Thermatel®
Enhanced Model TA2
Software v2.x

Installation and Operating Manual

Thermal Dispersion
Mass Flow Transmitter





MAGNETROL® / AMETEK®
LEVEL MEASUREMENT SOLUTIONS

Read this Manual Before Installing
This manual provides information on the Model TA2 Thermal Dispersion Mass Flow Transmitter. It is important that all instructions are read carefully and followed in sequence. Detailed installation, wiring and calibration instructions are included in this manual.

Conventions Used in this Manual
Certain conventions are used in this manual to convey specific types of information. General technical material, support data, and safety information are presented in narrative form. The following styles are used for notes, cautions, and warnings.

NOTES
Notes contain information that augments or clarifies an operating step. Notes do not normally contain actions. They follow the procedural steps to which they refer.

Cautions
Cautions alert the technician to special conditions that could injure personnel, damage equipment, or reduce a component's mechanical integrity. Cautions are also used to alert the technician to unsafe practices or the need for special protective equipment or specific materials. In this manual, a caution box indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

WARNINGS
Warnings identify potentially dangerous situations or serious hazards. In this manual, a warning indicates an imminently hazardous situation which, if not avoided, could result in serious injury or death.

Safety Messages
Follow all standard industry procedures for servicing electrical and computer equipment when working with or around high voltage. Always shut off the power supply before touching any components.

WARNING! Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

Low Voltage Directive
For use in Installation Category II, Pollution Degree 2. If equipment is used in a manner not specified by manufacturer, protection provided by equipment may be impaired.

Warranty
All AMETEK LMS electronic level and flow controls are warranted free of defects in materials or workmanship for eighteen months from the date of original factory shipment.

If returned within the warranty period; and, upon factory inspection of the control, the cause of the claim is determined to be covered under the warranty; then, AMETEK LMS will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

AMETEK LMS shall not be liable for misapplication, labor claims, direct or consequential damage or expense arising from the installation or use of equipment. There are no other warranties expressed or implied, except special written warranties covering some AMETEK LMS products.

Quality Assurance
The quality assurance system in place at AMETEK LMS guarantees the highest level of quality throughout the company. AMETEK LMS is committed to providing full customer satisfaction both in quality products and quality service.

The AMETEK LMS quality assurance system is certified to ISO 9001, affirming our commitment to internationally recognized quality management standards and continuous improvement.

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Performance specifications are effective with date of issue and are subject to change without notice. AMETEK LMS reserves the right to make changes to the product described in this manual at any time without notice. AMETEK LMS makes no warranty with respect to the accuracy of the information in this manual.

MAGNETROL® / AMETEK®

Thermatel® Enhanced Model TA2
Thermal Dispersion Mass Flow Transmitter

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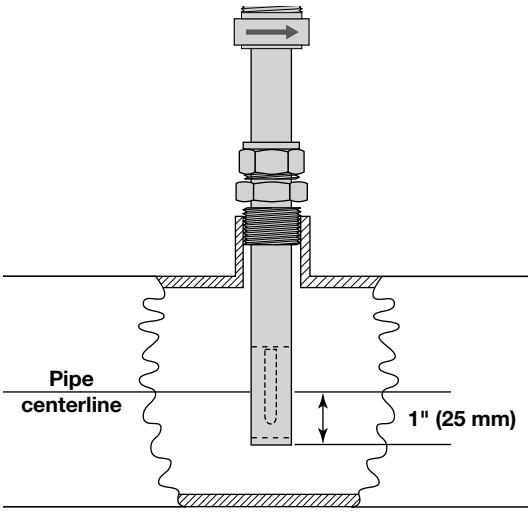


Figure 1
Probe Installation into Pipe or Duct Using a Compression Fitting

1.0 Quick Start Installation

The TA2 is calibrated and configured with the information supplied to Magnetrol with the order. The instrument can be installed, wired, and place directly into operation.

1.1 Probe Installation

Insert the probe into the pipe or duct at the appropriate location. It is recommended that the sensor be located on the center line of the pipe and that the flow arrow be positioned in the direction of flow.

See Appendix A for recommended straight run and flow conditioning plate installation details (if applicable).

1.2 Wiring

WARNING:
DO NOT OPEN WHEN ENERGIZED

WARNING:
POTENTIAL ELECTROSTATIC CHARGING HAZARD – SEE INSTRUCTIONS

WARNING:
DO NOT OPEN WHEN AN EXPLOSIVE GAS ATMOSPHERE IS PRESENT. KEEP ASSEMBLY TIGHTLY CLOSED WHEN IN OPERATION. COVER JOINTS MUST BE CLEANED BEFORE REPLACING COVER.

AVERTISSEMENT:
NE PAS OUVRIR LORSQU'IL EST ÉNERGÉTIQUE

AVERTISSEMENT:
ÉLECTROSTATIQUE POTENTIEL RISQUE DE CHARGE – VOIR LES INSTRUCTIONS

AVERTISSEMENT:
NE PAS OUVRIR LORSQU'UN L'ATMOSPHÈRE DES GAZ EXPLOSIFS EST PRÉSENT. GARDEZ L'ASSEMBLAGE HERMÉMENT FERMÉ EN FONCTIONNEMENT. LES JOINTS DE COUVERCLE DOIVENT ÊTRE NETTOYÉS AVANT DE REMPLACER LE COUVERCLE.

Caution: OBSERVE ALL APPLICABLE ELECTRICAL CODES AND PROPER WIRING PROCEDURES.
For US and Canadian installations, wire per the NEC and CEC. Install using working methods per the division rating as marked on the product label.

NOTE: Make sure the electrical wiring to the TA2 is complete and in compliance with all regulations and codes. For a maximum ambient temperature of 80° C use wiring rated up to 264 VAC and 105 °C. For a maximum ambient temperature of 70° C use wiring rated up to 264 VAC and 95 °C.

NOTE: The AC power terminal blocks accept 12-22 AWG wire and the DC power terminal blocks accept 14-30 AWG wire. Select wire size consistent with power requirements. The mA output and pulse output also accept 14-30 AWG wire.

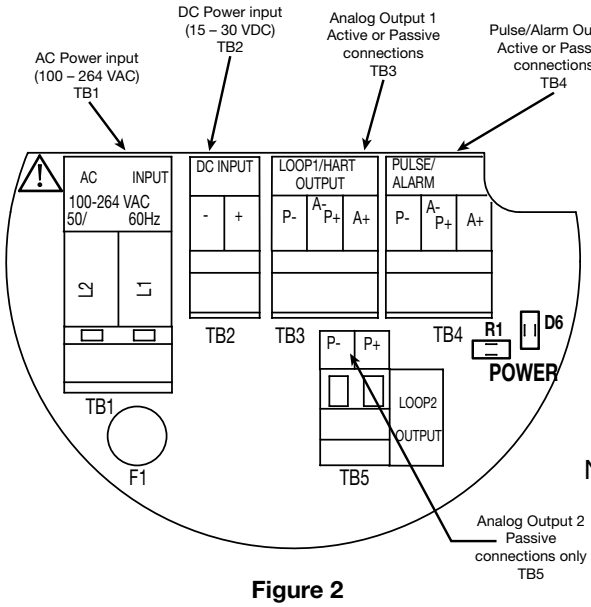


Figure 2
Wiring Connections

1. Remove the cover of the rear compartment.
2. Pull power supply and control wiring through conduit connection.
3. Connect power leads to proper terminals.
   a. 100 to 264 VAC – Make connections to TB1. Connect the “hot” wire to L1 and the second wire to L2.
   b. 15 to 30 VDC – Make the connections to TB2. Connect the positive wire to (+) and the negative lead to (–).

NOTE: Ensure that the correct wiring is made to the appropriate terminals. Connecting the DC power to the AC terminals will cause the unit not to operate. Connecting the AC power to the DC terminals will blow the fuse and potentially cause damage to the electronics boards.

NOTE: The green ground screw in the rear of the housing should be used for earth ground.

4. Connect the 4-20 mA signal wiring to TB3. Make connections to A-, A+ for an active output signal (power supplied by TA2) or P-, P+ for a passive signal using an external power supply.
5. Optional Pulse Output: connect signal wiring to TB4. Make connections to A-, A+ for an active output (power supplied by the TA2) or P-, P+ for a passive signal using an external power supply. (See specifications for voltage requirements.)
6. Optional second mA output – connect signal wiring to TB5. Make connections to P- and P+ using an external power supply. This is a passive connection requiring external power supply.

NOTE: If using both the passive pulse output and second mA output see Appendix B.

7. Replace the housing cover.

1.3 Configuration

The TA2 is pre-configured using the information supplied with the order. If desired, the user can view or change any of the configuration data. See Configuring the Transmitter, Section 2.5

2.0 Installation

2.1 Unpacking

Unpack the instrument carefully making sure all components have been removed from the packing material. Inspect all components for damage. Report any concealed damage to the carrier within 24 hours. Check the contents of the carton making sure they correspond with the packing slip and purchase order. Save the Calibration Certificate containing the calibration and configuration data for future reference.

Verify that the model number imprinted on the nameplate matches the number on the packing slip and the purchase order. Report any discrepancies to the factory. Record the serial number for future reference when ordering parts.

Model Number

Serial Number

2.2 Electrostatic Discharge (ESD) Handling Procedure



AMETEK LMS electronic instruments are manufactured to the highest quality standards. These instruments utilize electronic components which may be damaged by static electricity present in most work environments. The following steps are recommended to reduce the risk of component failure due to electrostatic discharge:

1. Ship and store circuit boards in anti-static bags. If an anti-static bag is not available, wrap board in aluminum foil. Do not place boards on foam packing materials.
2. Use a grounding wrist strap when installing and removing circuit boards. A grounded workstation is also recommended.
3. Handle printed circuit boards only by the edges. Do not touch components or connector pins.
4. Ensure that all electrical connections are completely secure and none are partial or floating. Ground all equipment to a good earth ground.

NOTE: The instrument is rated per IEC 61010-1 for use in Installation Category II, Pollution Degree 2.

2.3 Installation

2.3.1 Electronics

The instrument is rated for use in Class I, Division 1 and Class I, Division 2 areas. The enclosure is also rated NEMA 4X. Remote electronics (optional) should be installed in an easy to access location within 500 feet (150 meters) of the sensor. The electronics should not be installed in areas where ambient temperature exceeds +175 °F (+80 °C). If ambient temperature is between -22 to -65 °F (-30 to -54 °C), the unit will operate but the display will not be readable.

Provide watertight seals for all wiring entrances in the enclosure to maintain the NEMA 4X rating. Use appropriate NEC section when installing the instrument.

NOTE: A switch or circuit breaker should be installed in close proximity to the equipment and within easy reach of the operator. It should be marked as the disconnecting device for the equipment.

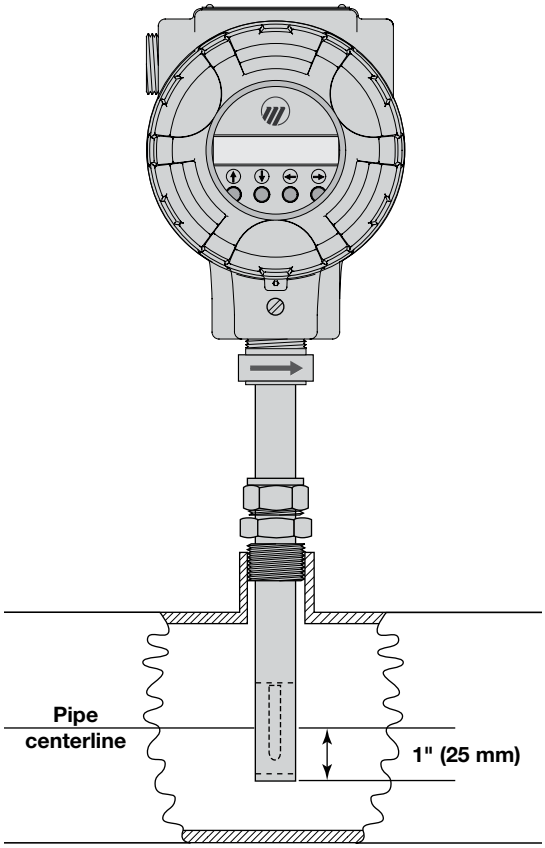


Figure 3
Probe Installation into Pipe or Duct Using a Compression Fitting

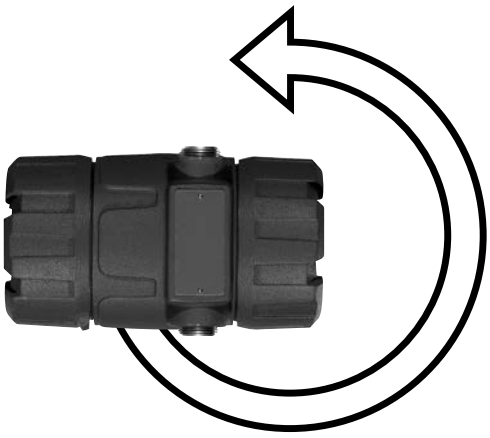


Figure 4

2.3.2 Probe/Flow Body

Proper installation of the probe in the pipe or duct is essential for accurate air or gas flow measurement. Normal procedures for installing any type of flow element should be followed. See Appendix A for additional information on probe location.

A flow arrow is etched on the sides of the probe to designate flow direction. The instrument is calibrated with the flow in this direction. Ensure that the flow arrow is aligned in the direction of flow. The instrument is unable to recognize flow direction if inserted with the flow arrow in the wrong direction.

It is generally recommended that the sensor be located in the center of the pipe. This location provides less sensitivity to changes in flow profile. Sensors mounted through compression fittings have the ability to field adjust the sensor to the desired location by using the dimensions as shown in Figure 3.

It may be necessary to rotate the head of the instrument to view the display while maintaining the proper flow orientation. This is accomplished by loosening the set screw on the bottom of the housing, rotating the enclosure to the desired position and re-tightening the set screw. The second set screw is a stop to prevent over rotating the enclosure. See figure 4.

Pressure ratings of the compression fitting:

Stainless steel ferrules:
1500 psig at +70 °F (103 bar at +20 °C)
1375 psig at +400 °F (95 bar at +200 °C)

Teflon® ferrules:
100 psig (7 bar)

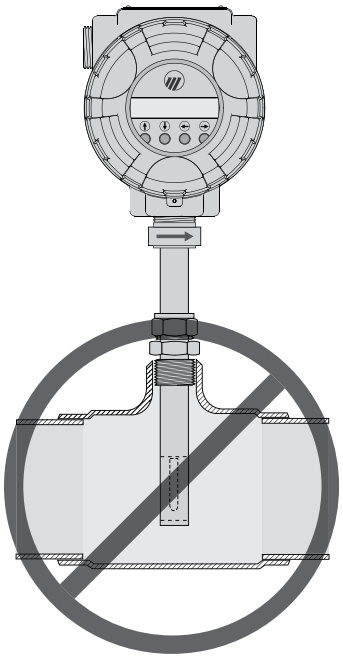


Figure 5
Probe Installation into a Tee Fitting is Not Recommended

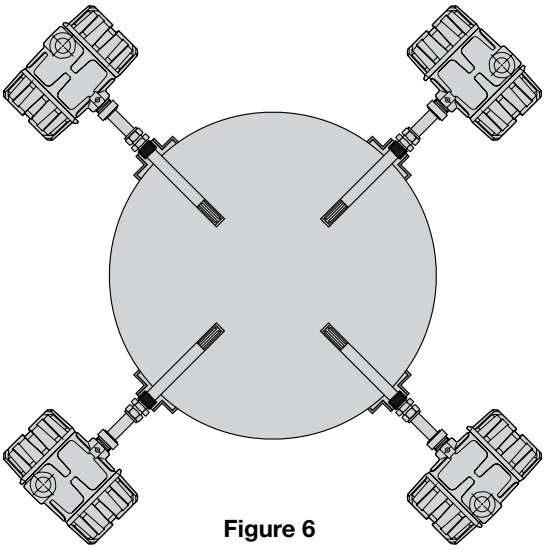


Figure 6
Install the TA2 at an Angle where Condensed Moisture may be Present

Various methods of mounting the probe include compression fittings, threads, and flanged connections. Refer to probe model numbers. The insertion probe can be installed through a compression fitting. The use of a bored-through fitting with ¾" or 1" NPT connection for ¾" outside diameter tube is recommended.

The use of Teflon® ferrules should be considered if repeated reposition of the sensor is considered. The stainless steel ferule can only be tightened once as it makes a permanent indentation on the probe. If using a compression fitting with stainless steel ferrules, ensure that the probe is in the desired location before tightening.

NOTE: The TA2 flow measurement is based on a fully developed turbulent flow profile in a pipe with the specified inner diameter. Accuracy will be affected if these conditions are not obtained. Installing the probe in a tee is not recommended as the flow profile and the flow area are distorted (See figure 5).

For applications where it is desirable to install or remove the probe without having to shut down the process,

The Magnetrol Retractable Probe Assembly (RPA) can be utilized. See the Model TA2 Product Catalog

(AMETEK LMS bulletin 54-140) for more information.

WARNING: To avoid potential damage or injury, never loosen a compression fitting while sensor is under pressure.

NOTE: Remote electronics is recommended for operating temperatures greater than +250 °F (+120 °C) or in locations where the temperature of the electronics will exceed +175 °F (+80 °C). Optionally, an insertion probe with extended probe length to provide at least four inches (100 mm) between the electronics and the compression fitting can be utilized.

