COM port is selected (select Preferences menu > Comm Settings to check this)
- the communication settings in Win-Situ and in the Level TROLL match. To reset the device communication settings to the serial defaults, click “Reset all Devices” in the Comm Settings dialog (Preferences menu > Comm Settings)
- the internal battery has voltage remaining, or external power is supplied

Problem: Real-time readings are in the wrong units

Probable Cause: Default units are being used

Suggested Remedy: Click the Sensors tab, select the sensor, click the configure button  and select the desired units for each parameter in the Sensor Setup window. Click OK  .

TROUBLESHOOTING DATA LOGS

Problem: Cannot add a new log

Probable Cause 1: Only one “active” log can reside in the device at a time—an “active” log is a log that is Ready, Pending, Running, or Suspended as shown in the Status column of the Logging Tab

Suggested Remedy: Stop or delete the log if possible. Alternatively, configure the new log after the active log is completed

Probable Cause 2: The device has its maximum number of logs already stored—the Level TROLL 300, 500, and Baro TROLL have a capacity of 2 logs

Suggested Remedy: Download, and then delete a log you are through with. This will make room for an additional log on the device

Problem: New log exceeds available memory (message from software)

Probable Cause: The log as configured would exceed the device memory

Suggested Remedy: Edit the log and try these:

- Select a longer sampling interval

- If available, select the “Wrap data” option (later data will overwrite earlier data when the memory is full)
- For a log with a scheduled start, select “None” as the stop condition, or select a stop time that is closer to the start time. You may intend to stop the log before the scheduled end date arrives, but the software doesn’t know that.

TROUBLESHOOTING PARAMETER CONFIGURATION

Problem: Cannot configure level or other parameters using the Configure button on the Sensors tab. The Sensor setup screen is shown, but the Configure... button is dimmed out

Probable Cause 1: The Level TROLL is actively “polling” (continually updating real-time readings) in the Home tab

Suggested Remedy: Return to the Home tab and stop real-time readings by clicking 

Probable Cause 2: The Level TROLL has an “active” log—a log that is Ready, Pending, Running, or Suspended as shown in the Status column of the Logging Tab. Only one “active” log can reside in the device at a time

Suggested Remedy: Stop or delete the log if possible. Alternatively, configure parameters after the log is completed

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In-Situ Inc.
WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Model: Level TROLL 300
Product Description: The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directives:

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

In-Situ Inc.
WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Model: Level TROLL 500
Product Description: The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directives:

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

In-Situ Inc.
WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Model: Level TROLL 700
Product Description: The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directives:

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

In-Situ Inc.
WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Product name: Baro TROLL
Product Description: The Baro TROLL measures and logs barometric pressure and temperature.

is in compliance with the following Directives:

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

- **Emissions**
  Class A requirements of EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006

In-Situ Inc.
WWW.IN-SITU.COM

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: TROLL Com
Model: USB TROLL Com
Product Description: RS485 to USB converter

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
  EN 61326, Electrical Equipment for Measurement, Control and Laboratory Use, Industrial Location

- **Emissions**
  Class A requirements of EN 61326, Electrical Equipment for Measurement, Control and Laboratory Use

Supplementary Information:
The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.

Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
June 17, 2006

CE FC

In-Situ Inc.

RuggedReader®

OPERATOR'S MANUAL

October 2007

In-Situ Inc.

Contents

1 INTRODUCTION

The ultra-rugged RuggedReader®—rock solid and field ready in the most extreme environments—is your reliable field companion. Designed for Windows Mobile® 5.0, your RuggedReader features a wide variety of application software choices, including Win-Situ® Mobile, control software for In-Situ's Level TROLL® and Aqua TROLL®, and Pocket-Situ 4 for In-Situ's MP TROLL® 9500, miniTROLL®, and MP TROLL® 9000.

WINDOWS MOBILE® 5.0

The Windows Mobile 5.0 operating system, designed for mobile devices, provides familiar Microsoft programs like Outlook® Mobile. Many Windows applications are compatible with Windows Mobile. You can use Windows Mobile to access Word, Excel®, and PowerPoint® files on your mobile device, or you can use Windows Mobile to access your e-mail messages and contacts from your Microsoft Outlook account.

More information about Windows Mobile 5.0 can be found at http://www.Microsoft.com/windowsmobile/5/default.mspx.

HOW TO USE THIS MANUAL

This operator's manual is designed as both a start-up guide and a permanent reference for the RuggedReader's features and applications.

Section 1: Introduction to the RuggedReader® and to In-Situ Inc. — Anatomy of the RuggedReader — Accessories — Warranty — Instrument Repair & Return Recommendations

Section 2: Getting Started — Installing & charging the battery pack — Installing Microsoft ActiveSync®

Section 3: Using the Hardware — Buttons — Power — Stylus — Touchscreen — CF and SD cards

Section 4: A quick overview of basic software operations in the Windows Mobile operating system

Section 5: Using ActiveSync®

Section 6: Using In-Situ Software — Win-Situ Mobile — Pocket-Situ 4 — TDG Logger — Transferring data files from the RuggedReader to a desktop computer

Section 7: Care and Maintenance of the RuggedReader

Conventions

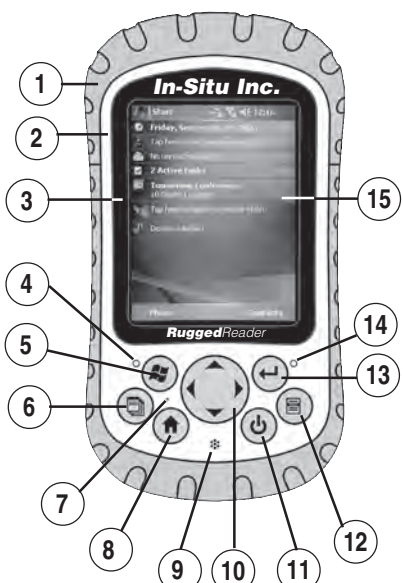
Throughout this operator's manual you will see the following symbols:

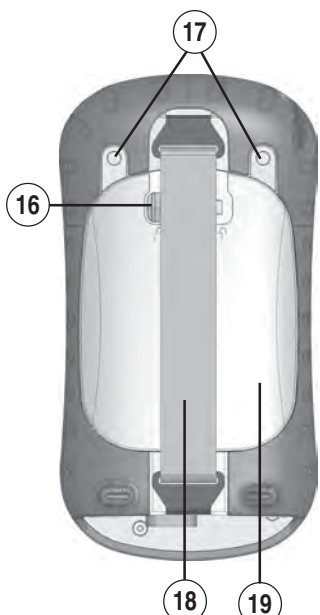
The check mark highlights a tip about a convenient feature of the RuggedReader or its software

The exclamation point calls your attention to a requirement or important action that should not be overlooked

THE ANATOMY OF THE RUGGEDREADER

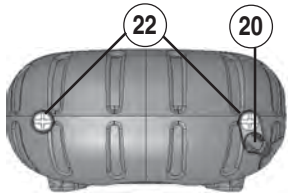
1 Elastomer overmold
2 Magnesium case front
3 Display bezel
4 Charge LED (page 31)
5 Start menu button (page 20)
6 Applications Manager button (page 20)
7 Microphone
8 Home button (page 20)
9 Speaker
10 Four-way directional button (page 20)
11 Power button (pages 22-23)
12 Context menu button (page 20)
13 Enter button (page 20)
14 Notification LED (p. 31)
15 Touchscreen/display (pages 29-30)
16 Battery door latch
17 Accessory attachment points
18 Hand strap
19 Battery door



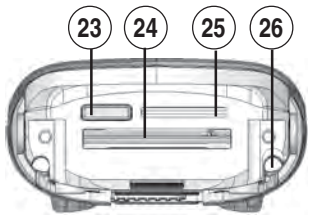


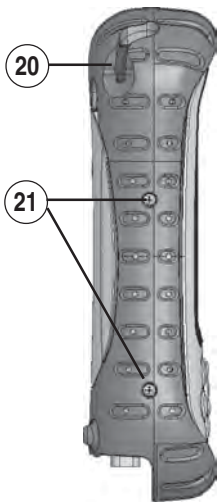
20 Stylus
21 Main screws (do not remove)
22 Top cap screws (captive) (page 32)
23 Slot for future accessory
24 Compact Flash card slot (page 32)
25 Secure Digital I/O card slot (page 32)
26 Stylus slot
27 USB Client (mini B)
28 12V DC jack
29 9-pin serial port
30 USB Host (mini A)
31 Cable routing channel

Top view with top cap

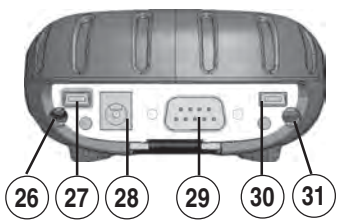


Top view without top cap





Communications module



WHAT WE PROVIDE

Accessories:

- Battery
- Stylus
- USB communications cable
- End User License Agreement (EULA)
- Wall charger & 4 plugs
- 12V auto adapter
- Dashboard accessory pad
- Screen Protectors (2)

Installed In-Situ software:

- Win-Situ Mobile, for use with the Level TROLL and Aqua TROLL
- Pocket-Situ 4, for use with the miniTROLL, Multi-Parameter TROLL 9500, and Multi-Parameter TROLL 9000
- TDG Logger, for use with the T506 Total Dissolved Gas probe

Reference Tools:

- A quick start guide
- Getting Started CD from Microsoft (installs ActiveSync®)
- In-Situ Software/Resource CD (includes user's guide)

Accessories

Accessory / Replacement Part	Catalog No.
12V Auto Charger Adapter	55410
Lithium-Ion Battery Pack	55420
USB Communication Cable	55430
Hand Strap	55440
Stylus	55460
Screen Protectors (2)	55470
CF Card, 512 MB	55480
CF Card, Bluetooth	55490
Dashboard Accessory Pad	59250

Warranty

In-Situ Inc. warrants the RuggedReader for two years, and the lithium battery for one year, from date of purchase by the end user against defects in materials and workmanship under normal operating conditions. To exercise this warranty contact Technical Support at the phone or e-mail address listed below for a return material authorization (RMA) and instructions. Complete warranty provisions are posted on our website at www.In-Situ.com.

HOW TO CONTACT US

Technical Support:	800 446 7488
	Toll-free 24 hours a day in the U.S. and Canada
Address:	In-Situ Inc. 221 East Lincoln Ave. Fort Collins, CO 80524 USA
Phone:	970 498 1500
Fax:	970 498 1598
Internet:	www.in-situ.com
e-mail:	support@in-situ.com

WARNING: *Do not attempt to service the device yourself. This action voids the warranty.*

To Obtain Repair Service (U.S.)

If you suspect that your RuggedReader is malfunctioning and repair is required, you can help assure efficient servicing by following these guidelines:

1. Call or e-mail In-Situ Technical Support (support@in-situ.com). Have the product model and serial number handy.

   To locate the device serial number and other identification information:
   a. Tap Start > Settings.
   b. In the Settings window, tap the System tab.
   c. Scroll down and tap System Config.

TIP: *To locate your device's serial number, tap Start > Settings > System tab > System Config.*

2. Be prepared to describe the problem, including how the RuggedReader was being used and conditions noted at the time of the malfunction.
3. If Tech Support determines that service is needed, they will ask that your company pre-approve a specified dollar amount for repair charges. When the pre-approval is received, Tech Support will assign an RMA (Return Material Authorization) number.

TIP: *Please keep your RMA number for future reference.*

4. Carefully pack your RuggedReader in its original shipping box, if possible.
5. Mark the RMA number clearly on the outside of the box with a marker or label.
6. Send the package, shipping prepaid, to

   In-Situ Inc.
   ATTN: Repairs
   221 East Lincoln Ave.
   Fort Collins, CO 80524

The warranty does not cover damage during transit. In-Situ recommends the customer insure all shipments. Warranty repairs will be shipped back prepaid.

Outside the U.S.

Contact your international In-Situ distributor for repair and service information.

In-Situ Inc.

2 GETTING STARTED

TIP: If you used the Quick Start guide to set up your RuggedReader, you completed Steps 1-5.

This chapter repeats the installation instructions in the RuggedReader Quick Start guide. If you used the Quick Start guide to set up your RuggedReader, you completed Steps 1-5.

STEP 1: INSTALL THE BATTERY PACK

1. Slowly unhook and lift up the bottom latch of the hand strap. CAUTION: Do not let the hand strap hook hit the display.

2. Press on the battery door and slide the latch to the right to unlock it.

3. Remove the battery door.

4. Insert the battery pack so battery contacts match up.

5. Insert the tabs on the bottom of the battery door into the case slots. Make sure the door latch is all the way to the right and properly aligned. Then close the battery door.

6. Press firmly on the battery door and slide the latch to the left to lock it.
7. Reattach the hand strap.

STEP 2: CHARGE THE BATTERY PACK

1. Mount the plug onto the wall charger (if it is not already assembled).
2. Plug the wall charger into an outlet.
3. Plug the other end of the wall charger into the DC jack on the RuggedReader. The device turns on after a few seconds, and a flashing red light appears to signal the device is charging.

TIP: Note: After a few minutes the device suspends, and the flashing red LED turns off, but the device keeps charging.

4. Charging the RuggedReader for 4.5 hours charges it up to 95%. Let the device charge for 6 hours to get a full charge.

STEP 3: CALIBRATE THE TOUCHSCREEN

When you first power your RuggedReader, or after a device reset, you will be prompted to calibrate the touchscreen. Using the stylus, follow the instructions on the screen.

To protect the touchscreen, we recommend that you apply a screen protector. See Protecting the Touchscreen in Section 3.

STEP 4: INSTALL ActiveSync® ON A DESKTOP COMPUTER

Windows Mobile 5.0 requires that you use ActiveSync 4.1 or greater. The Getting Started CD installs ActiveSync 4.1 on your desktop computer.

1. Insert the Getting Started CD into your desktop computer.

   The CD runs automatically.

   The options presented will differ depending on whether ActiveSync is currently installed on your computer.

*Install ActiveSync **before** attaching the USB cable to the desktop PC or to the RuggedReader.*

2. Follow the directions on the screen to install the latest version of ActiveSync on your desktop computer.

STEP 5: CREATE AN ActiveSync CONNECTION

Install ActiveSync on your desktop computer before creating a connection.

1. Plug USB Client end (mini B) of the USB communications cable into your RuggedReader when instructed by ActiveSync.

USB Client (mini B)

2. Plug the USB Host end (full size A) of the USB communications cable into your desktop computer.

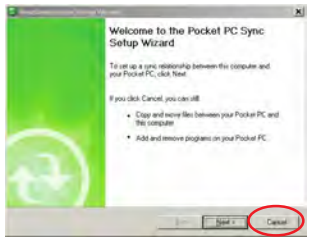
***TIP:** ActiveSync may refer to the device "cradle" On the RuggedReader, this means to plug in the mini B end of the USB cable.*

3. Establish an ActiveSync partnership by following the instructions on the desktop computer screen.

Tips for Your First ActiveSync Connection

- To use In-Situ's RuggedReader software, we recommend you set up a "Guest" connection in ActiveSync.

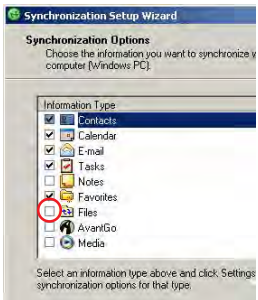
  To connect as a "Guest," just click Cancel on the first page of the Sync Setup wizard. ActiveSync then recognizes your device as a Guest.



  Setting up as a Guest creates a temporary relationship with a desktop computer. Each time the device connects to the desktop, you need to set it up as a Guest by clicking Cancel at the first screen of the Sync Setup Wizard.

TIP: Multiple RuggedReaders will not synchronize with ActiveSync on the same desktop computer. To connect multiple devices to your desktop computer, connect each as a guest.

- Synchronization of Pocket-Situ 4 or Win-Situ Mobile (Pocket-Situ 5) data files is handled by an In-Situ utility called "Win-Situ® Sync," which automates the transfer of data files from your RuggedReader to the Win-Situ working directory on your desktop PC. Even with a full synchronization partnership these files are not synchronized automatically by ActiveSync. For information on these In-Situ programs, see Section 6.



- The alternative to a Guest connection is a full synchronization partnership. You can set up Contacts, Calendar, E-mail, Tasks, etc. to automatically synchronize whenever ActiveSync makes a connection. Notes do not synchronize, and Files synchronize one way—from the desktop computer to the RuggedReader.

CAUTION: When setting up a full synchronization partnership, be sure to leave the "Files" option unchecked in the Sync Setup Wizard. A file in the synchronization folder on the desktop computer can overwrite a file of the same name on the RuggedReader.

THE NEXT STEP

You are now ready to use your RuggedReader.

- To find out about hardware features—buttons, touchscreen, stylus—continue to Section 3
- For Windows Mobile software features, go to Section 4
- For details on Microsoft ActiveSync, check out Section 5
- To start using In-Situ's RuggedReader applications to talk to your In-Situ devices, turn to Section 6

3 USING THE HARDWARE

This chapter describes the hardware components of the RuggedReader:

- Buttons
- Power Management: suspending, powering off, and resetting the RuggedReader
- Stylus
- Touchscreen
- LEDs signals
- Peripheral Devices (CF and SD cards, USB drives)

BUTTONS

The following chart shows the names and functions of each button on the keypad.

Button	Name	Function
	Start menu button	Provides a menu of applications
	Applications Manager button	Lets you switch between or close running applications; allows you to view memory allocations
	Home button	Returns you to the Today screen
	Context menu button	Displays the context menu related to the item selected (similar to a right-click on a desktop computer)
	Enter button	Enters the selected soft key or option
	Power button	Turns the RuggedReader on and off, resets, suspends (see more details in the Power button section)
	Four-way directional button	Allows you to navigate

Customizing Button Functions

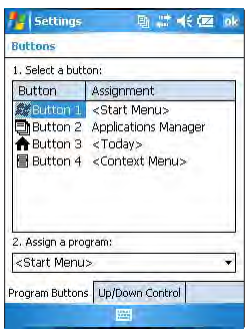
Each button performs a specific function. You can customize the function of the following four buttons to open programs or perform shortcuts:

- Start menu button (Button 1)
- Applications Manager button (Button 2)
- Home button (Button 3)
- Context menu button (Button 4)

TIP: The functions assigned to the Enter button, power button, and Four-way directional button cannot be customized.

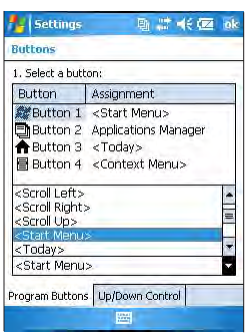
To reassign a program or shortcut to a button:

1. Tap Start > Settings > Personal tab > Buttons. A list of buttons and their current assignments is displayed on the Program Buttons tab.



2. Tap the button you want to reassign.

3. In the Assign a program box, tap the program or shortcut you want to assign to the button.



4. Tap OK.

POWER

The power button allows you to power on, suspend, power off, and reset the device. A series of keypad actions lets you restore factory defaults to the registry or to the whole device. Below are instructions for each action.

Suspending

Suspending the RuggedReader is different from powering it off:

- Suspending the device puts it to sleep, and when it is turned back on, the device remembers where it was. Some battery power is used.
- Powering off the device closes all programs and turns off all of the power. No battery power is used.

We recommend suspending your device if you want to resume your task or if you plan to use the device on a daily basis.

1. To suspend your device, press the power button briefly and release.
2. To resume the device from suspend mode, press the power button again.

TIP: If the device suspends while it is charging, the flashing red light disappears. However, the device continues to charge.

TIP: The RuggedReader suspends automatically after a specified period of time with no activity. To change this automatic timeout, tap Start > Settings > System tab > Power > Advanced tab.

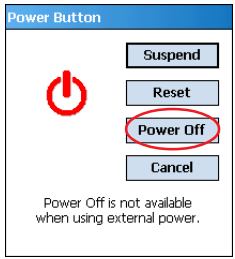
Powering Off

Powering off ends all programs and removes power from all system components except for the real-time clock. Unlike suspend mode, the device resets when it is powered on again.

To preserve battery power, we recommend you power off the device if it will be left unused for two weeks or longer.

To power off the RuggedReader:

TIP: The device cannot be powered off while it is plugged into the wall charger.



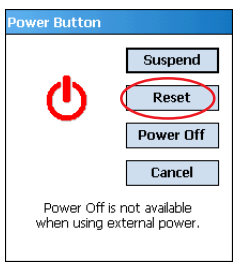
1. Save your open files and close any running programs.
2. Press ⏻ until the power button menu appears.
3. Tap Power Off.

   The keypad backlight stays on for a few seconds after the device shuts off. Until the keypad backlight turns off, the device cannot be powered on again.

To power on your RuggedReader, hold down ⏻ until the green notification light appears. Introductory splash screens will be displayed, then the Today screen. This process takes about a minute.

Resetting the Device (Soft Reset)

Some programs require you to reset your device during installation. Follow the steps below to reset the RuggedReader:



1. Save open files and close any running programs.
2. Press ⏻ until the power button menu appears.
3. Choose Reset.

If your device is locked up, you can reset it without the power button menu. Just press the power button for 10 seconds or until the screen goes dark. After a few seconds, the device turns on again.

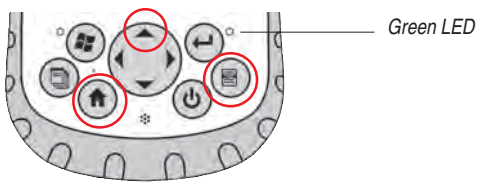
Restoring Factory Defaults (Hard Reset)

WARNING: Restoring the device to its original factory state will permanently erase data saved on the device, software installed by In-Situ Inc. (Win-Situ Mobile, Pocket-Situ 4, TDG Logger), any software you installed, and any changes you made to the device, including settings changes.

Follow the steps below to restore the hard drive, settings, and icons to their original factory state on your device. WARNING! Restoring the device to its original factory state will permanently erase data saved on the device, any software you installed, and any changes you made to the device, including settings changes.

To restore the device to its original factory state, follow these steps:

1. Reset the device from the power button menu or by holding down the power button until the display goes dark.
2. When the green LED light appears on the front of the RuggedReader, simultaneously press and hold the following buttons for several seconds: the Home button, the up arrow on the Four-way directional button, and the Context menu button.



3. Hold the buttons until the RuggedReader splash screen appears and then disappears. Factory settings are restored automatically.

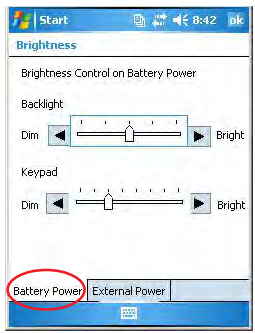
Conserving Power

The RuggedReader has several settings that let you save battery power.

Backlight

To dim or turn off the display and keypad backlights:

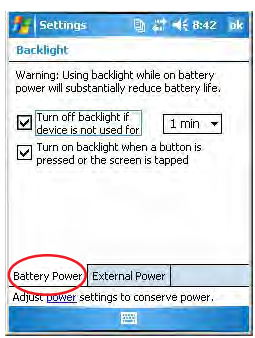
1. Tap Start > Settings > System tab > Brightness.
2. Select the Battery Power tab.
3. Drag the backlight slider slightly to the left to dim the backlight, or all the way to the left to turn it off. If the backlight does not turn off completely, tap on the arrow to the left of the Backlight slider.
4. Tap OK.



Adjusting the Backlight Timer

By default, the display and keypad backlights turn off after one minute of inactivity. You can adjust the time when the backlight turns off:

1. Tap Start > Settings > System tab > Backlight.
2. Select the Battery Power tab.
3. Set the options as you want them.
4. Tap OK.

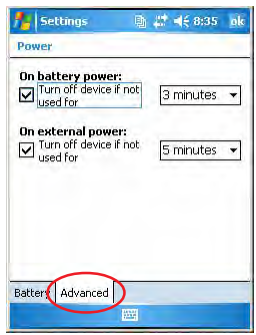


Automatic Suspend

By default, the RuggedReader will suspend automatically after three minutes of inactivity when on battery power.

To adjust the time when the device suspends, follow these steps:

1. Tap Start > Settings > System tab > Power.
2. Select the Advanced tab.
3. Adjust the device timeout as desired.
4. Tap OK.



TIP: *To resume the device from suspend at any time, press*

THE STYLUS

Like the left button on a desktop computer mouse, the stylus is a tool that lets you select items and enter data. Like the right button, the stylus lets you perform shortcuts like cutting and pasting. Instructions for these tasks are listed in the chart below.

The stylus is stored in an open slot at the top of the device. A hole in the end allows you to attach a lanyard.

To do this . . .	Follow these steps
Select an item	Tap once
Enter data	See Entering Information on the following page
Open an item or file	Tap the item or file
Open a context menu for an item	Tap and hold the item. The context menu appears.
Cut or copy	1. Tap and hold 2. Select Cut or Copy from the context menu
Paste	1. Tap and hold the area where you want to paste 2. Select Paste from the context menu
Drag and drop	1. Tap the item(s) 2. Drag the item(s) to the destination 3. Lift up the stylus
Select multiple items	Drag the stylus over the items

Entering Information

You have several options for entering information into your RuggedReader using the stylus.

 On-screen Keyboard utility (the default input method)

 Letter Recognizer—recognizes character strokes and gestures

 Block Recognizer—recognizes letters from single strokes

 Transcriber—recognizes cursive, print, or mixed handwriting

When you are ready to enter text, you can switch from the default input method (keyboard) by following these steps:

1. On the bottom center of the screen, tap the arrow next to the input method icon  . If the arrow is not displayed, tap the input method icon, then tap the arrow.
2. The input method menu appears, as shown here. Tap the input method you want from the list of options.
3. Using the selected input method, enter your text.

TIP: For more details about each input method, go to Start > Settings > Input and choose the input method from the Input window.

THE TOUCHSCREEN

Protecting the Touchscreen

The touchscreen is sealed to protect your device against water and dust. Protect your touchscreen from impact, pressure, or abrasive substances that could damage it. To further protect the touchscreen, apply one of the adhesive screen protectors that came with your RuggedReader. We recommend that you apply a new screen protector every 30 days. Extra screen protectors are available from In-Situ Inc. (catalog no. 55470).

To apply a screen protector, follow these steps:

1. Make sure the RuggedReader screen is free of oils and dirt. You can wipe it with a microfiber cloth.
2. Peel back the paper liner from the screen protector, exposing approximately one inch.
3. Align bottom corners of the screen protector with the RuggedReader screen, sticky side down.

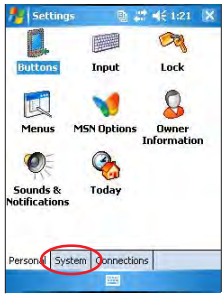
4. Smooth the screen protector while peeling back the liner, working out air bubbles as you go. Continue smoothing until the paper liner is removed.

TIP: *Some air bubbles may still be visible, but they fade away in a short time. You can use a credit card to gently push out any excess air.*

Calibrating the Touchscreen

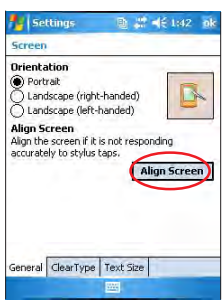
If the touchscreen is not responding accurately to stylus taps, try calibrating it manually:

1. Tap Start > Settings > System tab.



2. Scroll down and tap on the Screen icon.

3. In the Screen Settings window, select the Align screen button.
4. Follow the directions on the display to calibrate the touchscreen.
5. After you calibrate the touchscreen, the Screen window appears again. Click OK to exit the screen.



LED SIGNALS

The RuggedReader signals events and processes using LEDs.

Charge LED (Red)

This red light appears to the left of the Start menu button on the keypad.

Flashing : battery is currently charging
Solid : wall charger is connected but battery is fully charged

When the device is suspended or powered off, the charge LED does not appear.

Notification LED (Green)

The green LED is located to the right of the Enter button on the keypad. It appears briefly when you power on the unit after the device is reset or restored to factory defaults.

USING PERIPHERAL DEVICES

The RuggedReader accepts several peripheral devices.

- The USB Host (mini A) accepts devices like USB flash drives and keyboards.
- The Compact Flash (CF) and Secure Digital (SD) card slots accept memory cards and SDIO cards, such as GPS, modem, and Bluetooth cards.

TIP: To be compatible with Windows Mobile 5.0, some USB serial devices require drivers. Refer to your USB device's manual or contact the manufacturer to determine compatibility.

USB Devices

To install a USB device, plug the mini end of a USB communications cable into the USB Host (labeled A on your device). You may need to use a USB mini-to-full size adapter.

USB Host (mini A)

Removing the Top Cap

CAUTION: *When the top cap is removed, the RuggedReader is not sealed. Avoid exposing the device to moisture when the top cap is removed.*

The removable top cap protects the RuggedReader and storage cards. To remove the top cap:

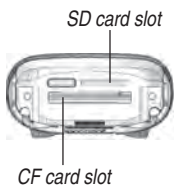
1. Remove the stylus.
2. Unscrew the top screws until you can slide the top cap off. The screws remain attached to the top cap.
3. Pull off the top cap.

Installing a CF or SD Card

TIP: *After removing a card, wait at least 6 seconds before inserting the same or another card. The RuggedReader needs this time to properly identify and use the newly inserted card. If a card is reinserted too quickly, the device may need to reset. To minimize this problem, close all programs before changing or reinserting a card.*

Remove the top cap as above and insert the card. The system should automatically detect and use the card. If the card is not recognized, try the following:

- Install an appropriate driver.
- Consult the user's guide that came with the card.



Reattaching the Top Cap

1. Make sure the hand strap is attached to its top latch.
2. Place the top cap over the case. Be sure the tabs are slotted into the sides of the case.
3. Use a screwdriver to turn the screws until they are firmly in place.

CAUTION: *Tighten the top cap screws firmly after you replace the top cap. Failure to replace the top cap properly may void your warranty.*

Note: Once the top cap rests against the magnesium case front, the screws become harder to turn. Apply an extra ¼ to ½ turn to properly seal the top cap.

Working with Files on a Peripheral Device

You can run programs located on a peripheral device, copy files from a peripheral device onto your RuggedReader, and back up files from the RuggedReader onto a peripheral device. Use File Explorer to find, run, open, and copy these files as you would other files on the RuggedReader. See Exploring Files in Section 4.

Tip: To access a CF or SD card in File Explorer, be sure to go all the way to the top (My Device) level:

1. Tap Start > Programs > File Explorer.
2. If My Device does not already appear as the current directory, tap on the arrow next to the directory that appears, then select My Device from the drop-down menu.

File Explorer at My Device Level

If a CF or SD storage card is installed, it appears at the top (My Device) level

4 BASIC OPERATIONS

This section covers things you need to know to perform everyday tasks on your RuggedReader.

THE TODAY SCREEN

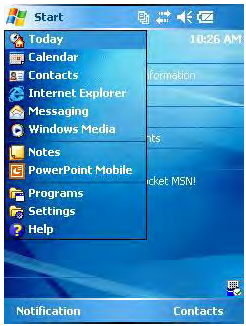
The Today screen is the default screen you see when your device powers on. From the Today screen you can view or select

- Today's date
- Owner information
- Messages
- Tasks
- Upcoming appointments

The Today screen allows you to lock or unlock your device. Locking the device disables your screen for easy cleaning.

- To lock the device, simply tap on the words "Device unlocked."
- To unlock the device, tap on the word "Unlock" on the two screens that appear.

THE START MENU



TIP: To access the Start menu, tap the Start menu icon Start *in the top left corner of the screen, or press the Start menu button on the keypad.*

The Start menu is the main access point to all programs, files, and settings in Windows Mobile. A description of each Start menu option follows.

- **Today.** The default RuggedReader display
- **Calendar.** Appointments and events
- **Contacts.** Contact information for your colleagues
- **Field PC Tutorial.** Describes basic procedures (e.g., replacing batteries) for easy reference
- **Microsoft Internet Explorer.** Internet browser
- **Messaging.** This e-mail client allows you to send and receive e-mail from Microsoft Outlook using ActiveSync on your desktop computer. With a direct Internet connection, you can adjust Messaging to send e-mail directly from the RuggedReader
- **Windows Media Player.** Plays audio and video files
- **Running programs.** If a program is running, it is listed on the Start menu. For example, in the picture above, Notes and PowerPoint Mobile are running. Tap on the program name to open the application
- **Programs.** Opens the Programs menu window, where you can view and access installed programs. To run a program, tap on it. For a list of the Programs installed on your RuggedReader, see Appendix C
- **Settings.** Displays three settings tabs: Personal, System, and Connections. For the location of specific settings, see the table in Appendix C. To change your settings, tap OK

- **Help.** Windows Mobile help is context-sensitive—the help screen information is directly related to what you are doing on the device. For some programs, you can open the program first, then tap Start > Help

STATUS ICONS

Status icons on the top line show the status of operations.

Icon	Name	Function
	Charge indicator, or	Shows device is charging
	Battery capacity	Tap to view remaining power
	Speaker	Tap to control volume
	Applications Manager	Tap to switch or close programs
	ActiveSync Connection	Shows connection status

For an additional list of icons and functions, Tap Start > Help, select *Overview of the Today screen*, tap *What do those status icons indicate?*

SOFT KEYS

These context-sensitive keys appear as words, buttons, or tabs on the menu bar. Tap on these keys to perform actions or open menus. Here you see soft keys on the Today screen.

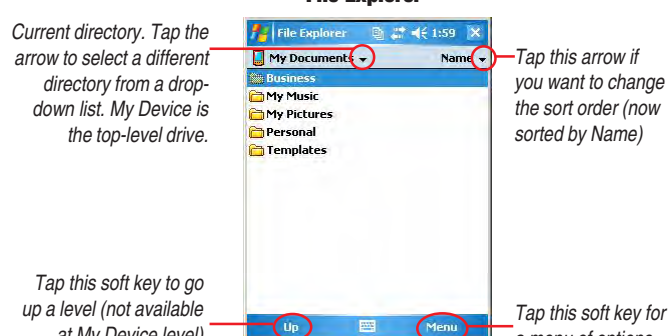
EXPLORING FILES

Use File Explorer to explore files stored on the RuggedReader or on a peripheral device:

1. Tap Start > Programs > File Explorer. File Explorer launches.
2. The current directory appears on the top line. To browse a different directory, do one of the following:
   - Tap the arrow next to the directory name, select the one you want from the drop-down list, or
   - Tap the "Up" soft key to go up a level.

   My Device is the top-level directory on the RuggedReader (the device drive) and allows you to explore all files, including those stored on a properly installed CF or SD card.
3. Navigate the file directory by tapping on the folders and files you want.

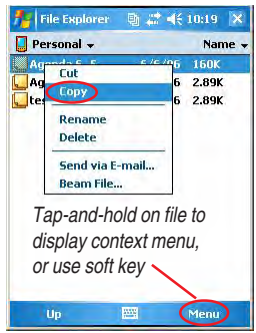
File Explorer

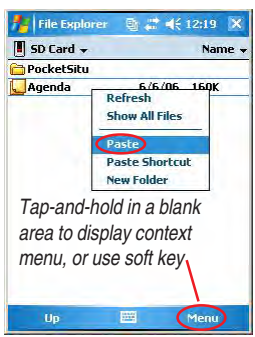


Working with Files

Locate the file you want in File Explorer, as described on the previous page.

- To run a program, tap it once.
- To manipulate a file—copy, cut, delete, rename—do one of the following:
  - Use the "right-click" context menu: hold the stylus on a file until a pop-up menu appears, then tap the action you want, or
  - Use the "Menu" soft key: select the file, tap the "Menu" soft key at the bottom of the screen, tap Edit, tap an action.
- To manipulate multiple files, drag the stylus over the files. Once selected, use the context menu or the "Menu" soft key to choose an option.
- To paste a copied file or files, first navigate to the destination folder (My Device, CF card, SD card, My Documents, etc.). Then do one of the following:
  - Tap and hold the stylus on the white space below the existing files until the pop-up menu appears, select Paste, or
  - Tap the folder, tap the "Menu" soft key, tap Edit > Paste.





CLOSING RUNNING PROGRAMS

TIP: Tapping on the X in the top right corner of a program only minimizes the program; it continues to run in the background.

To free memory and allow the device to run faster, close programs that are not being used:

1. Tap on the Applications Manager icon at the top of the screen or press the Applications Manager button.
2. Select the program you want to close.
3. Tap Stop. Or close all running programs by tapping Stop All.

SWITCHING BETWEEN RUNNING PROGRAMS

1. Tap on the Applications Manager icon or press the Applications Manager button.
2. Select the program you want to switch to.
3. Tap Activate. The program comes to the forefront.

ROTATING THE SCREEN

The RuggedReader can show information in portrait or landscape view. To change the orientation:

1. Select Start > Settings > System tab > Screen.
2. Choose from three screen orientations:
   Portrait,
   Landscape (right-handed), or
   Landscape (left-handed).

   The buttons automatically adjust for the screen orientation.

BACKING UP DATA

Your RuggedReader's non-volatile flash memory is designed to protect your data. However, it is still a good idea to back up your work regularly by saving information to a desktop computer or to a Compact Flash (CF) or Secure Digital (SD) card.

Backing up to a Desktop Computer

Use ActiveSync on the desktop computer. Follow the steps in Section 5 under the heading Transferring Files To & From the RuggedReader.

TIP: *Use Win-Situ Sync to copy TROLL data files from the RuggedReader. See details in Section 6.*

Backing up to a CF or SD card

Use File Explorer on the RuggedReader. See the steps earlier in this section.

In-Situ Inc.

5 USING ActiveSync®

The Getting Started section of this manual explained how to create an ActiveSync connection between your RuggedReader and your desktop computer. This section describes these ActiveSync tasks:

- Reconnecting
- Exploring the RuggedReader from a desktop computer
- Transferring files to and from the RuggedReader

TIP: *Microsoft ActiveSync version 4.1 or later is required to connect to the RuggedReader. This is supplied on the Getting Started CD. See installation instructions in Section 2 of this manual.*

RE-ESTABLISHING A CONNECTION

To re-establish an ActiveSync connection, follow these steps:

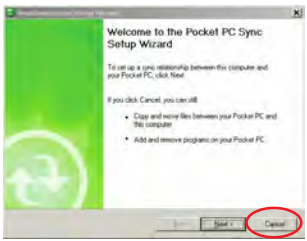
1. If you plan to charge the RuggedReader while it is connected in ActiveSync, plug the wall charger into the RuggedReader now.
2. Plug the USB Client end (mini B) of the USB communications cable into your RuggedReader.
3. Plug the USB Host end (full size A) into your desktop computer.
4. ActiveSync automatically detects the device.

USB Client (mini B)

TIP: If your device has trouble connecting, check firewall settings, remove laptop from docking station if attached, check the Microsoft website for Windows Mobile/Active Sync issues.

a. If you have not connected before or connected as a Guest, the Pocket PC Sync Setup Wizard is displayed. Do one of the following:

- To connect as a Guest (recommended), click Cancel. You are now connected as a Guest.
- To set up a full synchronizing partnership, click Next and select the items to synchronize (DO NOT INCLUDE Files and Notes)



b. If you created a full synchronizing partnership the first time you connected, ActiveSync synchronizes the items you selected.

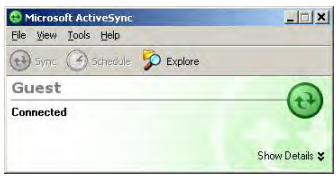
A guest connection is a temporary relationship with a desktop computer. Each time the device connects to the desktop, you need to set it up as a guest by cancelling the Pocket PC Sync Setup Wizard.

If Win-Situ Sync is installed on the desktop PC, it may launch automatically when ActiveSync detects the connection. You can disable this automatic launch if you want. See Using Win-Situ Sync in Section 6.

EXPLORING THE RUGGEDREADER FROM THE DESKTOP COMPUTER

You can explore and manipulate files on the RuggedReader from the desktop computer using ActiveSync. To explore the RuggedReader, follow these steps:

1. Connect the RuggedReader to the desktop and re-establish an ActiveSync Guest connection or partnership.



   Once connected, the Rugged Reader acts like a new drive called “Mobile Device” on the desktop computer.

2. To access the new “Mobile Device” drive (RuggedReader) from the desktop computer, click Tools > Explore Device in the ActiveSync window on your desktop computer.

   A list of folders appears, similar to File Explorer.

Double-click on My Windows-Mobile Based Device to see the folders on your RuggedReader.

From the list of folders, you can cut, copy, rename, and delete files, and you can transfer files to the desktop computer. See the following page for details.

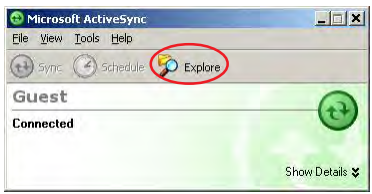
TRANSFERRING FILES TO & FROM THE RUGGEDREADER

TIP: Win-Situ Sync can automatically synchronize data files from In-Situ's RuggedReader applications to the Win-Situ data folders on your desktop PC. Use the "manual" method described here to transfer files created in other applications, or if Win-Situ Sync is not available.

You can copy or move files between the RuggedReader and a desktop computer using ActiveSync. File transfer is done **from the desktop computer side**.

To transfer files **from** the RuggedReader **to** the desktop computer:

1. Connect the RuggedReader to the desktop and re-establish an ActiveSync Guest connection or partnership.
2. In the ActiveSync window on your desktop computer, click the Explore icon on the toolbar or select Explore Device from the ActiveSync Tools menu.



