GE
Measurement & Control

Flow

AquaTrans™ AT600

User's Manual

imagination at work

910-312 Rev. B
December 2015

AquaTrans™ AT600

Panametrics Ultrasonic Flowmeter for Liquids

User's Manual

910-312 Rev. B
December 2015

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Information Paragraphs

Note: *These paragraphs provide information that provides a deeper understanding of the situation, but is not essential to the proper completion of the instructions.*

IMPORTANT: *These paragraphs provide information that emphasizes instructions that are essential to proper setup of the equipment. Failure to follow these instructions carefully may cause unreliable performance.*

CAUTION! This symbol indicates a risk of potential minor personal injury and/or severe damage to the equipment, unless these instructions are followed carefully.

WARNING! This symbol indicates a risk of potential serious personal injury, unless these instructions are followed carefully.

Safety Issues

WARNING! It is the responsibility of the user to make sure all local, county, state and national codes, regulations, rules and laws related to safety and safe operating conditions are met for each installation. The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

Auxiliary Equipment

Local Safety Standards

The user must make sure that he operates all auxiliary equipment in accordance with local codes, standards, regulations, or laws applicable to safety.

Working Area

WARNING! Auxiliary equipment may have both manual and automatic modes of operation. As equipment can move suddenly and without warning, do not enter the work cell of this equipment during automatic operation, and do not enter the work envelope of this equipment during manual operation. If you do, serious injury can result.

WARNING! Make sure that power to the auxiliary equipment is turned OFF and locked out before you perform maintenance procedures on the equipment.

WARNING! It is the responsibility of the user to make sure the PWR, Hart, Modbus and I/O cable can meet the cable specification, which is described in Appendix A.

Paragraphes d'informations

Remarque: *Ces paragraphes fournissent des informations à même de faciliter la compréhension de la situation, mais n'est pas indispensable à la bonne utilisation des instructions.*

IMPORTANT: *Ces paragraphes fournissent des informations qui mettent l'accent sur les instructions qui sont essentielles à une configuration correcte de l'équipement. Le non-respect de ces instructions peut entraîner une dégradation des performances.*

ATTENTION! Ce symbole indique un risque potentiel mineur de blessure aux personnes et / ou de sérieux dommages à l'équipement, à moins que ces instructions soient rigoureusement suivies.

ATTENTION! Ce symbole indique un risque potentiel grave de blessures aux personnes, à moins que ces instructions sont soient rigoureusement.

Questions de sécurité

ATTENTION! Il est de la responsabilité de l'utilisateur de s'assurer que tous les règlements, codes et lois locaux, nationaux et européens relatifs à la sécurité et aux conditions d'exploitation en toute sécurité soient respectés pour chaque installation. La sécurité de tout système intégrant l'équipement est de la responsabilité de celui qui l'assemble.

ATTENTION! Il est de la responsabilité de l'utilisateur de s'assurer que les c?bles d'alimentation, Hart, Modbus et Entrées/Sorties répondent à la spécification décrite à l'annexe A.

Matériel auxiliaire

Standards de sécurité locaux

L'utilisateur doit s'assurer que les équipements auxiliaires utilisés sont en tout point conforme aux codes, standards et réglementations relatifs à la sécurité.

Zone de travail

ATTENTION! Les équipements auxiliaires peuvent avoir à la fois des modes de fonctionnement manuel et automatique. Comme l'équipement peut bouger brusquement et sans signe préalable, ne pas entrer dans la zone de travail de ce dernier pendant le fonctionnement automatique, et ne pas s'en approcher de trop près pendant le fonctionnement manuel. Si vous le faites, cela peut entraîner de graves blessures.

ATTENTION! Assurez-vous que l'alimentation de l'équipement auxiliaire est éteinte et verrouillée avant d'effectuer toute opération de maintenance ou d'entretien de l'équipement.

Qualification of Personnel

Make sure that all personnel have manufacturer-approved training applicable to the auxiliary equipment.

Personal Safety Equipment

Make sure that operators and maintenance personnel have all safety equipment applicable to the auxiliary equipment. Examples include safety glasses, protective headgear, safety shoes, etc.

Unauthorized Operation

Make sure that unauthorized personnel cannot gain access to the operation of the equipment.

Environmental Compliance

Waste Electrical and Electronic Equipment (WEEE) Directive

GE Measurement & Control is an active participant in Europe's *Waste Electrical and Electronic Equipment* (WEEE) take-back initiative, directive 2012/19/EU.

The equipment that you bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.

In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end life equipment in a sound way.

The crossed-out wheeled bin symbol invites you to use those systems.

If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.

Visit www.gemeasurement.com/environmental-health-safety-ehs for take-back instructions and more information about this initiative.

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Chapter 1. Introduction

1.1 Overview

Thank you for purchasing the AT600 ultrasonic flow meter. AT600 is a clamp-on ultrasonic flow meter for measurement of liquid phase products. It is designed for the industrial market, including water, wastewater, steel, campus energy and other markets. AT600 utilizes a new electronics platform and industrial design to make it extremely simple to install and use in the field.

- **So easy to use, it practically installs itself.**

The AT600 consists of the new AT600 electronics, metal enclosure and field proven AT transducers system, including the clamp-on fixture.

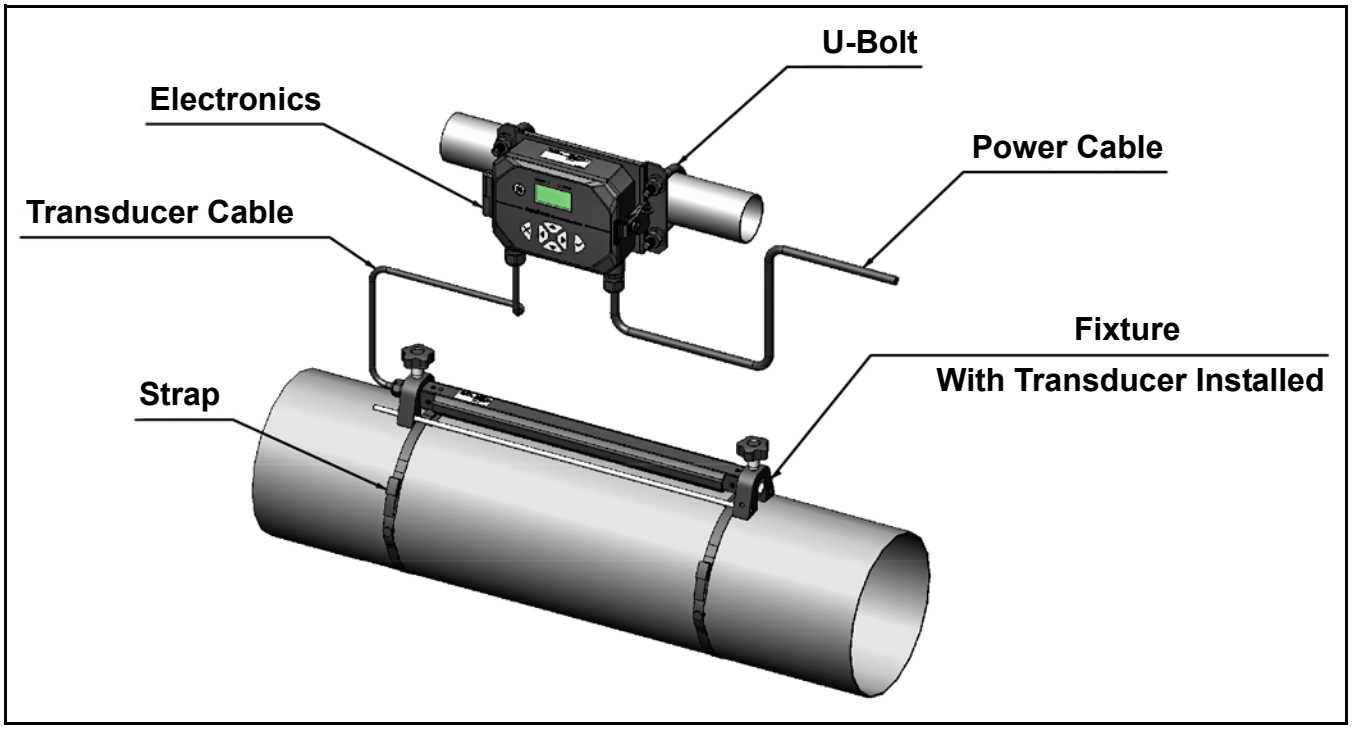


Figure 1: AT600 System (Pipe Mounting)

1.2 Theory of Operation

1.2.1 Transit-Time Flow Measurement

In this method, two transducers serve as both ultrasonic signal generators and receivers. They are in acoustic communication with each other; that is, the second transducer can receive ultrasonic signals transmitted by the first transducer and vice versa.

In operation, each transducer functions as a transmitter, generating a certain number of acoustic pulses, and then as a receiver for an identical number of pulses. The time interval between transmission and reception of the ultrasonic signals is measured in both directions. When the liquid in the pipe is not flowing, the transit-time downstream equals the transit-time upstream. When the liquid is flowing, the transit-time downstream is less than the transit-time upstream.

The difference between the downstream and upstream transit times is proportional to the velocity of the flowing liquid and its sign indicates the direction of flow.

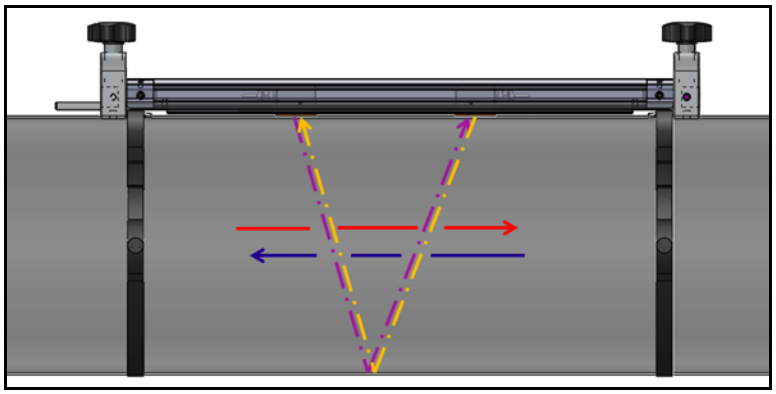


Figure 2: Flow and Transducer Paths (Dual Traverse)

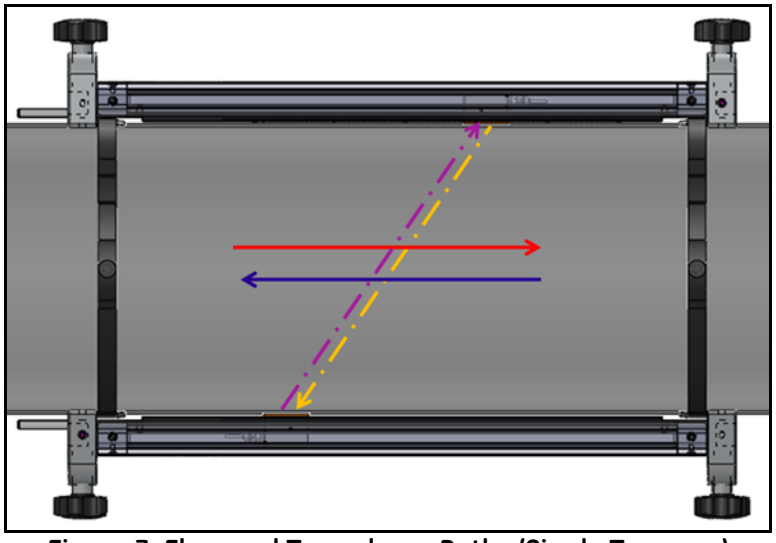


Figure 3: Flow and Transducer Paths (Single Traverse)

Chapter 2. Installation

2.1 Introduction

To ensure safe and reliable operation of the AT600, the system must be installed in accordance with the established guidelines. Those guidelines, explained in detail in this chapter, include the following topics:

- Unpacking the AT600 system
- Installing the electronics enclosure
- Installing the clamp-on fixture and transducer system
- Wiring the electronics enclosure

WARNING! The AT 600 flow transmitter can measure the flow rate of many fluids, some of which are potentially hazardous. The importance of proper safety practices cannot be overemphasized.

Be sure to follow all applicable local safety codes and regulations for installing electrical equipment and working with hazardous fluids or flow conditions. Consult company safety personnel or local safety authorities to verify the safety of any procedure or practice.

ATTENTION EUROPEAN CUSTOMERS! To meet CE Mark and UL Mark requirements, all cables must be installed as described in *"Wiring Cable Specifications and Requirements" on page 157*.

2.2 Unpacking the AT600 system

Before removing the AT600 system from the crate, please inspect the flow meter. Each instrument manufactured by GE Measurement & Control is warranted to be free from defects in material and workmanship. Before discarding any of the packing materials, account for all components and documentation listed on the packing slip. The discarding of an important item along with the packing materials is all too common. If anything is missing or damaged, contact GE Customer Care immediately for assistance.

Please note that your AT600 system may come in different configurations based on your selection, so the packing list could be a little different. Below is the typical packing list:

10. One AT600 electronics

20. Two clamp-on fixtures

30. Two transducers (installed in one of the two clamp-on fixtures)

40. One transducer cable (installed on fixture with transducers)

50. Four clamping fixture mounting straps

60. Two “U” bolts for pipe mounting of AT600

70. One USB flash drive with manual and calibration sheet

80. One inner hexagon spanner

90. Three M16 Gland (installed on AT600)

100. Two pieces of Solid Couplant

110. Quick installation guide

120. Calibration Sheet

130. Cabling tools

Figure 4: Standard Packing List

2.3 Installing the Electronics Enclosure

The AT600 electronics is housed in a powder-coated, aluminum, NEMA type 4X/IP67 enclosure suitable for indoor or outdoor use, See Figure 5 below for the mounting dimensions and weight of the AT600 electronics.

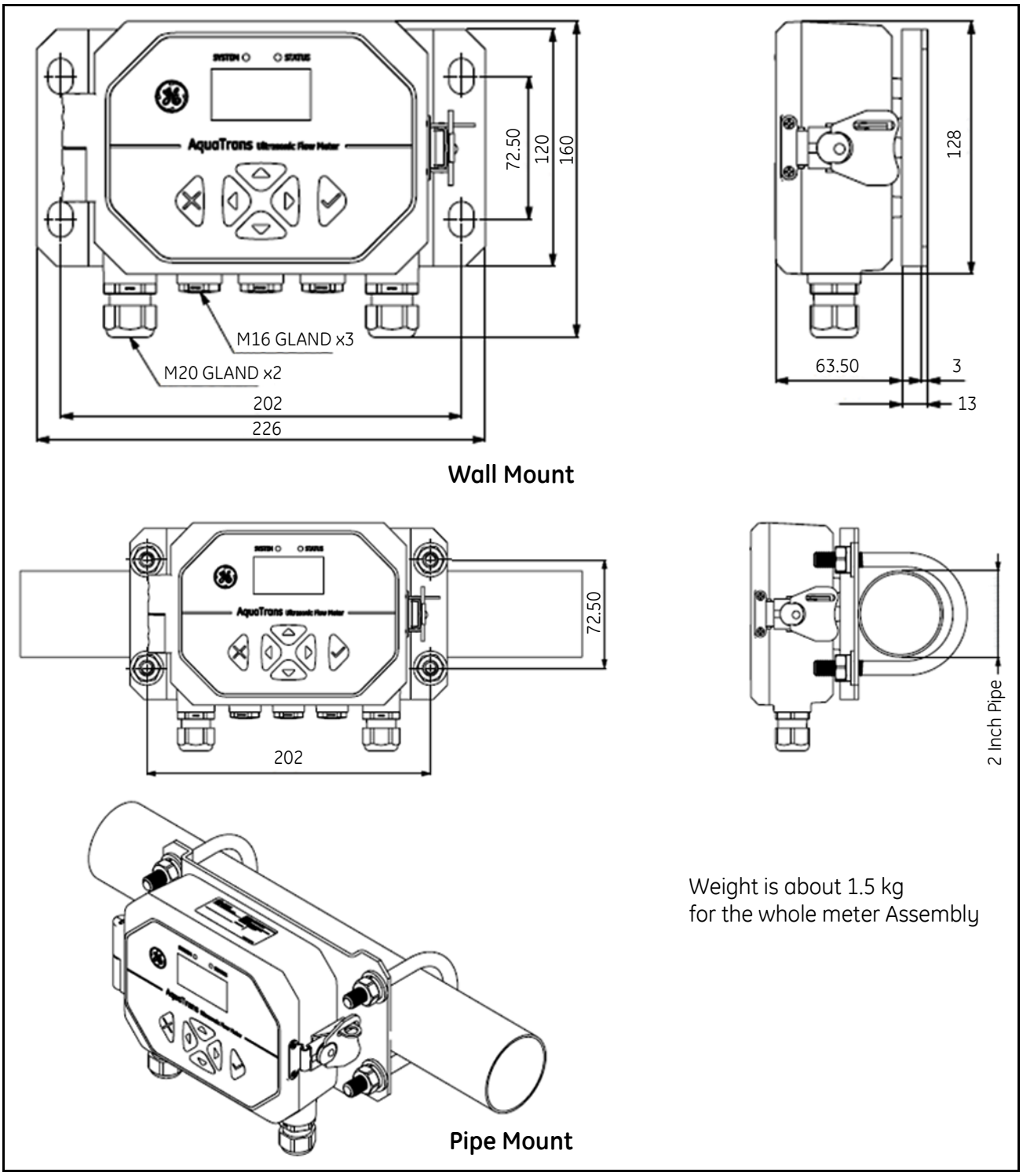


Figure 5: AT600 Electronics Mounting

2.3 Installing the Electronics Enclosure (cont.)

The installation base of AT600 electronics can also be rotated by 90 degrees to keep a horizontal view of the user interface in a horizontal or vertical mounting condition. See Figure 6 below for AT600 mounting of the installation base.

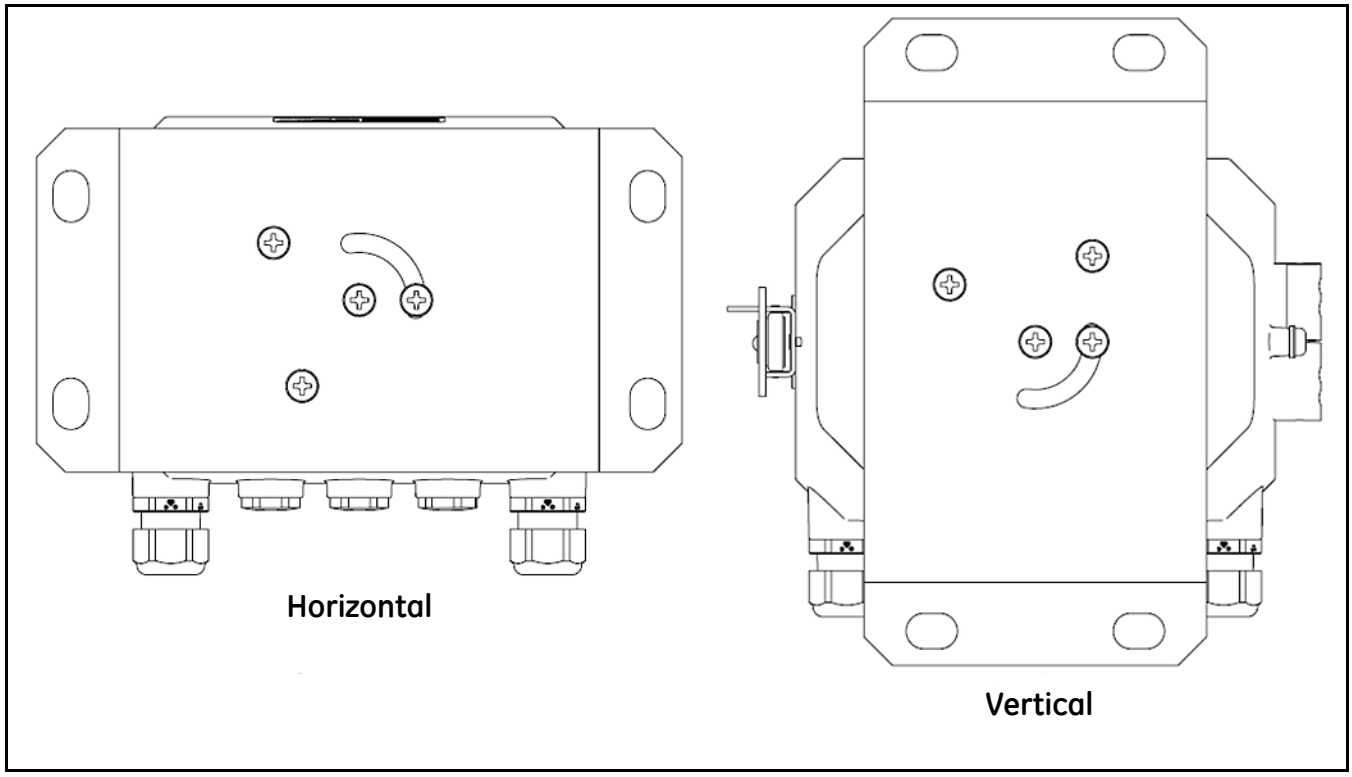


Figure 6: Mounting of AT600 Installation Base

2.4 Installing the Clamp-on Fixture And Transducer System

2.4.1 Clamp-on Fixture and Transducer Location

For a given fluid and pipe, the accuracy of AT600 depends on the location and alignment of the transducers. In addition to accessibility, when planning for transducer location, adhere to the following guidelines:

- Locate the clamp-on fixture and transducer system so that there are at least 10 pipe diameters of straight, undisturbed flow upstream and 5 pipe diameters of straight, undisturbed flow downstream from the measurement point. Undisturbed flow means avoiding sources of turbulence in the fluid such as valves, flanges, expansions, and elbows; avoiding swirl; and avoiding cavitation.

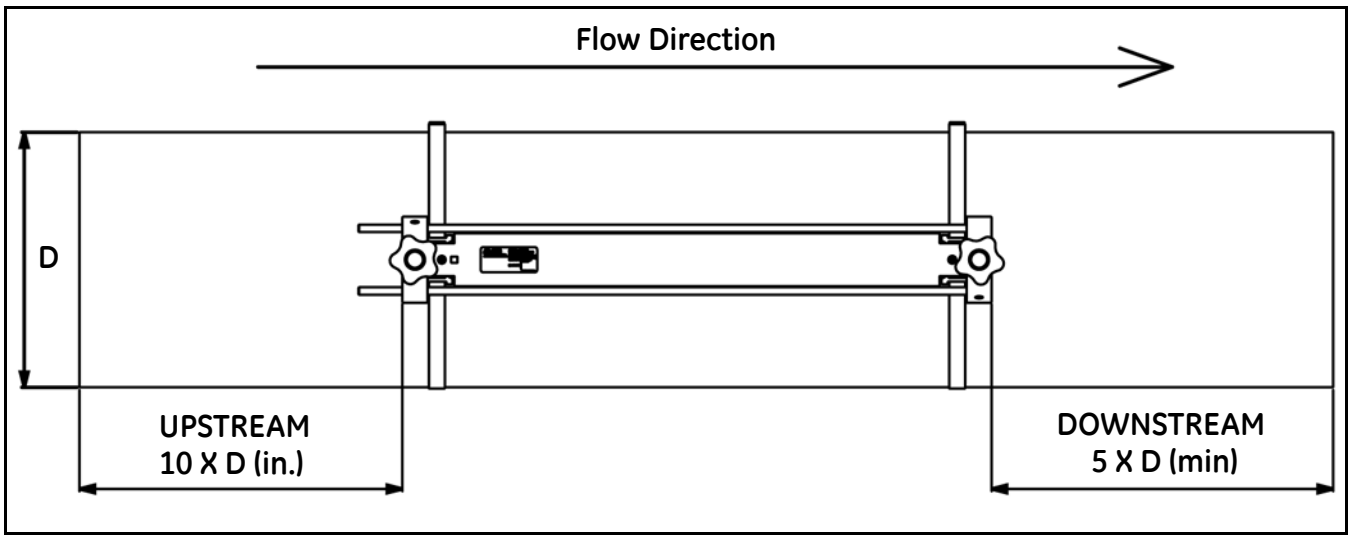


Figure 7: AT600 Transducer Location

- Locate the transducers on a common axial plane along the pipe. Locate the transducers on the side of the pipe, rather than the top or bottom, since the top of the pipe tends to accumulate gas and the bottom tends to accumulate sediment. Either condition will cause increased attenuation of the ultrasonic signal. There is no similar restriction with vertical pipes as long as the flow of fluids is upward to prevent free falling of the fluid of a less than full pipe.

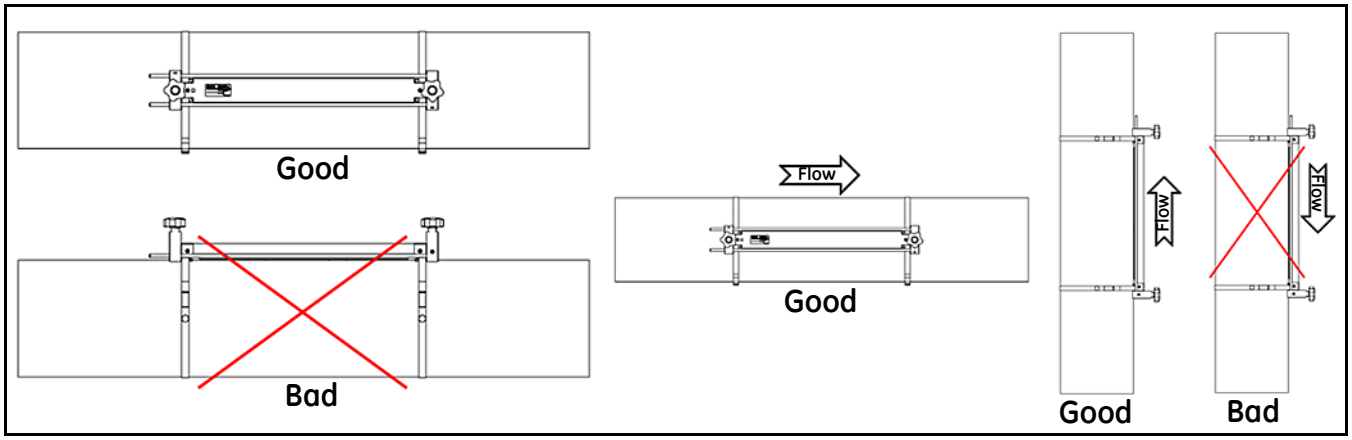


Figure 8: Good and Bad Transducer Locations

2.4.2 Mounting Clamp-on Fixture Onto Pipe (AT6 Transducers)

The AT600 transducer system contains one clamp-on fixture, two transducers embedded inside the fixture and one transducer cable. The transducer cable is already connected with the transducers and assembled with the fixture before shipment as a default setup for easy customer installation.

The AT600 clamp-on fixture and transducer system can support pipe size ranges from 2 inch to 24 inch.The customer can choose either dual traverse installation or single traverse installation for transducer mounting on the pipe.

As the maximum measurement range of one clamp-on fixture is 250mm, there are different kinds of installation configurations based on the transducer spacing range and dual or single installation method. See Table 1 below for rough estimates.

Table 1: Estimates for Pipe Configurations

Spacing	Traverse	Fixture	Typical Pipe Sizes
0-250	4	1	2" to 4"
0-250	2	1	4" to 10"
0-250	1	2	10" to 20"
250-750	2	2	10" to 30"
250-750	1	2	20" to 30"

Please see section 3.7 (Sensor Setup) for determining transducer spacing. A two traverse installation is recommended for most applications.

2.4.2a Dual Traverse Installation at Transducer Spacing Range 0 to 250mm

When the transducer spacing range is from 0 to 250mm, only one clamp-on fixture is needed for dual traverse installation. See Figure 11 on the next page for the dual traverse installation guide at transducer spacing range 0 to 250mm.

1. Install AT600 clamping fixture with transducers onto the pipe using the two mounting straps.
   a. Choose location with enough straight run; refer to Figure 7 on page 7.
   b. Install two straps onto the pipe with about 30 cm/1 ft apart.

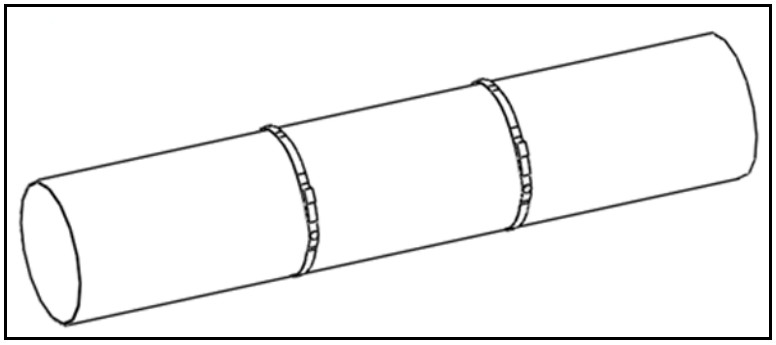


Figure 9: Strap Installation

2.4.2a Dual Traverse Installation at Transducer Spacing Range 0 to 250mm (cont.)

c. Put clamp-on fixture on pipe and move straps onto sides of fixture, then tighten screw on straps and validate strapping stays within sides of fixture.

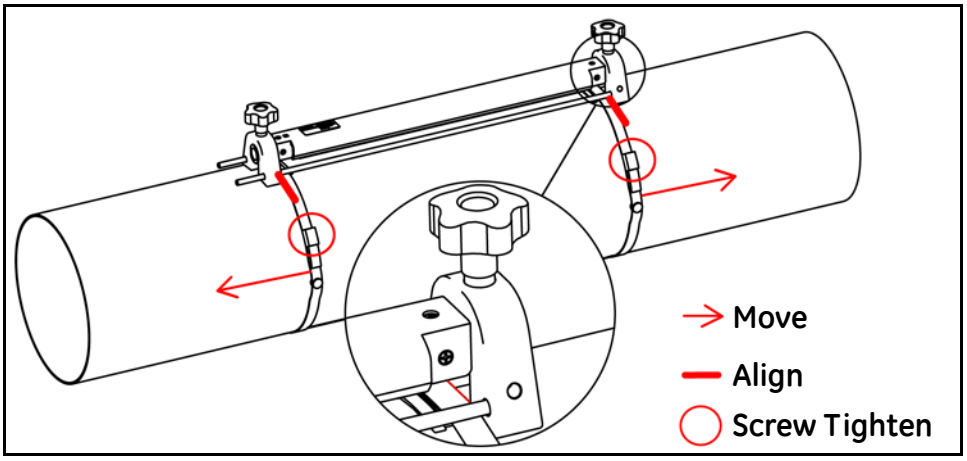


Figure 10: Clamp-on Fixture Installation

2. Wire power and transducer cables to the AT600; refer to Figure 22 on page 16.

3. Power meter and program flow meter to determine transducer spacing.(See *AT600 Programming* in Chapter 3.)

4. Set spacing between the two transducers and tighten back onto the pipe.

a. Loosen hand rails and rotate fixture so the transducers are in view.

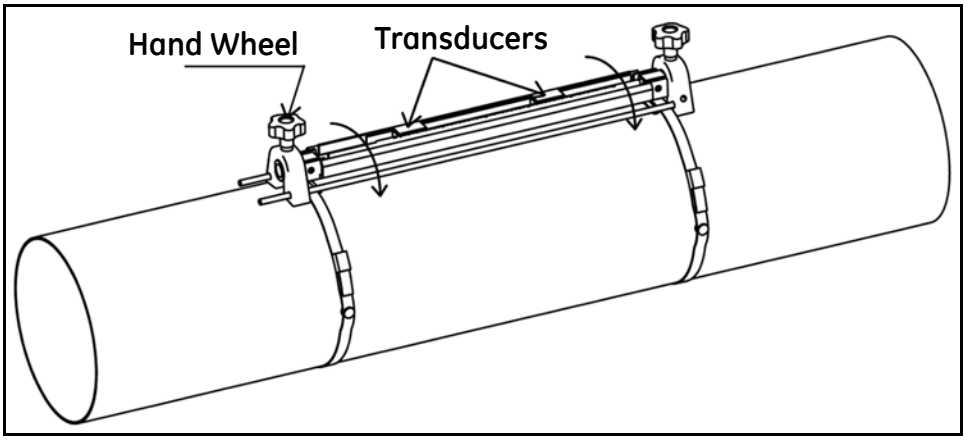


Figure 11: Transducer View

b. Set spacing between transducers, remove laminar piece on couplant, apply couplant to transducer and rotate back onto rail.

2.4.2a Dual Traverse Installation at Transducer Spacing Range 0 to 250mm (cont.)

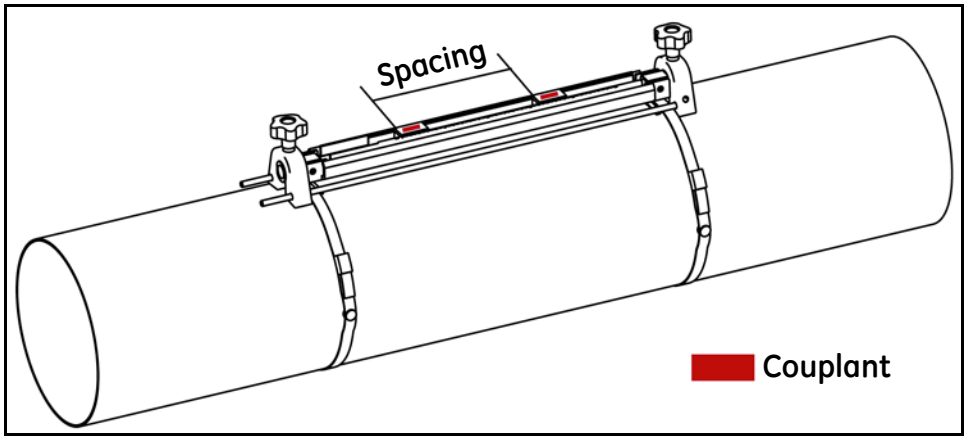


Figure 12: Transducer Spacing Adjustment

Note: *Two traverse (or two transducers in the same fixture) is the standard configuration. See the other configuration method below for fixture assembly procedure.*

Note: *If there is a coating or protection layer on the pipe, remove the coating layer on the pipe at first by rasping to expose the pipe material, where it is in contact with the transducer and couplant.*

2.4.2b Dual Traverse Installation at Transducer Spacing Range 250 to 750mm

When transducer spacing range is from 250 to 750mm, another fixture is needed for larger transducer spacing; see Figure 13 below for dual traverse installation guidance at transducer spacing range 250 to 750mm.

1. Install four straps onto the pipe with about 30 cm/1 ft apart from each other.
2. Put one clamp-on fixture with two transducers and one cable onto pipe and move straps onto sides of fixture, then tighten screw on straps and validate strapping stays within sides of fixture.
3. Put the second blank clamp-on fixture onto the pipe and connect the two fixtures through the bar on left side of the second fixture, then repeat step 2 to move the straps and tighten the second fixture.

Note: *Be sure the bar on the left side of the second fixture is in close contact with the bar on the first fixture.*

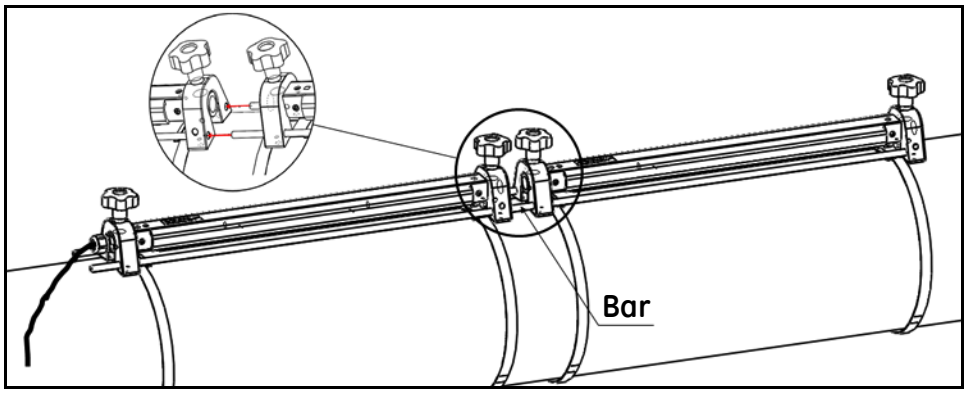


Figure 13: Dual Traverse Installation at Transducer Spacing Range 250 to 750mm

2.4.2b Dual Traverse Installation at Transducer Spacing Range 250 to 750mm (cont.)

4. Set spacing between the two transducers and tighten back onto the pipe.

   a. Loosen hand rails and rotate fixture so transducers are in view.

   b. Take out the downstream transducer from the first fixture, disassemble the transducer connection and route the cable into the second fixture and connect and locate the downstream transducer into the second fixture.