NOTE: The sensor must be installed in a location where moisture cannot drip or come in contact with the heated element. Any contact with condensed moisture in the gas flow will cause a false high flow indication. Consider mounting the probe at a 45° angle from top, from the side or bottom of the pipe to minimize possibility of condensed moisture running down the probe and contacting the sensor (see Figure 6). In extreme cases, it may be necessary to insulate or even heat trace the pipe to prevent the condensation of moisture.

The TA2 with an insertion probe provides a point measurement and assumes that a fully developed profile exists. See Appendix A. The user has the ability to compensate the flow measurements based upon flow profile considerations under the Advanced Configuration section of the software. See Section 2.5.11.

NOTE: If equipment is used in a manner not specified by manufacturer, protection provided by equipment may be impaired.

NOTE: All probes are filled with glass beads, per ISO-3310.

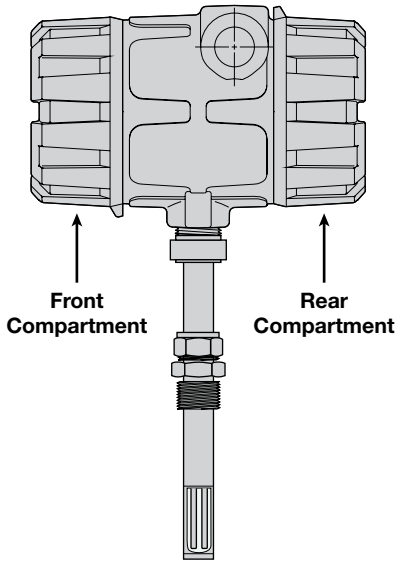


Figure 7
Wiring Housing Cover

2.4 Wiring

There are two connections in the electronics enclosure for ¾" NPT or M20 connections. These are generally used as one connection for input power and one for output signal.

2.4.1 Power and Signal Connection

The instrument has separate wiring connections for AC (100 to 264 VAC) and DC (15 to 30 VDC). AC power wiring connections are made to terminal block TB1. DC connections are made to terminal block TB2 (Figure 8).

NOTE: The AC power terminal blocks accept 12-22 AWG wire and the DC power terminal blocks accept 14-30 AWG wire. Select wire size consistent with power requirements. The mA output and pulse output also accept 14-30 AWG wire.

For a maximum ambient temperature of 80° C use wiring rated up to 264 VAC and 105° C. For a maximum ambient of 70° C use wire rated up to 264 VAC and 95° C.

Caution: OBSERVE ALL APPLICABLE ELECTRICAL CODES AND PROPER WIRING PROCEDURES.

1. Make sure the power source is turned off.
2. Unscrew and remove housing cover of rear compartment (Figure 7).
3. Pull power supply and control wires through conduit connection.
4. Connect power leads to proper terminals (Figure 8).
   a. VAC (100 to 264 VAC) Make connections to TB1. Connect hot wire to terminal marked L1 and the second wire to the terminal marked L2.
   b. DC (15 to 30 VDC) Make connections to TB2. Connect wires to terminals (+) and (-) on the terminal block.

NOTE: The green screw in the rear of the housing should be used for earth ground.

5. Connect the 4-20 mA signal wiring to terminal block TB3. Refer to Section 2.4.3.
6. If the TA2 model has the optional pulse/alarm output, connect the signal wiring to terminal block TB4. Connections for both an active (powered) connection and a passive (requires external power supply) are provided. Refer to section 2.4.4.
7. The TA2 has the optional second mA output connect signal wiring to terminal block TB5. This output is a passive connection requiring an external power supply.
8. Replace housing cover. Installation is complete.

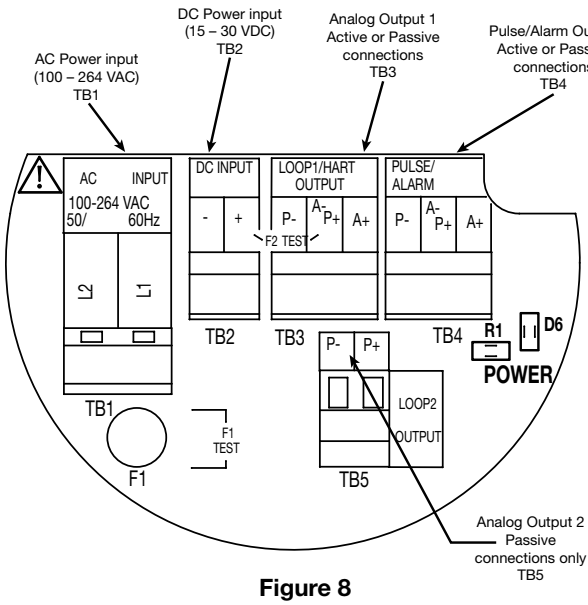


Figure 8
Wiring Connections
Input Wiring Board

Caution: In hazardous areas, do not apply power to the unit until the conduit is sealed and the enclosure cover is screwed down securely.

NOTE: Install using Teflon® tape at all conduit entries (maximum 2 turns).

2.4.2 Ground Connection

The instrument must be grounded in accordance with Article 250 of the National Electric Code.

2.4.3 4-20 mA Output

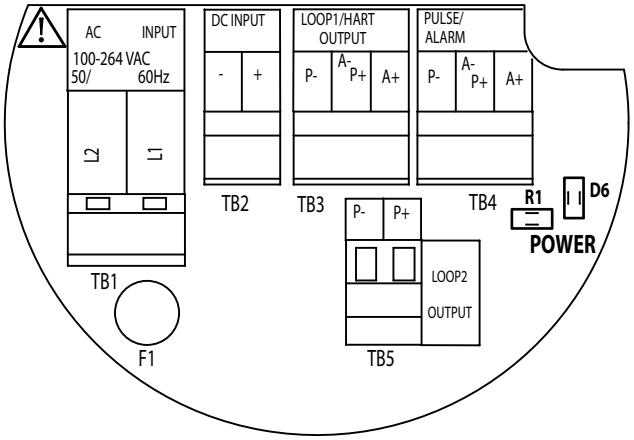


Figure 9
Wiring Connections
Input Wiring Board

NOTE: If using both the passive pulse output and second mA output see Appendix B.

A 4-20 mA output (Analog Output 1) of the flow rate is available at terminal block TB3. This output signal is isolated from the instrument. An active or a passive connection is available—see definition below.

For units with the optional second mA output (Analog Output 2) this connection is available at terminal block TB5; this output is isolated from the input power and from the primary 4-20 mA loop and shares a common with the pulse output. A passive connection is only available for this loop.

Active Connection—Use the active connection when the TA2 is providing power for the 4-20 mA signal. Use connections A- and A+ (see figure 8). The active connection will drive a 1000-ohm loop resistance.

Passive Connection—Use the passive connection when an external power supply or the control system is used to power the 4-20 mA loop. Use connections P- and P+ (see figure 8). The resistance is dependent upon the customer-supplied power supply.

2.4.4 Pulse/Alarm Output

The optional pulse signal is isolated from the input power and from the primary mA loop output. This signal shares a common with the secondary mA output (Analog Output 2). The pulse output is available with either an active or passive connection.

Pulse/alarm output—Use the active connection when the TA2 is providing power for the pulse/alarm output. Use connections A- and A+ on TB4 (see figure 8).

Use the passive connection when an external power supply is used to provide power to the pulse/alarm. Use connections P- and P+ on TB4.

NOTE: Electrical specifications for pulse and alarm output are specified below.

- Pulse Output:
  - Active: 24 VDC (±10%) power, 150 mA
  - Passive: 2.5 to 60 VDC power, 1.5 Amps
- Alarm Output:
  - Active: 24 VDC (±10%) power, 100 mA
  - Passive: 2.5 to 60 VDC power, 1 Amp.

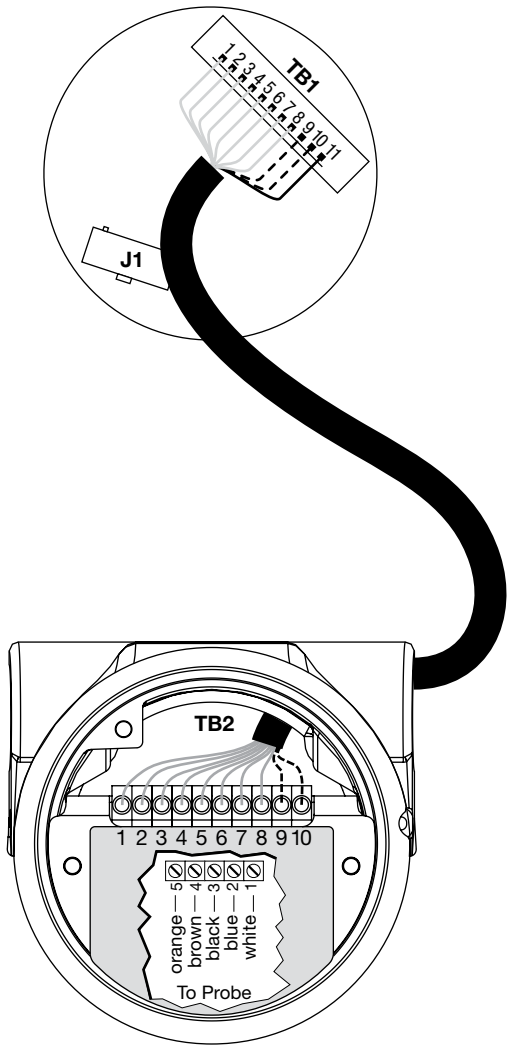


Figure 10
Probe Housing

Remote Wiring Cable Connections

Belden 8104 Max 200 Feet (60 meters) Wire Color	Belden 8305 Max 500 Feet (150 meters) Wire Number	TB2 connection Probe Housing	TB1 connection at Circuit Board in Electronics
Green/White	1	1	1
White/Green	2	2	2
Blue/White	3	3	3
White/Blue	4	4	4
Brown/White	5	5	5
White/Brown	6	6	6
Orange/White	7	7	7
White/Orange	8	8	8
	9	9	9
	10	10	10
Shield	Shield	Not used	11

2.4.5 Remote Electronics

If the electronics are remote from the probe, a remote board with terminal blocks is provided in the housing on the probe. For cable lengths up to 150 feet, the connection between the probe and electronics should be an 8-conductor shielded cable (Belden 8104). For cable lengths up to 500 feet, a 10-conductor shielded cable (Belden 8305) is used. This cable length can be adjusted in the field. If cable other than the recommended Belden cable is used, following are the maximum resistances which should be utilized:

8 Conductor—maximum resistance of 5.4 ohms

10 Conductor—maximum resistance of 10.0 ohms

Caution: The probe and electronics are calibrated and shipped as a matched set. The model number is indicated on both the electronics nameplate and the probe nameplate; verify that they are the same.

2.4.5.1 Probe Wiring

The probe housing contains a remote board with terminal blocks for ease of wiring between the probe and the electronics. An 8-wire (Belden 8104) or 10-wire (Belden 8305) shielded interconnecting cable from the probe housing to the instrument is required. Refer to Figure 10 for wiring connections inside the probe housing and for remote cable wiring from the probe housing to the electronics housing.

1. Remove electrical power to the instrument.
2. Remove and unplug the display module if provided.
3. Remove the two hex head fasteners using a 1⁄4" socket. This will remove a module consisting of the processor circuit board and the power loop circuit board.
4. Unplug the electrical connections at J1 of the power loop board.
5. Probe wiring connections are made to TB1 on the same side of the power loop circuit board. Refer to Figure 10.
6. Reattach the electrical connections to J1.
7. Reassemble the circuit boards in the enclosure. Make sure that the probe wiring does not get pinched between the standoffs on the circuit board and the attachment lugs in the housing.
8. Reinstall the display module if provided.
9. Apply power to the instrument.

2.5 Configuring the Transmitter

The TA2 electronics are easy to set up and configure to the user's specifications. When specified with the order, the configuration settings are programmed into the instrument at the factory. If not, or if the user wants to modify the configuration settings, follow these instructions for configuring the instrument. The primary structure of the software is divided into eight main groups:

Measured Values	View Selected Values
Basic Config	Configuration of essential programming information
I/O Config	Configure all input/output functions
Advanced Config	Additional configuration which affects the unit operation
Device Info	Provides information on the instrument
Diagnostics	Test operation of instrument
Factory Configuration	Factory calibration information
Run Mode	Normal operating mode

All necessary information can be input using the 4-button keypad located on the display module or via HART if supplied. If the TA2 is supplied with HART, PACT*ware*™ can be used to review or change configuration.

NOTE: The Display Module can be rotated in 90-degree increments. Remove cover, remove the two screws holding the display module, rotate to desired location and reattach display module. See Figure 11.

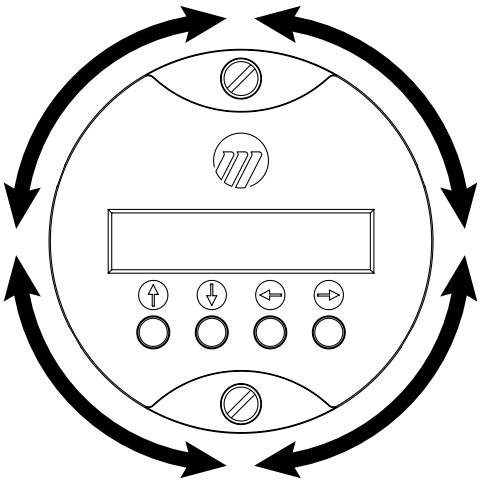


Figure 11
Display Module can be Rotated

2.5.1 Initialization

When power is first applied to the TA2 there is an initialization period for the sensor to reach stabilization. During this time the TA2 will output a 4 mA signal and the display (if provided) will read "Initializing."

Only after the sensor has stabilized and a valid flow measurement is obtained will the display show a flow measurement. The output signal will be active and the totalizer will begin counting.

2.5.2 Operator Keypad

The TA2 has a local user interface using a 2-line ¥ 16-character liquid crystal (LCD) and 4-push-button keypad. All measurement data and configuration information is shown in the LCD.

The TA2 is configured via a “tree” type menu structure where it is easy to access branches of the tree to configure the various parameters. The four push buttons have different functions for various operating modes in the menu structure.

2.5.2.1 Menu Traversal Mode

Push Button		Keystroke Action
↑	Up	Moves to the previous menu
↓	Down	Moves to the next item in the menu
←	Back	Moves back one level to the previous higher branch
→	Enter	Enters into the lower level branch

2.5.2.2 Item List Selection

Data is selected from a pre-specified list of entries. When Enter → key is depressed on a menu item the following modes are available. The symbol (↕) is shown on the right most character of the 2nd line to indicate that various selections are available.

Push Button		Keystroke Action
↑	Up	Moves to the previous selection in the list
↓	Down	Moves to the next selection in the list
←	Back	Returns to the previous mode without changing selection
→	Enter	Accepts the selection and returns to the menu traversal mode

NOTE: If a key is not pressed for 5 minutes, the display returns to the run mode.

2.5.2.3 Numeric Entry

The Numeric Entry Mode is used to enter numeric values. This mode is accessed when the Enter Key is pressed on a menu item that requires entry of a numeric value. Data is entered at the cursor position:

Push Button		Keystroke Action
	Up	Moves to the next digit (0,1,2,3…9). If held down the digits scroll until the push button is released. The leftmost position cycles between "–" (minus symbol) and blank.
	Down	Moves to the next digit (9,8,7,6…0). If held down the digits scroll until the push button is released. The leftmost position cycles between "–" (minus symbol) and blank.
	Back	Moves the cursor to the left and deletes the digit. If the cursor is located at the leftmost position the entire value is deleted and the previous saved value is displayed.
	Enter	Moves the cursor to the right. If the cursor is located at a blank position, the new value is saved and the display returns to the previous menu.

NOTE: Numeric entries are left justified and new values are entered from left to right. A decimal point can be entered after the first digit is entered. The leftmost position used for either a "–" negative symbol or blank which implies a positive value.

2.5.2.4 Character Data Entry Mode

This mode is most commonly used when entering a new local tag line into the TA2. The local tag as shipped from the factory is “Magnetrol TA2” and can be changed to permits the user to identify the instrument with a the actual tag line of the instrument or the service. When this mode is entered, a cursor marks the leftmost character on the 2nd line.

Push Button		Keystroke Action
	Up	Moves to the next character (Z, Y, X, W, …). If held down the characters scroll until the push button is released.
	Down	Moves to the previous character (A, B, C, D, …). If held down the characters scroll until the push button is released.
	Back	Moves the cursor to the left. If the cursor is located at the leftmost position the screen is exited without changing the original characters.
	Enter	Moves the cursor to the right. If the cursor is located at the rightmost position the new value is saved and the display returns to the previous menu.

2.5.2.5 Increment/Decrement Digit Mode

The Increment/Decrement digit entry mode is used with some screens for changing numeric values.

Push Button		Keystroke Action
	Up	Increases the displayed value. If held down the digits scroll until the push button is released. Depending upon what screen is being revised, the increment amount may change by a factor of 10 after the value has been increased 10 times.
	Down	Decreases the displayed value. If held down the digits scroll until the push button is released. Depending upon what screen is being revised, the decrement amount may change by a factor of 10 after the value has been decreased 10 times.
	Back	Return to the previous menu without changing the original value which is immediately redisplayed.
	Enter	Accepts the displayed value and returns to the previous menu.