3. On the desktop computer, open My Computer or Windows Explorer.

TIP: As an alternative to cut/paste, you can drag and drop files and folders between the windows.

4. In the ActiveSync window, navigate to the file(s) or folder(s) you want to copy or move, select them, right-click, and select Copy or Cut from the pop-up menu.
5. In My Computer or Windows Explorer on the desktop computer, navigate to the folder where you want to place the files, right-click on a blank area of the folder and select Paste from the pop-up menu.

To transfer files **to** the RuggedReader **from** the desktop computer, follow steps 1 through 3. Then

- In Step 4, navigate to and select files on the desktop computer,
- In Step 5, switch to the ActiveSync window, navigate to the folder where you want to put the files, drag or paste onto the RuggedReader.

6 USING IN-SITU SOFTWARE

Control software for In-Situ instruments is pre-installed, licensed, and ready to run on your new RuggedReader.

For this Instrument	Use this Program
Level TROLL®, Aqua TROLL®	Win-Situ® Mobile
Multi-Parameter TROLL® 9500, Multi-Parameter TROLL® 9000, miniTROLL®	Pocket-Situ 4
T506 Total Dissolved Gas probe	TDG Logger

TIP: *Win-Situ Mobile talks to Level TROLLs and Aqua TROLLs. Pocket-Situ 4 talks to Multi-Parameter TROLLs and miniTROLLs.*

USING WIN-SITU® MOBILE

Win-Situ Mobile communicates with Level TROLLs and Aqua TROLLs. A brief overview of the software is presented here. If you need help, refer to the Win-Situ Mobile Quick Start included with your RuggedReader.

Connect the Hardware

Connect the Level TROLL or Aqua TROLL to the RuggedReader's 9-pin serial port (see the RuggedReader Quick Start guide).

Launch the Software

TIP: For convenience in launching Win-Situ Mobile, you can assign it to one of the keypad buttons. See the procedure in Section 3.

Press the power button . Tap Start to display the Start menu.

Tap Programs > Win-Situ Mobile . The program launches and displays the functional area called "My Data"

Connect to the Device

Tap the Connect button

TIP: If the program launches in "demo" mode, you can activate it with the license key and activation code from your In-Situ License Agreement. Or contact In-Situ Technical Support at 1-800-446-7488.

When connected, focus shifts to the functional area called "Home." A real-time reading of each supported parameter is displayed. Readings update automatically while the **Read** button is pressed.

= Device not connected

= Device connected

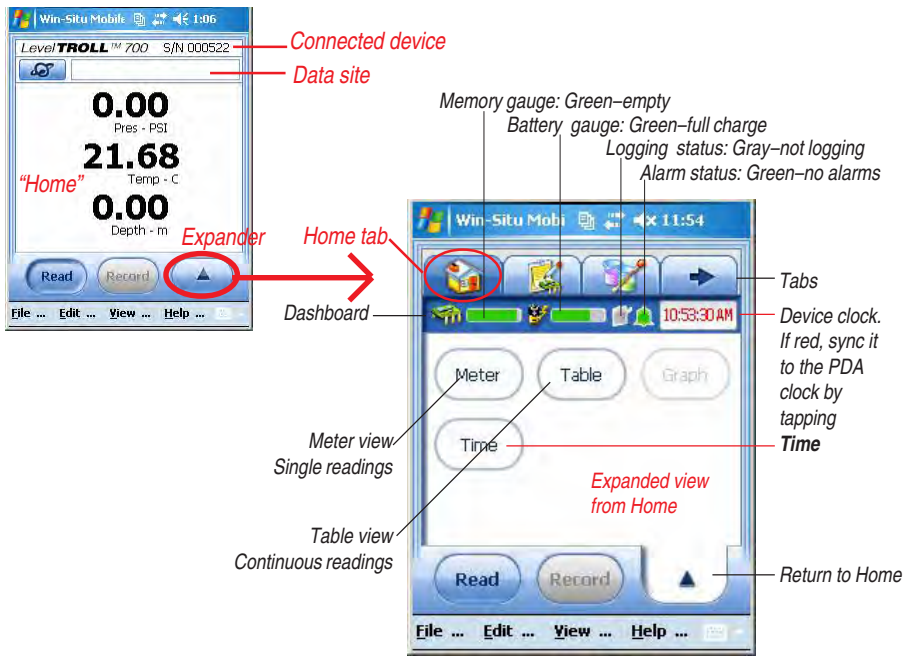
= Read button pressed (default)

= Read button not pressed

The following page introduces the buttons and functions in the Win-Situ Mobile Home screen.

Win-Situ Mobile, Functions from "Home" Tab

Note the all-important Expander button. It expands your view of available functions on all tabs



Set the TROLL's Clock

Set the device clock before logging: From Home, tap this sequence:

→ **Time** button → **Sync** button → →

Add a Data Site

= *Expander*

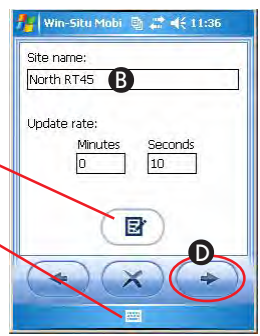
= *OK*

= *Next*

Data logs are organized and filed by the **Site** where the data were collected. The first thing you will be asked for in a log configuration is a site name. If a default site is provided, it may be used. But to clearly identify the place where data were logged, enter a new site, like this:

A File menu > New Site, tap the **New** button

B You are prompted for a Site name. There are 2 keypads you can use to enter text:
cellphone-type keypad
standard keypad



C Key in a short identifying name, then tap OK or to close the keypad

D Accept the default update rate, tap next

E In the next screen, enter site coordinates if you want, or tap OK to finish

F When the new site is shown again, tap OK

G When the Home tab returns to the screen, tap the site button , select the new site, tap OK. Your new site is now shown in the Home tab and is ready to use in logs.

Set up a Data Log

A Tap View menu > Logging to go to the Logging tab.

B At the Logging tap, tap the Expander button  .

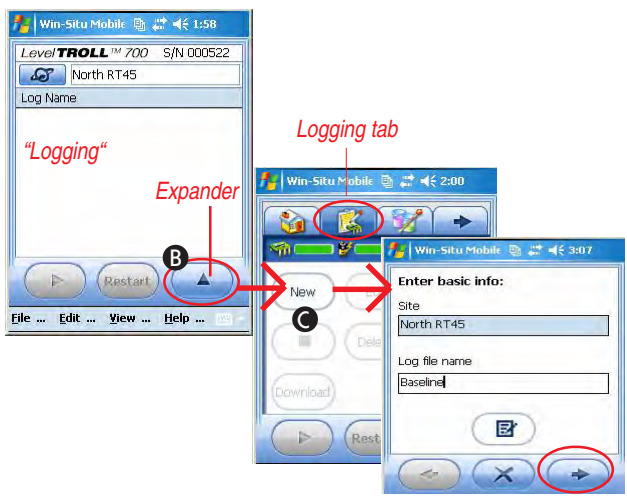
C In the Expander, tap the **New** button. The logging setup wizard starts. Follow the steps in the wizard, tapping Next  to continue in each screen. For help on the prompts, see the Win-Situ Mobile Quick Start included with your RuggedReader.

At the end of the Logging Setup Wizard, a summary of the log setup is shown. Tap OK  to write the log to the device.

 = *Expander*

 = *OK*

 = *Next*



= Manual Start log

= Scheduled Start log

= Running log

Start the Log

A Scheduled log starts at its programmed time.

To start a Manual log: Tap View menu > Logging, tap the log, tap Start.

You can safely disconnect from the RuggedReader now.

Download/View the Log

Tap View menu > Logging, tap the log, tap the Expander, tap **Download**. To view the data, select Yes at the end of the download. In My Data tab, tap **View**.

Stop the Log

Tap View menu > Logging, tap the log, tap the Expander, tap Stop

A Tap the log
B Tap the Expander
C Tap an action button

Exit Win-Situ Mobile

When you're ready to exit Win-Situ Mobile, tap File menu > Exit.

USING POCKET-SITU 4

TIP: Pocket-Situ 4 talks to Multi-Parameter TROLLs and miniTROLLs.

If you've used Win-Situ® 4 to communicate with your TROLL 9500, miniTROLL, or TROLL 9000, you already know how to run Pocket-Situ! If you need help, refer to the Win-Situ 4/Pocket-Situ 4 user's guide on the In-Situ Software/Resource CD. A brief overview is given here.

Connect the Hardware

Connect the instrument to the RuggedReader's 9-pin serial port (see the RuggedReader Quick Start guide).

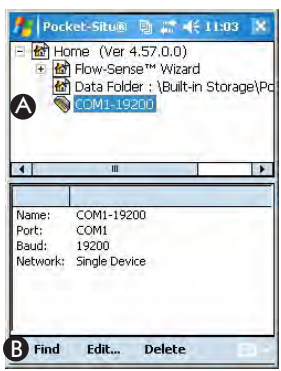
TIP: If the program launches in "demo" mode, you can activate it with the license key and activation code from your In-Situ License Agreement. Or contact In-Situ Technical Support at 1-800-446-7488.

Launch the Software

Press the power button on the RuggedReader. Tap Start to display the Start menu. Tap Programs > Pocket-Situ 4

On your first connection, follow the Connection Wizard to set up the COM port. Select a **Direct** connection to **One** device on **COM1** at **19200** baud.

"Find" the TROLL



A Tap the COM port.

B Tap **Find**. Pocket-Situ connects: First, the TROLL appears in the Navigation tree. Then Pocket-Situ retrieves device information. This can take a moment for an MP TROLL.

After the connection is made, the TROLL is shown in the Navigation tree with all device information.

If you are prompted to upgrade the device firmware, do so.

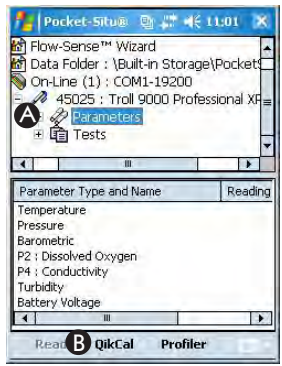
Set the TROLL's Clock

Select the TROLL in the tree and tap **Edit**, then **Clock** to synchronize the device clock to the RuggedReader clock.

Calibrate Water Quality Sensors

A Select **Parameters**

B Tap **QikCal**



Read Parameters

single reading:

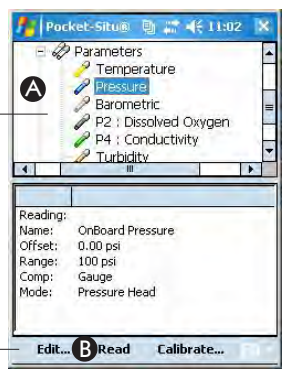
A Select any parameter

B Tap **Read**

Continuous readings (profiling):

A Select **Parameters**

B Tap **Profiler**



Log Data

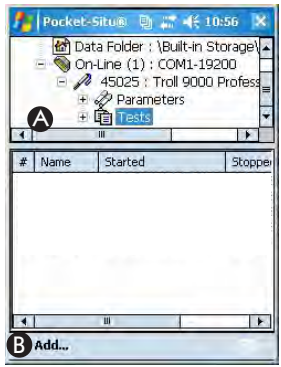
First, set up a test:

A Tap **Tests**

B Tap **Add**

C Follow the Wizard

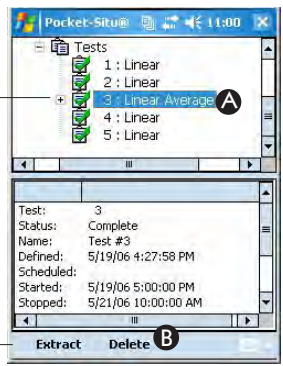
When finished, the test appears in the Navigation tree.



To start, stop, extract (download/view), or delete a test

A Tap a test

B Tap an action



Exit Pocket-Situ

When you're ready to exit Pocket-Situ:

Scroll to the top of the Navigation tree, tap **Home**

Tap **Exit**

USING TDG LOGGER

This application can display and log total dissolved gas and temperature readings from In-Situ's T506 TDG probe.

1. Connect the T506 to the RuggedReader's 9-pin serial port.
2. On the RuggedReader, tap Start > Programs > TDG Logger.

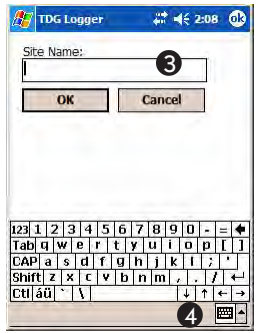
   The TDG Logger application will launch, and in a moment device readings will be displayed. Allow a few minutes for the readings to stabilize.

To record (log) readings, you must first specify a site. The Record button is dimmed out (unavailable) until a site is entered.

To enter a site:

1. Tap the down arrow beside the site box.
2. Select <New>.

3. Tap to put the cursor in the Site Name box.



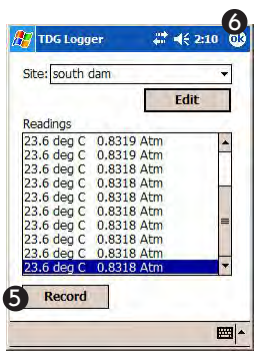
4. Tap the keyboard symbol and enter a site name.

   Tap OK when finished.

5. Tap the Record button to log readings.

6. Output will be logged until you tap OK to exit TDG Logger, or disconnect the probe.

   Readings will be logged to a .txt file on the RuggedReader (Built-In Storage \ TDGLogger) with the same name as the site. For the example here, use the File Explorer to navigate to My Device \ Built-In Storage \ TDGLogger \ south dam.txt.



TRANSFERRING FILES FROM THE RUGGEDREADER TO A DESKTOP/LAPTOP PC

Insure the following are installed on your desktop/laptop PC:

- Microsoft ActiveSync
- Win-Situ 5 for Level TROLL Aqua TROLL, and/or
- Win-Situ 4 for TROLL 9500, TROLL 9000, miniTROLL

Using Win-Situ® Sync (Automatic Transfer)

Win-Situ Sync can do the following on every ActiveSync connection (this is the default), or manually any time it is launched:

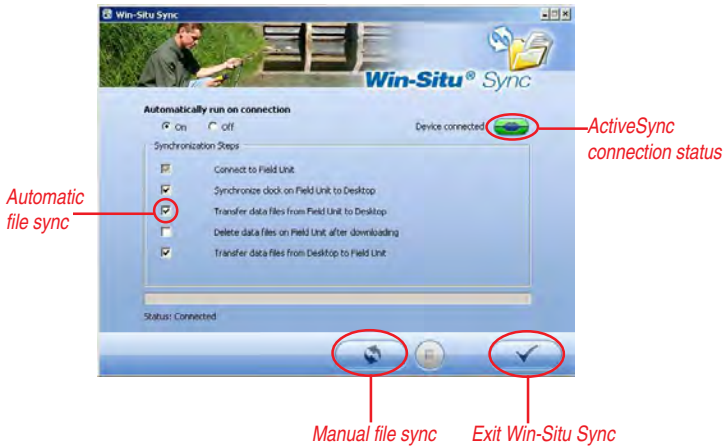
- Pull log data from Win-Situ Mobile on the RuggedReader to Win-Situ 5 on the desktop
- Pull log data from Pocket-Situ 4 on the RuggedReader to Win-Situ 4 on the desktop
- Pull log data from TDG Logger on the RuggedReader to MyDocuments \ TDGLogger on the desktop
- Optionally delete these files from the RuggedReader after the transfer
- Synchronize the RuggedReader time with the PC
- Push selected data files from Win-Situ 5 to Win-Situ Mobile
- Push selected Low Flow and data files from Win-Situ 4 to Pocket-Situ 4

TIP: If Win-Situ Sync is not available, ActiveSync may be used to manually transfer the files. See the following page.

1. Install Win-Situ Sync from the In-Situ website at www.in-situ.com (click on Downloads), or from the In-Situ Software/Resource CD.

2. When installed, the program will launch on ActiveSync connection. If the utility does not start automatically, briefly disconnect and then reconnect the USB cable. ActiveSync starts, and Win-Situ Sync begins to synchronize.

Application defaults are as shown below (you can change them). Progress is tracked as the steps are completed.



Using Microsoft ActiveSync (Manual Transfer)

If Win-Situ Sync is not available, ActiveSync can be used to transfer files manually from the RuggedReader to the desktop. Follow the procedure in Section 5, Transferring Files To & From the RuggedReader.

After the Transfer (either method)

To view the data, launch Win-Situ 5 or Win-Situ 4 on the desktop.

In the data area, navigate to and select the log file or test file.

To export to spreadsheet format, select File menu > Export to CSV or Export to Excel.

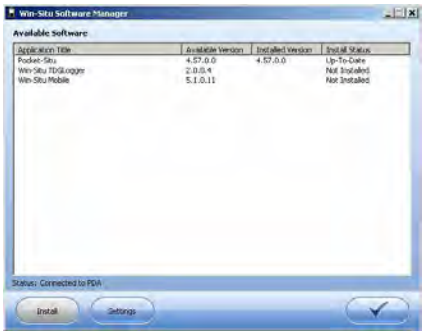
REINSTALLING THE IN-SITU SOFTWARE

TIP: *If possible, we recommend you re-establish an ActiveSync connection before downloading software. This simplifies installation.*

If you need to re-install the In-Situ software, follow these steps. Software may be installed from the In-Situ Software/Resource CD or the Downloads section of the In-Situ website at www.in-situ.com.

1. Do one of the following:
   - Insert the In-Situ Software/Resource CD in the CD drive of your desktop/laptop computer. (If the menu does not display automatically, choose Run from the Windows Start menu and type D:\ISISoftwareCD.html, where *D* is your CD-ROM drive letter.) Select Win-Situ Mobile or Pocket-Situ 4. Click on Setup. Follow the instructions to install the desktop utility, Win-Situ Software Manager, to your local hard drive. OR
   - Go to www.in-situ.com, click on Downloads, then on Software. Click the Win-Situ Mobile or Pocket-Situ 4 link and follow the instructions to install the desktop utility, Win-Situ Software Manager.
2. When prompted, launch the Software Manager utility. (You can also launch it from the Windows Start menu > Programs > In-Situ Inc folder.)
3. Connect to the RuggedReader via ActiveSync (if not already connected).

The Software Manager utility displays the available and current versions of software and the status of each.



4. Select the software to add to the RuggedReader and press **Install**. The selected software will be installed on the RuggedReader.

TIP: *If the software launches in "demo" mode after re-installation, you can activate it with the License Key and Activation Code from the In-Situ License Agreement shipped with your RuggedReader. Or contact In-Situ Technical Support at 1-800-446-7488.*

Installing from a CAB File

You can install Win-Situ Mobile or Pocket-Situ 4 onto the RuggedReader without an installation utility if you have the application's install file on your desktop/laptop computer as a "CAB" (a form of compressed application).

1. On the desktop: Connect in ActiveSync and drag the CAB into any folder on the RuggedReader. (See the procedure Transferring Files To & From the RuggedReader in Section 5.)

2. On the RuggedReader: Use File Explorer to navigate to the CAB file and tap to run it. (See Exploring Files in Section 4.) This installs the application.

The CAB file remains on the RuggedReader for re-installation of the application, if needed.

7 CARE AND MAINTENANCE

STORING THE RUGGEDREADER AND BATTERY PACKS

Storage Temperature Range

The RuggedReader can be stored at temperatures between -22° F and 140° F (-30° C to 60° C). If possible, store your RuggedReader indoors. Doing so helps protect your device from extreme temperatures and helps it run efficiently at startup.

Storing for Less than Two Weeks

If you plan to store your device for less than two weeks, suspend the device by following these steps:

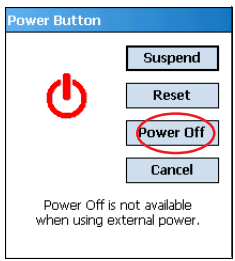
1. As a precaution, back up your data onto a desktop computer or an external storage device such as a CF or SD card.
2. Leave the battery pack in the device.
3. If you plan to store the device longer than a few days, it is a good idea to leave the device connected to the wall charger to make sure the battery pack is fully charged.
4. Suspend the device (press the power button briefly and release).

Storing for More than Two Weeks

To store the device safely for longer than two weeks, follow these steps:

1. Back up your data.
2. Tap the Applications Manager icon to close all running programs.
3. Charge the battery pack to full capacity (100%).
4. Unplug the wall charger.
5. Press the power button until the power button menu appears.
6. Select Power Off from the menu.
7. Place the RuggedReader in a safe, dry place.

TIP: The device cannot be powered off while it is plugged into the wall charger.



Taking the RuggedReader out of Extended Storage

The battery pack discharges slightly during extended storage periods. When you are ready to use your RuggedReader again, follow these steps so your battery pack runs efficiently:

1. Plug the RuggedReader into a charger.
2. Charge the battery pack.

   You can check the battery power status by tapping on the battery icon at the top of the screen.

PROTECTING AGAINST MECHANICAL SHOCK

The RuggedReader is designed for protection against mechanical shock. It can be dropped from up to five feet onto concrete. Shock protection is guaranteed only when the top cap and main piece are securely in place.

SAFELY USING THE BATTERY PACK

- Use only battery packs approved for use with this device.
- Do not store or leave your device or battery pack near a heat source such as a radiator, fireplace, stove, electric heater, or other heat-generating appliance or otherwise expose it to temperatures in excess of 140° F (60° C).
- Do not try to open the battery pack.
- Do not carry a battery pack in your pocket, purse, or other container where metal objects (such as car keys or paper clips) could short-circuit the battery pack terminals.
- Charge the battery pack only in the RuggedReader.
- Charge the battery pack in temperatures between 32°F and 95°F (0° C and 32° C).
- Keep the battery pack contacts clean. If they get dirty wipe them off with a soft cloth.
- Dispose of the battery pack properly. See Disposing of the RuggedReader and Batteries.

SAFELY USING THE WALL CHARGER

Use only the AC adapter shipped with your RuggedReader. Damage caused by the use of third-party converters is not covered by the warranty.

- Use only wall chargers intended for the RuggedReader. Using any other external power source can damage your product and voids your warranty.
- Wall chargers are designed for indoor use only. Avoid using the wall charger in wet, outdoor areas.
- Unplug the wall charger from the power outlet when it is not being used to charge the device.

REPLACING THE BATTERY PACK

To replace the battery pack, follow these steps:

CAUTION: The device only stays on for about five seconds without a power source. ***Always suspend your device before replacing the battery pack.***

1. Close all running programs.
2. **Suspend the device** (press the power button briefly and release)**.**
3. Slowly unhook and lift up the bottom hand strap latch. CAUTION: Do not let the hand strap hook hit the display.

4. Press on the battery door about ¼" beneath the door latch and slide the door latch to the right.

5. Remove the battery door.

   The door may make a noise while it is being removed, caused by the door scraping against the battery. The sound is normal and no damage is done when you hear this sound.

6. Remove the old battery pack.
7. Make sure the battery contacts of the replacement battery pack are clean and dry.

8. Insert the replacement battery pack, lining up the battery contacts with the RuggedReader contacts.

9. Insert the tabs on the bottom of the battery door into the case slots. Close the battery door, making sure the door latch is in the unlock position as the door meets the case.

10. With the door latch in the unlock position, press on the battery door just below the door latch and slide the latch to the left to lock it.

11. Reattach the hand strap.

Note: If you remove the battery from your device and the device is still attached to the wall charger, the battery icon still appears on the display. When the battery is replaced, charging resumes.

For instructions on charging a battery, see Step 2 in Section 2. For guidelines on caring for your battery pack, see Safely Using the Battery Pack earlier in this section.

USING THE RUGGEDREADER IN EXTREME TEMPERATURES

The RuggedReader operates from -22° F to 122° F (-30° C to 50° C). To help your device function properly, store it device indoors when possible.

Other tips:

- If the RuggedReader is exposed to temperatures below 14° F (-10°C), the device may slow down or its display backlight may become dim to reduce the load on the battery power.
- Extremely low or high temperatures may prevent the battery pack from charging. Charge the battery pack in temperatures between 32°F and 95°F (0° C and 32° C).

Always make sure the top cap is on and the screws are fitted tightly before you begin cleaning your RuggedReader.

CLEANING THE RUGGEDREADER

CAUTION: Long exposure to the following may damage your device:

· pine oil
· oil-based paint
· automotive brake cleaner
· isopropyl alcohol
· carburetor cleaner

TIP: *Try to avoid prolonged direct exposure to salt water, mud, or debris. Rinse the Rugged Reader in clean running water, shake or wipe to remove moisture, especially from the connectors. Note that the battery door may trap water or dirt.*

If the device is exposed to one of these, wipe it off with a mild cleaning solution. After exposure to salt water, rinse in clean water and dry.

Touchscreen

To clean the touchscreen, follow these steps:

1. Press the power button briefly to suspend the device.
2. If you applied a protector to the touchscreen, carefully remove it.

3. Apply water or a mild cleaning solution such as Windex or 409 to a microfiber cloth and gently wipe off the touchscreen. Other approved cleaners include Citrus Wonder and Citrus All Purpose Cleaner. CAUTION: Do not use tissues, paper towels, or harsh cleaning agents to clean the touchscreen.

4. If you used a cleaning solution, rinse the touchscreen with water and dry it with a microfiber cloth.

5. Press the power button to resume the device.

Case Overmolding

Clean the rubber-like overmolding that surrounds the case with a cloth and a mild cleaning solution like 409 or Citrus Wonder. Rinse with water and wipe dry.

Communications Module

This is the area housing the USB port, DC jack, and serial port. To clean the communications module, run it under a faucet. Use a soft toothbrush or toothpick to clean out any remaining dirt. Shake or blot to dry.

Speaker and Microphone

If debris gets in the speaker or microphone, use a soft bristle brush to remove it. Do not insert any object into the speaker or microphone holes.

Stylus Slot

Rinse the stylus slot with water. Shake to remove the excess.

Display Bezel

If the edge under the bezel gets dirty, use a microfiber cloth to remove the debris. Do not remove the bezel.

REPAIRING THE RUGGEDREADER

Do not attempt to service the RuggedReader yourself. *This action voids the warranty.*

If the RuggedReader is in need of repair, contact In-Situ Inc. for a Return Materials Authorization (RMA) number as described in Section 1. Do not attempt to service the device yourself. This action voids the warranty.

DISPOSING OF THE RUGGEDREADER AND BATTERIES

Do not dismantle your RuggedReader. To recycle your RuggedReader, return it to your distributor.

The lithium-ion battery packs for your RuggedReader are recyclable. Avoid placing them in the trash or the municipal waste system.

To find the nearest battery recycling center in the USA, visit the Rechargeable Battery Recycling Corporation's website at www.rbrc.org/call2recycle/index.html or call 1-800-8-battery.

ENVIRONMENTAL HAZARDS

The RuggedReader contains no mercury or cadmium.

8 TROUBLESHOOTING

Answers to issues not addressed here may be available through on-device help or the Windows Mobile website from Microsoft at www.Microsoft.com/mobile. If you cannot find answers to your questions through these methods, contact In-Situ Inc. as described in Section 1.

Problem

The touchscreen does not respond accurately to stylus taps.

Solutions

- Try recalibrating the touchscreen. (See Calibrating the Touchscreen in Section 3.)
- If the device is not responding to stylus taps at all and you are on the Today screen, look to see if the device is locked. To unlock the device, press the “Unlock” soft key on the screen.
- If the device is unlocked but the stylus continues to respond inaccurately, close all open programs and reset the device. (Press  until the power button menu appears, choose Reset.)

Problem

During calibration, the screen does not respond to stylus strokes or does not complete the calibration process.

Solutions

Check to see if there is something stuck underneath the bezel. Use a microfiber cloth to remove any excess debris. Also check to see if there is damage or wear on any area of the touchscreen. In case of damage, contact In-Situ Inc.

Problem

The RuggedReader runs slowly.

Solutions

It is possible that you have too many programs running. Try closing any programs you are not using. To view and close running programs:

1. Tap on the Applications Manager icon  .
2. Tap on the Running Programs tab in the Applications Manager window.
3. Select a program and tap Stop. This closes the program.

Problem

My RuggedReader quickly drops its ActiveSync connection to my desktop computer.

Solutions

Firewall programs sometimes cause ActiveSync connection problems. In these cases, the firewall sees the RuggedReader as a strange and possibly hostile computer and prevents the device from connecting to the desktop computer. To allow the mobile device to connect to your desktop computer, follow these steps:

1. Use the serial cable to connect your device to the desktop computer. Follow the ActiveSync wizard instructions.
2. If your firewall application brings up a warning message asking whether you want to allow a connection, check the option to allow the connection and click "Yes." Note: If the warning message above does not appear when you try to connect to the desktop computer but the device is still being dropped, contact your system administrator.

For other ActiveSync issues, visit www.Microsoft.com/Windowsmobile/help/ActiveSync/default.mspx.

Problem

The RuggedReader locks up.

Solution

To reset the device, press and hold the power button  for 10 seconds or until the screen goes dark. The device turns on again after a few seconds.

APPENDIX A: SPECIFICATIONS

Operating System	Microsoft® Windows Mobile® 5.0
Processor	Intel® XScale® PXA270, 520 MHz
Memory	64 MB low-power RAM
Storage	Internal solid-state 128 MB Flash
Display	3.5" (89 mm) QVGA active matrix color TFT transflective (outdoor) viewable) LCD with LED backlight; 240 x 320 pixels
Touchscreen	Sealed, resistive, pressure sensitive
CF and SD Card Slots	Compact Flash (Type I or Type II), Secure Digital (SD or SDIO); CF card slot provides 3.3 volts; user accessible, sealed
Keyboard	Four-way directional button, standard key functions, LED backlit keys
Physical	6.5" length x 3.5" wide x 1.7" thick (165 x 89 x 43 mm), 17 oz (482 g); magnesium case with elastomer overmold
Operating Temperature	-22° to 122° F (-30° to 50° C)
Storage Temperature	-22° to 140° F (-30° to 60° C)
IP67	Sealed rating, waterproof and dustproof
MIL-STD-810F	Water, humidity, sand and dust, vibration, altitude, shock, high temperature, low temperature, temperature shock
Shock Absorbency	Multiple drops onto concrete from 5 ft (1.5 m) through temperatures ranging from -22 to 122° F (-30 to 50° C)

Batteries	Intelligent, rechargeable Li-Ion battery pack, 14 W-hr (nom.), operates for more than 20 hours on one charge, charges in 3 to 5 hours, internal circuitry sealed against moisture when battery is removed, change without tools
Communications Module	9-pin D-sub connector, USB Host (Mini A), USB Client (Mini B), 12 VDC jack for power input and battery charging; modular; field replaceable
Wireless Communication options	Bluetooth-supported with CF or SD Bluetooth card, Wi-Fi supported, wireless cellular modem
Internal Clock	Battery-backed real time clock keeps time and date when battery is removed
Development Environment	SDK for Windows Mobile for Embedded Visual C++ version 4.0 and Visual Studio 2005
Enunciators	External power/charge LED and notification LED; other enunciators on system tray
Standard Accessories	Rechargeable Li-Ion battery, wall charger (universal voltage, output 12V, 0.84A max.), USB sync cable, captured full-size stylus, hand strap, screen protectors, quick start guide, dashboard accessory pad, Microsoft Getting Started CD, In-Situ Software/Resource CD
Certifications	FCC Class A, European CE Mark
Software Included	Microsoft Internet Explorer® Mobile, Microsoft Office Mobile (Word Mobile, Excel® Mobile, PowerPoint® Mobile), Microsoft Outlook® Mobile (Inbox, Calendar, Contacts, Instant Messaging, Tasks, Notes, Spell Checker), Microsoft ActiveSync® 4.0 for desktop computer, Terminal Services Client, Microsoft Windows Media Player 10 Mobile, Calculator, games, Pictures and Videos (image and video viewer), Voice Recorder, Handwriting Recognition, Win-Situ® Mobile, Pocket-Situ 4, TDG Logger

9-PIN SERIAL PORT PINOUTS

Pin #	Description
1	Data Carrier Detect (DCD) Input
2	Receive Data (RCD) Input
3	Transmit Data (TXD) Output
4	Data Terminal Ready (DTR) Output
5	Ground (GND)
6	Data Set Ready (DSR) Input
7	Request To Send (RTS) Output
8	Clear To Send (CTS) Input
9	Ring Indicator (RI) Input

In-Situ Inc.

APPENDIX B: CERTIFICATIONS & REGULATORY INFORMATION

REGULATORY INFORMATION

U.S.A.

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 used in a commercial or residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not used in accordance with the user's guide, may cause harmful interference to radio communication. Operation of this equipment is subject to the following two conditions:

1. The device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and EN 450 14

Manufacturer's Name:	Juniper Systems, Inc.
Manufacturer's Address:	1132 West 1700 North Logan, UT 84321 USA

Declares, under our sole responsibility, that the product:

Product Name:	Archer Field PC
Model Number:	1.01
Product Options:	ALL

Conforms to the following Product Specifications:

- Emissions Testing EN 55022
- Immunity Testing EN 55024
- Electrostatic Discharge Immunity (IEC 61000-4-2)
- Radiated Immunity (IEC 61000-4-3)
- Electrical Fast Transients (EFT) Immunity (IEC 61000-4-4)
- Surge Immunity (IEC 61000-4-5)
- Conducted Immunity (IEC 61000-4-6)
- Power Frequency Magnetic Field Immunity (IEC 61000-4-8)
- Power Quality (dips and sags) (IEC 61000-4-11)

CAUTION: Only approved accessories may be used with this equipment. In general, all cables must be high quality, shielded, correctly terminated, and normally restricted to two meters in length. AC adapters approved for this product employ special provisions to avoid radio interference and should not be altered or substituted. Unapproved modifications or operations beyond or in conflict with these instructions for use may void authorization by the authorities to operate the equipment.

APPENDIX C: PROGRAMS & SETTINGS

APPLICATIONS IN THE PROGRAMS MENU

The Programs menu lists applications installed on your RuggedReader. To access the Programs menu, tap Start > Programs. Applications in the Programs menu are described below in the order they appear.

TIP: *Many programs provide on-device help. To use it, open the program, then tap Start > Help.*

Games. Bubble Breaker and Solitaire.

ActiveSync. Synchronizes your RuggedReader with a desktop or laptop computer. You can also use ActiveSync to explore your RuggedReader and synchronize your contacts, calendar, e-mail, and more.

Calculator. Simulates a calculator.

Download Agent. Automates the process of downloading RuggedReader software updates from the Internet directly to your RuggedReader. If you are connected through ActiveSync to a PC with an Internet connection or if you are connected to the Internet through a modem card such as a dial-up, Ethernet, Wi-Fi, cellular, or Bluetooth card, Download Agent automatically displays available updates to the RuggedReader.

Excel Mobile. Lets you view and create charts. Compatible with Microsoft Excel— open and edit an Excel chart from your desktop computer using Excel Mobile on your RuggedReader.

File Explorer. Lets you view, expand, and collapse the RuggedReader directory folders so you can locate files.

Modem Link. Allows you to connect your RuggedReader to the Internet or computer network through Compact Flash (CF) and Secure Digital (SD) adapters (e.g., 56K dial-up modem or Ethernet adapters).

Notes. Lets you create personal notes or record voice clips. If you don't see the Recording toolbar, tap Menu > View Recording Toolbar.

Pictures & Videos. Lets you preview a picture or video without opening it.

Pocket MSN. Gives you quick access to your MSN Hotmail Inbox and your MSN Messenger account.

Pocket-Situ 4. Installed by In-Situ Inc.

PowerPoint Mobile. Lets you view or rehearse PowerPoint presentations built on a desktop computer.

Search. Searches for files or programs on the RuggedReader.

Tasks. Stores and tracks new and existing tasks.

Terminal Services Client. Lets you log on to a PC running Terminal Services or Remote Desktop and use all of the programs available on that PC from your mobile device.

TDG Logger. Installed by In-Situ Inc.

Win-Situ Mobile. Installed by In-Situ Inc.

Word Mobile. Creates and edits documents with graphics while maintaining document formatting. Compatible with Microsoft Word—open and edit a Word file from your desktop computer using Word Mobile.

Programs Installed by In-Situ Inc.

Pocket-Situ 4. Control software for MP TROLL 9500s, miniTROLLs, and MP TROLL 9000s.

TDG Logger. Displays and logs readings from In-Situ's T506 Total Dissolved Gas probe.

Win-Situ Mobile. Control software for Level TROLLs and Aqua TROLLs.

ACCESSING PROGRAMS ON THE GETTING STARTED CD

In addition to installing ActiveSync, the Getting Started CD that came with your RuggedReader provides links to purchase additional programs from Microsoft. If you wish to take advantage of these, insert the Getting Started CD into your desktop computer, select "Add new programs to my device," and follow the instructions. For further help, visit Microsoft's website, www.Microsoft.com/mobile.

SETTINGS

To access settings, tap Start > Settings. The Settings window appears, showing three menu tabs: Personal settings, System settings, and Connections settings. The table below shows the location of specific settings.

To change settings on your device: Choose one of the tabs at the bottom of the Settings screen, tap on the setting you want to change, adjust the setting controls and tap OK.

Settings

Setting	Personal settings	System settings	Connections settings
About		X	
Backlight		X	
Beam			X
Bluetooth			X
Buttons	X		
Brightness		X	
Certificates		X	
Clock & Alarms		X	
Connections			X
Error Reporting		X	
Input	X		
Lock	X		
Memory		X	
Menus	X		
MSN options	X		
Network cards			X
Owner Info	X		
Power		X	
Regional Settings		X	
Remove Programs		X	
Screen		X	
Sounds & Notifications	X		
Today	X		

In-Situ Inc.

Index

User's Guide

Instruction Sheet

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ISO 9001 CERTIFIED CORPORATE QUALITY
STAMFORD, CT

ISO 9002 CERTIFIED CORPORATE QUALITY
MANCHESTER, UK

OM-EL-USB-4

4-20mA CURRENT LOOP USB DATA LOGGER

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Toll Free in United Kingdom: 0800-488-488
e-mail: sales@omega.co.uk

OM-EL-USB-4
4-20mA CURRENT LOOP USB DATA LOGGER

INSTRUCTION SHEET

This data logger measures and stores up to 32,000 current loop readings over a 4-20mA measurement range. The user can easily set up the logging rate and start time, and download the stored data by plugging the module straight into a PC's USB port and running the purpose designed software under Windows 98, 2000 or XP. The data can be graphed, printed and exported to other applications. The data logger is supplied complete with a long-life lithium battery. Correct functioning of the unit is indicated by a flashing red and green LED. The data logger features a pair of screw terminals and is supplied complete with a set of measurement leads terminating in crocodile clips.

- 4-20mA Current Loop Measurement Range
- Logging Rates between 1s and 12hr
- Stores 32,000 readings
- Connection via two screw terminals
- USB Interface for Set-up and Data Download
- User-Programmable Alarm Thresholds
- Red and Green LED Status Indication
- Replaceable Internal Lithium Battery

Windows™ Control Software

Model No - OM-EL-USB-4

Easy to install and use, the control software runs under Windows 98, 2000 and XP (Home Professional Editions). It allows the user to set up and download any OM-EL-USB-4. The latest version of the control software may be downloaded free of charge from www.omega.com.

Data Logger Set-ups

- Logger Name
- Logging Rate (1s, 10s, 1m, 5m, 30m, 1hr, 6hr, 12hr)
- High and Low Alarms
- Start Date and Start Time

ORDERING INFORMATION

	Stock Number
Standard Data Logger (Data Logger, Measurement Leads, Software on CD and Battery)	OM-EL-USB-4
Replacement Battery	OM-EL-BATT

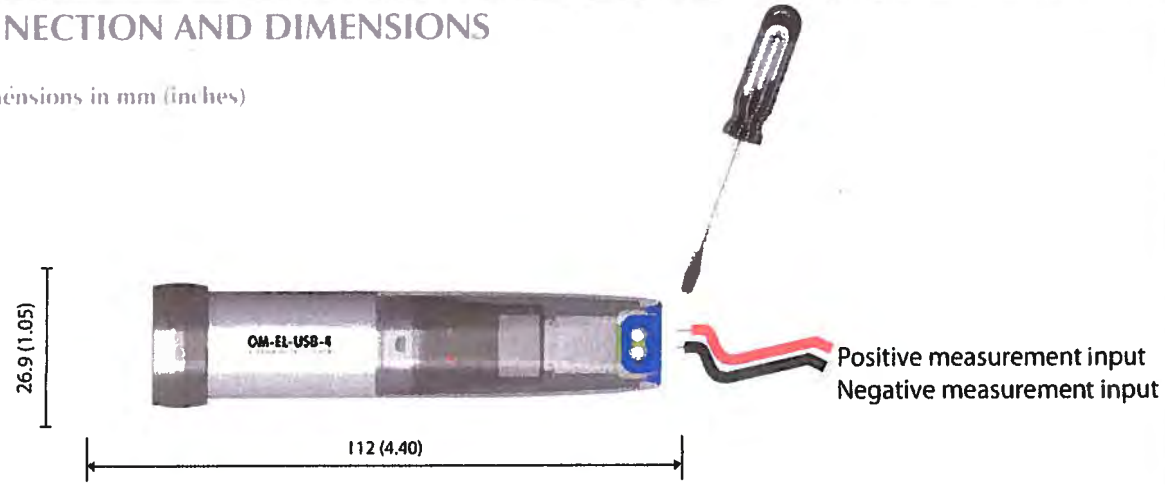
SPECIFICATIONS

Specification	Min.	Typ.	Max.	Unit
4-20mA d.c measurement range		4-20		mA d.c.
Internal resolution		±0.05		mA d.c.
Accuracy (overall error)		±1		%±1 count
Logging rate	every 1s		every 12hr	-
Operating temperature range	-35 (-31)		+80 (176)	°C (°F)
1/2AA 3.6V Lithium Battery Life*	1			Year

* depending on ambient temperature, logging rate and use of alarm LEDs.