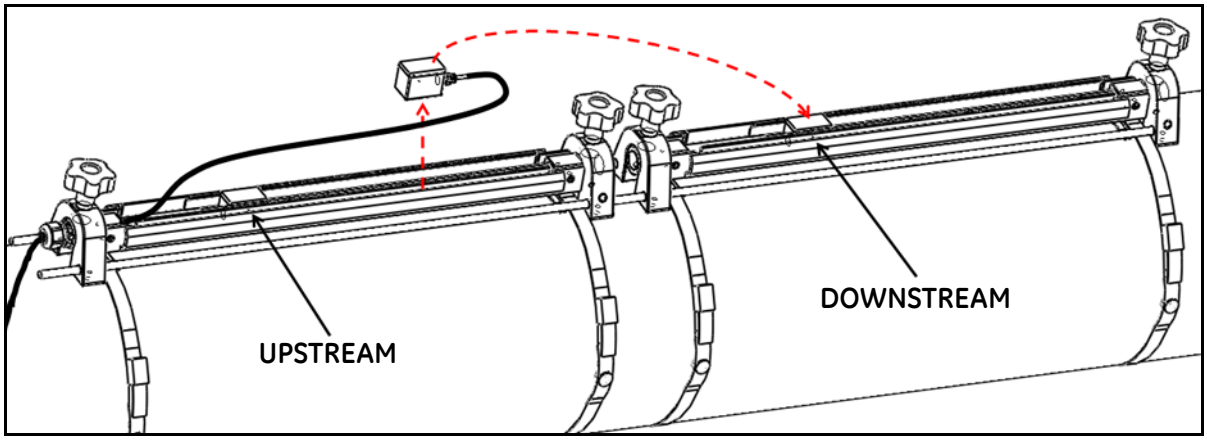


Figure 14: Dual Traverse Installation at Transducer Spacing Range 250 to 750mm

Note: *See detailed spacing set below for dual traverse installation:*

1. **Spacing range from 0 to 250mm; only one fixture is needed.**
   Put the upstream transducer at "zero" position, and then put the downstream transducer at the required position on the same fixture.

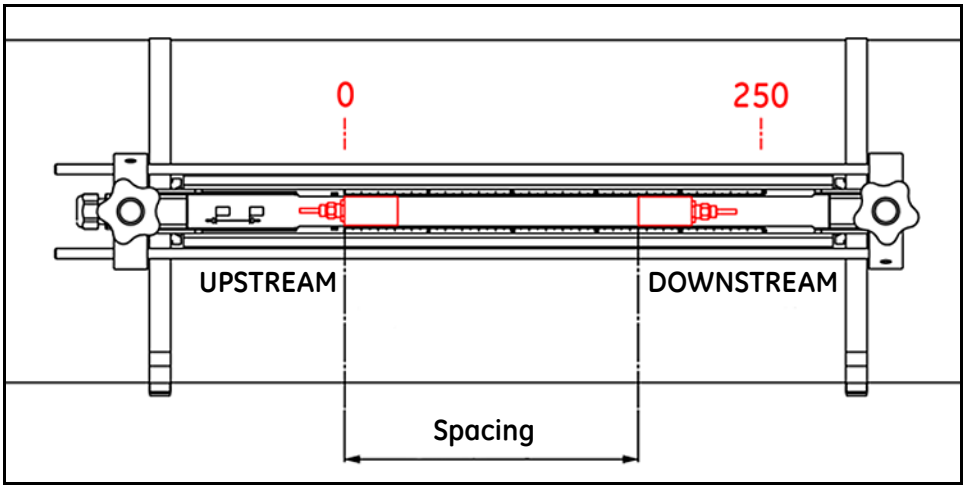


Figure 15: Transducer Spacing between the Two Fixtures

2.4.2b Dual Traverse Installation at Transducer Spacing Range 250 to 750mm (cont.)

2. **Spacing range from 250 to 750mm; two fixtures are needed, to be pushed:**

   a. Spacing from 250 to 500mm
   Put the upstream transducer at "250mm" position of the first fixture, and then put the downstream transducer at the required position on the second fixture, as shown below.

Note: *A tight contact should be made between two fixtures through the two bars to make an accurate spacing.*

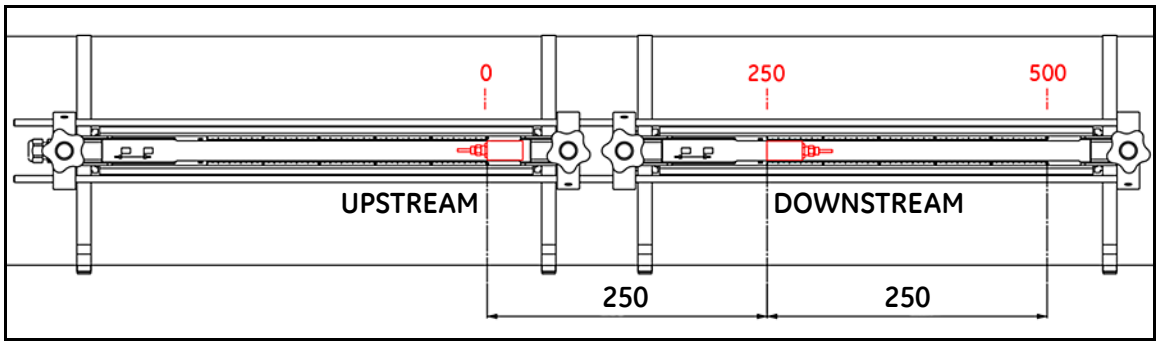


Figure 16: Spacing Range from 250 to 500mm

   b. Spacing from 500 to 750mm
   Put the upstream transducer at "zero" position of the first fixture, and then put the downstream transducer at the required position on the second fixture, as shown below.

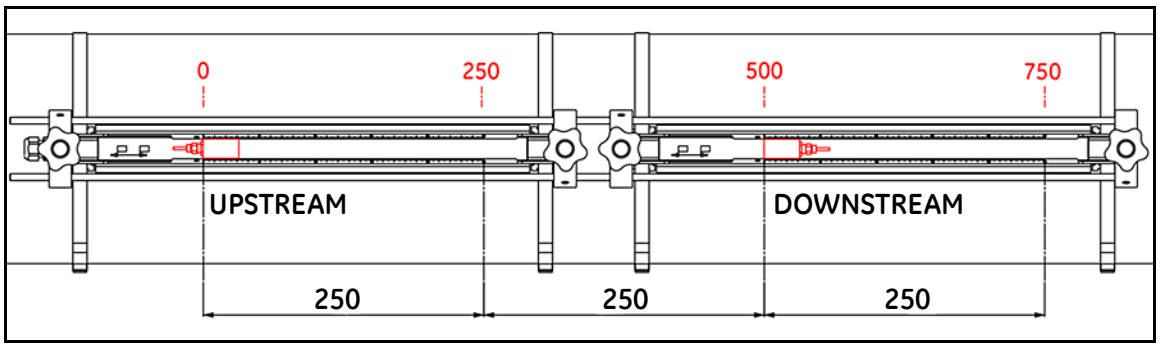


Figure 17: Spacing Range from 500 to 750mm

2.4.2c Single Traverse Installation at Transducer Spacing Range 0 to 250mm

When the transducer spacing range is from 0 to 250mm in a single traverse installation, two clamp-on fixtures are needed for this installation. See the steps below for the single traverse installation guide.

1. Mark one straight line parallel with the pipe direction on the pipe surface, use a band tape to measure the circumference of the pipe, and mark another two lines on position of +1/4 and -1/4 of circumference. This creates two lines for two fixture alignment.
2. Install two straps onto the pipe with about 30 cm/1 ft apart from each other.
3. Put one clamp-on fixture embedded with two transducers and one cable onto the pipe and move the two straps on two sides of the clamp-on fixture to catch the holder on the fixture, then put another blank fixture onto the opposite side of the first fixture and hold it by the two straps. Align the middle of the two fixtures with the red straight line marked on the pipe surface in step 1.

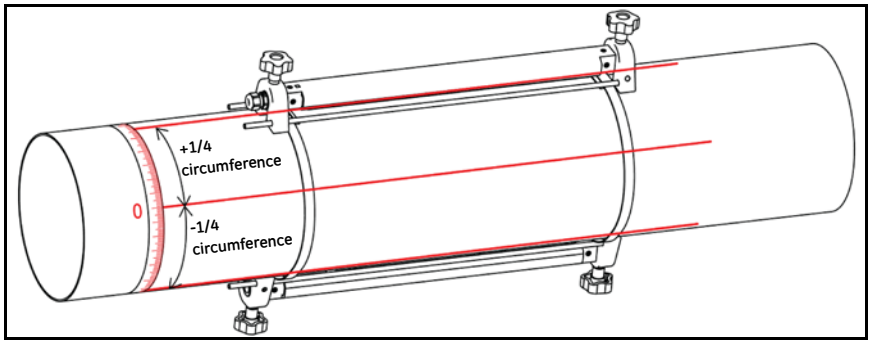


Figure 18: Fixture Installation of Single Traverse at Transducer Spacing Range 0 to 250mm

4. Set spacing between the two transducers and tighten back onto the pipe.
   a. Loosen hand rails and rotate fixture so transducers are in view.
   b. Take out the upstream transducer from the first fixture, disassemble the transducer connection and route the cable into the second fixture, and connect and re-locate the upstream transducer into the second fixture.

Note: *Put upstream transducer at "zero" position of the second fixture, and then move the downstream transducer at the required position of the first fixture. The separate cable of the upstream transducer needs to be pulled out from one side of rail on first fixture and put into the side of the rail on second fixture; refer to the cabling on the fixture done by the plant.*

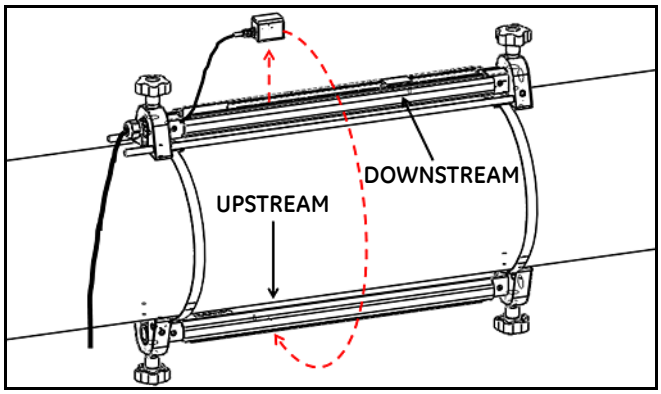


Figure 19: Single Traverse Installation at Transducer Spacing Range 0 to 250mm

2.4.2d Single Traverse Installation at Transducer Spacing Range 250 to 750mm

When transducer spacing range is from 250 to 750mm in a single traverse installation, two clamp-on fixtures range from 250 to 750mm.

1. Mark one straight line parallel with the pipe direction on pipe surface, use a band tape to measure the circumference of the pipe, and mark another two lines on position of +1/4 and -1/4 of circumference; these two lines are made for two fixture alignment. Then mark two transducer positions on the two straight lines separately using the band tape. Refer to Figure 20 for the line marking method.
2. Install four straps onto the pipe with about 30 cm/1 ft apart from each other.
3. Put one clamp-on fixture embedded with two transducers and one cable onto the pipe and move straps onto sides of fixture, then tighten screw on straps and validate the strapping stays within sides of fixture.
4. Put the second blank clamp-on fixture onto the pipe on another side, then repeat step 3 to move the straps and tighten the second fixture. Refer to Figure 20 for the fixture position.
5. Set spacing between the two transducers and tighten back onto the pipe.
   a. Loosen hand rails and rotate fixture so transducers are in view.
   b. Take out the upstream transducer from the first fixture, disassemble the transducer connection and route the cable into the second fixture and connect and re-locate the upstream transducer into the second fixture.
   c. Align the transducer side with the two marks done on step 1 in the first and second fixture.

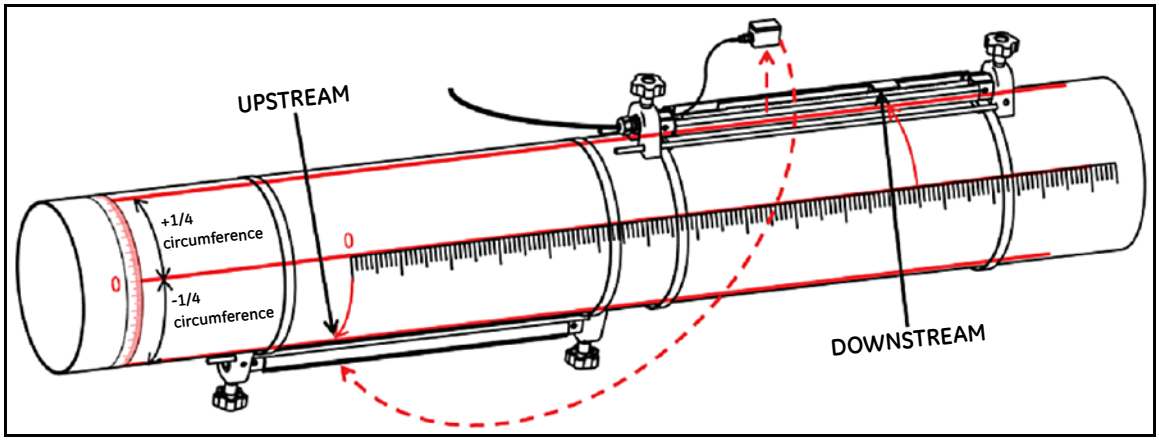


Figure 20: Single Traverse Installation at Transducer Spacing Range 250 to 750mm

2.5 Installing C-RS Fixture and Transducer System

2.5.1 Installation Guide for C-RS transducer

Refer to GE document 916-077, the *C-RS Installation Guide*, for C-RS transducer installation onto the pipe (Section 6, *Installing General Clamping Fixture*).

2.5.2 Install Cable Adaptor for C-RS transducer and AT6 cable

To match the BNC type connector on the C-RS transducer with the SMA type connector on the AT6 cable, one BNC to SMA adaptor is needed for C-RS transducer cabling. See *Figure 21* below for adaptor installation.

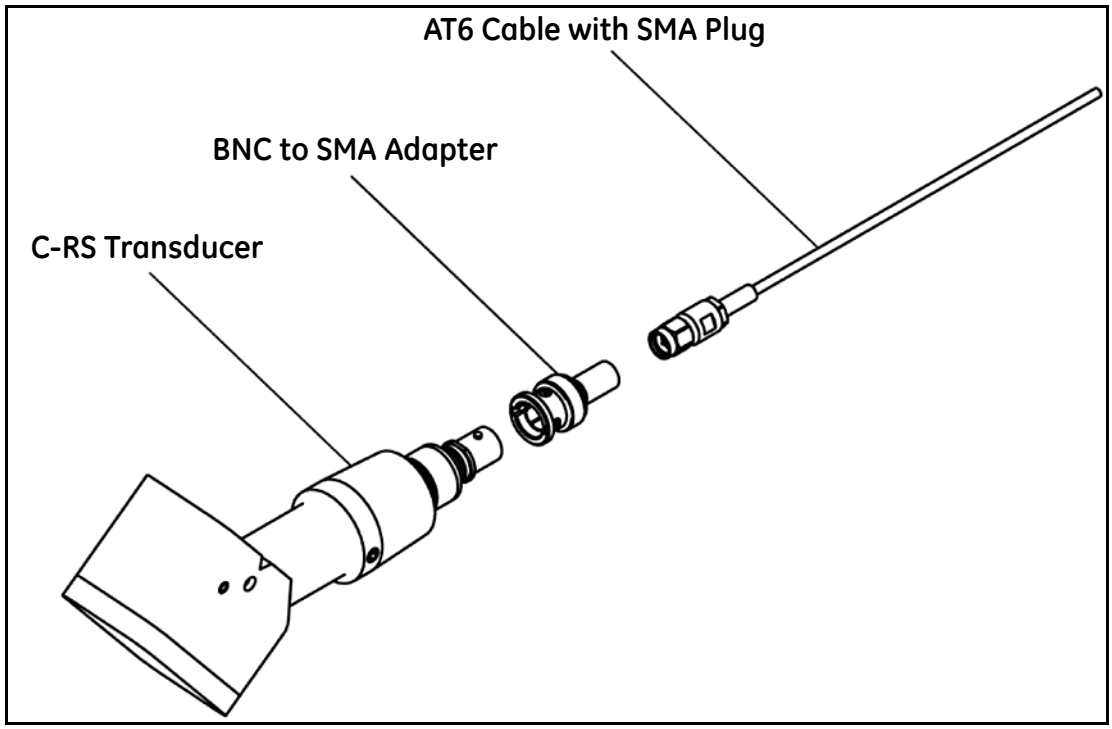


Figure 21: Install Cable Adaptor for C-RS Transducer

2.6 Making Electrical Connections

ATTENTION EUROPEAN CUSTOMERS! To meet CE Mark requirements, all cables must be installed as described in *"Wiring Cable Specifications and Requirements" on page 157*.

This section contains instruction for making all the necessary electrical connections to the AT600 flowmeter. Refer to Figure 22 below for the complete wiring diagram of the unit.

IMPORTANT: *Except for the transducer connector, all electrical connectors are stored in their terminal blocks during shipment and may be removed from the enclosure for more convenient wiring. Feed the cables through the cable gland holes on the bottom of the enclosure, attach the wires to the appropriate connectors and plug the connectors back into their terminal blocks.*

Once the AT600 is completely wired, proceed to Chapter 3, *Initial Setup*, to configure the unit for operation.

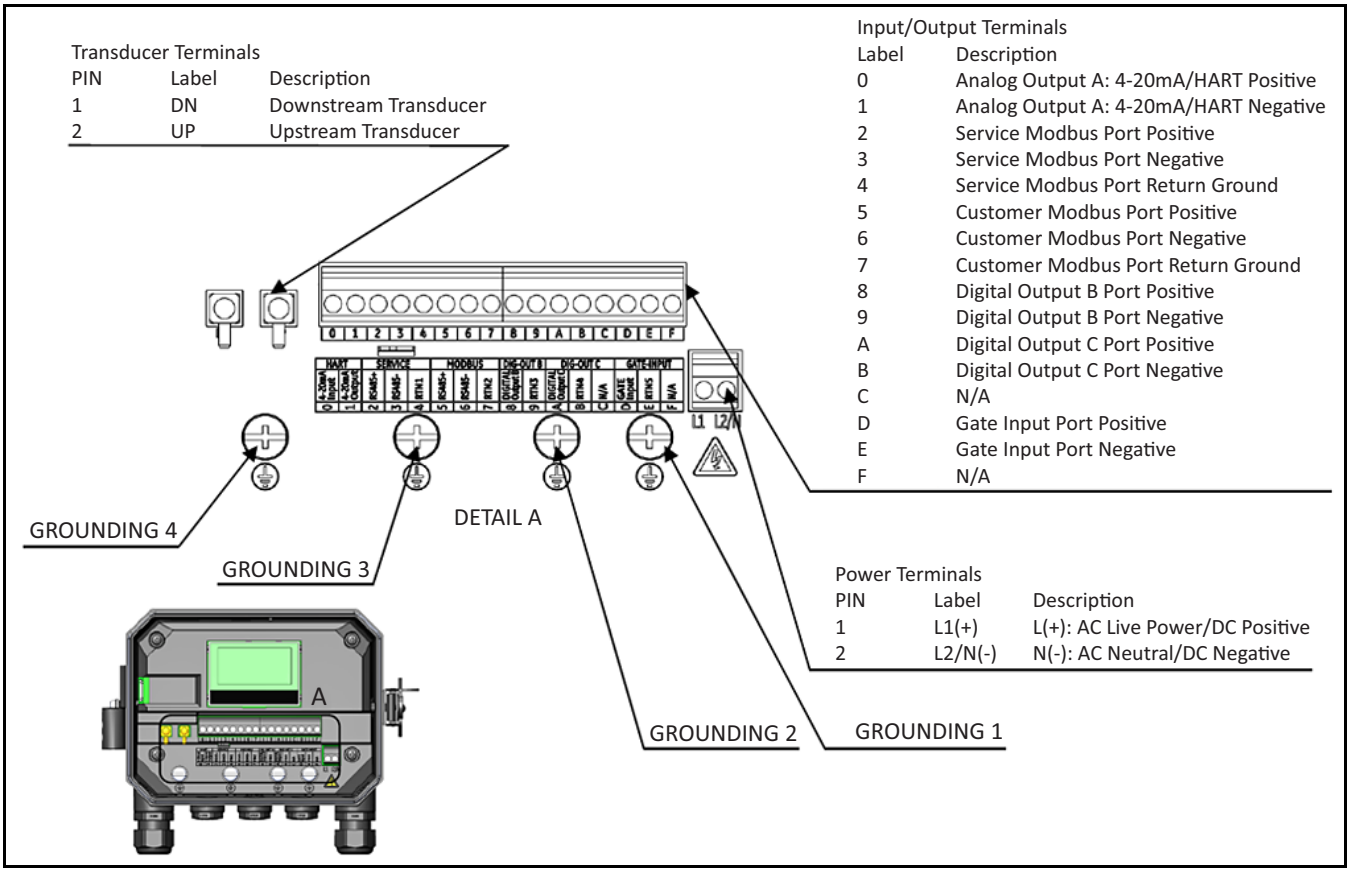


Figure 22: Wiring Diagram

Note: *HART or MODBUS communication are optional selections for the AT600 electronics and must be chosen at the time of ordering.*

To lead the wiring cables into the enclosure, power lines, transducer line and I/O lines are distributed to different gland holes. Refer to Appendix A, section A.2.10 for cable criteria. Be sure to select the cable to connect the meter only to the specified cables.

2.6 Making Electrical Connections (cont.)

Refer to Figure 23 below for cable gland usage definition. If no cables feed through the cable clamp holes, it must be blocked with the gland-insert provided together with meter.

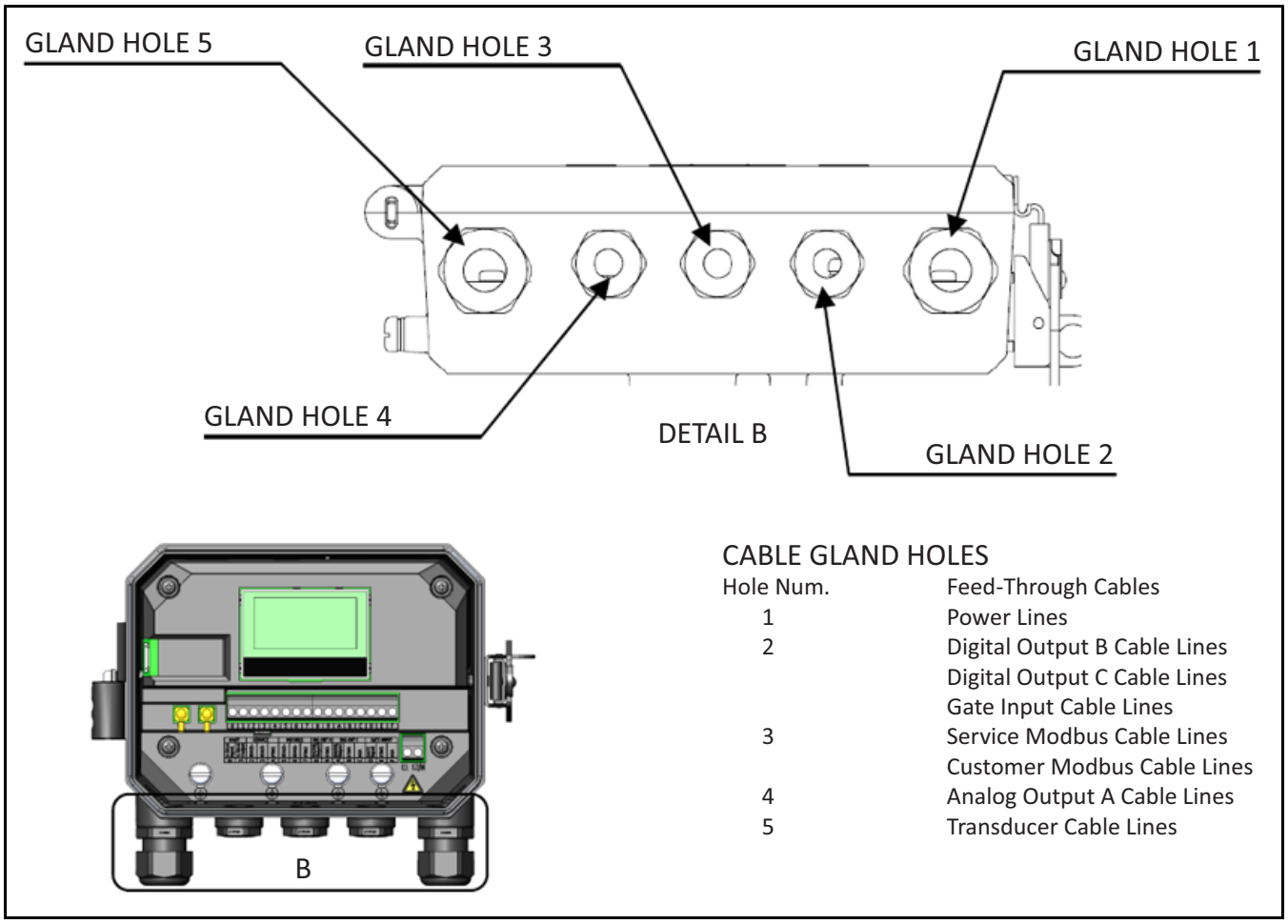


Figure 23: Gland Usage Definition

2.6.1 Wiring the Line Power

ATTENTION EUROPEAN CUSTOMERS! To meet CE Mark requirements, all cables must be installed as described in *"Wiring Cable Specifications and Requirements" on page 157*.

The AT600 may be ordered from operation with power inputs of 85-264 VAC, or 12-28 VDC. The label on the shroud inside the electronics enclosure, lists the required line voltage. Be sure to connect the meter only to the specified line voltage.

2.6.1 Wiring the Line Power (cont.)

Refer to Figure 24 below for power inputs of the meter.

Note: *For compliance with the European Union's Low Voltage Directive, this unit requires and external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the unit.*

Refer to Figure 22 on page 16 to locate the terminal block and connect the line power as follows:

WARNING! Improper connection of the line power leads or connecting the meter to the incorrect line voltage will damage the unit. It will also result in hazardous voltages at the flowcell and associated piping and within the electronics console.

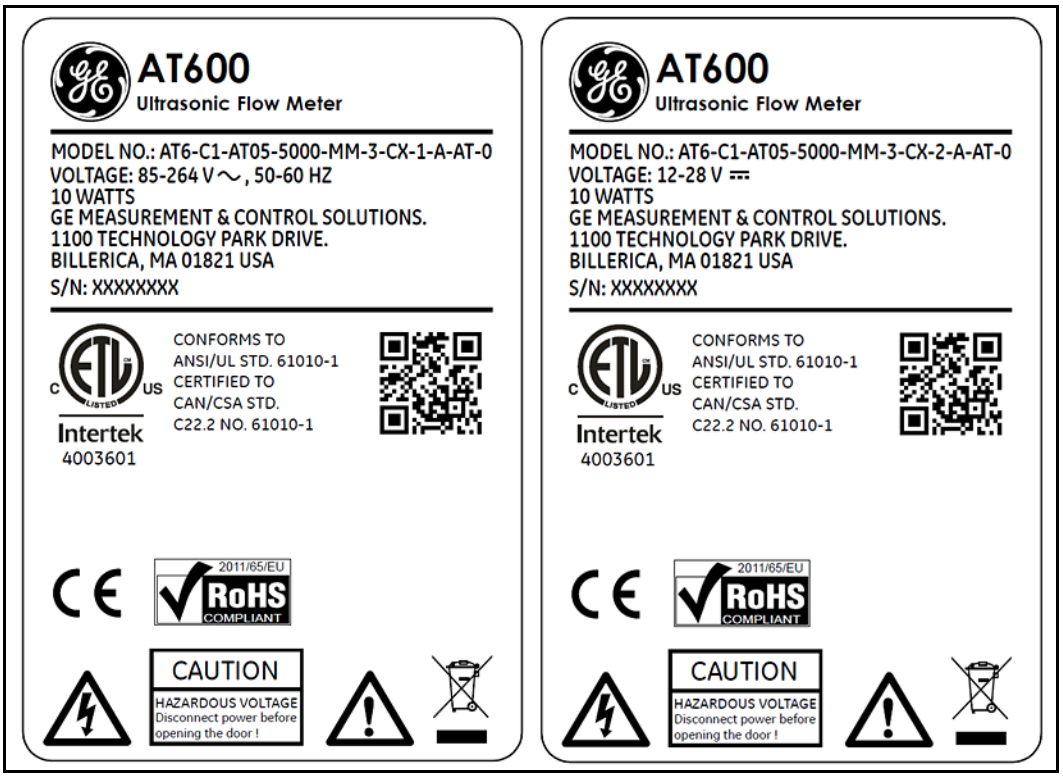


Figure 24: Meter SN Label Example (AC and DC Version):

1. Strip 1/4” of insulation from the end of the power and neutral or line leads (or the positive and negative DC power leads), and 1/2” from the end of the ground lead.
2. Connect the ground lead to the internal ground connection (GROUNDING 1) located on the bottom panel of the enclosure (See Figure 22).

IMPORTANT: *The incoming ground lead must be connected to the internal ground connection.*

3. Connect the neutral or line lead (or the negative - DC power lead) to L2/N(-) and the line power lead (or the positive +DC power lead) to L1(+) as shown in Figure 22 on page 16.

IMPORTANT: *Do not remove the existing PC board ground wire or the cover ground wire.*

2.6.2 Wiring the Transducers

ATTENTION EUROPEAN CUSTOMERS! To meet CE Mark requirements, all cables must be installed as described in *"Wiring Cable Specifications and Requirements" on page 157*.

Wiring a typical AT600 ultrasonic liquid flow meter system requires interconnection of the following components:

- A pair of transducers installed inside the fixture;
- The electronics console

To wire the transducers, complete the following steps:

WARNING! Before connecting the transducers, take them to a safe area and discharge any static build-up by shorting the center conductor of the transducer cables to the metal shield on the cable connector.

1. Locate the transducer cables and connect them to the two transducers.
2. Connect the cable connector with yellow "DN" jacket on the cable to DN and connect cable connector with white "UP" jacket on the cable to UP as shown in Figure 22 on page 16. Then, secure the cable gland.
3. Make vertical insertion when the cable connector is plugged into the receptacle to avoid destroying the connector.

2.6.3 Wiring System Ground

Proper system ground must be connected to an AT600 Meter. Refer to Figure 25 to locate the system ground screw. This ground screw must be connected to a safe ground in the field.

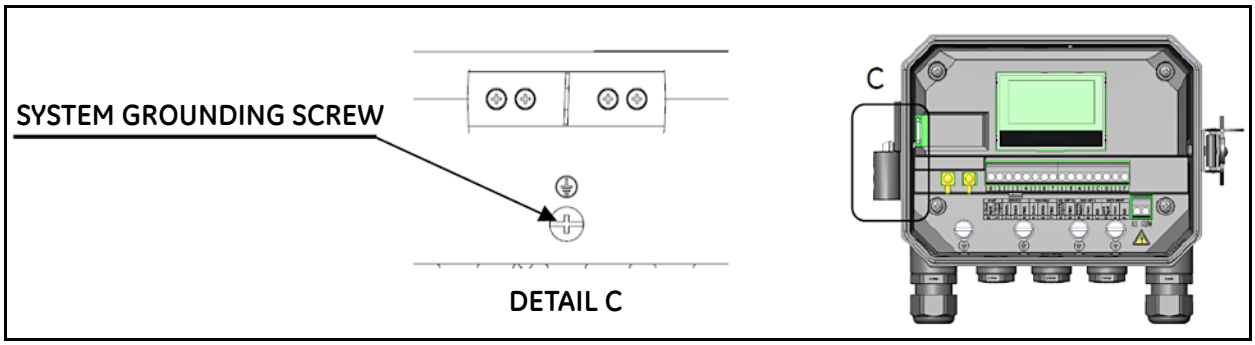


Figure 25: System Grounding Screw

2.6.4 Wiring Analog Output/HART Communication

The standard configuration of the Model AT600 flow meter includes one isolated 0/4-20mA analog output. Connections to this output may be made with standard twisted-pair wiring. The current loop impedance for this circuit must not exceed 600 ohms.

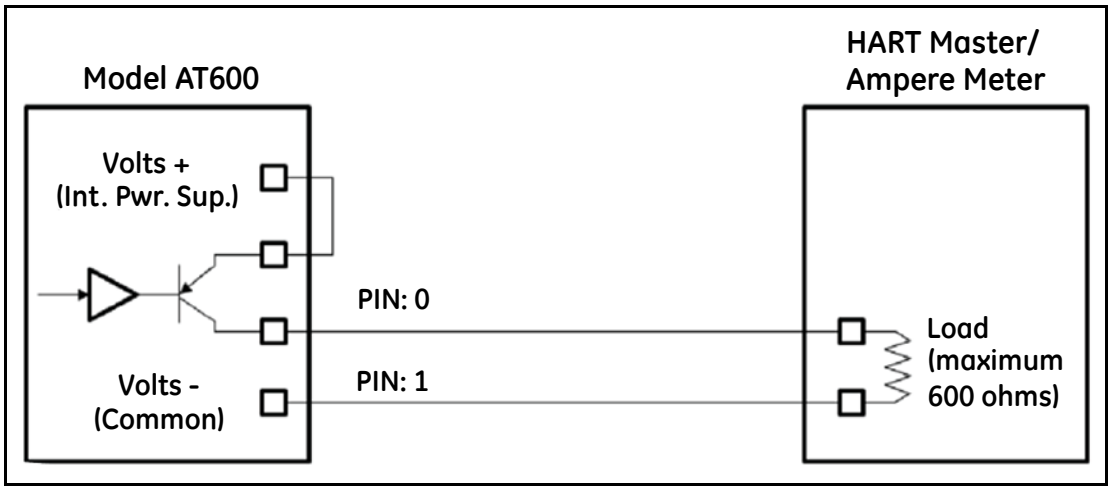


Figure 26: Analog Output/HART Communication

To wire the analog output, complete the following steps:

1. Disconnect the main power to the unit and open the enclosure.
2. Install the required cable gland in the chosen gland hole on the bottom of the enclosure.
3. Refer to Figure 22 on page 16 for the location of terminal block I/O and wire the terminal block as shown. Secure the cable clamp.

The standard port is only 0/4-20mA analog output, but the HART communication is optional upon request.

Note: *Analog Output is active mode. Do not supply a 24V supply to this circuit. The circuit is powered by the flow meter.*

Note: *Prior to use, the analog output must be set up and calibrated. Proceed to the next section to continue the initial wiring of the unit.*

Note: *When in meter configuration, the analog output will go to 3.6 mA. After exiting from configuration mode, the meter will leave 3.6 mA.*

2.6.5 Wiring Modbus Communication

The AT600 is equipped with an optional Modbus communication port. The port is a two-wire, half-duplex RS485 interface. The standard AT600 disables the Modbus communication. Proceed to the appropriate configuration for menu instructions to activate the Modbus communication.

To wiring Modbus RS485 serial port, refer to Figure 22 on page 16 and complete the following steps:

1. Disconnect the main power to the unit.
2. Install the required cable clamp in the chosen gland hole on the side of the electronics enclosure.
3. Feed one end of the cable through the gland hole, wire it to terminal block and secure the cable gland as shown in Figure 22 on page 16.

2.6.6 Wiring Frequency/Totalizer/Alarm Output

The AT600 can accommodate up to 2 channels of totalizer/frequency/alarm outputs. Each totalizer/frequency/alarm can be configured as totalizer, frequency or alarm output by software setting. Refer to section 3.6.4 for the output setting.

Each totalizer/frequency/alarm output requires two wires. Wire this terminal block in accordance with the pin number assignments shown in Figure 27 below. Figure 22 shows sample wiring diagrams of totalizer/frequency/alarm output circuit.

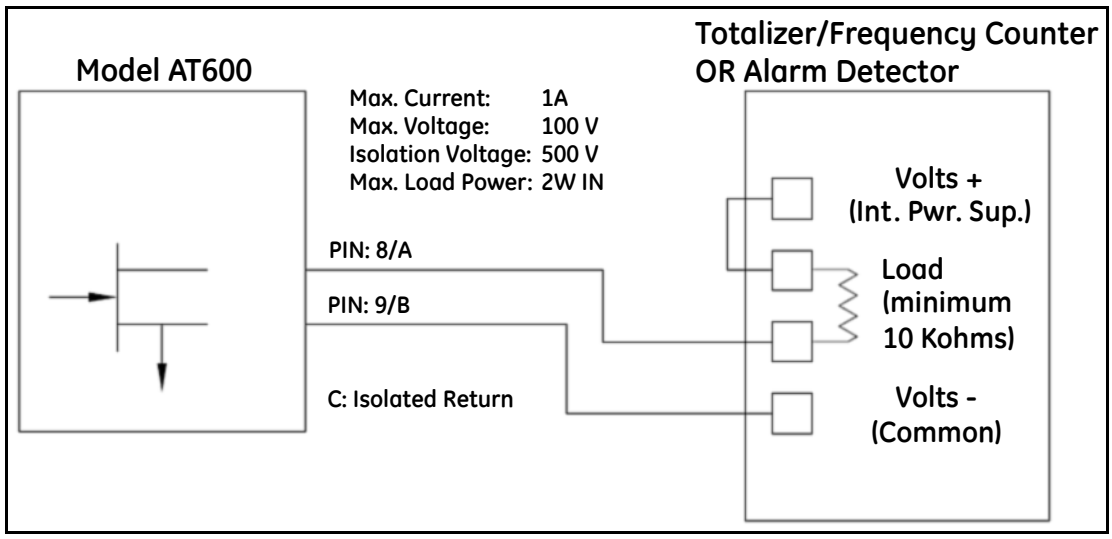


Figure 27: Totalizer/Frequency/Alarm Output Wiring

2.6.7 Wiring Gate Input

The AT600 provides a Gate Contact Input port. This port is designed to start/stop the totalizer. During normal measurement mode, an operator can start the totalizer functionality by clicking the switch. And if the operator wants to stop the totalizer, another switching ON/OFF action stops the totalizer.