2.5.3 Password

A password protection system restricts access to portions of the menu which affect the unit's operation and configuration. The default user password installed in the TA2 at the factory is 0 which effectively disables the user password feature. This allows complete configuration to be done without entering a password.

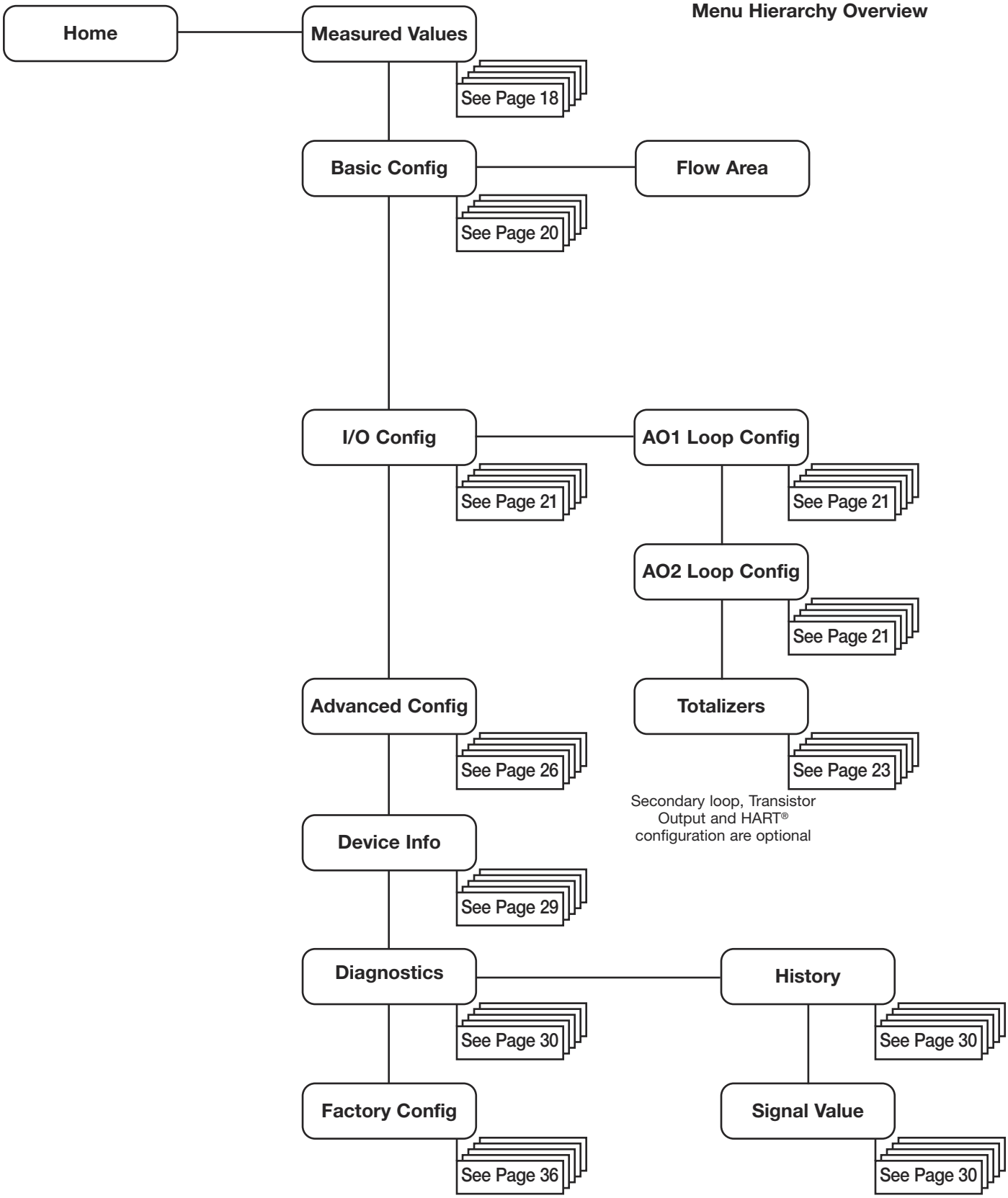
If desired, a new user password can be entered in the Advanced Configuration in the New Password screen.

The password can be changed to any numerical value up to 255. Once the password is changed from the factory default value of 0 then the new password will be required whenever any configuration values are changed.

2.5.4 Configuration Menu Overview

Configuration of the TA2 is performed by use of a tree-like menu structure. The chart at right shows an overview of the top level menu items. This basic configuration structure is used both with the user interface using the 16-character display and keypad and in the HART menu structure (see section 2.6.3).

TA2 User Interface
Menu Hierarchy Overview



2.5.5 Run Mode

The Run Mode is the normal display for the TA2. The user has the option of selecting displayed values such as Flow, Mass, Temperature, Totalized Flow, Tag Line, Custom Units, or mA output. These values will rotate at 2-second intervals on the display during operation. Run Mode appears on power-up or after a 5-minute period with no keypad activity.

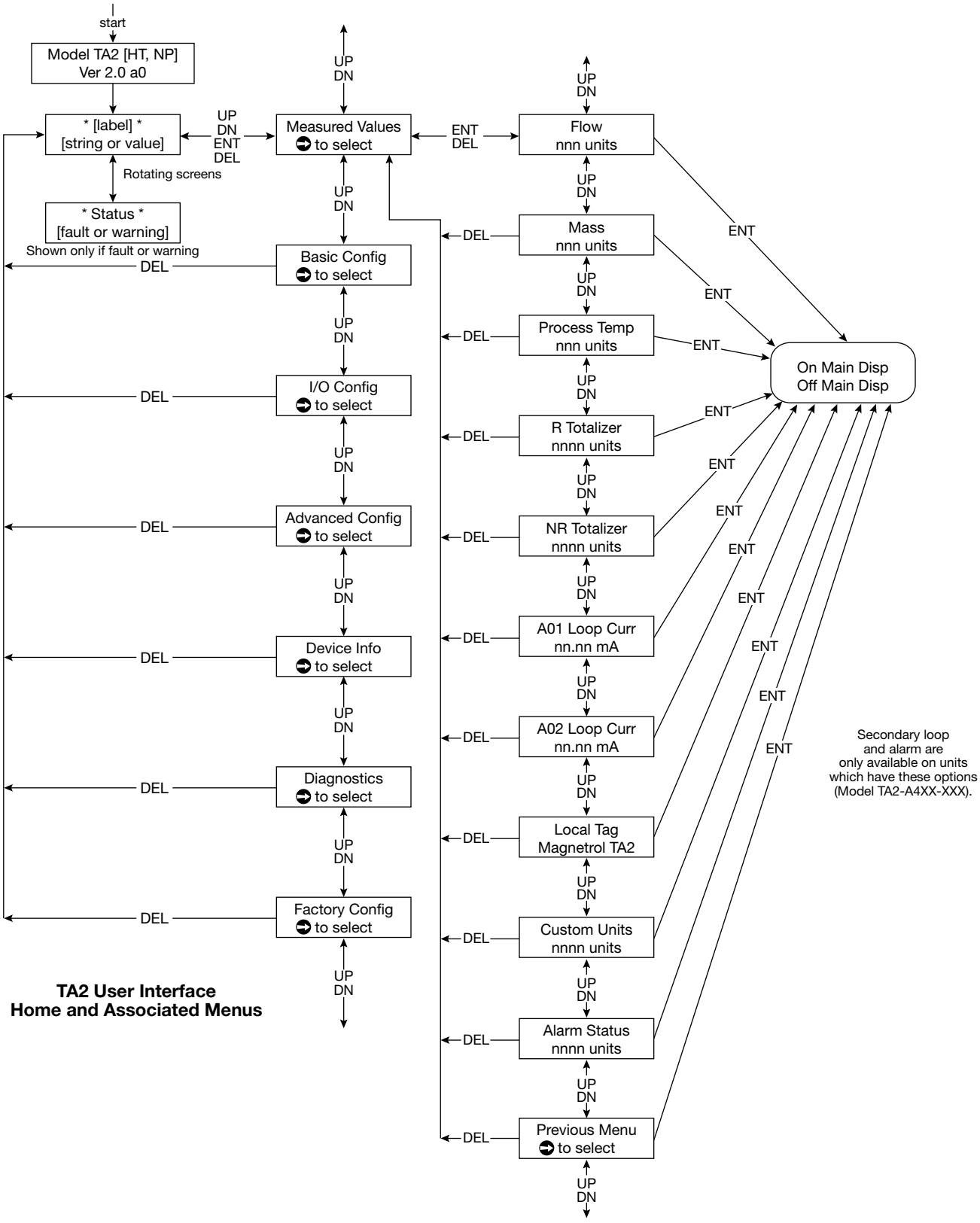
The main menu is used to access the various subroutines. From the Run mode, press any key to enter the Main Menu. The following describes the various selections available.

2.5.6 Measured Values

The Measured Values menu is used to display the current values measured by the TA2 and determine which parameters will be shown on the display during run mode. Enter this section by pressing ➔ when Measured Values is displayed from the Main Menu.

From the factory, the Home Menu will show the tag line and the flow value. To add or remove parameters from the Home Menu press the ➔ key. Use the ↑ or ↓ keys to add (On Main Disp) or remove (Off Main Disp) variables. To return to the rotating Home Menu, simply press the ← key twice.

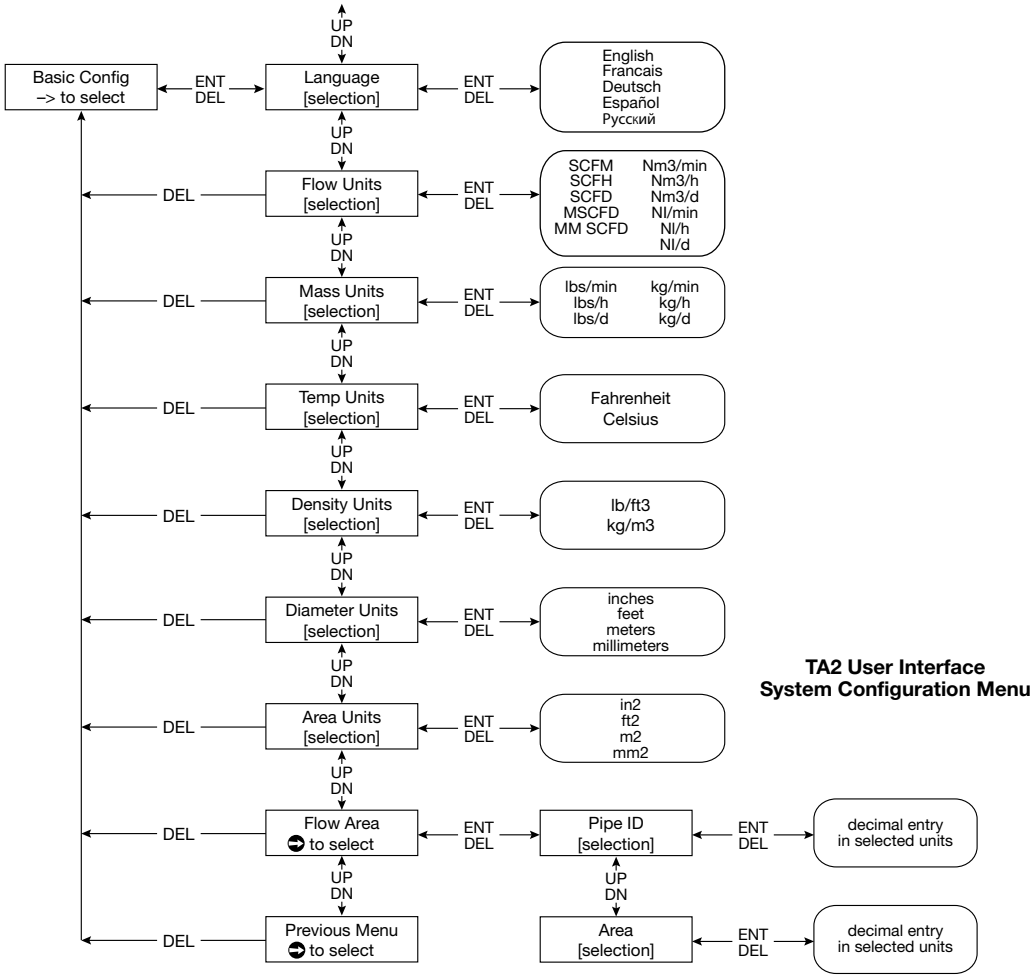
Note that the Second Loop current (AO2 Loop Current) and Alarm Status are available only on units where these options have been purchased.



TA2 User Interface
Home and Associated Menus

2.5.7 Basic Configuration Menu

The Basic Configuration menu is used to select the display units and enter specific information for the application. Access this section by pressing Enter when Basic Config is displayed from the Main Menu. To calculate the flow or mass, it is necessary to accurately enter the inside area of the pipe or duct. If the pipe or duct is circular, simply enter the inside diameter; the cross sectional area of the pipe is automatically calculated. If the duct is rectangular, skip over the entry of diameter, and directly enter the cross sectional area in the area section. The instrument will then back calculate an equivalent diameter.

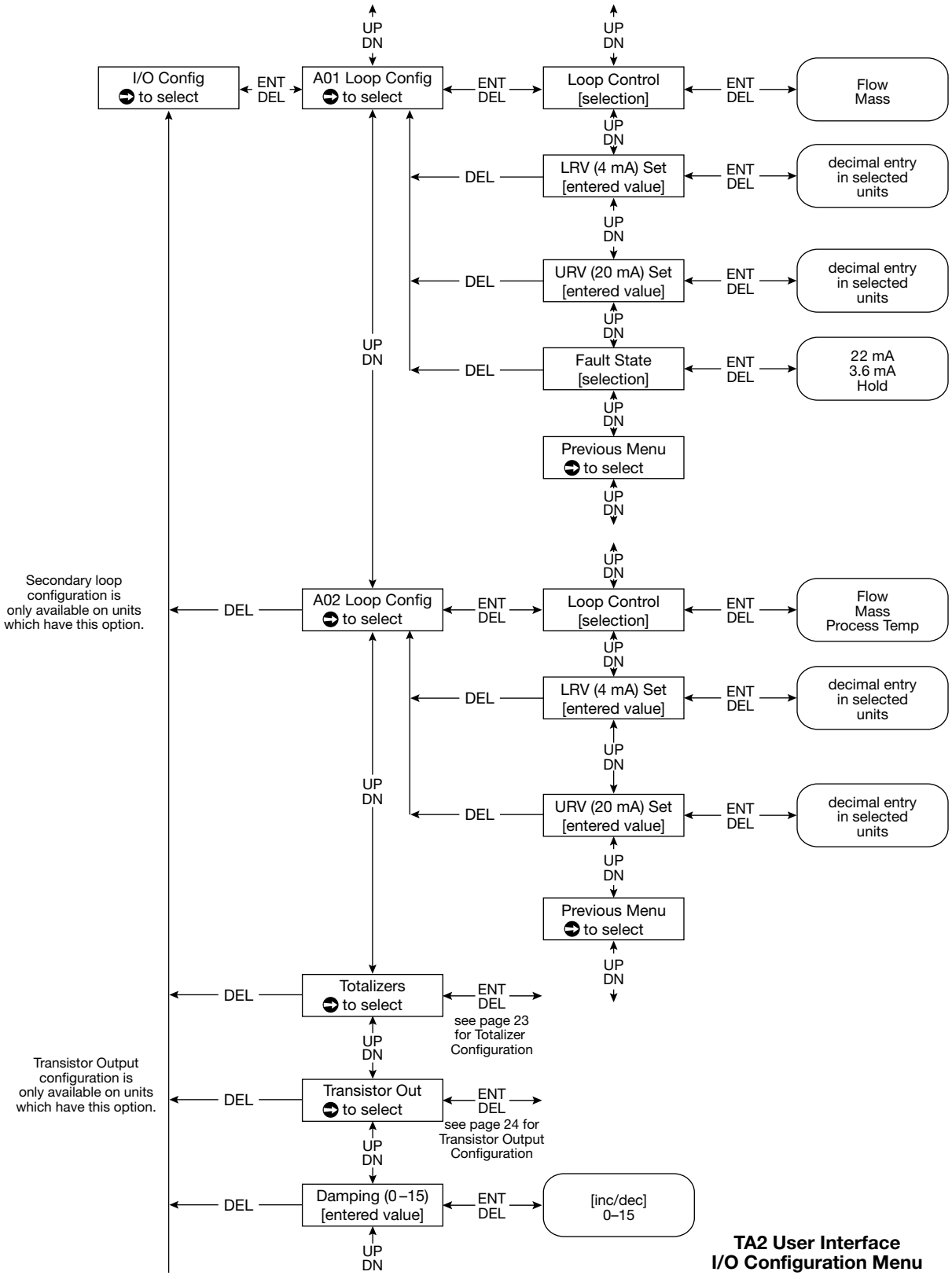


TA2 User Interface
System Configuration Menu

Configuration Parameter	Explanation
Language	The TA2 can be configured in English (default value), French, German, Spanish or Russian
Flow Units	Selection of SCFM, SCFH, SCFD, MSCFD, MMSCFD, Nm3/min, Nm3/h, Nm3/d, Nl/min, Nl/h Nl/d. Should other units of flow be desired, the Custom Unit feature can be used in the Advanced Configuration Menu
Mass Units	Selection of lbs/min, lbs/h, lbs/d, kg/min, kg/h, kg/d. Should some other units of flow be desired, the Custom Unit feature can be used in the Advanced Configuration Menu
Temperature Units	Selection of Fahrenheit, Celsius
Density Units	lb/ft3, kg/m3
Diameter Units	Selection of inches, feet, meters, mm
Area Units	in2 (square inches), ft2 (square feet), m2 (square meters), mm2 (square mm)
Flow Area	The TA2 requires entry of the pipe size or flow area to properly calculate the flow rate. This can either be entered by specifying the ID of the pipe or the flow body or by entering the flow area. Units of measurement are specified above.