CONNECTION AND DIMENSIONS

All dimensions in mm (inches)



BATTERY REPLACEMENT

We recommend that you replace the battery every 12 months, or prior to logging critical data.

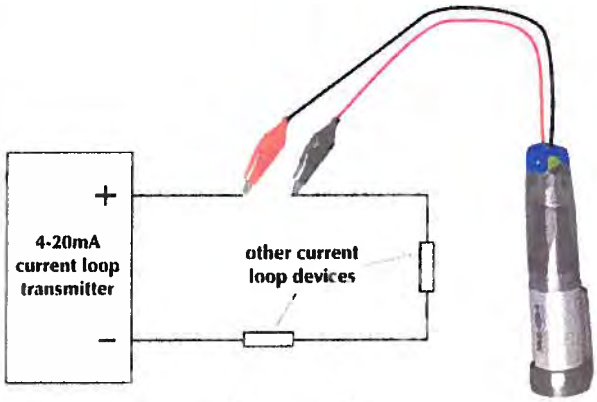
The OM-EL-USB-4 does not lose its stored readings when the battery is discharged or when the battery is replaced; the data logging process will however be stopped and cannot be re-started until the battery has been replaced and the logged data has been downloaded to PC.

Use only Omega model no. OM-EL-BATT replacement battery. The battery is 'press fit' and is not fitted with solder tags.

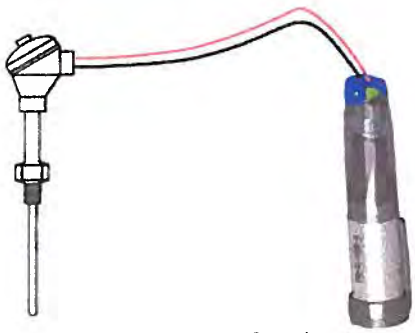
Note:
Leaving the OM-EL-USB-4 plugged into the USB port for longer than necessary will cause some of the battery capacity to be lost.

WARNING: Handle lithium batteries carefully, observe warnings on battery casing. Dispose of in accordance with local regulations.

APPLICATIONS



OM-EL-USB-4 fitted to a 4-20mA current loop transmitter



OM-EL-USB-4 fitted to a 4-20mA probe head

LED FLASHING MODES

OM-EL-USB-4 features a red and a green LED.

The LEDs on an OM-EL-USB-4 will flash in one of the following ways, assuming alarm latching is turned off (exact timings to be confirmed).

- Green single flash, every 30 seconds	Logger primed and ready to start.
- Green single flash, every 10 seconds	Logging in progress, last stored value OK
- Red single flash, every 10 seconds	Logging in progress, the last stored reading is equal to or exceeds the low alarm level (If latching is turned on, then a stored value is equal to or exceeds the low alarm level)
- Red double flash every 10 seconds	Logging in progress, the last stored reading is equal to or exceeds the high alarm level (If latching is turned on, then a stored value is equal to or exceeds the high alarm level)
- Green single flash, every 20 seconds	Low battery, logging in progress, the last stored value OK
- Red single flash, every 20 seconds	Low battery, logging in progress, the last stored value is equal to or exceeds the low alarm level
- Red double flash, every 20 seconds	Low battery, logging in progress, the last stored value is equal to or exceeds the high alarm level
- Green double flash, every 20 seconds	Logger is full, last stored value OK
- Red/Green single flash, every 20 seconds, alarm latching turned on	Logger is full, last stored value is equal to or exceeds the low or high alarm level
- No LEDs flash	LEDs disabled during configuration to save battery power and increase logging duration. or Battery dead.

By default latching is disabled. This means that the red LED will then no longer continue to flash after the logged voltage has returned to normal. Instead, the green LED will then flash.

Latching can be turned on via the control software. This means that the red LED will continue to flash, even after the logged voltage has returned to normal. The red LED will effectively have latched into its alarm condition. This feature ensures that the user is notified that an alarm level has been exceeded, without the need to download the data from the logger.

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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- Transducers & Strain Gages
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- Data Acquisition & Engineering Software
- Communications-Based Acquisition Systems
- Plug-in Cards for Apple, IBM & Compatibles
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- Recorders, Printers & Plotters

HEATERS

- Heating Cable
- Cartridge & Strip Heaters
- Immersion & Band Heaters
- Flexible Heaters
- Laboratory Heaters

ENVIRONMENTAL MONITORING AND CONTROL

- Metering & Control Instrumentation
- Refractometers
- Pumps & Tubing
- Air, Soil & Water Monitors
- Industrial Water & Wastewater Treatment
- pH, Conductivity & Dissolved Oxygen Instruments

M4220/1008

VOLUMETRIC WEIRS

For measuring flows in Manholes and Open End Pipes

WEIR SET
(refer to back page for details)

15" WEIR WITH 18" ADAPTER

WEIR WITH BUBBLER TUBE

The most practical, economical instrument for testing new sewer lines - night flow studies of existing lines – free flow from open end pipe.

A VOLUMETRIC calibrated weir is a portable flow measuring device that is used to determine infiltration in newly installed sewer lines, or measure substantial flows in existing lines.

THE THEL-MAR VOLUMETRIC weir is basically a compound weir that incorporates the advantage of a 90° V-notch for measuring small infiltration flow where accuracy is of prime importance. The V-notch section measures from 57 gallons to 3700 gallons per 24 hours, which is the range of normal Acceptance Test Requirements. The rectangular section of the weir is capable of measuring in gallons per day up to 35% of pipe capacity.

A BUBBLE LEVEL is mounted at the top of the weir's face plate for easy visibility. Thel-Mar weirs are calibrated in U.S. GALLONS PER 24 HOURS (METRIC WEIRS CUBIC METERS PER HOUR) in large, easy to read type. Calibration lines are in 2 millimeter increments.

DISCHARGE CALIBRATIONS for the Volumetric Weir were accurately determined in a hydraulic laboratory where manhole conditions were duplicated. Therefore, there are no induced errors by insufficient drop of the nappe or by contractions, velocity of approach, submergency, or drawdown.

RUGGED CONSTRUCTION and noncorroding materials make the Thel-Mar weir extremely reliable. There are no loose parts that require assembly. Installation is quick and positive and the weir requires a minimum of care.

A COMPOUND WEIR offers minimum restriction to flow and is relatively free from becoming clogged by debris from sewage. Thel-Mar weirs can be installed for extended periods of time without accumulation of sediment.

ERRORS IN EXCESS OF 100% exist in other calibrated V-notch weirs. Unlike the Thel-Mar weir these were calibrated by the cone formula.

EASY TO READ FLOW RATE Simply check water level at the face plate. The figure above the line matching the water level gives you the rate of flow in GALLONS PER 24 HOURS (METRIC WEIRS-CUBIC METERS PER HOUR).

BUBBLER FLOW METERS Especially designed for use with Bubbler Flow Meters, all Volumetric Weirs are now available with an attached "Bubbler Tube". These weirs are manufactured with a 1/8 inch O.D. stainless steel tube attached to the right side of the adjustable ring. The bubbler tube protrudes forward approximately two inches from near the top of the ring for easy connection to a line. It runs from there down the inside of the ring to approximately 1 3/8-inch behind and below the V-notch. This bubbler tube does not in any way affect the function of the Volumetric Weir.

INSTALLATION INSTRUCTIONS
Prior to installation, the interior edge of the incoming pipe should be cleared of sediment and foriegn matter to assure seal of the gasket.

Turn thumb-wheel to extreme right. Place hand through weir opening, wiht thumb and index finger compress spring. Insert weir into incoming pipe about 1", and release tension from spring. Secure by turning thumb-wheel to left and finger tighten.

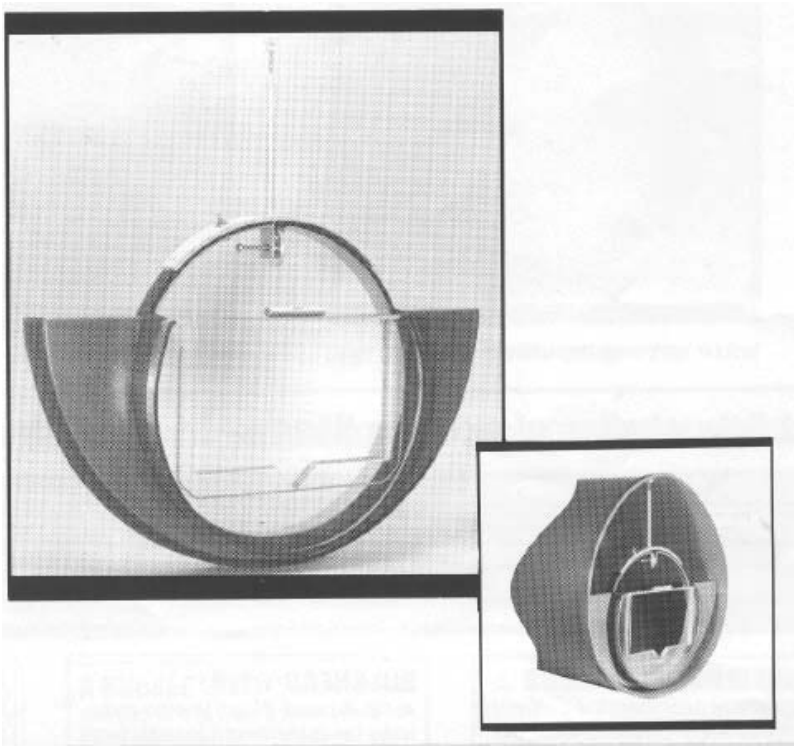
Allow sufficient time for water to back up and behind the weir and establish a uniform flow; five to ten minutes for existing flow to an hour for accurate infiltration readings.

15” WEIR WITH ADAPTOR INSTALLED IN 24” PIPE

Individual Volumetric Weirs are available for 6", 8", 10", 12", 14", 15" and 16" pipe. The 14" weir uses a 12" face plate. Adaptors for 18", 21", 24", 27", 30", 36", 42" and 48" pipe are used in conjunction with the 15" weir.

Volumetric Weirs are also available in a set. Set A consists of 6", 8", 10’, 12" and 15" weirs with an 18” adaptor and carrying case with handle and hasp. It measures 191/2"W x 191/2"D x 71/2"H. Set B is similar and designed to be used with Bubbler Flow Meters.

Adaptors are available individually or in a set. Set C consists of 21" through 48" adaptors. No carrying case included.



WEIR CAPACITIES AND HEAD

CAPACITIES*			HEAD**
6"	57 to 3700 GPD within V-notch,	rectangular to 46,000 GPD	2.8437
8"	57 to 3700 GPD within V-notch,	rectangular to 124,000 GPD	4.0000
10"	57 to 3700 GPD within V-notch,	rectangular to 234,000 GPD	5.1250
12"	57 to 3700 GPD within V-notch,	rectangular to 361,000 GPD	5.8125
14"	57 to 3700 GPD within V-notch,	rectangular to 361,000 GPD	5.8125
15"	57 to 3700 GPD within V-notch,	rectangular to 610,000 GPD	7.3125
16"	57 to 3700 GPD within V-notch,	rectangular to 610,000 GPD	7.3125
Bulkhead Weir	57 to 3700 GPD within V-notch,	rectangular to 610,000 GPD	7.3125

* Calibration lines are in 2 millimeter increments.
** In inches from top of rectangular opening to bottom of V-notch.

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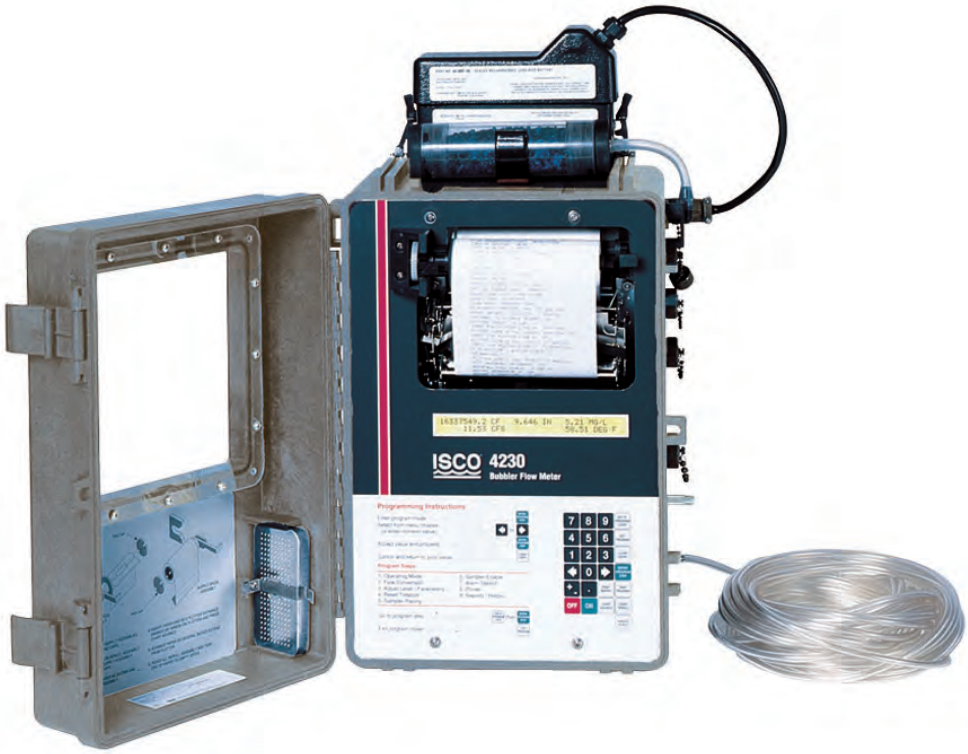
4230 Flow Meter

Installation and Operation Guide



TELEDYNE ISCO
A Teledyne Technologies Company

Part #60-3233-142 of Assembly #60-3234-051

Revision EE, November 2, 2011

Foreword

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

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

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

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

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

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

Contact Information

Customer Service

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

Technical Support

Phone:	(800) 775-2965	(Analytical)
	(866) 298-6174	(Samplers and Flow Meters)
Email:	IscoService@teledyne.com	
Return equipment to:	4700 Superior Street, Lincoln, NE 68504-1398	

Other Correspondence

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

Revised March 17, 2009

General Warnings

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

WARNING

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

AVERTISSEMENT

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

Hazard Severity Levels

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

CAUTION

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

WARNING

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

DANGER

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

Hazard Symbols

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

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

- ADDENDUM -

The 4230 flow meter will become inaccurate displaying the depth, flow, and total flow when exposed to electromagnetic fields in excess of 1.0V/m between 105 MgHz and 820 MgHz. It is suggested that the instrument be placed in a location where these electromagnetic fields are not present, or the source of the radiation is removed from the vicinity of the instrument if possible.

4230 Flow Meter

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Section 1 Introduction

Section 2 Programming

Section 3 Installation

Section 4 Optional Equipment

Section 5 Maintenance and Service

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Appendix B Programming Worksheets

Appendix C General Safety Procedures

Appendix D Material Safety Data Sheets

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List of Tables

4230 Flow Meter

Section 1 Introduction

This section provides a general introduction to the 4230 Bubbler Flow Meter. It includes a description of the flow meter, an explanation of how the unit operates, and technical specifications.

Manual Organization – This manual provides the information necessary to operate, maintain, and perform minor service on the 4230. The manual is organized into five sections:

Section 1: Introduction, operation, and specifications

Section 2: Keypad operation and programming for the 4230 Flow Meter

Section 3: Installation and options application-specific to the 4230

Section 4: Options and accessories for all 4200 Series flow meters

Section 5: Routine maintenance and minor service

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

1.1 Description

The 4230 uses the bubbler method of level measurement. The flow meter is normally used with some type of primary measuring device to measure flow in an open channel. The 4230 has built-in standard level-to-flow conversions, that cover the vast majority of open channel flow measurement situations. The 4230 is also capable of calculating flow using the Manning Equation. Additionally, you can enter a non-standard equation or data points, that effectively plot a user-derived flow profile for a flow stream. The 4230 supports the Isco data acquisition, storage, and retrieval system with the use of optional Flowlink software. The 4230 has enough memory to store over 40,000 data readings. An optional 4200T Modem, with speech capability, is available to transmit stored data over standard dial-up telephone lines.

1.2 Compatible Equipment

The 4230 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
- GLS and Glacier Compact Samplers
- 4-20 mA Output Interface
- 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 Equipment and Accessories

- 4200T Modem - Speech-capable, with connector and cable
- D.O. (dissolved oxygen) and pH parameter probes
- Flow Metering Inserts for round-pipe installations in sizes of 6", 8", 10", and 12".
- Bubble lines, in lengths of 25 feet (Teflon 0.125" OD, 0.065" ID) and 50 feet (vinyl 0.250" OD, 0.125" ID)
- Stainless steel extension tube for the bubble line (4.0 feet 0.125" OD)
- Isco Flowlink® Software for data acquisition, storage, and management
- Carrier and Mounting rings for mounting the bubble line outlet in round pipes.

1.3 Operating Principles

When measuring flow rate, the 4230 is used with a primary measuring device (typically a weir or a flume) or other open channel flow arrangement where a known relationship exists between level and flow rate. The level measuring device is a bubbler which measures the liquid level in the flow stream. The flow meter electronically converts the level reading into a properly-scaled flow rate value. The flow meter also provides standard or optional flow-related output signals to be used for:

- Flow-proportional sampler pacing and enabling
- Recording flow rate information on an external printer/plotter or circular chart recorder
- Data transfer through a modem
- Control of a 4-20 mA device
- Data transfer by a laptop computer

The flow meter contains microprocessor-controlled circuitry to calculate level and flow rate from the signals produced by the pressure transducer, store the program you entered, and operate the display and the internal printer. An alphanumeric liquid crystal display (LCD) is provided to show current total flow, level, and flow rate, and to prompt you in programming the flow meter during setup or subsequent program 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 4230 are arranged vertically on the right side of the flow meter case.

1.3.1 Operation of the Bubbler System

The bubbler system, used by the 4230 to sense level in the flow stream, works as follows: A small compressor pumps air into a reservoir. This air is released slowly by a needle valve into a bubble line, a length of small diameter flexible tubing. The other end of this tube is submerged in the flow stream. Inside the flow meter, the bubble line also connects to one side of a differential pressure transducer. As air is released slowly into the bubble line by the needle valve, pressure builds inside the line to force the air out of the line into the flow stream. When there is enough pressure to counteract the hydrostatic pressure of the flow stream, a bubble will be forced from the end of the line. The amount of pressure required to force the bubble from the end of the line is directly dependent on the hydrostatic pressure of the flow stream over the end of the bubble line. The pressure transducer inside the flow meter senses this pressure and converts it into an electrical signal that the 4230 converts into level. From the measured level detected by the bubbler and consulting lookup tables for the primary device you are using, the flow meter then calculates flow rate and total flow.

1.3.2 Pressure Transducer Operation

The differential pressure transducer used with the bubbler contains a resistance bridge on a silicon diaphragm. Pressure against one side of this diaphragm causes it to flex slightly. This flexing causes the resistors on one side of the bridge to stretch slightly. At the same time the resistors on the other side of the bridge compress slightly. The result is an unbalance in the bridge, proportional to the increase of air pressure, caused in turn by an increase in level of the flow stream. This bridge is fed from a constant-voltage source; changes in output are the result of changes in pressure.

1.3.3 Automatic Drift Compensation Valve

The 4230 Flow Meter contains the software and circuitry necessary to measure the output of the pressure transducer at zero pressure. When the flow meter is first turned on, and periodically after that, the processor actuates the automatic drift compensation valve, which connects the input port of the pressure transducer to the reference port. With the two ports connected, it then measures the output offset. The flow meter stores this offset reading in memory and uses it in level calculations. The flow meter periodically repeats this zero-offset measurement and stores the new reading in memory. The repetition of this process causes zero drift in the pressure transducer or the amplifier to cancel out, eliminating the most significant cause of drift, especially when the flow meter is operating at low water levels.

The valve also provides temperature compensation at zero pressure. The software controlling the 4230 determines how often this compensation cycle is repeated. Drift compensation cycles range from two to fifteen minutes.

1.4 Software Upgrades

To update the software in a 4200 Series Flow Meter, you do not have to return the unit to the factory or replace an EPROM. With Flash Memory, software updates can easily be installed in the field with a disk, a computer, and a cable. See Section 5 for instructions for Flash software updates. For more information about installing software upgrades in the 4230 Flow Meter, contact your Teledyne Isco representative or call the factory.

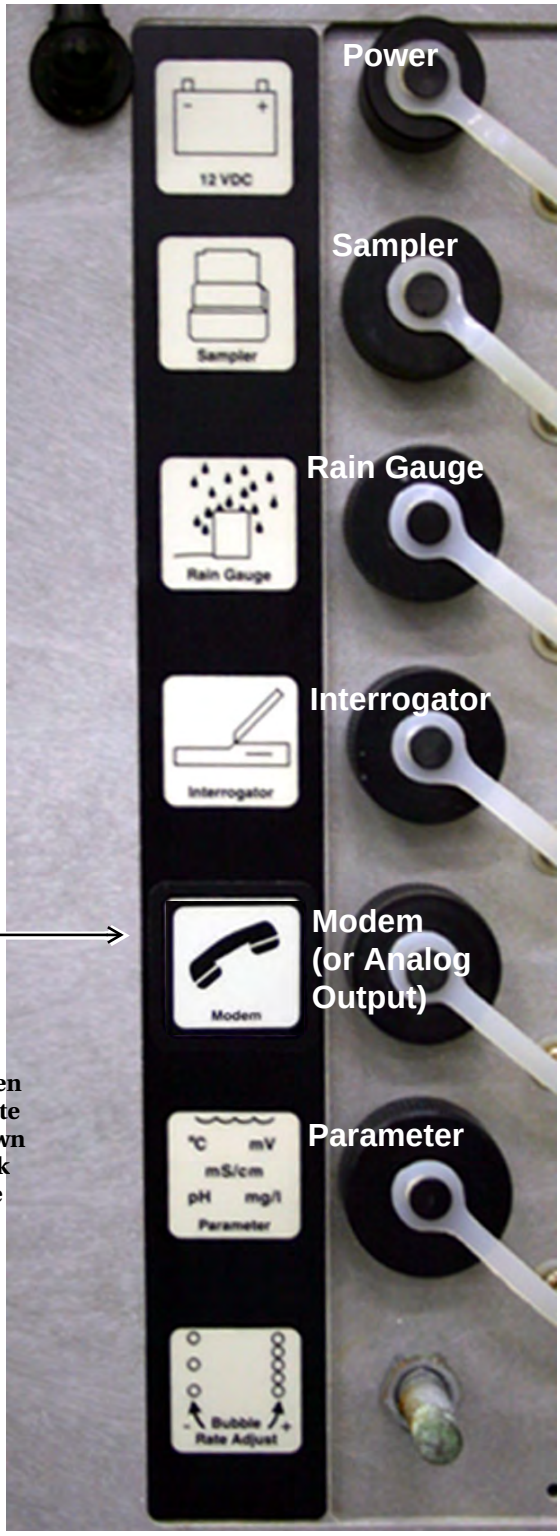
1.5 Controls, Indicators, and Connectors

The controls, indicators, and connectors of the 4230 Flow Meter are listed in Table 1-1, and their functions are briefly described. Refer to Figure 1-1 for a view of the connectors and their pin functions.

1.6 Technical Specifications

The technical specifications for the 4230 Flow Meter are found in Table 1-2. The anticipated longevity for a roll of paper used in the printer is shown for various chart speeds in Table 1-3. Battery life expectancy for three programming combinations is found in Table 1-5, with a brief description of how to make battery calculations immediately following.

> ☑ ***Note***
>
> Various options and accessories used with the 4230 are described throughout the manual. For convenience, the Teledyne Isco part numbers for these items are listed on the Accessory Parts List found at the end of the Replacement Parts List. Part numbers for equipment not listed on this sheet are available from the factory.



Pin	Function
A	Ground
B	12V
A	12V
B	Ground
C	Flow Pulse Output
D	Bottle Number Input
E	Event Mark Input
F	Inhibit/Enable Output
A	12V
B	Ground
C	SDO
D	Rain Gauge Input
A	12V
B	Ground
C	Sense Line
D	SDO
E	SDI
F	Analog Output Pulse
B	Tip
C	Ring
A	12V
B	Ground
C	Input Signal (+)
D	Temp (-)
E	Temp (+)
F	Switched 12V
G	Input Signal (-)

A = Channel 1 (-) Red
B = Channel 3 (+) Green
C = Channel 1 (+) White
D = Channel 2 (-) Brown
E = Channel 3 (-) Black
F = Channel 2 (+) Blue

Bubble Rate Adjust Knob

Figure 1-1 4230 Side View Showing Connectors and Pin Functions

Table 1-1 4230 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 key-strokes 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.**
Bubble Rate Adjust Valve	1 bubble per second (normally)	Controls the rate of air discharge from the pump and reservoir into the bubble line.
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 hard copy 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 flow pulse to sampler; receives sampler bottle number, composite sample and event mark signal.
Rain Gauge/ YSI 600 Sonde	9-pin female M/S (Custom)	Connects flow meter to a 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.

Table 1-2 4230 Technical Specifications

Physical and Electrical	
Size	17" high × 11½" wide × 10½" deep (without power source)
Weight	19 lb. 1 oz
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)

Table 1-2 4230 Technical Specifications (Continued)	
Typical Battery Life	7-10 days with printer at 1" per hour and 4 Ampere-hour Ni-Cad battery 12 days with purge and printer turned *off* and bubble rate set at 1 bubble per second
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 - both relays operated
Internal Printer	
Chart Speeds	Off, 1/2, 1, 2, or 4 inches per hour See Table 1-3 for chart 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 Chart Resolution Display Resolution	User-selected from 3/4 ft. (3.6 cm) to over 30 ft. (9.1 m) with multiple over-ranges 1/240 of selected recording span 0.001 ft. (0.3 mm)
Paper	4.5" wide × 58 ft. (11.4 cm × 17.7 m) plain white paper, replaceable.
Plotter Reliability	2.5 million lines MCBF (mean cycles before failure)
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.
Plotted Linear Data	3 different linear plots can be printed at the same time

Table 1-3 4230 Chart Longevity

Note

Report Generator is turned off.

Chart Speed, Inch/Hour	Time to Empty Roll
4	7 1/4 Days
2	14 1/2 Days
1	29 Days
0.5	58 Days

Table 1-4 Technical Specifications for Flowlink and Bubbler

Isco Flowlink Data Storage and Retrieval System	
Memory Partitions	Maximum of 6 user-defined memory partitions for level or event storage
Data Storage	Rate of 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 Date	Level readings are stored as a 16-bit number representing $^{1}/_{10,000}$ meter (0.0394 inch); effective range is 0–65279 meters
Bubbler Specifications	
Measurement Range	0.01 ft. (3 mm) to 10.0 ft. (3.1 m)
Maximum Depth	21.0 ft. (6.4 m)
Measurement Accuracy (22°C, 1 bubble per second) Long-term calibration change Temperature effects on level measurement accuracy	Level change of 0.01 to 1.0 ft. (0.006 to 1.5 m) ±0.005 ft. (0.003 m) Level change of 0.1 to 5.0 ft. (0.03 to 1.6 m) ±0.010 ft. (0.006 m) Level change of 0.1 to 10.0 ft. (0.03 to 3.1 m) ±0.035 ft. (0.01 m) Typically, 0.5% of reading per year Maximum error (feet) = 0.0003 × Level (in feet) × Temperature (Deviation from 22°C within compensated range)
Transducer Pressure Safety Range	Transducer is capable of withstanding maximum air pump outlet pressure without damage
Standard Bubble Lines	25 ft. (7.6 m) 0.125" (0.32 mm) OD, 0.065" (0.17 cm) ID Teflon® 50 ft. (15.2 m) 0.250" (0.63 cm) OD, 0.125" (0.32 cm) ID vinyl
Automatic Drift Compensation	Zero-corrected to ±0.002 ft. (0.0006 m) at intervals of 2 to 15 minutes. (Interval is software-controlled.)
Optional	Stainless steel extension tubes for the bubble line. 4 ft. 1.2 m long × 0.065" (0.17 cm) or 0.125" (0.32 cm) ID
Compensated Temperature Range	0 to 60°C
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 1-5 Battery Life Expectancy

Flow Meter Settings	Minimum	Default[2]	Maximum
Bubble Rate	1.5 / Second	1.5 / Second	1.5 / Second

Table 1-5 Battery Life Expectancy (Continued)

Printer	Off	Off	4" per Hour
Report Generator	Off	Off	Every Hour
Purge Interval	1 Hour	15 Minutes	5 Minutes
Purge Duration	1/2 Second	1/2 Second	3 Seconds
Average Current	**14 mA**	**15 mA**	**27 mA**
Nickel-Cadmium[3]	**10.7 Days[5]**	**10 Days**	**5.5 Days**
Lead-Acid[4]	**17.4 Days**	**16.2 Days**	**9 Days**

Notes
1. These figures are approximations based on calculations; actual times for your flow meter may deviate due to factors of battery age, charge condition, operating temperatures, and component variations. “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. This battery has a capacity of 4.0 ampere-hours at room temperature (20° C).
4. This battery has a capacity of 6.5 ampere-hours at room temperature (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.

1.7 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. Batteries are considered **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.

Note that 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 ampere-hours × 1,000 = 4,000 mAh

6.5 ampere-hours × 1,000 = 6,500 mAh

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

4,000 ÷ 15 = 266.67 hours

Divide this number by twenty-four to get days:

266.67 hours ÷ 24 = 11.1 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 days

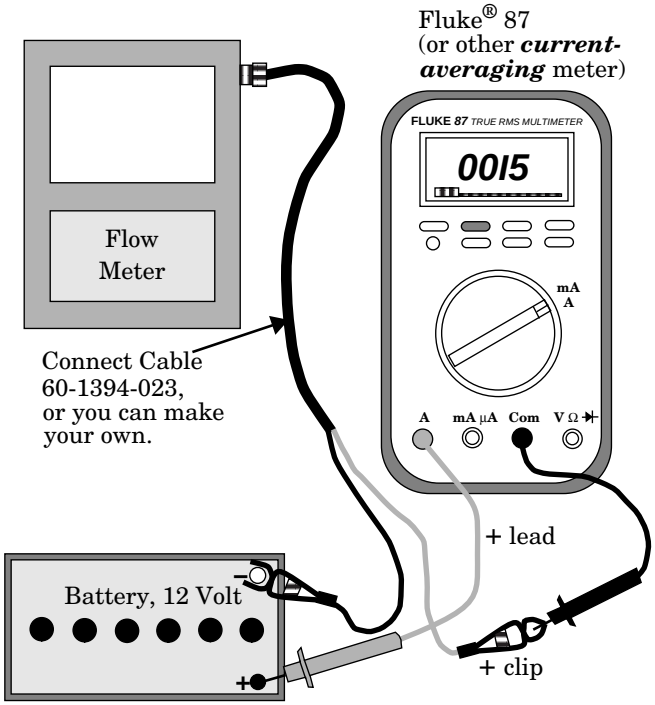
This is the battery expectancy for a nickel-cadmium battery with a 15 mA continuous average drain, with a 10% derating factor. You can use the same method to calculate for lead-acid batteries, except the current will be 6,500 mA, and the period correspondingly longer, in this case a little over 16 days. 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.**

1.7.1 Calculating Current Draw

Calculating current draw for a 4230 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 1-2) to measure the actual current draw.



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 1-2 Measuring Flow Meter Current

> **☑ 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.

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.

4230 Flow Meter

Section 2 Programming

2.1 Getting Started

You must program the 4230 Flow Meter to accurately monitor a flow stream. The 4230 will usually also need a primary measuring device, a structure placed across a stream that regulates flow. This section describes programming the flow meter with the aid of the keypad and display. There are nine program steps that control all aspects of the flow meter's operation.

Teledyne Isco ships the flow meter with a program already installed that is called the **default program**. You can use this program as an example to see the flow meter's capabilities. 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.

2.2 Operation of the 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 4230 Flow Meter.

The letter C appears when the flow meter is communicating with a remote computer (Flowlink applications only). The letter Z will appear when the flow meter is doing an auto-zero. The letter P will appear when the flow meter is purging the bubble line. The letters E or D will appear (Enable or Disable) when the Sampler Enable function (step 6) is programmed by condition. (Pro-

grammed 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.)

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

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.

2.3 Keypad Functions

Programming is done on the flow meter's keypad in response to messages on the display. The following sections describe the function of each key.

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

Go To Program Step – Pressing this key lets you go directly to a particular step without passing through all the steps of the 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 have 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 makes the flow meter print out a complete list of the current program kept in memory.

Print Report – One of the functions of the flow meter is to print periodic reports of the 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 at 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. 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 press this key.

Chart Reroll – You can unroll the chart from the take-up roll to look at it by pulling it out with your hands. Pressing this key rewinds the chart onto the take-up roll.

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

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

Manual Purge – This key lets you purge the bubble line on the 4230 at any time.

2.4 Programming Procedure

To begin programming the 4230, 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 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 that is 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 is over the last selection.

From time to time you will notice an arrow that points to the right edge of the display. This indicates 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 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 are 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, 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 be completed before you advance to the next program step. Some 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 correct value.

You can program most of 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, generally you will begin by pressing **Enter**, and start with **step 1**. If the flow meter has been in use and you only need to change the program, you would be more likely to use the **Go To Program Step** key. With this key, you can go directly to the program step you need to change, instead of having to step through every single screen.

If you change an entry and want to change it again, 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 you exit 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.

2.5 Description of Program Steps

The flow meter is programmed using the following steps:

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

The sections that follow provide a description of each of the program steps.

2.5.1 Operating Mode

Step 1, Operating Mode, determines how you set up the flow meter. In this step there are two choices: **Program** and **Setup**. Program advances you into **step 1**, 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 2-15), 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.

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.

2.5.2 Flow Conversion Type

Step 2, Flow Conversion Type, determines how the flow meter calculates flow rate and total flow. For the 4230, flow rate is calculated by knowing the measured level and (usually) the characteristics of a structure called a primary measuring device.

A primary measuring device is a structure placed in a flow stream through which the stream flows. 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.

Information about many common 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 on request from Teledyne Isco. 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 – However, it is not always necessary to have a primary measuring device. The 4230 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) pipes.

An accessory is available for the 4230 called the **Flow Metering Insert**. These inserts, used in round pipes of 6", 8", 10", and 12", form a primary device inside the pipe by restricting flow and measuring the level of the liquid backed-up behind the insert. The opening in the insert, either a smaller round opening or a V-notch that forms a weir, forms a primary device.

The conversion types available are WEIR/FLUME, MANNING, DATA POINTS, EQUATION, and FLOW METERING INSERTS.

You use **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 of the device and the appropriate formula are used to calculate flow. 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 uses the standard flow equation:

$$\mathbf{Q = k1H^{P1} + k2H^{P2}}$$

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.

The **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 4230 Flow Meter can calculate flow in round pipes, rectangular, U-shaped, or trapezoidal channels based on this formula.

The **Data Points** Flow Conversion calculates flow based on a set of user-entered data points for a flow stream. Data consists 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 non-standard, but where tables of level and flow rate data are available from the device manufacturer. The 4230 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.

Flow Metering Insert Conversion - The inserts are installed in upstream pipes and held with compressed air pressurizing a bladder. They are set from street level with a handle that can be extended as far as sixteen feet. The inserts contain a bubble line outlet and have an opening in the face that is either round or triangular. The 4230 reads the upstream level (the water backs up behind the insert) and calculates the flow through the insert from this measured level.

2.5.3 Adjust Level, Parameters

Adjust Level, Parameters calibrates the sensors that provide the flow meter with level and other information. In this step you set the level in the flow stream. First you measure the level, as accurately as possible. Then you enter this value with the numeric keys. Accuracy is important. **This measurement provides the basis for all subsequent flow calculations in the flow meter.**

The flow meter also has an input port for measurements other than level. This is the Parameter Port. Here you can sense such variables in the stream as temperature, pH (the acidity or alkalinity of a solution) and D.O. (dissolved oxygen) in the flow stream. 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. You can change the sensor. For example, you can change from a pH probe to a D.O. sensor if you change the programming. Selection of either parameter will keep the other from appearing later 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 4230. 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.

The YSI 600 can measure the following water qualities: **dissolved 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 Section 4 (Accessories). 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.

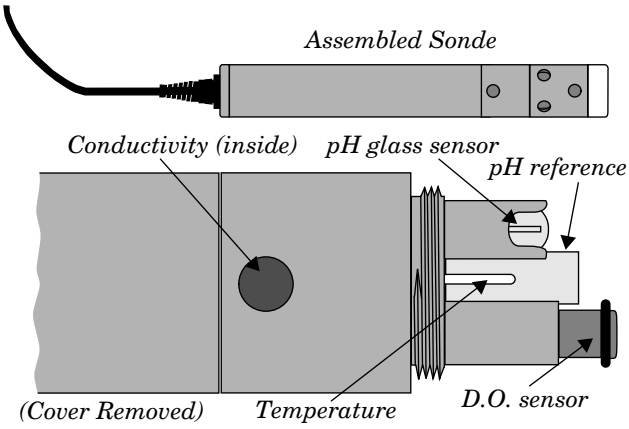


Figure 2-1 The YSI 600 Sonde

2.5.4 Reset Totalizer

In this step you decide whether you want to 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 generally reset the totalizer between sites.

2.5.5 Sampler Pacing

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

☑ Note

If you choose CONDITIONAL for sampler pacing and it doesn't seem to work properly for you, read the section explaining hysteresis (page 2-15). Then check the hysteresis setpoints for your conditions. (The defaults are all zero.)

You must also have the appropriate sensors to measure temperature, dissolved oxygen, conductivity, or pH; the flow meter cannot do this by itself, nor does it occur automatically.

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 information.

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 particular condition has been met, or has changed. Among these conditions are changes in level, flow rate, temperature, rainfall, (if you are using the optional rain gauge), dissolved oxygen, or pH. You can also use a pair of conditions, or if you are using the YSI 600 sonde, you can select multiple conditions from its sensors.

2.5.6 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.

2.5.7 Alarm Dialout Mode

This feature allows you to program a 4230 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 twenty-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.

2.5.8 Printer

The 4230 has a built-in printer. The printer is also 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 ½" 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 chart paper roll, you would probably pick a slower speed.

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

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.

2.5.9 Reports/History

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

The flow meter will let you create two separate reports, and let you 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.

2.6 Interpreting the Program Screens

Following are the program screens as they appear on the display of a 4230. Explanations of most of the screens will be provided.

> ☑ ***Note***
>
> Some items that appear in these menus will have parentheses (...) around them. This means that the item may or may not appear on your flow meter. Choices you make early in the program will make some options unavailable later.

An example of this is the pH/D.O. (Dissolved Oxygen) sensor option. Selection of either in **step 1** will keep the other from appearing in all following menus. If your installation does not use either sensor, you would select NOT MEASURED for both, and no further reference to either sensor would appear again for the rest of the program.

As you work through the program, your selections will rule out alternatives. This will cause those alternatives not to appear later in the program. Since there is no way of knowing what program choices will be made for a particular installation, it is necessary to provide all the *possible* menus in the manual, even though some of them will not appear on your instrument.

> ☑ ***Note***
>
> This list does not include all possible screens for the unit, but does cover the screens found in a typical programming sequence. Some diagnostic and error screens are discussed in Section 5.

2.7 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 (step 1). 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 display, 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 •
```

LANGUAGE may not appear on your unit. This is intended primarily for export models, as they are programmed in different languages. Flow meters will contain English and one other language, as ordered.

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
• DO/PH READING INTERVAL • • YSI 600 READING INT-
```

```
MEASUREMENT SETUP
-ERVAL • • PURGE INTERVAL • • SUPER BUBBLE MODE •
```

> ☑ ***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.

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.

If you select PURGE INTERVAL, the following will appear:

```
PURGE INTERVAL
• 5 MIN • • 10 MIN • • 15 MIN • • 30 MIN • • 1 HR •
```

PURGE INTERVAL refers to how often the flow meter discharges a blast of air through the bubble line. These periodic blasts are intended to keep the end of the bubble line clear from any obstruction that could clog it, preventing it from releasing any bubbles. The option of setting the purge interval is offered for the sake of battery conservation.

If your bubble line shows a tendency to clog, characteristic of dirty flow streams, you should select a more frequent purge. If the stream is very clean and there appears to be no tendency to clog the bubble line, you could try a less frequent purge. However, if your installation is battery-powered, you should try to get by with less frequent purges to prolong the battery life. Some experimentation may be necessary to find the right setting for your installation.