Refer to Figure 28 below for wiring the Gate Input port.

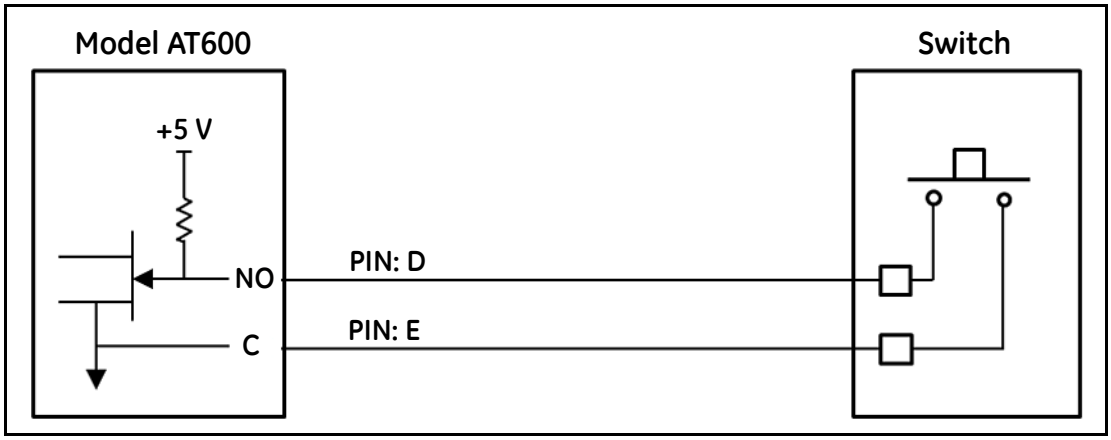


Figure 28: Gate Input Wiring

Chapter 3. Initial Setup and Programming

3.1 Introduction

This chapter provides instructions for programming the AT600 flowmeter to place it into operation. Before the AT600 can begin taking measurements, the User Preferences, Inputs/Outputs, and Sensor setup must be entered and tested.

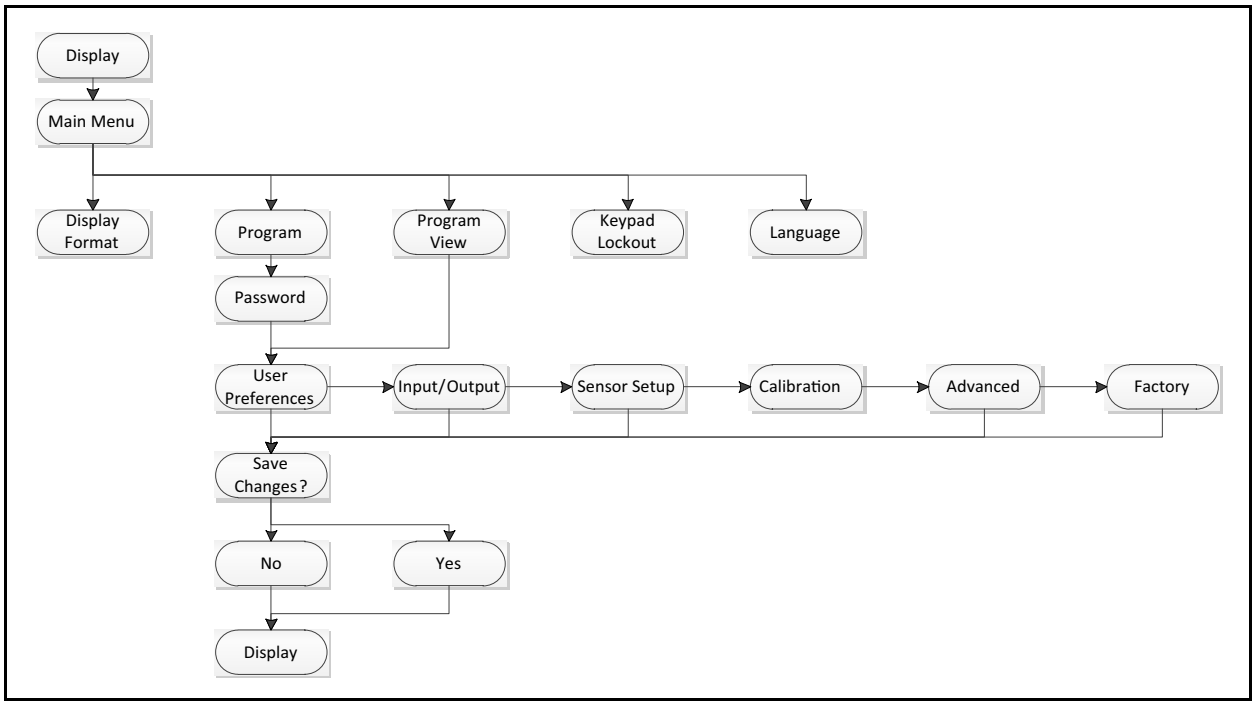


Figure 29: High Level Menu Map

3.2 AT600 Keypad Operation

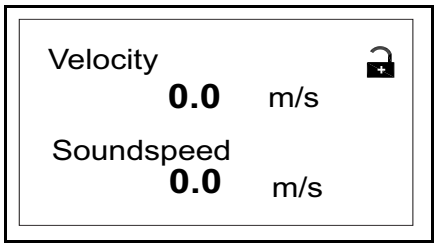
There are six keys and two LEDs on the AT600 keypad. The green light is a system health indicator and is on when the meter is operational and not in error. The red light is a system status indicator and is on when the meter is in error. Both lights being off indicates that the system is in configuration mode or no power has been applied to the meter.

Figure 30: AT600 Keypad

Six keys on the magnetic keypad enable users to program the AT600:

- [√] - confirms the choice of a specific option and data entry within the option
- [✕] - enables users to exit from a specific option without entering unconfirmed data
- [△] and [▽] - enable users to highlight a specific window in the display option or to scroll through a list of options (parameters, letters, and numbers, 0-9 as well as the negative sign and decimal point) in a menu
- [◁] and [▷] - enable users to scroll to a specific option, among choices in an option, or to a character in a text entry.

When the AT600 is powered up, the initial screen display appears, followed by a display of measurement parameters.



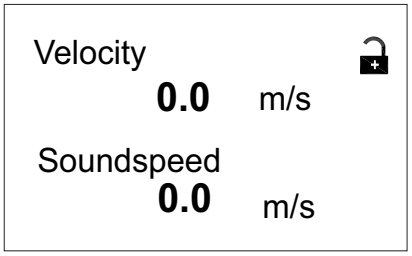
As a guide in following the programming instructions in this chapter, the relevant portions of the AT600 menu map have been reproduced on page 98.

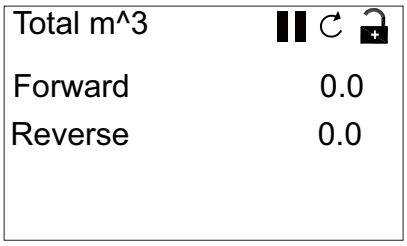
IMPORTANT: *If the keypad has not been pressed for 5 minutes, the AT600 exits the Keypad Program and returns to displaying measurements. The meter discards any configuration changes. Changes can only be retained after the user commits them.*

3.3 Display Programming

The AT600 keypad has six keys and two LEDs.

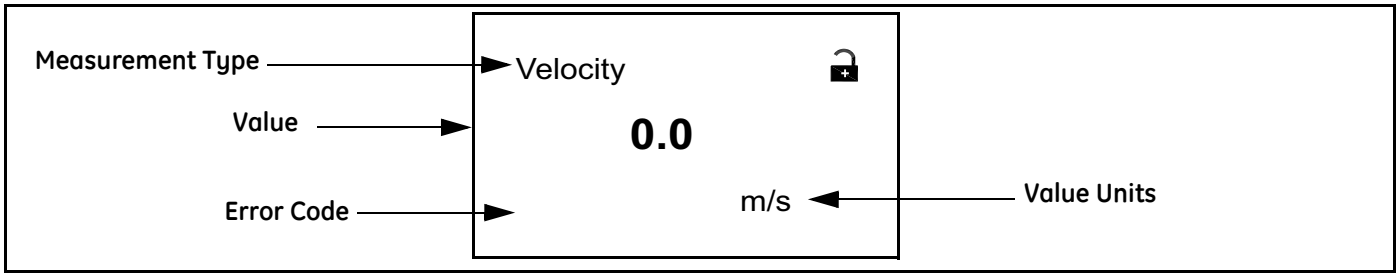
The green light is a system health indicator and it is on when the meter is operational and not in error. The red light is a system status indicator and it is on when the meter is in error. When both lights are off, the meter indicates the system is in configuration mode or no power has been applied to the meter.





3.3.1 Changing Value for One or Two-Variable Screens

An outline of a typical one or two-variable screen appears below.

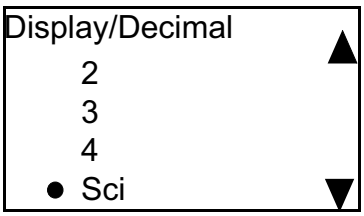


To change the number of decimal places in the displayed value:

From the display screen, press either the [◁] or [▷] buttons until the value is highlighted.

Once the value is highlighted, press [√] to open the Display/Decimal option.

3.3.1 Changing Value for One or Two-Variable Screens (cont.)

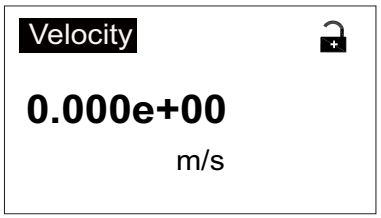


Use the [△] and [▽] buttons to scroll to the appropriate value. (Available options include 0, 1, 2, 3, 4, and Sci (Scientific Notation). Press [√] to select the value, and then [√] again to confirm the selection or [✕] to cancel the selection.

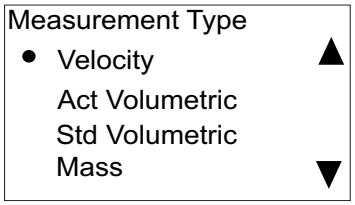
3.3.2 Changing Measurement Type for One- or Two-Variable Screens

To change the measurement type:

From the display screen, press either the [◁] or [▷] buttons until the measurement type is highlighted.



Once the value is highlighted, press [√] to open the Measurement Type option.



The screen changes to Display/Measurement Type. Press the [△] and [▽] buttons to scroll to the desired parameter. Available parameters include: Velocity, Act Volumetric, Std volumetric, Mass, Batch Totals, Inventory Totals, Soundspeed, Reynolds, KFactor, and Diagnostics. After you have chosen the measurement type, press [√] to select the value, and then [√] again to confirm the selection or [✕] to cancel the selection.

Note: *To select a particular measurement unit, go to "Units Setting" on page 28.*

3.3.3 Changing the Measurement Type or Value for Totalizer Screens

The totalizer screen appears similar to *Figure 31* below.

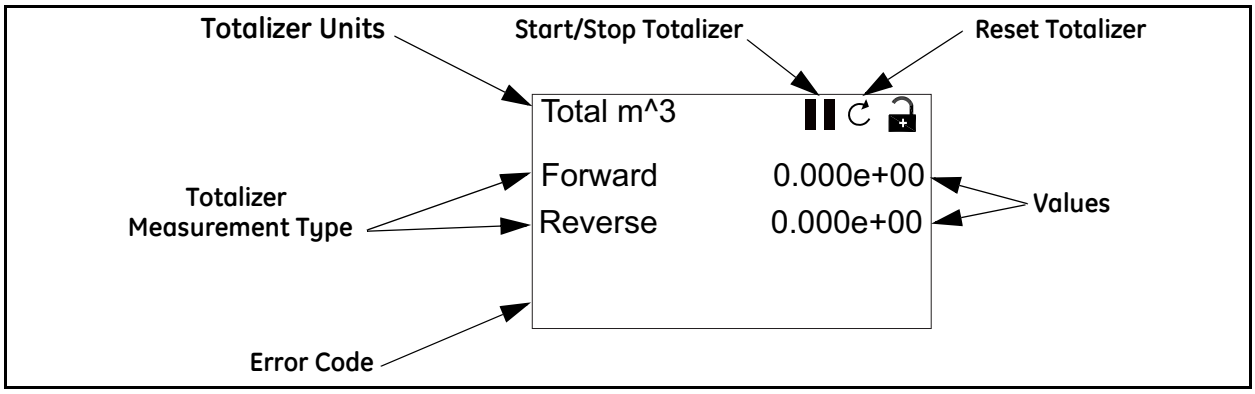
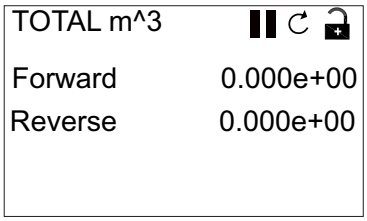
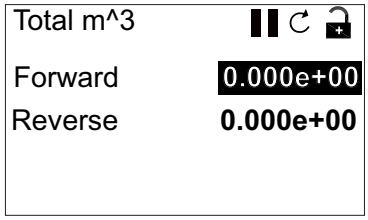


Figure 31: The Totalizer Screen

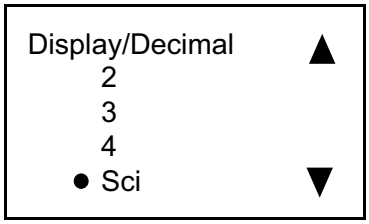
To change the number of decimal places in the value displayed on a totalizer screen, proceed as follows:



From the display screen, press either the [◁] or [▷] buttons until the value is highlighted.



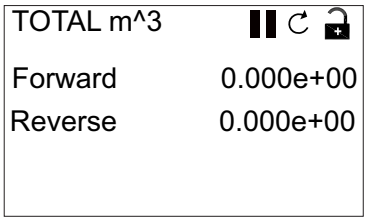
Once the value is highlighted, press [√] to open the Display/Decimal option.



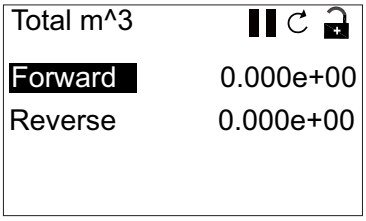
Use the [△] and [▽] buttons to scroll to the appropriate value. (Available options include 0, 1, 2, 3, 4, and Sci (Scientific Notation). Press [√] to select the value, and then [√] again to confirm the selection or [✕] to cancel the selection.

3.3.3 Changing the Measurement Type or Value for Totalizer Screens (cont.)

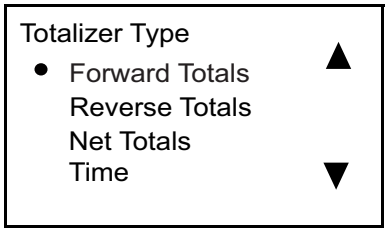
To change the totalizer measurement type, proceed as follows:



From the display screen, press either the [◁] or [▷] buttons until the measurement type is highlighted.

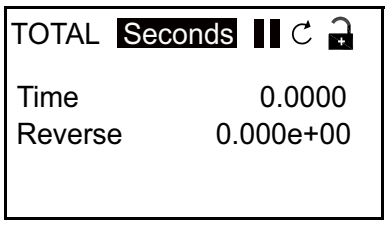


Once the type is highlighted, press [√] to open the Display/Decimal option.

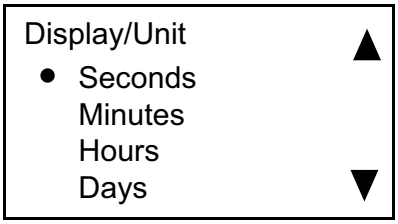


The screen changes to Totalizer Type. Press the [△] and [▽] buttons to scroll to the appropriate parameter. Available parameters include: Forward Totals, Reverse Totals, Net Totals and Time. Once you have chosen the type, press [√] to select the value, and then [√] again to confirm the selection or [✕] to cancel the selection.

If the first value is selected to Time, the unit will display the time unit. If the first value is selected to Forward Totals, Reverse Totals, Net Totals, the unit will be the selected unit in the "Units Setting" The available time measurement units are seconds, minutes, hours or days. To choose the appropriate unit, from the highlighted measurement type, press the [◁] or [▷] buttons until the measurement unit is highlighted.



Once the unit is highlighted, press [√] to open the Display/Unit option.

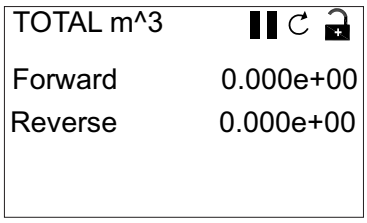


Press the [△] and [▽] buttons to scroll to the appropriate unit, and press [√] to select the unit, and then [√] again to confirm the selection or [✕] to cancel the selection.

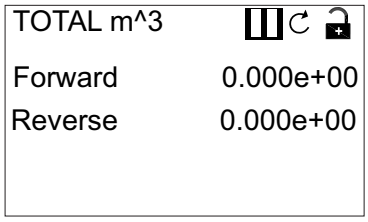
Note: *If you selected* "Time"*, the available units are seconds, minutes, hours and days.*

3.3.4 Starting or Stopping Totalizer Measurement

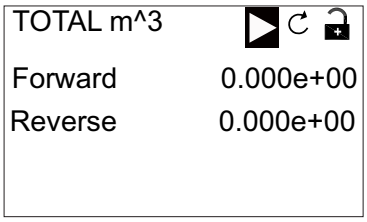
To start or stop totalizer measurements:



From the display, press either the [◁] or [▷] buttons until the Start/Stop icon (either an arrow icon for Start or a two-bar icon for Stop) is highlighted.



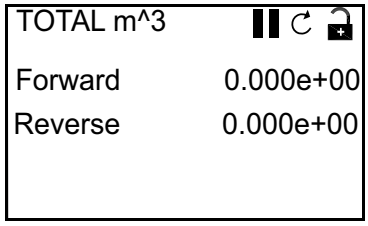
Once the value is highlighted, press [√] to start or stop totalizing.



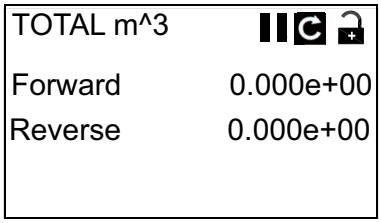
The icon then changes to indicate the new status (start or stop).

3.3.5 Resetting the Totalizer

To reset the totalizer, proceed as follows:



From the display screen, press either the [◁] or [▷] buttons until the Reset icon (a partial circle with an arrow) is highlighted.



Once the Reset icon has been highlighted, press [√] to reset the totalizer to 0.

3.4 Entering the Main Menu (Lock Button)

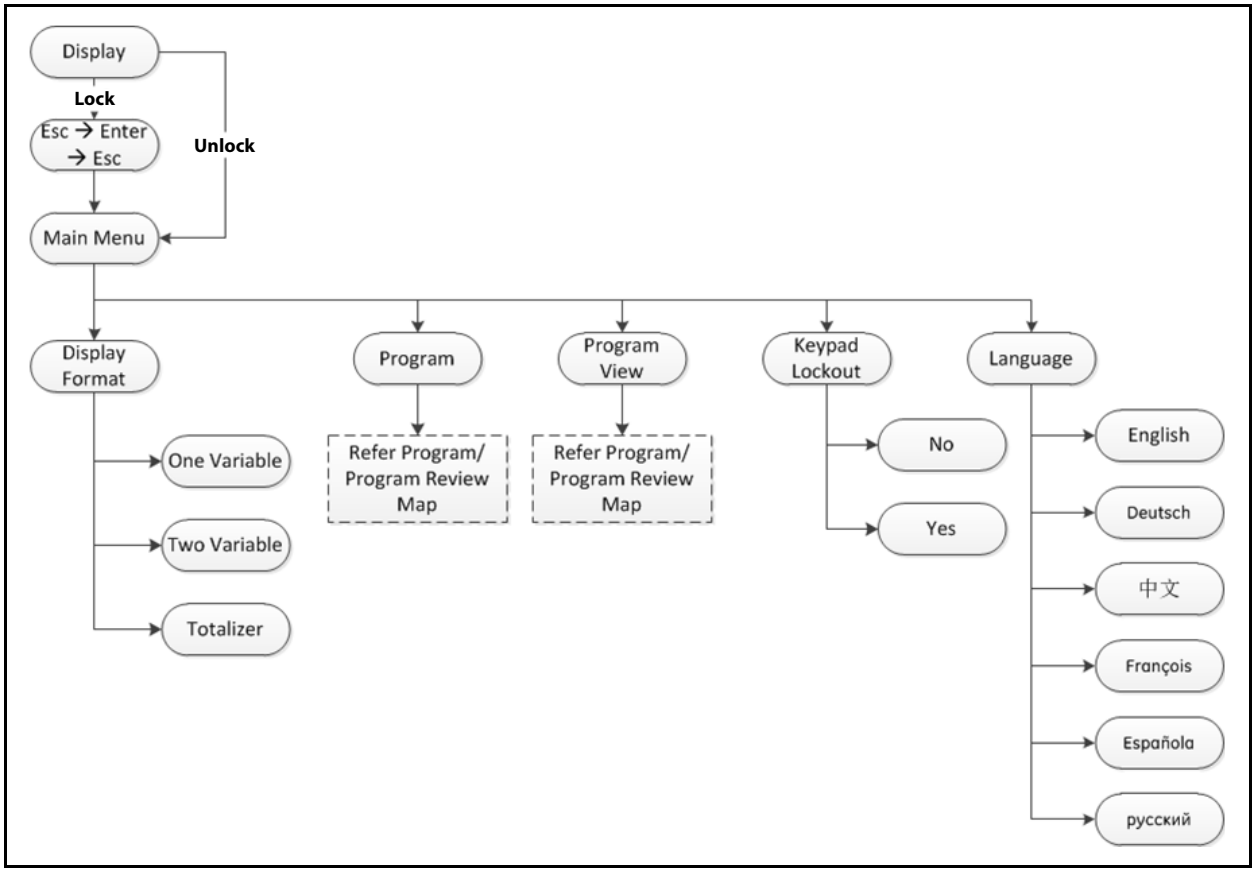


Figure 32: Main Menu Map

3.4.1 Display Format

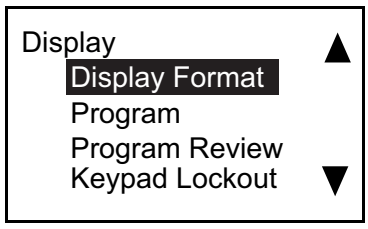
To begin programming your meter, you must select the system units as discussed below. Remember to record all programming data in Appendix B, *Data Records*.

The Display Format submenu is used to set up the type of format to be used in representing information.

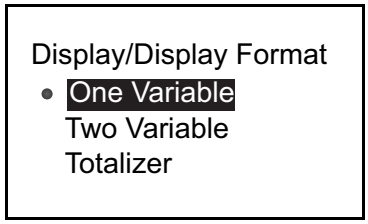
On the initial screen, use the arrow keys to highlight the lock symbol and press [√].

The following screen appears.

3.4.1 Display Format (cont.)

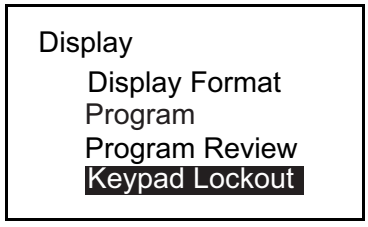


Use the [◁] or [▷] buttons to highlight Display Format and press [√]. The following screen appears.

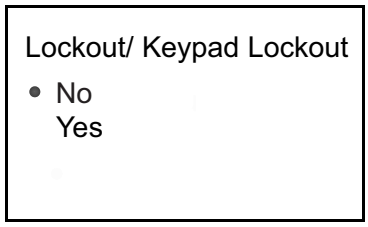


Use the [△] and [▽] arrow keys to highlight the desired format setup and press [√]. The window returns to the previous screen.

3.4.2 Keypad Lockout



To lock or unlock the keypad for security, on the Display menu, select Keypad Lockout and press [√]. A screen similar to the following appears.

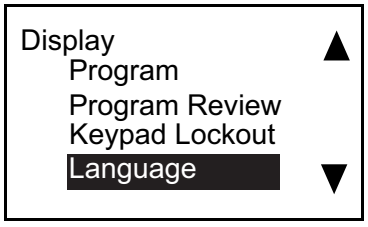


To lock the display, press [△] and [▽] to highlight **Yes** and press [√]. The screen returns to the previous display.

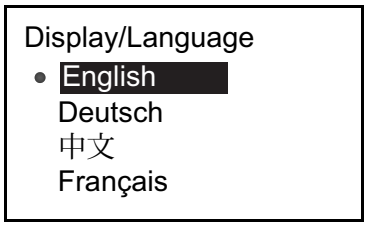
To unlock the display, press [△] and [▽] to highlight **No** and press [√]. The screen returns to the previous display.

Note: *When the keypad is locked, press* [✕], [√], [✕] *to unlock the screen.*

3.4.3 Language



To change the display language, on the Display menu, select Language and press [√]. A screen similar to the following appears.



Use the [△] and [▽] arrow keys to highlight the desired language and press [√]. The window returns to the previous screen and the displayed language will be changed online.

3.4.4 Program/Program Review

The Program and Program Review menus enable the setting up or viewing of several categories of information. As discussed previously, to edit parameters, you will need to input the right password. The next section will explicitly state which access is required to edit parameters. To view all parameters without editing, select Program Review.

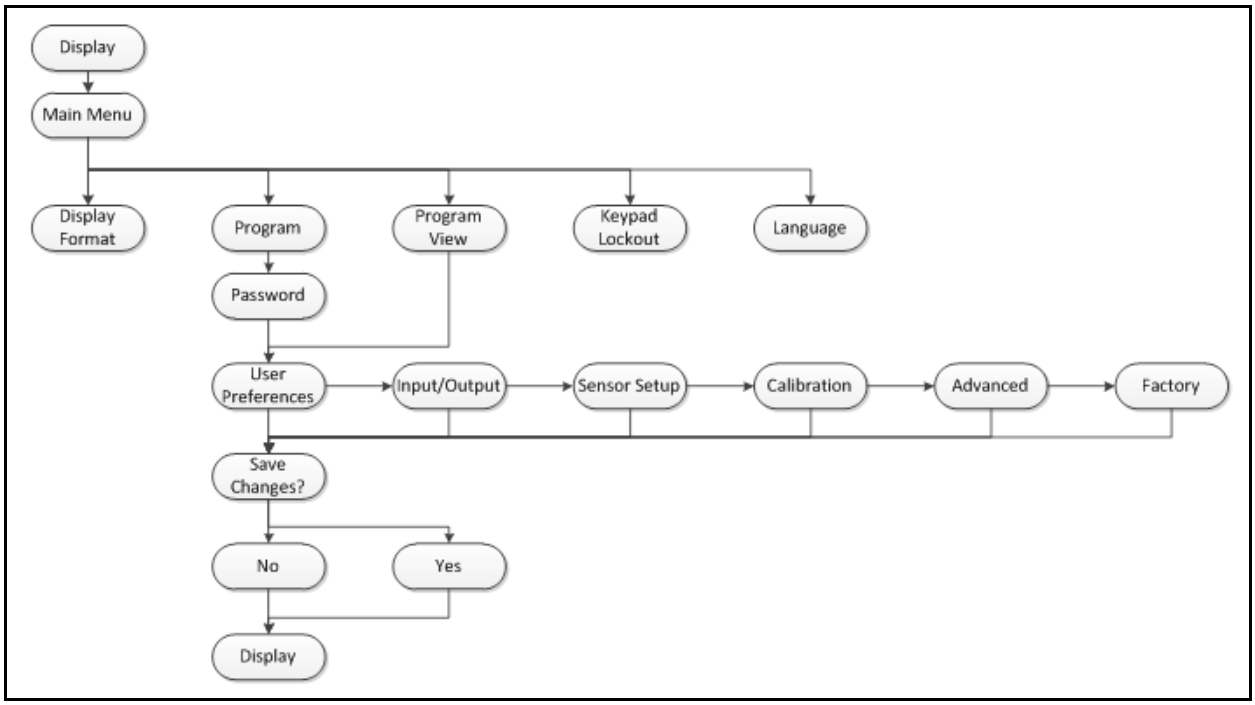


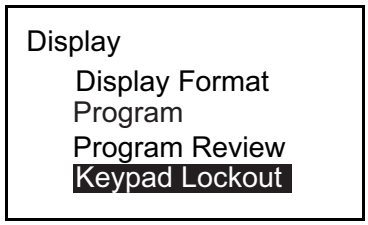
Figure 33: Program/Program Review Menu Map

3.4.5 Program Review

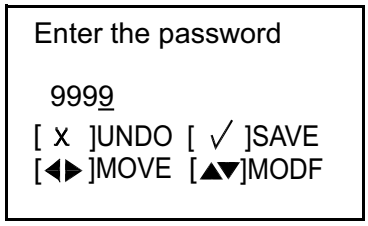
The Program Review menu requires no user password. However, it provides view-only access to the screens. To change any setting or parameter, you must enter the Program Menu and supply the correct password.

3.4.6 Program

IMPORTANT: *The measurement will stop and the output will go to error level when you enter Program (configure) mode.*



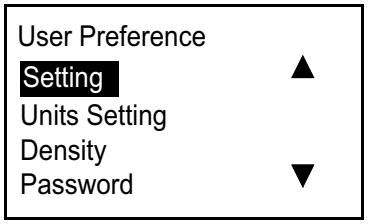
To enter the Programming menu, on the Display menu, use the arrow keys to highlight Program and press [√]. The following screen appears.



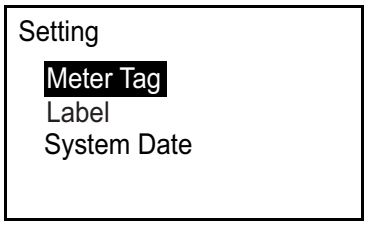
To enter the password, use the [◁] or [▷] arrow key to select each digit to be changed and the [△] or [▽] arrow keys to change the value of the selected number. When the password number is correct, press [√] and the User Preference screen appears. The password is **1111**.

3.5 User Preferences

3.5.1 Setting

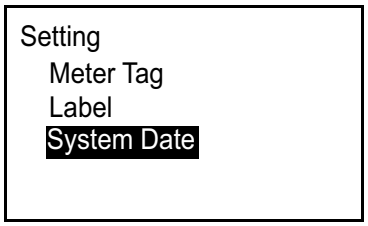


To check or change the desired settings, under User Preference, select Settings and press [√]. The following screen appears.

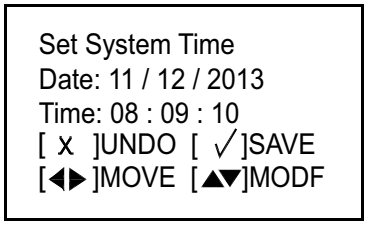


To check the Meter Tag and/or Label, highlight your choice on the Setting menu and press [√]. Press [✕] to return to the previous screen.

Note: *You can only change the Meter Tag and Label data using* Vitality software.

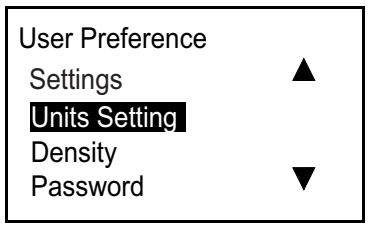


To check or change the date/time, highlight System Date and press [√]. The following screen appears.

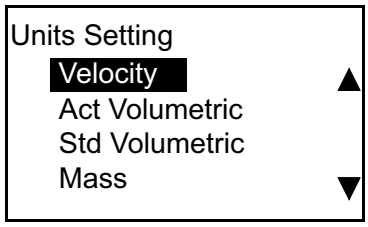


Use the [△] or [▽] arrow keys to select the correct time and press [√]. The screen returns to the previous display.

3.5.2 Units Setting

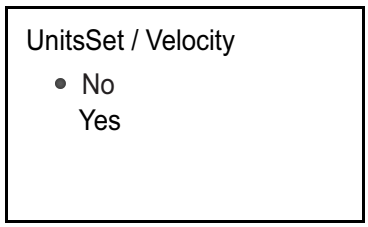


To check or change velocity flow units, under User Preference, use the [△] or [▽] arrow key to select Units Setting and press [√]. The following screen appears.

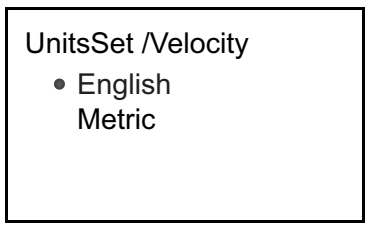


Under Units Setting menu, use the [△] or [▽] arrow key to select the unit that need to be changed and press [√] to reach the next level screen.

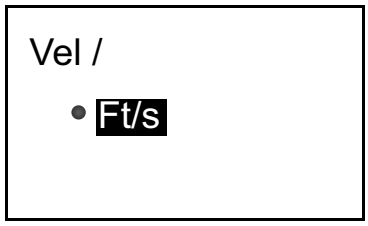
Note: *Select "Velocity" as an example.*



If you don't want to change the unit, select No and press [√]. If you do want to display the unit, select Yes, press[√] twice, and the following screen appears.

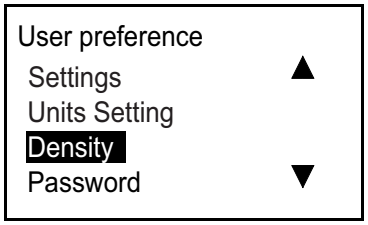


If no change is desired, press [✕] twice and the screen returns to the Units Setting menu. To change the measurement type, select the desired option, press [√] twice, and a screen similar to the following appears.

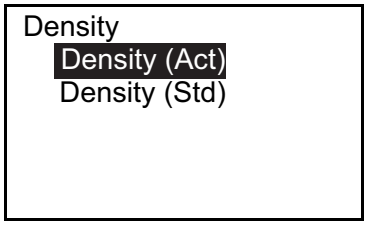


Confirm the selected units, press [✕] three times and return to the Units Setting menu.

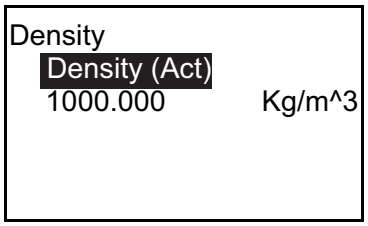
3.5.3 Density



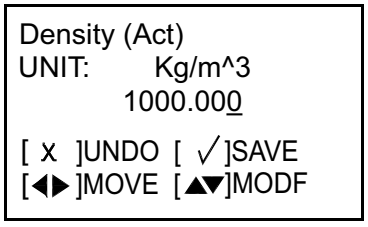
To configure flow density, under User Preference, use the [△] or [▽] arrow key to select Density and press [√]. The following screen appears.



Use the [△] or [▽] arrow keys to highlight the desired density type and press [√].

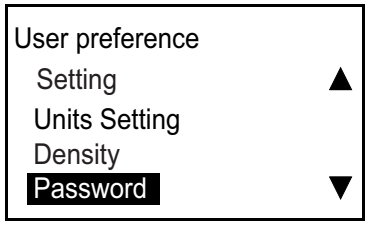


Press [√] again and a screen similar to the following appears.

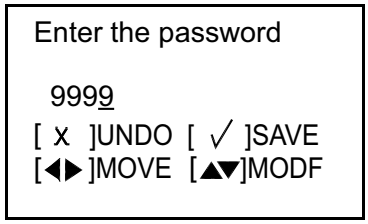


Use the arrow keys to select the correct density value and press [√]. The screen returns to the previous display.

3.5.4 Password



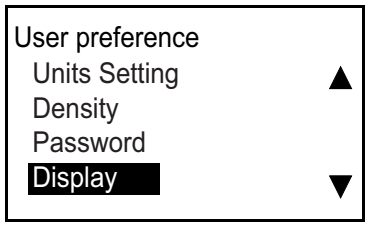
To set up a password, under User Preference, use the [△] or [▽] arrow key to select Password and press [√]. The following screen appears.



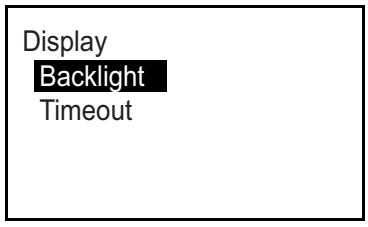
Use the [△] or [▽] arrow key to change the digit value and press [√]. Press the [✕] key to return to the Password screen.

3.5.5 Display

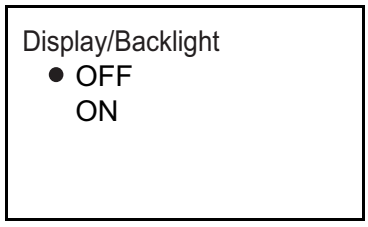
3.5.5a Backlight



To turn the backlight OFF or ON, under User Preference, use the [△] or [▽] arrow key to select Display and press [√]. The following screen appears.