2.5.8 I/O Configuration Menu

The I/O Configuration menu is used to set up the operations of 4–20 mA output, the totalizer, and the pulse/alarm output.



TA2 User Interface
I/O Configuration Menu

The previous page shows the I/O configuration menu for setting up the 4-20 mA loop, the Totalizers, and the Damping. The basic TA2 has a single 4-20 mA loop referred to as AO1. Optionally the TA2 can be provided with a second 4-20 mA loop referred to as AO2 and a Transistor Output that can be configured to provide either a Pulse Output or an Alarm Output (see page 10 for specifications). The configuration menu for the Totalizers is shown on page 23 and the Transistor output is shown on page 24.

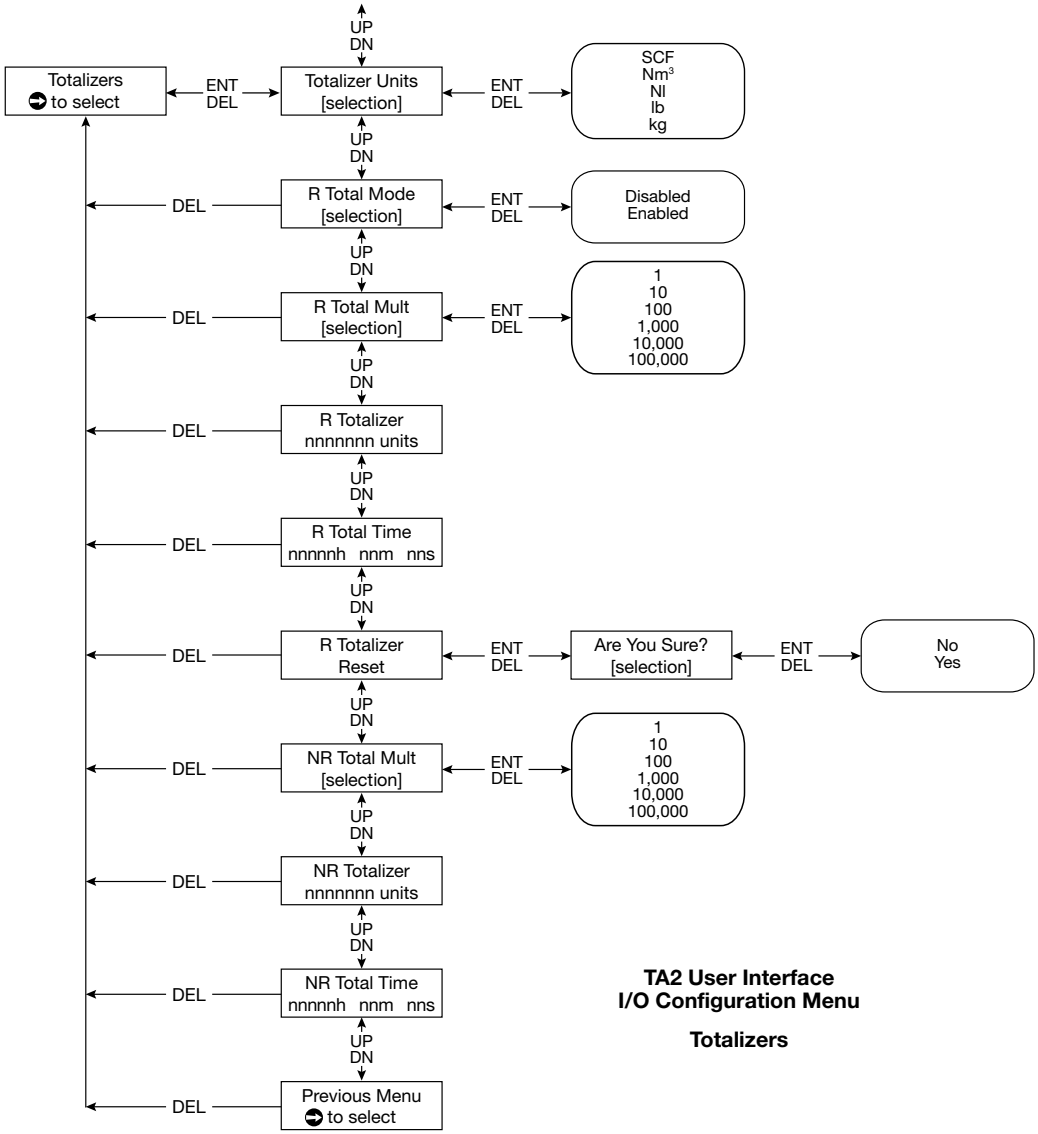
Configuration Parameter	Explanation
Loop Control	Selects which measurement (Flow or Mass) will control the mA loop (AO1) output. AO2 permits selection of mA value for Temperature, Flow or Mass; Temperature is the default selection.
LRV (4 mA) Set	Enter the desired Lower Range Value (LRV) or the 4 mA value
URV (20mA) Set	Enter the desired Upper Range Value (URV) or the 20 mA value
Fault State	Select **3.6 mA**, **22 mA** or **Hold** (last value). Note that the Fault State is only configurable on the primary loop (AO1).
Previous Menu	Previous Menu exits the 4-20 mA Configuration Menu
Totalizer	The TA2 provides both a resettable and a non-resettable totalizer. Configuration information on the totalizers is found on page 23.
Transistor Output	Provides either a Pulse output which is proportional to the flow rate or an alarm which can be used as a low flow or high flow indication. Configuration information begins on page 24.
Damping	Increasing the Damping will smooth the TA2 display and the loop output. This may be used in cases when turbulence is causing fluctuations in the measurement. The damping value is expressed in time constants. A one-second time constant means that with a step change in flow, the measured flow value will reach approximately 63% of the new value in one second and approximately 99% of the new value in five seconds. The lower limit is 0 which means no damping (other than the inherent response time of the sensor); the upper limit is 15 seconds.

2.5.9 Totalizer

The totalizer provides seven digits of resolution. In the event of a fault indication, the totalizer will not accumulate. When the value in the totalizer exceeds 9,999,999, the totalizer will rollover. The Total Time will keep counting.

Both the Resettable and Non-Resettable totalizers have individual multiplier factors which can be used to prevent too frequent rollover and potential loss of data.

The Totalizer data is stored in nonvolatile memory, eliminating the need of backup batteries. Data is written hourly.



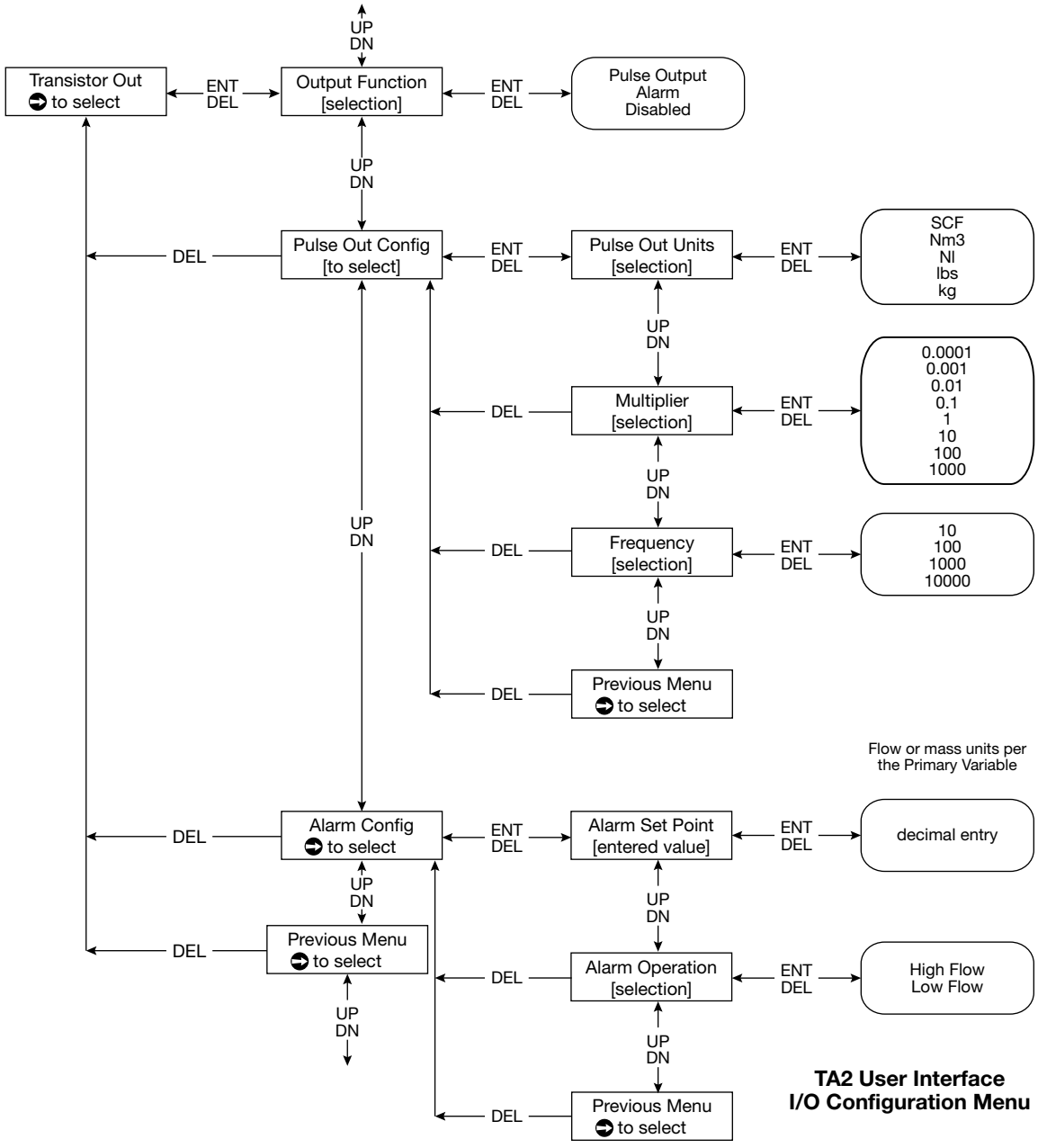
TA2 User Interface
I/O Configuration Menu

Totalizers

Configuration Parameter	Explanation
Totalizer Units	The Totalizer Units permits selection of the units for both the resettable and the non-resettable totalizers. Select SCF (Standard Cubic Feet), Nm3 (Normal Cubic Meters), Nl (Normal Liters), lb (Pounds), or kg (Kilograms).
R Total Mode	R Total Mode allows the user to enable or disable the Resettable totalizer. Default mode is Enabled.
R Total Mult	The R Total Mult permits selection of the multiplier to be used for the resettable totalizer. The function of the totalizer multiplier is such that if the units are SCF and the multiplier is set to 100, then the totalizer will increment for each 100 SCF. The default value is 1.
R Totalizer	This is a read-only screen that displays the present value of the resettable totalizer.
R Total Time	This is a read-only screen that displays the time that has elapsed since the resettable totalizer was last reset.
R Totalizer Reset	The R Totalizer Reset screen allows the user to reset the total flow and elapsed time of the resettable totalizer to zero. Since this action will permanently lose this data, a second chance is provided with an “Are you sure” selection.
NR Total Mult	The NR Total Mult permits selection of the multiplier to be used for the Non-resettable totalizer. The function of the totalizer multiplier is such that if the units are SCF and the multiplier is set to 100, then the totalizer will increment for each 100 SCF. The default value is 1000.
NR Totalizer	This is a read-only screen that displays the value of the Non-resettable totalizer.
NR Total Time	This is a read-only screen that displays the time that corresponds to the value of the NR Totalizer.

2.5.10 Transistor Output

The optional transistor output can be configured to provide a pulse output proportional to the flow rate or an alarm indication where the output can serve as a low flow or a high flow alarm indication. When used as a pulse output a multiplier factor can be applied. A selection of maximum frequency ensures that the pulse output from the TA2 does not exceed the maximum allowable frequency of any external counter. The default is 10 KHz.



TA2 User Interface
I/O Configuration Menu

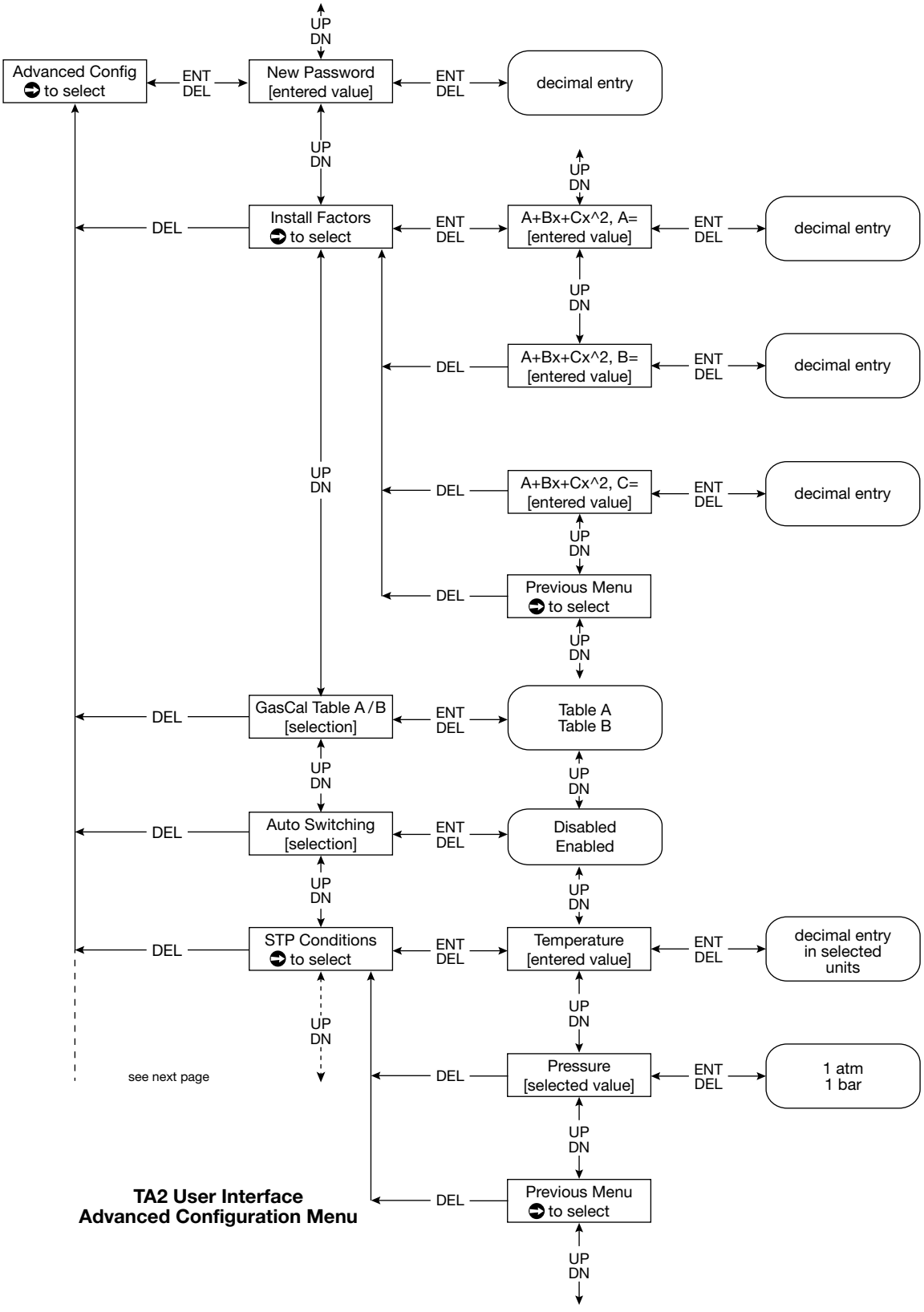
Configuration Parameter	Explanation
Output Function	Selects the operation of the transistor output. Can be set up for Pulse Output, Alarm, or Disabled. Default is disabled.
Pulse Output Units	Permits selection of the units for the pulse output. Select SCF (Standard Cubic Feet), Nm3 (Normal Cubic Meters), Nl (Normal Liters), lb (Pounds), or kg (Kilograms).
Multiplier	Use this factor to match the pulse output from the TA2 with the input of the remote totalizer or counter. The value represents the flow in selected units which correspond to one pulse output.
Frequency	Selects maximum frequency output from the TA2. This should match the maximum input frequency of the external counter/totalizer. For instance: mechanical totalizers will have a lower maximum frequency.
Alarm Set Point	Enter the desired set point for the alarm. Units are same as those selected under AO1 loop control. The alarm contacts will change state when this value is reached. There is a built in hysteresis requiring the flow to change by 10% for the switch to reset.
Alarm Operation	Choose Low Flow or High Flow. When Low Flow is selected, the contacts will remain closed at flow rates above the set point value and will open when the flow rate is equal to or less than the entered set point value. If High Flow is selected, the contacts will remain closed at flow rates below the set point value and will open when the flow rate is equal to, or greater than, the entered set point.