If you select SUPER BUBBLE MODE, the following will appear:

```
SUPER BUBBLE MODE
• ON • • OFF •
```

Super Bubble is an Isco feature that increases the air supply to the bubble line when the flow meter senses a rapidly rising liquid level. This allows the level measurement to be more accurate and to change more quickly. In operation, Super Bubble resembles Purge in the way it forces a blast of air through the bubble line, but the effect is different. Without Super Bubble, there would be a period when no bubbles come out of the bubble line when the level rises suddenly. Until the bubble rate is re-established, the flow meter cannot accurately measure the level.

Super Bubble helps maintain accurate level measurement by filling the bubble line with air, thereby ensuring that the bubble rate will re-establish quickly when the level stabilizes.

Operation of Super Bubble will cause an increase in power consumption, because the air pump has to run. If your flow meter operates from AC power, leave Super Bubble on. If your installation is battery-powered and the flow is generally stable (without sudden increases), you can probably turn Super Bubble off. Again, some experimentation may be necessary.

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 (and prolonging the life of the D.O. sensor. After selecting the appropriate parameter reading interval, press **Enter**. The Setup menu will reappear. 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•
```

After selecting the appropriate parameter reading interval, press **Enter**. The Setup menu will reappear. This time select STATUS from the Setup menu. The following will appear:

```
4230 HW REV: XXXXXX SW REV X.XX
ID XXXXXXXXXXX
```

HW REV refers to the hardware revision number.

SW REV refers to the software revision number.

ID is an internal identification for the flow meter.

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

```
SUPPLY VOLTAGE: XX.X
PUMP DUTY CYCLE    XX.X%
```

The supply voltage should be from 10.5 to 13.5 (volts DC). PUMP DUTY CYCLE tells you how much the air pump is running. The value is refreshed every few minutes and should generally average below 20%. If you see a value consistently higher than this, check the bubble line, look for leaks, or check the air system inside the flow meter.

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. 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, 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 briefly and then falls away? It is possible for a condition to vary rapidly over a narrow range. Without hysteresis, the flow meter would turn the sampler off and on repeatedly, causing a condition known as *chattering,* resulting in very erratic operation of the sampler.

With hysteresis, you can enter a value that will keep the flow meter from responding to small changes in the enabling condition. Select a value for hysteresis narrow enough to allow the

flow meter to respond to any significant change, but broad enough to ignore minor changes that could cause chattering. Press **Enter** again and the following will appear:

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

The next three menus may appear or not, depending on selections you made earlier 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. You can measure temperature alone, or temperature with either pH or D.O. You *cannot* measure either pH or D.O. without measuring temperature.

☑ *Note*

You cannot measure pH and D.O. at the same time, and 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.

2.7.1 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.

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

ALARM BOX refers to an external accessory used to signal alarms from flow meter measurements. See Section 4 for more information. The choice of SERIAL OUTPUT will eliminate ALARM BOX as an option. Likewise, the 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.

To activate the internal analog output(s), return to the main screen and press **4**, **2**, **0**.

```
ANALOG CAPABLE ('0' TO DISABLE)
OUTPUTS 3▮ ('EXIT PROGRAM' WHEN DONE
```

Additional information for the internal analog output board, including specifications for the loops, is found in Section 4.3.2.

The following menus determine the behavior of the 4-20 mA current outputs. If you select ANALOG OUTPUT (another term 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) • •
```

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)
- the battery is very large, such as a deep-cycle or marine type battery, or an Isco 35 Ampere-hour lead-acid battery.
- using 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 1-8.)

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.

Programming for the conditions and values that determine the operation of the 4-20 mA loop (or loops) is done in Programming Step 2, following the entry of FLOW RATE AT MAXIMUM HEAD.

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.

> ☑ ***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 (or loops) is done in Programming Step 2, following the entry of FLOW RATE AT MAXIMUM HEAD

2.7.2 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.

> **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 port. Special cables may be required. Contact Teledyne Isco technical support for more information.

Command Line: (Use the INTERROGATOR connector.) 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%
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
YCO	YSI 600 Conductivity	Millisiemens per centimeter
YSP	YSI 600 Specific Conductance	Millisiemens per centimeter
YSA	YSI 600 Salinity	Parts per thousand

Table 2-1 ASCII Output Codes (Contin-

Code	Parameter	Units
YTD	YSI 600 Total Dissolved Solids	Milligrams per liter
YTE	YSI 600Temperature	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 tips counter that rolls over every 255 tips. (See **Rain Gauge**, page 4-12.) 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. 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).

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:

DE,TheresaStreet,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,B0,35317.269907,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.

The alarm box, also called the High-Low Alarm Box, is an Isco product that allows you to operate control relays to signal alarms when flow rate rises above or falls below a certain set value. You can set both the high and low alarm values from 1 to 99% of the controlling condition. (See Section 4 for more information about the alarm box.)

Return to the SETUP menu.

This time, select REPORT SETUP.

```
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 flow meter recording 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.

```
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. You must have a rain gauge connected to the flow meter to sense rainfall occurrence. The following will appear:

```
REPORT SETUP
• FLOW • • DO/PH • • SAMPLE HISTORY • • FLOW MET...
```

FLOW METER HISTORY is just off the screen.

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 sense parameters; the flow meter 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 display 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
• YSI 600 • • 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. Then press **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.

Select LCD BACKLIGHT with the arrow key. 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 (other than On and Off). 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 coming less than two minutes apart. At the end of programming, the backlight will go out, and will stay out 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 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 cause the backlight to be lit 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.

Press **Enter**. The SETUP menu will return. 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. This time, select PROGRAM LOCK from the menu.

```
PROGRAM LOCK
• ON • • OFF •
```

PROGRAM LOCK keeps 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. At that, we suggest using the lock only if there are compelling security reasons.

Further changes will require entry of the password, which is the number of the flow meter, 4230. 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.

> **☑ 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** and the SETUP menu will reappear.

Program:

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

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

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 either pH or D.O. will prevent the display of any references to the other in later program steps. All sensors but the rain gauge must be fully submerged in the flow stream. The pH and D.O. probes must be kept constantly wet or they can be damaged.

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

☑ *Note*

The 270 D.O. module has been discontinued. Probes, service kits, and accessories are still available to maintain existing field units.

Their use in streams with intermittent flow (such as storm drainage) is not recommended. See Section 4 (Accessories) for more information about the pH, D.O. probes, and rain gauge. The pH probe is a consumable item, and will eventually need replacement.

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

You must have an Isco 674 Rain Gauge connected to the flow meter through the Rain Gauge Port to sense rainfall. MM = millimeters. The rain gauge is factory-calibrated. If you do not want to use a rain gauge, you would select NOT MEASURED for this step.

- If you choose NOT MEASURED, no further 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 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. The pH probe requires periodic recalibration 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, you will be unable to activate pH later in the program.
- If you select pH, you will be unable to measure D.O. later in the program.
- If your situation requires the measurement of both 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 for pH 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 to sense dissolved oxygen. The probe attaches to the **Parameter Port**. 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 measurement of the water temperature. You must have a Temperature Probe attached to the Parameter Port. The temperature probe contains a thermistor and needs no 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 later.

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

The following menus concern the use of the YSI 600 Multi-Parameter Sonde. This probe allows you to measure several characteristics of a flow stream at the same time. The YSI 600 Sonde attaches to the Rain Gauge connector. This connector must be a special connector with nine pins.

☑ Note

4230 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. There are also significant internal modifications to the flow meter's electronics and software.

You can use both the YSI Sonde and a Rain Gauge on flow meters that support the YSI with a special Y-connect cable. 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

Do not disconnect either the sonde or flow meter power during a communications check. 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 for any of the YSI menus will prevent you from activating those functions later in the program.

If you want the YSI 600 to measure pH, select pH. If you do not, select NOT MEASURED.

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

If you want the YSI 600 to measure D.O., 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), NH_4Cl (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 units appropriate for your application.

2.8 Step 2 - Flow Conversion

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

METERING INSERTS will also appear.

WEIR/FLUME = weir or flume; EQUATION = equation; MANNING = Manning; DATA POINTS = data points. If you select WEIR/FLUME, the following display 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. 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 display 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 the type 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, 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, 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 the type of 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' •
```

If you select H FLUME, the following will appear:

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

If you select HL FLUME, 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 •
```

(This completes the section on WEIR/FLUME flow conversions.) 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 $Q = k1H^{P1} + k2H^{P2}$, 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.

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.XXXXX 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.XXXXX* ROUGH = *X.XXX*

(Slope and roughness are entered as for ROUND PIPE previously.) 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.XXXXX* ROUGH = *X.XXX*

(Slope and roughness are entered as for ROUND PIPE previously.) 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.XXXXX* ROUGH = *X.XXX*

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

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

Then:

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

Returning to **step 2**, FLOW CONVERSION TYPE, if you select DATA POINTS, the following displays 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 a few times, the following units of measure 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 4230 can accept as many as four sets of data points with each set containing up to 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 4230 does not support in its internal flow conversion set.

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

After the FLOW RATE UNITS menu has appeared, 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 will 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)*

2.8.1 Flow Metering Inserts

There is one more possible flow conversion for the 4230 Bubbler Flow Meter. This option will appear as FLOW METERING INSERTS. These devices are metal inserts for 6", 8", 10", and 12" diameter round pipe sewers. The inserts form a primary measuring device inside the pipe when they are placed. The inserts are installed from street level to a maximum depth of 16 feet with a handle made up of snap-fit extension pipes.

The inserts are sealed into the upstream pipe by inflating a rubber bladder. Each insert is supplied with two circular weir plates that provide either a round orifice or V-notch opening. Once installed, the flow backs up behind the insert and a bubbler tube in the bottom of the insert measures level.

The flow meter calculates flow based on this measured level. If you select METERING INSERTS for the FLOW CONVERSION mode, the following menu will appear:

SELECT WEIR/ORIFICE TYPE • V-NOTCH • • ROUND •

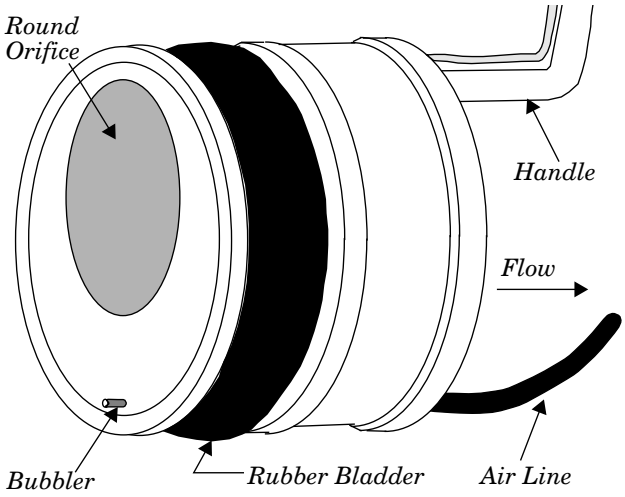


Figure 2-2 Flow Metering Insert

Then:

SELECT FLOW INSERT SIZE • 6" • • 8" • • 10" • • 12" •

2.8.2 Enter 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. Note, however that 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)*

2.8.3 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 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 choices available to you will depend on what parameter measurements 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 a choice, the flow meter will request the minimum and maximum values for that choice:

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

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 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 parameter, the flow meter will request that you enter a value for full-scale, or 100%:

```
ANALOG OUTPUT 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 currently two feet, the analog output would read 12 mA (50% if the 4-20 mA 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 outputs you activated previously in Setup.

2.9 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:

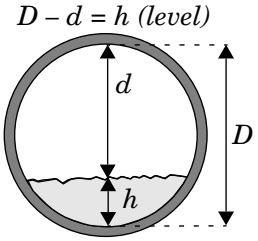
```
PARAMETER TO ADJUST
• NONE • • (LEVEL) • • (pH) • • (D.O.) • • (YSI 600) •
```

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 out your choice with selections made in the early part 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 other units of measure, as selected)*

For this value, you must measure the level in the stream (usually done with a measuring stick.) Generally, you should measure the level upstream from the bubble line outlet, or at the prescribed point in the primary measuring device. The bubbler should be installed in an area of stable flow.



This drawing shows you how to measure level. You then enter this value with the number keys. LEVEL ADJUST must be done at the job site, while most other programming can be done in the shop.

Figure 2-3 Level Measurement in Round Pipes

You should remove the bubbler and mounting ring to measure the level if either of the following occur:

- If it is not possible to measure the level upstream when the bubbler is installed, (cramped quarters inside smaller pipes).
- If the bubbler and its mounting ring create a visible "jump" in the stream.
  This "jump" would be any noticeable disturbance on the surface of the flow stream where it passes over the bubbler and mounting ring, and is typical of lower flows.

Enter this value with the number keys. LEVEL ADJUST must be done at the job site, while most other programming can be done in the shop. Unless you have reliable information about the size of the channel, you should measure that, also.

☑ 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 be incorrect also.

For example, an error of only ¼" for a 3" level and ¼" 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.

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 in 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 parameter 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 atmospheric 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 millisiemens 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. See Figure 2-4 for a YSI calibration flow chart.

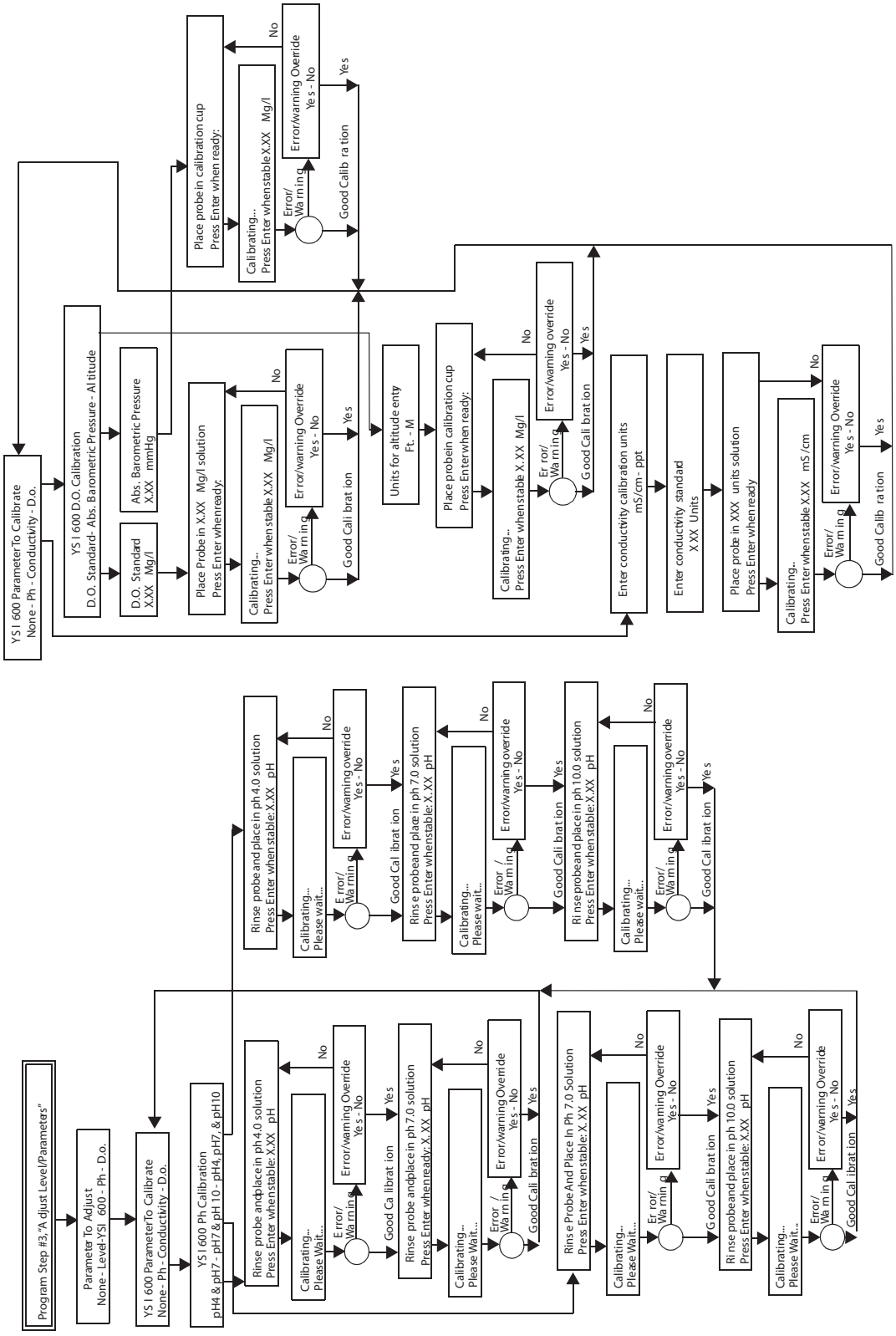


Figure 2-4 YSI 600 Sonde Calibration Flow Chart

2.10 Step 4 - Reset Totalizer

This step allows you to reset the flow meter's internal flow totalizer. Note that there is the possibility of more than one totalizer. All 4200 meters have the capability of maintaining a separate totalizer for the time the sampler is enabled through the sampler enabling feature (**step 6**).

If you select **step 4**, the following 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
PRESS 'ENTER
```

(Other units of measure may appear.) Then:

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

2.11 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, Teledyne Isco's proprietary data acquisition and storage 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 as if the flow meter weren't there. 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 (units)
```

(Range is max. flow ÷ 10 to max. flow × 10,000)

If FLOWLINK appears for sampler pacing, the operation of sampler pacing has been determined by choices made in Flowlink software. Flowlink controls the flow meter remotely, via phone lines and a modem, or locally with a laptop computer and cable. In any event, 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. Which ones actually appear depend on your previous programming selections. 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, (provided they are available for use.)

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 a change in the selected condition causes the flow meter to send a flow pulse to the sampler. The following menu will appear:

```
(Selected 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 request 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 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.

However, suppose you wanted to select two conditions, either of which would trigger the sampler. In such a 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 that 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 lets you send flow pulses periodically to the sampler when the conditions you established for sampler pacing are being met. Then:

```
CONDITION FALSE 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 not being met. Again, entering 0 sends no pulses.

2.12 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 has been 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 overridden 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 to measure rainfall. The following menus are the STORM sequence:

```
LEVEL
GREATER THAN X.XXX FT (Or other units, as selected.)
```

Then:

```
RAINFALL AMOUNT
X.XX INCHES    (Or other units, as selected.)
```

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. The above 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 programming 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.)
```

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. will not 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 non-latching 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 it will remain enabled regardless of any subsequent changes in the enabling condition. If this is the case, the following menu will allow you to reset the sampler enable feature. 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 printer on or off when the sampler is enabled from the flow meter. This allows you to conserve battery power and print a chart only when the sampler is enabled. This feature is useful for monitoring storm water runoff.

2.13 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. 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 inactivated 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 D.O.), (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, 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 interval over which change occurs. Then the display will advance to the following:

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

As described previously for sampler enabling, this step allows you to combine conditions to produce an alarm dialout signal. Select DONE if you need only 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. Five numbers are possible, in decreasing order of importance. You can enter as many as eighteen digits for each phone, so the targets need not necessarily be local.

```
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 multiple digit numbers, or you can use the **+/–** key to enter a dash as telephone numbers are often written. Pressing the **.** (decimal) key inserts a **,** (comma). 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 are the three digits of the site ID number.

2.14 Step 8 - Printer

This step sets up the operation of the flow meter's internal printer. This printer also functions as a plotter. 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 while 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 relatively stable situation, are using only one data line, and you want to achieve maximum longevity for the chart paper roll, select a lower speed for chart advance.

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

After you select the printer speed, the flow meter will ask you to define what input you want depicted by printer LINE A. (The printer can print as many as three separate data lines at the same time.) The following display will appear:

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

(TEMPERATURE), (D.O.), (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**, previously. 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)
```

Enter here the highest pH value (or other condition) you expect to see in your stream. Note that selection depends on the range that you would normally expect to 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 in the flow meter.