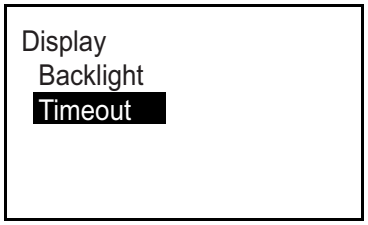


Select Backlight, press [√], and a screen similar to the following appears.



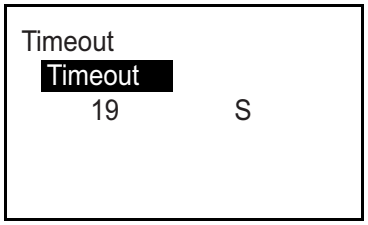
Select OFF or ON, press [√] twice, and the screen returns to the previous display.

3.5.5b Timeout

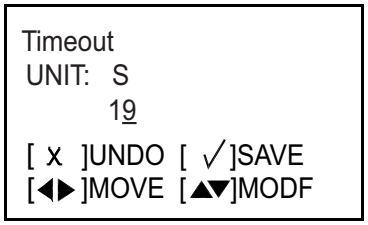


To provide a timeout, under Display, select Timeout and press [√]. A screen similar to the following appears.

Note: *The default value for the timeout is 0, so users must set a timeout if they wish one.*



Press [√] again, and a screen similar to the following appears.

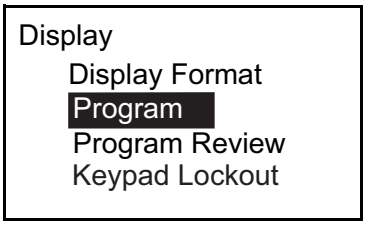


Use the [△] or [▽] arrow key to change the digit value and press [√]. Press [×] three times to return to the User Preference screen.

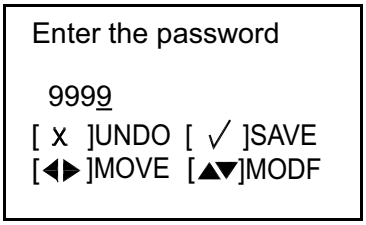
3.6 Inputs/Outputs

3.6.1 Programming the Analog Output Menu

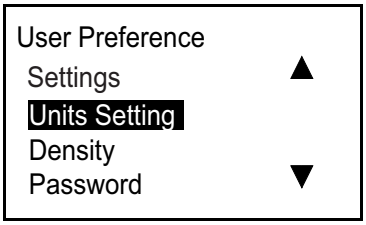
To access the Analog Output menu, on the initial screen, highlight the lock symbol and press [√]. The following screen appears.



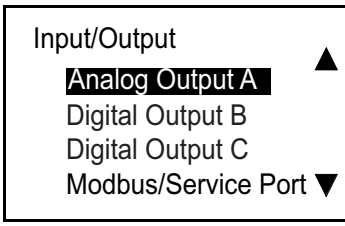
Select Program and press [√]. The following screen appears.



To enter the password, use the [◁] or [▷] arrow key to select each digit to be changed, use the [△] or [▽] arrow keys to change the value of each digit, and press [√]. The following screen appears.

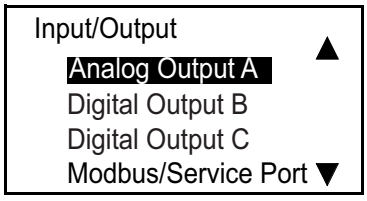


In the User Preference menu, select Units Setting and press the right arrow key. A screen similar to the following appears.

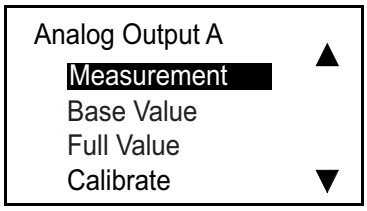


Select the desired Output number with the [△] or [▽] arrow keys, and press [√] to enter the relevant configuration menu.

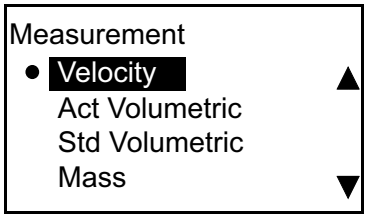
3.6.1a Setting Analog Measurements



Select the desired Output number with the [△] or [▽] arrow keys, and press [√] to enter the relevant configuration menu.

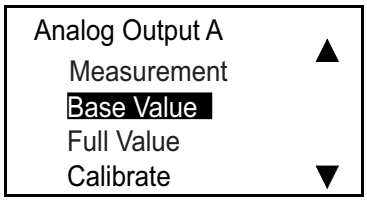


Select Measurement and press [√]. The following screen appears.

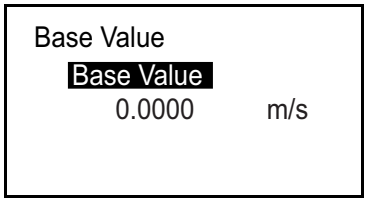


In the Measurement menu, select the type of analog output to be used, and press [√]. The screen returns to the previous display.

3.6.1b Setting Base Value and Full Value

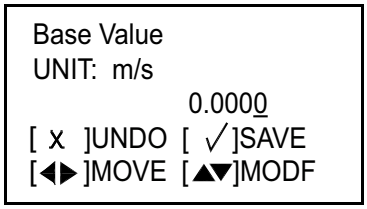


Base Value is the flow rate represented by 4 mA, and Full Value is the flow rate represented by 20 mA. In the Analog Output menu, select Base Value or Full Value and press [√]. A screen similar to the following appears.



Press [√] again and a screen similar to the following appears.

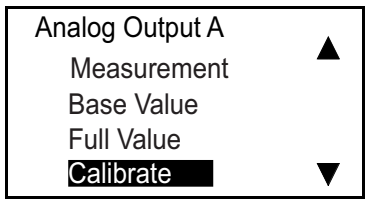
Note: *The units that appear will be the units selected in Units Setting on page 28.*



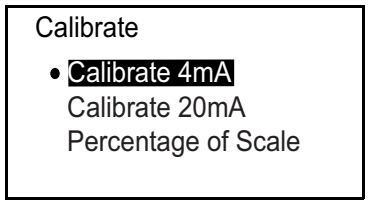
Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Base Value or Full Value and press [√].

Repeat these steps to set the Full Value setting. Press [✕] to return to the Analog Output A menu.

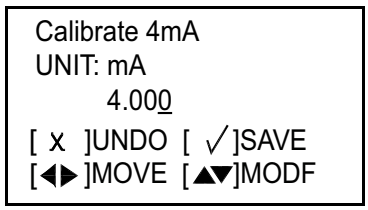
3.6.1c Calibrate the Output



Use the Calibrate menu to trim the analog output to your measurement system. In the Analog Output menu, select Calibrate and press [√]. A screen similar to the following appears.



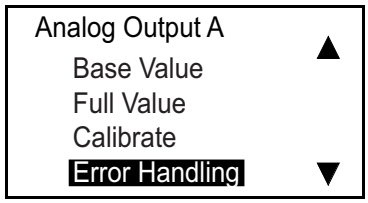
Select 4 mA to trim the 4 mA level, 20 mA to trim the 20 mA level, or Percentage of Scale to test linearity. Select the appropriate option and press [√]. A screen similar to the following appears.



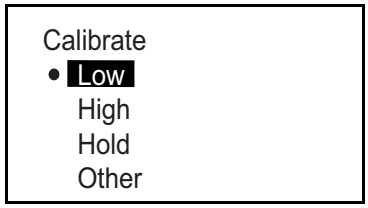
Read the analog output by a multimeter or other device. And input the current value.
Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Calibrate setting value and press [√]. Press [✕] to return to the previous display.

Repeat these steps until the output value is correct.

3.6.1d Setting Error Handling

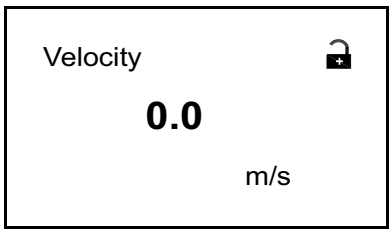


To specify the error handling status in the Analog Output A menu, select Error Handling and press [√]. The following screen appears.

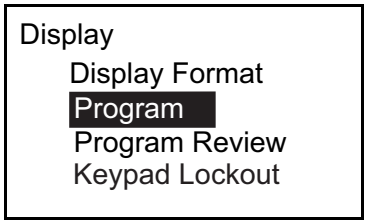


Selecting Low will force the Analog Output to 3.6 mA or below, while High will force it to 21.6 mA or above. Select the appropriate status and press [√].

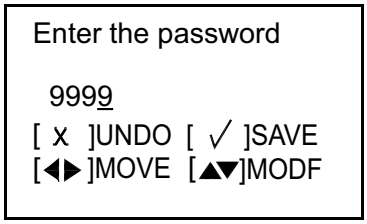
3.6.2 Programming the Digital Output Menu



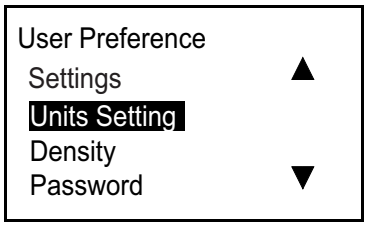
To access the Digital Output menu, on the initial screen, highlight the lock symbol and press [√]. The following screen appears.



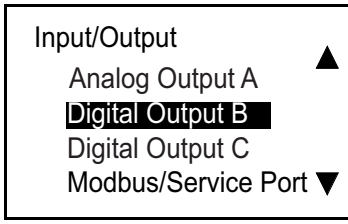
Select Program and press [√]. The following screen appears.



To enter the password, use the [◁] or [▷] arrow key to select each digit to be changed, use the [△] or [▽] arrow keys to change the value of each digit, and press [√]. The following screen appears.



In the User Preference menu, select Units Setting and press the right arrow key. A screen similar to the following appears.

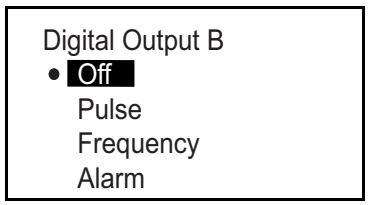


Select the desired Digital Output number with the [△] or [▽] arrow keys, and press [√] to enter the relevant configuration menu.

Note: *The operation steps for "Digital Output B" and "Digital Output C" are the same.*

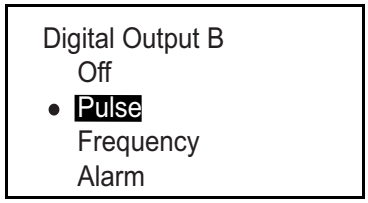
Digital outputs can be programmed as Pulse, Frequency or Alarm, or turned off.

3.6.2a Disable the Digital Output



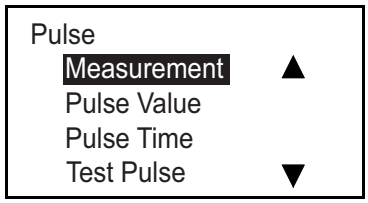
To specify the error handling status in the Digital Output B menu, select Off and press [√] twice.

3.6.2b Setting the Pulse Output

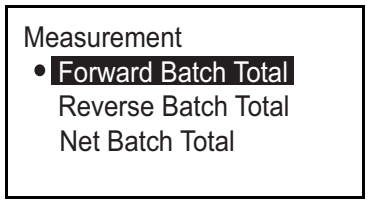


The Pulse output will put out a square wave pulse for each unit of flow that passes through the pipeline. Select Pulse and press [√]. The following screen appears.

Setting Measurement Type

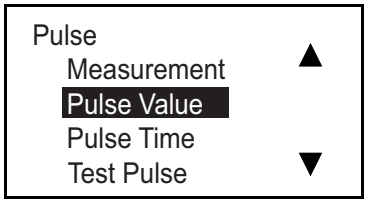


Select Measurement and press [√]. A screen similar to the following appears.

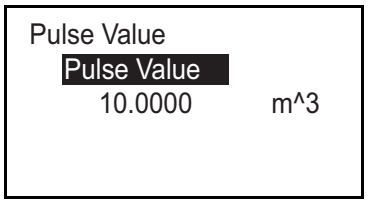


In the Measurement menu, select the type of analog output to be used, and press [√]. The screen returns to the previous display.

Setting Pulse Value

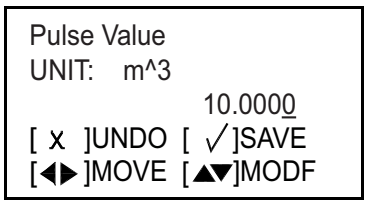


Use the [△] or [▽] arrow keys to select Pulse Value and press [√]. A screen similar to the following appears.



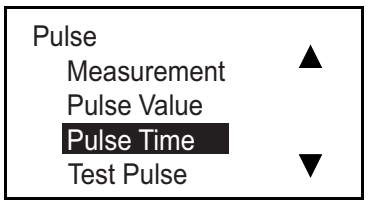
The Pulse Value, the amount of flow represented by one pulse, is displayed. (For example, 1 pulse = 10 m^3.) To change the existing number, press [√] and a screen similar to the following appears.

Note: *The units that appear will be the units selected in Units setting on page 28.*

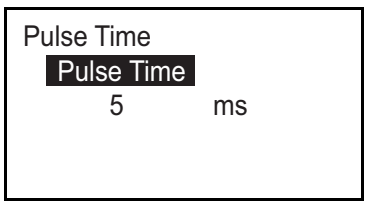


To change the Pulse Value, use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to provide a new number and press [√] to save. Press [√] to return to the Pulse menu.

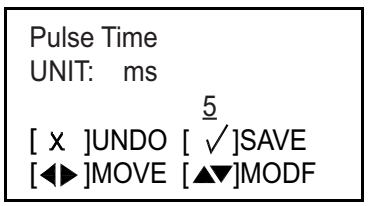
Setting Pulse Time



Use the [△] or [▽] arrow keys to select Pulse Time and press [√]. A screen similar to the following appears.

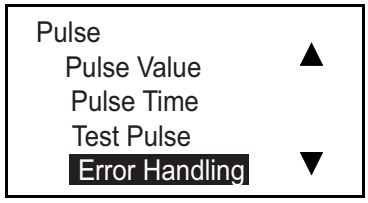


The Pulse Time, pulse width, is displayed. To change the existing number, press [√] and a screen similar to the following appears.

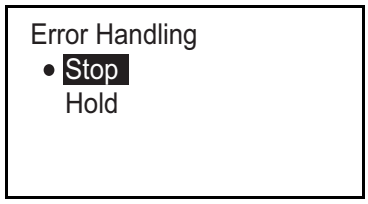


To change the Pulse Time, use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to provide a new number and press [√] to save. Press [√] to return to the Pulse menu.

Setting Pulse Error Handling



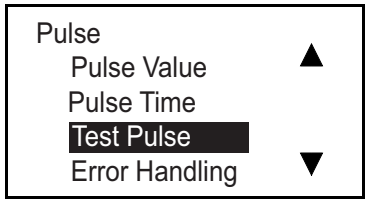
To change the Error Handling status, select it on the screen and press [√]. The following screen appears.



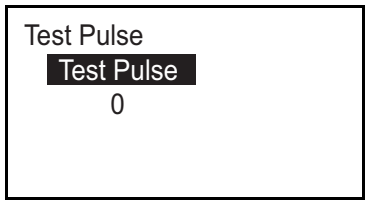
Select Hold or Stop. Hold directs the meter, in case of a flow measurement error, to keep sending the pulses sent at the last good reading. Stop directs the meter, in case of measurement error, to stop pulsing.

Press [√], and the screen returns to the previous display. Press [✕] to return to the Digital Output menu.

Test Pulse

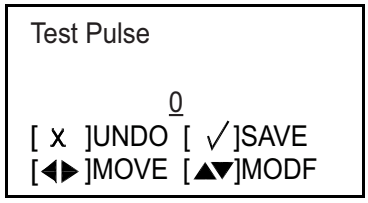


To test the pulse output, select Test Pulse and press [√]. The following screen appears.



Press [√]. A screen similar to the following appears.

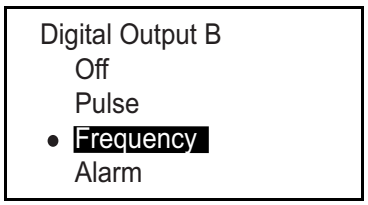
Press [√], and the screen returns to the previous display. Press [✕] to return to the Digital Output menu.



Enter a number of pulses and the instrument will send that many out. Note on your measurement system that the right number of pulses were received.

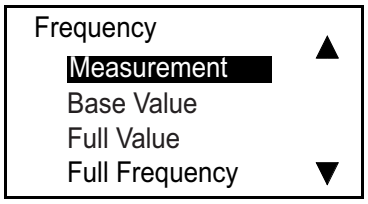
After testing, press [✕] to return to the Digital Output menu.

3.6.2c Setting the Frequency

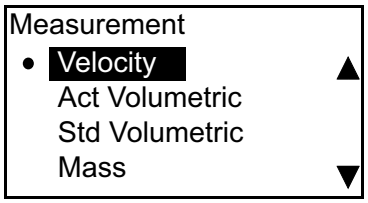


Frequency sends out a continuous square wave, with the frequency proportional to a measured value. Select Frequency and press [√]. The following screen appears.

Setting Measurement Type

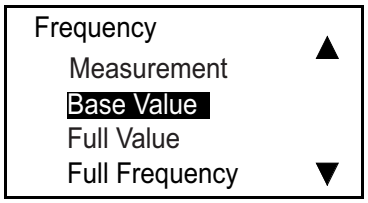


Select Measurement and press [√]. A screen similar to the following appears.



In the Measurement menu, select the type of analog output to be used, and press [√]. The screen returns to the previous display.

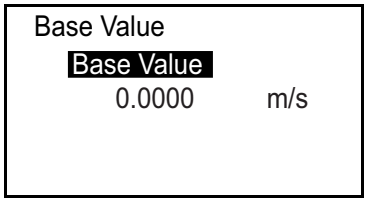
Setting Base Value/Full Value/Frequency



The Base Value is the measurement value represented by 0 Hz. The Full Value is the measurement value represented by Full Frequency. The Full Frequency is the maximum Hz, which represents the Full Value of measurement.

Use the [△] or [▽] arrow keys to select the appropriate option and press[√]. A screen similar to the following appears.

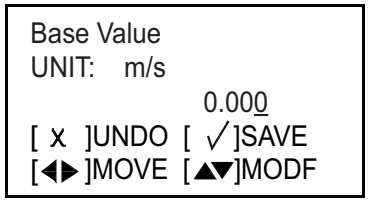
Note: *The operation steps of Base Value, Full Value and Full Frequency are the same.*



To change the existing number, press [√] and a screen similar to the following appears.

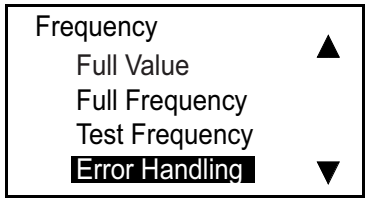
Note: *The units that appear will be the units selected in Units Setting on page 28.*

Setting Base Value/Full Value/Frequency (cont.)

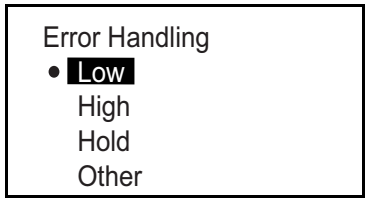


To change the Base Value, use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to provide a new number and press [√] to save. Press [√] to return to the Frequency menu.

Setting Frequency Error Handling



To change the Error Handling status, select it on the screen and press [√]. The following screen appears.

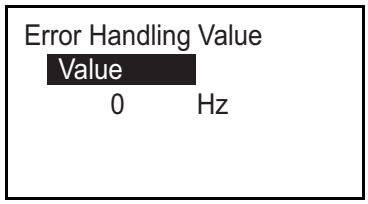


To change the current Error Handling status, select the option desired, and press [√]. The screen returns to the previous display.

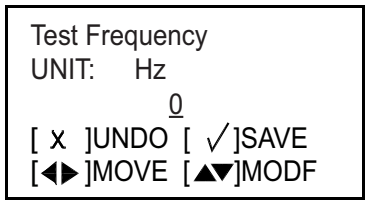
You have four options for error handling in case of a measurement error:

- Hold — hold last good value
- Low — show 0 Hz.
- High —show Full Frequency.

Note: *If Other is selected, a screen similar to the following appears:*

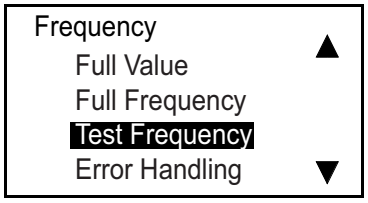


Enter the Hz value you want to appear for error. (For example, if Full = 1 kHz, you may want to set Error to 2 kHz.) Press [√] again, and a screen similar to the following appears.

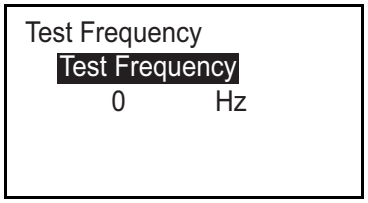


Use the [△] or [▽] arrow key to change the Other value and press [√] to save the number. Press [✕] to return to the previous screen.

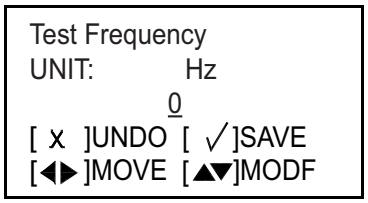
Test Frequency



To test the Frequency output, select Test Frequency and press [√]. The following screen appears.



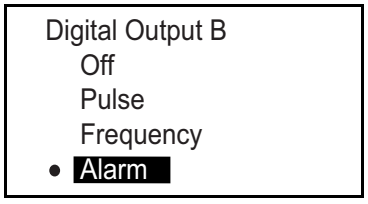
Press [√], and a screen similar to the following appears.



To change the current test frequency, press [√]. Set a Hz value. The meter will set the digital output to this value. Then verify at your measurement system that you see the frequency you entered. You can repeat this procedure with several frequencies.

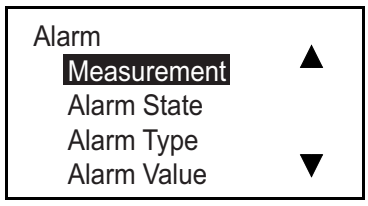
After testing, press [✕] to return to the Digital Output menu.

3.6.2d Setting the Alarm

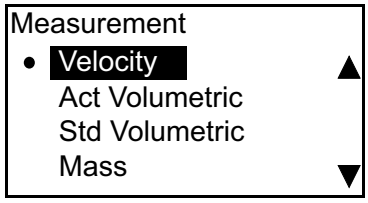


The alarm can be an open or a short circuit, depending on the error condition. To check the alarm and/or change its settings, in the Digital Output menu select Alarm and press [√]. The following screen appears.

Setting Measurement Type

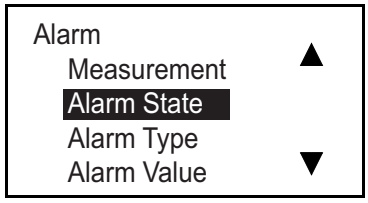


Select Measurement and press [√]. A screen similar to the following appears.

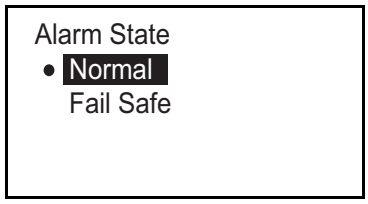


In the Measurement menu, select the type of analog output to be used, and press [√]. The screen returns to the previous display.

Setting Alarm State



Use the [△] or [▽] arrow keys to select Alarm State and press[√]. A screen similar to the following appears.

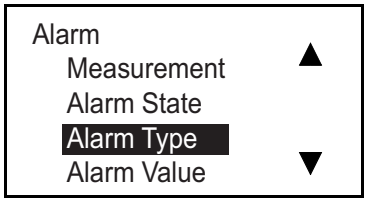


Two alarm states are available:

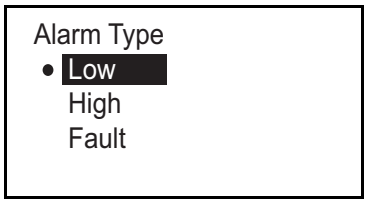
- Normal — Normally open, close for alarm
- Fail Safe — Close

To change the state of the alarm, select the desired status and press [√],. The screen returns to the previous display.

Setting Alarm Type



Use the [△] or [▽] arrow keys to select Alarm Type and press [√]. A screen similar to the following appears.

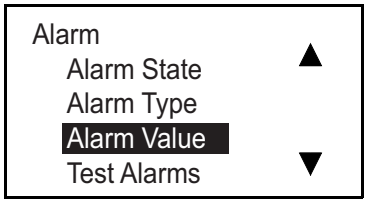


You can choose from three alarm types:

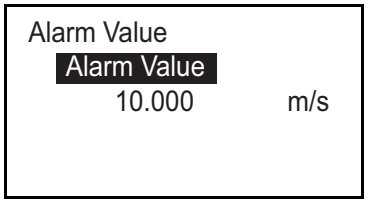
- Low — No alarm if measurement is greater than the threshold, alarm if measurement is less than or equal to the threshold
- High— No alarm if measurement is less than the threshold, alarm if measurement is greater than or equal to the threshold
- Fault — No alarm if no errors, alarm if errors.

To change the type of alarm, select the appropriate type and press [√],. The screen returns to the previous display.

Setting Alarm Value

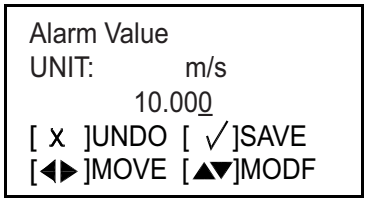


The Alarm Value is the threshold that trips the alarm. (This parameter does not apply to Fault Alarms.) To check and/or change the alarm value, select Alarm Value and press [√]. A screen similar to the following appears.



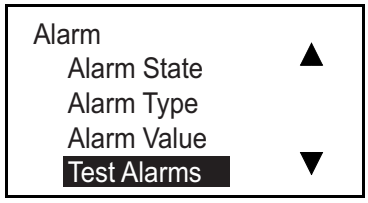
Press [√] again, and a screen similar to the following appears.

Note: *The units that appear will be the units selected in Units Setting on page 28.*



To change the Alarm Value, use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to provide a new number and press [√] to save. Press [√] to return to the Alarm menu.

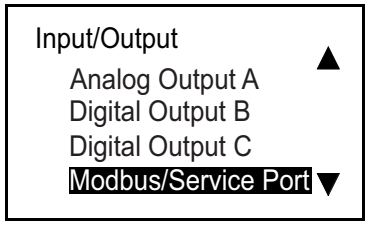
Test Alarms



To test the Alarms output, select Test Alarms and press [√]. The following screen appears.

Select OFF to turn the alarm off, or ON to turn it on. To begin testing, select ON and press [√]. To stop testing, press [✕].

3.6.3 Programming Modbus/Service Port



The configuration of service MODBUS port is fixed. The baud rate is “115200”, Bits/Parity is “8/None”, Stop Bits is “1”. The address is “1”.

To view the Modbus/Service Port, select it on the Input/Output screen and press [√]. The following screen appears.

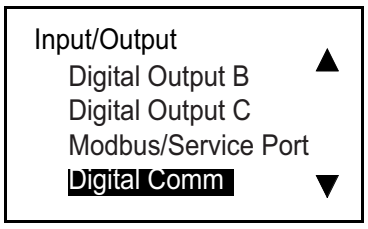
3.6.4 Programming Digital Communications

The AT600 flow meter supports the digital communication types below:

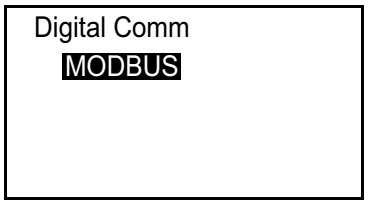
- MODBUS
- HART

They are activated by the **Password**. Please contact GE for assistance.

3.6.4a MODBUS

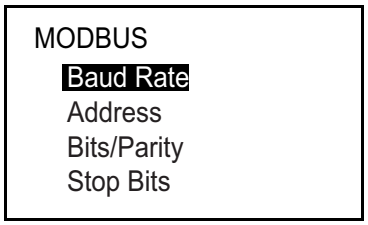


To set up the Modbus, select Digital Comm on the Input/Output screen and press [√]. The following screen appears.

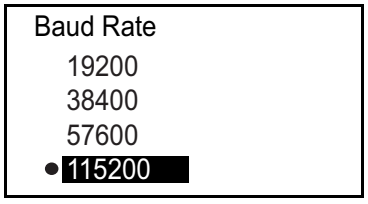


Press [√] again, and a screen similar to the following appears.

Selecting the Baud Rate

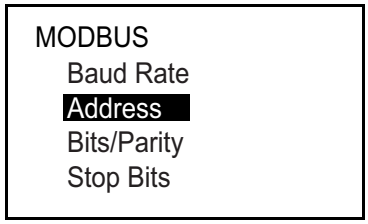


To set the baud rate, in the Modbus/Service menu, select Baud Rate and press [√]. A screen similar to the following appears.

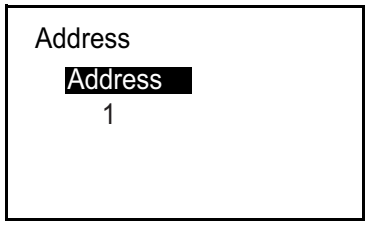


The default baud rate is 115200. Select the appropriate baud rate and press [√],. The screen returns to the previous display.

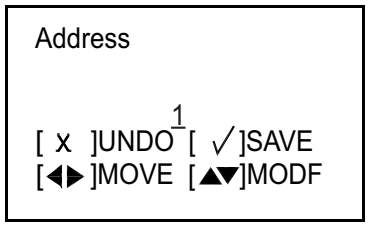
Selecting the Modbus Address



To set the address, in the Modbus menu, select Address and press [√]. A screen similar to the following appears.

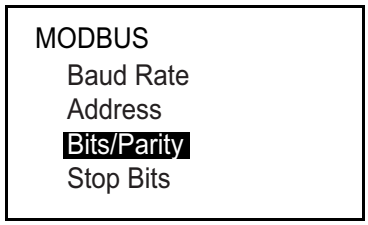


Press [√] again, and a screen similar to the following appears.

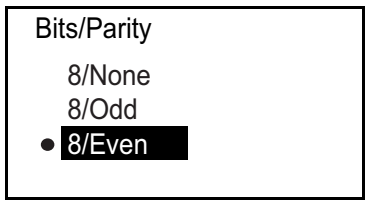


Use the [△] or [▽] arrow keys to change the address number (from 1 to 254 — not 0) and press [√]. Press [✕] to return to the previous screen.

Selecting the Bits/Parity

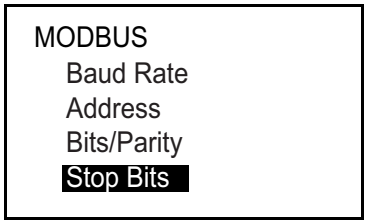


To set the Bits/Parity, in the Modbus menu, select it and press [√]. A screen similar to the following appears.

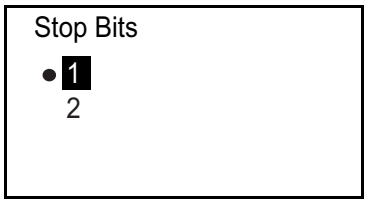


Select the appropriate number and press [√]. The screen returns to the previous display.

Selecting the Stop Bits

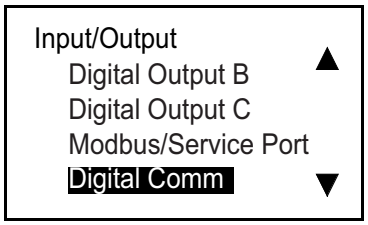


To set the Stop Bits, in the Modbus menu, select it and press [√]. A screen similar to the following appears.



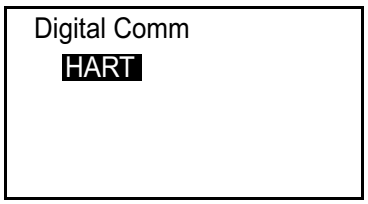
Select the appropriate number and press [√]. The screen returns to the previous display.

3.6.4b HART



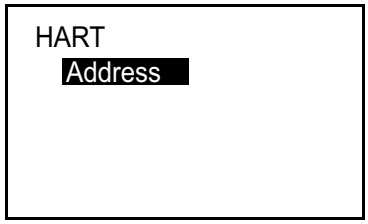
To set up the HART, select Digital Comm on the Input/Output screen and press [√]. The following screen appears.

Note: *Please ensure the HART function is selected for your unit.*

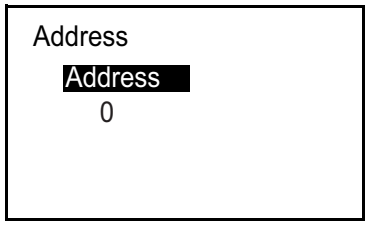


Press [√] again, and a screen similar to the following appears.

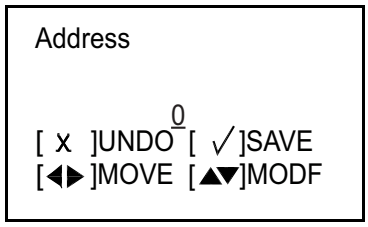
Setting the HART Address



To set the address, in the Modbus menu, select Address and press [√]. A screen similar to the following appears.



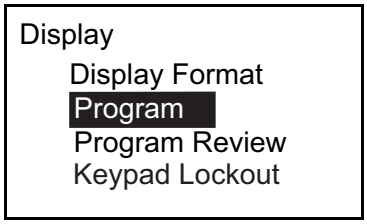
Press [√] again, and a screen similar to the following appears.



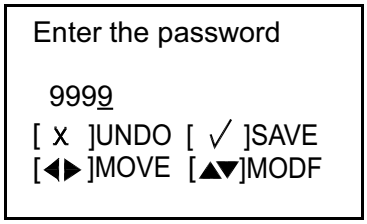
Use the [△] or [▽] arrow keys to change the address number (from 0 to 62) and press [√]. Press [✕] to return to the previous screen.

3.7 Sensor Setup

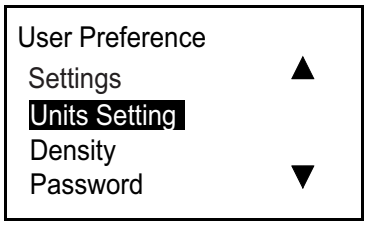
To access the Sensor Setup menu, on the initial screen, highlight the lock symbol and press [√]. The following screen appears.



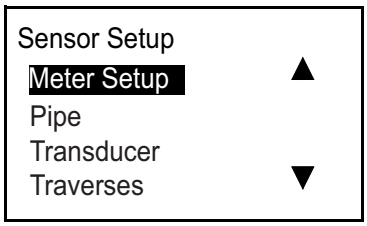
Select Program and press [√]. The following screen appears.



To enter the password, use the [◁] or [▷] arrow key to select each digit to be changed, use the [△] or [▽] arrow keys to change the value of each digit, and press [√]. The following screen appears.



In the User Preference menu, select Units Setting and press the right arrow key twice. A screen similar to the following appears.

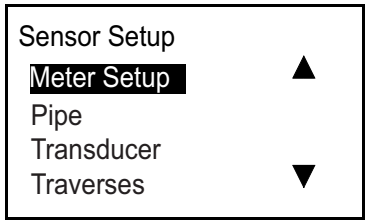


Select the desired parameter with the [△] or [▽] arrow keys, and press [√] to enter the relevant configuration menu.

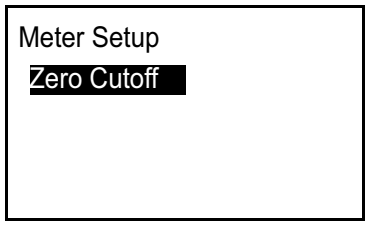
3.7.1 Programming the Meter Setup

3.7.1a Setting Zero Cutoff

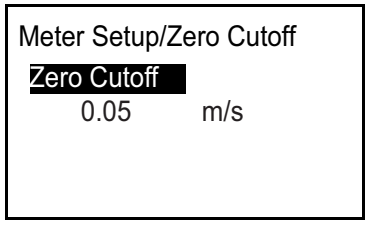
Near a zero flow rate, the AT600's readings may fluctuate due to small offsets caused by thermal drift or similar factors. To force a Zero display reading, when there is minimal flow, enter a zero cutoff value as described below.



Select Meter Setup and press [√]. The following screen appears.

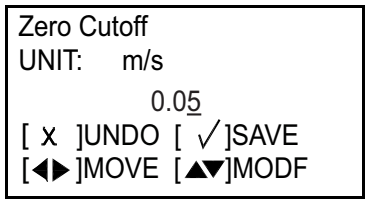


Select Zero Cutoff and press [√]. The following screen appears.