2.5.10.1 Pulse Rate Calculation Example

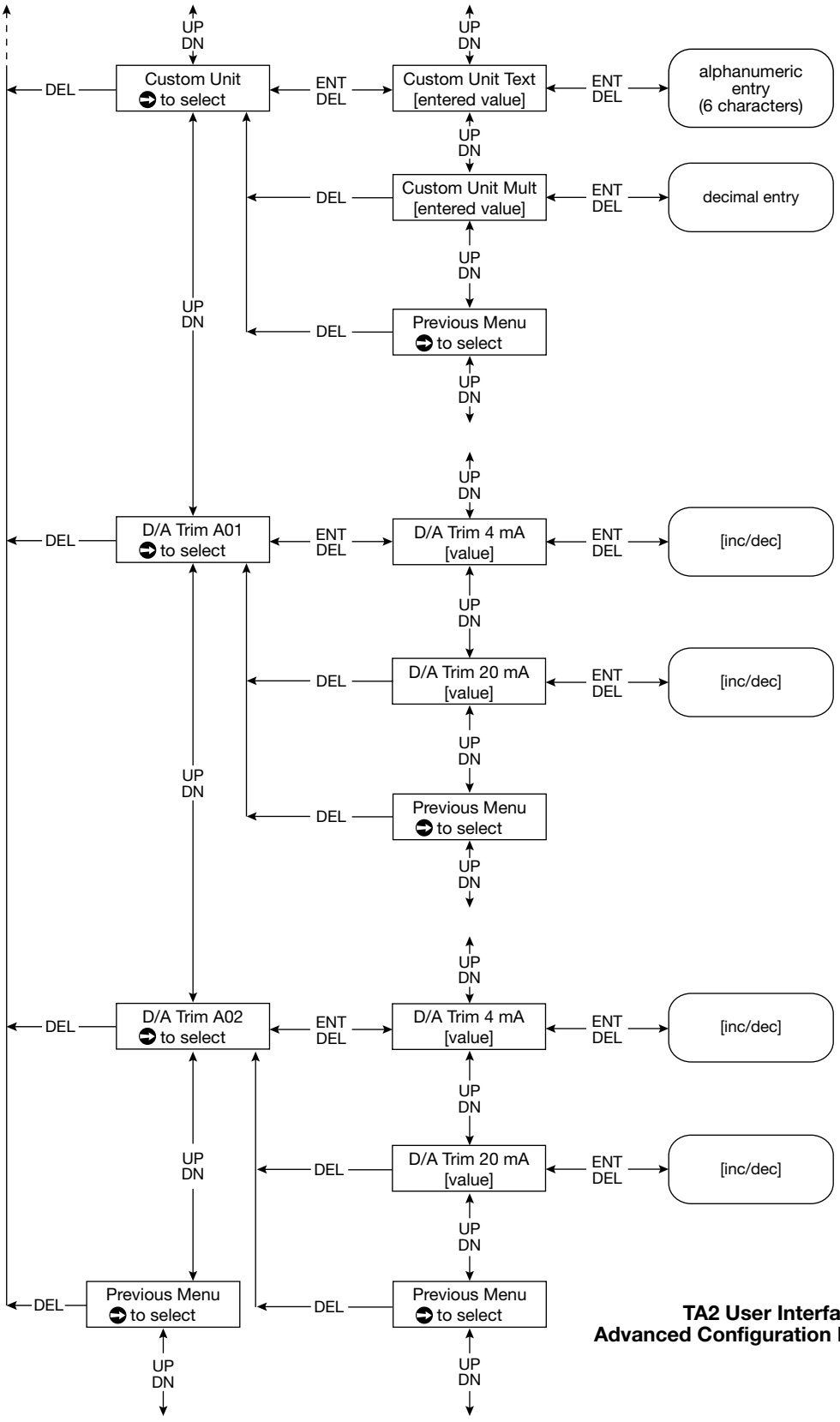
NOTE: See Appendix C example.

2.5.11 Advanced Configuration Menu

The Advanced Configuration menu sets advanced parameters that may occasionally be required for proper operation of the TA2.



TA2 User Interface
Advanced Configuration Menu



Secondary loop configuration is only available on units which have this option.

TA2 User Interface
Advanced Configuration Menu (cont)

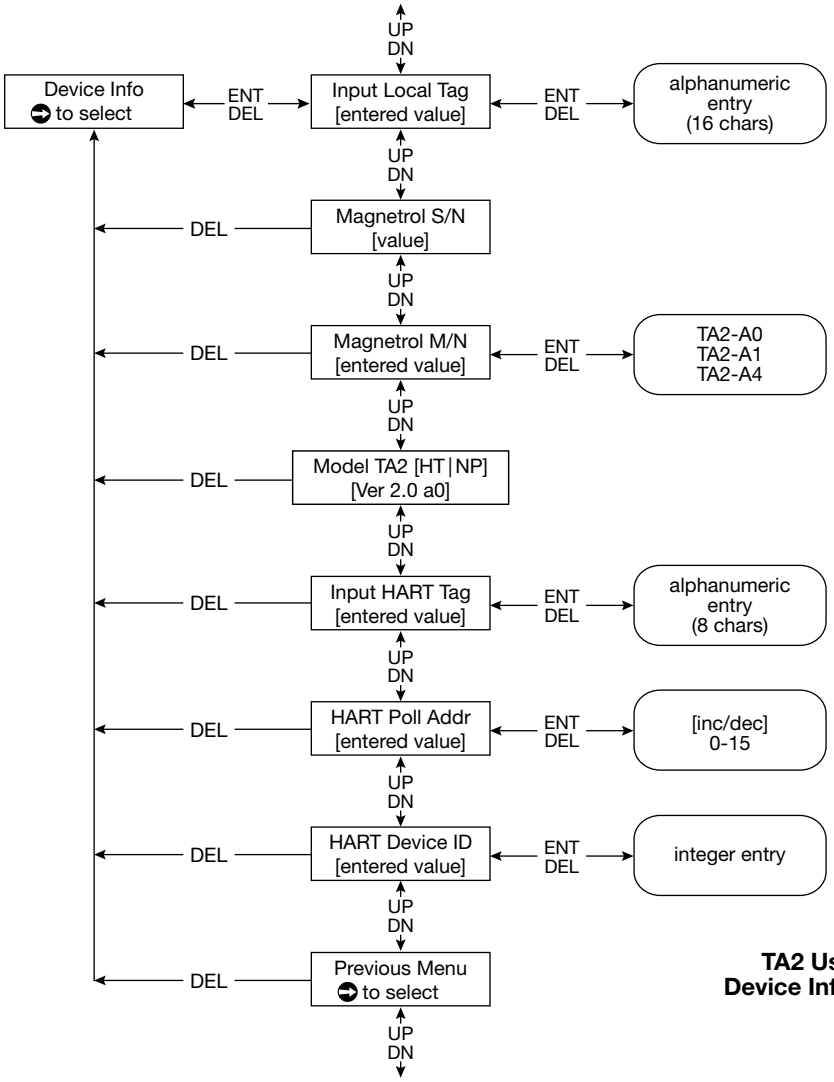
Configuration Parameter	Explanation
New Password	The default password is 0 which effectively disables the password feature. This allows the configuration to be modified without entering a password. If desired, a different password can be entered in the New Password screen. The password can be changed to any numeric value up to 255. If the password is changed from the factory default of 0, then the new password will be required whenever any configuration values are changed. If the user changes the password, the display will show an encrypted value. Contact Magnetrol Technical Support with this value to determine the actual password which was last entered.
Install Factors	Permits the user to enter field adjustment factors to make adjustments to the flow measurement. These might be due to flow profiles considerations. The formula is a second order polynomial equation where adjusted flow = a + bx + cx2 where x is in units selected for AO1 (Analog Output 1) Loop Control. Linear adjustments (changing the B factor) are the simplest. Ensure that units of measurement are finalized before Install Factors are determined. Changing units of measurement after Install Factors are calculated can result in reset of the Install Factors and a warning message.
Gas Cal Table A/B	Permits the user to select calibration for two different gases. If specifically ordered with calibration for two different gases, then each gas table will represent the calibration data for each gas. If calibrated for a gas other than air, the “A” table will represent the calibration data for the specified gas and the “B” table will represent the calibration data for air within a selected calibration range. The two gas tables can also be used for different ranges of the same gas.
Auto Switching	Allow automatic switching between a low flow Table A and a high flow Table B. It is necessary to have a dual calibration and distinct flow rate differences between tables in order to perform switching function.
STP Conditions	Permits the user to select STP (Standard Temperature and Pressure) conditions. Also referred to as Standard Conditions or Normal Conditions. Any value for temperature can be entered. Pressure can be selected to be 1 Atmosphere or 1 Bar. Adjustment of the STP conditions will affect the flow calculations.
Custom Units Text	The TA2 permits the user to create any desired units of flow measurement that is not shown in the standard selection. The user can select the text for the custom units using up to a 6-character abbreviation.
Custom Unit Mult	This multiplier is used to calculate the Custom Unit value. The Custom Unit value is equal to the Loop Control Variable selected under AO1 Loop Control times this custom multiplier. See example in section 2.5.11.1.
D/A Trim 4mA	Permits the user to fine tune the 4 mA point. This is done at the factory; yet, there may be differences in control systems. To adjust the 4 mA point, use the up or down arrows until the control system indicates 4 mA.
D/A Trim 20mA	Permits the user to fine tune the 20 mA point. This is done at the factory; yet, there may be differences in control systems. To adjust the 20 mA point, use the up or down arrows until the control system indicates 20 mA.

2.5.11.1 Custom Unit Multiplier Example

If the AO1 Loop Control is selected to be Nm3/h and the user desires to use custom units on NL/min, the multiplier 16.67 (1000/60) is used to adjust the flow measurements in Nm3/h to Nl/min.

2.5.12 Device Information

This section is used to display information about the device. Also in this section is the ability for the user to enter a local tag describing the location of the instrument.



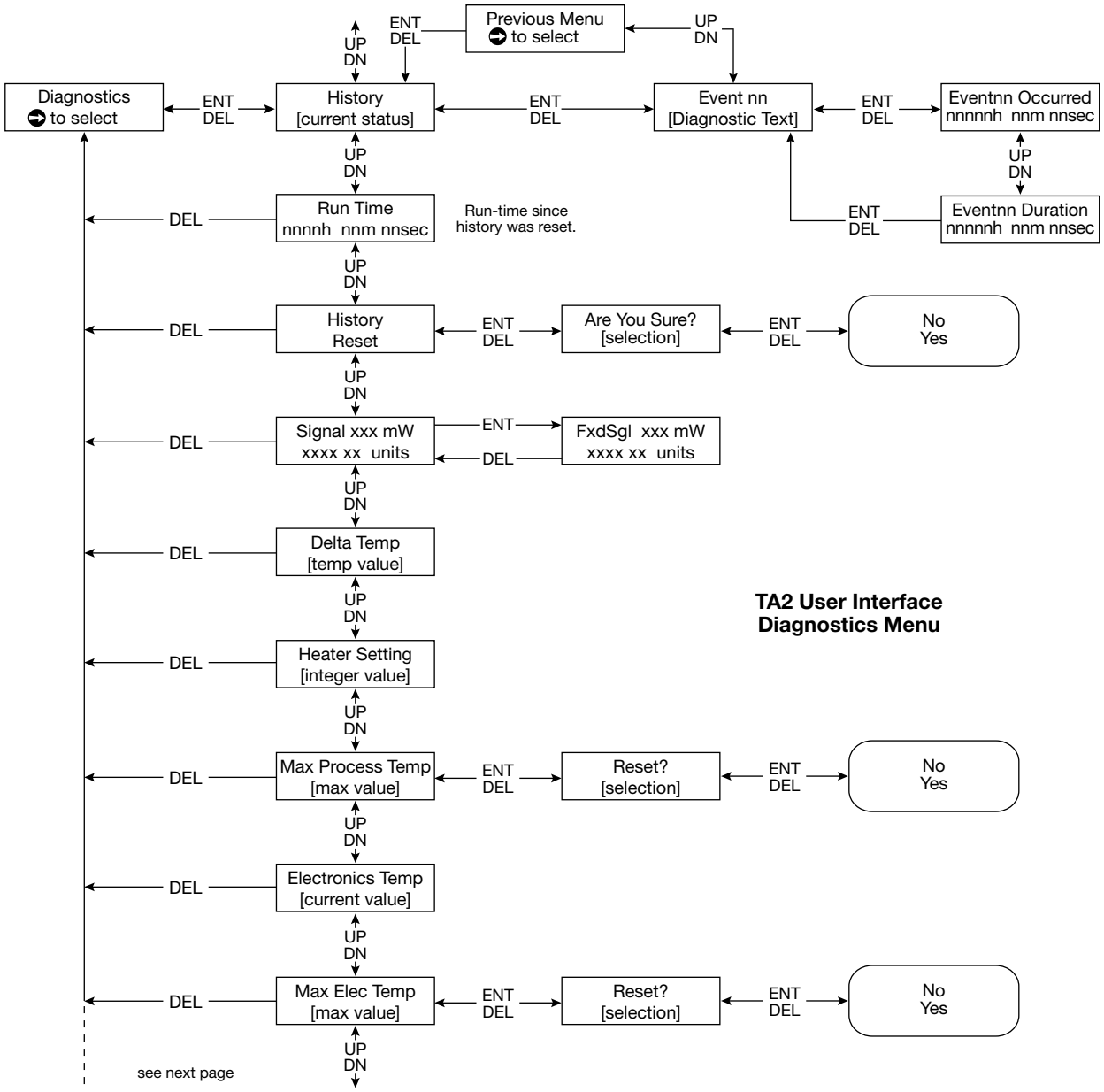
HART configuration is available on units which have HART on the primary loop.

TA2 User Interface
Device Information Menu

Configuration Parameter	Explanation
Input Local Tag	From the factory this tag is shown as “Magnetrol TA2” but this can be changed to describe the application or the flow transmitter number. The tag can contain a maximum of 16 characters. All upper and lower case letters, numbers and other characters are provided for the tag. See section 2.5.2.4 for details on entering characters.
Magnetrol S/N	Displays the Magnetrol serial number of the instrument. This is needed if information on the specific instrument is desired in the future.
Magnetrol M/N	Displays the first 5 digits of the TA2 serial number. This is used by the firmware to determine what screens are shown in this user interface menu.
Model TA2[ ]	Provides information on the firmware used in this version of the TA2.
Input HART Tag	Enter a HART tag with length up to 8 digits. This screen is only visible on units with HART.
HART Poll Addr	Select a HART Poll Address from 0 to 15. Enter 0 for a single installation. Enter 1–15 for a multi-drop installation. Default value is 0. This screen is only visible on units with HART.
HART Device ID	Required for units with HART. This screen is only visible on units with HART.

2.5.13 Diognostics Menu

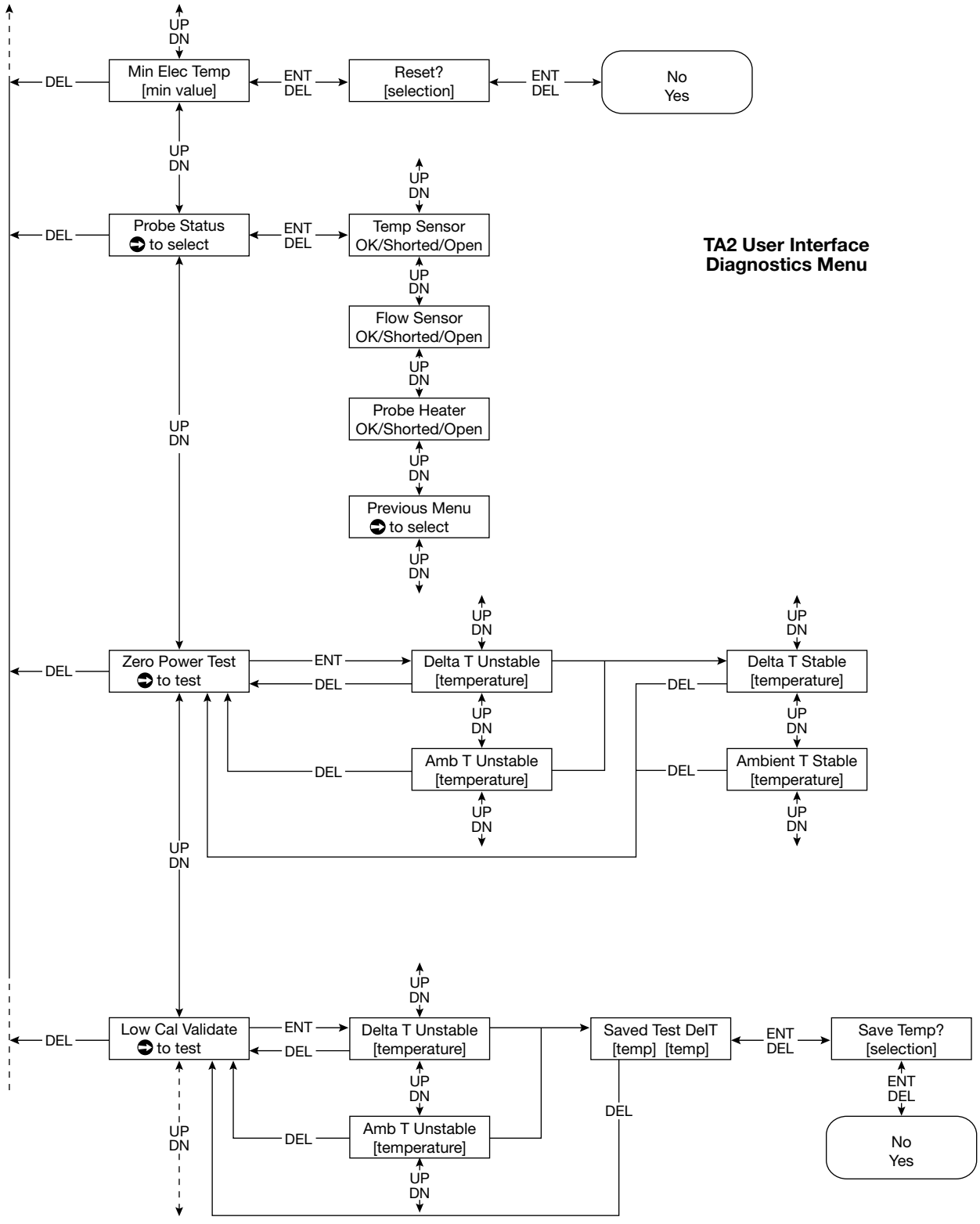
The Diagnostics Menu contains both informational items and diagnostic screens that can assist in obtaining information on the operation of the unit and troubleshooting if faults or warnings occur.