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 data if the plotted line rises past the full-scale point. For the other conditions, the full-scale units will be appropriate for what is being measured (D.O., pH, temperature, etc.) Note that the flow meter is capable of multiple over-ranges.

```
INPUT FOR PRINTER LINE B
•(LEVEL) • • (FLOW RATE) • • (D.O.) • • (pH) • • 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 condition to plot on the chart. The flow meter will request a full-scale value, or bottom and full-scale values. These values can differ from that entered for line A.

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

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

For line C, you can select yet another condition to plot on the chart. The flow meter will also request entry of a full-scale, or bottom and full-scale values, as for the previous two lines.

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

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

2.15 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 display 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 two independent reports at different intervals, for example. This is useful for those who need both a weekly and a monthly summary of activity on the flow meter.

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 for the first report, the program will advance to the following:

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

The final step on the flow meter is HISTORY. This step presents a record of the programming activity on the flow meter that you can have printed on the printer. 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 50 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 again begin keeping track of changes the next time you change the program.

2.15.1 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

4230 Flow Meter

Section 3 Installation

This section contains instructions for installing the 4230 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 Install Desiccant Canister

If the unit is new, you can 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.

3.1.2 Install External Desiccant Cartridge

The desiccant cartridge snaps into the large metal clamp mounted on top of the cabinet. There is a short length of silicone tubing that attaches to a plastic fitting on the side of the cabinet. Attach the other end of the tubing to one end of the desiccant cartridge. Like the case desiccant canister, the material inside the external desiccant cartridge should be colored a definite blue. If they are violet or pink, you need to regenerate them. See Section 5. You will need to dump the particles out of the cartridges into a small heat-proof pan for regeneration; you cannot regenerate them inside the cartridge. The cartridge is plastic and will melt.

Venting the Desiccant Cartridge – If you suspend the flow meter over the flow stream and there is any possibility of accidental submersion, vinyl tubing, available from Teledyne Isco, should be attached to the vent on the end of the external desiccant cartridge and routed to a place higher than the maximum

possible level of the flow stream. This will prevent any water from entering the flow meter or the vent tube for the bubbler in case of accidental submersion.

CAUTION

Do not operate the 4230 with a saturated desiccator cartridge. Moisture eventually will seep inside the unit causing unseen damage.

Operation in low temperature-high humidity environments is particularly risky. Moisture drawn into the pump will form ice, jamming the pump and ruining it.

Do not operate the flow meter with the door left open. Moisture will quickly saturate the desiccator. Dust may settle inside and damage the printer.

For maximum equipment life, inspect the desiccants regularly and regenerate them when necessary. Keep the lid closed and latched unless you are programming or servicing the flow meter.

3.1.3 Opening the Case

To access the flow meter keypad and internal printer, 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. A case left open will defeat the purpose of the seal by causing the desiccant canister to quickly saturate with moisture.

Dust will also settle inside the case, wearing the moving parts of the printer prematurely. Many flow meters are installed in damp environments. Moisture and fumes dispersed inside the case can form acids that will corrode the electronics.

3.2 Connection to a Power Source

The 4230 requires a 12 volt, direct current (12 VDC) power input. This power may come from various sources.

- Companion Isco Automatic Wastewater Sampler
- Isco AC Power Supply
- Isco Battery (lead-acid or nickel-cadmium) attached to the flow meter
- 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 normal operation, the message POWER LOST/LOW BATTERY will appear on the display. When power is lost or falls below operating limits, the flow meter will stop accumulating data (if you are using Flowlink), and the printer will not print, but the 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 4230 Flow Meter with an Isco Sampler in a flow-paced 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 "Flow Meter" connector on the sampler and "Sampler" connector on the flow meter. The flow meter will then receive power from the sampler.

Under certain conditions, such as a "fast" setting on the printer 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 AC, there could be problems with battery. In that case, it would be better 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 must use 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 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. 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. This battery is similar in size to the nickel-cadmium battery, except somewhat larger, reflecting its greater capacity.

For those familiar with nickel-cadmium batteries, operation and maintenance of these batteries differs somewhat. Fewer charge-discharge cycles are possible, and a single deep discharge can ruin a battery. There is a linear voltage decrease as the battery discharges, while nickel-cadmium batteries show essentially the same voltage throughout discharge. Failure to recharge promptly can also ruin the battery.

Proper operation is necessary for normal service life. For more information on these batteries refer to the *Power Products Guide*. Please read that manual if you want to use lead-acid batteries.

Attaching the Isco Lead-Acid Battery – The lead-acid battery is installed the same 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.

CAUTION

Do not test any type of battery for its charge condition by "sparking" the output (shorting the terminals together with a screwdriver or other tool).

3.2.5 AC Power Supplies

Teledyne Isco 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 on 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 for export. Both have 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 by a 1.2 Ampere-hour nickel-cadmium battery. This power supply 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. This power supply is also available in 120 and 240-volt versions.

Attaching the Power Supply – 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 *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 externally, 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 inadvertently 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 attach the flow meter to a source of unknown polarity or voltage. If in doubt, check with a reliable DC voltmeter. Never attach the flow meter directly to an AC power source regardless of circumstances. Charge the battery in accordance with the manufacturer's instructions.

3.3 Bubble Rate

The Bubble Rate Adjust valve, located on the side of the case, is a “needle” type valve that controls the rate air is fed from the reservoir into the bubble line and the rate the bubbles are released into the flow stream. Turning the valve knob counterclockwise causes the bubble rate to increase. Turning the knob clockwise causes the bubble rate to decrease. Turning the knob clockwise until it stops will completely shut off the air supply to the bubble line.

CAUTION

Do not use anything but your fingers to turn the Bubble Rate Adjust valve. The needle and seat inside the valve are very small and you can damage or break them if you use tools or force to close the valve. Once you have set the valve properly, do not overtighten the hex screw that locks the adjustment knob or you may strip the threads or ruin the Allen wrench.

3.3.1 Setting the Bubble Rate

The recommended bubble rate is approximately one bubble per second. For relatively clean flow streams, this bubble rate provides adequate sensitivity with reasonable power consumption. For flow streams with suspended solids (for example, domestic raw sewage or streams with a high grease content), two bubbles per second may help prevent plugging of the bubble line at the expense of higher power consumption.

3.3.2 Bubble Rate and Power Consumption

Power consumption by the flow meter's air pump is directly related to the setting of the bubble rate and the inside diameter of the bubble line. At one bubble per second, the 1/8" (0.32 cm) ID bubble line uses about 2 1/2 times more power for the air pump than does the 1/16" (0.16 cm) ID bubble line. Likewise, increasing the bubble rate from 1 to 2 bubbles per second causes a 2 1/2 times increase in power usage by the air pump.

The power the rest of the flow meter uses (except the printer) is constant and cannot be changed, but you do select bubble rate and bubble line size (as well as printer settings) and these items do significantly affect power consumption. If your installation must be battery-powered, consider the effect these factors have very carefully before setting up the flow meter. One indication of power consumption is the pump duty cycle. It should run less than 20%. You can check this value in the STATUS menu of the program.

Use caution when setting the bubble rate any higher than one bubble per second. For greatest accuracy in small channels, where you use either small ID tubing, or where the bubble line is long, Teledyne Isco does not recommend bubble rates over one bubble per second. When measuring low water levels (a few inches, typically) it is especially important to pay attention to the bubble line inside diameter, length, and bubble rate.

Setting a faster bubble rate causes an increase in frictional back pressure as a result of the tubing wall's resistance to increased air flow. For example, consider a 25 foot (7.6 m) 1/16" ID bubble line; the back pressure at one bubble per second is approximately equal to 1/10" (0.25 cm) of water. If you increase the bubble rate to 2 bubbles per second, the back pressure rises to approximately 2/10" (0.51 cm) of water, or *double* what it was at one bubble per second.

Another problem that occurs with long, small-ID bubble lines set at higher bubble rates, is that back pressure varies slightly during the period between air pump cycles. This will show up as

a change in level on the display, and it will generally also show up on the chart as a change in level. At the normal bubble rate this variation is not noticeable, but it will become noticeable if you set the bubble rate too high. For greatest accuracy in measuring low levels, use short bubble lines with the flow meter set at one bubble per second. If you need longer lines, use the 1/8" ID line rather than the 1/16" ID line.

3.3.3 Purging a Clogged Bubble Line

When you use the 4230 to measure levels in small channels, it is best to keep the bubble rate at one-per-second and use shorter bubble lines. Larger-ID bubble lines are less likely to clog than small ones, but require more energy to supply the additional air needed.

In applications where bubble line clogging is likely to be a problem, using the 4230 Purge feature (increasing the frequency of the automatic purge) may be a better solution than increasing the bubble rate. However, turning on the Purge feature will also cause an increase in battery consumption.

3.3.4 Adjusting the Bubble Rate

Make the initial setting of the bubble rate at the shop, rather than at the job site. At the shop you can put the bubble line in a container beside the flow meter and watch the rate while you adjust it. You can, of course, set the bubble rate at the job site if you wish, but it is easier with clean water in a clear container beside the flow meter.

To set the bubble rate:

- Connect the flow meter to a power source and turn it on.
- Turn the valve knob all the way clockwise so no air is escaping.

Allow some time for the system to pressurize. (The pump motor will stop running when the system reaches the correct operating pressure.)

- Attach a bubble line to the barbed Bubble Line fitting on the side of the case.
- For best results, use the same size bubble line you expect to use for the installation.

Setting the bubble rate with a large ID line and then connecting the flow meter to a small ID line will produce a much faster bubble rate than you want. Attach the 50-foot vinyl line directly to the barbed fitting by pressing it over the barbs. To attach the Teflon tube, press it into a short length of silicone tubing. Then press the other end of the silicone tube over the barbed fitting.

- Put the free end of the bubble line in a small container of water. Set it near the flow meter so you can watch the escaping bubbles as you turn the valve knob.
- Turn the valve slowly counterclockwise until bubbles start coming out of the end of the tube.
- Adjust the knob to achieve a rate of one bubble per second.

- Lock the adjustment knob by tightening the hex screw in the handle; do not over-tighten it. You will strip the hex screw.

> **☑ Note**
>
> Always recheck the bubble rate after you have installed the flow meter. This is particularly important if you install the bubble line under several feet of water. Since you set the rate with the bubble line under only a few inches of water, it may change if you install the line in a deep channel.

3.3.5 Locking the Bubble Rate

If you want to prevent accidental readjustment of the valve after you have set it, you can lock the valve knob in place. Do this by tightening the smaller of the two hex set screws on the valve's handle with the 0.035" hex socket key included in the flow meter's accessory package.

Be sure to loosen this screw before attempting to readjust the position of the valve. Failure to do so may score the valve core or strip the screw head.

3.3.6 Effects of Changing the Bubble Rate

Changing the bubble rate may cause a change in the indicated level. Air flow through the relatively small diameter bubble line generates a frictional back pressure or head in the bubble line. For a given bubble rate, this frictional head is constant and creates a fixed level offset for which level calibration automatically compensates. However, increasing the bubble rate a significant amount (for example, from one to two bubbles per second) will cause an increase in the frictional head and a consequent increase in the indicated liquid level.

- Always set the bubble rate before you adjust the liquid level reading on the flow meter.
- If you change the bubble rate for any reason, check and compare the readings between the real level in the flow stream and the indicated levels on the flow meter.

Adjust the indicated level if necessary. Since the friction head generated at a given flow rate is a function of the bubble line length and ID, you can minimize these frictional effects by using the shortest length of bubble line possible.

3.3.7 Super Bubble

The 4230 features an electronic “Super Bubble” feature that detects a rapidly-rising liquid level and temporarily increases the bubble rate to respond correctly to the rising level. Due to a higher friction head generated by the increased bubble rate during this operation, the flow meter will hold the indicated liquid level constant until the bubble rate returns to normal.

3.4 4230 Mounting and Installation

Because the 4230 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, at your option.

3.4.1 Carrying Handle

To assist in carrying the flow meter, a handle is provided in the instrument's accessory package. To use the handle, snap the hooks at both ends into the two metal brackets at the top of either side of the flow meter case.

3.4.2 Location of the Flow Meter

Because it uses a bubble line, the 4230 Flow Meter does not have to be mounted directly above the primary device, or particularly close to the flow stream. You will need to mount the unit within 25 feet (7.6 m), or 50 feet (15.3 m) if you are using the 50 foot bubble line. Distances greater than 50 feet are not recommended.

The 4230 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 handle.

3.4.3 Safety Considerations

In field installations of 4230 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 appendix on working safely in manholes and avoiding hazardous gases; found at the back of this manual.

WARNING

The 4230 Flow Meter has not been approved for use in "hazardous locations" as defined by the National Electrical Code.

Figure 3-2 4230 Suspended by Handle (handles may vary)

3.5 The Bubble Line

Anchor the bubble line in the flow stream at the appropriate measuring point in the weir, flume, or other open channel flow situation. Air slowly bubbles out of the line into the flow stream. The pressure in the bubble line is proportional to the liquid level in the flow stream, and the flow meter measures this pressure, sensing the liquid level.

3.5.1 Standard Bubble Lines

Two different bubble lines are available for use with the 4230:

- 1/8" (0.32 cm) OD, 1/16" (0.17 cm) ID, Teflon® line, 25 feet long (7.6 m).
- 1/4" (0.63 cm) OD, 1/8" inch (0.32 cm) ID, vinyl line, 50 feet long (15.2 m).

You can specify either line at the time you order the unit. Teledyne Isco ships the bubble line in the flow meter's accessory package, and Teledyne Isco offers replacement lengths.

3.5.2 Comparing Vinyl and Teflon Bubble Lines

The vinyl line has two significant advantages over the Teflon line. First, the vinyl line has a longer usable length than the Teflon line. This is due to the small inside diameter of the Teflon tubing, which generates an undesirable friction head at lengths greater than 25 feet. And second, experience has shown that the larger ID vinyl line is less likely to clog than the Teflon line when used in flow streams with suspended solids (for example, domestic raw sewage or streams with a high grease content).

However, the smaller ID Teflon line also has advantages. First, since it has a very small inside diameter, the air volume necessary (and, as a result, battery power) is minimized, a definite advantage for battery-powered installations. And second, almost nothing attacks the Teflon line, while certain chemicals may attack the vinyl.

In general, Teledyne Isco recommends that, wherever practical, you use the **vinyl** line. Practice has shown that this line usually results in more trouble-free operation. Furthermore, if the distance between the flow meter and the measuring point exceeds 25 feet, you *must* use the vinyl bubble line. However, if power consumption is critical, or there are known agents in the flow stream that might attack the vinyl line, you should use the Teflon line.

3.5.3 Bubble Line Length

No matter which line you use, Teledyne Isco recommends you make it as short as possible. This will minimize friction head effects in the line and will also minimize the amount of line exposed to cuts, kinks, etc. Shorten the line as necessary by cutting the tubing with a sharp knife.

Long Bubble Lines – For certain applications (for example, where it is necessary to exceed the 50-foot length of the bubble line, or where the flow stream is extremely dirty and the end of the line may clog), you may need to use a bubble line with an inside diameter larger than either of the two standard lines.

Consult the factory for specific recommendations regarding size of line, special connectors required, etc. In no case should the inside diameter of the bubble line exceed 1/4" (0.64 cm), and you should recognize that a larger bubble line will result in increased power consumption, a concern if you must power the flow meter by battery. You should keep the bubble rate at one to two bubbles per second, regardless of bubble line size.

3.5.4 Teflon Line Connector

The Teflon bubble line attaches to the flow meter with the Bubble Line fitting on the side of the case and the silicone rubber tubing connector. The tubing connector is a short length of 0.109 inch (0.20 cm) ID, 0.192 inch (0.49 cm) OD silicone tubing attached to a barbed fitting on the case.

The 1/8" OD bubble line simply slips inside the silicone tubing, forming a reliable union you can make and unmake without tools. This type of tubing connector is superior to a ferrule or compression type tubing fitting for this application due to its simplicity of use (no tools required), its lack of small parts you can easily lose or misplace (ferrules and nuts), and its long term reliability when used with the semi-rigid bubble line Teflon tubing.

3.5.5 Attaching the Teflon Bubble Line

To attach the Teflon bubble line, first slip the 2 inch (5.1 cm) length of 1/4" (0.63 cm) ID vinyl tube included in the instrument accessory package over the end of the bubble line. Grasp the silicone tube to stiffen it and insert the end of the bubble line into the silicone tube.

Slip the short length of vinyl tube over the union and force in onto the shoulder of the barbed fitting. The purpose of the short length of vinyl tube is to support the union, preventing fatigue or kinking of the silicone tube.

To remove the bubble line from the tubing connector, first pull the vinyl tube off of the barbed fitting and slip it down the bubble line. Grasp the end of the silicone tube and then pull the bubble line straight out of the silicone tube.

Several replacement lengths of the silicone tubing are included in the instrument accessory package. Install them on the unit by simply forcing the end of the tube over the barbed tubing connector.

> ☑ ***Note***
>
> Avoid placing too much tension on the silicone tube where it attaches to the barbed fitting. Try to direct the Teflon tube straight away from the fitting rather than at a sharp angle. This will reduce the likelihood that the tubing will tear and leak around the fitting.

3.5.6 Attaching the Vinyl Bubble Line

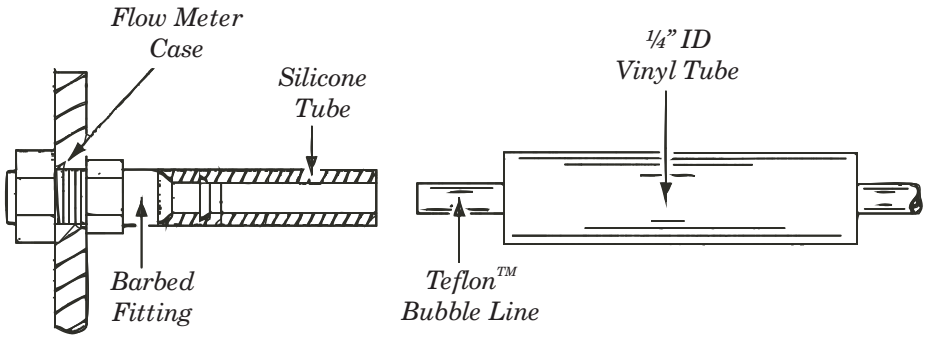
The vinyl bubble line attaches directly to the barbed fitting. Remove the silicone tube and slip the 1/8" (0.32 cm) tubing over the fitting.

3.5.7 Installing the Bubble Line

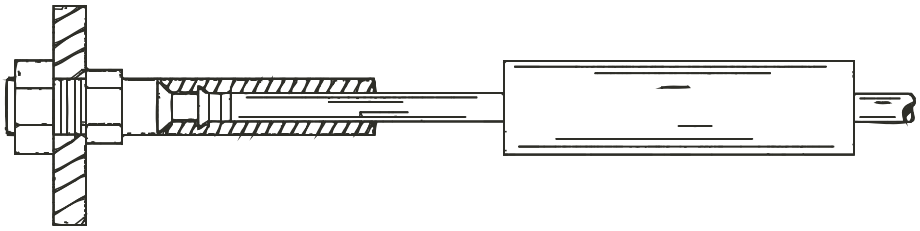
Install the bubble line at the recommended level measuring point in the primary device or other open channel flow situation. If you don't know where this is and you are using a manufactured primary device, consult the manufacturer.

If you are not using a fabricated device, consult the *Isco Open Channel Flow Measurement Handbook* for suggestions. Many different devices are discussed there. Proper location of the bubble line outlet is necessary for accurate measurement. Normally, you place the bubble line in the flow stream so the end is positioned at a right angle to the flow.

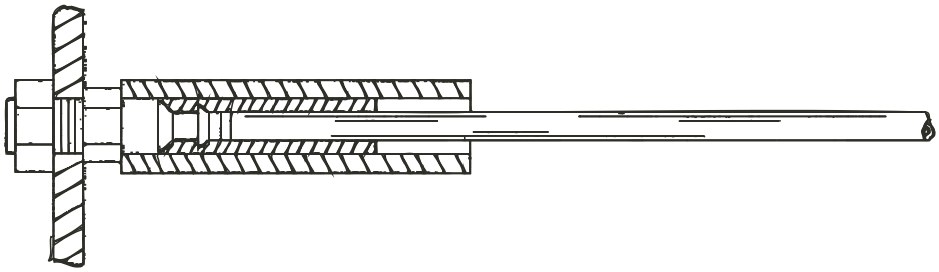
You do not need to locate the outlet of the bubble line precisely at the "zero" liquid level of the weir or flume. The Parameter to Adjust program step of the 4230 allows you to locate the outlet end of the bubble line anywhere within ten feet (3 m) above or below the actual zero level of the primary device. Then you calibrate the displayed level using the Parameter to Adjust step in the program.



Step 1

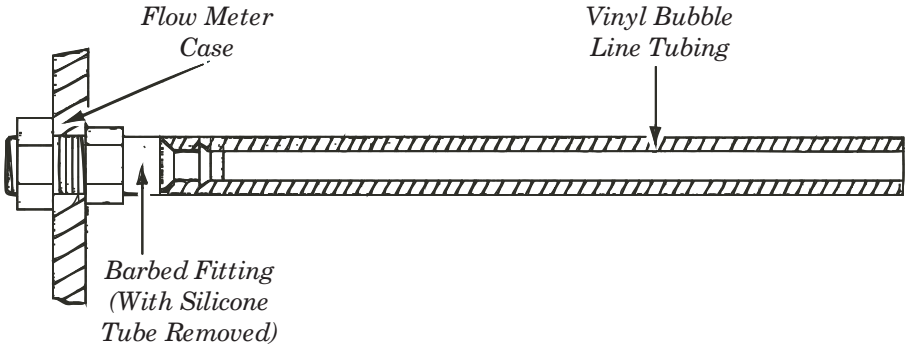


Step 2



Step 3

A. ⅛" OD x 1/16" ID Teflon™ Bubble Line



B. ¼" OD x ⅛" ID Teflon™ Bubble Line

Figure 3-3 Attaching the Bubble Line to the 4230

☑ Note

The 4230 cannot accurately measure liquid levels that are even with or below the bubble line outlet.

If you need to measure the liquid level down to the actual "zero" level of the primary device, Teledyne Isco recommends placing the bubble line outlet at least 1 to 2 inches (2.5 to 5.1 cm) **below** the primary device zero level to avoid measurement failures when the liquid level is even with the outlet. Since the flow meter can display negative measurements, you can compensate when you set the level in the flow meter.

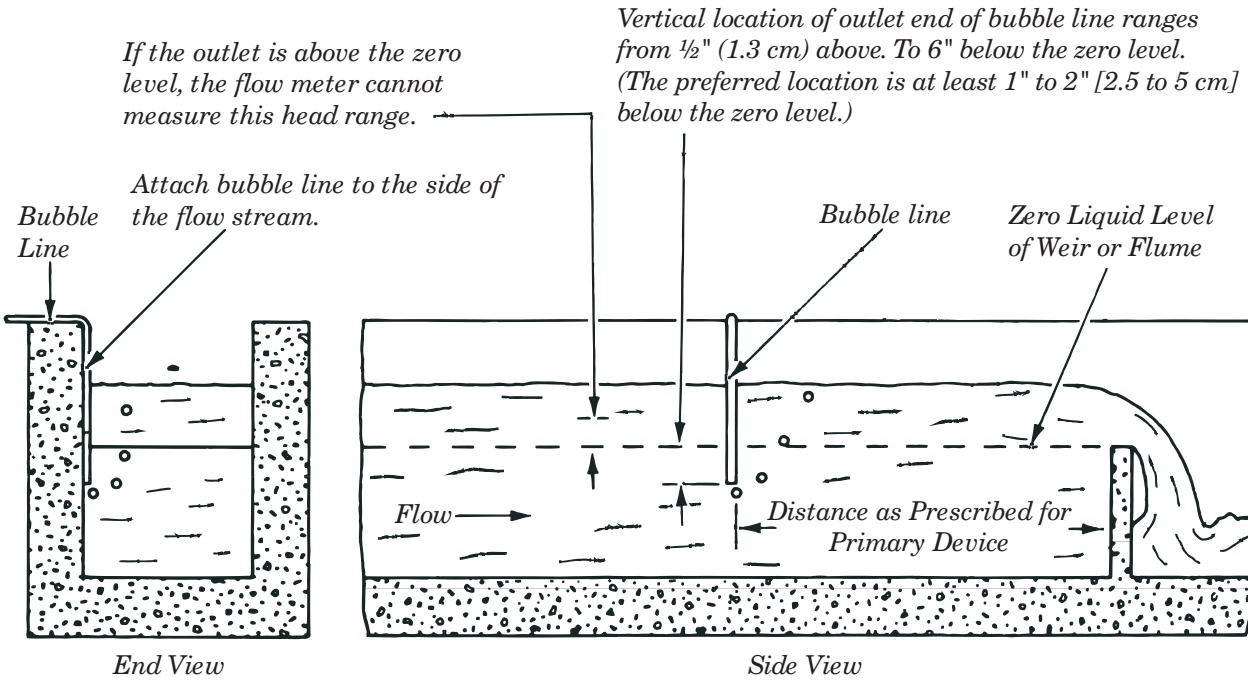


Figure 3-4 Positioning the Bubble Line in the Flow Stream

3.5.8 High-Velocity Flow Streams

The normal position of the bubble line in the flow stream is at a right angle to the flow. However, studies have indicated that at relatively high flow stream velocities (greater than five feet per second [1.5 meters per second]), this location may lead to a measured level lower than actual. This negative level offset is due to localized areas of low pressure near the bubble line outlet; the size of the offset depends upon the velocity of the flow stream and the configuration of the flow stream channel. You can, of course, adjust the level at the flow meter to compensate for the error. However, this is only effective if the flow rate and velocity are essentially constant. If the flow rate drops and the velocity decreases, the level adjustment you made earlier will be incorrect for the new, lower velocity and flow rate.

The best way to overcome this problem is to completely isolate the bubble line from the flow stream velocity by placing it in a stilling well, as described below. If this is not possible, you can perhaps create a cavity in the bottom of the channel, and locate the outlet of the bubble line in the depression, again isolating it from the flow stream velocity.

In flow streams carrying large amounts of solids, however, this may cause problems because of silt collecting in the depression, restricting the bubble line. A third alternative is to put a 90 degree bend in the end of the bubble line, forming a horizontal leg approximately two inches (5 cm) long, and orienting this horizontal leg downstream, parallel with the flow. Tests have shown that this orientation of the bubble line minimizes the effect of flow stream velocity.

3.5.9 Stilling Wells

If the installation includes a stilling well in the primary measuring device, you should probably install the bubble line in the stilling well. Attach the line securely to the stilling well, using stainless steel and/or plastic mounting hardware.

For details on the construction and use of stilling wells, refer to Section VI, Section 93, of the *Water Measurement Manual*, published by the United States Department of the Interior, Bureau of Reclamation (1967). Not all stilling wells are suitable for bubble line installation. If the well is subject to silting or buildup of foreign material, you should probably avoid it and mount the bubble line in the flow stream proper.

3.5.10 Flume Bubble Line Fittings

The large variety of primary measuring devices and installations makes comprehensive bubble line installation instructions impractical. However, valid general observations on bubble line installation can be made. Flumes can be specified to include a bubbler fitting. In new construction, this is highly recommended. It may even be possible to modify an existing installation to include a permanent bubbler fitting.

3.5.11 Bubble Line Extensions

For some applications, metallic bubble line extensions may be helpful. Teledyne Isco offers both stainless steel and copper bubble line extensions. The stainless steel tube may be easier to install in the flow stream than the plastic bubble line because of its relative rigidity. Two different extensions are available to match the two standard bubble lines.

The extension for the Teflon bubble line includes a silicone rubber tubing connector, and the tubing installation is as described above. The vinyl bubble line attaches by simply slipping the vinyl tube over the end of the extension. Some people have found that the use of a copper extension to the bubble line is advantageous in applications where algae tends to grow in the bubble line.

The copper salts released by the tubing are algicidal agents that tend to inhibit the growth of algae. However, the copper tubing may not be compatible with the flow stream, so use it with caution. Attach the copper bubble line extensions to the bubble line in the same way as the stainless steel extensions.

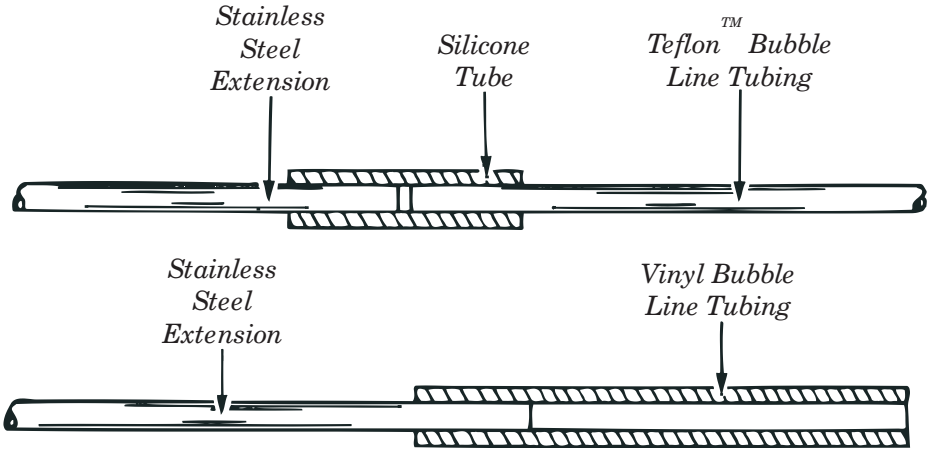


Figure 3-5 Installing the Stainless Steel Bubble Line Extension

3.5.12 Open Channel Installation

If you do not use a stilling well, attach the bubble line to the side of the flow channel or flume. Make the attachment so it causes a minimum amount of disturbance to the flow stream. If possible, cut a groove in the side of the channel, place the bubble line in the groove, and then grout over the groove.

Alternatively, you can attach the bubble line to the side of the channel, and then grout over the line to form smooth, sloped lead-in and lead-out surfaces. However, if neither of these methods is practical, you may simply attach the bubble line to the side of the channel or the upstream side of a weir using stainless steel and/or plastic mounting hardware.

In any case, always install the bubble line so it causes as little disturbance to the flow stream as possible. This usually means an installation on or adjacent to a channel wall where there is a condition of stagnant flow. For temporary survey applications, you can attach the bubble line with waterproof tape or other temporary means.

3.6 Flow Metering Inserts

Flow metering inserts are available for use with the 4230 Flow Meter that you can temporarily install inside **round pipe** sewers and flow streams to create a primary device inside the pipe. These inserts are available to fit 6", 8", 10", and 12" pipes and install from street level.

Teledyne Isco does not recommend using these inserts for permanent installation due to the likelihood of eventual clogging. For long-term operation, use of the Bubbler Tube Retainer Assembly, with an appropriate Isco Mounting Ring, is a preferable alternative to the Flow Metering Inserts, as there is no restriction to flow. Moreover, with the Scissors Ring, pipe sizes

up to 80" in diameter can be accommodated. Consult your *Isco Mounting Rings Installatino and Operation Guide* for more details.

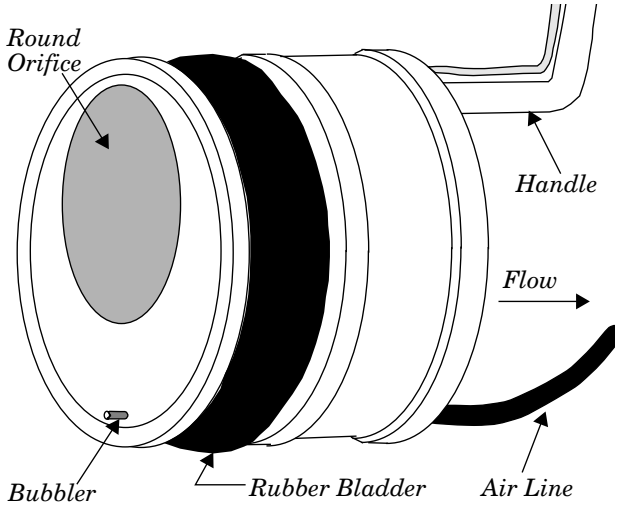


Figure 3-6 Flow Metering Insert

The insert consists of a metal collar surrounded by an inflatable rubber bladder. A removable metal plate, formed with a V-notch opening, attaches to the upstream side of the insert. Each insert also contains a bubble line for a 4230. The rubber bladder, inflated by a removable, foot-powered pump, holds the insert securely in place after you install it inside the pipe.

The metal plate, attached to the insert, forms a V-notch weir inside the pipe. If you remove this V-notch plate from the insert, an off-center round opening appears in the insert. This opening is 60% of the nominal pipe size. If flow in the pipe exceeds 1/4 to 1/3 of full capacity, Teledyne Isco recommends you use the round orifice rather than the V-notch plate.

CAUTION

The flow metering inserts create a restriction in the flow stream and a corresponding head loss. Use them with care in flow streams with suspended solids, or high grease content, such as sanitary sewers.

The inserts may cause clogging, requiring maintenance. Where this is could be a problem, we suggest using the Bubbler Tube Retainer with an Isco Mounting Ring instead.

The inserts are anodized aluminum and are corrosion-resistant. However, you should avoid using them in flows with agents capable of attacking either the aluminum (strong alkalies) or the rubber bladder (certain organic solvents).

3.7 The Bubbler Tube Retainer Assembly

For situations where the Flow Metering Inserts are not an ideal solution, Teledyne Isco offers the Bubbler Tube Retainer Assembly for installation inside round pipe. This system uses a bubbler tube attached to a snap-on probe carrier similar to those used for the other probes (see Section 4).

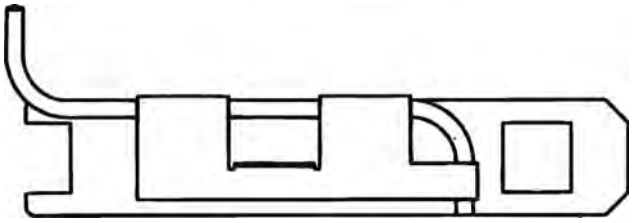


Figure 3-7 Bubbler Tube Retainer Assembly

The carrier snaps onto the mounting tabs of a stainless steel ring. The ring itself fits inside the pipe. Teledyne Isco offers two systems: one that attaches to an Isco Mounting Ring for pipes with diameters 15 inches or less. For pipe sizes from 16" to 80" in diameter, Teledyne Isco offers the Scissors Ring. These rings are designed to accommodate various Isco submerged probes, all installed with the same easy snap-on carriers.

Information on the installation of probes, etc. on rings inside round pipes is provided at the end of Section 4. For more details about probe mounting hardware, see your *Isco Mounting Rings Installation and Operation Guide*.

3.8 Connection to a Sampler

The following sections describe connecting the 4230 to Teledyne Isco and non-Isco samplers.

One of the uses of the 4230 Flow Meter is to control a sampler in a flow-paced sampling mode. Flow-paced sampling means that the flow meter signals the sampler to take a sample after a certain volume of flow has passed through the flow stream, rather than after a particular period of time. In this mode, the sampler and flow meter are able to compensate for varying flow rates.

You can use the 4230 Flow Meter with most Isco samplers and with most other manufacturers' samplers as well.

An optional 25-foot (7.6 m) long connect cable is available to connect the flow meter to the sampler. Attach the 6-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 connector on the sampler. This also connects the flow meter 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. You must use the new cable if you want to take advantage of the programming “sampler enabling” feature. Earlier cables will not allow this feature to work. Pin “F” is not connected; you can verify this pin with an ohmmeter or continuity checker. A “new” cable will show continuity (zero ohms) between the two “F” pins; an old” cable will show open.

3.8.1 Connection to Other Isco Equipment

Teledyne Isco manufactures a variety of useful accessories for use with the 4230 Flow Meter. Among these options are: modems, parameter sensors, the alarm relay box, the rain gauge, a 4-20 mA output device, software, and a mechanical totalizer.

These and other options, along with details about their use, are all described in Section 4.

4230 Flow Meter

Section 4 Optional Equipment

This section describes accessories and companion equipment available for use with the 4230 flow meter. There are two groups of equipment. One group can be used with any 4200 series flow meter. The other group is equipment for a specific type of level sensing and can only be used with the 4230 flow meter. This section covers the accessories 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 (Analog) 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

The 4-20 mA Output Interface, alarm box, rain gauge, 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.

4.1 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.

4.1.1 How it 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.**

4.1.2 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.

4.1.3 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.

> ☑ ***Note***
>
> **"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) 228-4373 or, outside the U.S.A., call (402) 464-0231, 4700 Superior St., Lincoln Nebraska, 68504-1398, 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."

4.1.4 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:

☑ *Note*

"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.

4.2 Connections to 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 2.7.2.

Teledyne Isco still offers the older 300 baud output for the Model 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 which 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 a '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.

> ☑ ***Note***
>
> 1. You cannot use both serial outputs at the same time. You must select one or the other.
> 2. 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.

4.3 4 to 20 mA (Analog) Outputs

These outputs provide connection between a 4230 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 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.

4.3.1 External 4-20 mA Output Interface

The external **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 4-20 mA Output Interface: Technical 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.

Table 4-1 4-20 mA Output Interface: Technical Specifications (Continued)	
Adjustments/ Calibration	Factory-calibrated; when used within range, no adjustment needed,
Maximum Distance	1,500 ft. (457.3 m) using 18 AWG wire.

Figure 4-1 4-20 mA Output Interface

4.3.2 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 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 1-5 and Section 5.)

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 Multiple Analog Output Board: Technical Specifications (each circuit)	
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.	

4.4 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.

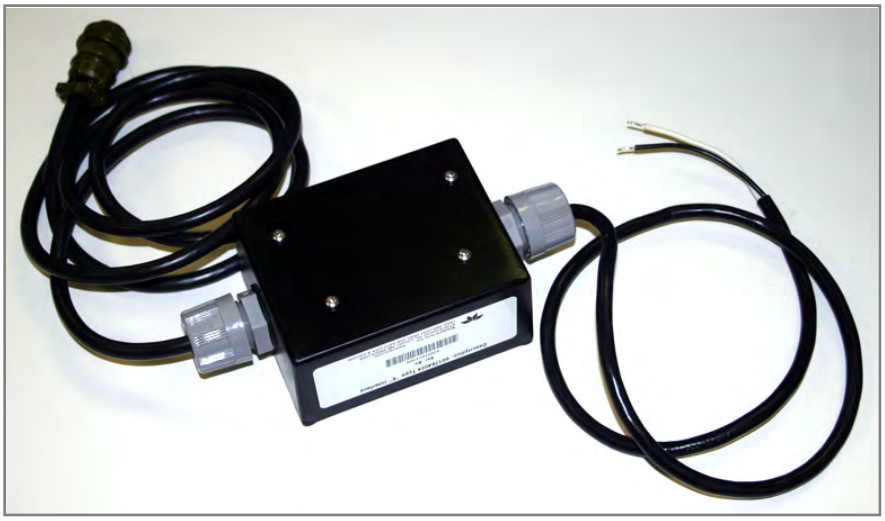


Figure 4-2 Type 'E' Interface for pacing non-Isco equipment

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 5.9.1 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.

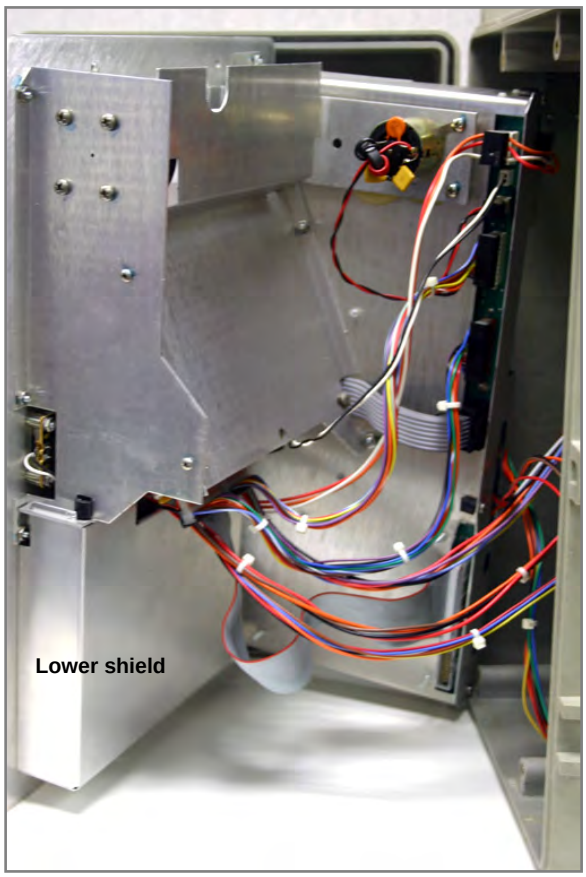


Figure 4-3 Flow meter with front panel removed

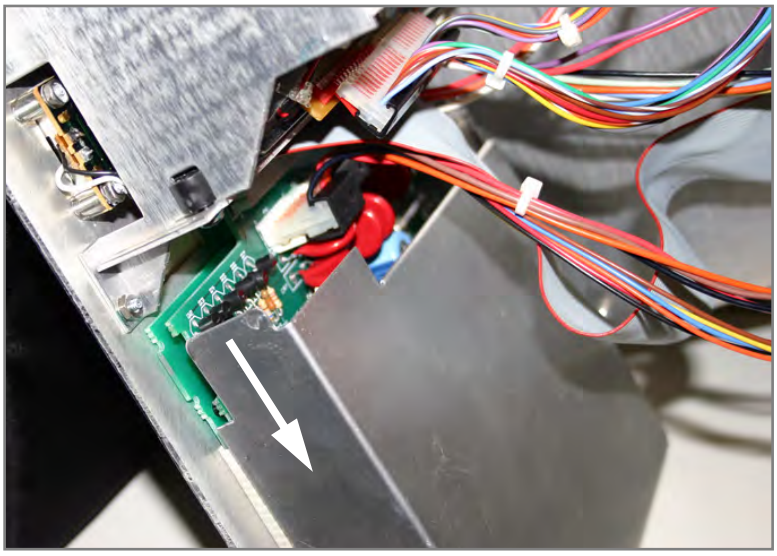
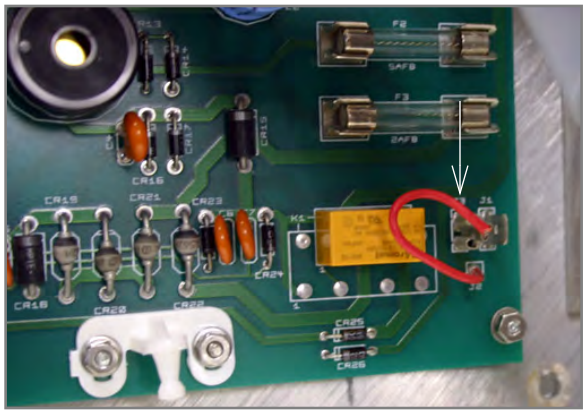
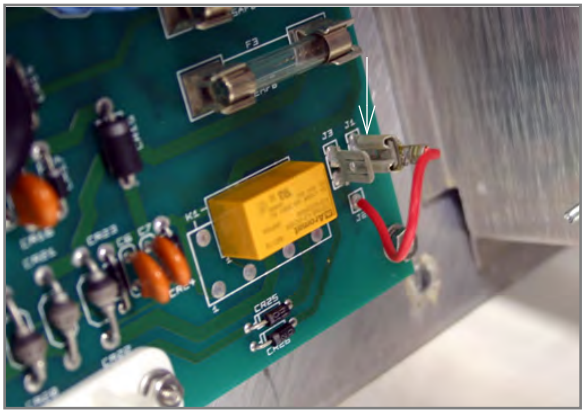


Figure 4-4 Removing the lower shield

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.

4.5 Tipping Bucket Rain Gauge

A Tipping Bucket Rain Gauge is available from Teledyne Isco for use with 4200 Series Flow Meters. The rain gauge connects to the flow meter by a cable terminated in an M/S connector. This connector plugs into the 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 specifications:

- 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 4-6 674 Tipping Bucket Rain Gauge

4.6 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.

4.7 High-Low Alarm Relay Box

Teledyne Isco offers a control box that monitors flow rate data available from any 3000 or 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*

1. Do not use the alarm box if your flow meter has a modem or uses Flowlink software (through either a modem or laptop computer).
2. 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.

4.7.1 Installation

The High-Low Alarm Relay Box is enclosed in a high-strength plastic box. Mount the unit with corrosion-resistant hardware through the two holes in the stainless steel mounting plate attached to the case. Two threaded holes in the case allow the use of either ½" 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 microprocessor 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.

4.7.2 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 Rain Gauge connector on the flow meter. The other end of the cable has three stripped wires. Attach them to the alarm box according to the instructions in the alarm box manual.

BLACK	+12 VDC
GREEN	–12 VDC
WHITE	DATA

4.8 Parameter Sensing

All Isco 4200 Series Flow Meters have the capability of displaying, recording, and (if Flowlink software is used) storing data provided from parameter sensors. The parameter sensors that are available from Teledyne Isco for use with 4200 Series Flow Meters are for temperature measurement, dissolved oxygen (D.O.) and pH (indicating the acidity or alkalinity of a solution), and the YSI 600 Multi-Parameter Sonde. See Section 4.12 for information on the YSI 600 Sonde. This section covers the Isco pH, D.O., and temperature sensors.

4.8.1 Installation of Parameter Probes

All three parameter probes, as well as other Isco probes such as the submerged probe level sensor and area-velocity probe, require complete 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 all 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. 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 change certain aspects of the flow meter's program. Selection of either pH or D.O. in **step 1** of the program (where units of measure are defined) will lock out any mention of the other probe 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.**

4.8.2 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 during programming.

4.9 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.

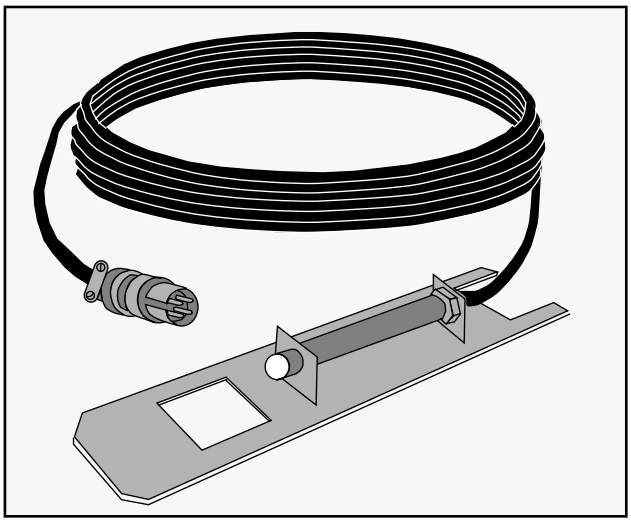


Figure 4-7 Temperature Probe

A dissociation constant is a number that indicates the amount of ionic dissociation occurring for a given substance after it is dissolved in aqueous solution. Dissociation constants vary widely for substances depending on the nature of the chemical bonds within the substance.

Figure 4-8 pH Probe With Protective Cap

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.

4.9.1 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 and sensitive only to hydrogen ions. It is exposed to the solution to be measured. The specific sensitivity to hydrogen ions prevents interference from other ions that may be present in the solution. 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 a 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 201 module to allow greater operating distance from the flow meter. The flow meter determines the pH value and displays it.

4.9.2 pH Probe Calibration

The 4230 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.

1. To calibrate the pH probe with the flow meter, first 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.) 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 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.

4.9.3 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 Universal Mounting 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 screw 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 that could clog the sewer.

Mount the pH 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.

Figure 4-9 201 pH Module

☑ 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 Technical 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 Junctions	Type II Double porous junction
Temperature Compensation: Done by software inside the flow meter. The pH Probe contains an integral temperature sensor.	

All 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.

4.9.4 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 may ruin the probe.

The pH sensitive glass can 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 deionized water 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 works, it may be necessary to replace the probe.

4.10 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.

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. Note that 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.

> ☑ ***Note***
>
> The 270 D.O. module has been discontinued. Probes, service kits, and accessories are still available to mainain existing field units.

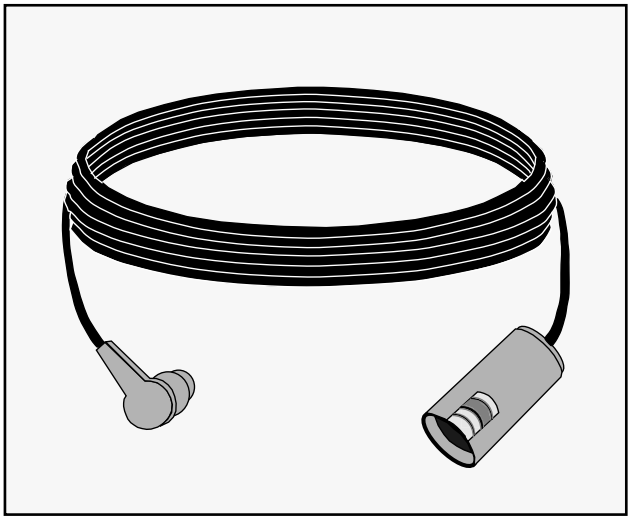


Figure 4-10 D.O. (Dissolved Oxygen) Probe

For successful use of the D.O. Probe, please read and consider the following:

- 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 high grease or solids content. Tests conducted by Teledyne Isco with probes installed in various waste streams have indicated that greases 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 pores. It is generally necessary to replace both the electrolyte and the diaphragm to get an accurate reading. In such severe cases of fouling it may be necessary to change the diaphragm very frequently, even as often as every other day.

4.10.1 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 propor-

tional 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.

4.10.2 Probe Preparation

The following describes how to prepare a new probe for use, or how to change membranes on an existing probe. 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 surface.
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.

4.10.3 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. Use of other membrane thicknesses will result in inaccuracy.

4.10.4 Probe Installation

The D.O. probe attaches to a sensor carrier bracket that snaps into an Isco mounting ring. Use the specific size mounting 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.

4.10.5 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 will not 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.

Table 4-4 D.O. Probe Technical 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^{o} C	19 microamps (nominal)
Probe Current in Nitrogen at 30^{o} 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.	

Figure 4-11 D.O. Parameter Module

You must use the Isco Model 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.)

☑ Note

The 270 D.O. Module has been discontinued. Probes, service kits, and accessories are still available to maintain existing field units.

4.10.6 Calibrating the D.O. Probe with a Flow Meter

Prepare the probe as described above if this has not already been done (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.

Wrap both the D.O. Probe and Temperature Probe in a damp cloth. Wait ten minutes for it to stabilize, then proceed.

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. Select NOT MEASURED. Then D.O. UNITS will appear. Select either MG/L or PPM. Exit the program and re-enter going to **step 3**.

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. •
```