Press [√] again, and a screen similar to the following appears.

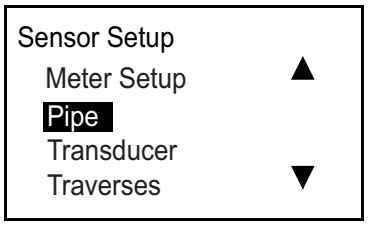
Note: *The units that appear will be the units selected in Units Setting on page 28.*



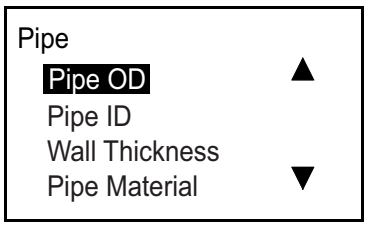
To change the Zero Cutoff, use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to provide a new number and press [√] to save. Press [✕] to return to the previous screen.

3.7.2 Programming the Pipe

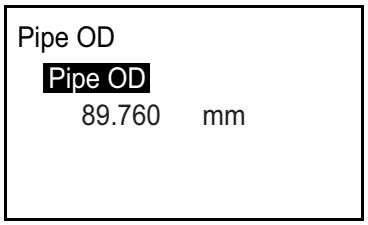
3.7.2a Setting Pipe OD/ID/Wall Thickness



Select Pipe and press [√]. The following screen appears.

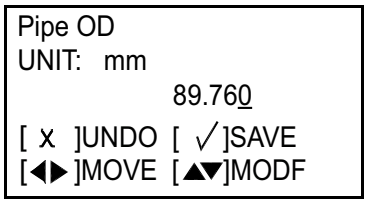


In the User Preference menu, select Pipe OD, Pipe ID or Wall Thickness and press [√]. A screen similar to the following appears.



Press [√] again, and a screen similar to the following appears.

Note: *The units that appear will be the units selected in Units Setting on page 28.*

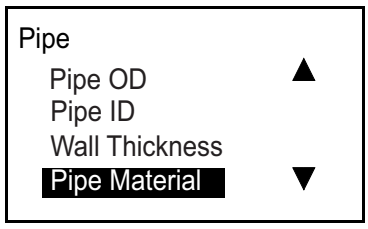


Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to provide a new number and press [√] to save.

Repeat these steps to set the Pipe ID and Wall Thickness. Press [✕] to return to the Pipe menu.

Note: *Changing the Pipe ID (inner diameter) with automatically change the wall thickness. Changing the wall thickness value will automatically change the Pipe ID.*

3.7.2b Setting Pipe Material

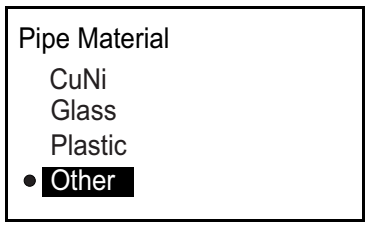


In the Pipe menu, select Pipe Material and press [√]. The following screen appears.

Table 2 below lists the pre-programmed pipe materials.

Table 2: Pre-programmed Pipe Materials

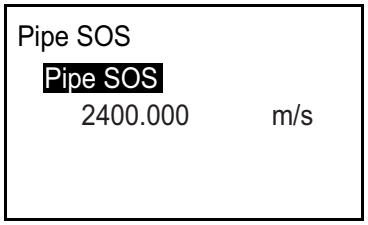
Name	Pipe Material
CARBON STEEL	Carbon Steel
SS STEEL	Stainless Steel
DUCT IRON	Duct Iron
CAST IRON	Cast Iron
Cu	Cuprum
Al	Aluminum
BRASS	Brass
30%Ni	30% Nickel Copper Alloy
10%Ni	10% Nickel Copper Alloy
PYREX GLASS	Pyrex Glass
FLINT GLASS	Flint Glass
CROWN GLASS	Crown Glass
NYLON PLSTC	Nylon Plastic
POLYE PLSTC	Polyethylene
POLYP PLSTC	Polypropylene
PVC PLSTC	Polyvinyl chloride
ACRYL PLSTC	Acrylic Plastic



Select the appropriate option and press [✕] to return to the previous screen.

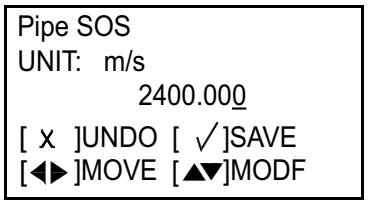
If the material is not listed, select Other and press [√] twice. A screen similar to the following appears.

3.7.2b Setting Pipe Material (cont.)



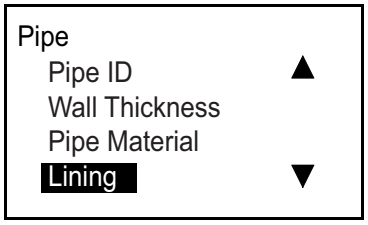
Press [√] again, and a screen similar to the following appears.

Note: *The units that appear will be the units selected in Units Setting on page 28.*

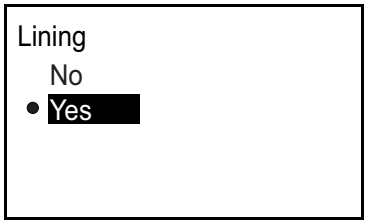


Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Pipe SOS value and press [√]. Press [✕] to return to the previous display.
Press [✕] twice to return to the Pipe menu.

3.7.2c Setting the Lining

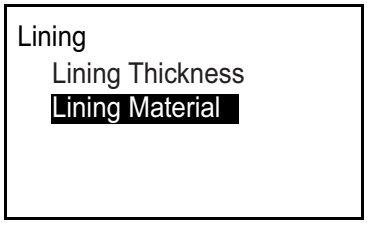


In the Pipe menu, select Lining and press [√]. The following screen appears.



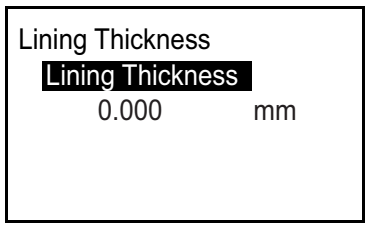
If there is no lining, select No and press [√] to return to the previous screen.

If there is a lining, select Yes and press [√] twice. A screen similar to the following appears.



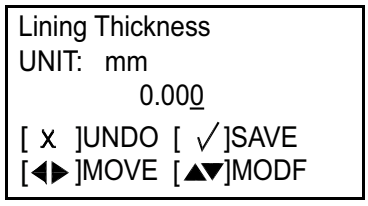
To set the lining thickness, select it and press [√]. A screen similar to the following appears.

3.7.2c Setting the Lining (cont.)

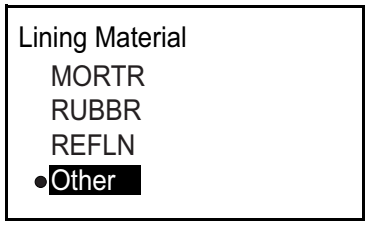


Press [√] again, and a screen similar to the following appears.

Note: *The units that appear will be the units selected in Units Setting on page 28.*



Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Lining Thickness value and press [√] to return to the previous display. Then press [✕] to return to the Lining screen.



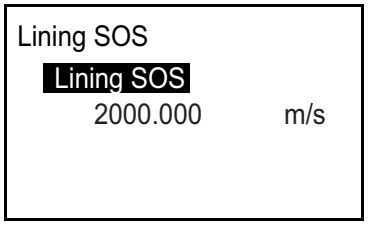
Select the appropriate option and press [✕] to return to the previous screen.

If the material is not listed, select Other and press [√] twice. A screen similar to the following appears.

Table 3: Pre-programmed Lining Materials

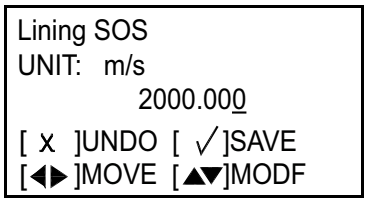
Name	Lining Material
Tar Epoxy	Tar Epoxy
Pyrex Glass	Pyrex Glass
Asbestos Cement	Asbestos Cement
Mortar	Mortar
Rubber	Rubber
Teflon	Teflon (PFTE)

3.7.2c Setting the Lining (cont.)



Press [√] again, and a screen similar to the following appears.

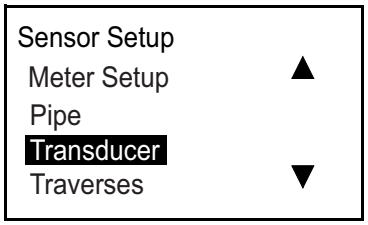
Note: *The units that appear will be the units selected in Units Setting on page 28.*



Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Lining SOS value and press [√]. Press [✕] to return to the previous display.

3.7.3 Programming the Transducer

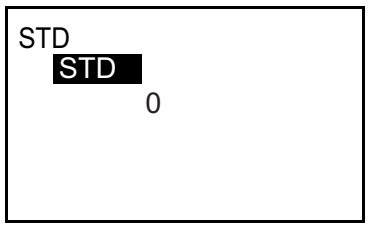
3.7.3a Setting the Standard Transducer



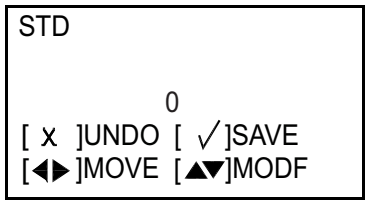
Select Transducer and press [√]. The following screen appears.

Select STD and press [√]. A screen similar to the following appears.

3.7.3a Setting the Standard Transducer (cont.)



Press [√] again, and a screen similar to the following appears.



Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Transducer setting, and press [√] to return to the previous screen. Then press [✕] to return to the Transducer screen.

Note: *Available transducer types for the AT600 are listed in Table 4 below.*

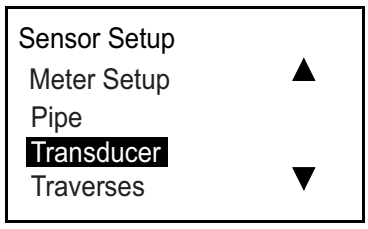
Table 4: Transducer Types

Transducer Name	Transducer Type
10	CPT-0.5CPT-0.5
11	CPT-2.0
12	CPT-0.5-MT C-PB-05-M
13	CPT-1.0-MT C-PB-10-M
14	CPT-2.0-MT C-PB-20-M
15	CPT-0.5-HT
16	CPT-1.0-HT
17	CPT-2.0-HT
18	CPS-0.5
19	CPSM-2.0
20	CTS-1.0
21	CTS-1.0-HT
22	CTS-2.0
23	C-LP-40-HM
24	C-LP-40-NM
25	CPB-0.5-HT
26	CPB-2.0-MT
27	CPB-0.5-MT
28	CPB-2.0
29	CPB-0.5

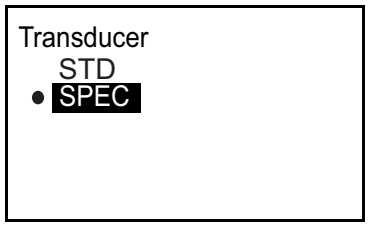
Table 4: Transducer Types (cont.)

Transducer Name	Transducer Type
30	CPS-1.0 CPT-1.0
31	CWL-2
32	CPS-1.0
33	CPW (WT-1P-1.0 on AB82
34	CPW (WT-1P-0.5 on NDT plastic
35	CPW (WT-1P-1.0 on NDT plastic
36	CPB-1.0-HT
37	CPB-2.0-HT
38	CPB-1.0
39	CPB-1.0-MT
301	C-RL-0.5
302	C-RL-1
304	C-RL-0.5
305	C-RL-1
307	C-RL-0.5
308	C-RL-1
310	C-RV-0.5
311	C-RV-1
313	C-RW-0.5
314	C-RW-1
401	C-RS-0.5[1]
402	C-RS-1 [1]
403	C-RS-2
407	UTXDR-2
408	UTXDR-5
601	CAT-0.5
602	CAT-1
603	CAT-2 [1]
[1] Currently supported transducer	

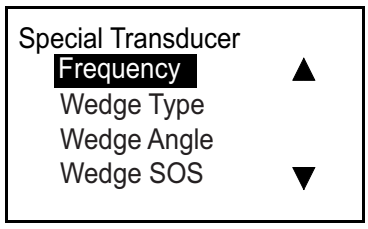
3.7.3b Setting a Special Transducer



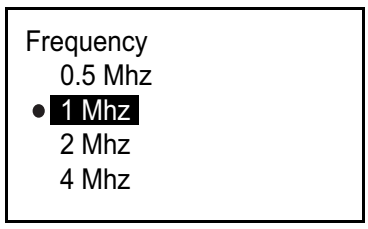
Select Transducer and press [√]. The following screen appears.



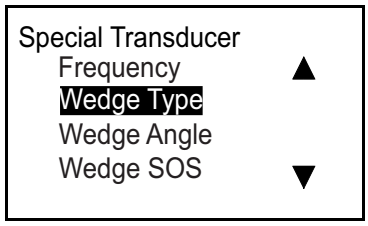
Select SPEC and press [√]. A screen similar to the following appears.



In the Special Transducer menu, select Frequency and press [√]. The following screen appears.

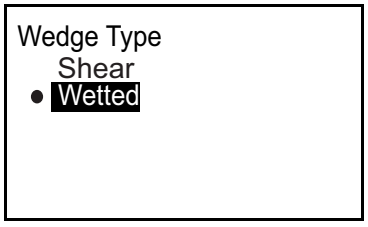


Select the appropriate option and press [√] twice to return to the previous screen.

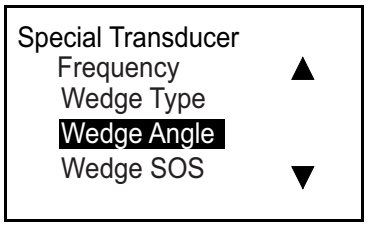


Select Wedge Type and press [√]. The following screen appears.

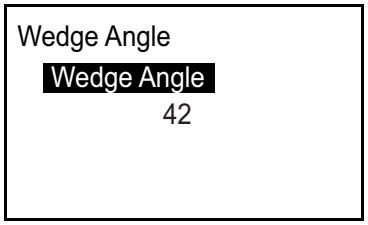
3.7.3b Setting the Special Transducer



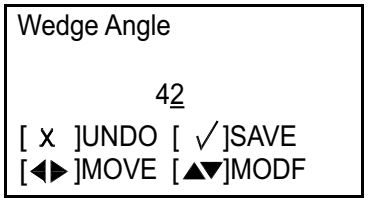
Select the appropriate option and press [√] twice to return to the previous screen.



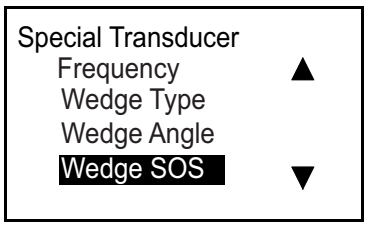
Select Wedge Angle and press [√]. The following screen appears.



Press [√] again, and a screen similar to the following appears.

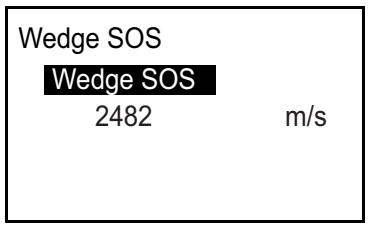


Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Wedge Angle setting, and press [√] to return to the previous screen. Then press [✕] to return to the Transducer screen.

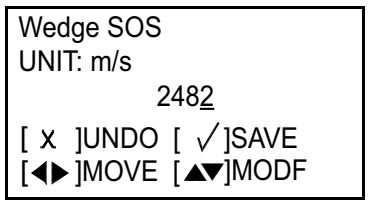


Select Wedge SOS and press [√]. The following screen appears.

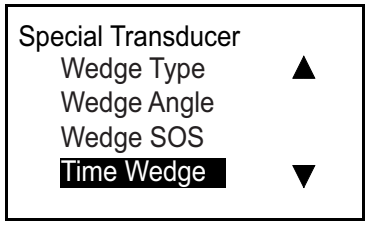
3.7.3b Setting the Special Transducer (cont.)



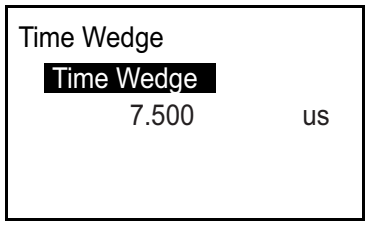
Press [√] again, and a screen similar to the following appears.



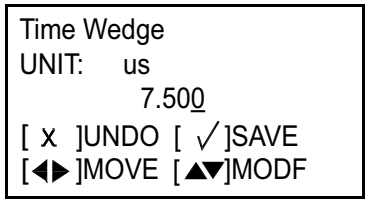
Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Wedge SOS setting, and press [√] to return to the previous screen. Then press [✕] to return to the Transducer screen.



Select Time Wedge and press [√]. The following screen appears.



Press [√] again, and a screen similar to the following appears.



Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Time Wedge setting, and press [√] to return to the previous screen. Then press [✕] to return to the Transducer screen.

3.7.4 Programming the Traverses

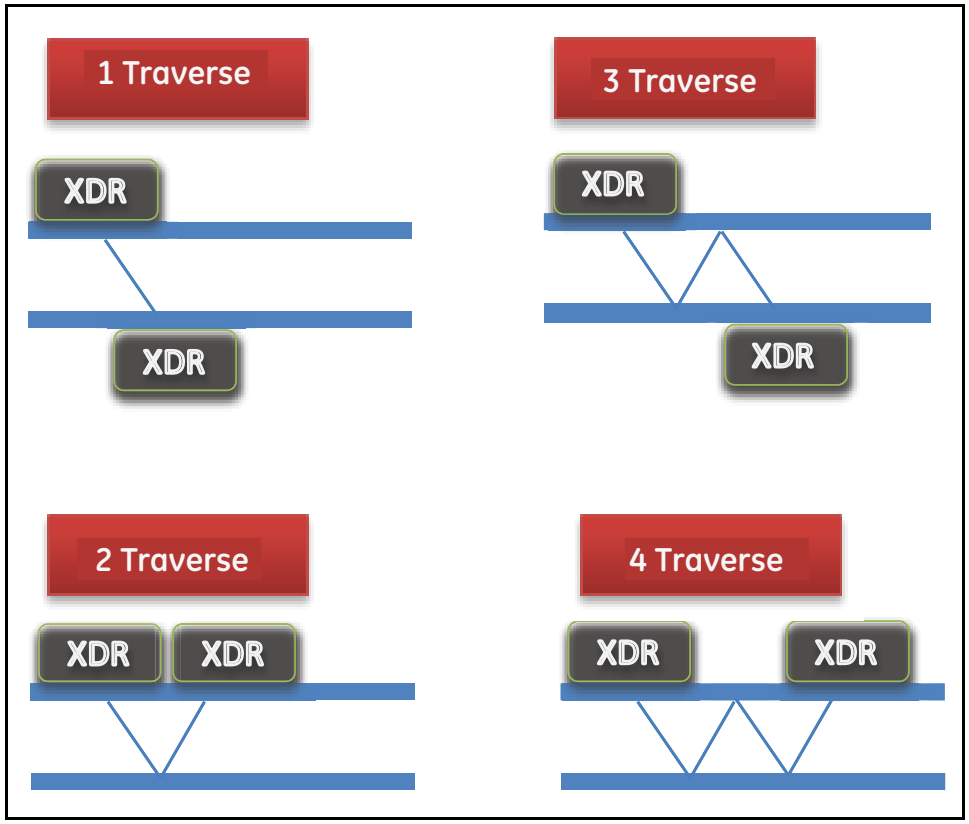
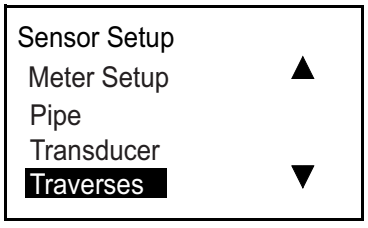
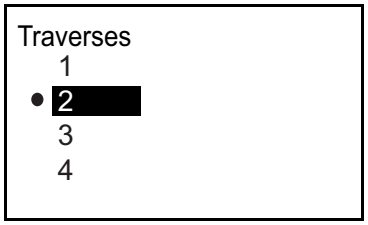


Figure 34: Traverse Examples



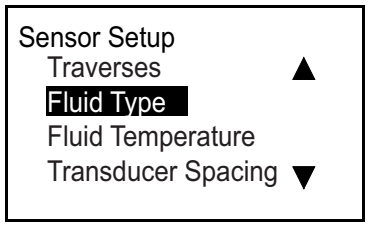
Select Traverses and press [√]. The following screen appears.



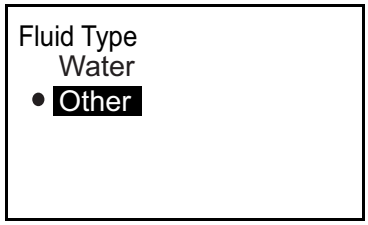
Select the appropriate option and press [√] to return to the previous screen.

3.7.5 Programming the Fluid Type

If the fluid type is known, the meter will run calculations based on customer input. However, if the fluid type is not known, open the Tracking Windows function discussed below. Relocating the transducers is not necessary.

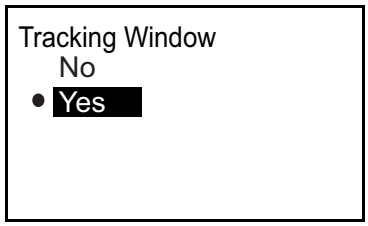


Select Fluid Type and press [√]. The following screen appears.



If the fluid type is water, select Water and press [√] to return to the previous screen.

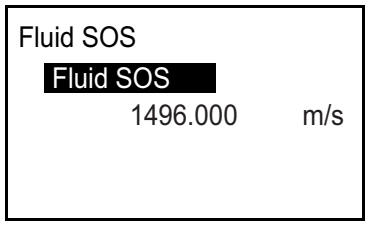
If the fluid is not water, select Other and press [√]. A screen similar to the following appears.



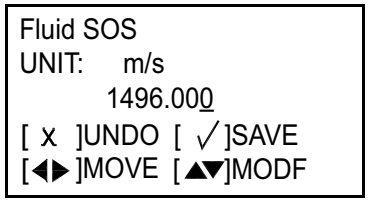
If the tracking window is not applied, select No and press [√]. A screen similar to the following appears. In it, you enter the Fluid SOS.

If you don't know the fluid SOS, you can enable the tracking window so that the meter detect it automatically. If the "tracking window" is applied, select Yes and press [√]. A screen similar to the following appears. Enter the Maximum SOS and Minimum SOS.

Note: *Fluid SOS, Maximum SOS and Minimum SOS all operate in the same manner.*

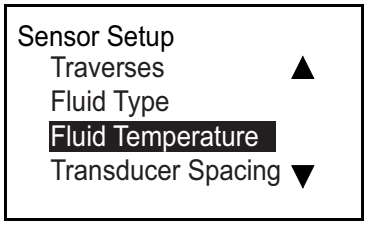


Press [√] again, and a screen similar to the following appears.

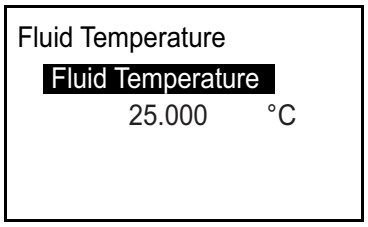


Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Fluid SOS setting, and press [√] to return to the previous screen. Then press [✕] to return to the Sensor Setup screen.

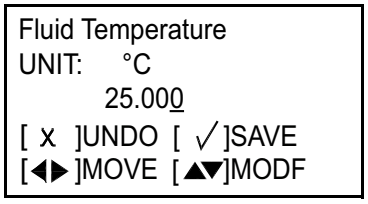
3.7.6 Programming the Fluid Temperature



Select Fluid Type and press [√]. The following screen appears.



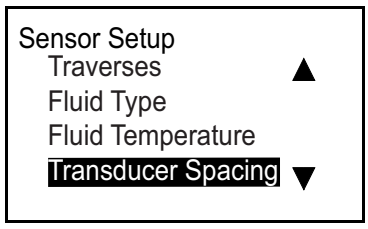
Press [√] again, and a screen similar to the following appears.



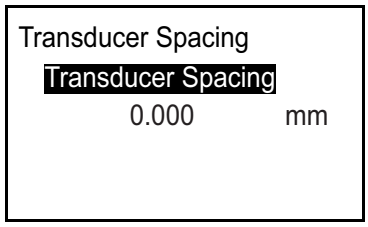
Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the Fluid Temperature setting, and press [√] to return to the previous screen. Then press [✕] to return to the Sensor Setup screen.

Note: *Since meter calculations are based on customer inputs, temperature will affect the speed of sound during the measurement.*

3.7.7 Programming the Transducer Spacing

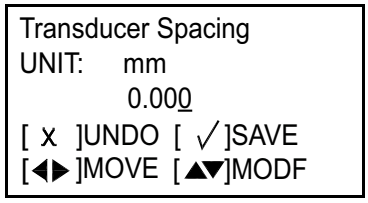


Select Transducer Spacing and press [√]. The following screen appears.



Press [√] again. Please note this transducer spacing for setting the transducers based on sensor setup input (pipe, transducer, fluid, and transducers).

Note: *If setting this spacing is not possible, please contact the factory for further assistance. If instructed by the factory, press [√] again, and a screen similar to the following appears.*



Use the [◁] or [▷] arrow key to select the digit to be changed, use the [△] or [▽] arrow keys to change the setting, and press [√] to return to the previous screen. Then press [✕] to return to the Sensor Setup screen.

Note: *Changing the transducer spacing should only be completed with contact from the factory.*

Chapter 4. Error Codes and Troubleshooting

4.1 Error Display in the User Interface

The bottom line of the LCD displays a single, top priority error message during operation. This line, called the Error Line, includes two parts: Error header and Error String. The Error header indicates the error pattern and error number, while the Error string gives a detailed description of the error information.

4.1.1 Error Header

Error Pattern	Error Header
Flow Error	En (n is error number)
Device Error	Dn (n is error number)
Warning	Sn (n is error number)

4.1.2 Flow Error String

Flow errors are errors in the course of making a flow measurement. These errors can be caused by disturbances in the fluid, such as excessive particles in the flow stream or extreme temperature gradients. The errors could also be caused by an empty pipe or other such issue with the fluid itself. Flow errors are typically not caused by a malfunction of the flow measurement device, but by an issue with the fluid itself.

Option Bar	Description	Good	Bad
Tup	Displays the upstream ultrasonic signal transit time.	NA	NA
Tdn	Displays the downstream ultrasonic signal transit time.	NA	NA
DeltaT	Displays the transit time difference between the upstream and downstream signals.	NA	NA
Up Signal Quality	Displays the signal quality for the upstream transducer	≥1200	<400
Dn Signal Quality	Displays the signal quality for the downstream transducer	≥1200	<400
Up Amp Disc	Displays the value for the signal amplitude of the upstream transducer.	24±5	<19 or >29
Dn Amp Disc	Displays the value for the signal amplitude of the downstream transducer.	24±5	<19 or >29
SNR Up	Display the value for the signal-to-noise of the upstream signal	≥4	<4
SNR Dn	Display the value for the signal-to-noise of the downstream signal	≥4	<4
Gain Up	Display the value for the gain of the upstream transducer	9-85	<9 or >85
Gain Dn	Display the value for the gain of the downstream transducer	9-85	<9 or >85
Up Peak	Displays the first value in the upstream correlation signal, which is more than the positive threshold or is less than the negative threshold.	NA	NA
Dn Peak	Displays the first value in the downstream correlation signal, which is more than the positive threshold or is less than the negative threshold.	NA	NA
PeakPctUp	Displays the percentage of peak of the upstream signal	NA	NA
PeakPctDn	Displays the percentage of peak of the downstream signal	NA	NA

4.1.2a E1: Low Signal

Problem: Poor ultrasonic signal strength or the signal exceeds the limit via the *Program;*

Cause: When SNR is less that the value of "Signal Low Limits" or the signal cannot be found when the flow is started, the Low Signal error will occur. Poor signal strength may be caused by a defective cable, a flowcell problem, a defective transducer or a problem in electronic console. A signal that exceeds the programmed limits is probably caused by the entry of an improper value in the menu *Program → Advanced → Error Limits → Signal Low limits*.

Action: Check the components listed above (Refer to "Diagnostics" on page 76.). Also check the inputted value in the menu *Program → Advanced → Error Limits → Signal Low limits*.

4.1.2b E2: Sound Speed Error

Problem: The sound speed exceeds the limits programmed in the menu**:** *Program → Advanced → Error Limits → SNSD +- limits*.

Cause: When the measured sound speed is out of the limit of sound speed, it will cause this error. The error may be caused by incorrect programming, poor flow conditions and poor transducer orientation;

Action: Correct the programming errors. Refer to "Diagnostics" on page 76, to correct the flowcell and/or transducer problems. Also check the inputted value in the menu *Program → Advanced → Error Limits → SNSD +- limits*.

4.1.2c E3: Velocity Range

Problem: The velocity exceeds the limits programmed in the menu *Program → Advanced → Error Limits → Velocity Low/High;*

Cause: When the measured velocity is out of the limit of velocity, it will cause this error. The error may be caused by improper programming data, poor flow conditions and/or excessive turbulence;

Action: Make sure the actual flow rate is within the programmed limits. Also, check the entered value in the menu *Program → Advanced → Error Limits → Velocity Low/High.* Refer to "Diagnostics" on page 76, to correct the flowcell and/or transducer problems.

4.1.2d E4: Signal Quality

Problem: The signal quality is outside the limits programmed in the menu *Program → Advanced → Error Limits → Correlation Peak*.

Cause: The peak of the upstream or downstream correlation signals has fallen below the correlation peak limit, as set in the menu *Program → Advanced → Error Limits → Correlation Peak*. This may be caused by a flowcell or electrical problem.

Action: Check for sources of electrical interference and verify the integrity of the electronics console by temporarily substituting a test flowcell that is known to be good. Check the transducers and relocate them, if necessary. See "Diagnostics" on page 76, for instructions.

4.1.2e E5: Amplitude Error

Problem: The signal amplitude exceeds the limits programmed in the menu *Program → Advanced → Error Limits →Amp Disc Min/Max;.*

Cause: Solid or liquid particulates may be present in the flowcell. Poor coupling for the clamp-on transducers.

Action: Refer to “Diagnostics” on page 76, to correct any flowcell problems.

4.1.2f E6: Cycle Skip

Problem: The acceleration exceeds the limits programmed in the menu *Program → Advanced → Error Limits →Acceleration.*

Cause: This condition is usually caused by poor flow conditions or improper transducer alignment.

Action: Refer to “Diagnostics” on page 76, to correct any flowcell and/or transducer problems.

4.2 Diagnostics

4.2.1 Introduction

This section explains how to troubleshoot the AT600 if problems arise with the electronics enclosure, the flowcell, or the transducers. Indications of a possible problem include:

- Display of an error message on the LCD display screen, Vitality PC software, or HART.
- Erratic flow readings
- Readings of doubtful accuracy (i.e., readings that are not consistent with readings from another flow measuring device connected to the same process).

If any of the above conditions occurs, proceed with the instructions presented in this chapter.

4.2.2 Flowcell Problems

If preliminary troubleshooting with the *Error Code* indicates a possible flowcell problem, proceed with this section. Flowcell problems fall into two categories: *fluid problems* or *pipe problems*. Read the following sections carefully to determine if the problem is indeed related to the flowcell. If the instructions in this section fail to resolve the problem, contact GE for assistance.

4.2.2a Fluid Problems

Most fluid-related problems result from a failure to observe the flowmeter system installation instructions. Refer to Chapter 2, Installation, to correct any installation problems.

If the physical installation of the system meets the recommended specifications, it is possible that the fluid itself may be preventing accurate flow rate measurements. The fluid being measured must meet the following requirements:

1. *The fluid must be homogeneous, single-phase, relatively clean and flowing steadily.*

   Although a low level of entrained particles may have little effect on the operation of the AT600, excessive amounts of solid or gas particles will absorb or disperse the ultrasound signals. This interference with the ultrasound transmissions through the fluid will cause inaccurate flow rate measurements. In addition, temperature gradients in the fluid flow may result in erratic or inaccurate flow rate readings.

2. *The fluid must not cavitate near the flowcell*.

   Fluids with a high vapor pressure may cavitate near or in the flowcell. This causes problems resulting from gas bubbles in the fluid. Cavitation can usually be controlled through proper installation design.

3. *The fluid must not excessively attenuate ultrasound signals*.

   Some fluids, particularly those that are very viscous, readily absorb ultrasound energy. In such a case, an error code message will appear on the display screen to indicate that the ultrasonic signal strength is insufficient for reliable measurements.

4.2.2a Fluid Problems (cont)

4. *The fluid sound speed must not vary excessively.*

The AT600 will tolerate relatively large changes in the fluid sound speed, as may be caused by variations in fluid composition and/or temperature. However, such changes must occur slowly. Rapid fluctuations in the fluid sound speed, to a value that is considerably different from that programmed into the AT600, will result in erratic or inaccurate flow rate readings. Refer to Chapter 3, *Initial Setup and Programming,* and make sure that the appropriate sound speed is programmed into the meter.

4.2.2b Pipe Problems

Pipe-related problems may result either from a failure to observe the installation instructions, as described in Chapter 2, or from improper programming of the meter. By far, the most common pipe problems are the following:

1. *The collection of material at the transducer location(s).*

Accumulated debris at the transducer location(s) will interfere with transmission of the ultrasound signals. As a result, accurate flow rate measurements are not possible. Realignment of the flowcell or transducers often cures such problems, and in some cases, transducers that protrude into the flow stream may be used. Refer to Chapter 2, *Installation*, for more details on proper installation practices.

2. *Inaccurate pipe measurements.*

The accuracy of the flow rate measurements is no better than the accuracy of the programmed pipe dimensions. For a flowcell supplied by GE, the correct data will be included in the documentation. For other flowcells, measure the pipe wall thickness and diameter with the same accuracy desired in the flow rate readings. Also, check the pipe for dents, eccentricity, weld deformity, straightness and other factors that may cause inaccurate readings. Refer to Chapter 3, *Initial Setup*, for instructions on programming the pipe data.

In addition to the actual pipe dimensions, the path length (P) and the axial dimension (L), based on the actual transducer mounting locations, must be accurately programmed into the flowmeter. For a GE Sensing flowcell, this data will be included with the documentation for the system. If the transducers are mounted onto an existing pipe, these dimensions must be precisely measured.

3. *The inside of the pipe or flowcell must be relatively clean.*

Excessive buildup of scale, rust or debris will interfere with flow measurement. Generally, a thin coating or a solid well-adhered build up on the pipe wall will not cause problems. Loose scale and thick coatings (such as tar or oil) will interfere with ultrasound transmission and may result in incorrect or unreliable measurements.

[no content intended for this page]

Chapter 5. Communication

5.1 MODBUS

5.1.1 Introduction

In general, the AT600 flowmeter follows the standard MODBUS communications protocol defined by the reference MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b. This specification is available at www.modbus.org on the internet. With this reference as a guide, an operator could use any MODBUS master to communicate with the flowmeter.

Listed below are two limits of this implementation:

1. The AT600 supports only four of the standard function codes. These are Read Holding Registers (0x03), Read Input Registers (0x04), Write Multiple Registers (0x10), and Read File Record (0x14).
2. The flowmeter needs a 15 ms gap between Modbus requests. The prime objective of the flowmeter is to measure flow and drive the output, so the Modbus server has a low priority.

5.1.2 MODBUS Map

Table 5: MODBUS Map

	Register (in Hex)	Register (in Decimal)	Access Level	Description	RO/RW	Format
100	100	256	User	Product Short Tag	RW	CHAR * 16
	108	264	User	Product Long Tag	RW	CHAR * 32
	118	280	User	Product message (for HART)	RW	CHAR * 32
	128	296	User	Product descriptor (for HART)	RW	CHAR * 16
140	140	320	User	Product Electronic serial number	RW	CHAR * 16
	148	328	User	Product fixture serial number	RW	CHAR * 16
	150	336	User	Product transducer1 serial number	RW	CHAR * 16
	158	344	User	Product transducer2 serial number	RW	CHAR * 16
300	300	768	RO	Main Hardware version	RO	CHAR * 8
	304	772	RO	Option Hardware version	RO	CHAR * 8
	308	776	RO	Main Software version	RO	CHAR * 8
500	500	1280	User	Global Unit group 1 for Actual Volumetric	RW	INT32
	502	1282	User	Global Unit group 2 for Day	RW	INT32
	504	1284	User	Global Unit group 3 for dB	RW	INT32
	506	1286	User	Global Unit group 4 for Density	RW	INT32
	508	1288	User	Global Unit group 5 for Dimension	RW	INT32

Table 5: MODBUS Map (cont.)