TA2 User Interface
Diagnostics Menu

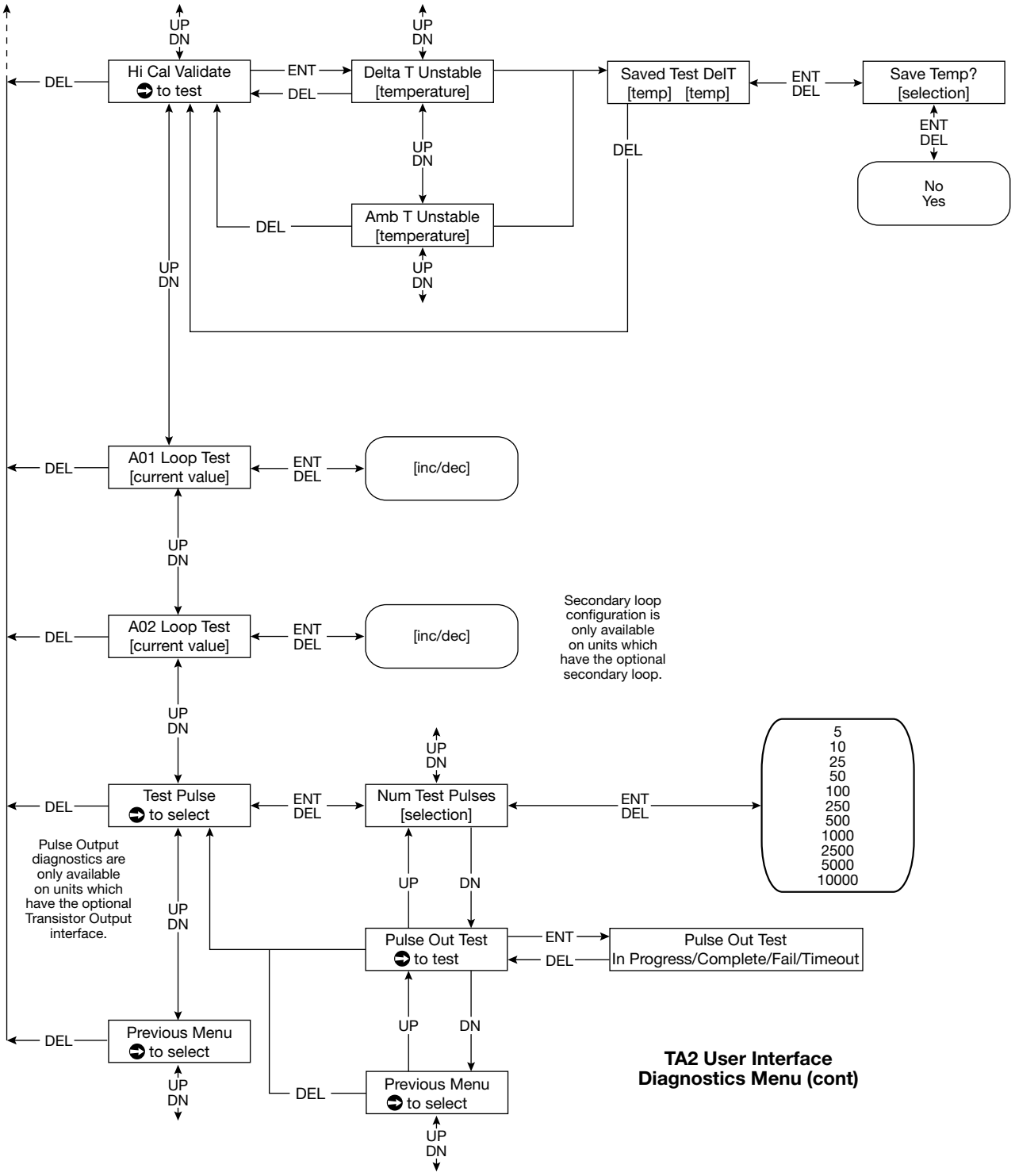
Configuration Parameter	Explanation
History	Displays the present status and the sequence in which any diagnostic events may have occurred. The second line of the menu shows the present status. If there are no present diagnostic events, this screen will have History on the top line and OK on the bottom line. Pressing → extends to a lower menu level to view diagnostics events that have been logged in History. Each "event" is indicated by the event number label. The first event number label presented corresponds to the most recent diagnostic event. This event number also indicates the number of diagnostic events currently in the History submenu. Pressing the ↑ or ↓ will cycle between the relative time of the occurrence and the duration of the event.
Run Time	Displays how much time has elapsed since the History was last reset.
History Reset	Provides a means to clear all of the diagnostic events that are stored in the History log.
Signal	Provides a live signal of the mW reading from the sensor. Also shown on the second line is the calculated flow rate. This is based on the units selected under AO1 Loop Control. This data can be compared against the original calibration document to determine if there has been any change in the configuration. Pressing → enters the **Fixed Signal Mode**. When in this mode, pressing the ↑ or ↓ permits the user to change the signal; the TA2 then calculates the flow which corresponds with this signal. Press ← to return to the main menu. NOTE: During fixed signal mode the mA output of AO1 will adjust with change in signal. The Totalizers will stop operation and the display will show the "In Test Mode" message.
Delta Temp	Displays the temperature difference between the two RTDs.
Heater Settings	Displays the current value sent to the heater. This can be compared against an actual reading which can be obtained from connections on the circuit board. See section 3.5.1.
Maximum Process Temp	Displays the maximum temperature which the sensor has recorded.
Electronic Temp	Displays the current temperature in the electronics enclosure.
Max Elect Temp	Displays the maximum temperature which the electronics have recorded.

2.5.13 Diognostics Menu (cont.)



Configuration Parameter	Explanation
Min Elect Temp	Displays the minimum temperature which the electronics have recorded.
Probe Status	Press → to select and then the ↑ or ↓ arrows to scroll between the Temp Sensor, Flow Sensor, and Probe Heater. If the probe is operational, the display will show “OK”. If there is a problem with the probe, then the diagnostics will show either “Shorted” or “Open.” Press ← to return to the main menu.
Zero Power Test	Diagnostic test. Note that the mA output signal will be disabled during this test. During this test the heater is turned off and the sensor is given time for the sensors to stabilize. The temperature difference between the sensors is displayed. See section 3.5.2 for more information on this test.
Low Cal Validate Hi Cal Validate	The Low Cal Validate and the Hi Cal Validate test will verify that the heat transfer characteristics of the sensor have not changed. This test will verify that the unit is still within calibration. The tests are performed when off-line with the TA2 in air and in a water bath. See section 3.5.3 for more information on this test.

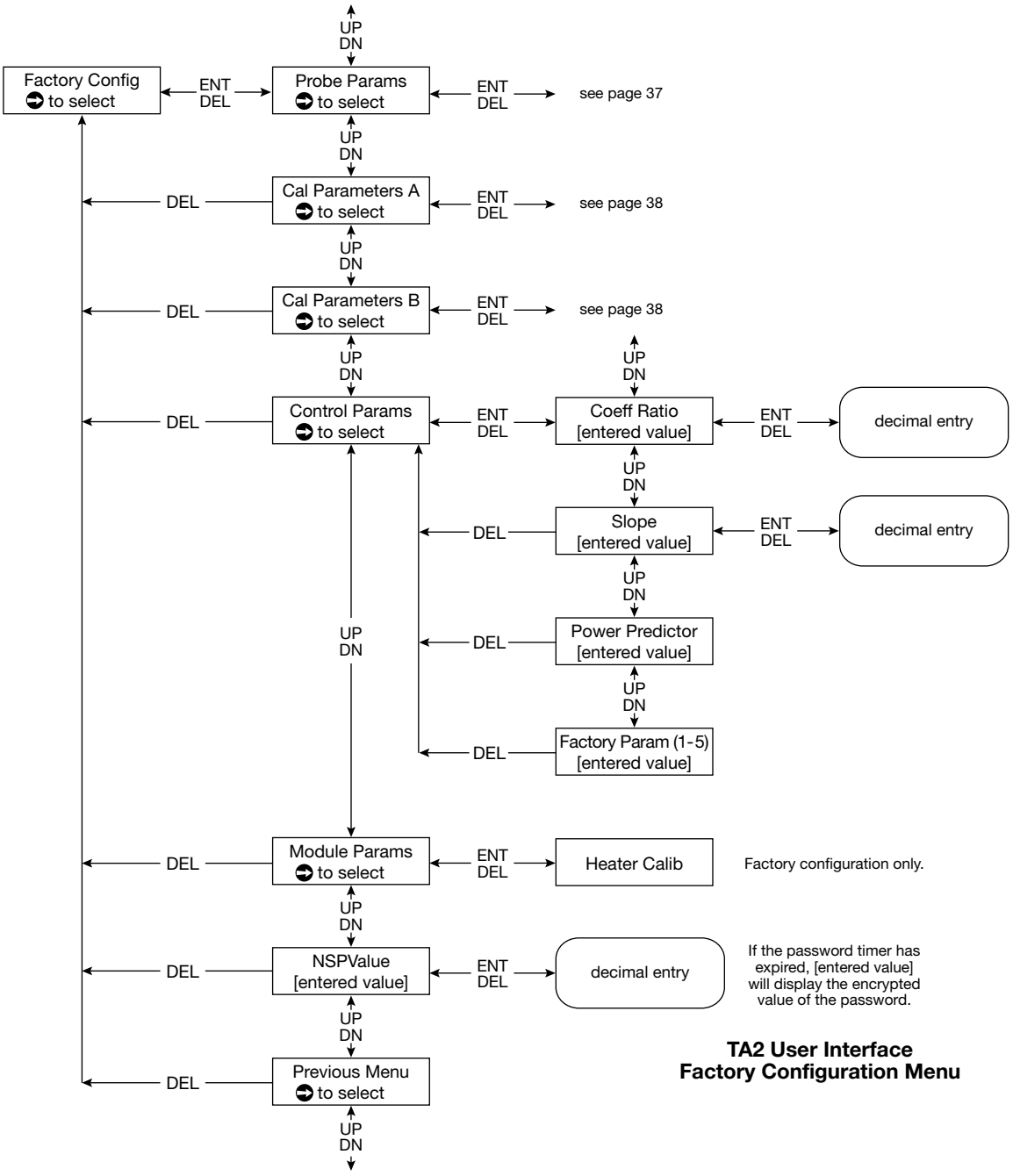
2.5.13 Diognostics Menu (cont.)



TA2 User Interface Diagnostics Menu (cont)

Configuration Parameter	Explanation
AO1 Loop Test	Shows the current mA value output on the 4–20 mA output signal for the first (AO1) loop. This value can be increased or decreased by pushing the ↑ or ↓ arrows. Pressing → or ← treturns the mA signal to normal operation.
AO2 Loop Test	Shows the current mA value output on the 4–20 mA output signal for the second (AO2) loop. This value can be increased or decreased by pushing the ↑ or ↓ arrows. This menu selection is only shown on units that have the optional second mA loop. Pressing → or ← returns the mA signal to normal operation.
Test Pulse	Tests the pulse output signal by sending a specific number of pulses to the external totalizer/ counter. TA2 must be configured for Pulse Output. See sections 2.5–10. Test will fail if not configured for Pulse Output. Once the specific number of pulses is selected, the user will then push the down ↓ arrow to the next screen to conduct the test. When the → arrow is pressed, the TA2 will stop generating pulses based on the flow rate and will then generate the specified number of pulses selected. The display will show status. At completion of the test, the screen will indicate that the test is complete. At this time the user can verify that this number of pulses has been received by the external device. Press ← to conduct the test again; press ← two times to return to normal operation where the pulse is generated based on the measured flow rate. The TA2 will “Time Out” and return to normal operation after 5 minutes if no action is taken.

2.5.14 Factory Configuration

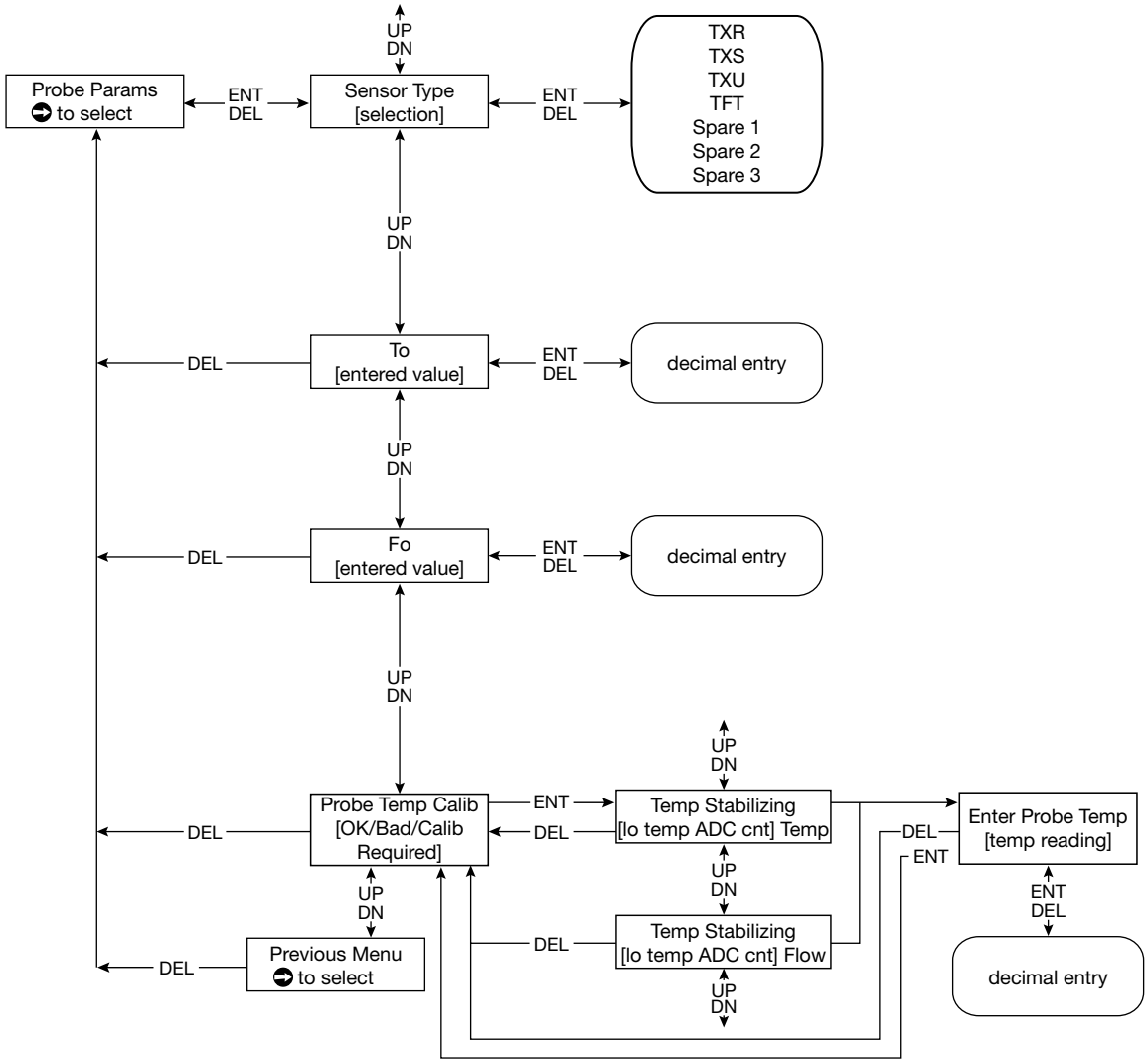


TA2 User Interface
Factory Configuration Menu

Configuration Parameter	Explanation
Probe Params	Provides the probe calibration parameters—see separate section 2.5.16.
Cal Parameters A	Provides the calibration parameters for Gas A—see separate section 2.5.17.
Cal Parameters B	Provides the calibration parameters for Gas B (if specified)— see separate section 2.5.17.
Control Parameters	Factory set parameters which should only be changed under direction of Magnetrol
Module Params	Module Parameters—Factory set parameters

2.5.15 Probe Parameters

These parameters are specific characteristics defining the operation of the probe.