Select D.O. The following 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)
```

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.

4.11 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)**.

4.11.1 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.

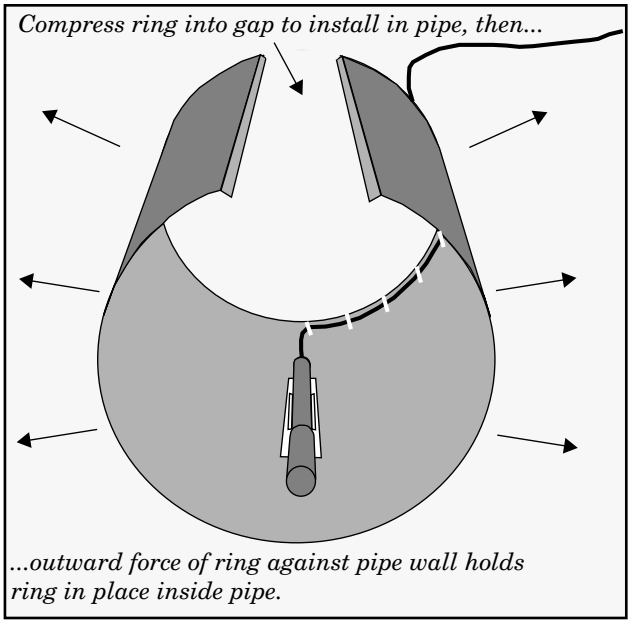


Figure 4-12 Sensor Installed on a Spring Ring

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.

4.11.2 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 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.

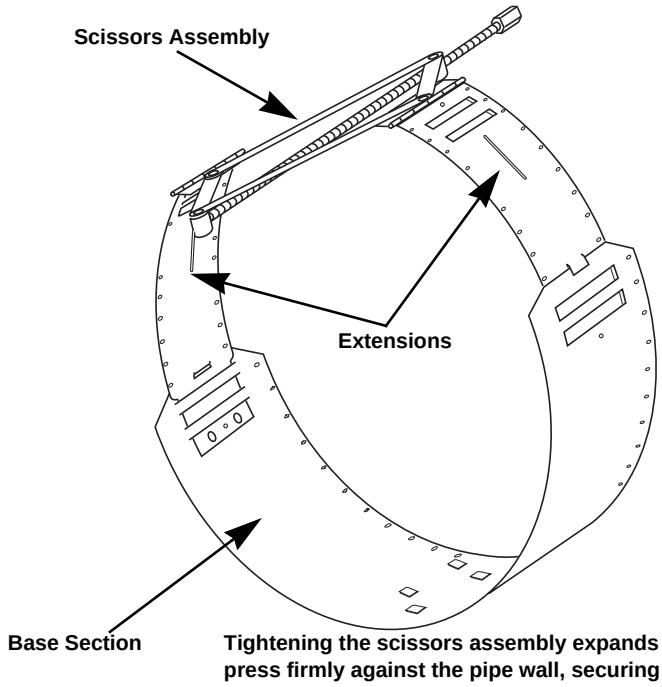


Figure 4-13 Scissors Ring Adjustment

4.12 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 YSI 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.

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 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.

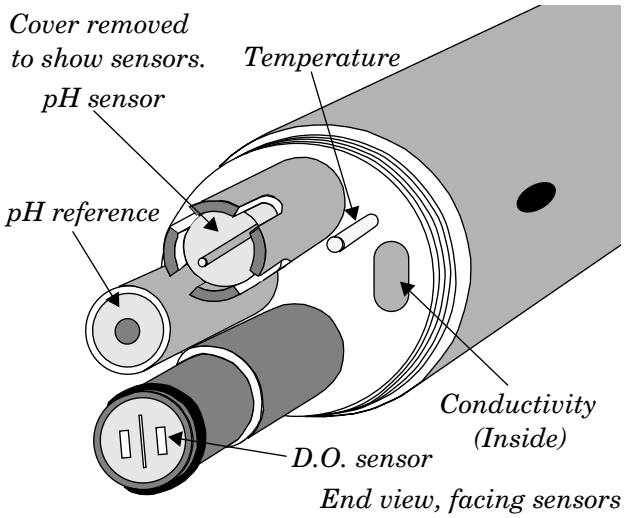


Figure 4-14 YSI 600 Multiple Sensor Sonde

4.13 Mechanical Totalizer

A mechanical totalizer is available for the 4230 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 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.

4230 Flow Meter

Section 5 Maintenance and Service

This section of the 4230 instruction manual provides routine maintenance and servicing instructions. Included are sections on cleaning the flow meter, reactivating the desiccators, maintaining the bubble line, servicing the internal printer, elementary troubleshooting, and servicing CMOS circuitry.

Teledyne Isco recommends that you become familiar with the maintenance procedures presented here. While the 4230 is ruggedly built to withstand severe field conditions, it will function best and remain most reliable if you follow these simple procedures.

5.1 Care of the Flow Meter Case

If you close and latch the lid, and cap all the M/S connectors on the side of the case tightly, 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 used at car washes. Do not immerse the flow meter in a tank of water to wash it. The flow meter will withstand accidental submersion in water, if that should occur, but it is not intended for routine submersion.

5.1.1 Care of the Case Seal

From time to time you should inspect the case seal and clean it, if necessary. The ridge around the edge of the case and the groove on the cabinet door form a seal when the door is closed. Keep this seal free of dirt, sand, etc. If it is not, clean it carefully with a damp cloth. Also keep the rubber gasket in the lid clean. You can clean it with a small brush and a damp cloth. If you do any cleaning while the case is open, be careful not to let any dirt or debris fall inside the flow meter assembly. It is best to work on the flow meter with the case standing upright. If you do not maintain the seals properly, they may leak, causing damage and eventual failure of the components inside.

5.1.2 Preventing Moisture Damage

To prevent moisture damage to the internal components, keep the lid tightly latched at all times, except when it is necessary to change the program or change the chart. Do not operate the flow meter routinely with the case open. This will expose the internal components to dirt and moisture; it will also saturate the desiccant canister inside the case very quickly. Inspect this canister periodically and recharge it as necessary as described subsequently. 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 terminals (pins or jacks) inside the connectors; residue from the sprays could cause intermittent or failed connections.

5.2 Desiccators

The 4230 has a reusable desiccant canister held by a steel clamp on the inside of the case lid. There is also a tubular desiccant cartridge on the top of the case next to the connectors. The canister contains silica gel that adsorbs 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 quickly absorb moisture from the surrounding air and will soon be saturated. It will no longer be able to protect the flow meter. Both desiccators use a color indicator that changes from blue to pink or yellow when saturated. The external desiccant cartridge vents the reference port of the pressure transducer and the air intake port for the bubbler system air pump.

5.2.1 Regenerating the Internal Case Desiccant

Look at the desiccant canister each time you open the case. The canister has a window on its side that appears blue or yellow when the desiccant is dry. As the desiccant absorbs moisture, the window will turn pink or green. When the window is pink or green, you need to regenerate the desiccant, or replace it with the spare canister provided in the flow meter accessory package. Remove the canister from the flow meter by pulling outward on the spring clamp, releasing its hold on the canister.

Remove the canister and heat it in a **vented** oven in a well-ventilated room at 300°F (150°C) for about three hours, or until the blue or yellow color returns. **Do not use a microwave oven**; the metal case of the canister could cause arcing. After cooling, reinstall the canister in the flow meter. Make sure the window on the side of the canister remains visible.

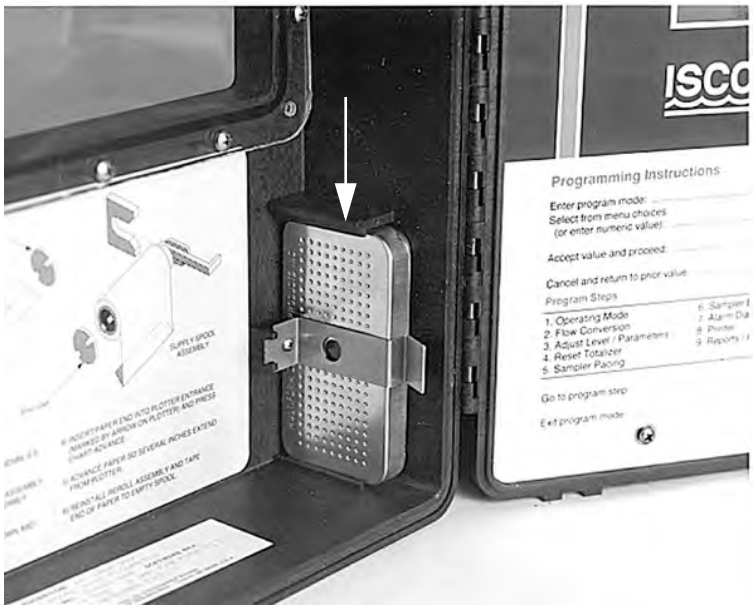


Figure 5-1 Location of the Case Desiccating Canister

5.2.2 Regenerating the External Desiccant Cartridge

Teledyne Isco uses two types of silica gel:

- One chemical looks like small beads or pellets that are blue-black when dry, pale pink to transparent when saturated.
- The other chemical looks like coarse sand, yellow when dry, dark green when saturated.

Regenerate desiccant by heating at 212° - 350° F (100° - 175°C).

MSDS (Material Safety Data Sheets) for silica gel chemicals are provided at the back of this manual.

To regenerate the desiccant cartridge:

1. Snap it out of its bracket.
2. Pull the silicone tubing from the end of the cartridge.
3. Remove one of the end caps from the cartridge by twisting and pour the saturated desiccant into a metal, ceramic, or other heat-resistant container.
4. Identify the desiccant and heat it at the proper temperature two to three hours, or until the blue or yellow color returns.
5. Do not try to regenerate the desiccant inside the cartridge; the cartridge is plastic and will melt.
6. Refill the cartridge with the regenerated desiccant (or with the extra desiccant provided in the accessory package.
7. Replace the end caps. If you have difficulty removing or replacing the end caps, you can coat the O-rings with a small amount of silicone oil. (Do not use any other type of oil; it may attack the plastic.)

Notice the filters in the end caps; they keep small pieces of the desiccant material from falling out of the cartridge. Clean these filters from time to time using ordinary dish soap and water, and allow to dry.

CAUTION

There have been reports of irritating fumes coming from the desiccant during regeneration. While our attempts to duplicate the problem have been unsuccessful, we still urge you to use caution.

- Use a vented oven in a well-ventilated room.
- Do not remain in the room while the regeneration is taking place.

Regeneration of the desiccators is extremely important. While it is true that the equipment may run for some time with saturated desiccators, the operating environment of many installations places the units at risk. Please consider the following:

> ☑ ***Note***
>
> Saturated desiccators let the flow meter draw moisture inside, exposing both mechanical and electronic components. The air in many installations contains fumes that will form acids in the presence of moisture. These acids may corrode electrical components, particularly connectors and circuit boards.
>
> Operation of the air pump in low temperature, high humidity environments causes ice to form inside the pump. The ice formed could jam the pump, ruining it.
>
> **Unseen damage caused by moisture will eventually ruin the flow meter.** For maximum equipment life and reliability, inspect the desiccators regularly and regenerate them when necessary.

5.3 Bubble Line Maintenance

Periodically inspect the bubble line from the 4230 to make sure that it has not become kinked, frayed, cut, nicked, or damaged in any other way. If you find damage to the bubble line, replace it. A leaking or obstructed line will cause inaccurate level readings and lower battery life. (The pump must run more frequently.) Look for a pump duty cycle value in the STATUS menu higher than 20%. If you need to replace the bubble line, install a new line the same way you installed the original. Generally, the new line should be the same length and diameter as the old.

> ☑ ***Note***
>
> If you replace the bubble line or if you change the outlet either by cutting off the tip or by installing a bubble line extension, you must recalibrate the level. You should also recheck the bubble rate to make sure it has not changed.

5.3.1 Inspection of the Bubble Line Outlet

Inspect the outlet of the bubble line regularly for any signs of clogging. Sediment or debris from the flow stream and algae can all clog the line. If the line is blocked, you can either clean it out, or simply cut off the tip.

If clogging proves to be a recurring problem, you may want to use a bubble line with a larger inside diameter. However, you will usually find it preferable to increase the frequency of **Purge** to increasing the size of the bubble line.

If you decide to change the bubble line size, consult the factory for specific recommendations regarding the size of the line, connectors required, etc.

If algae growth is a problem, consider using a copper bubble line extension. The copper salts formed on the line by the flow stream are algicidal. Again, recheck the bubble rate and re-enter the actual level measurement.

5.3.2 Automatic Air Purge

The 4230 has an automatic purge feature to clear deposits from the bubble line with a sharp burst of air from the pump. Purge is intended to help keep the outlet of the bubble line open. The program substep PURGE INTERVAL (in Setup) allows you to set the time between purge cycles, from five minutes to one hour.

The **Purge** key on the keypad lets you manually purge the bubble line anytime just by pressing the key. You don't have to wait until the next programmed purge cycle occurs to purge the line.

When you press **Purge**, the pump will start running inside the flow meter. The pump will continue to run as long as you press the button, and for a short while after you release it.

5.4 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.

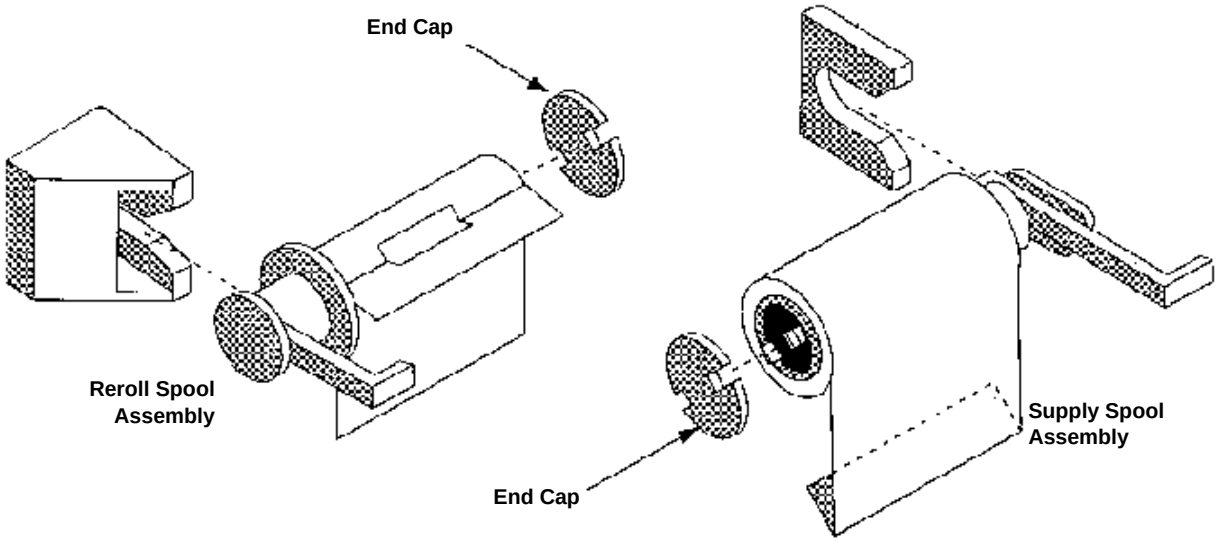


Figure 5-2 Changing the Chart Paper

5.4.1 Changing the Paper Roll

To change the chart paper you will need:

- new roll of paper
- a knife or a pair of scissors
- a 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:

1. Locate the handle on the left side of the take-up roll.
2. Pull straight out on this handle until the take-up roll slips off the printer.

3. 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.
4. Snap the white end cap free from the two black catches on the end of the spool.
5. Pull the paper roll off the spool with your other hand.
6. Remove the feed spool by pulling on the handle extending from the right side of the printer.
7. Snap off the other white end cap as described previously. Save the white end caps; you will reuse them.
8. Remove the empty roll from the spool by holding the handle in one hand and pulling the roll from the spool with the other.

Installing the New Roll of Paper

After you remove the empty roll:

1. Slide the new roll onto the feed spool so it unrolls from the back side - facing away from you.
2. Line up the slots in the cardboard tube with the raised guides on the spool.
3. 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.
4. 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.
5. Fold the paper over on itself so the end is straight and stiffer than a single layer of paper would be.
6. Unroll a few inches of the paper and set the roll on top of the cabinet.
7. 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.
8. Press the Chart Advance key and hold it until the paper comes through the printer mechanism.

Re threading the Paper

1. When the paper comes through, reinstall the feed spool with the new roll on it by snapping it into the printer assembly.
2. Run a few inches through the printer, using the Chart Advance key; then unfold the end.
3. 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.
4. Use the piece of tape to attach the end of the new paper to the cardboard tube from the old roll.
5. 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.

6. 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.
7. When the take-up spool is back in place, again push the Paper Reroll key; this will remove any slackness in the paper.

5.4.2 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.

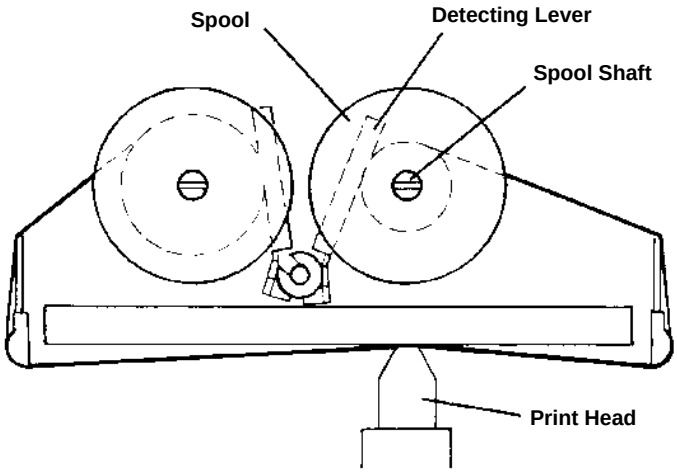


Figure 5-3 Ink Ribbon Replacement

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. Grasp 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.

5.4.3 Do Not Lubricate or Disassemble

You do not need to oil the printer mechanism. As long as you keep the lid closed, keep the inside of the cabinet clean, and do not abuse the printer in any way, it should function normally. Teledyne Isco recommends you make no attempt to oil or disassemble the mechanism if it malfunctions.

Oil attracts dirt; some oils can become gummy over time and may cause parts to bind or stick. Do not attempt to disassemble the printer mechanism, as you may bend or distort the frame or component parts. This will certainly cause malfunction.

Do not force any part of the mechanism with tools or probes. If you disassemble the flow meter, do not lift the chassis from the case by holding on to any part of the printer. The internal printer contains no user-serviceable parts other than the paper and the ribbon. If the printer needs service, Teledyne Isco recommends you return the flow meter to the factory.

5.5 Servicing And Troubleshooting

The remainder of this section provides servicing information and a general troubleshooting guide. This information will help you decide whether to attempt to repair the flow meter yourself or return it to the factory.

Included are sections on removing the flow meter chassis, fuse replacement, and an explanation of the components of the bubbler system. There are also general comments on servicing electronic equipment with special consideration of CMOS circuitry.

5.5.1 Disassembling the Flow Meter

You can remove the flow meter chassis from the cabinet for inspection and servicing. Unscrew the four screws, two at the top, and two at the bottom, that hold the flow meter chassis in the cabinet. You can then lift the chassis out by inserting the thumb or index finger from each hand into the upper right and lower left corners of the opening for the internal printer.

Do not try to lift the flow meter out of its case by holding on to any part of the printer mechanism. This could bend or distort part of the printer, possibly damaging it. Once the chassis has cleared the case, you can hold onto the edges with both hands and lift it free of the case.

Figure 5-4 Lifting the Flow Meter from the Case

> **Note**
>
> If you disassemble the flow meter for servicing, you will also remove the aluminum chassis covers to access the circuitry. Always replace these covers when repairs have been completed. The covers protect the circuit boards and also reduce signal emissions that could interfere with the operation of nearby electronic equipment. For the same reason, do not remove any of the ferrite beads or alter the wiring harnesses inside the cabinet in any way.

5.5.2 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 directly behind the keypad. There is an aluminum cover over this board. Remove the cover by pressing against its surface with the palm of your hand and then pulling downward on it with your fingers. A plastic catch under the cover holds it in place. 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 - 2½ amp., fast blow

Always replace a blown fuse with one of the same value. Using a larger value of fuse could cause serious damage to the flow meter or to its power supply. Replace the protective cover, making sure

the two ears on top of the cover slide into the mating slots on the chassis. There should be a noticeable snap when the plastic catch re-engages the cover.

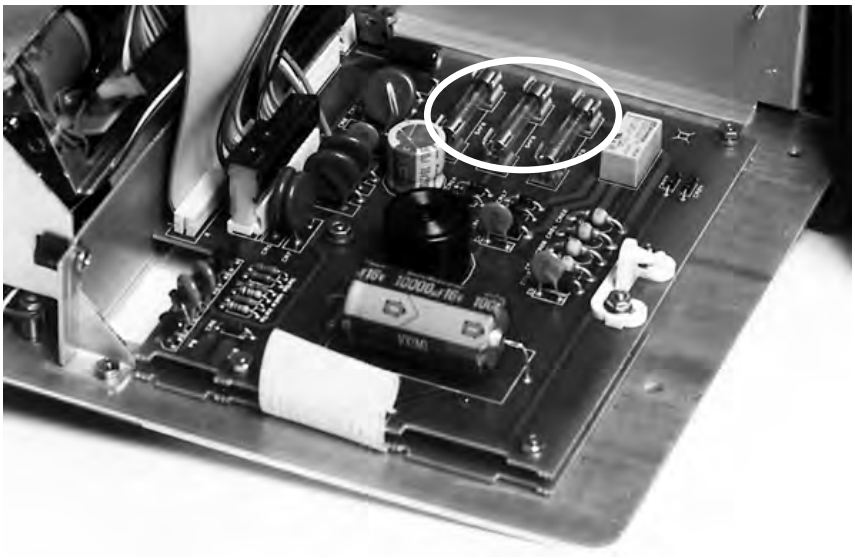


Figure 5-5 Location of the Three Fuses

5.5.3 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 by the LCD:

CHECK PRINTER FUSE

PRINTER JAMMED

PAPER OUT

5.6 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 does not 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 4230 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 for you to reprogram the unit to meet the specifications of your installation. For this reason, it may be a good idea to keep a record of how you programmed the unit. The **Print Program** feature will do that for you.

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, the Teledyne Isco Technical Repair Department should be called for instructions at (866) 298-6174 or (402) 464-0231.

CAUTION

Do not attempt to disassemble or repair the 4230 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.

5.7 Operation of the Bubbler System

This system produces the pressurized air supply for the bubbler, regulates the rate of air to the bubbler tube, measures the pressure in the bubbler tube, does purge, drift compensation, and other functions.

5.7.1 Internal Air Pump

A small, high-efficiency pump generates the pressurized air supply for the bubbler. The suction side of the pump connects to the outside of the case through the pump inlet port barbed hose connector. This vent is separate from the other components to prevent interference from the pumping cycles. The exhaust side of the pump connects to the air supply tank, which is pressurized by the pump.

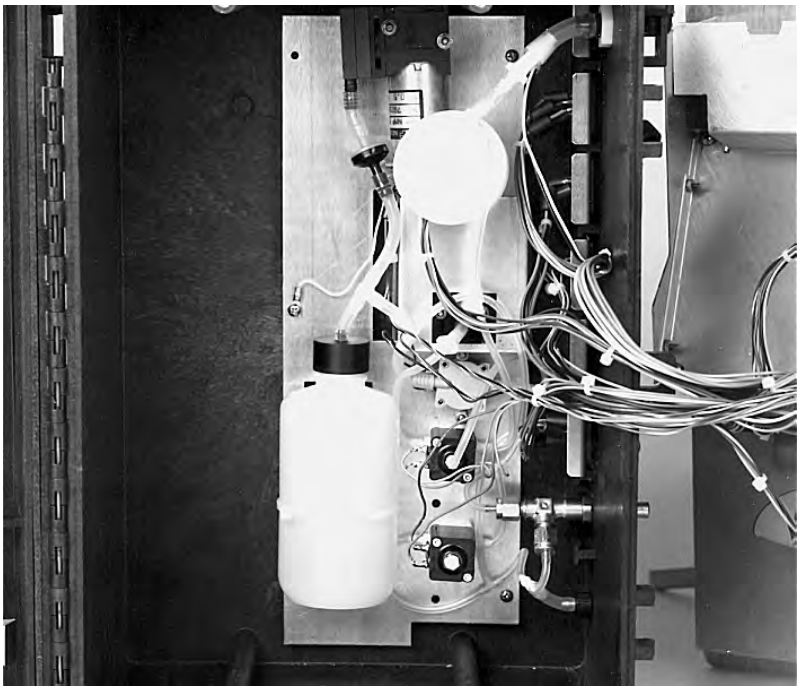


Figure 5-6 4230 Bubbler System Pressure Control

A fixed set-point pressure switch monitors air pressure in the tank. The reference side of this differential pressure switch connects to the bubble line. When the pressure in the tank falls below 3.5 psig above the water pressure being measured, the pressure switch turns the pump on for a fixed period of time. Thus, the system maintains pressure in the tank at approximately 3.5 psig above the current water pressure.

5.7.2 Air Output to Bubble Line

The output from the air supply tank leads to the bubble line tubing connector on the side of the case. The bubble line attaches to the flow meter through this connector. The pressurized air in the tank can take two possible paths to the bubble line. The normal route is through the **Bubble Rate Adjust** valve. This adjustable, fine-metering valve controls the rate of air escaping from the bubble line, establishing the bubble rate. The adjustment knob of this valve is on the outside of the flow meter case, allowing external adjustment of the bubble rate.

5.7.3 Purge

The other path air can take to reach the bubble line is through the bypass Purge valve. Purge is an electrically-operated valve. When this valve turns on, air bypasses the Bubble Rate Adjust valve and discharges directly into the bubble line. This valve also opens momentarily to release bursts of air when the pressure transducer detects a rapidly rising liquid level.

The flow meter normally operates with a battery-saving low bubble rate, but these air bursts allow fast response to a sharply rising liquid level. This quick-response feature is called **Super Bubble**.

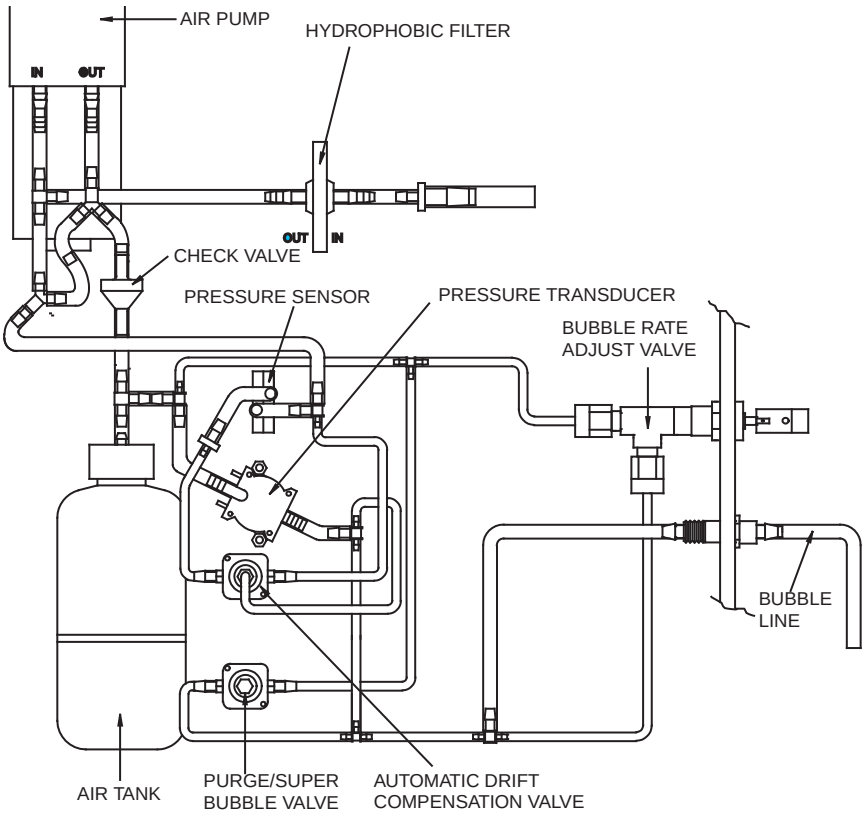


Figure 5-7 Schematic Diagram of the Bubbler System

While the purge valve pulses for short cycles to produce the Super Bubble, it also opens to produce longer discharges of air at intervals selected from the program, or you can operate it manually through the use of the manual Purge switch on the keypad. The purpose of the purge feature is to clear deposits from the bubble line that build up over time and could eventually cause clogging.

5.7.4 Pressure Transducer

A temperature-compensated solid-state pressure transducer measures the air pressure in the bubble line. The pressure is proportional to the level. The pressure transducer connects to the bubble line through the automatic drift compensation valve. The reference side of this transducer vents to the outside of the case through the external desiccator. The microprocessor converts the output from this transducer into level and flow rate.

5.7.5 Automatic Drift Compensation Valve

This valve, located directly across both ports of the pressure transducer, turns on at power-up and from time to time after that to tie the input and reference ports of the transducer together to compensate for any drift that might occur. The software determines how often this valve turns on.

5.8 Preliminary Troubleshooting Steps

CAUTION

Do not attempt to disassemble or repair the 4230 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.

The electronic circuitry of the 4230 is solid-state and its reliability is high. 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 or (rarely) poor electrical connection through keypad switches should be suspected.

5.8.1 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. The service department will advise you on how to return the 4230 to the factory for servicing.

The Technical Repair Department has trained technicians and specially-designed equipment necessary for timely, efficient repair of the 4230 Flow Meter. If you still wish to attempt repairs, the Technical Repair Department is available to provide additional advice and information on servicing.

5.8.2 Processor

When attempting to isolate problems within the unit, you should assume that the CPU and memory are 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 doubtful that the repair facility would have the time or equipment to do worthwhile troubleshooting (beyond exchanging components) on the CPU or memory.

When the unit does not work, do not automatically assume the CPU is at fault. Following are suggested areas to check before attempting to service the CPU and associated circuitry. Telephone consultation with Teledyne Isco Technical Service is strongly recommended. Look for the following:

1. First verify that the problem is in the flow meter and not caused by the bubble line, power supply, or any other equipment connected to the flow meter.
   The flow meter could be all right and will appear not to work because of a clogged or leaking tube or other component; check these first.
2. Check to see if any fuses are blown
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.
   Burnt or broken components, overly hot components, stuck or inoperative switches, or the evidence of water damage, again brought about by neglect or abuse, may be apparent if you look closely.
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. Make sure the air pump and associated circuitry are functioning correctly.
   Check both the electronic and pneumatic circuits. A leaky piece of tubing will seriously affect accuracy.
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.

5.9 Precautions for Servicing CMOS Circuitry

Most of the circuitry in the 4230 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.

Many of the driver transistors in the 4230 are power MOS devices; they are just as susceptible to static damage as CMOS ICs are. Because of this risk, certain precautions must be taken when working on these circuits.

5.9.1 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 your sleeves so that your arms are in contact with the working surface.
- Avoid using a work surface made of an extremely good insulator.
  Plastic 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 outdoor low temperatures 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 are also stuck into a block of black conductive foam. If replacement components that are purchased do not come in marked, protective packaging, do not use them. They may already be destroyed.
- 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 excessive heat or pressure has broken the foil traces or pulled the cores from holes on the board.

5.10 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.

5.10.1 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.

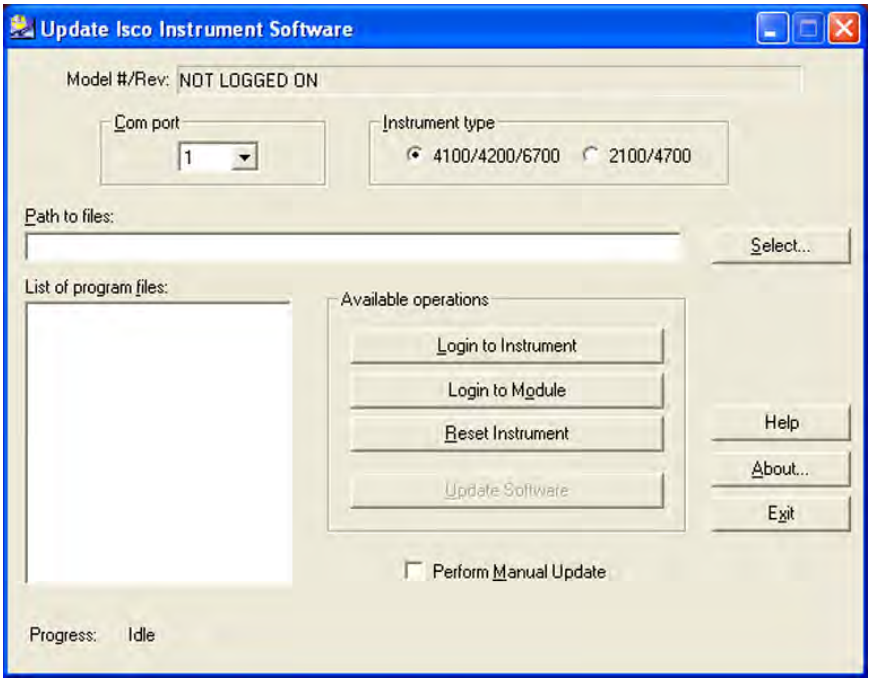


Figure 5-8 Open the software update program

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.

4230 Flow Meter

Appendix A Accessories and Replacement Parts

A.1 Replacement Parts

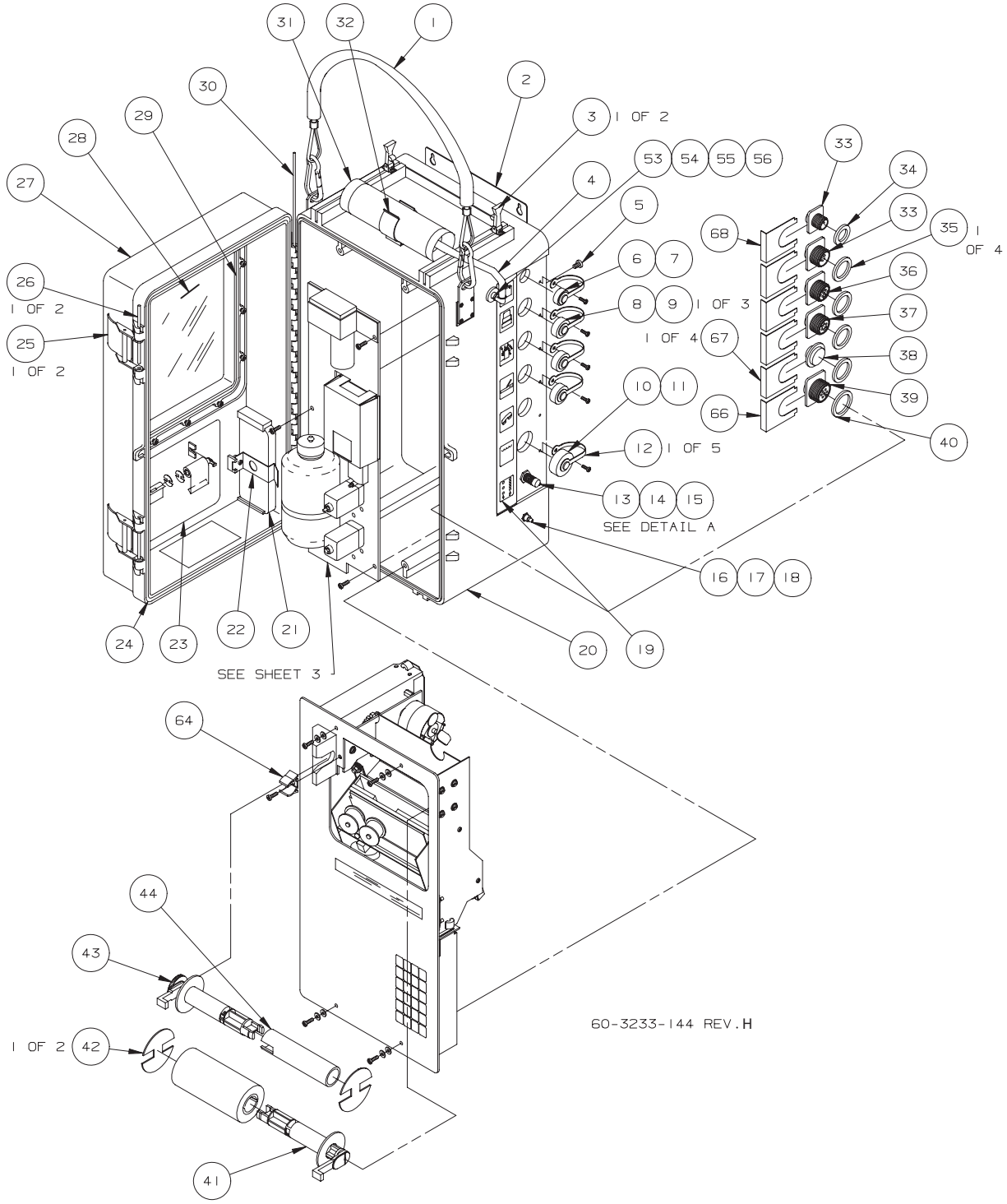
The following section contains illustrations and corresponding tables of 4230 Flow Meter replacement parts. A list of accessories and optional equipment can be found at the end of this section.

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

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

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

E-mail:IscoInfo@teledyne.com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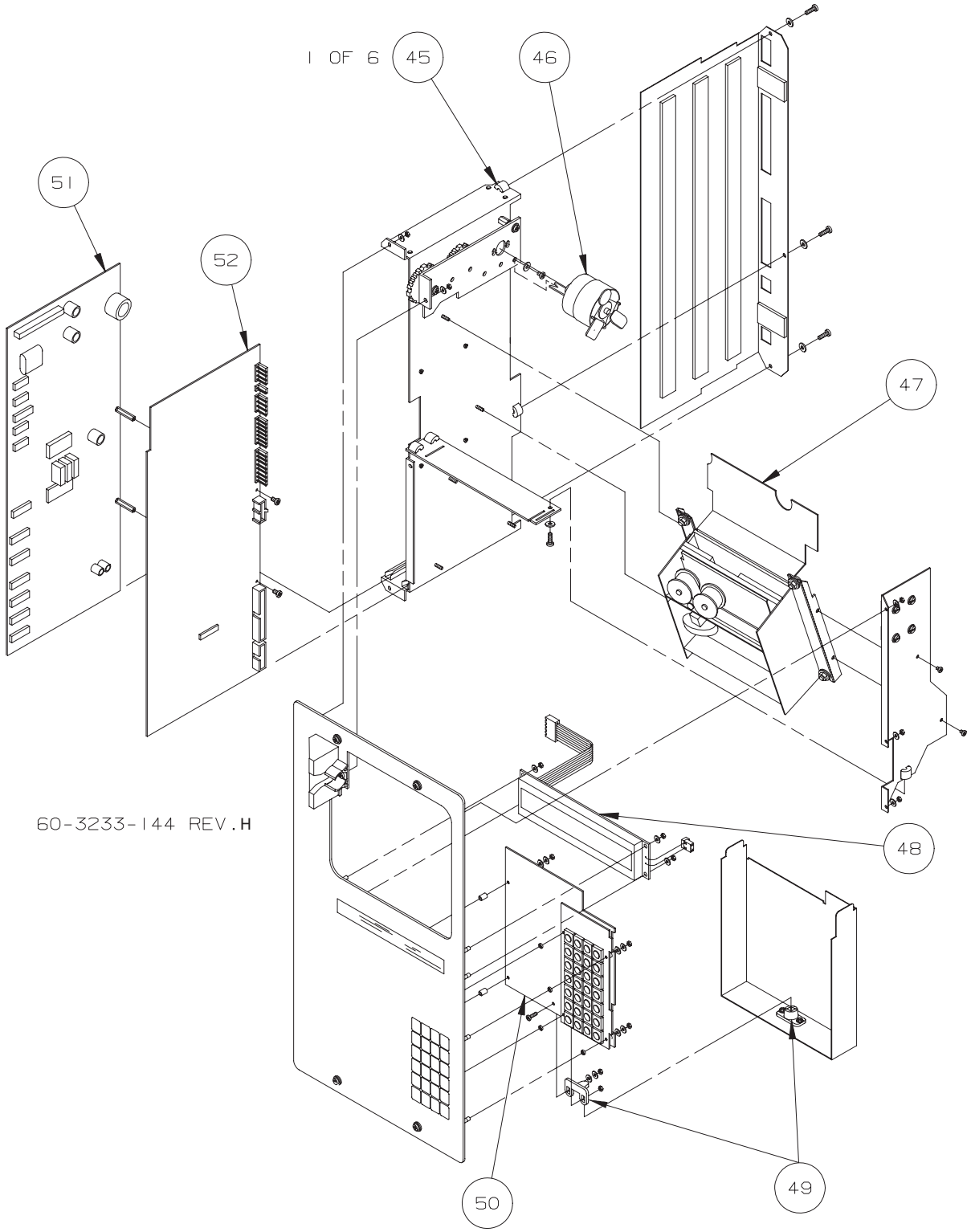
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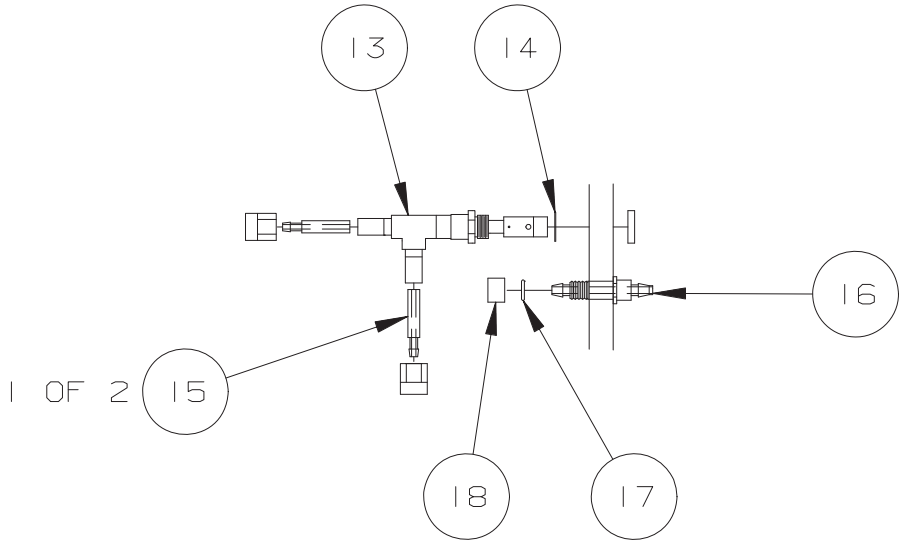
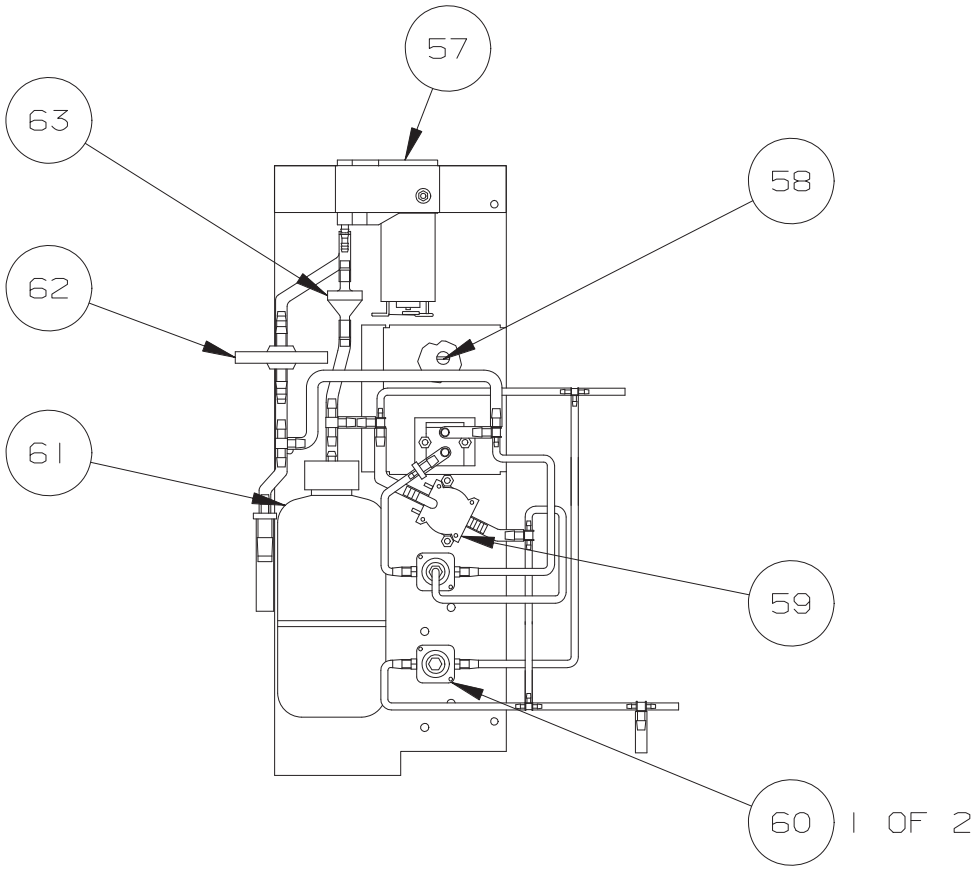
60-3233-144 REV.H



DETAIL A



DRAWING NO: 60-3233-144
REVISION: H
SHEET 4 of 6
EFFECTIVE DATE: 102811

REPLACEMENT PARTS LIST

ITEM NUMBER	PART NUMBER	DESCRIPTION
1	60-1704-017	CARRYING HANDLE ASSEMBLY
2	60-3213-255	WALL MOUNT
3	109-0605-01	DRAW LATCH ASSEMBLY, SMALL
4	60-3233-139	EXTERNAL DESICCANT TUBE
5	231-0197-04	SELF SEALING SCREW 10-32 X ¼
6	60-3213-310	CONNECTOR PROTECTOR CAP, SMALL
7	60-3213-308	CONNECTOR CAP GASKET, SMALL
8	60-3113-024	CONNECTOR PROTECTOR CAP, MEDIUM
9	60-3113-032	CONNECTOR CAP GASKET, MEDIUM
10	60-3213-311	CONNECTOR PROTECTOR CAP, LARGE
11	60-3213-309	CONNECTOR CAP GASKET, LARGE
12	60-9003-291	CONNECTOR CAP STRAP
13	209-0090-07	METERING VALVE
14	60-3233-033	BUBBLE RATE ADJUSTMENT VALVE GASKET
15	60-3233-021	HOSE BARB
16	60-3233-014	AIR FITTING
17	202-1000-10	O RING .240 ID X .070 CROSS SECTION
18	60-3233-015	FITTING NUT
19	60-3233-121	CONNECTOR LABEL
20	60-3234-067	CASE BOTTOM SUB ASSEMBLY, GRAY
21	099-0012-00	DESICCANT DRI-CAN CANNISTER
22	60-3233-106	DESICCANT CAN HOLDER
23	60-3213-060	PRINTER LABEL
24	60-3213-261	DOOR GASKET
25	60-3214-141	CASE LATCH ASSEMBLY
26	60-3113-034	LATCH PIN
27	66-4230-006	REPLACEMENT LID
28	60-3213-259	WINDOW
29	60-3213-260	4200 CASE LID GASKET

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

DRAWING NO: 60-3233-144
REVISION: H
SHEET 5 of 6
EFFECTIVE DATE: 102811

REPLACEMENT PARTS LIST

ITEM NUMBER	PART NUMBER	DESCRIPTION
30	60-3233-099	HINGE PIN
31	60-9004-282	DESICCANT CARTRIDGE ASSEMBLY
32	142-2004-00	SPRING CLIP
33	60-3214-120	12VDC/SAMPLER WIRING ASSEMBLY
34	202-4001-14	O RING .612 ID X .103 CROSS SECTION
35	202-4001-18	O RING .862 ID X .103 CROSS SECTION
36	60-3214-140	RAIN GAUGE WIRING ASSEMBLY
37	60-3214-122	INTERROGATOR WIRING ASSEMBLY
38	60-9003-031	CONNECTOR HOLE PLUG
39	60-3214-125	PARAMETER WIRING ASSEMBLY
40	202-4001-20	O RING .987 ID X .103 CROSS SECTION
41	60-3234-022	SUPPLY SPOOL ASSEMBLY
42	60-3213-229	SPOOL END CAP
43	60-3234-023	REROLL SPOOL ASSEMBLY
44	60-2313-005	PRINTER PAPER CORE
45	239-0416-32	SHEET EDGE FASTENER, 6-32
46	60-3214-139	CHART DRIVE MOTOR ASSEMBLY
47	60-3214-159	PRINTER SUB ASSEMBLY
48	60-3214-093	BACKLIT LCD MODULE ASSEMBLY
49	109-0609-00	CABINET CATCH, WHITE
50	60-3214-098	CIRCUIT BOARD ASSEMBLY, KEYBOARD
51	60-3234-052	CIRCUIT BOARD ASSEMBLY, 4230 AMPLIFIER
52	60-3239-002	KIT, 4230 CPU REPLACEMENT
53	60-3223-009	BULKHEAD NUT
54	202-1000-14	O RING .489 ID X .070 CROSS SECTION
55	60-3223-010	BULKHEAD FITTING
56	209-0166-65	ELBOW, 1/8 NPT TO ¼" ID, NYLON
57	306-1000-04	MICRO-DIAPHRAGM PUMP, 12VDC
58	60-3234-060	CIRCUIT BOARD ASSEMBLY, 4230 SENSOR

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

DRAWING NO: 60-3233-144
REVISION: H
SHEET 6 of 6
EFFECTIVE DATE: 102811

REPLACEMENT PARTS LIST

ITEM NUMBER	PART NUMBER	DESCRIPTION
59	410-9099-06	PRESSURE SENSOR, 2 PORT DIFFERENTIAL
60	209-0095-04	SOLENOID VALVE 12VDC
61	299-0015-08	BOTTLE, 8 OZ, WITH CAP, NALGENE
62	209-0093-03	HYDROPHOBIC FILTER, UNIDIRECTIONAL
63	209-0096-12	CHECK VALVE, .5 PSI, .125 TUBING
64	60-3215-001	COMPONENT CLIP MODIFICATION
65	60-3233-120	CASE TOP LABEL
66	60-3233-117	CONNECTOR CLIP, .938 DIAMETER
67	60-3233-116	CONNECTOR CLIP, .813 DIAMETER
68	60-3233-115	CONNECTOR CLIP, .688 DIAMETER
69	60-3239-001	AIR PUMP REPLACEMENT KIT

Notes:

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

A.2 Accessories

The following section lists optional equipment and accessories for the 4230 flow meter.

Model 4230 Basic Unit, 68-4230-001

Includes:

Bubble Line 1/16" ID × 25' Teflon 60-1873-051
Stainless Steel Bubble Tube 60-1704-018
4230 Flow Meter 60-3234-048
Accessory Package 60-3234-050
Instruction Manual 60-3234-051
Pocket Guide 60-3233-102
Caution Tag 60-3003-256
Dri-Can Desiccant 099-0012-00
Flow Data Handbook 60-3003-041

Basic Unit with Vinyl Bubble Line, 68-4230-002

Includes:

Bubble Line 1/8" ID × 50' Vinyl 60-1873-044
Stainless Steel Bubble Tube 60-1873-043
4230 Flow Meter 60-3234-048

4230 Accessories

Bubble Line, 1/16" ID × 25' Teflon 60-1873-051
Bubble Line, 1/8" ID × 50' Vinyl 60-1873-044
Bubble Line, 1/8" ID × 100' Vinyl 68-1700-003
4' Stainless Steel Bubble Tubes (attach to bubble line outlet)
(For use with the 1/16" ID Teflon Bubble Line) 60-1704-018
(For use with the 1/8" ID Vinyl Bubble Line) 60-1873-043
Supplemental Desiccant Cartridge 60-3244-059
Printer ribbon, black 250-0200-00
Plotter paper roll, 58 ft 60-2313-019
Reference Port Tubing 10' ×1/4" ID Vinyl 60-2703-111
Reference Port Tubing 25' × 1/4" ID Vinyl 60-2703-112
Bubbler Tube Retainer Assembly (includes carrier and stainless bubble outlet)
(Allows installation in round pipes with Isco Mounting Rings, 1/8" ID Vinyl only) .. 60-3204-007
6" Flow Metering Insert with Pump and Poles (handle extensions) 68-3230-005
8" Flow Metering Insert with Pump and Poles 68-3230-006
10" Flow Metering Insert with Pump and Poles 68-3230-007
12" Flow Metering Insert with Pump and Poles 68-3230-008
6" Flow Metering Insert 60-3234-031
8" Flow Metering Insert 60-3234-032
10" Flow Metering Insert 60-3234-033
12" Flow Metering Insert 60-3234-034

Pole Section Assembly 60-2814-046
Flow Metering Insert Instruction Manual 60-3234-064
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

Options

High-Low Alarm Relay Box 60-3404-028
4-20 mA Output Interface 60-1784-039
674 Rain Gauge (0.01") 60-3284-001
Type 'E' Interface 60-1784-024
Flowlink Software 68-2540-200
(Call factory for additional information)
Chart Roller 60-3004-156
Spreader Bar 60-3004-110
pH Probe and 201 pH Module (25 ft. cable standard) *(Includes probe, built-in temperature sensor)* 68-4200-002
pH Probe only 60-9004-126
D.O. Probe only 472-0000-00
D.O. Membrane Kit *(Includes 30, 0.002" membranes, electrolyte, sanding tool and disks)* 479-0020-02
O-Ring Kit for D. O. Probe 479-0020-00
Temperature Probe only 60-3214-130
Isco Sampler to Flow Meter Connect Cable - 25 ft. 60-3004-107
External 12VDC Source Connect Cable- 6 ft. 60-1394-023
YSI 600 Sonde with pH, D.O., conductivity, temperature sensors, and 25 ft. cable 68-0600-110

Note: Item 68-0600-110 includes a YSI-to-Isco 4200/6700 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 (10µS/cm or less). Call the factory for more information.

YSI 600 Accessories

D.O. Sensor Maintenance Supplies

D.O. Probe membrane and electrolyte kit (30 membranes, 30 mL KCl soln., 2 O-rings) 60-0603-205
D.O. Probe reconditioning kit (Instructions and sanding disks) 60-0603-206

Miscellaneous – for use with the YSI Sonde

YSI 600 Instruction Manual 60-0603-218
YSI 600 to Isco 4200/6700 Adapter Cable 60-0604-001
YSI 600 and Isco 674 Rain Gauge Y-Connect Cable 60-0604-002
(This cable 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 with internal temperature sensor..... 60-3208-001
Probe Carrier for D.O. probe and separate Temperature probe..... 60-3204-006

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 Ring
(for Pipes 16" diameter and larger)

Base Section (with tabs for mounting up to five probes)..... 60-3004-171
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 Ring Assemblies will require a base and scissors section for all sizes. Sizes from 21" to 80" will also require two or more extension sections.

4230 Flow Meter

Appendix B Programming Worksheets

Use this form to make a hard copy of the program you use in your 4230. 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 sheet without first studying the manual, especially Section 2 Programming. This section describes the program in detail and offers reasons you might choose one option over another. This is particularly so for those using the flow meter for the first time. Keep this chart as a record. For steps where a space is not provided on the sheet, underline or circle your choices.
- 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 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. An 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 early steps 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.

B.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, D.O./pH Reading Interval
5. Purge Interval: 5 min, 10 Min, 15 Min, 30 Min, 1 Hour_____
6. Super Bubble Mode: On, Off_____
7. D.O./ph Reading Interval: Continuous, 15 Sec, 30 Sec, 1Min, 2 Min, 5 Min

8. YSI 600 Reading Interval: Continuous, 15 Sec, 30 Sec, 1Min, 2 Min, 5 Min
9. Level Enable/Alarm: Hysteresis _____Feet (Or Meters)
10. Flow Rate Enable/Alarm Hysteresis _____Units_____
11. Temperature Enable/Alarm Hysteresis _____Deg. F (C)
12. pH Enable/Alarm Hysteresis _____pH units.