	Register (in Hex)	Register (in Decimal)	Access Level	Description	RO/RW	Format
	50A	1290	User	Global Unit group 6 for Hz	RW	INT32
	50C	1292	User	Global Unit group 7 for Viscosity	RW	INT32
	50E	1294	User	Global Unit group 8 for mA	RW	INT32
	510	1296	User	Global Unit group 9 for Mass	RW	INT32
	512	1298	User	Global Unit group 10 for Milli Second	RW	INT32
	514	1300	User	Global Unit group 11 for Nano Second	RW	INT32
	516	1302	User	Global Unit group 12 for Percent	RW	INT32
	518	1304	User	Global Unit group 13 for Second	RW	INT32
	51A	1306	User	Global Unit group 14 for Standard Volumetric	RW	INT32
	51C	1308	User	Global Unit group 15 for Thermo	RW	INT32
	51E	1310	Viewer	Global Unit group 16 for Totalizer time	RW	INT32
	520	1312	User	Global Unit group 17 for Totalizer	RW	INT32
	522	1314	User	Global Unit group 18 for Unitless	RW	INT32
	524	1316	User	Global Unit group 19 for Micro Second	RW	INT32
	526	1318	User	Global Unit group 20 for Velocity	RW	INT32
	528	1320	User	Global Unit group 21 for Acceleration	RW	INT32
540	540	1344	Viewer	Batch request command	RW	INT32
	542	1346	User	inventory request command	RW	INT32
	544	1348	Viewer	system request password	RW	INT32
	546	1350	Viewer	system request command	RW	INT32
700	700	1792	RO	System Reported error	RO	INT32
	702	1794	RO	System Error Bitmap	RO	INT32
	704	1796	RO	System Startup error Bitmap	RO	INT32
	706	1798	RO	System Flow error Bitmap	RO	INT32
	708	1800	RO	System Device error Bitmap	RO	INT32

Table 5: MODBUS Map (cont.)

	Register (in Hex)	Register (in Decimal)	Access Level	Description	RO/RW	Format
	70A	1802	RO	System Warning Bitmap	RO	INT32
740	740	1856	RO	System Protocol type	RO	INT32
900	900	2304	Viewer	Display Language	RW	INT32
	902	2306	User	Display Backlight Enable	RW	INT32
	904	2308	User	Display Timeout	RW	INT32
	906	2310	Viewer	Display Type	RW	INT32
	908	2312	Viewer	Display Variable1 Type	RW	INT32
	90A	2314	Viewer	Display Variable2 Type	RW	INT32
	90C	2316	Viewer	Display Totalizer1 Type	RW	INT32
	90E	2318	Viewer	Display Totalizer2 Type	RW	INT32
	910	2320	Viewer	Display Decimal selection	RW	INT32
940	940	2368	User	select the velocity	RW	INT32
	942	2370	User	select the Actual Volumetric	RW	INT32
	944	2372	User	select the Standardized Volumetric	RW	INT32
	946	2374	User	select Mass	RW	INT32
	948	2376	User	select Totalizer	RW	INT32
A00	A00	2560	RO	Display Variable1 Value	RO	(IEEE 32 bit)
	A02	2562	RO	Display Variable2 Value	RO	(IEEE 32 bit)
	A04	2564	RO	Display Totalizer1 Value	RO	(IEEE 32 bit)
	A06	2566	RO	Display Totalizer2 Value	RO	(IEEE 32 bit)
C00	C00	3072	User	Analog Out Error Handling Value	RW	(IEEE 32 bit)
	C02	3074	User	Analog Out Test Value (Percent of Span)	RW	(IEEE 32 bit)
	C04	3076	User	Analog Out Zero Value	RW	(IEEE 32 bit)
	C06	3078	User	Analog Out Span Value	RW	(IEEE 32 bit)
	C08	3080	User	Analog Out Base Value	RW	(IEEE 32 bit)
	C0A	3082	User	Analog Out Full Value	RW	(IEEE 32 bit)
C40	C40	3136	User	Digital Out 1 Pulse Value	RW	(IEEE 32 bit)
	C42	3138	User	Digital Out 1 Frequency Base Value	RW	(IEEE 32 bit)
	C44	3140	User	Digital Out 1 Frequency Full Value	RW	(IEEE 32 bit)
	C46	3142	User	Digital Out 1 Alarm Value	RW	(IEEE 32 bit)
C80	C80	3200	User	Digital Out 2 Pulse Value	RW	(IEEE 32 bit)

Table 5: MODBUS Map (cont.)

	Register (in Hex)	Register (in Decimal)	Access Level	Description	RO/RW	Format
	C82	3202	User	Digital Out 2 Frequency Base Value	RW	(IEEE 32 bit)
	C84	3204	User	Digital Out 2 Frequency Full Value	RW	(IEEE 32 bit)
	C86	3206	User	Digital Out 2 Alarm Value	RW	(IEEE 32 bit)
D00	D00	3328	User	Analog Out Mode	RW	INT32
	D02	3330	User	Analog Out Type	RW	INT32
	D04	3332	User	Digital Out 1 Mode	RW	INT32
	D06	3334	User	Digital Out 1 Type	RW	INT32
	D08	3336	User	Digital Out 2 Mode	RW	INT32
	D0A	3338	User	Digital Out 2 Type	RW	INT32
D20	D20	3360	User	Analog Out Measurement Type	RW	INT32
	D22	3362	User	Analog Out Error Handling	RW	INT32
D40	D40	3392	User	Digital Out 1 Pulse Measurement Type	RW	INT32
	D42	3394	User	Digital Out 1 Pulse Test Value	RW	INT32
	D44	3396	User	Digital Out 1 Pulse Error Handling	RW	INT32
	D46	3398	User	Digital Out 1 Pulse Time	RW	INT32
D50	D50	3408	User	Digital Out 2 Pulse Measurement Type	RW	INT32
	D52	3410	User	Digital Out 2 Pulse Test Value	RW	INT32
	D54	3412	User	Digital Out 2 Pulse Error Handling	RW	INT32
	D56	3414	User	Digital Out 2 Pulse Time	RW	INT32
D60	D60	3424	User	Digital Out 1 Frequency Measurement Type	RW	INT32
	D62	3426	User	Digital Out 1 Test Frequency Value	RW	INT32
	D64	3428	User	Digital Out 1 Frequency Error Handling	RW	INT32
	D66	3430	User	Digital Out 1 Frequency Error Handling Value	RW	INT32
	D68	3432	User	Digital Out 1 Frequency Full Frequency	RW	INT32
D70	D70	3440	User	Digital Out 2 Frequency Measurement Type	RW	INT32

Table 5: MODBUS Map (cont.)

	Register (in Hex)	Register (in Decimal)	Access Level	Description	RO/RW	Format
	D72	3442	User	Digital Out 2 Test Frequency Value	RW	INT32
	D74	3444	User	Digital Out 2 Frequency Error Handling	RW	INT32
	D76	3446	User	Digital Out 2 Frequency Error Handling Value	RW	INT32
	D78	3448	User	Digital Out 2 Frequency Full Frequency	RW	INT32
D80	D80	3456	User	Digital Out 1 Alarm Measurement Type	RW	INT32
	D82	3458	User	Digital Out 1 Alarm Test Value	RW	INT32
	D84	3460	User	Digital Out 1 Alarm State	RW	INT32
	D86	3462	User	Digital Out 1 Alarm Type	RW	INT32
D90	D90	3472	User	Digital Out 2 Alarm Measurement Type	RW	INT32
	D92	3474	User	Digital Out 2 Alarm Test Value	RW	INT32
	D94	3476	User	Digital Out 2 Alarm State	RW	INT32
	D96	3478	User	Digital Out 2 Alarm Type	RW	INT32
E00	E00	3584	RO	Analog Out Measurement Value	RO	(IEEE 32 bit)
	E02	3586	RO	Digital Out 1 Pulse Measurement Value	RO	(IEEE 32 bit)
	E04	3588	RO	Digital Out 1 Frequency Measurement Value	RO	(IEEE 32 bit)
	E06	3590	RO	Digital Out 1 Alarm Measurement Value	RO	(IEEE 32 bit)
	E08	3592	RO	Digital Out 2 Pulse Measurement Value	RO	(IEEE 32 bit)
	E0A	3594	RO	Digital Out 2 Frequency Measurement Value	RO	(IEEE 32 bit)
	E0C	3596	RO	Digital Out 2 Alarm Measurement Value	RO	(IEEE 32 bit)
1100	1100	4352	Viewer	HART meter address	RW	INT32
	1102	4354	Viewer	HART preamble length	RW	INT32
	1104	4356	Viewer	HART device ID	RW	INT32
	1106	4358	Viewer	HART assembly number	RW	INT32

Table 5: MODBUS Map (cont.)

	Register (in Hex)	Register (in Decimal)	Access Level	Description	RO/RW	Format
1140	1140	4416	Viewer	HART Dynamic Variable Index _1	RW	INT32
	1142	4418	Viewer	HART Dynamic Variable Index _2	RW	INT32
	1144	4420	Viewer	HART Dynamic Variable Index _3	RW	INT32
	1146	4422	Viewer	HART Dynamic Variable Index _4	RW	INT32
1300	1300	4864	RO	HART Configuration Change Count	RO	INT32
	1302	4866	RO	HART Device Status	RO	INT32
	1304	4868	RO	HART Device Status Extended	RO	INT32
	1306	4870	RO	HART master status	RO	INT32
	1308	4872	RO	HART secondary status	RO	INT32
	130A	4874	RO	HART variable status	RO	INT32
1500	1500	5376	User	PC MODBUS baud rate	RW	INT32
	1502	5378	User	PC MODBUS parity	RW	INT32
	1504	5380	User	PC MODBUS stop bits	RW	INT32
	1506	5382	User	PC MODBUS meter address	RW	INT32
1540	1540	5440	User	Log control / status	RW	INT32
	1542	5442	User	Log interval	RW	INT32
	1544	5444	User	Logging time	RW	INT32
	1546	5446	User	Number of variables to log	RW	INT32
1580	1580	5504	User	variable address array	RW	INT32
15C0	15C0	5568	User	Variable unit code array	RW	INT32
1700	1700	5888	RO	PC Service baud rate	RO	INT32
	1702	5890	RO	PC Service parity	RO	INT32
	1704	5892	RO	PC Service stop bits	RO	INT32
	1706	5894	RO	PC Service meter address	RO	INT32
1740	1740	5952	RO	Number of records	RO	INT32
2000	2000	8192	User	Pipe Inner Diameter	RW	(IEEE 32 bit)
	2002	8194	User	Pipe Outer Diameter	RW	(IEEE 32 bit)
	2004	8196	User	Pipe Wall Thickness	RW	(IEEE 32 bit)
	2006	8198	User	Pipe Soundspeed	RW	(IEEE 32 bit)
	2008	8200	User	Lining Thickness	RW	(IEEE 32 bit)
	200A	8202	User	Lining Soundspeed	RW	(IEEE 32 bit)

Table 5: MODBUS Map (cont.)

	Register (in Hex)	Register (in Decimal)	Access Level	Description	RO/RW	Format
	200C	8204	User	XDR wedge angle	RW	(IEEE 32 bit)
	200E	8206	User	XDR wedge time	RW	(IEEE 32 bit)
	2010	8208	User	Wedge Sound speed	RW	(IEEE 32 bit)
	2012	8210	User	Fluid Sound speed	RW	(IEEE 32 bit)
	2014	8212	User	Fluid Sound speed Min	RW	(IEEE 32 bit)
	2016	8214	User	Fluid Sound speed Max	RW	(IEEE 32 bit)
	2018	8216	User	Fluid Static Density	RW	(IEEE 32 bit)
	201A	8218	User	Fluid Reference Density	RW	(IEEE 32 bit)
	201C	8220	User	Fluid Temperature	RW	(IEEE 32 bit)
	201E	8222	User	XDR space	RW	(IEEE 32 bit)
	2020	8224	User	Calibration Factor	RW	(IEEE 32 bit)
	2022	8226	User	Kinematic Viscosity	RW	(IEEE 32 bit)
2040	2040	8256	User	MultiK Velocity 1	RW	(IEEE 32 bit)
	2042	8258	User	MultiK Velocity 2	RW	(IEEE 32 bit)
	2044	8260	User	MultiK Velocity 3	RW	(IEEE 32 bit)
	2046	8262	User	MultiK Velocity 4	RW	(IEEE 32 bit)
	2048	8264	User	MultiK Velocity 5	RW	(IEEE 32 bit)
	204A	8266	User	MultiK Velocity 6	RW	(IEEE 32 bit)
2060	2060	8288	User	MultiK Velocity KFactor1	RW	(IEEE 32 bit)
	2062	8290	User	MultiK Velocity KFactor2	RW	(IEEE 32 bit)
	2064	8292	User	MultiK Velocity KFactor3	RW	(IEEE 32 bit)
	2066	8294	User	MultiK Velocity KFactor4	RW	(IEEE 32 bit)
	2068	8296	User	MultiK Velocity KFactor5	RW	(IEEE 32 bit)
	206A	8298	User	MultiK Velocity KFactor6	RW	(IEEE 32 bit)
2080	2080	8320	User	MultiK Reynolds 1	RW	(IEEE 32 bit)
	2082	8322	User	MultiK Reynolds 2	RW	(IEEE 32 bit)
	2084	8324	User	MultiK Reynolds 3	RW	(IEEE 32 bit)
	2086	8326	User	MultiK Reynolds 4	RW	(IEEE 32 bit)
	2088	8328	User	MultiK Reynolds 5	RW	(IEEE 32 bit)
	208A	8330	User	MultiK Reynolds 6	RW	(IEEE 32 bit)
20A0	20A0	8352	User	MultiK Reynolds KFactor1	RW	(IEEE 32 bit)
	20A2	8354	User	MultiK Reynolds KFactor2	RW	(IEEE 32 bit)
	20A4	8356	User	MultiK Reynolds KFactor3	RW	(IEEE 32 bit)
	20A6	8358	User	MultiK Reynolds KFactor4	RW	(IEEE 32 bit)
	20A8	8360	User	MultiK Reynolds KFactor5	RW	(IEEE 32 bit)
	20AA	8362	User	MultiK Reynolds KFactor6	RW	(IEEE 32 bit)

Table 5: MODBUS Map (cont.)

	Register (in Hex)	Register (in Decimal)	Access Level	Description	RO/RW	Format
20C0	20C0	8384	User	Correlation peak low limit	RW	(IEEE 32 bit)
	20C2	8386	User	Acceleration Limit	RW	(IEEE 32 bit)
	20C4	8388	User	Velocity Low limit - Used for Volumetric low limit calculation	RW	(IEEE 32 bit)
	20C6		User	Velocity High limit - Used for Volumetric High limit calculation	RW	(IEEE 32 bit)
	20C8	8392	User	Amplitude discriminator min limit	RW	(IEEE 32 bit)
	20CA	8394	User	Amplitude discriminator max limit	RW	(IEEE 32 bit)
	20CC	8396	User	Soundspeed Plus minus limit	RW	(IEEE 32 bit)
	20CE	8398	User	signal low limit	RW	(IEEE 32 bit)
20E0	20E0	8416	User	Zero Cutoff	RW	(IEEE 32 bit)
	20E2	8418	User	DeltaT Offset	RW	(IEEE 32 bit)
2100	2100	8448	User	Pipe Material	RW	INT32
	2102	8450	User	Lining Material	RW	INT32
	2104	8452	User	XDR Type	RW	INT32
	2106	8454	User	XDR frequency	RW	INT32
	2108	8456	User	XDR wedge type	RW	INT32
	210A	8458	User	Fluid Type	RW	INT32
	210C	8460	User	Lining existence	RW	INT32
	210E	8462	User	Traverse number	RW	INT32
2140	2140	8512	User	Enable Reynolds Correction	RW	INT32
	2142	8514	User	Enable Active MultiK	RW	INT32
	2144	8516	User	MultiK Type	RW	INT32
	2146	8518	User	MultiK Pairs	RW	INT32
2180	2180	8576	User	Peak%	RW	INT32
	2182	8578	User	Min Peak%	RW	INT32
	2184	8580	User	Max Peak%	RW	INT32
	2186	8582	User	Errors Allowed	RW	INT32
21C0	21C0	8640	User	Enable Active TW	RW	INT32
	21C2	8642	User	Enable Tracking Windows	RW	INT32
	21C4	8644	User	Response Time	RW	INT32
	21C6	8646	User	Sample Size	RW	INT32
2200	2200	8704	RO	Velocity	RO	(IEEE 32 bit)

Table 5: MODBUS Map (cont.)

	Register (in Hex)	Register (in Decimal)	Access Level	Description	RO/RW	Format
	2202	8706	RO	Volumetric	RO	(IEEE 32 bit)
	2204	8708	RO	Standard Volumetric	RO	(IEEE 32 bit)
	2206	8710	RO	Mass Flow	RO	(IEEE 32 bit)
2240	2240	8768	RO	Batch Fwd totals	RO	(IEEE 32 bit)
	2242	8770	RO	Batch rev totals	RO	(IEEE 32 bit)
	2244	8772	RO	Batch net totals	RO	(IEEE 32 bit)
	2246	8774	RO	Batch totals time	RO	(IEEE 32 bit)
	2248	8776	RO	Inventory Fwd totals	RO	(IEEE 32 bit)
	224A	8778	RO	inventory rev totals	RO	(IEEE 32 bit)
	224C	8780	RO	inventory net totals	RO	(IEEE 32 bit)
	224E	8782	RO	inventory totals time	RO	(IEEE 32 bit)
2280	2280	8832	RO	Transit Time Up	RO	(IEEE 32 bit)
	2282	8834	RO	Transit Time Dn	RO	(IEEE 32 bit)
	2284	8836	RO	DeltaT	RO	(IEEE 32 bit)
	2286	8838	RO	Up Signal Quality	RO	(IEEE 32 bit)
	2288	8840	RO	Dn Signal Quality	RO	(IEEE 32 bit)
	228A	8842	RO	Up Amp Disc	RO	(IEEE 32 bit)
	228C	8844	RO	Dn Amp Disc	RO	(IEEE 32 bit)
	228E	8846	RO	SNR on UP channel	RO	(IEEE 32 bit)
	2290	8848	RO	SNR on DOWN channel	RO	(IEEE 32 bit)
	2292	8850	RO	Time in buffer on Up channel	RO	(IEEE 32 bit)
	2294	8852	RO	Time in buffer on Dn channel	RO	(IEEE 32 bit)
	2296	8854	RO	Signal Gain Up	RO	(IEEE 32 bit)
	2298	8856	RO	Signal Gain Down	RO	(IEEE 32 bit)
22C0	22C0	8896	RO	Sound Speed	RO	(IEEE 32 bit)
	22C2	8898	RO	Current Reynolds Number	RO	(IEEE 32 bit)
	22C4	8900	RO	Current Correction Factor	RO	(IEEE 32 bit)
	22C6	8902	RO	Path Length P	RO	(IEEE 32 bit)
	22C8	8904	RO	Axial Length L	RO	(IEEE 32 bit)
2300	2300	8960	RO	Up +- Peak	RO	INT32
	2302	8962	RO	Dn +- Peak	RO	INT32
	2304	8964	RO	dynamic threshold on UP channel	RO	INT32
	2306	8966	RO	dynamic threshold on DOWN channel	RO	INT32

5.2 HART

5.2.1 Device Identification

The AT600 flowmeter supports the HART communication, for which the manufacturer ID is 0x9D (157 Dec) and the Device type Code is 0x9D73 (127 Dec).

5.2.2 Commands

5.2.2a Universal Commands

Table 6: Universal Commands for HART

Command	Function	Description
0	Read Unique Identifier	Returns identity information about the meter including: the Device Type, revision levels, and Device ID.
1	Read Primary Variable	Returns the Primary Variable value along with its Unit Code
2	Read Loop Current And Percent Of Range	Reads the Loop Current and its associated Percent of Range.
3	Read Dynamic Variables and Loop Current	Reads the Loop Current and up to four predefined Dynamic Variables. The Dynamic Variables and associated units are defined via Commands 51 and 53.
6	Write Polling Address	Writes the polling address and the loop current mode to the field device.
7	Read Loop Configuration	Read polling address and the loop current mode.
8	Read Dynamic Variable Classification	Reads the Classification associated with the Dynamic variable.
9	Read Device Variables with Status	Request the value and status of up to eight device Device or Dynamic Variables.
11	Read Unique Identifier Associated With Tag	If the specified tag matches that of the meter, it responds with the Command 0 response.
12	Read Message	Reads the Message contained within the meter.
13	Read Tag, Descriptor, Date	Reads the Tag, Descriptor, and Date contained within the meter.
14	Read Primary Variable Transducer Information	Reads the Transducer (meter) Serial Number, Limits/Minimum Span Units Code, Upper Transducer Limit, Lower Transducer Limit, and Minimum Span for the Primary Variable transducer.
15	Read Device Information	Reads the alarm selection code, transfer function code, range values units code upper range value, Primary Variable lower range value, damping value, write protect code, and private label distributor code.
16	Read Final Assembly Number	Reads the Final Assembly Number associated with the meter.
17	Write Message	Write the Message into the meter.
18	Write Tag, Descriptor, Date	Write the Tag, Descriptor, and Date Code into the meter.
19	Write Final Assembly Number	Write the Final Assembly Number into the meter.

Table 6: Universal Commands for HART (cont.)

Command	Function	Description
20	Read Long Tag	Read the 32-byte Long Tag.
21	Read Unique Identifier Associated with Long Tag	Read Unique Identifier Associated with Long Tag
22	Write Long Tag	Write the 32-byte Long Tag
38	Reset Configuration Changed Flag	Resets the configuration changed indicator (Device Status Byte bit 6).
48	Read Additional Device Status	Returns meter status information not included in the Response Code or Device Status Byte.

5.2.2b Common Commands

Table 7: Common Commands

Command	Function	Description
33	Read Device Variables	Allows a Master to request the value of up to four Device Variables.
50	Read Dynamic Variable Assignments	Reads the Device Variables assigned to the Primary, Secondary, Tertiary, and Quaternary Variables.
51	Write Dynamic Variable Assignments	Allows the user to assign Device Variables to the Primary, Secondary, Tertiary, and Quaternary Variables
54	Read Device Variable Information	Get device variable information
59	Write Number of Response Preambles	Sets the number of asynchronous preamble bytes to be sent by the meter before the start of a response message.

5.2.2c Device Specific Commands

The AT600 flow meter supports the following device specific commands. In some commands, the parameter is the measurement type. Measurement types are shown in Table 8 below.

Table 8: Measurement Type

Index	Meaning
1	Velocity
2	Volumetric
3	Standard Volumetric
4	Mass Flow
5	Batch Fwd. Totalizer
6	Batch Rev. Totalizer
7	Batch Net Totalizer
8	Batch Totalizer Time
9	Inventory Fwd. Totalizer
10	Inventory Rev. Totalizer
11	Inventory Net Totalizer
12	Inventory Totalizer Time
13	Sound Speed
14	Reynolds Kfactor
15	MultiK Kfactor
16	Transit Time Up
17	Transit Time Down
18	Deltat
19	Signal Quality Up
20	Signal Quality Down
21	Amp Disc Up
22	Amp Disc Down
23	SNR Up
24	SNR Down
25	ActiveTW Up
26	ActiveTW Down
27	Gain Up
28	Gain Down
29	System Error Bitmap
30	System Report Error Number
31	Peak Up
32	Peak Down
33	Peak Pct. Up
34	Peak Pct. Down

Command 128 (0x80): Login with Password

This command will send a password to the flow meter. If the password is right, the flow meter will allow a user to operate it until there are not any commands to the flow meter after 10 minutes.

Table 9: Request Data Bytes for Login with Password

Byte	Format	Description
0 - 3	Unsigned-32	User password

Table 10: Response Data Bytes for Login with Password

Byte	Format	Description
None		

Table 11: Command-Specific Response Codes for Login with Password

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 129 (0x81): Logout and Save

This command will commit the changes and logout the flow meter.

Table 12: Request Data Bytes for Logout and Save

Byte	Format	Description
None		

Table 13: Response Data Bytes for Logout and Save

Byte	Format	Description
None		

Command 129 (0x81): Logout and Save (cont.)

Table 14: Command-Specific Response Codes for Logout and Save

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 130 (0x82): Logout without Saving

This command will logout the flow meter and not save anything.

Table 15: Request Data Bytes for Logout without Saving

Byte	Format	Description
None		

Table 16: Response Data Bytes for Logout without Saving

Byte	Format	Description
None		

Table 17: Command-Specific Response Codes for Logout without Saving

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 135 (0x87): Read Current User Access Right

This command will read the current user access right.

Table 18: Request Data Bytes for Read Current User Access Right

Byte	Format	Description
None		

Table 19: Response Data Bytes for Read Current User Access Right

Byte	Format	Description
None		

Table 20: Command-Specific Response Codes for Read Current User Access Right

Code	Class	Description
0	Success	No Command-Specific Errors
1-127		Undefined

Command 136 (0x88): Sends New Password

This command will send a new password to the flow meter. If the user has the right, the flow meter changes the user password.

Table 21: Request Data Bytes for Sends New Password

Byte	Format	Description
0 - 3	Unsigned-32	User password

Table 22: Response Data Bytes for Sends New Password

Byte	Format	Description
None		

Command 136 (0x88): Sends new password (cont.)

Table 23: Command-Specific Response Codes for Sends New Password

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 144 (0x90): Read Unit Group

This command will read the unit group in the meter.

Table 24: Request Data Bytes for Read Unit Group

Byte	Format	Description
0	Unsigned-8	Group index: 1: Velocity unit; 2: Actual Volumetric unit; 3: Standard Volumetric unit; 4: Mass unit; 5: Totalizer unit; 6: Density unit; 7: Pipe Dimension; 8: Thermal; 9: Acceleration;

Command 144 (0x90): Read Unit Group (cont.)

Table 25: Response Data Bytes for Read Unit Group

Byte	Format	Description
0	Unsigned-8	Group index: 1: Velocity unit; 2: Actual Volumetric unit; 3: Standard Volumetric unit; 4: Mass unit; 5: Totalizer unit; 6: Density unit; 7: Pipe Dimension; 8: Thermal; 9: Acceleration;
1	Enum	unit code

Table 26: Command-Specific Response Codes for Read Unit Group

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 145 (0x91): Read Density Value

This command will read density value in meter.

Table 27: Request Data Bytes for Read Density Value

Byte	Format	Description
0	Unsigned-8	Density type: 1: Actual Density; 2: Reference Density;

Command 145 (0x91): Read Density Value (cont.)

Table 28: Response Data Bytes for Read Density Value

Byte	Format	Description
0	Unsigned-8	Density type: 1: Actual Density; 2: Reference Density;
1	Unsigned-8	Density Unit Code
2 - 5	Float	Density value

Table 29: Command-Specific Response Codes for Read Density Value

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 146 (0x92): Read Backlight Setting

This command is to read the backlight setting.

Table 30: Request Data Bytes for Read Backlight Setting

Byte	Format	Description
None		

Table 31: Response Data Bytes for Read Backlight Setting

Byte	Format	Description
0	Unsigned-8	Backlight control switch (0:off/ 1:on)
1 - 4	Unsigned-32	Display backlight timeout, unit is second.

Command 146 (0x92): Read Backlight Setting (cont.)

Table 32: Command-Specific Response Codes for Read Backlight Setting

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-127		Undefined

Command 152 (0x98): Write Unit Group

This command will write unit group in meter.

Table 33: Request Data Bytes for Write Unit Group

Byte	Format	Description
0	Unsigned-8	Group index: 1: Velocity unit; 2: Actual Volumetric unit; 3: Standard Volumetric unit; 4: Mass unit; 5: Totalizer unit; 6: Density unit; 7: Pipe Dimension; 8: Thermal; 9: Acceleration;
1	Enum	unit code

Command 152 (0x98): Write Unit Group (cont.)

Table 34: Response Data Bytes for Write Unit Group

Byte	Format	Description
0	Unsigned-8	Group index: 1: Velocity unit; 2: Actual Volumetric unit; 3: Standard Volumetric unit; 4: Mass unit; 5: Totalizer unit; 6: Density unit; 7: Pipe Dimension; 8: Thermal; 9: Acceleration;
1	Enum	unit code

Table 35: Command-Specific Response Codes for Write Unit Group

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3 - 4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8 - 15		Undefined
16	Error	Access Restricted
17 - 127		Undefined

Command 153 (0x99): Write Density Value

This command will write density value in meter.

Table 36: Request Data Bytes for Write Density Value

Byte	Format	Description
0	Unsigned-8	Density type: 1: Actual Density; 2: Reference Density;
1	Unsigned-8	Density Unit Code
2 - 5	Float	Density value

Table 37: Response Data Bytes for Write Density Value

Byte	Format	Description
0	Unsigned-8	Density type: 1: Actual Density; 2: Reference Density;
1	Unsigned-8	Density Unit Code
2 - 5	Float	Density value

Table 38: Command-Specific Response Codes for Write Density Value

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3 - 4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8 - 15		Undefined
16	Error	Access Restricted
17 - 127		Undefined

Command 154 (0x9A): Write Display Backlight

This command is to set the back light.

Table 39: Request Data Bytes for Write Display Backlight

Byte	Format	Description
0	Unsigned-8	Backlight control switch (0:off/ 1:on)
1 - 4	Unsigned-32	Display backlight timeout, unit is second.

Table 40: Response Data Bytes for Write Display Backlight

Byte	Format	Description
0	Unsigned-8	Backlight control switch (0:off/ 1:on)
1 - 4	Unsigned-32	Display backlight timeout, unit is second.

Table 41: Command-Specific Response Codes for Write Display Backlight

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 160 (0xA0): Read Analog Measurement Range Values

This command is to read the Analog Measurement range.

Table 42: Request Data Bytes for Read Analog Measurement Range Values

Byte	Format	Description
None		

Table 43: Response Data Bytes for Read Analog Measurement Range Value

Byte	Format	Description
0	Unsigned-8	Upper and Lower Range Values Unit Code
1 - 4	Float	Upper Range Value
5 - 8	Float	Lower Range Value

Command 160 (0xA0): Read Analog Measurement Range Values (cont.)

Table 44: Command-Specific Response Codes for Read Analog Measurement Range Value

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 5		Undefined
6	Error	Device-Specific Command Error
7 - 127		Undefined

Command 161 (0xA1): Read Loop Current Error Handling

This command is to read the loop current output error handling.

Table 45: Request Data Bytes for Read Loop Current Error Handling

Byte	Format	Description
None		

Table 46: Response Data Bytes for Read Loop Current Error Handling

Byte	Format	Description
0	Unsigned-8	Analog Output Error Handling: 0: Low; 1: High; 2: Hold; 3: Other value;
1 - 4	Float	Error Value, unit is mA

Table 47: Command-Specific Response Codes for Read Loop Current Error Handling

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 5		Undefined
6	Error	Device-Specific Command Error
7 - 127		Undefined

Command 168 (0xA8): Enter / Exit Fixed Loop Current

Enter or exit the fixed mode of loop current.

Table 48: Request Data Bytes for Enter / Exit Fixed Loop Current

Byte	Format	Description
0	Unsigned-8	Fixed current level: 0: Exit Fixed Loop Current; 1: Fixed 4 mA; 2: Fixed 20mA; 3: Fixed Percentage of Scale

Table 49: Response Data Bytes for Enter / Exit Fixed Loop Current

Byte	Format	Description
0	Unsigned-8	Fixed current level: 0: Exit Fixed Loop Current; 1: Fixed 4 mA; 2: Fixed 20mA; 3: Fixed Percentage of Scale

Table 50: Command-Specific Response Code for Enter / Exit Fixed Loop Currents

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8 - 10		Undefined
11	Error	Loop Current Not Active
12 - 15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33 - 127		Undefined

Command 169 (0xA9): Set Loop Current Zero

This command is to trim the zero or lower endpoint value of the loop current to its minimum.

Table 51: Request Data Bytes for Set Loop Current Zero

Byte	Format	Description
0-3	Float	Externally Measured Loop Current Level, units of milliamperes

Table 52: Response Data Bytes for Set Loop Current Zero

Byte	Format	Description
0-3	Float	Externally Measured Loop Current Level, units of milliamperes

Table 53: Command-Specific Response Codes for Set Loop Current Zero

Code	Class	Description
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Passed Parameter Too Large
4	Error	Passed Parameter Too Small
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8		Undefined
9	Error	Incorrect Loop Current Mode or Value
10 - 15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33 - 127		Undefined

Command 170 (0xAA): Set Loop Current Gain

This command is to trim the gain or upper endpoint value of the loop current to its maximum.

Table 54: Request Data Bytes for Set Loop Current Gain

Byte	Format	Description
0-3	Float	Externally Measured Loop Current Level, units of milliamperes

Table 55: Response Data Bytes for Set Loop Current Gain

Byte	Format	Description
0-3	Float	Externally Measured Loop Current Level, units of milliamperes

Table 56: Command-Specific Response Codes for Set Loop Current Gain

Code	Class	Description
0	Success	No Command-Specific Errors
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Passed Parameter Too Large
4	Error	Passed Parameter Too Small
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8		Undefined
9	Error	Incorrect Loop Current Mode or Value
10 - 15		Undefined
16	Error	Access Restricted
17 - 31		Undefined
32	Error	Busy
33 - 127		Undefined

Command 171 (0xAB): Set Loop Current Percentage

This command is to set the output percentage of loop current.

Table 57: Request Data Bytes for Set Loop Current Percentage

Byte	Format	Description
0 - 3	Float	Loop Current Percentage, units of percent.

Table 58: Response Data Bytes for Set Loop Current Percentage

Byte	Format	Description
0 - 3	Float	Loop Current Percentage, units of percent.

Table 59: Command-Specific Response Codes for Set Loop Current Percentage

Code	Class	Description
0	Success	No Command-Specific Errors
1-2		Undefined
3	Error	Passed Parameter Too Large
4	Error	Passed Parameter Too Small
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8		Undefined
9	Error	Incorrect Loop Current Mode or Value
10 - 15		Undefined
16	Error	Access Restricted
17-31		Undefined
32	Error	Busy
33 - 127		Undefined

Command 172 (0xAC): Set Analog Measurement Range Values

This command is to set the Analog Measurement range.

Table 60: Request Data Bytes for Set Analog Measurement Range Values

Byte	Format	Description
0	Unsigned-8	Upper and Lower Range Values Unit Code
1 - 4	Float	Upper Range Value
5 - 8	Float	Lower Range Value

Table 61: Response Data Bytes for Set Analog Measurement Range Values

Byte	Format	Description
0	Unsigned-8	Upper and Lower Range Values Unit Code
1 - 4	Float	Upper Range Value
5 - 8	Float	Lower Range Value

Table 62: Command-Specific Response Codes for Set Analog Measurement Range Values

Code	Class	Description
0	Success	No Command-Specific Errors
1 - 4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8	Warning	Set To Nearest Possible Value (Upper or Lower Range Pushed)
9	Error	Lower Range Value Too High
10	Error	Lower Range Value Too Low
11	Error	Upper Range Value Too High
12	Error	Upper Range Value Too Low
13 - 15		Undefined
16	Error	Access Restricted
17		Undefined
18	Error	Invalid Units Code
19 - 31		Undefined
32	Error	Busy
33 - 127		Undefined

Command 173 (0xAD): Set Loop Current Error Handling

This command will set the loop current output error handling.

Table 63: Request Data Bytes for Set Loop Current Error Handling

Byte	Format	Description
0	Unsigned-8	Analog Output Error Handling: 0: Low; 1: High; 2: Hold; 3: Other value;
1 - 4	Float	Error Value, unit is mA

Table 64: Response Data Bytes for Set Loop Current Error Handling

Byte	Format	Description
0	Unsigned-8	Analog Output Error Handling: 0: Low; 1: High; 2: Hold; 3: Other value;
1 - 4	Float	Error Value, unit is mA

Table 65: Command-Specific Response Codes for Set Loop Current Error Handling

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 176 (0xB0): Read Digital Configuration

This command is to read the digital output configuration.

Table 66: Request Data Bytes

Byte	Format	Description
None	Unsigned-8	Channel Number (1/2)

Table 67: Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Channel Number
1	Unsigned-8	Digital Output type: 0: Off; 1: Pulse; 2: Frequency; 3: Alarm;

Table 68: Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 177 (0xB1): Read Pulse Configuration

This command is to read the pulse configuration.

Table 69: Request Data Bytes for Read Pulse Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number (1/2)

Table 70: Response Data Bytes for Read Pulse Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number
1	Unsigned-8	Measurement Type: 5: Forward Batch Total; 6: Reverse Batch Total; 7: Net Batch Total;
2	Unsigned-8	Pulse Value Unit
3 - 6	Float	Pulse Value
7 - 10	Unsigned-32	Pulse Time, Unit is MS
11	Unsigned-8	Pulse Error Handling: 2: Hold Good Value; 4: Stop;

Table 71: Command-Specific Response Codes for Read Pulse Configuration

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 178 (0xB2): Read Frequency Configuration

This command is to read the frequency configuration.

Table 72: Request Data Bytes for Read Frequency Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number (1/2)

Table 73: Response Data Bytes for Read Frequency Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number
1	Unsigned-8	Measurement Type
2	Unsigned-8	Frequency Value Unit
3 - 6	Float	Frequency Base Value
7 - 10	Float	Frequency Full Value
11 - 14	Unsigned-32	Full Frequency, unit is Hz
15	Unsigned-8	Frequency Error Handling: 0: Low; 1: High; 2: Hold; 3: Value
16 - 19	Unsigned-32	Error Handling value, unit is Hz

Table 74: Command-Specific Response Codes for Read Frequency Configuration

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 179 (0xB3): Read Alarm Configuration

This command is to read the alarm configuration.