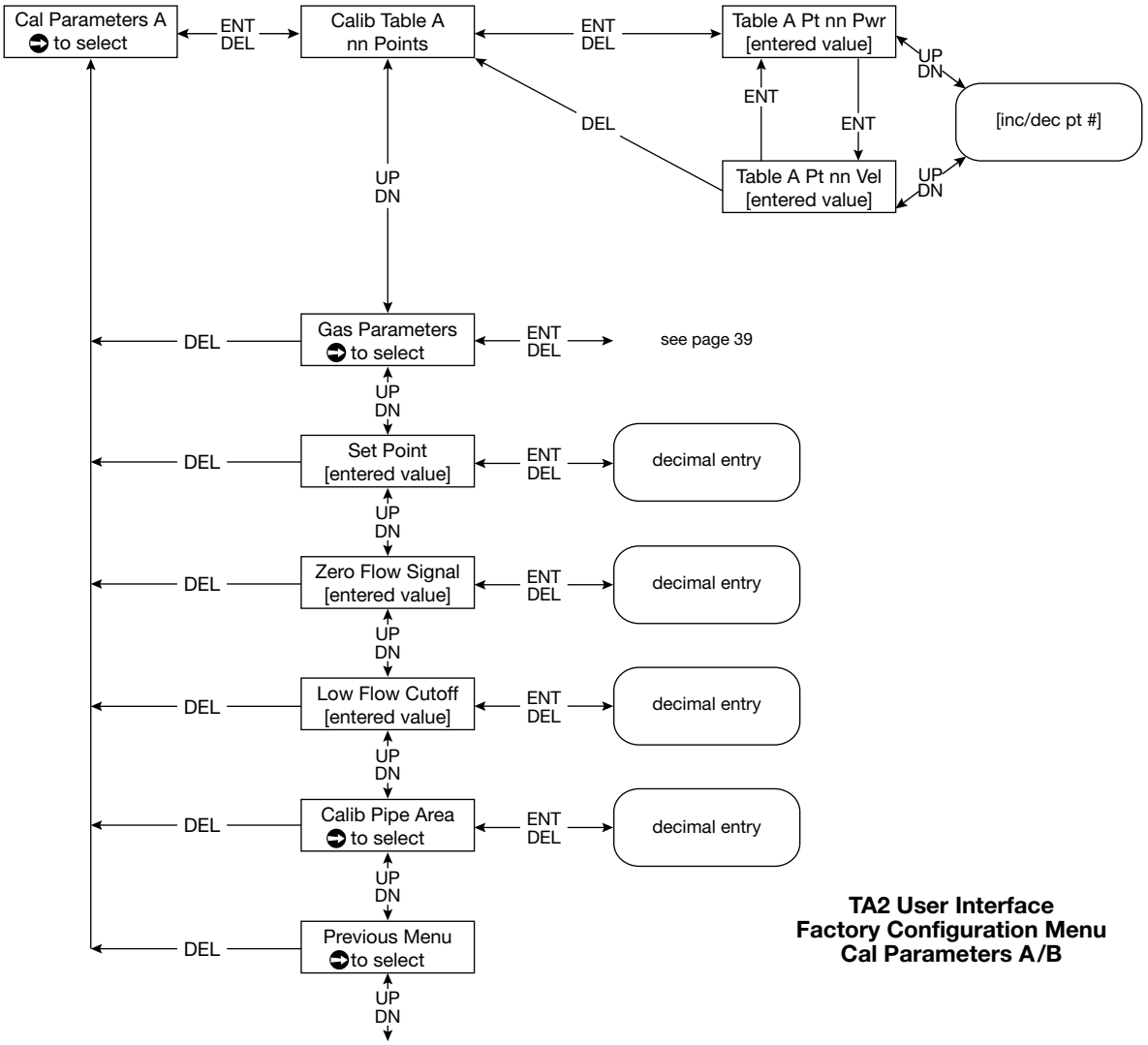
TA2 User Interface
Factory Configuration Menu
Probe Parameters

Configuration Parameter	Explanation
Sensor Type	Selects the type of sensor used with the TA2. Various sensors have different methods of calculating the flow rate.
To	Calibration parameter determined when calibrating the RTDs.
Fo	Calibration parameter determined when calibrating the RTDs.
Probe Temp Calib	Used during calibration of the RTDs. See section 4.3.

2.5.16 Calibration Parameters

There are two separate menus for Calibration Parameters titled Cal Parameters A and Cal Parameters B. These two different sets of Calibration Parameters are used when the TA2 is calibrated on two gases or for two different ranges. If the unit is calibrated for air, then only Calibration Parameter A is used. If the TA2 is calibrated for a different gas, then the calibration parameters for the specified gas is contained in Cal Parameters A, and the air calibration parameters are contained in Calibration Parameters B.

There is an identical menu structure for Cal Parameters B.

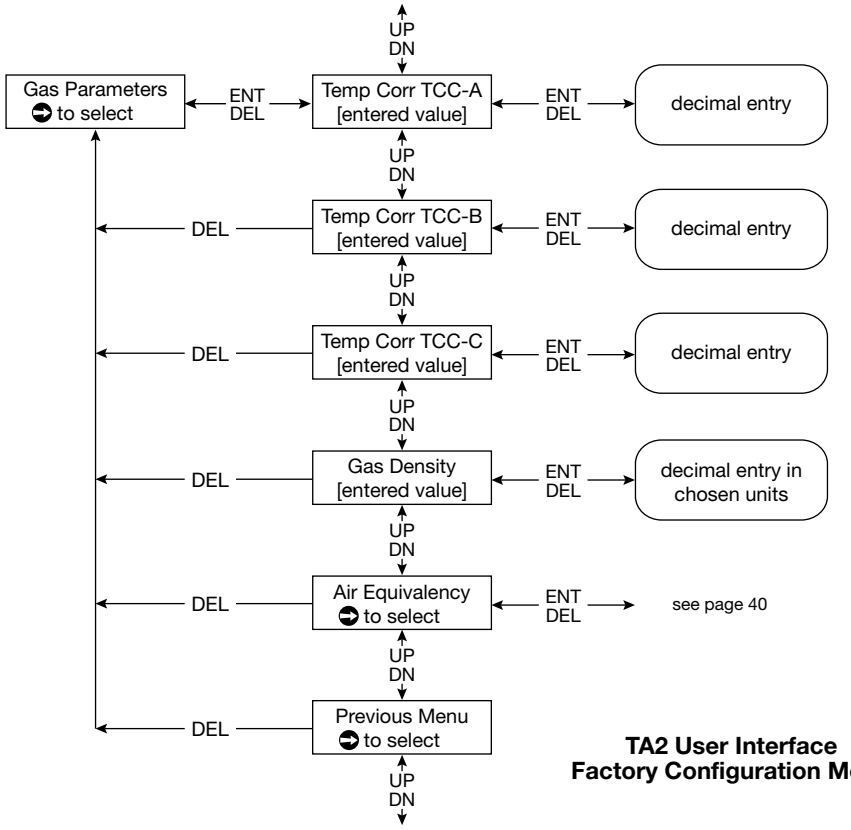


TA2 User Interface
Factory Configuration Menu
Cal Parameters A/B

Configuration Parameter	Explanation
Calib Table A nn Points	Provides actual calibration data points obtained during the calibration.
Gas Parameters	See section 2.5.17.
Set Point	Indicates the temperature difference which the TA2 is attempting to maintain. This parameter should only be changed under direction of Magnetrol.
Zero Flow Signal	Used to adjust the zero flow data point, if necessary, for application-specific related issues. See Troubleshooting Section 3.4.
Low Flow Cutoff	The TA2 will ignore flow rates below this value. This can be changed for application-specific issues. See Troubleshooting Section 3.4.
Calibration Pipe Area	See Recalibration section 4.4.

2.5.17 Gas Parameters

Contains specific information on the gas which are used in the TA2 calculations.



TA2 User Interface
Factory Configuration Menu

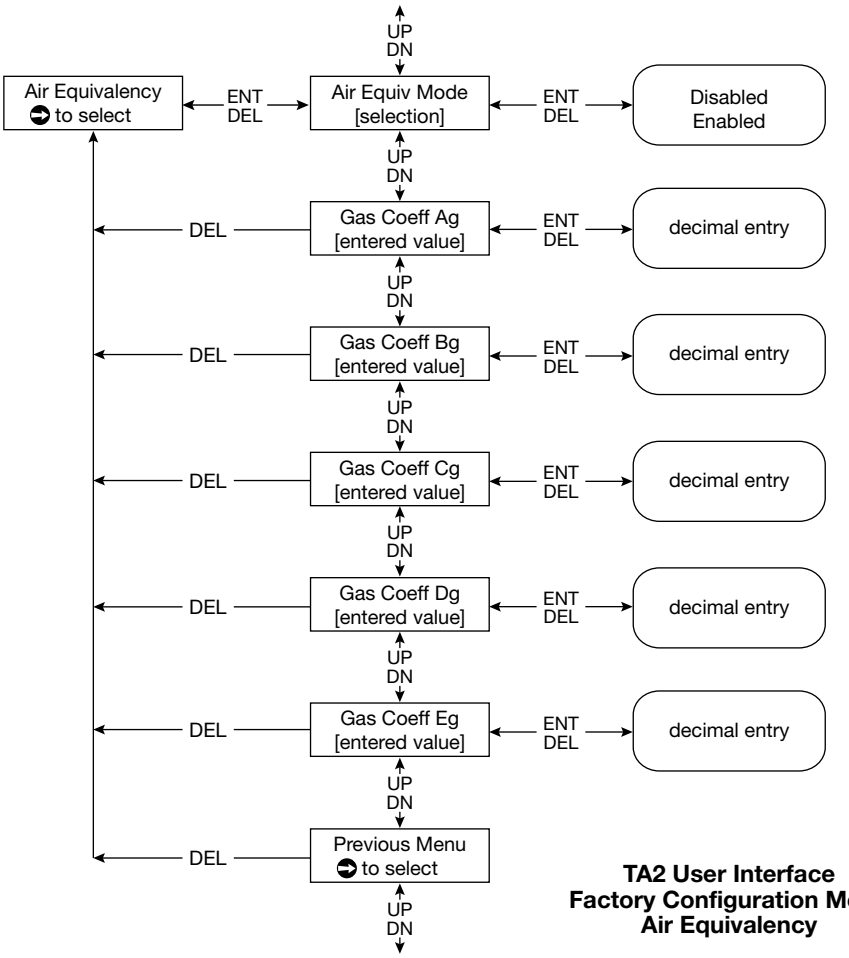
Gas Parameters menu exists for both Gas A and Gas B

Configuration Parameter	Explanation
TCC-A, TCC-B TCC-C	Gas-specific factors used for temperature compensation. This parameter should only be changed under direction of Magnetrol.
Gas Density	Provides the density of the gas at the specified STP (Standard Temperature and Pressure) conditions.
Air Equivalency	Contains factors which relate the relationship of the gas flow to the flow of air. Contact Magnetrol for factors specific to different gases.

2.5.18 Air Equivalency Calibration

The Air Equivalency calibrations permits the use of an air calibration and then, using the Magnetrol historic data base, relate the flow of air to the flow of gas. The equations use a polynomial curve fit. A fault will occur if the curve fit becomes non-monotonic (signal decreases with increasing flow) which can occur if operating outside the data range. Consult Magnetrol regarding proper sizing with Air Equivalency calibrations. The user may contact Magnetrol to obtain air equivalency factors for various gases. These values should only be used when the TA2 was calibrated on air. If the calibration data in the Calibration Table is for a different gas, the results are invalid.

Configuration Parameter	Explanation
Enable/Disable	Enables or Disables the Air Equivalency calculations
Ag - Eg	Factors in a Polynomial equation in the form of $A + Bv + Cv^2 + Dv^3 + Ev^4$ where v is the mass velocity. Contact Magnetrol for factors



TA2 User Interface
Factory Configuration Menu
Air Equivalency

Air Equivalency menu exists for both Gas A and Gas B

2.6 Configuration Using HART®

A HART® (Highway Addressable Remote Transducer) remote unit, such as a HART communicator, can be used to provide a communication link to the TA2.

When connected to the control loop, the same system measurement readings shown on the transmitter are displayed on the communicator. The communicator can also be used to configure the transmitter.

To confirm HART handheld communications, attach the unit as shown in figure 12. If the communicator reads GENERIC on the first two lines, then the HART handheld does not contain the current DDs (Device Descriptions) for the TA2 transmitter.

Contact your local HART Service Center.

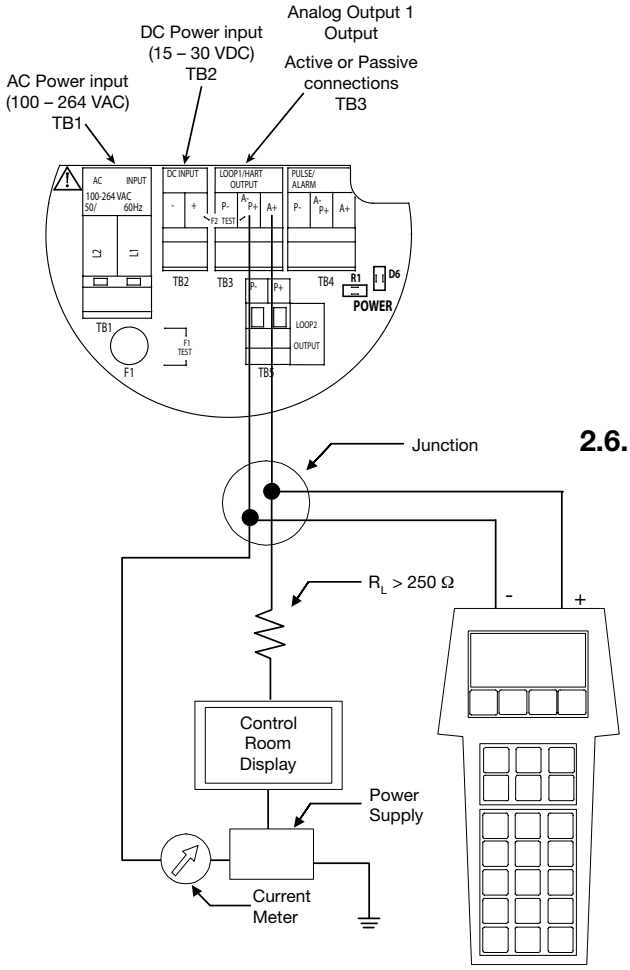


Figure 12

2.6.1 Connection

The TA2 can be used with a HART remote unit to provide communication of the process variables. The communicator can also be used for configuration of the transmitter.

The dynamic variables which can be transmitted over HART are Flow, Mass, Temperature, and Totalized Flow. The Primary Variable is Flow or Mass.

Virtually all configuration and diagnostics available via the user interface with the keypad and display are accessible via HART. See System Configuration Menu, Section 2.6.3.

A HART device can be connected to either the active or passive 4-20 mA output loop from AO1.