13. D.O. Enable/Alarm Hysteresis _____ppm.
14. YSI-pH Enable/Alarm Hysteresis _____pH units.
15. YSI-D.O. Enable/Alarm Hysteresis _____ppm/mg./L
16. YSI-Conductivity Enable /Alarm Hysteresis_____mS/cm
17. YSI-Temperature Enable/Alarm Hysteresis_____Deg.
18. Optional Outputs: 4-20 Ma Output, Serial Output, Alarm Box, Mechanical Totalizer
19. Report Setup, Report A: Flow, D.O./pH, YSI 600, Sample History, Flow Meter History
20. Level In Report: Yes, No
21. Flow Rate In Report: Yes, No
22. Rainfall In Report: Yes, No
23. pH or D.O. In Report: Yes, No
24. Temperature In Report: Yes, No
25. YSI 600 Data in Report: Yes, No
26. Sample History In Report: Yes, No
27. Flow Meter History In Report: Yes, No
28. Report Setup, Report B: Flow, D.O./pH, YSI 600, Sample History, Flow Meter History
29. Level In Report: Yes, No
30. Flow Rate In Report: Yes, No
31. Rainfall In Report: Yes, No
32. pH or D.O. In Report: Yes, No
33. Temperature In Report: Yes, No
34. YSI 600 Data in Report: Yes, No
35. Sample History In Report: Yes, No
36. Setup Options: Status, Report Setup, LCD Backlight
37. LCD Backlight Mode: Time-out, Continuous, Off
38. Language: English, French, German, Spanish
39. Program Lock: On, Off
40. Select Option: Program, Setup. *This time, select Program and do the following* (Program Section)
41. Units Of Level Measure: Ft., In, M, mm, Not Measured
42. Flow Rate Units of Measure: GPS, GPM, GPH, MGD, CFS, CFM, CFH, CFD, LPS, M3S, M3M, M3H, M3D, AFD
43. Totalized Volume Units: GAL, MGAL, CF, L, M3, AF

44. Rain Gauge: Inches, MM, Not Measured
45. pH Units Of Measure: pH, Not Measured
46. D. O. Units: MG/L, PPM, Not Measured
47. Temperature Units: Deg F, Deg. C, (Not Measured)
48. YSI-pH Units Of Measure: pH, Not Measured
49. YSI-D.O. Units: MG/L, PPM, Not Measured
50. YSI-Conductivity Parameter: Specific Conductivity, Salinity, Conductivity, T.D. S.
    _____Units_____Coeff._____
51. YSI-Temperature: Deg F, Deg. C, (Not Measured)

B.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___._____Feet (or meters)
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 = ___.___H^___ + ___.___H^___
    ($Q = kH^{P1} + kH^{P2}$)
    (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, M^3S, M^3H, M^3D, LPS, CFD, GPH, AFD, CFH, CFM, M^3M
30. Set __(1-4): (0) Points Entered: Add Point, (units)
31. Set 1 Data Point 1: Enter: __.____ (level units) __.____ (volume units)
32. Set __(1-4): __(1-50) Pointes Entered: (Use), Edit Point, Add Point, Clear, Print_____
33. Set__(1-4) Data Point __(1-50) Enter: __.___(level units) __.___(volume units)

Enter data points in the table below. If you have multiple data point sets, photocopy this table.

Data Point Set

Level	Flow	Level	Flow	Level	Flow	Level	Flow

34. Flow Metering Inserts: Select Weir/Orifice Type: V-notch, Round_____
35. Select Insert size: 6”, 8”, 10”, 12”_____

Enter Maximum Head

36. Maximum Flow: ___._____ (units of measure)

B.3 Parameter to Adjust

1. Parameter To Adjust: None, Level, pH, D.O., YSI 600
2. (Job Site only) Enter Current Level: __.____ Ft (or M). Note: Installations generally use either the Teledyne Isco parameter probes or the YSI 600 Sonde, but not both. Use the following menus for either the Teledyne Isco probes or the YSI 600 Sonde. Steps 3, 4, and 5 can be used for both 2 and 3-point pH calibrations.
3. Rinse Probe And Place In 4.0 pH Solution: Press Enter When Stable __.____ pH (job site only)
4. Rinse Probe And Place In 7.0 pH Solution: Press Enter When Stable __.____ pH (job site only)
5. Rinse Probe And Place In 10.0 pH Solution: Press Enter When Stable __.____ pH (job site only)
6. (YSI 600 D.O. Calibration only): D.O. Standard, Absolute Barometric Pressure, Altitude
7. Altitude Units Of Measure: Ft., M (D.O. probe only)___ (job site only)
8. (D.O. only) Enter Altitude: Altitude = _____ Feet (or meters, at job site only)
9. Wrap D.O. Probe In Moist Cloth: Press Enter When Stable: __.____ MG/L (at job site only)
10. Conductivity Calibration Units: Ms/cm, Ppt_____
11. Place Probe In _____Ms/cm. (or ppt) Press Enter When Stable: _____Ms/cm (at job site only)
12. YSI 600 Dissolved Oxygen Calibration: D.O. Standard, Absolute Barometric Pressure, Altitude

B.4 Reset Totalizer

1. Reset Totalizer: Yes, No
2. Enable Totalizer _____CF (or other units)_____
3. Reset Sampler Enable Totalizer: Yes, No

B.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 D.O., 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.

B.6 Sampler Enable

1. Sampler Enable Mode: Disable, Enable, Conditional, (Storm), (Flowlink)
2. Level: Greater Than __.____ Feet (or meters)
3. Rainfall Amount: __.____ Inches (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 D.O., 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

B.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 (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

B.8 Printer

1. Enter Printer Speed: Off, ½"/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

B.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

NOTES

Additional table for Data Point Entry

Data Point Set #2.

Level	Flow	Level	Flow	Level	Flow	Level	Flow

4230 Flow Meter

Appendix C General Safety Procedures

In field installations of 4230 Flow Meters and associated equipment, the safety of the personnel involved should be the foremost consideration. The following sections provide safety procedures for working in and around manholes and sewers. the first section offers general safety advice. The second section deals with the special problem of hazardous gases found in sewers.

WARNING

The 4220 Flow Meter has not been approved for use in hazardous locations as defined by the National Electrical Code.

CAUTION

Before any flow meter is installed, the proper safety precautions must be taken. The following discussions of safety procedures are only general guidelines. Each situation in which you install a flow meter varies. You must take into account the individual circumstances you are in. Additional safety considerations, other than those discussed here, may be required.

C.1 Practical Safety Precautions

The following procedures are those used by Black & Veatch, a respected consulting firm, and are published here by permission.

"Field personnel must keep safety uppermost in their minds at all times. When working above ground, rules of common sense and safety prevail. However, when entering manholes, strict safety procedures must be observed. Failure to do so could jeopardize not only your own life, but also the lives of other crew members.

"1. **Hazards.** There are many hazards connected with entering manholes. Some of the most common hazards are:

"**Adverse Atmosphere.** The manhole may contain flammable or poisonous gases or the atmosphere may be deficient in oxygen. Forced ventilation may be necessary.

"**Deteriorated Rungs.** Manhole steps may be corroded and not strong enough to support a man. It may be difficult to inspect the rungs because of poor lighting.

"**Traffic.** Whenever manholes are located in the traveled way, barricades and warning devices are essential to direct traffic away from an open manhole.

"**Falling Object.** Items placed near the manhole opening may fall and injure a worker in the manhole.

"**Sharp Edges.** Sharp edges of items in or near a manhole may cause cuts or bruises.

"**Lifting Injuries.** Unless proper tools are used to remove manhole covers, back injuries or injuries to hands or feet may result.

"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.

"3. **Adverse Atmosphere.** [Refer to Table C-1, Hazardous Gases, at the end of this appendix.] Before workers enter a manhole, tests should be made for explosive atmosphere, presence of hydrogen sulfide, and oxygen deficiency. Combustible or toxic vapors may be heavier than air, so the tests on the atmosphere must be run at least 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.

"4. **Entering Manholes.** Since the top of the manhole is usually flush with the surrounding surface, there may not be anything for the person who is entering the manhole to grab on to steady himself. Persons who are entering manholes should not be permitted to carry anything in their hands as they enter the manhole, to ensure that their hands will be free to hold on or grab if they slip. A good method for entering a manhole is to sit on the surface facing the manhole steps or ladder, with the feet in the hole and the arms straddling the opening for support. As the body slides forward and downward, the feet can engage a rung, and the back can rest against the opposite side of the opening. If there is any doubt about the soundness of the manhole steps, a portable ladder should be used.

"A person should never enter a manhole unless he is wearing personal safety equipment, including a safety harness and a hard hat. Two persons should be stationed at the surface continuously while anyone is working inside a manhole, to lift him out if he is overcome or injured. One man cannot lift an unconscious man out of a manhole. The persons stationed at the surface should also function as guards to keep people and vehicles away from

the manhole opening. To avoid a serious injury, a person should not be lifted out of a manhole by his arm unless it is a dire emergency.

"When more than one person must enter a manhole, the first person should reach the bottom and step off the ladder before the next one starts down. When two men climb at the same time, the upper one can cause the lower one to fall by slipping or stepping on his fingers.

"5. **Traffic Protection.** In addition to traffic cones, markers, warning signs, and barricades, a vehicle or a heavy piece of equipment should be placed between the working area and oncoming traffic. Flashing warning signals should be used to alert drivers and pedestrians. Orange safety vests should be worn by personnel stationed at the surface when the manhole is located in a vehicular traffic area.

"6. **Falling Object.** All loose items should be kept away from the manhole opening. This applies to hand tools as well as stones, gravel and other objects.

"7. **Removing the Covers.** Manhole covers should be removed with a properly designed hook. Use of a pick ax, screwdriver, or small pry bar may result in injury. A suitable tool can be made from 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.

"8. **Other Precautions.** Other precautions which should be taken when entering a manhole are:

- Wear a hard hat.
- Wear coveralls or removable outer garment that can be readily removed when the work is completed.
- Wear boots or nonsparking safety shoes.
- Wear rubberized or waterproof gloves.
- Wear a safety harness with a stout rope attached.
- Do not smoke.
- Avoid touching yourself above the collar until you have cleaned your hands.

"9. **Emergencies.** Every member of the crew should be instructed on procedures to be followed in cases of an emergency. It is the duty of each crew chief to have a list of emergency phone numbers, including the nearest hospital and ambulance service, police precinct, fire station, and rescue or general emergency number.

"10. **Field Equipment.** The following equipment will be available for use:

Blowers	Gloves	Traffic cones
Breathing apparatus	Hard Hats	Coveralls
Harnesses	First aid kits	Manhole irons
Emergency flashers	Pick axes	Flashlights
Rain slickers	Mirrors	Ropes
Gas detectors	Safety vests	Gas masks
Waders"		

C.2 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%t. 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 H_2S. 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 H_2S, in the air. This is considered to be a lethal concentration. Many people have died from H_2S, not only in sewers and industries, but also from swamps and from hot springs. In one resort area, at least five persons died from H_2S poisoning before the people were ready to admit that H_2S is not a therapeutic agent. Hardly a year passes in the U.S. without a sewer fatality from H_2S as well as deaths elsewhere in the world.

"The presence of H_2S 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 H_2S 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 H_2S 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 H_2S 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 H_2S.

"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 H_2S concentrations, flammable atmospheres, and hazards of physical injuries. Remember that much H_2S 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."

C.3 Hazardous Gases

The following table contains information on the properties of hazardous gases.

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_6H_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)

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
Carbon 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_2O	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_5H_{12} to C_9H_{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

Table C-1 Hazardous Gases (Continued)

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
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_2S	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_2S Ampoule. 2. 5% by weight lead acetate solution.
Methane	CH_4	Simple asphyxiant. Colorless, odorless, tasteless, flammable.	0.55	Acts mechanically to deprive tissues of oxygen. Does not support life.	Probably no limit, provided oxygen percent-age is sufficient for life.	—	5.0 15.0	At top, increasing to certain depth.	Natural gas, sludge gas, manufactured gas, sewer gas. Strata of sedimentary origin. In swamps or marshes.	1. Combustible gas indicator 2. Oxygen deficiency indicator.
Nitrogen	N_2	Simple asphyxiant. Colorless, tasteless. Non-flammable. Principal constituent of air. (about 79%).	0.97	Physiologically inert.	—	—	— —	Near top, but may be found near bottom.	Sewer gas. sludge gas. Also issues from some rock strata.	Oxygen deficiency indicator.
Nitrogen Oxides	NO N_2O NO_2	Colorless Colorless, sweet odor. Reddish-brown. Irritating odor. Deadly poison	1.04 1.53 1.58	60 to 150 ppm cause irritation and coughing. Asphyxiant. 100 ppm dangerous. 200 ppm fatal.	50	10	— —	Near bottom.	Industrial wastes. Common air pollutant.	NO_2 detector tube.
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.

Table C-1 Hazardous Gases (Continued)

Gas	Chemical Formula	Common Properties	Specific Gravity or Vapor Density Air =1	Physiological Effect	Max Safe 60 Min. Exposure ppm	Max. Safe 8 Hour Exposure ppm	Explosive Range (% by vol. in air) Limits lower/upper	Likely Location of Highest Concentration	Most Common Sources	Simplest and Cheapest Safe Method of Testing
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_5H_{12} to C_9H_{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_8H_{10}	Colorless, flammable	3.66	Narcotic in high concentrations. less toxic than benzene.	—	100	1.1 7.0	At bottom.	Solvent	Combustible gas indicator.

* Percentages shown represent volume of gas in air.
** For concentration over 0.3%.
***Mostly methane and carbon dioxide with small amounts of hydrogen, nitrogen, hydrogen sulfide, and oxygen; occasionally traces of carbon monoxide.

4230 Flow Meter

Appendix D Material Safety Data Sheets

D.1 Overview

This appendix provides Material Safety Data Sheets for the desiccant used by the 4230 Flow Meter.

Teledyne Isco cannot guarantee the accuracy of the data. Specific questions regarding the use and handling of the products should be directed to the manufacturer listed on the MSDS.

Material Safety Data Sheet

Indicating Silica Gel

Identity (Trade Name as Used on Label)

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

Section 1 - Material Identification and Information

Components - Chemical Name & Common Names (Hazardous Components 1% or greater; Carcinogens 0.1% or greater)	%*	OSHA PEL	ACGIH TLV	OTHER LIMITS RECOMMENDED
Silica Gel SiO_2	98.0	6mg/m^3 (total dust)	10mg/m^3 (total dust)	
Cobalt Chloride	>2.0	0.05mg/m^3 (TWA cobalt metal dust & fume)	.05mg/m^3 (Cobalt, TWA)	
Non-Hazardous Ingredients				
TOTAL	100			

Section 2 - Physical/Chemical Characteristics

Boiling Point	N/A	Specific Gravity (H_20 = 1)	2.1
Vapor Pressure (mm Hg and Temperature	N/A	Melting Point	N/A
Vapor Density (Air =1)	N/A	Evaporation Rate (_____=1)	N/A
Solubility in Water	Insoluble, but will adsorb moisture.	Water Reactive	Not reactive, but will adsorb moisture.
Appearance and Odor	Purple crystals, no odor.		

Section 3 - Fire and Explosion Hazard Data

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

Section 4 - Reactivity Hazard Data

STABILITY ☐**Stable** ☐**Unstable**	Conditions To Avoid	Moisture and high humidity environments.
Incompatibility (Materials to Avoid)	Water.	
Hazardous Decomposition Products	Carbon dioxide, carbon monoxide, water	
HAZARDOUS POLYMERIZATION ☐May Occur	Conditions To Avoid	None.

*Optional

Section 5 - Health Hazard Data

PRIMARY ROUTES OF ENTRY	☐Inhalation ☐Skin Absorption	☐Ingestion ☐Not Hazardous	**CARCINOGEN LISTED IN**	☐NTP ☐IARC Monograph	☐OSHA ☐Not Listed
HEALTH HAZARDS	Acute	May cause eye, skin and mucous membrane irritation.			
	Chronic	Prolonged inhalation may cause lung damage.			
Signs and Symptoms of Exposure	Drying and irritation.				
Medical Conditions Generally Aggravated by Exposure	Asthma.				
EMERGENCY FIRST AID PROCEDURES - Seek medical assistance for further treatment, observation and support if necessary.					
Eye Contact	Flush with water for at least 15 minutes.				
Skin Contact	Wash affected area with soap and water.				
Inhalation	Remove affected person to fresh air.				
Ingestion	Drink at least 2 glasses of water.				

Section 6 - Control and Protective Measures

Respiratory Protection (Specify Type)	Use NIOSH approved dust mask or respirator.		
Protective Gloves	Light cotton gloves.	Eye Protection	Safety glasses.
VENTILATION TO BE USED	☐ Local Exhaust	☐Mechanical (General)	☐Special
	☐Other (Specify)		
Other Protective Clothing and Equipment	None.		
Hygienic Work Practices	Avoid raising dust. Avoid contact with skin, eyes and clothing.		

Section 7 - Precautions for Safe Handling and Use/Leak Procedures

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

*Optional Indicating Silica Gel

MULTISORB
Multisorb Technologies Inc.

MATERIAL SAFETY DATA SHEET

Effective Date March 8, 2005
MSDS Number M163

Section 1 – Product and Company Information

Product Name: **Silica gel, indicating, yellow**

Product Use: Desiccant, absorbent
Grades: Silica gel, indicating
Synonyms: Amorphous silica gel, SiO_2, silicon dioxide (amorphous)

Company; Multisorb Technologies, Inc.
Street Address: 325 Harlem Road
City, State, Zip, Country: Buffalo, NY 14224-1893 USA

Telephone Number: (716) 824 8900 [USA] Monday - Friday (8:00 - 5:00 EDT)
Fax Number: (716) 824 4091 [USA]
Website / E-Mail : multisorb.com

Section 2 – Composition / Information on Ingredients

Component Name	CAS Number	% by Weight
Synthetic amorphous silica gel (SiO_2)	112926-00-8	100
Phenolphthalein	77-09-08	100 ppm

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

Section 3 – Hazard Identification

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

Potential Health Effects:

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

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

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

Inhalation: Slight irritation is possible but none is expected.

Medical Effects Generally Aggravated by Exposure: Respiratory ailments.

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

Section 4 – First Aid Measures

Eyes: Rinse the eyes well with water while lifting the eye lids. If irritation persists, consult a physician.

Skin: Wash affected area with soap and water.

Ingestion: Ingestion is unlikely, this material will pass through the body normally.

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

Notes to Physician: Not applicable

Section 5 – Fire Fighting Measures

Flammable Properties: Not flammable

Flash Point: Not applicable **Method:** Not applicable

Flammable Limits: Not flammable

Lower Flammability Limit: Not applicable

Upper Flammability Limit: Not applicable

Autoignition Temperature: Not applicable

Hazardous Combustion Products: Not applicable

Extinguishing Media: Use extinguishing media that is appropriate for the surrounding fire. Silica gel is not combustible.

Fire Fighting Instructions: Not combustible

Unusual Fire and Explosion Hazards: None

Section 6 – Accidental Release Measures

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

Section 7 – Handling and Storage

Handling: Avoid raising dust and minimize the contact between worker and the material. Practice good hygienic work practices.

Storage: Store in a cool, dry location. Keep in sealed containers away from moisture. The silica gel will readily adsorb moisture.

Section 8 – Exposure Controls/Personal Protection

Engineering Controls: Use exhaust ventilation to keep the airborne concentrations below the exposure limits.

Respiratory Protection: Use NIOSH approved respirator when the air quality levels exceed the TLV's.

Skin Protection: Light gloves will protect against abrasion and drying of the skin.

Eye Protection: Safety glasses.

Component Name	Exposure Limits		
	OSHA PEL	**ACGIH TLV**	**Other Recommended Limits**
Silica gel	TWA 20 mppcf (80 mg / m^3 % SiO_2)	TWA 10 mg / m^3	NIOSH REL TWA 6 mg / m^3 IDLH 3000 mg / m^3
Phenolphthalein	Not Applicable	Not Applicable	Not Applicable

Section 9 – Physical and Chemical Properties

Appearance: Yellow beads or granules

Odor: None

Physical State: Solid bead

PH: Not applicable

Vapor Pressure: Not applicable

Vapor Density: Not applicable

Boiling Point: 4046° F (2230° C)

Melting Point: 3110° F (1710° C)

Solubility: Insoluble in water

Specific Gravity: 2.1

Section 10 – Stability and Reactivity

Stability: Stable

Conditions to avoid: Moisture and high humidity environments.

Incompatibility: Water, fluorine, oxygen difluoride, chlorine trifluoride

Hazardous Decomposition Products: None

Hazardous Polymerization: Will not occur

Section 11 – Toxicological Information

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

Animal Toxicology Tests for DOT Hazard classification
(Tests Conducted on finely ground silica gel)

1 - hour LC_{50} (rat) > 2 mg / l
48 - hour oral LD_{50} (rat) est. > 31,600 mg / kg
48 - hour dermal LD_{50} (rabbit) est. > 2,000 mg / kg
Considered an ocular irritant

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

Section 12 – Ecological Information

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

Section 13 – Disposal Information

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

Section 14 – Transportation Information

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

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

TSCA Listed: Yes

DSL/NDSL (Canadian) Listed: Yes

OSHA: TWA 20 mppcf (80 mg / m^3 % SiO_2) for Silica gel

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

ACGIH: TLV - 10 mg / m^3 for Silica gel

DOT: Not classified as a hazardous material.

HMIS – Hazardous Materials Identification System

HMIS Rating	
Health	0
Flammability	0
Reactivity	0

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

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

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

4230 Flow Meter

Index

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.

DECLARATION OF CONFORMITY

CE
ISM1-A

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:	Model 4230 Bubbler Flow Meter
Year of Issue:	2000
Standards to which Conformity is Declared:	EN 50082-1 Generic Immunity for Commercial, Light Industrial Environment EN 61010-1 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use

Standard	Description	Severity Applied	Performance Criteria
IEC 801.2	Electrostatic Discharge	Level 2 - 4kV contact discharge Level 3 - 8kV air discharge	B B
IEC 801.3	Radiated RF Immunity	27 MHz to 500MHz *Level 2 - 3 V/m	A
IEC 801.4	Electrical Fast Transient	Level 2 - 1kV on ac lines	B
CISPR11/ EN 55011	RF Emissions	Group 1, Class A Industrial, Scientific, and Medical Equipment	

*Instrument is susceptible to 3V/m between 105 mHz and 500 mHz.

We, the undersigned, hereby declare that the design of the equipment specified above conforms to the above Directive(s) and Standards as of January 1, 1997

William Foster

William Foster
USA Representative

TELEDYNE ISCO
A Teledyne Technologies Company

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

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

60-3232-023
Rev. B

DECLARATION OF CONFORMITY

ISM1-A

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

TELEDYNE ISCO
A Teledyne Technologies Company

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

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

60-3212-049
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 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, Inc. 4700 Superior, Lincoln, NE 68504, U.S.A.

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

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

August 13, 2011 P/N 60-1002-040 Rev F

TELEDYNE ISCO
A Teledyne Technologies Company

EnduroFlow™ Series EF10

Ultrasonic Transit-Time Flowmeter For Permanent Installation

Applications

- Water / Wastewater
- Hot / Chilled Water / Mixture of Water and Glycol
- Chemical Liquids and Solvents
- Petroleum Products
- Oil / Crude Oil / Fuel Oil / Diesel / Lubricant Oil /Hydraulic Oil
- Water management in buildings, metropolitan areas, water / wastewater treatment plants, irrigation systems and more
- Flow monitoring and control in desalination plants, steel plants, power plants, machining plants
- Liquid process control in chemical plants and industrial automation
- Oil / fuel / chemicals and other liquid transfer
- Retrofit capability to upgrade or augment existing systems
- Automated batching and scheduling
- Efficiency monitoring and improvement of liquid-based heating / cooling systems, including solar / geothermal systems

- Beverage, food and pharmaceutical processors where non-contact is essential
- Remote flow monitoring network and leakage detection

Features And Benefits

- Accurate bi-directional flow measurement
- Economical and non-intrusive
- No moving parts to wear and tear
- No maintenance required
- NIST-traceable factory calibration
- Suitable for pure liquids and liquids with minimal particles
- No dependency on conductivity
- Suitable for all commonly used metal and plastic pipes
- Built-in daily and monthly data log. Optional SD data logger
- Easy to use and set up
- Communication: RS485/MODBUS. Optional GPRS, BACnet / MTSP
- Compatible with various types of transducers
- Clamp-on transducer: non-contact, non-invasive, easy and economical installation, no pipe work or plumbing needed
- Insertion transducer: sturdy, excellent long-term stability, hot-tapping installation, no need to shut down the flow
- Flow-cell transducer: most accurate and robust. Plug and play. Excellent long-term performance
- Velocity, flowrate, volumetric total, scheduler, batch controller and more
- Compatible with Spire Metering's uGalaxy wireless telemetry system

Spire Metering Technology LLC, 249 Cedar Hill Street, Marlborough, MA 01752, USA
Tel +1 978 263-7100 / 888 738-0188 (toll-free) **Fax** +1 978 418-9170 sales@spiremt.com www.SpireMT.com

EnduroFlow™ Series EF10

Ultrasonic Transit-Time Flowmeter For Permanent Installation

A member of the EnduroFlow™ Series, the EF10 General Purpose Wall-Mount Ultrasonic Flowmeter is the first member of the 3rd generation ultrasonic flow meters from Spire Metering. Compared with its predecessors, the 3rd generation flowmeters offer better performance and a richer feature set.

The EF10 ultrasonic flowmeter is designed to be installed at a fixed location for long-term flow measurement on a closed pipe carrying pure liquids or liquids with some suspended particles (no more than 1% and particle size less than 75um. EF10 can be equipped with clamp-on or wetted (insertion or flow-cell) type transducers to meet various application challenges.

Signal Quality Tracking

The EF10 flowmeter utilizes cutting-edge technologies such as advanced transducer design, low voltage transmission, digital signal processing, self adaptation, and others, to achieve high performance. Its proprietary quality tracking mechanism analyzes the quality of the received signal and automatically tunes the meter system to its optimized condition. This mechanism leads the system to be easily adaptable to pipe material variations and liquid property changes.

Transducer Pairing and Wetted Calibration

As QUALITY is of crucial importance, all transducers are carefully paired, and all flowmeters are wet-calibrated on a flow loop at the factory to further ensure the system's accuracy and reliability.

Versatile Interfaces

EF10 provides versatile input / output interfaces, such as digital and relay outputs, batch control, alarm and flow totalizing, 4-20mA output and optional thermal energy measurement, which can be easily used by a host computer, PLC or a flow controller for process monitoring and control. Additionally, the built-in isolated RS-485 port and the optional BACnet / GPRS module make remote flow monitoring easyand reliable.

Non-intrusive. Non-obstructive

With clamp-on transducers, the installation becomes very simple and easy. No pipe work is required and there is no risk of leaking or contamination. With wetted transducers, there is no obstruction to the flow, thus, there is no pressure drop.

Economical to Own and Operate

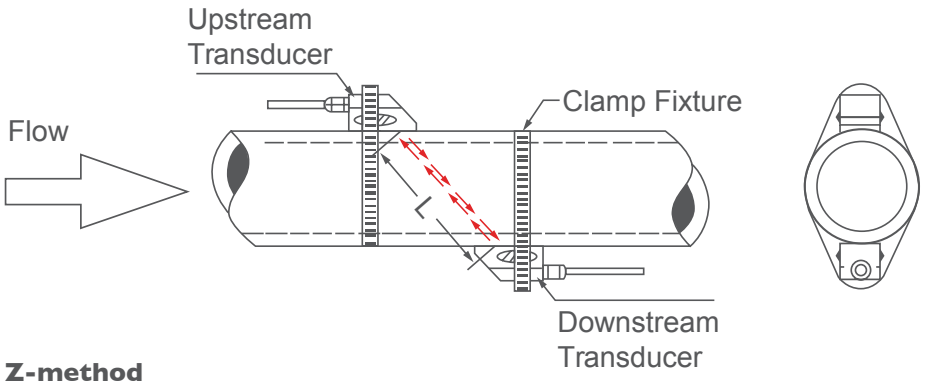
The ultrasonic transducers are made from crystal, and there are no moving parts to wear and tear. The whole meter system is completely solid state, and therefore, the EF10 is both a robust and reliable system. It does not require maintenance or downtime which eliminates any potential incurred costs.

Measurement Principle

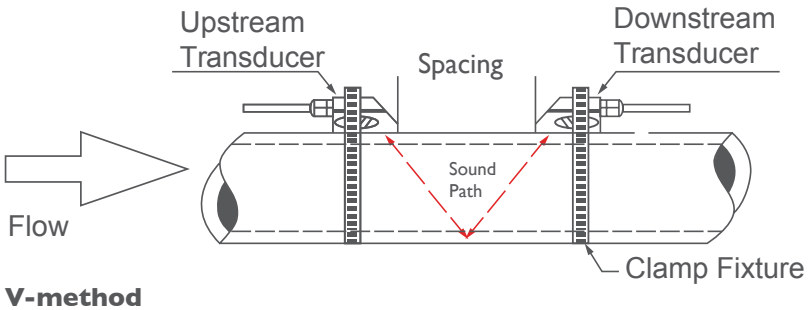
The EnduroFlow™ Series flowmeters are based on the transit-time measurement principle. The system utilizes a pair of sensors (A and B in figure below) that function as both ultrasonic transmitter and receiver. The sensors are installed on the pipe wall, either clamped on the outside of the pipe or inserted into the pipe at a specific distance from each other, and the flow meter operates by alternately transmitting and receiving a coded burst of sound energy between those two sensors and measuring the transit time it takes for sound to travel between the two sensors. The difference in the transit time is directly related to the velocity of the liquid in the pipe. The flowrate is then calculated based on the transit-time difference, the geometry of the pipe and the fluid dynamics formula.

The sensors are commonly mounted with the Z-method or the V-method. With the Z-method, the two sensors are installed on opposite sides of a pipe. This method offers shorter sound path, thus, better signal strength. It is often used for large size pipes where signal strength is more important. With the V-method, the two sensors are installed on the same side of the pipe. The sound path is doubled, and as a result, the measurement accuracy is better. This method is often used for small and medium size pipes.

For insertion and flow-cell type transducers, however, only the Z-method is used.



Z-method



V-method

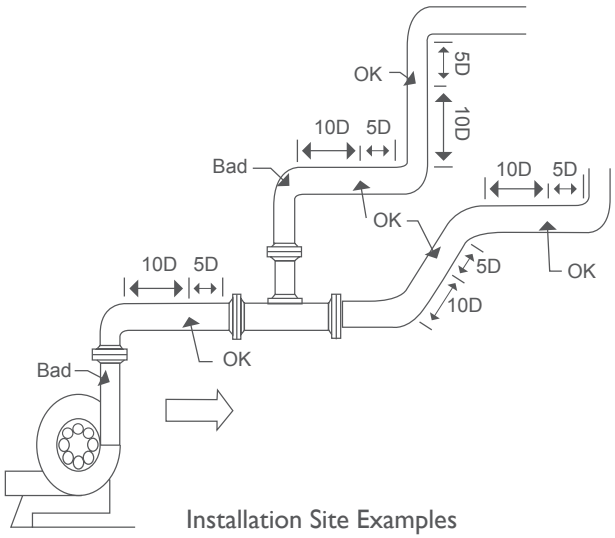
Typical Transducer Installation

The four figures below illustrate how the transducers are installed on a pipe. The clamp-on transducer (figure a) is mounted on the outside of a pipe with a mounting fixture using the V-method. The insertion transducer (figure b) is hot-tapped or cold-tapped onto the pipe using the Z-method. The flow-cell (spool-piece) transducer comes in two varieties. For sizes 1½" or smaller, PI-type transducers (figure c) are used and the pipe joint could be threaded or flanged. For sizes 2" and larger, the transducers are configured in a standard spool-piece with two ultrasonic sensors installed via the Z-method (figure d). The spool-piece is normally connected to a pipe line using a flange.

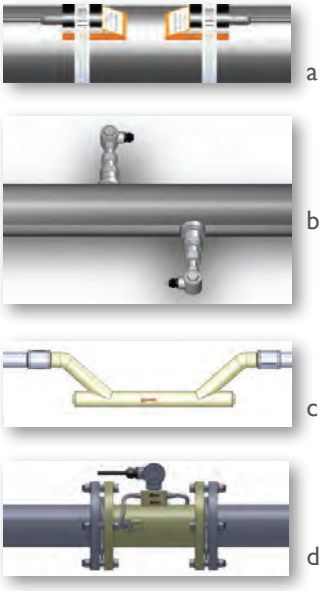
Transducer Mounting Site Selection

The site of the transducer installation is very important. Here are some recommendations for selecting the right site:

- In order to achieve good accuracy, it is recommended to have 15D straight-pipe run: upstream 10D and downstream 5D, where D is pipe diameter.
- If there is a valve upstream and the valve is not fully open, it could generate flow disturbance. A longer upstream straight pipe is recommended.
- If there is a pump upstream, we recommend to have 25D straight pipe run.
- If the pipe is vertical, make sure the flow is going upward, not downward. Downward flow could have air gaps if the flow is in a free fall.
- If the pipe is horizontal, make sure the pipe is full! The transducers should be installed on the side of the pipe, not on the top or bottom of the pipe.



Installation Site Examples



EnduroFlow™ Series EF10

Ultrasonic Transit-Time Flowmeter For Permanent Installation

Specifications: Flow Transmitter (Main Unit)

Flow Velocity	±32 ft/s. Bi-directional
Accuracy	±1% of reading ±0.03ft/s in velocity*
Repeatability	0.2%
Response Time	0.5s. Configurable between 0.5s and 99s
Display/Keypad	LCD with backlight. 2 x 20 letters. 4 x 4 tactile-feedback membrane keypad. Displays instantaneous flow rate, flow total (positive, negative and net), velocity, time, temperature, energy, analog outputs/inputs
Units	English (U.S.) or metric
Physical Quantity	Volumetric flow rate, total flow, velocity, analog inputs