Table 75: Request Data Bytes for Read Alarm Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number (1/2)

Table 76: Response Data Bytes for Read Alarm Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number
1	Unsigned-8	Measurement Type
2	Unsigned-8	Alarm Value Unit
3 - 6	Float	Alarm Value
7	Unsigned-8	Alarm Type: 0: Low; 1: High; 2: Fault
8	Unsigned-8	Alarm State: 0: Normally; 1: Failsafe;

Table 77: Command-Specific Response Codes for Read Alarm Configuration

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 184 (0xB8): Write Digital Configuration

This command is to write the digital output configuration.

Table 78: Request Data Bytes for Write Digital Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Digital Output type: 0: Off; 1: Pulse; 2: Frequency; 3: Alarm;

Table 79: Response Data Bytes for Write Digital Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Digital Output type: 0: Off; 1: Pulse; 2: Frequency; 3: Alarm;

Table 80: Command-Specific Response Codes for Write Digital Configuration

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
8-127		Undefined

Command 185 (0xB9): Write Pulse Configuration

This command is to write the pulse configuration.

Table 81: Request Data Bytes for Write Pulse Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Measurement Type: 5: Forward Batch Total; 6: Reverse Batch Total; 7: Net Batch Total;
2	Unsigned-8	Pulse Value Unit
3 - 6	Float	Pulse Value
7 - 10	Unsigned-32	Pulse Time, Unit is ms
11	Unsigned-8	Pulse Error Handling: 2: Hold Good Value; 4: Stop;

Table 82: Response Data Bytes for Write Pulse Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Measurement Type: 5: Forward Batch Total; 6: Reverse Batch Total; 7: Net Batch Total;
2	Unsigned-8	Pulse Value Unit
3 - 6	Float	Pulse Value
7 - 10	Float	Pulse Time, Unit is ms
11	Unsigned-8	Pulse Error Handling: 0: Hold Good Value; 1: Stop;

Command 185 (0xB9): Write Pulse Configuration (cont.)

Table 83: Command-Specific Response Codes for Write Pulse Configuration

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
8-127		Undefined

Command 186 (0xBA): Write Frequency Configuration

This command is to write the frequency configuration.

Table 84: Request Data Bytes for Write Frequency Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Measurement Type
2	Unsigned-8	Frequency Value Unit
3 - 6	Float	Frequency Base Value
7 - 10	Float	Frequency Full Value
11 - 14	Unsigned-32	Full Frequency, unit is Hz
15	Unsigned-8	Frequency Error Handling: 0: Low; 1: High; 2: Hold; 3: Value
16 - 19	Unsigned-32	Error Handling value, unit is Hz

Command 186 (0xBA): Write Frequency Configuration (cont.)

Table 85: Response Data Bytes for Write Frequency Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Measurement Type
2	Unsigned-8	Frequency Value Unit
3 - 6	Float	Frequency Base Value
7 - 10	Float	Frequency Full Value
11 - 14	Float	Full Frequency, unit is Hz
15	Unsigned-8	Frequency Error Handling: 0: Low; 1: High; 2: Hold; 3: Value
16 - 19	Unsigned-32	Error Handling value, unit is Hz

Table 86: Command-Specific Response Codes for Write Frequency Configuration

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
8-127		Undefined

Command 187 (0xBB): Write Alarm Configuration

This command is to write the alarm configuration.

Table 87: Request Data Bytes for Write Alarm Configuration

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Measurement Type
2	Unsigned-8	Alarm Value Unit
3 - 6	Float	Alarm Value
7	Unsigned-8	Alarm Type: 0: Low; 1: High; 2: Fault
8	Unsigned-8	Alarm State: 0: Normally; 1: Failsafe;

Table 88: Response Data Bytes for Write Alarm Configurations

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Measurement Type
2	Unsigned-8	Alarm Value Unit
3 - 6	Float	Alarm Value
7	Unsigned-8	Alarm Type: 0: Low; 1: High; 2: Fault
8	Unsigned-8	Alarm State: 0: Normally; 1: Failsafe;

Table 89: Command-Specific Response Codes for Write Alarm Configuration

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
8-127		Undefined

Command 191 (0xBF): Test Digital Output

This command is to test the digital output

Table 90: Request Data Bytes for Test Digital Output

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Test DO Type Test Stop Pulse Frequency Alarm
2 - 5	Unsigned-32	Test value

Table 91: Response Data Bytes for Test Digital Output

Byte	Format	Description
0	Unsigned-8	Channel Number(1/2)
1	Unsigned-8	Test DO Type Test Stop Pulse Frequency Alarm;
2 - 5	Unsigned-32	Test value

Table 92: Command-Specific Response Codes for Test Digital Output

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
8-127		Undefined

Command 192 (0xC0): Read Pipe Size

This command is to read pipe size.

Table 93: Request Data Bytes for Read Pipe Size

Byte	Format	Description
None		

Table 94: Response Data Bytes for Read Pipe Size

Byte	Format	Description
0	Unsigned-8	Pipe size unit
1 - 4	Float	Pipe OD Value
5 - 8	Float	Pipe ID Value
9 - 12	Float	Pipe WT Value

Table 95: Command-Specific Response Codes for Read Pipe Size

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-127		Undefined

Command 193 (0xC1): Read Pipe Material

This command is to read pipe material.

Table 96: Request Data Bytes for Read Pipe Material

Byte	Format	Description
None		

Table 97: Response Data Bytes for Read Pipe Material

Byte	Format	Description
0 - 3	Unsigned-32	Pipe Material
4 - 7	Float	Pipe Sound speed

Table 98: Command-Specific Response Codes for Read Pipe Material

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-127		Undefined

Command 194 (0xC2): Read Pipe Lining Attribute

This command is to read pipe lining attribute.

Table 99: Request Data Bytes for Read Pipe Lining Attribute

Byte	Format	Description
None		

Table 100: Response Data Bytes for Read Pipe Lining Attribute

Byte	Format	Description
0	Unsigned-8	Lining Existing
1 – 4	Float	Lining Thickness
5 - 8	Unsigned-32	Lining Material
9 – 12	Float	Lining Sound speed

Table 101: Command-Specific Response Codes for Read Pipe Lining Attribute

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-127		Undefined

Command 195 (0xC3): Read Sensor Meter Setup

This command is to read the sensor meter setup.

Table 102: Request Data Bytes for Read Sensor Meter Setup

Byte	Format	Description
None		

Table 103: Response Data Bytes for Read Sensor Meter Setup

Byte	Format	Description
0-3	Float	Zero Cutoff

Table 104: Command-Specific Response Codes for Read Sensor Meter Setup

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-127		Undefined

Command 196 (0xC4): Read Transducer Information

This command is to read transducer information.

Table 105: Request Data Bytes for Read Transducer Information

Byte	Format	Description
None		

Table 106: Response Data Bytes for Read Transducer Information

Byte	Format	Description
0 - 3	Unsigned-32	Transducer type: 0: Other; 10: CPT-0.5 11: CPT-2.0 12: CPT-0.5-MT C-PB-05-M 13: CPT-1.0-MT C-PB-10-M 14: CPT-2.0-MT C-PB-20-M 15: CPT-0.5-HT 16: CPT-1.0-HT 17: CPT-2.0-HT 18: CPS-0.5 19: CPSM-2.0 20: CTS-1.0 21: CTS-1.0-HT 22: CTS-2.0 23: C-LP-40-HM 24: C-LP-40-NM 25: CPB-0.5-HT 26: CPB-2.0-MT 27: CPB-0.5-MT 28: CPB-2.0 29: CPB-0.5 30: CPS-1.0 CPT-1.

Table 106: Response Data Bytes for Read Transducer Information (cont.)

Byte	Format	Description
		31: CWL-2 32: CPS-1.0 33: CPW (WT-1P-1.0 on AB82 34: CPW (WT-1P-0.5 on NDT plastic 35: CPW (WT-1P-1.0 on NDT plastic 36: CPB-1.0-HT 37: CPB-2.0-HT 38: CPB-1.0 39: CPB-1.0-MT 301: C-RL-0.5 302: C-RL-1 304: C-RL-0.5
		305: C-RL-1 307: C-RL-0.5 308: C-RL-1 310: C-RV-0.5 311: C-RV-1 313: C-RW-0.5 314: C-RW-1 401: C-RS 0.5M 402: C-RS 1M 403: C-RS 2M 407: UTXDR-2 408: UTXDR-5 601: CAT0.5M 602: CAT1M 603: CAT2M
4 - 7	Unsigned-32	Transducer Frequency
8 - 11	Unsigned-32	Transducer Wedge Type
12 - 15	Float	Transducer Wedge Angle
16 - 19	Float	Transducer Wedge SOS
20 - 23	Float	Transducer Tw

Command 196 (0xC4): Read Transducer Information

Table 107: Command-Specific Response Codes for Read Transducer Information

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-127		Undefined

Command 197 (0xC5): Read Transducer Traverses and Spacing

This command is to read transducer traverses and spacing.

Table 108: Request Data Bytes for Read Transducer Traverses and Spacing

Byte	Format	Description
None		

Table 109: Response Data Bytes for Read Transducer Traverses and Spacing

Byte	Format	Description
0	Unsigned-8	Transducer traverse
1 - 4	float	Transducer spacing

Table 110: Command-Specific Response Codes for Read Transducer Traverses and Spacing

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-127		Undefined

Command 198 (0xC6): Read Fluid Information

This command is to read fluid information.

Table 111: Request Data Bytes for Read Fluid Information

Byte	Format	Description
None		

Table 112: Response Data Bytes for Read Fluid Information

Byte	Format	Description
0 - 3	Unsigned-32	Fluid Type: 0: Other 1. Water
4 - 7	Float	Fluid SOS
8 – 11	Float	Fluid minimum SOS
12 - 15	Float	Fluid Maximum SOS
16 - 19	Float	Fluid Temperature

Table 113: Command-Specific Response Codes for Read Fluid Information

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-127		Undefined

Command 200 (0xC8): Write Pipe Size

This command is to write pipe size.

Table 114: Request Data Bytes for Write Pipe Size

Byte	Format	Description
0	Unsigned-8	Pipe size unit
1 - 4	Float	Pipe OD Value
5 - 8	Float	Pipe ID Value
9 - 12	Float	Pipe WT Value

Command 200 (0xC8): Write Pipe Size (cont.)

Table 115: Response Data Bytes for Write Pipe Size

Byte	Format	Description
0	Unsigned-8	Pipe size unit
1 - 4	Float	Pipe OD Value
5 - 8	Float	Pipe ID Value
9 - 12	Float	Pipe WT Value

Table 116: Command-Specific Response Codes for Write Pipe Size

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17		Undefined
18	Error	Wrong Unit code
19-127		Undefined

Command 201 (0xC9): Write Pipe Material

This command is to write Pipe Material.

Table 117: Request Data Bytes for Write Pipe Material

Byte	Format	Description
0 - 3	Unsigned-32	Pipe Material
4 - 7	Float	Pipe Sound speed

Table 118: Response Data Bytes for Write Pipe Material

Byte	Format	Description
0 - 3	Unsigned-32	Pipe Material
4 - 7	Float	Pipe Sound speed

Command 201 (0xC9): Write Pipe Material (cont.)

Table 119: Command-Specific Response Codes for Write Pipe Material

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 202 (0xCA): Write Pipe Lining Attribute

This command is to write pipe lining attribute.

Table 120: Request Data Bytes for Write Pipe Lining Attribute

Byte	Format	Description
0	Unsigned-8	Lining Existing
1 – 4	Float	Lining Thickness
5 - 8	Unsigned-32	Lining Material
9 – 12	Float	Lining Sound speed

Table 121: Response Data Bytes for Write Pipe Lining Attribute

Byte	Format	Description
0	Unsigned-8	Lining Existing
1 – 4	Float	Lining Thickness
5 - 8	Unsigned-32	Lining Material
9 – 12	Float	Lining Sound speed

Command 202 (0xCA): Write Pipe Lining Attribute (cont.)

Table 122: Command-Specific Response Codes for Write Pipe Lining Attribute

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 203 (0xCB): Write Sensor Meter Setup

This command is to write sensor meter setup.

Table 123: Request Data Bytes for Write Sensor Meter Setup

Byte	Format	Description
0 - 3	Float	Zero Cutoff

Table 124: Response Data Bytes

Byte	Format	Description
0 - 3	Float	Zero Cutoff

Table 125: Command-Specific Response Codes for Write Sensor Meter Setup

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 204 (0xCC): Write Transducer Information

This command is to write transducer information.

Table 126: Request Data Bytes for Write Transducer Information

Byte	Format	Description
0 - 3	Unsigned-32	Transducer type: 0: Other; 10: CPT-0.5 11: CPT-2.0 12: CPT-0.5-MT C-PB-05-M 13: CPT-1.0-MT C-PB-10-M 14: CPT-2.0-MT C-PB-20-M 15: CPT-0.5-HT 16: CPT-1.0-HT 17: CPT-2.0-HT 18: CPS-0.5 19: CPSM-2.0 20: CTS-1.0 21: CTS-1.0-HT 22: CTS-2.0 23: C-LP-40-HM 24: C-LP-40-NM 25: CPB-0.5-HT 26: CPB-2.0-MT 27: CPB-0.5-MT 28: CPB-2.0 29: CPB-0.5 30: CPS-1.0 CPT-1.0 31: CWL-2 32: CPS-1.0 33: CPW (WT-1P-1.0 on AB82 34: CPW (WT-1P-0.5 on NDT plastic 35: CPW (WT-1P-1.0 on NDT plastic 36: CPB-1.0-HT 37: CPB-2.0-HT 38: CPB-1.0 39: CPB-1.0-MT

Table 126: Request Data Bytes for Write Transducer Information (cont.)

Byte	Format	Description
		301: C-RL-0.5 302: C-RL-1 304: C-RL-0.5 305: C-RL-1 307: C-RL-0.5
0 - 3	Unsigned-32	Transducer type: 0: Other;
4 - 7	Unsigned-32	Transducer Frequency
8 - 11	Unsigned-32	Transducer Wedge Type
12 – 15	Unsigned-32	Transducer Wedge Angle
16 – 19	Unsigned-32	Transducer Wedge SOS
20 - 23	Unsigned-32	Transducer Tw

Command 204 (0xCC): Write Transducer Information (cont.)

Table 127: Response Data Bytes for Write Transducer Information

Byte	Format	Description
0 - 3	Unsigned-32	Transducer type: 0: Other;
4 - 7	Unsigned-32	Transducer Frequency
8 - 11	Unsigned-32	Transducer Wedge Type
12 – 15	Unsigned-32	Transducer Wedge Angle
16 – 19	Unsigned-32	Transducer Wedge SOS
20 - 23	Unsigned-32	Transducer Tw

Table 128: Command-Specific Response Codes for Write Transducer Information

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 205 (0xCD): Write Transducer Traverses and Spacing

This command is to write transducer traverses and spacing.

Table 129: Request Data Bytes for Write Transducer Traverses and Spacing

Byte	Format	Description
0	Unsigned-8	Transducer traverse
1 - 4	float	Transducer spacing

Table 130: Response Data Bytes for Write Transducer Traverses and Spacing

Byte	Format	Description
0	Unsigned-8	Transducer traverse
1 - 4	Unsigned-32	Transducer spacing

Table 131: Command-Specific Response Codes for Write Transducer Traverses and Spacing

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 206 (0xCE): Write Fluid Information

This command is to write fluid information.

Table 132: Request Data Bytes for Write Fluid Information

Byte	Format	Description
0 - 3	Unsigned-32	Fluid Type: 0: Other 1. Water
4 - 7	Float	Fluid SOS
8 – 11	Float	Fluid minimum SOS
12 - 15	Float	Fluid Maximum SOS
16 - 19	Float	Fluid Temperature

Table 133: Response Data Bytes for Write Fluid Information

Byte	Format	Description
0 - 3	Unsigned-32	Fluid Type: 0: Other 1. Water
4 - 7	Float	Fluid SOS
8 – 11	Float	Fluid minimum SOS
12 - 15	Float	Fluid Maximum SOS
16 - 19	Float	Fluid Temperature

Table 134: Command-Specific Response Codes

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 208 (0xD0): Read Calibration Configuration

This command is to read Calibration Configuration.

Table 135: Request Data Bytes for Read Calibration Configuration

Byte	Format	Description
None		

Table 136: Response Data Bytes for Read Calibration Configuration

Byte	Format	Description
0	Unsigned-8	Reynolds correction
1	Unsigned-8	Active MultiK Enable
2	Unsigned-8	KFactor Type: 0: Velocity, 1: Reynolds
3 – 6	Float	Static KFactor
7	Unsigned-8	KFactor Points
8 - 11	Float	Kinematic Viscosity

Table 137: Command-Specific Response Codes for Read Calibration Configuration

Code	Class	Description
0	Success	No Command-Specific Errors
1-5		Undefined
6	Error	Device-Specific Command Error
7-127		Undefined

Command 209 (0xD1): Read Velocity KFactor Table

This command is to read the Velocity KFactor table.

Table 138: Request Data Bytes for Read Velocity KFactor Table

Byte	Format	Description
0	Unsigned-8	Velocity KFactor Index (1 - 6)

Table 139: Response Data Bytes for Read Velocity KFactor Table

Byte	Format	Description
0	Unsigned-8	Velocity KFactor Index (1 - 6)
1	Unsigned-8	Velocity Unit
2 – 5	Float	Velocity Value
6 – 9	Float	Velocity KV Value;

Table 140: Command-Specific Response Codes for Read Velocity KFactor Table

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 210 (0xD2): Read Reynolds KFactor Table

This command is to read Reynolds KFactor table.

Table 141: Request Data Bytes for Read Reynolds KFactor Table

Byte	Format	Description
0	Unsigned-8	Reynolds KFactor Index (1 - 6)

Table 142: Response Data Bytes for Read Reynolds KFactor Table

Byte	Format	Description
0	Unsigned-8	Reynolds KFactor Index (1 - 6)
1 – 4	Float	Reynolds Value
5 – 8	Float	Reynolds KV Value;

Table 143: Command-Specific Response Codes for Read Reynolds KFactor Table

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 216 (0xD8): Write Calibration Configuration

This command is to write Calibration Configuration.

Table 144: Request Data Bytes for Write Calibration Configuration

Byte	Format	Description
0	Unsigned-8	Reynolds correction: 0: Disable, 1: Enable
1	Unsigned-8	Active MultiK Enable: 0: Disable, 1: Enable
2	Unsigned-8	KFactor Type: 0: Velocity, 1: Reynolds
3 – 6	Float	Static KFactor
7	Unsigned-8	KFactor Points
8 - 11	Float	Kinematic Viscosity

Table 145: Response Data Bytes for Write Calibration Configuration

Byte	Format	Description
0	Unsigned-8	Reynolds correction
1	Unsigned-8	Active MultiK Enable
2	Unsigned-8	KFactor Type: 0: Velocity, 1: Reynolds
3 – 6	Float	Static KFactor
7	Unsigned-8	KFactor Points
8 - 11	Float	Kinematic Viscosity

Table 146: Command-Specific Response Codes for Write Calibration Configuration

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 217 (0xD9): Write Velocity KFactor Table

This command is to write Velocity KFactor table.

Table 147: Request Data Bytes for Write Velocity KFactor Table

Byte	Format	Description
0	Unsigned-8	Velocity KFactor Index (1 - 6)
1	Unsigned-8	Velocity Unit
2 – 5	Float	Velocity Value
6 – 9	Float	Velocity KV Value;

Table 148: Response Data Bytes for Write Velocity KFactor Table

Byte	Format	Description
0	Unsigned-8	Velocity KFactor Index (1 - 6)
1	Unsigned-8	Velocity Unit
2 – 5	Float	Velocity Value
6 – 9	Float	Velocity KV Value;

Table 149: Command-Specific Response Codes for Write Velocity KFactor Table

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 218 (0xDA): Write Reynolds KFactor Table

This command is to write Reynolds KFactor table.

Table 150: Request Data Bytes for Write Reynolds KFactor Table

Byte	Format	Description
0	Unsigned-8	Reynolds KFactor Index (1 - 6)
1 – 4	Float	Reynolds Value
5 – 8	Float	Reynolds KV Value;

Table 151: Response Data Bytes for Write Reynolds KFactor Table

Byte	Format	Description
0	Unsigned-8	Reynolds KFactor Index (1 - 6)
1 – 4	Float	Reynolds Value
5 – 8	Float	Reynolds KV Value;

Table 152: Command-Specific Response Codes for Write Reynolds KFactor Table

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 224 (0xE0): Read Error Limits

This command is to read flow meter error limits.

Table 153: Request Data Bytes for Read Error Limits

Byte	Format	Description
0	Unsigned-8	Error limit: 1. Correlation Peak Limit 2. Acceleration Limit 3. Velocity Low Limit 4. Velocity High Limit 5. Amp Disc Min 6. Amp Disc Max 7. Signal Low Limit 8. Sound Speed Limit 9. Errors Allowed

Table 154: Response Data Bytes for Read Error Limits

Byte	Format	Description
0	Unsigned-8	Error limit: 1. Correlation Peak Limit 2. Acceleration Limit 3. Velocity Low Limit 4. Velocity High Limit 5. Amp Disc Min 6. Amp Disc Max 7. Signal Low Limit 8. Sound Speed Limit 9. Errors Allowed
1-4	float	Error limit Value;

Table 155: Command-Specific Response Codes for Read Error Limits

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 225 (0xE1): Read Signal Setup

This command is to read flow meter signal setup.

Table 156: Request Data Bytes for Read Signal Setup

Byte	Format	Description
0	Unsigned-8	signal setup type: 1. Delta T Offset 2. Percentage Peak 3. Min Peak Percentage 4. Max Peak Percentage

Table 157: Response Data Bytes for Read Signal Setup

Byte	Format	Description
0	Unsigned-8	signal setup type: 1. Delta T Offset 2. Percentage Peak 3. Min Peak Percentage 4. Max Peak Percentage
1 - 4	Float	signal setup Value

Table 158: Command-Specific Response Codes for Read Signal Setup

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 226 (0xE2): Read Flowmeter S/N

This command is to read flow meter s/n.

Table 159: Request Data Bytes for Read Flowmeter S/N

Byte	Format	Description
0	Unsigned-8	Flowmeter S/N: 1. Electronic S/N 2. UP Sensor 3. S/N 4. DN Sensor S/N

Table 160: Response Data Bytes for Read Flowmeter S/N

Byte	Format	Description
0	Unsigned-8	signal setup type: 1. Electronic S/N 2. UP Sensor 3. S/N 4. DN Sensor S/N
1 - 16	Unsigned-8	S/N

Table 161: Command-Specific Response Codes for Read Flowmeter S/N

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 227 (0xE3): Read Flowmeter Version

This command is to read flow meter version.

Table 162: Request Data Bytes for Read Flow Meter Version

Byte	Format	Description
0	Unsigned-8	Flowmeter version 1. Main Hardware version 2. Main Software version

Table 163: Response Data Bytes for Read Flow Meter Version

Byte	Format	Description
0	Unsigned-8	Version type: 1, Main Hardware version 2. Main Software version
1 - 8	Unsigned-8	Version Number

Table 164: Command-Specific Response Codes for Read Flow Meter Version

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 232 (0xE8): Write Error Limits

This command is to write flow meter error limits.

Table 165: Request Data Bytes for Write Error Limits

Byte	Format	Description
0	Unsigned-8	Error limit: Correlation Peak Limit Acceleration Limit Velocity Low Limit Velocity High Limit Amp Disc Min Amp Disc Max Signal Low Limit Sound Speed Limit Errors Allowed
1 - 4	float	Error limit Value;

Table 166: Response Data Bytes for Write Error Limits

Byte	Format	Description
0	Unsigned-8	Error limit: Correlation Peak Limit Acceleration Limit Velocity Low Limit Velocity High Limit Amp Disc Min Amp Disc Max Signal Low Limit Sound Speed Limit Errors Allowed
1 - 4	float	Error limit Value;

Command 232 (0xE8): Write Error Limits (cont.)

Table 167: Command-Specific Response Codes for Write Error Limits

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 233 (0xE9): Write Signal Setup

This command is to write flow meter signal setup.

Table 168: Request Data Bytes for Write Signal Setup

Byte	Format	Description
0	Unsigned-8	signal setup type: Delta T Offset percentage Peak Min Peak Percentage Max Peak percentage
1 - 4	Float	signal setup Value

Table 169: Response Data Bytes for Write Signal Setup

Byte	Format	Description
0	Unsigned-8	signal setup type: Delta T Offset percentage Peak Min Peak Percentage Max Peak percentage
1 - 4	Float	signal setup Value

Table 170: Command-Specific Response Codes for Write Signal Setup

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 239 (0xEF): Reset Flow Meter Data

This command is to reset flowmeter data.

Table 171: Request Data Bytes for Reset Flow Meter Data

Byte	Format	Description
0	Unsigned-8	Reset type: 1. Reset Error Log 2, Forward Inventory 3. Reverse Inventory 4. Net Inventory 5. Inventory Time 6. All 7. Inventory

Table 172: Response Data Bytes for Reset Flow Meter Data

Byte	Format	Description
0	Unsigned-8	Reset type: Reset Error Log Forward Inventory Reverse Inventory Net Inventory Inventory Time All Inventory

Table 173: Command-Specific Response Codes for Reset Flow Meter Data

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 241 (0xF1): Read the Factory Setting

This command is to read the factory setting.

Table 174: Request Data Bytes for Read the Factory Setting

Byte	Format	Description
None		

Table 175: Response Data Bytes for Read the Factory Setting

Byte	Format	Description
0	Unsigned-8	Response time 0.5s 1s 5s 10s 30s 60s
1 - 4	Unsigned-32	Sample Size: 2 4 8 16 32

Table 176: Command-Specific Response Codes for Read the Factory Setting

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7-127		Undefined

Command 248 (0xF8): Write the Factory Setting

This command is to write the factory setting.

Table 177: Request Data Bytes for Write the Factory Setting

Byte	Format	Description
0	Unsigned-8	Response time 0.5s 1s 5s 10s 30s 60s
1 - 4	Unsigned-32	Sample Size: 2 4 8 16 32

Table 178: Response Data Bytes for Write the Factory Setting

Byte	Format	Description
0	Unsigned-8	Response time 0.5s 1s 5s 10s 30s 60s
1 - 4	Unsigned-32	Sample Size: 2 4 8 16 32

Command 248 (0xF8): Write the Factory Setting (cont.)

Table 179: Command-Specific Response Codes for Write the Factory Setting

Code	Class	Description
0	Success	No Command-Specific Errors
1		Undefined
2	Error	Invalid Selection
3-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

Command 253 (0xFD): Reset to Factory Setting

This command is to reset the setting to the factory setting.

Table 180: Request Data Bytes for Reset to Factory Setting

Byte	Format	Description
None		

Table 181: Response Data Bytes for Reset to Factory Setting

Byte	Format	Description
None		

Table 182: Command-Specific Response Codes for Reset to Factory Setting

Code	Class	Description
0	Success	No Command-Specific Errors
1-4		Undefined
5	Error	Too Few Data Bytes Received
6	Error	Device-Specific Command Error
7	Error	In Write Protect Mode
8-15		Undefined
16	Error	Access Restricted
17-127		Undefined

5.3 Additional Device Status

Command 48 returns 4 bytes of data, with the following status information:

Table 183: HART Additional Device Status

HART Additional Device Status			Class	Device Status Bits Set
Byte	**Bit**	**Error Description**		
0	0	Amplitude Error	Error	4, 7
	1	Low Signal	Error	4, 7
	2	Sound Speed Error	Error	4, 7
	3	Velocity Range	Error	4, 7
	4	Signal Quality	Error	4, 7
	5	Cycle Skip	Error	4, 7
	6	Reserve		
	7	Reserve		
1	0	Reserve		
	1	Reserve		
	2	Reserve		
	3	Reserve		
	4	Reserve		
	5	Reserve		
	6	Reserve		
	7	Reserve		
2	0	FPGA error;		4, 7
	1	Setting files CRC error;		4, 7
	2	Flash Error		4, 7
	3	KEY/LED Error		4, 7
	4	I/O Error		4, 7
	5	Display Error		4, 7
	6	RTC Error		4, 7
	7	Reserve		
3	0	In configure mode;		4, 0
	1	Not calibrated;		4, 0
	2	Reserve		
	3	Reserve		
	4	Reserve		
	5	Reserve		
	6	Reserve		
	7	Reserve		

5.4 Device Variables

Table 184: Device Variables

Measurement	Device Variable code	Device Variable Classification Code	
		Code	Classification
Velocity	0	67	Velocity
Actual Volumetric	1	66	Volumetric Flow
Standardized Volumetric	2	66	Volumetric Flow
Fwd. Batch Totals	3	68	Volumetric
Rev Batch Totals	4	68	Volumetric
Net Batch Totals	5	68	Volumetric
Batch Totalizer Time	6	70	Time
Fwd. Inventory Totals	7	68	Volumetric
Rev Inventory Totals	8	68	Volumetric
Net Inventory Totals	9	68	Volumetric
Inventory Totalizer Time	10	70	Time
Mass Flow	11	72	Mass flow
Sound Speed	12	67	Velocity
Reynolds	13	0	Not Classified
Kfactor	14	0	Not Classified
Transit Time Up	15	70	Time
Transit Time Dn	16	70	Time
DeltaT	17	70	Time
Up Signal Quality	18	0	Not Classified
Dn Signal Quality	19	0	Not Classified
Up Amp Disc	20	0	Not Classified
Dn Amp Disc	21	0	Not Classified
SNR Up	22	0	Not Classified
SNR Dn	23	0	Not Classified
ActiveTW Up	24	0	Not Classified
ActiveTW Dn	25	0	Not Classified
Gain Up	26	0	Not Classified
Gain Dn	27	0	Not Classified
Error Status	28	0	Not Classified
Reported Error	29	0	Not Classified
Up Peak	30	0	Not Classified
Down Peak	31	0	Not Classified
Peak% Up	32	81	Analytical
Peak% Down	33	81	Analytical

5.5 HART Engineering Units

The unit types allowed for the AT600 flowmeter device variables are listed below

Table 185: HART Engineering Units

Device Variable		Unit	
Code	**Classification**	**Code**	**Description**
64	Temperature	32	Degrees Celsius
		33	Degrees Fahrenheit
66	Volumetric Flow	27	cubic feet per day
		130	Cubic feet per hour
		15	Cubic feet per minute
		26	Cubic feet per second
		187	Standard cubic feet per day
		185	Standard cubic feet per hour
		123	Standard cubic feet per minute
		186	Standard cubic feet per second
		29	Cubic meter per day
		19	Cubic meter per hour
		131	Cubic meters per minute
		28	Cubic meters per second
		240	Million cubic meters per day
		187	Standard cubic Meter per Day
		188	Standard cubic meter per hour
		189	Standard cubic meter per minute
		190	Standard cubic meter per second
		235	gallon per day
		136	Gallons per hour
		16	Gallons per minute
		22	Gallons per second
		135	Barrels per day
		134	Barrels per hour
		133	Barrels per minute
		132	Barrels per second
		174	Liters per day
		138	Liters per hour
		17	Liters per minute
		24	Liters per second
		25	million liters per day

Table 185: HART Engineering Units (cont.)

Device Variable		Unit	
Code	**Classification**	**Code**	**Description**
		177	Standard liter per day
		178	Standard liter per hour
		179	Standard liter per minute
		180	Standard liter per second
67	Velocity	20	Feet per second
		21	Meters per second
68	Volume	43	Cubic Meter
		41	Cubic Decimeter (Liter)
		243	Mega Liters
		244	Million Cubic Meter
		112	Cubic Feet
		40	Gallon
		46	Barrel
		245	Mega Gallons
		246	Million Cubic feet
		172	Standard Cubic Meter
		171	Standard Liters
		61	Kilogram
		62	Metric Ton
		168	Standard Cubic Feet
		63	Pound
		247	Kilo Pound
		64	Short Tons
69	Length	44	Feet
		47	Inch
		45	Meter
		49	Millimeter
70	Time	172	Nanoseconds
		171	Microseconds
		170	Milliseconds
		51	Seconds
		50	Minute
		52	Hour
		53	Day
72	Mass Flow	73	Kilograms per seconds

Table 185: HART Engineering Units (cont.)

Device Variable		Unit	
Code	**Classification**	**Code**	**Description**
		74	Kilograms per minute
		75	Kilograms per hour
		76	Kilograms per day
		242	Metric tons per second
		77	Metric tons per minute
		78	Metric tons per hour
		79	Metric tons per day
		80	pounds per seconds
		81	pounds per minute
		82	pounds per hour
		83	pounds per day
		241	Short ton per seconds
		84	Short ton per minute
		85	Short ton per hour
		86	Short ton per day
73	Mass per Volume	94	Pounds per cubic feet
		92	Kilograms per cubic meter
74	Viscosity	54	Centistokes
		248	Square Meter per Sec
81	Analytical	57	Percent
96	Acceleration	171	Feet per second squared
		172	Meter per second squared
0	Not Classification	38	dB
		156	Hertz

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Appendix A. Specifications

A.1 Operation and Performance

A.1.1 Fluid Types

Liquids: Acoustically conductive fluids, including most clean liquids, and many liquids with limited amounts of entranced solids or gas bubbles

A.1.2 Flow Measurement

Patented Correlation Transit-Time™ mode

A.1.2a Meter Sizes

Standard: 2 to 24 in. (50 to 600 mm)
Optional: up to 300 in. (7500mm) available upon request.

A.1.2b Accuracy

In Application: ±1% of reading
In Field Calibration: ±0.5% of reading

Note: *Final installation assumes a fully developed flow profile (typically 10 diameters upstream and 5 diameters downstream of straight pipe run) and single phase fluids. Applications with piping arrangements that induce swirl (e.g., two out-of-plane elbows) may require additional straight run or flow conditioning.*

A.1.2c Calibration Fluid

Water

A.1.2d Repeatability

±0.2% of reading

A.1.2e Range (Bidirectional)

0.1 to 40 ft/s (0.03 to 12.19 m/s)

A.1.2f Range ability (Overall)

400:1

A.2 Meter Body/Transducer

A.2.1 Meter Body Material

Aluminum (ASTM A380)

A.2.2 AT6 Transducer System and Material

AT6 Transducer body: Aluminum (ASTM AL6061)
Fixture body: Aluminum (ASTM AL6061)/Stainless Steel (ASTM A304)

A.2.3 C-RS Transducer System and Material

C-RS Transducer body: Stainless Steel (ASTM A316)
Fixture body: Aluminum (ASTM AL6061)

Please contact GE sales representative for other transducers.

A.2.4 Meter Temperature Ranges

-4°F to 131°F (-20° to 55°C)

A.2.5 AT6 Transducer Temperature Ranges

-40°F to 302°F (-40° to 150°C)

A.2.6 C-RS Transducer Temperature Ranges

-40°F to 302°F (-40° to 150°C)

Please contact GE sales representative for other transducers.

A.2.7 Humidity Range

Up to 90% RH

Please contact GE sales representative for tropicalization of the unit for 100% RH

A.2.8 Altitude Range

Up to 2000 meters maximum;

A.2.9 CAT Transducer Cables

Up to 90 meters (300 ft) RG316 coaxial cable.

Temperature Range is -40° to 302°F (-40° to 150°C)

A.2.10 Wiring Cable Specifications and Requirements

Cable diameter range for PWR connection: 7 to 12mm, refer to Gland Hole 1 on Figure 23 on page 17
Cable diameter range for Hart, Modbus and I/O connection: 5 to 8mm, refer to Gland Hole 2,3 and 4 in Figure 23 on page 17
Temperature range of cable for PWR, Hart, Modbus and IO connection: 14° to 185°F (-10° to 85°C);

The cable should meet the CE and UL standard below:
Conductor cross section solid range: 0.2 $mm^2$to 2.5 mm^2
Conductor cross section stranded range: 0.2 $mm^2$to 2.5 mm^2
Conductor cross section stranded, with ferrule without plastic sleeve range: 0.25 mm^2 to 1 mm^2
Conductor cross section stranded, with ferrule with plastic sleeve range: 0.25 mm^2 to 1 mm
Conductor cross section AWG/kcmil range: 12 to 26 AWG according to UL/CUL range: 14 to 28

A.2.11 Cable Fixing Requirement and Gland Torque

Refer to Figure 23 on page 17 for the Gland Hole position.

To make a reliable IP67 sealing performance of the enclosure during cabling, the gland must be tightened well, below torque value is a reference to make a reliable NEMA 4X/IP67 sealing between cable and gland:

Operation torque for Gland Hole 1 and 5: 2.7 N.M

Operation torque for Gland Hole 2, 3 and 4: 2.5 N.M

A.3 Electronics

A.3.1 Enclosures

Epoxy coated, copper-free, aluminum

A.3.2 Weatherproof

Enclosures: IP67

Please contact your GE sales representative for other transducers.