Totalizers	Positive totalizer, negative totalizer, net totalizer, daily totalizer, monthly totalizer, yearly totalizer, manual totalizer
Security	Keypad can be locked with password
Outputs	See below for outputs.
• Current Output	0/4~20mA isolated output for flowrate, velocity or sound speed. Impedance 0-1k. Accuracy 0.1%
• Digital Output	Optically isolated OCT (Open Collector Transistor) output. Up to 0.5A load. Can be programmed as: • Pulse signal for flow totalization • ON/OFF signal for special event such as overflow, no flow, reverse flow, leakage alarming, and more • START/STOP signal for batch control Can be used to drive pulse counter, external relay, alarm, PLC counter
• Relay Output	1A@125VAC or 2A@30VDC. Can be programmed as: • Pulse signal for flow totalization • ON/OFF signal for special event such as overflow, no flow, reverse flow, leakage alarming, and more • START/STOP signal for batch control Can be used to drive pulse counter, external relay, alarm, PLC counter, or, to control pump, valve, light
• Sound Alarm	One sound alarm, programmable to specific event such as overflow, no flow, reverse flow, leakage alarm

EnduroFlow™ Series EF10

Ultrasonic Transit-Time Flowmeter For Permanent Installation

Inputs	One 4-20mA input for temperature, pressure or liquid level transmitter Two temperature channels for accommodating two PT100 4-wire temperature sensors. This function is only available upon request.	
Recording	Automatically records the daily total of the last 512 days and the monthly total of the last 128 months Optional SD data logger (2GB space) for recording velocity, flow, status, etc.	
Communication Interface	Isolated RS-485 with power surge protection. Supports the MODBUS protocol Optional BACnet MSTP or GPRS module for networking, remote monitoring and remote control	
Software	StufManager PC software available upon request	
Telemetry	uGalaxy_GPRS wireless telemetry systems are available upon request**	
Enclosure	Standard (EF10-x-A)	Enhanced (EF10-x-B)
• Protection	IP65	IP66 (NEMA 4X)
• Dimensions	11" x 7.5" x 2.1"	12" x 10" x 4"
• Features	Weather-proof Aluminum, power coded	Weather-proof Polycarbonate. High-impact, UV resistant. UL-50/c-UL Listed
Weight	10lbs	15lbs
Environment Temp	140°F	140°F
Power sources	12-24 VDC, 90-260 VAC 50/60 Hz <2W @12VDC	12-24 VDC, 90-260 VAC 50/60 Hz <2W @12VDC

Notes:

** Under reference condition and velocity should be above 0.5ft/s Flowrate is calculated by multiplying velocity with the inner cross-section area of the pipe.*

*** For wireless telemetry system solution, please contact solutions@spiremt.com.*

How To Order Flow Transmitter (Main Unit)

Please select one option **(ID)** from each category.

EF10 - □ -1

Enclosure	ID
Standard IP65	A
Enhanced IP66	B
Stainless Steel, IP65	C
Other, please specify	D

Attention

You must order both flow transmitter (main unit) and Transducer pair to make a complete flowmeter system. Both flow transmitter and transducer should have the same frequency.

Required Accessories

Power Supply Cable	Model No.
110VAC (American Standard Plug)	WA-PWC-1

Optional Accessories

External Adapter (please select only one)	Model No.
485-USB (to connect to a PC)	WA-485USB
485-BACnet / MSTP (to connect to a BACnet Gateway)	WA-BACMSTP
485-GPRS (Must select the Enhanced IP66 Enclosure option)	WA-EP228
Disc Antenna	WA-EPANT
PC Software (485-USB adapter required for PC software use)	**Model No.**
StufManager (for real-time data acquisition)	SW-STMGR
Telemetry System (required for 485-GPRS adapter)	Please contact us
Data Logger	**Model No.**
2GB SD data logger (for recording flow, temperature, and energy)	WA-SD

Specifications: Clamp-On Transducer

Model	Picture	Description
Type: RM1 **PN#:** TWC-RM1		**Standard temperature, clamp-on WITH mounting rail, 1MHz** **Temperature** 0˚F~176˚F **TWC-RM1:** 1MHz transducer WITH mounting rail for pipe size 2½"~28"
Type: RM1HT **PN#:** TWC-RM1HT		**High temperature, clamp-on WITH mounting rail, 1MHz** **High temperature** 32˚F~300˚F **TWC-RM1HT:** 1MHz high temp transducer WITH mounting rail for pipe sizes 3"~28"
Type: S1HT **PN#:** TWC-S1HT		**High temperature, clamp-on WITHOUT mounting rail, 1MHz** **High temperature** 32˚F~300˚F **TWC-S1HT:** 1MHz high temp transducer WITHOUT mounting rail for pipe sizes 1½"~4"
Type: M1HT **PN#:** TWC-M1HT		**High temperature, clamp-on WITHOUT mounting rail, 1MHz** **High temperature** 32˚F~300˚F **TWC-M1HT:** 1MHz high temp transducer WITHOUT mounting rail for pipe sizes 3"~28"

How To Order Clamp-on Transducer:

Please select one option **(ID)** from each category.

TWC - ☐

Transducer Type	ID
Standard temperature (32~176˚F), clamp-on	
1MHz transducer WITH mounting rail for pipe sizes 2½"~28"	RM1
High temperature (32~300˚F), clamp-on	
1MHz high temp transducer WITH mounting rail for pipe sizes 3"~28"	RM1HT
1MHz high temp transducer WITHOUT mounting rail for pipe sizes 1½"~4"	S1HT
1MHz high temp transducer WITHOUT mounting rail for pipe sizes 3"~28"	M1HT

Required Accessories (choose one from each category)

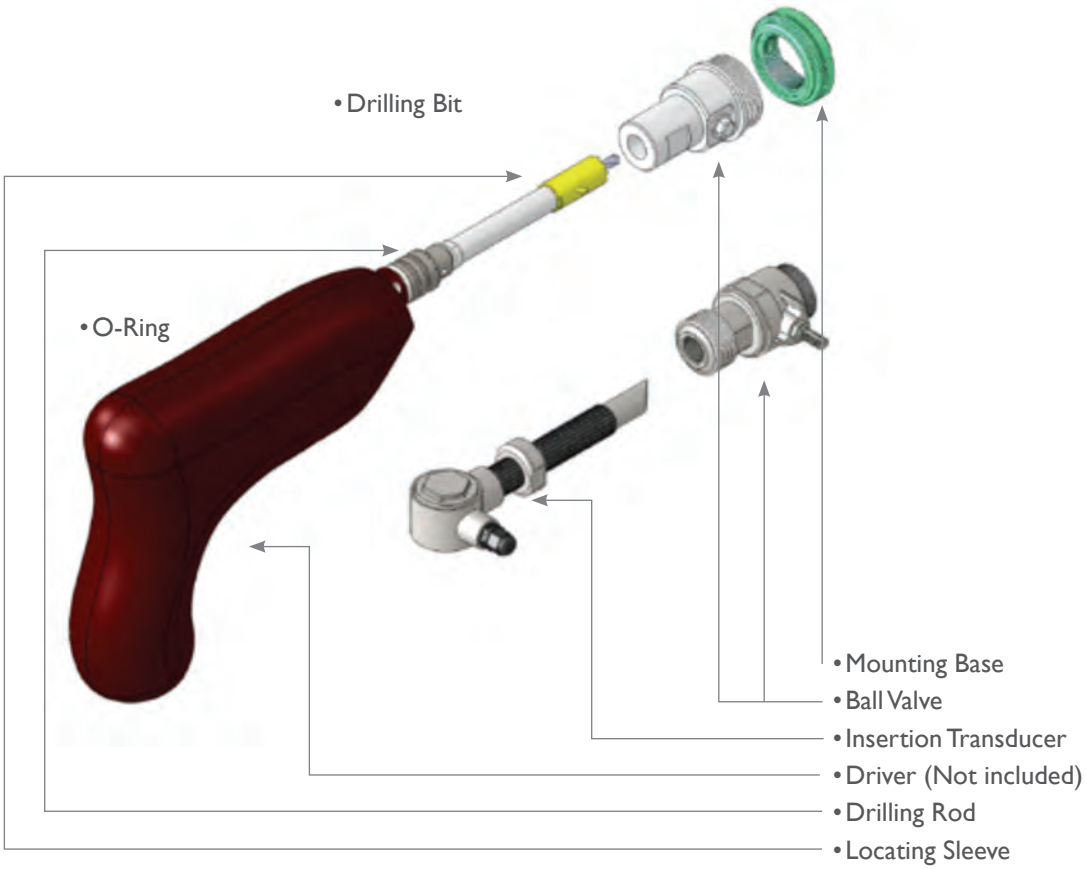
Transducer Cable	Model No.
15ft shielded transducer cable (in pair)	TW-CBL-15Ft
50ft shielded transducer cable (in pair)	TW-CBL-50Ft
150ft shielded transducer cable (in pair)	TW-CBL-150Ft
300ft shielded transducer cable (in pair)	TW-CBL-300Ft
Clamp Fixture	**Model No.**
Metal strip clamp for ¾"~2" pipe	TW-CLP-1
Metal strip clamp for 2"~4" pipe	TW-CLP-2
Metal strip clamp for 5"~8" pipe	TW-CLP-3
Metal strip clamp for 10"~12" pipe	TW-CLP-4
Metal strip clamp for 14"~16" pipe	TW-CLP-5
Metal strip clamp for 18"~20" pipe	TW-CLP-6

EnduroFlow™ Series EF10

Ultrasonic Transit-Time Flowmeter For Permanent Installation

Specifications: Insertion Transducer

Model	Picture	Description
Type: INS PN#: TWI-V		Insertion transducer, vertical type, 1MHz. For pipe size 3"~40" Temperature range 32˚F~300˚F.
Type: INS PN#: TWI-I		Insertion transducer, inclined type, 1MHz. For pipe size 3"~40" Temperature range 32˚F~300˚F. (Not recommended)
Type: PN#: TWI-HTK		Hot-tapping tool kit for insertion transducer installation



EnduroFlow™ Series EF10

Ultrasonic Transit-Time Flowmeter For Permanent Installation

How To Order Insertion Transducer

Please select one option (ID) from each category.

TWI -□-□-□-□

Type	ID
Vertical	V
Inclined	I

Pipe Size	ID
3”~40”	1
40”~120”	2

Pipe Material	ID
Steel	1
Plastic	2
Concrete	3
Other, please specify	4

ID	Pressure
A	87psig
B	145psig
C	232psig
D	362psig
E	Other, please specify

Required Accessories

Cable Length	Model No.
15ft	TW-CBL-15Ft
50ft	TW-CBL-50Ft
150ft	TW-CBL-150Ft
300ft	TW-CBL-300Ft
Hot-tapping Tool Kit	TWI-HTK

EnduroFlow™ Series EF10

Ultrasonic Transit-Time Flowmeter For Permanent Installation

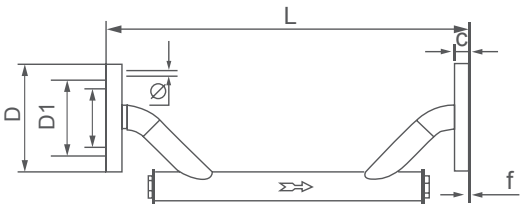
Specifications: Flow-Cell Transducer

Flow Cell	Pipe Size Range	Temperature Range	Flow Vel. Range	Pipe Joint
PI-type	⅜"~1½"	32°F~266°F	±15ft/s	Thread / Flange
Standard-type	2"~40"	32°F~266°F	±24ft/s	Flange

PI Type Flow-cell Transducer

Unit: IN
Max Pressure Rating: 362psig

Nominal Size	Length	Flange Dimension ANSI RF#150					Flange Thickness
in	L	D	D1	D-Φ	D2	f	C
⅜"							
½"	12.60	3½	2⅜	4 * ½	1⅜	1/16	7/16
¾"	14.17	3⅞	2¾	4 * ½	1-11/16	1/16	½
1"	15.35	4¼	3⅛	4 * ½	2	1/16	9/16
1¼"	17.72	4⅝	3½	4 * ½	2½	1/16	⅝
1½"	19.69	5	3⅞	4 * ½	2⅞	1/16	11/16



Notes :

- *The above flange is DIN type. ANSI flange is available upon request.*
- *Threaded pipe joint, BSP or NPT, is available upon request.*

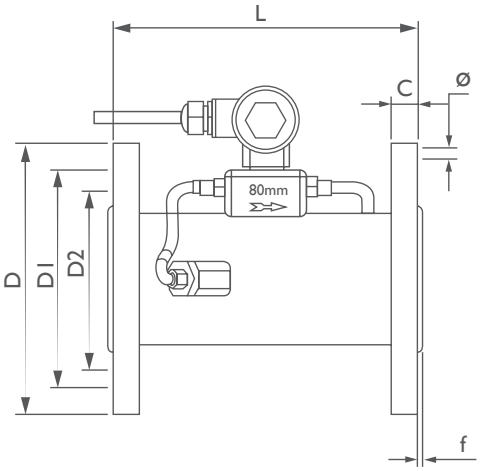
EnduroFlow™ Series EF10

Ultrasonic Transit-Time Flowmeter For Permanent Installation

Standard Type Flow-cell Transducer

Unit: IN
Max Pressure Rating: 232psig

Nominal Size	Length	Flange Dimension ANSI RF#150					Flange Thickness
In	L	D	D1	D-Φ	D2	f	C
2″	7.87	6	4¾	4 * ⅝	3⅝	1/16	¾
2½″	7.87	7	5½	4 * ⅝	4⅛	1/16	⅞
3″	8.86	7½	6	4 * ⅝	5	1/16	15/16
4″	9.84	9	7½	8 * ⅝	6-3/16	1/16	15/16
5″	9.84	10	8½	8 * ¾	7-5/16	1/16	15/16
6″	11.81	11	9½	8 * ¾	8½	1/16	1
8″	13.78	13½	11¾	8 * ¾	10⅝	1/16	1⅛
10″	17.72	16	14¼	12 * ⅞	12¾	1/16	1-3/16
12″	19.69	19	17	12 * ⅞	15	1/16	1¼
14″	21.65	21	18¾	12 * 1	16¼	1/16	1⅜
16″	23.62	23½	21¼	16 * 1	18½	1/16	1-7/16
18″	27.56	25	22¾	16 * 1⅛	21	1/16	1-9/16
20″	31.50	27½	25	20 * 1⅛	23	1/16	1-11/16
24″	39.37	32	29½	20 * 1¼	27¼	1/16	1⅞



Notes :

- *The above flange is ANSI type.*
- *For sizes larger than 20”, please consult us before placing order.*

How To Order Flow-Cell Transducer

Please select one option (ID) from each category.

TWF - □□-□-□-□-□

Flow-cell Size	ID
⅜"	01
½"	02
¾"	03
1"	04
1¼"	05
1½"	06
2"	07
2½"	08
3"	09
4"	10
5"	11
6"	12
8"	13
10"	14
12"	15
14"	16
16"	17
18"	18
20"	19
24"	20
28"	21
32"	22
36"	23
40"	24

ID	Pressure
A	87psig for sizes >20"
B	145psig for sizes from 12" to 20"
C	232psig for sizes from 2" to 10"
D	362psig for sizes <2"
E	Other, please specify

ID	Flow-cell Material
1	Carbon Steel (default)
2	Stainless Steel
3	Plastic
4	Other, please specify

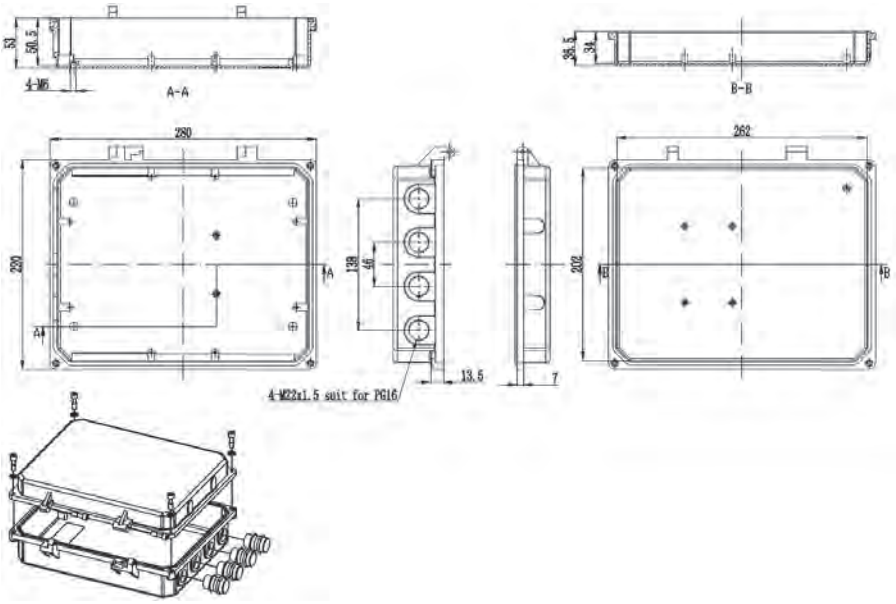
ID	Pipe Joint
B	NPT Threading (only available for size <2")
D	ANSI 150# Flange
E	Other, please specify

Required Accessories

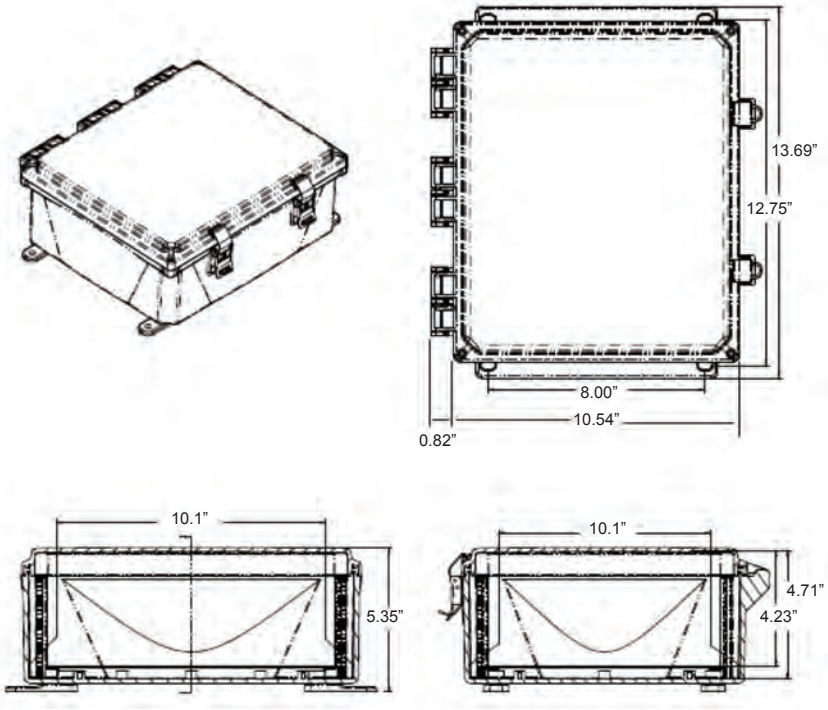
Cable Length	Model No.
15ft	TW-CBL-15Ft
50ft	TW-CBL-50Ft
150ft	TW-CBL-150Ft
300ft	TW-CBL-300Ft

Dimensions

Standard Enclosure (EF10-A)



Enhanced Enclosure (EF10-B)



Application Examples

Example 1: Chiller System

Company A has a chiller pipe, 8" size, carbon steel, schedule 40. They want to monitor the flowrate in the pipe with clamp-on technology. There is a 10ft straight pipe run after an elbow and the flow transmitter (main unit) will be installed in a control room which is 15 feet away from the transducer location.

In this application, the customer needs to use the following:

Flow transmitter:
EF10-A-0
WA-PWC-1

Clamp-on Transducer (pair):
TWC-RM1
TW-CBL-15Ft
TW-CLP-IN008

Example 2: Geothermal System

Company B has a geothermal hot water system. They need to measure how much hot water has been generated each day. The main pipe is a 4" copper pipe with the water temperature being around 160°F. They want to use a non-intrusive method to measure the flow, and the flow data needs to be logged every 5 minutes for 3 months.

The operator of this geothermal plant wants to use their cell phone to check the flow so to further monitor the system status anywhere they go. Also, in case the flow is over the limit or below certain flowrate requirements, which could indicate a pump failure, the operator wants to receive an alarm message from the flowmeter immediately.

In this application, the customer needs to use the following: EF10-C clamp-on flowmeter with GPRS wireless option.

Flow transmitter:
EF10-B-0
WA-PWC-1
WA-EP228
WA-SD

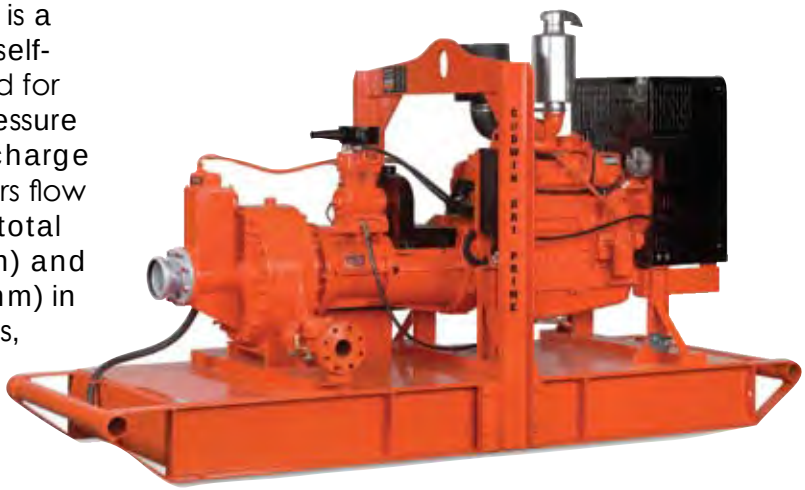
Clamp-on Transducer (Pair):
TWC-M1
TW-CBL-15Ft
TW-CLP-IN004

About Spire Metering Technology

Spire Metering is a global leader in flow and energy management solutions. Through continuous innovation, we transform cutting-edge technologies into affordable, reliable solutions for accurate flow and energy measurement. Spire Metering offers water, heat, electricity and gas meters as well as AMR/AMI and billing solutions. Let us help you with your application today.

HL110M Dri-Prime® Pumps

The Godwin Dri-Prime® 4" x 3" (100 mm x 80 mm) HL110M pump is a heavy-duty, fully automatic self-priming pump specifically offered for pumping under extreme high pressure discharge conditions or high discharge lift applications. The HL110M offers flow rates up to 500 GPM (115 m^3/h), total dynamic heads up to 615' (185 m) and solids handling up to 0.787" (20 mm) in diameter. Like all Godwin pumps, the HL110M pump includes the Dri-Prime air ejector priming system for fully automatic priming up to 28' (8.5 m) of static suction lift.



Features

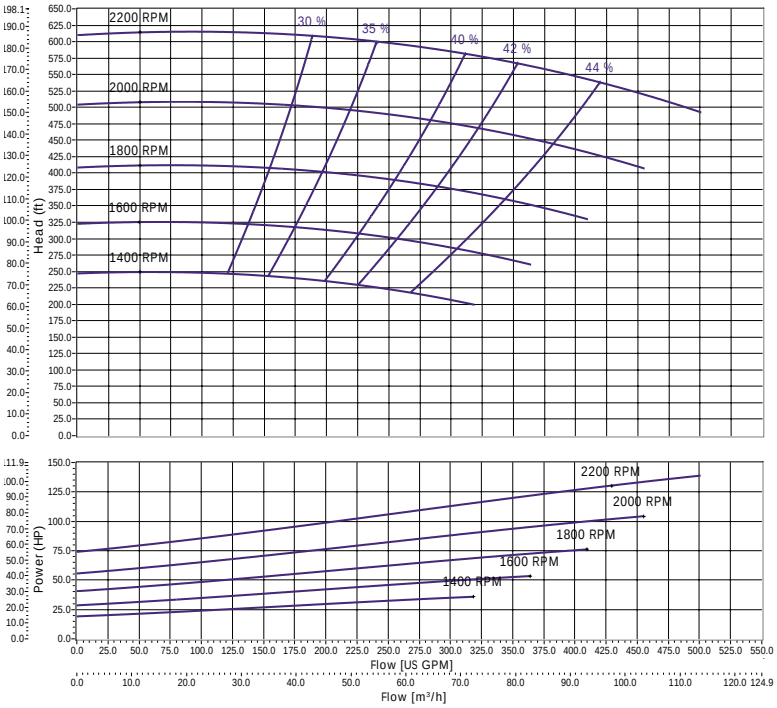
- Fully automatic priming from dry to 28' (8.5 m) of suction lift.
- Handles liquids with solids up to 0.787" (20 mm) in diameter.
- Continuously operated Venturi air ejector priming system operated by an air compressor, requires no form of periodic adjustment or operator intervention.
- Dual, high pressure, dry running solid silicon carbide inboard and carbon/stainless outboard mechanical seal with self-contained oil-bath cooling.
- Mounted to a structural steel skid with integrated 175 gal. (662 l) fuel tank and lifting bail. Optional road going trailer also available.
- Standard engine - JD6068T. Other engines and electric motor also available upon request.

Specifications

Suction	4" (100 mm/125#)
Discharge	3" (80 mm/250#)
Max. Capacity	500 GPM (115 m^3/h)
Max. Head	615' (185 m)
Max. Solids Handling	0.78" (20 mm)
Impeller Type	Fully open
# of Blades	3
Max. Impeller Diam.	20" (465 mm)
Max. Op. Temp.	176°F (80°C)
Max. Working Press.	276 psi (19 BAR)
Max. Suction Press.	87 psi (6 BAR)
Max. Test Press.	413.25 psi (28.5 BAR)
Max. Op. Speed	2200 RPM
Normal Op. Speed	2000 RPM
Min. Op. Speed	1400 RPM

godwin pumps®

Pump Curves



Materials

Pump Casing/ Separation Tank	Cast steel
Impeller	Cast steel, hardened to Brinnell 200 HB
Wearplates	High chrome cast iron hardened to Brinnell 625 HB
Mechanical Seal	Solid silicon carbide

Performance Table

Diesel Set - JD6068T, 144 HP (187 kW) @ 2200 RPM
Impeller Diameter: 18" (465 mm)

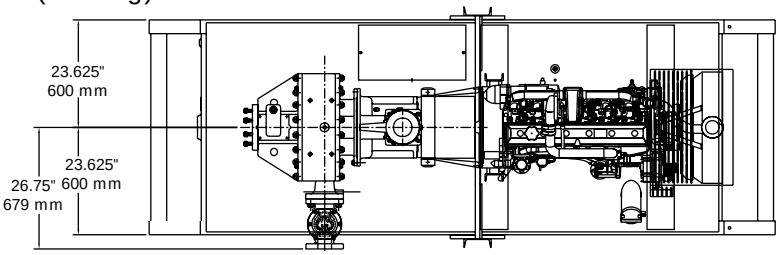
Total Delivery Head - Feet

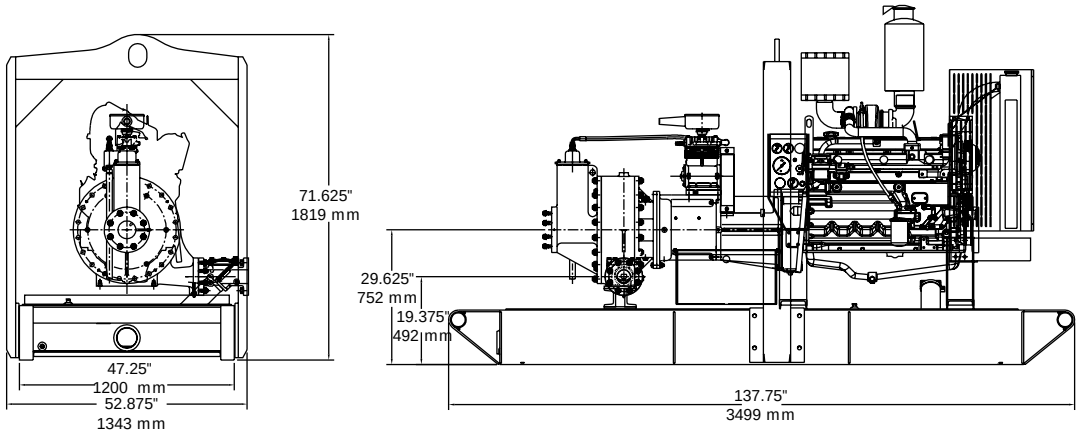
Total Suction Head - Feet	500	525	560	575
		Output - GPM		
10	484	420	350	286
15	462	395	330	264
20	440	375	300	240

Performance data listed in table and curves based on water test at sea level and 68°F (20°C). Maximum flows may require larger diameter pipes.

Drawings

Skid-mounted John Deere 6068T engine
Dry weight - 6100 lbs. (2769 kg)





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APPENDIX B

Bird Mitigation Protocols for the Yerington Site

Bird Mitigation and Monitoring Program at Yerington Site

Based on discussions throughout 2013, ARC has enhanced the bird mitigation and monitoring program since December 2013 with additional deterrents and protocols to adapt to new challenges that have arisen after creation of the Nevada Department of Environmental Protection (NDEP) B and C ponds. This document updates the original bird monitoring and mitigation protocol. This protocol formally provides our field team with updated direction for ongoing operation of the bird deterrence program.

The passive deterrents now include one “Wetland Wailer” each at the Slot and NDEP ponds, bird balls added to the diverter cables on the NDEP ponds, plus three additional backup wind dancers that can be placed where needed when bird activity is high (deterrent locations shown in Figure 1). The active deterrents include a remotely controlled Goosinator designed to chase birds off the pond like a predator (without touching the bird), a rope and drag net designed to corral birds to one end of the pond (encouraging them to fly off), and air horns.

Our updated activities and procedures are outlined as follows.

1. Areas of the mine site where ARC has bird deterrence responsibilities:

- Former Anaconda and PWS areas
  - PWS ponds
  - Unlined evaporation ponds
  - Lined evaporation ponds
- Arimetco areas, operated by ARC on behalf of NDEP
  - VLT pond
  - 4-Acre pond (NDEP A pond)
  - NDEP B and EPA C ponds
  - Slot ponds

2. Definition of periods of the year that determine which deterrence activities are performed:

- Presumed peak periods of bird activity (migratory season) previously approved by USFWS
  - March 1 through May 31
  - September 1 through November 30
- Non-peak periods
  - All year outside of the peak periods

3. Bird deterrence activities must be undertaken on all normal work days through the year (weekends and holidays are excluded).
4. ARC bird deterrence activities will consist of the following:

- Bird observation monitoring
- Bird deterrence activities
  - Bird deterrence
  - O&M of bird deterrence devices
- Reporting of bird related information to regulatory agencies

5. Bird observation monitoring:

- Former Anaconda and PWS Ponds
  - Peak periods
    - Bird observations should be made and recorded using a routine schedule between dawn and dusk. Bird observations should be performed at least three times each day (Monday–Friday): around sunrise, mid-day, and sunset. If birds are observed during either morning or mid-day watches, that particular site should be revisited every two hours until birds were no longer observed, or until the last watch of the day.
  - Non-peak periods
    - Observations will have a reduced frequency for the former Anaconda and PWS ponds in summer and winter. A reduced schedule of twice a day should be sufficient in summer and may not be needed at all in the absence of water in the ponds. Similarly, in the winter, observations twice a day should be sufficient and the observation schedule should be adjusted to coincide with the shortened daylight hours. These observations would be conducted in coordination with schedules for other site activities conducted by ARC onsite staff.
- Arimetco areas
  - Peak periods
    - Bird observations should be made and recorded four times per normal work day, with the day's first and last visits occurring approximately around sunrise and sunset, respectively. Observations need to be conducted at the VLT, NDEP A, NDEP B, NDEP C, and Slot ponds.
  - Non-peak periods

    Outside of peak periods, observations will be made and recorded two times per normal working day, once at sunrise and once at sunset at the NDEP A, NDEP B, NDEP C, VLT, and Slot ponds.

  - During cold periods when the sewage ponds are frozen, the order of daily monitoring will be changed so that the NDEP ponds are the first and last pond surveyed, given the NDEP A pond does not freeze easily compared to the other ponds with its high salt level and all three ponds together may attract more birds during cold periods.

6. Bird deterrence activities (see Figure 1)

- Former Anaconda and PWS areas
  - Peak periods
    - Conduct bird deterrence activities from sunrise to sunset using any or all of the following equipment/procedures. Some equipment may require periodic O&M which should be administered as appropriate:
      - Bird Gard Towers
        (a) Operation of Bird Gard Towers when Ponds are Dry
          (i) When the pumpback and evaporation ponds are dry, the Bird Gard towers can be turned off to reduce habituation to the towers. No threat exists to the birds when there is no water. Turning off the towers will reduce bird habituation.
          (ii) When any precipitation (snow or rain) is forecast for the Yerington area, the Bird Gard towers will be activated before staff leave the site at the end of the day preceding the forecasted event or on Friday if the precipitation is forecast for the weekend. During the days when staff are on site, if not already in operation, the

towers are to be powered up prior to the start of precipitation when conditions visually appear threatening. If there is visible wetness in the pumpback or lined evaporation ponds, the Bird Gard towers are to remain in operation, unless staff are directed differently.

- Mylar and scare eye balloons
- Hand waving, yelling, and car or air horn honking
- Rock Throwing
  (a) Maintain a small stockpile of ~1-inch gravel at each pond and toss rocks to land on the water near the bird to create a splash that drives the birds out of the ponds. Rocks can be tossed by hand or a wrist rocket (i.e. sling shot) can be used for better control and to reduce chance of shoulder injury.
- Pyrotechnics (bangers and screamers)
- Goosinator
  (a) The Goosinator is a radio-controlled wingless deterrent device shaped like an orange dog that is propeller-powered, pushed by an electric motor. It runs on water, short grass, sand, and ice. It can potentially herd birds (one or more), sit motionless like a predator, chase and then give space to a bird to allow it to take flight as it flees from the perceived "predator".
- Weighted ropes or nets to drag across the pond to haze a bird off the pond
  (a) The use of a long rope or net, held by one person on each side of the pond, can be used to attempt to sweep the bird to one end of the pond and encourage them to fly off. This method is often used for diving birds who are likely to dive under water when pyrotechnics are used. However, it can be used for any species resistant to leaving the pond. Approach the bird quietly to reduce the chances of the bird diving.
- Wind dancer flags
  (a) Cement blocks hold flags on long poles. The flags are moved to different locations to avoid habituation. The flags are periodically replaced as they become worn.
- Wind dancers
  (a) Electric-powered fan operated active tubular fabric figures randomly placed to operate in different locations on a sporadic schedule. During windy periods when onsite staff judge winds to be too strong for normal operation of the devices, they will be shut down and stored until winds subside. Similarly, during rainy periods when the device is too wet to operate, the device will be shut down. If safety issues arise, the wind dancers will be turned off until safe conditions are restored. A portable gasoline-powered wind dancer may be added periodically during periods of high bird activity or extreme cold weather that freezes the sewage ponds. Wind socks are replaced as needed.

  - Non-peak periods
    - Mitigation activities not required but optional. However, given bird mortalities do occur during non-peak periods, the devices will normally be operated the same as during peak periods when the ponds are wet.

- Arimetco areas (see Figure 1)
  - Peak and non-peak periods

- Conduct bird deterrence activities from sunrise to sunset utilizing any or all of the following equipment/procedures that have been authorized and directed by the EPA. Some equipment may require periodic O&M which should be administered as appropriate:
  - Wetland Wailer
    (a) A Wetland Wailer is deployed between the NDEP B and NDEP C ponds and at the Slot pond. The Wailer emits very loud surround-sounds of incessant sirens, gunshots, helicopter sounds, distressed bird calls, and predator calls at irregular intervals for variable lengths of time. The sound level is set to 3 for natural sounds and 2 for artificial sounds, unless a bird is on the pond. In addition to sounds emitted from above-ground speakers, there is a strobe light that flashes when the speakers are active and underwater speakers which may be attached to Wailer to emit the same sounds under water to potentially haze diving birds.
  - Propane cannons
    (a) Due to safety concerns and their replacement by the Wetland Wailers, the propane cannons have been discontinued (as of July 7, 2014) and have been placed in storage.
  - Wind dancer flags
  - Wind dancers
    (a) The wind dancers are operated at ponds with an electric power source, which now include the VLT, Slot and three NDEP ponds (where power is now available).
  - Hand waving, yelling, and car or air horn honking
  - Mylar and scare eye balloons
  - Rock Throwing
  - Pyrotechnics (bangers and screamers)
  - Goosinator
  - Weighted ropes or nets to drag across the pond to haze a bird off the pond
  - Solar-powered owl with a rotating head at NDEP A pond.
  - Bird Diverter Lines at NDEP B and NDEP C ponds.
    (a) Bird diverter lines are lines that extend across the pond so that bird balls, shiny diverters and/or Mylar balloons can be placed directly over the fluid in the ponds

o Rain Protocol
- Throughout much of the year the NDEP A pond consists of solidified salt with no standing water to attract birds. When this condition exists and no water is exposed, no active bird deterrent devices are necessary. At times when rain occurs, water may pool on the surface creating a potentially hazardous attraction to birds. At these times when it is raining, or anticipated to rain sufficiently to cause pooling on the top of the salt cap, begin the following protocol:
  - Wind Dancers: Place up to two additional wind dancers, operated by portable generator, in the NDEP A pond area near the east and west sides along the predominant flight path
  - Flags: Add additional flags to the NDEP A pond
  - Wetland Wailer: Increase the volume of the natural sounds by one level (i.e. from level 3 to level 4). Leave the artificial sounds at level 2.

7. Bird observation monitoring reporting:

- One form per visit; forms are summarized in tables for the week.
- Arcadis prepares and submits monthly reports to Chris Nicolai at the USFWS and people on the cc list (Jack Oman, John Batchelder, Rich Curley, Rich Mattucci, David Seter, J.C. Isham, and Toby McBride)

8. Response to an observation of dead or distressed birds at ponds.

- Distressed birds include birds that will not leave a pond even after all appropriate deterrence methods have been used. Following are recommended steps to take in the event that a dead bird is observed anywhere at the site:
  A. Arcadis – Record all factual information on Yerington Mine site dead bird data sheets.
  B. Arcadis – If the USFWS expresses interest in picking up the dead bird, physically mark the location of the dead bird or the point from which it can be seen. If using a handheld GPS, establish a way point and record latitude and longitude.
  C. Arcadis – Call Dr. Carolyn Meyer at her office phone (303-231-9115 ext. 124) or mobile phone (303-524-2747). If Carolyn is not available, leave a voice mail message and email to have her call back (Carolyn.Meyer@arcadis-us.com) and then call Emily Schlenker (office 303-231-9115 ext.114; mobile 254-718-0217) or Emily Morrison (office 410-295-1205 ext. 16; mobile 517-214-2397). If Carolyn, Emily Schlenker and Emily Morrison are not available, email them to ask them to call back (Emily.Schlenker@arcadis-us.com, Emily.Morrison@arcadis-us.com).
  D. Arcadis – Email a summary of the location of the dead bird and the detailed information provided in the dead bird data sheet to Carolyn Meyer or, if Carolyn is unavailable, Emily Schlenker or Emily Morrison. Other team members will be copied on the email to review the report: Jack Oman, John Batchelder, and Rich Curley.
  E. ARC – Notify NDEP of the dead bird.
  F. Arcadis– Email a summary of the location of the dead bird and the detailed information provided in the dead bird data sheet to Chris Nicolai at the USFWS Nevada Fish and Wildlife Office (Chris_Nicolai@fws.gov). Copy the following people on the email: Jack Oman, John Batchelder, Brian Johnson, Rich Curley, Rich Mattucci, David Seter, J.C. Islam, Toby McBride and Damian Higgins. Note: Observation of a distressed bird does not require notification to USFWS unless the bird dies.

Please note that ARC does not have permits nor safety procedures in place to collect dead birds, or refrigerated facilities to store them.

Yerington Mine Site Dead Wildlife Data

Date:	Species:	Observer:
Site Description:		

Circle most appropriate term(s) below, and add any additional notes

Sex:

Age:

Body Condition:

Post-Mortem Condition:

Other dead, injured or sick animals present?

If yes, how many? Dead_____ Injured_____ Sick 1

Additional dead/injured/sick species and notes:

Collected and labeled? No

Sent for necropsy? No Date:

Note any other important observations below and on reverse:

Yerington Mine Site Dead Bird Data Sheet Instructions:

Upon encountering a dead bird:

1. Enter date (mm/dd/yyyy).
2. Enter the species or identity of dead bird to best of your ability
3. Enter your initials
4. Enter a brief site description. This should include the operable unit and other information about the location where the animal was found (e.g., roadside ditch near air monitoring equipment, under power lines, or in water).
5. Circle the appropriate words in the next section and add notes as needed. Use the following general guidelines:

Sex: This is easiest to determine for mammals and for adult birds in mating plumage; consulting a field guide may help.

Age: Determine whether the bird is an adult or a juvenile. If more detail is observed, list it in addition (e.g., "spike buck" or "spotted fawn" is more descriptive than just "juvenile").

Body Condition: List the physical condition of the carcass. Good means the body is basically intact, Fair means it is mostly intact with some predator or scavenger damage, and Poor denotes partial remains which would probably not be worth collecting.

Post-Mortem Condition: Lists the extent of carcass decomposition. You may want to note the magnitude of rotting odors, etc. Birds dead much past a few days are usually not worth collecting for future necropsy.

Presence of additional dead or sick animals is useful to note for documenting diseases or other large scale afflictions. Sick animals are usually identified by strange behaviors such as not fleeing from humans, moving slowly, or not being able to fly. Note numbers of any dead, injured, or sick animals seen near the carcass, and note anything else that seems strange. THERE CAN NEVER BE TOO MUCH DETAIL!

Additional Notes: Describe any obvious injuries, as well as possible circumstantial evidence of death. Circumstantial evidence could be anything from recent weather events, nearby live power lines, freshly fired firearms cartridges on site, or nearby highways. Be factual without speculations of causes of death.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Nevada Fish and Wildlife Office
1340 Financial Blvd., Suite 234
Reno, Nevada 89502
Ph: (775) 861-6300 ~ Fax: (775) 861-6301

September 3, 2008

Roy Thun
Environmental Business Manager
Atlantic Richfield Company
4 Centerpointe Drive
LaPalma, California 90623-1066

Dear Mr. Thun:

Subject: Approval for the "Mitigation Plan for Deterring Birds from Lined Evaporation and Pumpback Ponds – Yerington Mine Site"

We have reviewed the "Mitigation Plan for Deterring Birds from Lined Evaporation and Pumpback Ponds – Yerington Mine Site" (Plan) dated August 15, 2008. The Plan is in response to incidents of avian mortality observed by the U.S. Fish and Wildlife Service (Service) on areas of the Yerington Mine site that contain water which is highly acidic and potentially acutely toxic to avian life. The Service presented its avian mortality observations to the Yerington Mine Technical Workgroup at a meeting in Reno, Nevada, on May 29, 2008. A request was then made to Atlantic Richfield Company and the Environmental Protection Agency to develop and implement an avian mitigation plan for all areas of the Yerington Mine site where avian exposure could occur. The goal of the Plan is to effectively deter avian taxa from using the pumpback ponds and lined evaporation ponds located within the Yerington Mine site using non-lethal procedures.

The Service approves the implementation of the Plan as described and prescribes the following additional monitoring requirements, as provided by our authority under the Migratory Bird Treaty Act:

1. A summary of daily records of wildlife observations made by site personnel will be provided to the Service's Nevada Fish and Wildlife Office on a weekly basis from March 1 through May 31 and from September 1 through November 31.
2. A summary of daily records of wildlife observations made by site personnel will be provided to the Service's Nevada Fish and Wildlife Office on a monthly basis during the months of June through August and December through January.

3. Daily wildlife observation records made by site personnel will include the following:
    a. Location (Pumpback, lined evaporation, or unlined evaporation ponds)
    b. Type of avian wildlife (duck, grebe, shorebird, or other)
    c. Species of bird (if possible)
    d. Status (healthy, sick, injured, dead)
4. Observations of avian mortality must be reported to the Service's Nevada Fish and Wildlife Office within 24 hours of observation. The Service will assume responsibility for additional reporting to the Nevada Department of Wildlife (NDOW).
5. When possible and consistent with a developed Health and Safety Plan, collect any avian carcasses on the site and preserve by freezing until transfer to a Service or NDOW representative can occur.
6. At any time, with 24 hours notice, Service or NDOW personnel may observe or assist site personnel in daily wildlife observations to ensure monitoring needs are met as part of implementation of this plan.

The Service recognizes that site personnel may not have the skills or expertise to fully implement some of the monitoring requirements described above. Therefore, the Service will work with site personnel to provide training to meet monitoring needs. Should you have questions, need clarification on the monitoring requirements, or need assistance in training site personnel, please contact me or Selena Werdon at (775) 861-6300.

Sincerely,

Robert D. Williams
Field Supervisor

cc:
Environmental Manager, Yerington Paiute Tribe, Yerington, Nevada (Attn: Albert Roberts)
Senior Science Advisor, Integral Consulting, Inc., Mercer Island, Washington (Attn: Les Williams)
Director of Ecological Services, Wallace-Kuhl and Associates, West Sacramento, California (Attn: Erik Ringelberg)
McGinnis and Associates LLC, Reno, Nevada (Attn: Dietrick McGinnis)
Biologist, Habitat Division, Nevada Department of Wildlife, Fallon, Nevada (Attn: Kris Urquhart)
Superfund Remedial Project Manager, Environmental Protection Agency, San Francisco, California (Attn: Nadia Hollen-Burke)
Nevada On-Scene Coordinator, Environmental Protection Agency, Carson City, Nevada (Attn: Tom Dunkelman)
NRDAR Coordinator, Bureau of Land Management, Denver, Colorado (Attn: Paul Meyer)

Minerals Specialist, Nevada State Office, Bureau of Land Management, Reno, Nevada
(Attn: Bob Kelso)
Special Agent, Office of Law Enforcement, U.S. Fish and Wildlife Service, Reno, Nevada