A.3.3 Electronics Classifications (Pending)

CE (EMC directive) IEC 61326-1:2012, IEC 61326-2-3:2012, LVD 2006/95/EC, EN 61010-1 2010)
ETL(UL61010-1, CSA 22.2 No 61010.1, No. 142, FCC part 15, CISPR 11)
WEEE Compliance
ROHS Compliance

Note: *The electronics package includes an installed battery which shall only be replaced at a GE Service center. Replacement involves de-soldering battery contacts, which could lead to a breach of Functional Safety. Please contact GE Service to get this battery replaced.*

A.3.4 Display Languages

English/Chinese/German/French/Italian/Japanese/Portuguese/Russian/Spanish/Swedish

Note: *The meter will be set to the language requested by the customer before shipping.*

A.3.5 Keypad

Film keypad, Six-button keypad, for full functionality operation

A.3.6 Inputs/Outputs

Standard: One analog output*, service (RS485) output, two digital outputs***, one gate input;
Option A: One analog output* with HART**, service (RS485) output, two digital outputs***, one gate input;
Option B: One analog output*, service (RS485) output, one Modbus(RS485) output, two digital outputs***, one gate input;

*Analog output is NAMUR NE43 compliant
**HART is compliant with Protocol of Version 7
***Digital Outputs are programmable as either pulse, frequency, alarm, or control outputs. Digital outputs will be configured into the output mode as requested by customer before shipping to customer.

A.3.7 Product Models

The AT600 ultrasonic flow meter is categorized to 2 series:

1. Models of AC meter: 85-264VAC, 50-60Hz, 10W, Class I
   AT6-**-****-****-*-1-*-**-**-*-*, AT6KIT-*1, AT6KIT-*2, AT6KIT-*3 and AT6KIT-*7
2. Models of DC meter: 12-28VDC, 10W, Class I
   AT6-**-****-****-*-2-*-**-**-*-*, AT6KIT-*4, AT6KIT-*5, AT6KIT-*6 and AT6KIT-*8

Note: ** in the product model name is either a number from 0-9 or a letter from A-Z.*

Appendix B. Data Records

B.1 Service Record

Whenever any service procedure is performed on the AT600 flowmeter, the details of the service should be recorded in this appendix. An accurate service history of the meter can prove very helpful in troubleshooting any future problems.

B.2 Data Entry

Record the complete and detailed service data for the AT600 in Table 186 below. Make additional copies of the table as needed.

Table 186: Service Record

Date	Description of Service Performed	Performed

B.3 Initial Settings

The values for the initial measurement settings immediately after initial installation of the meter and verification of proper operation should be entered below.

Table 187: Initial Settings

Parameter	Initial Value
Pipe OD	
Pipe ID	
Pipe Wall Thickness	
Pipe Material	
Pipe Sound speed	
Lining Thickness	
Lining Material	
Transducer ID	
Transducer Frequency	
Transducer Wedge Type	
Transducer Wedge Angle	
Transducer Wedge SOS	
Transducer TW	
Traverses	
Fluid Type	
Fluid SOS	
Fluid Minimum SOS	
Fluid Maximum SOS	
Fluid Temperature	
Transducer Spacing	

B.4 Diagnostic Parameters

The values for the diagnostic parameters immediately after initial installation of the meter and verification of proper operation should be entered below. These initial values can then be compared to current values to help diagnose any future malfunction of the system.

Table 188: Diagnostic Parameters

Parameter	Initial Value
Velocity	
Actual Volumetric	
Standardized Volumetric	
Fwd. Batch Totals	
Rev Batch Totals	
Net Batch Totals	
Batch Totalizer Time	
Fwd. Inventory Totals	
Rev Inventory Totals	
Net Inventory Totals	
Inventory Totalizer Time	
Mass Flow	
Sound Speed	
Reynolds	
Kfactor	
Transit Time Up	
Transit Time Dn	
DeltaT	
Up Signal Quality	
Dn Signal Quality	
Up Amp Disc	
Dn Amp Disc	
SNR Up	
SNR Dn	
ActiveTW Up	
ActiveTW Dn	
Gain Up	
Gain Dn	
Error Status	
Reported Error	
Up Peak	
Down Peak	
Peak % Up	
Peak % Down	

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Appendix C. Menu Maps

C.1 The Display Measurement Menu

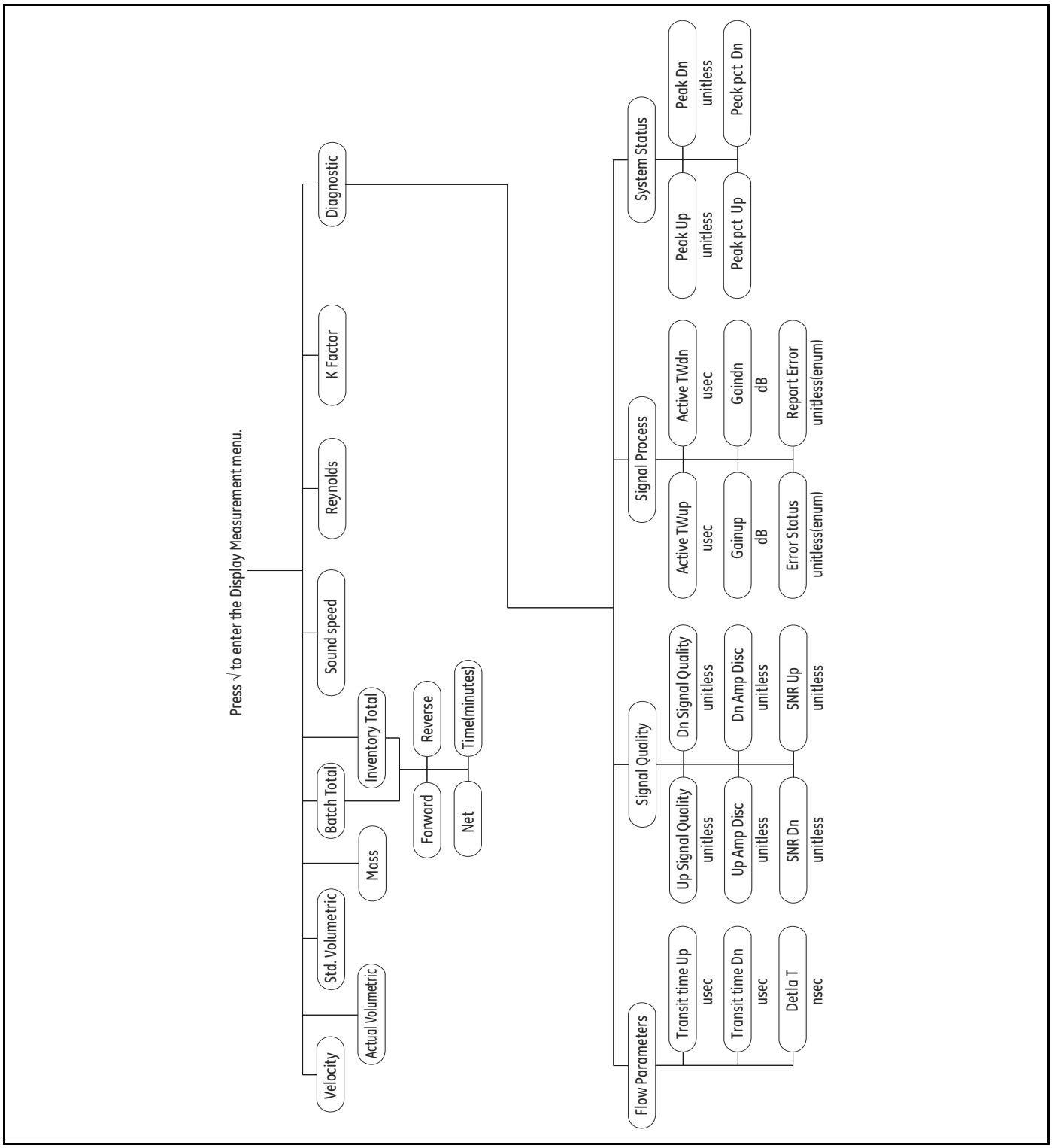

Figure 35: The Display Measurement Menu

C.2 The Main Menu

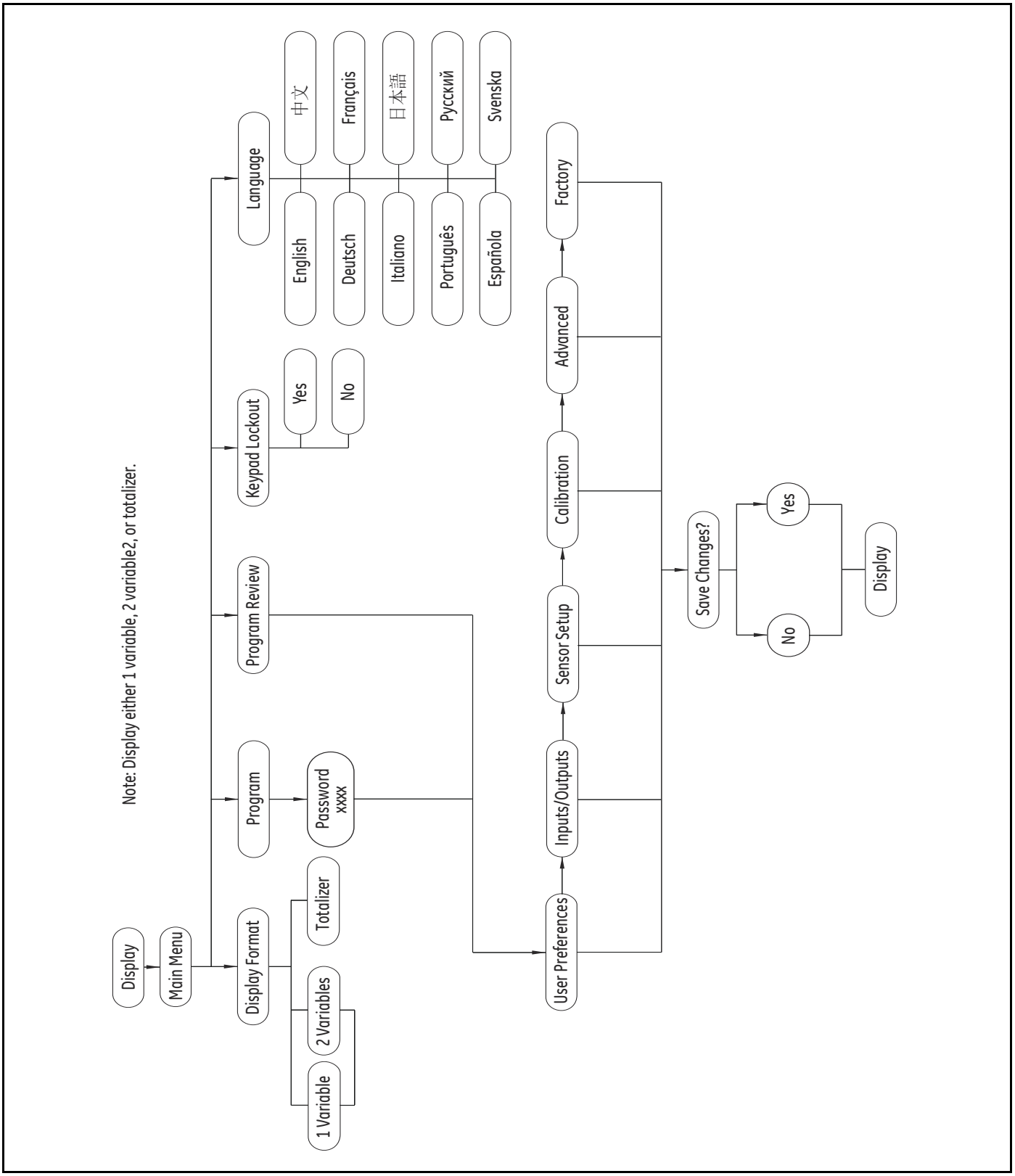

Figure 36: The Main Menu

C.3 The Main Menu > User Preferences Menu

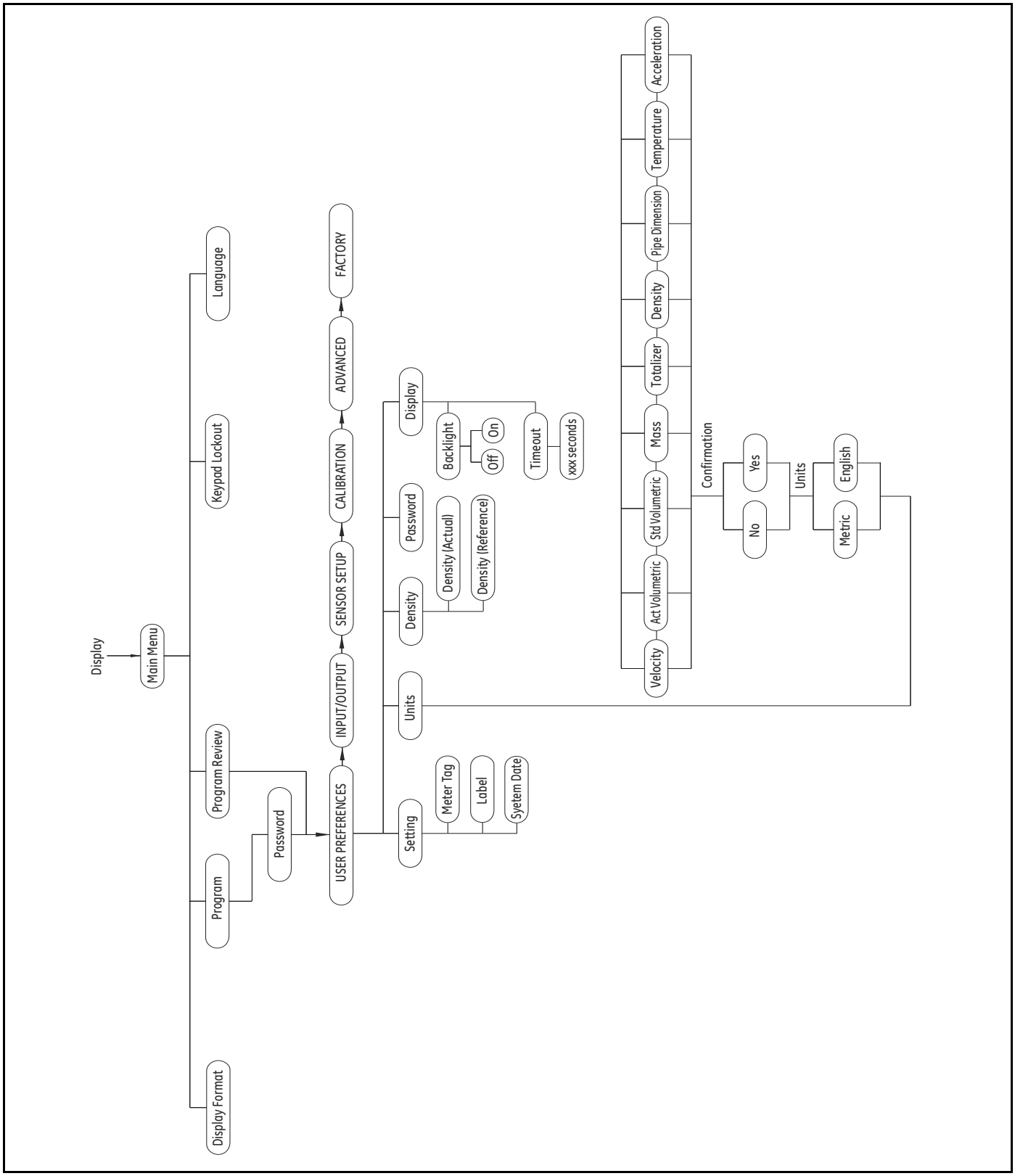

Figure 37: The Main Menu > User Preferences Menu

C.4 The Main Menu > Inputs/Outputs Menu

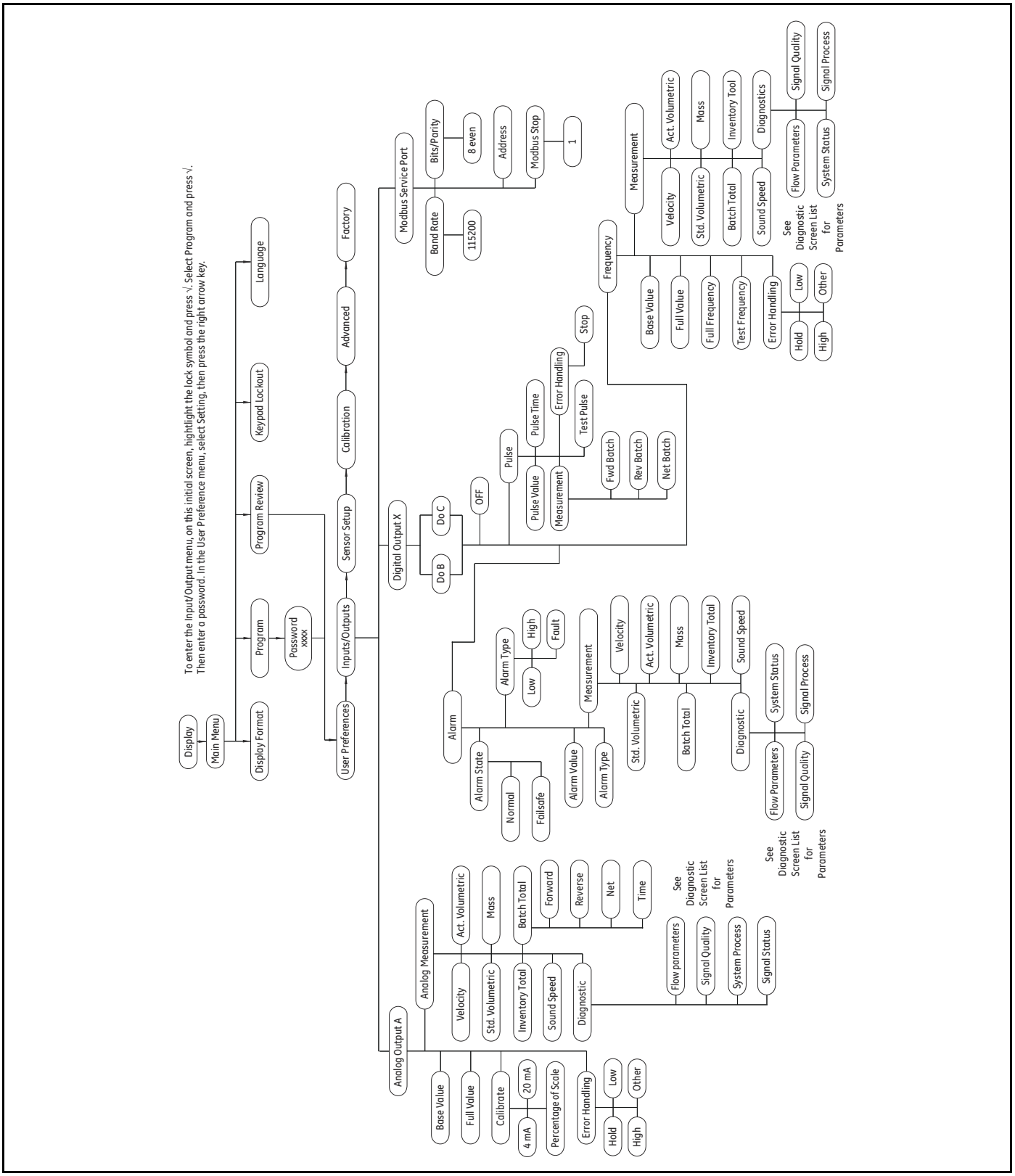

Figure 38: The Main Menu > Inputs/Outputs Menu

C.5 The Main Menu> Sensor Setup Menu

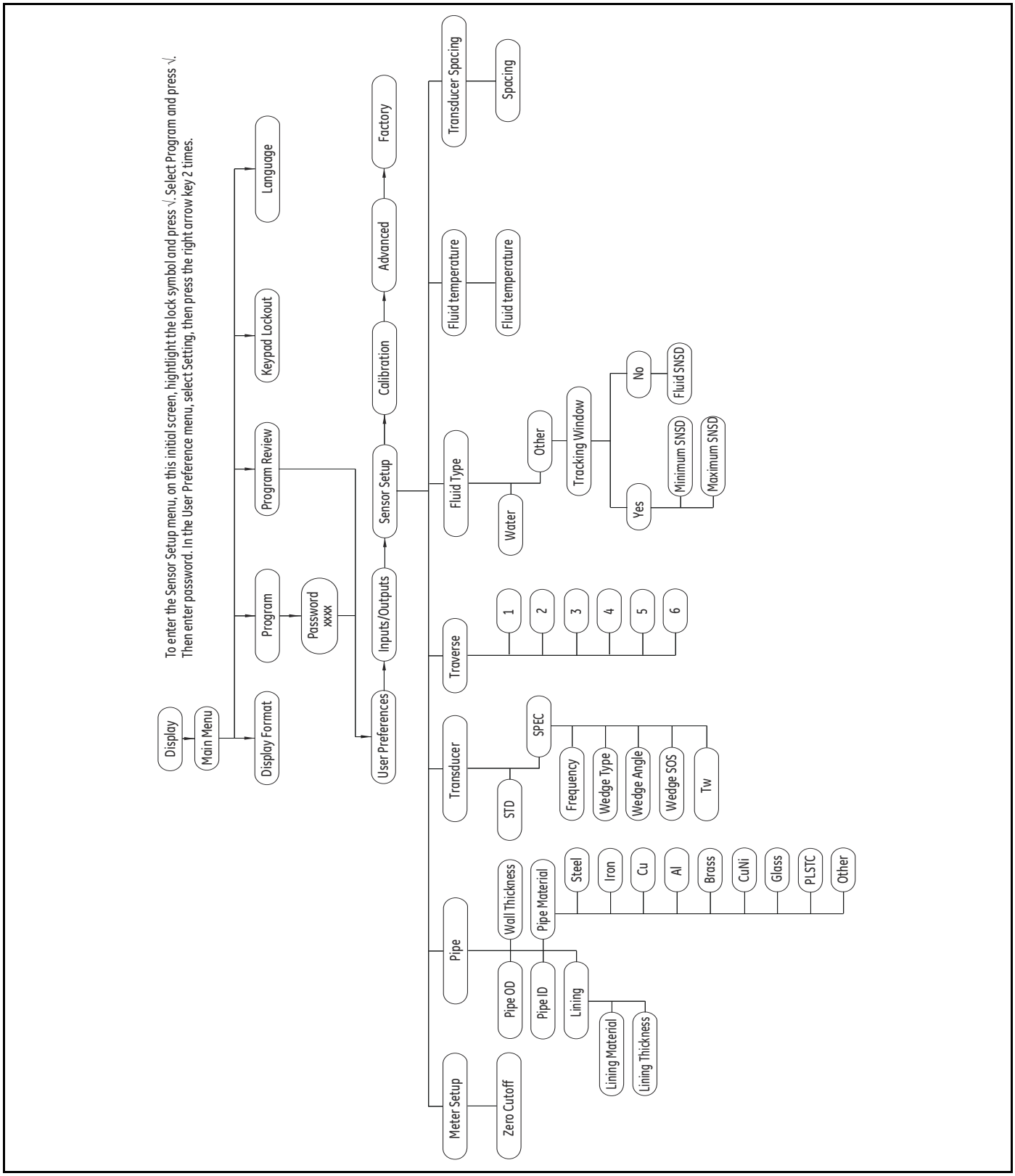

Figure 39: The Main Menu> Sensor Setup Menu

C.6 The Main Menu>Calibration Menu

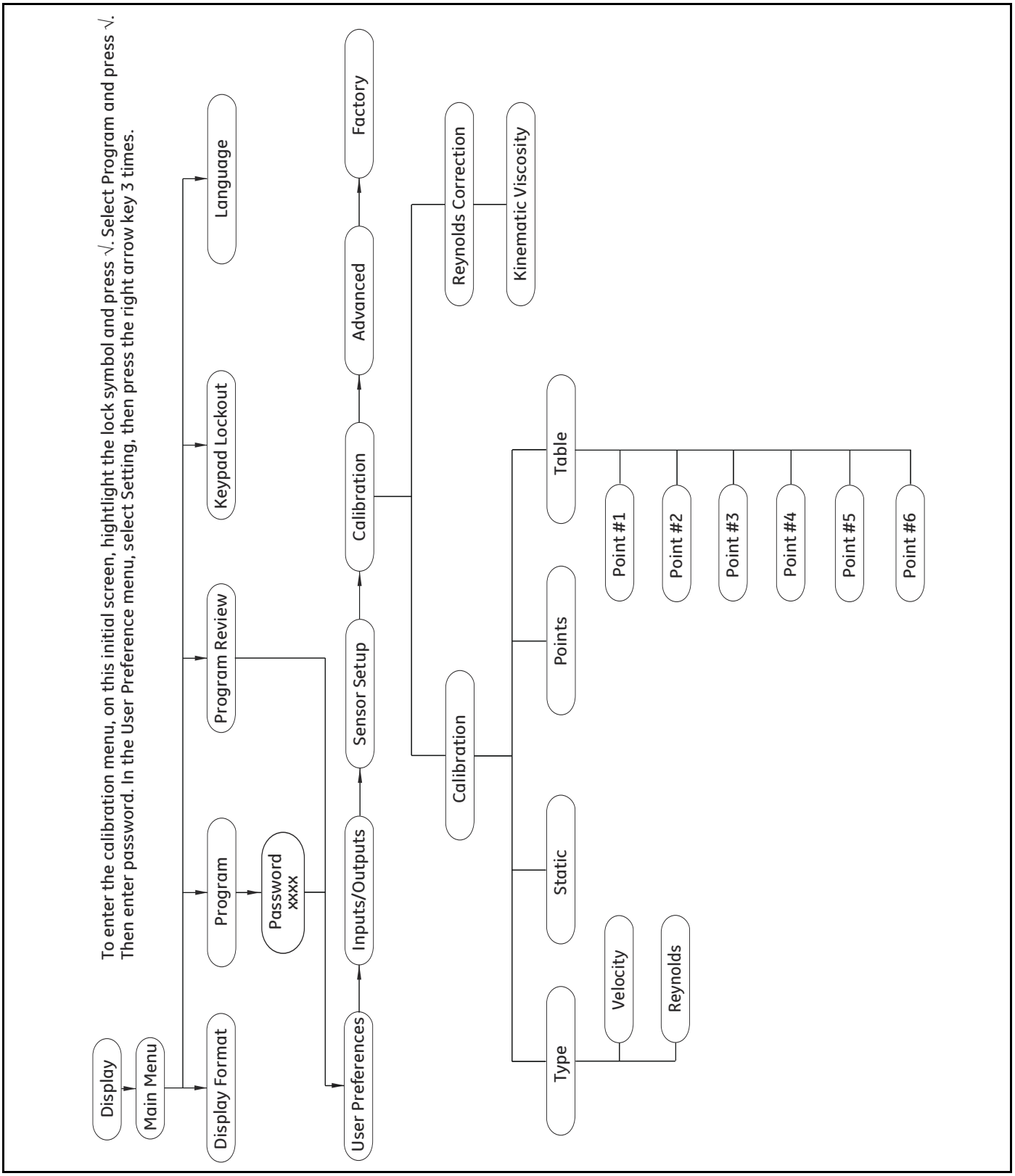

Figure 40: The Main Menu>Calibration Menu

C.7 The Main Menu>Advanced Menu

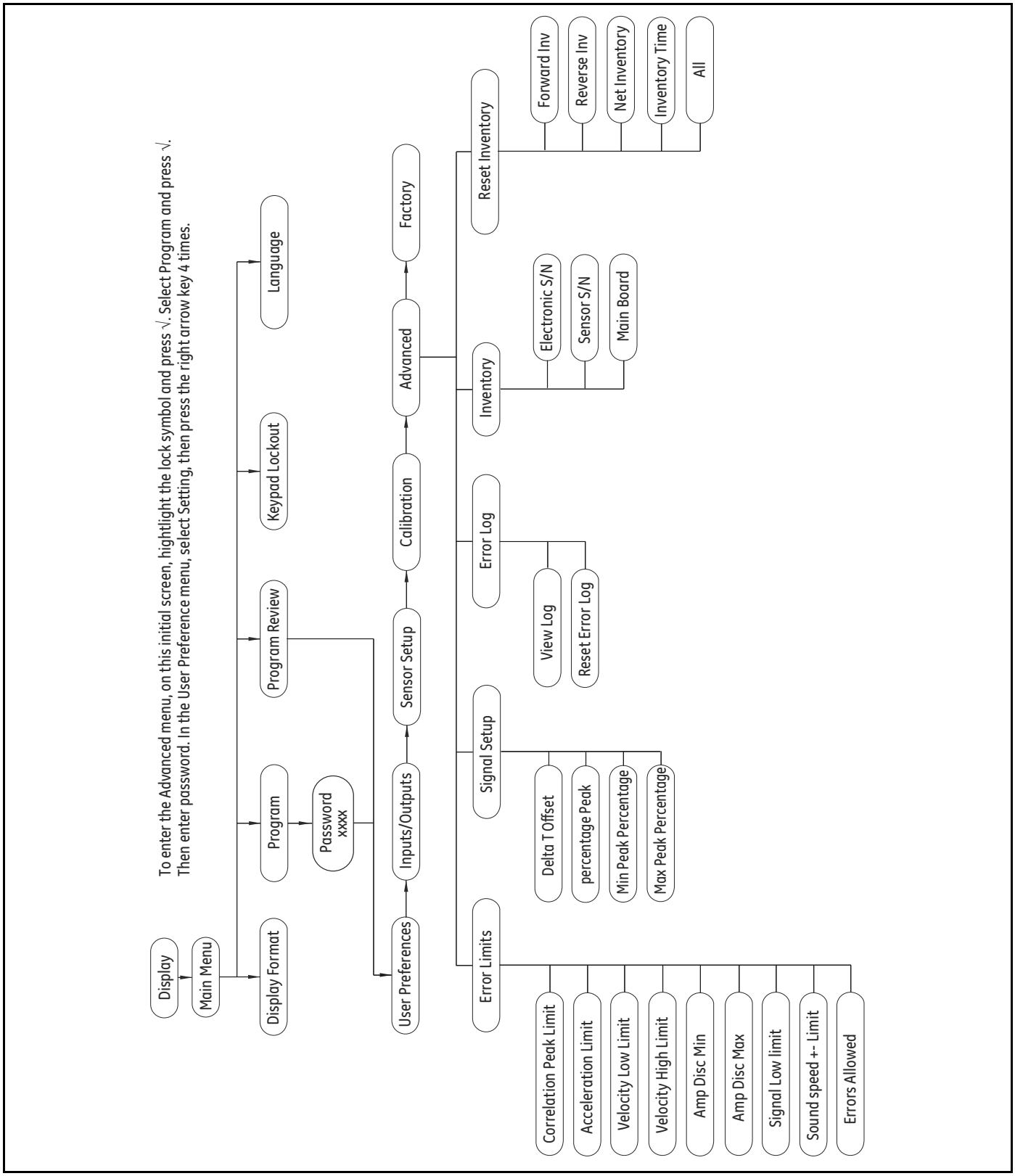

Figure 41: The Main Menu>Advanced Menu

C.8 The Main Menu>Factory Menu

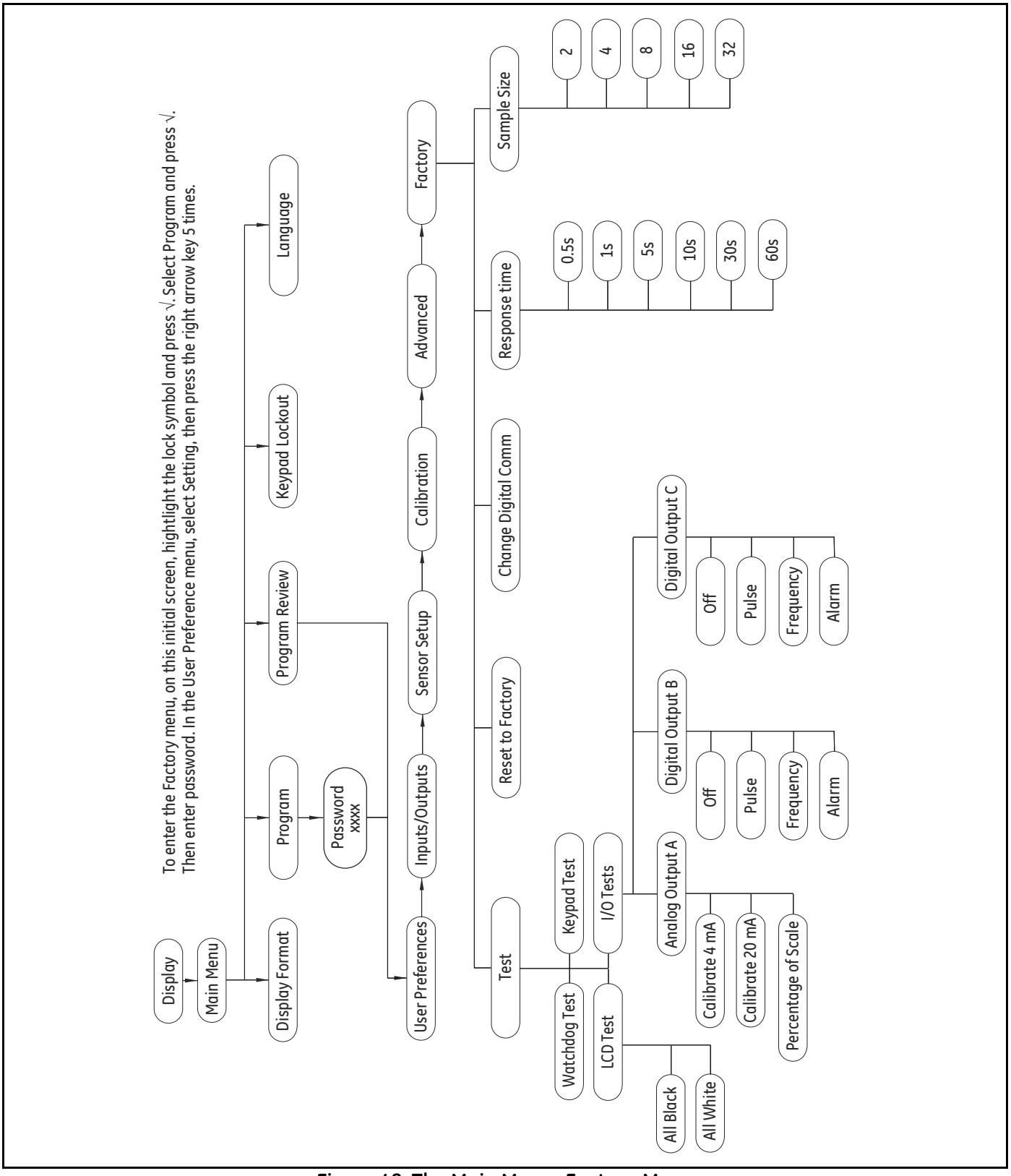

Figure 42: The Main Menu>Factory Menu

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GE
Measurement & Control

Certification & Safety Statements

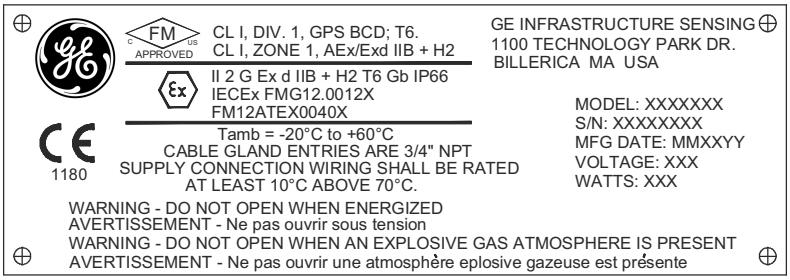
Certification & Safety Statements for GE Measurement & Control Ultrasonic Flow Transmitters

When installing this apparatus, the following requirements must be met:

- Field wiring shall be rated at least 10°C above 70°C.
- Connecting cables shall be mounted securely and protected from mechanical damage, pulling and twisting.
- Cable entries are ¾" NPT.
- Cable glands of an approved flameproof design are required. These must be installed according to the manufacturer's instructions. Where the cable glands are provided by GE, the manufacturer's instructions, as supplied, to GE, will be included in the documentation.
- Unused cable entries must be sealed using a certified threaded plug.
- Modifications to the flameproof enclosure are not permitted.
- The apparatus should be de-energized before opening.
- Installation should comply with IEC/EN 60079-14.
- Equipment is of type flameproof "d" design and complies with: EN 60079-0:2009, EN 60079-1:2007, EN 60529:1991 +A1:2000, IEC 60079-0:2011, IEC 60079-1:2007, IEC 60529:2001.
- The product contains no exposed parts which produce surface temperature infrared, electromagnetic ionizing, or non-electrical dangers.
- The product must not be subjected to mechanical or thermal stresses in excess of those permitted in the certification documentation and the instruction manual.
- The product cannot be repaired by the user; it must be replaced by an equivalent certified product. Repairs should only be carried out by the manufacturer or by an approved repairer.
- Only trained, competent personnel may install, operate and maintain the equipment
- The product is an electrical apparatus and must be installed in the hazardous area in accordance with the requirements of the EC Type Examination Certificate. The installation must be carried out in accordance with all the appropriate international, national and local standard codes and practices and site regulations for flameproof apparatus and in accordance with the instructions contained in the manual. Access to the circuitry must not be made during operation.

Special Conditions for Safe Use: Consult the manufacturer if dimensional information on the flameproof joints is necessary.

Markings: Markings shall appear on the product as shown below:



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