2.6.2 HART Revision Table

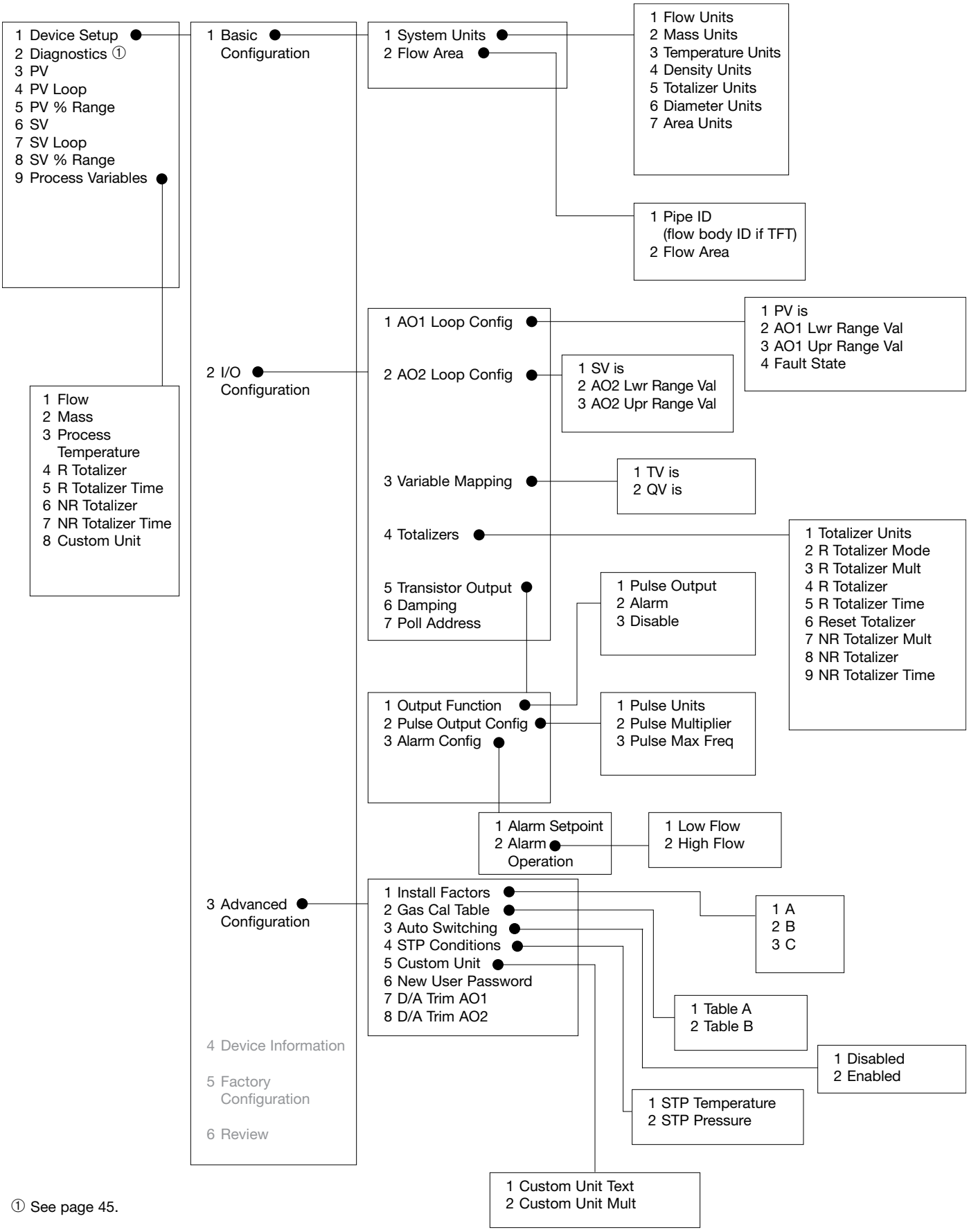
HART Version	HCF Release Date	Compatible with Software
Dev V2 DD V1	February 2016	Version 2.1b0 and later

2.6.3 HART Display Menu

When connected, the top line of each menu displays the model (TA2) and its tag number or address.

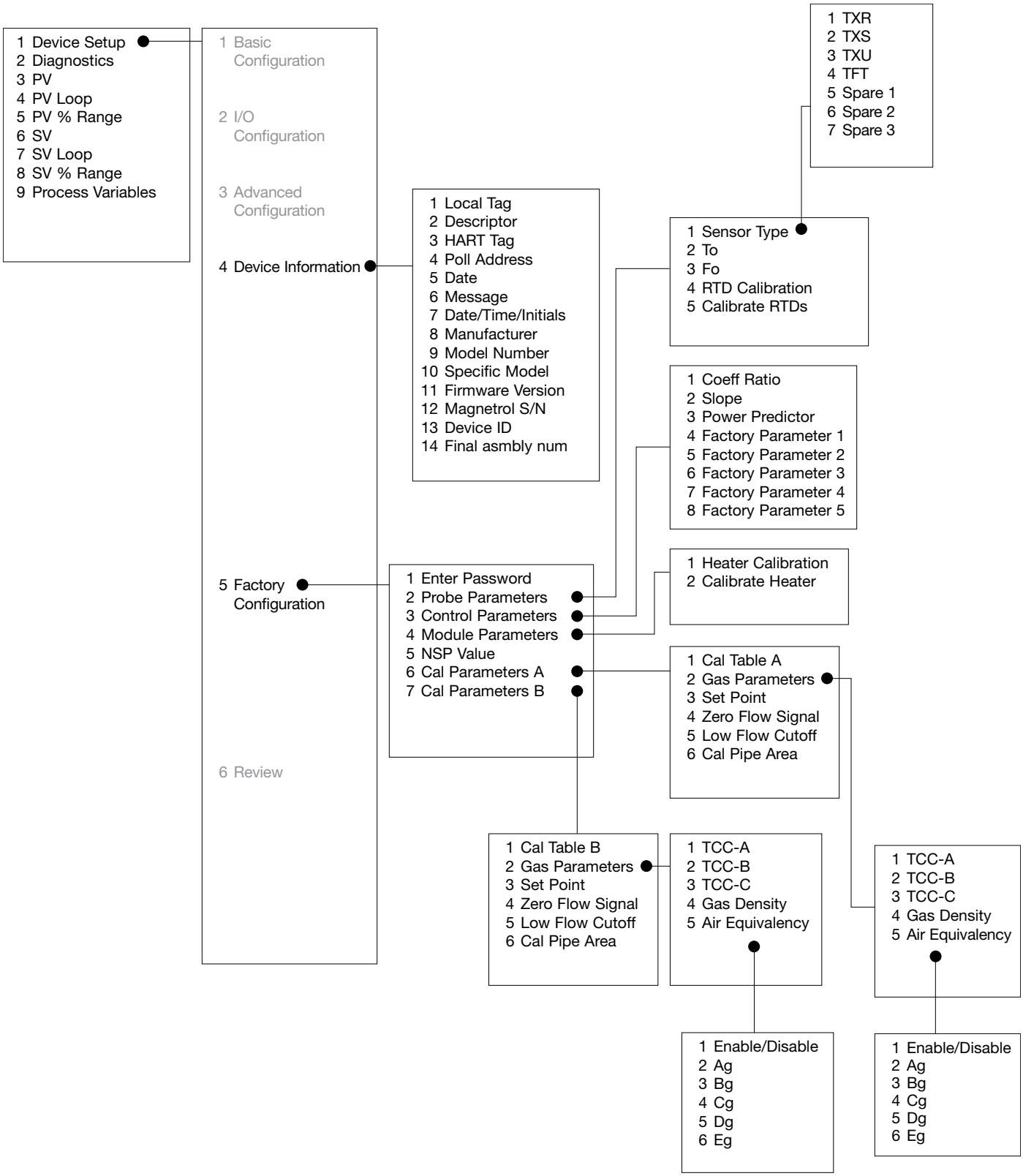
Open the TA2 online menu tree by pressing alphanumeric key 1 to enter the Device Setup menu.

2.6.3 HART Menu

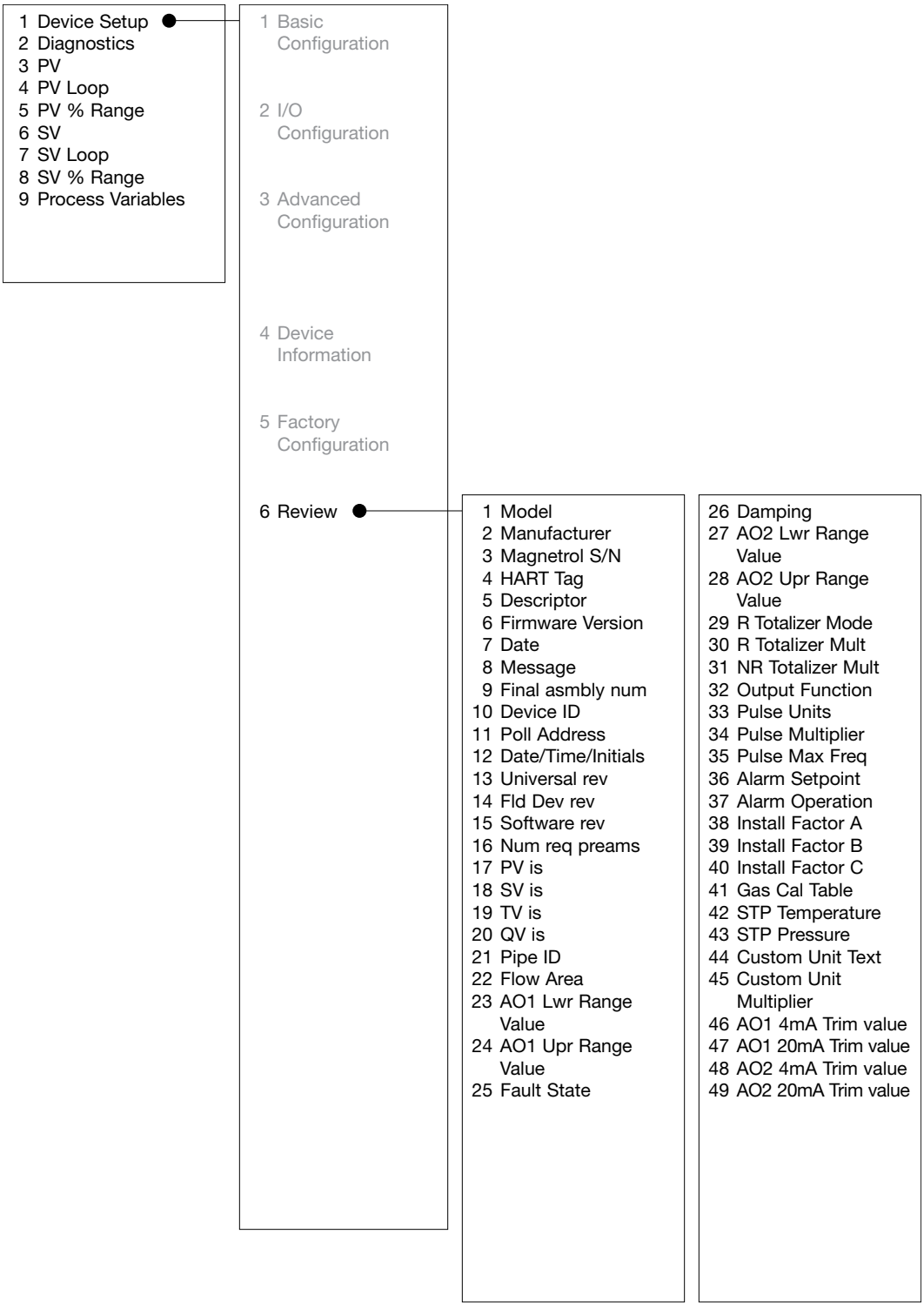


① See page 45.

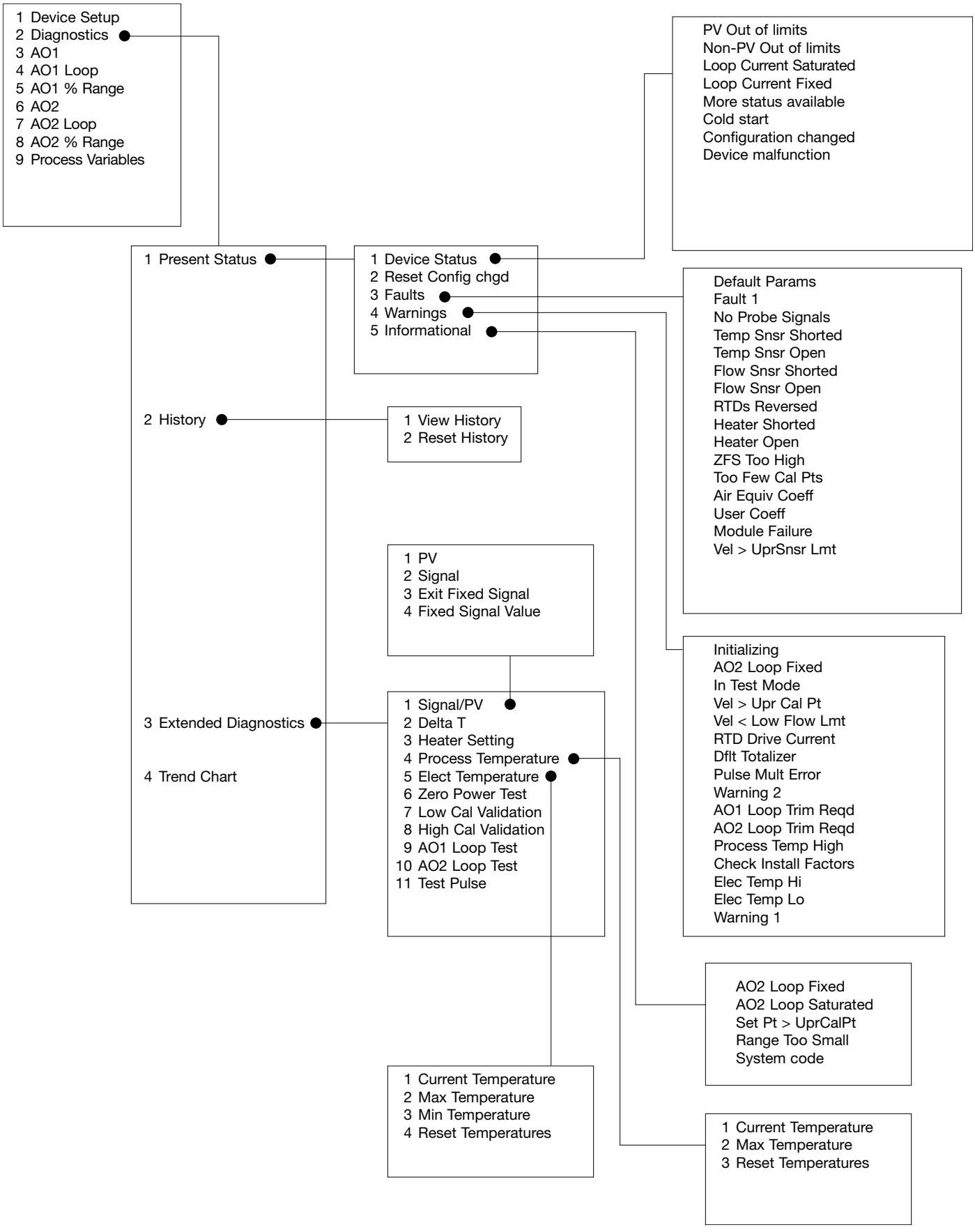
2.6.3 HART Menu (cont.)



2.6.3 HART Menu (cont.)



2.6.3 Diagnostics Menu



3.0 Reference Information

3.1 Description

The Thermatel Model TA2 Thermal Mass Flow Meter provides a mass flow measurement of air and other gases. The TA2 consists of a probe or flow body with electronics either integrally mounted on the probe or remotely located.

The electronics are rated for use in explosion proof service. The unit will accept 15 to 30 VDC power or 100 to 264 VAC input power. Output from the TA2 is a 4-20 mA signal of the mass flow rate. An optional version also provides a second mA signal which can represent the temperature or flow, and a pulse output.

The optional plug-in display module with four-button keypad permits the user to easily make changes in the configuration of the TA2 for application-specific conditions. The display provides an indication of the mass flow, temperature and totalized flow, plus other selectable information.

Each instrument is calibrated and configured by Magnetrol for the type of gas, pipe size, flow area and flow rate. Calibration is performed in a NIST traceable flow bench.

The TA2 provides real-time temperature compensation which adjusts the flow measurement due to changing gas properties caused by process temperature changes.

3.2 Theory of Operation

The flow element of the TA2 Thermal Mass Flow Meter utilizes a heater and two resistance temperature detectors (RTDs). The heater and the active RTD are contained in one sensor. The second sensor contains the reference RTD and a mass balancing element.

The reference RTD measures the temperature of the process where the flow element is installed. A variable power is provided to the heater. The active RTD measures the temperature of the heated sensor in a feedback loop to the electronics. The electronics vary the power to the heater to maintain a constant temperature difference between the active and reference RTDs. As the mass flow rate increases there is a cooling effect on the heated sensor. The power to the heated sensor is controlled to maintain a constant temperature difference between the two sensors. The amount of power required to maintain this temperature difference provides a measurement of the mass flow.

There is an inherent non-linear relationship between heater power and the mass flow rate. The microprocessor based electronics convert the heater power to provide a linear measurement of the mass flow rate. The electronics also provide real time temperature compensation which automatically adjusts the flow measurement for changes in process temperature over the entire operating range of the instrument.

The 4-20 mA output signal can be adjusted to provide maximum resolution of flow measurement over the calibration range of the instrument. The 4-20 mA signal can be wired for either active or passive operation.

The temperature measured by the reference RTD and the totalized flow can be viewed on the display, and is also available over HART communication. An optional version of the TA2 has a mA output of the temperature and also a pulse output that can be used for an external counter/totalizer or for an alarm indication.

3.3 Display Module

The Enhanced model TA2 has a back-lit, plug-in, rotatable display module. The display module consists of a 2-line ¥ 16-character Liquid Crystal Display with four-push-button keypad for configuring the instrument, or for diagnostics.

The display can be rotated in 90-degree increments to permit viewing from various orientations. To rotate the display, remove the two screws on the front of the display module, rotate to the desired position, and reattach.

3.4 Troubleshooting

The TA2 Thermal Mass Flow Meter is designed for ease of use and trouble-free operation. The TA2 is shipped pre-calibrated and pre-configured based on information provided at time of order. The following lists possible problems and solutions to investigate.

WARNING! Explosion hazard. Do not remove the TA2 housing cover unless power has been switched off or the area is known to be non-hazardous. Use of the PACTware™ PC program is highly recommended and invaluable for troubleshooting and advanced configuration. A HART RS232 or USB model (purchased separately) is required.

3.4 Troubleshooting

Symptom	Problem	Solution
No Output signal No Display	No input power	Verify that LED D6 on the input wiring board is on. If not, check wiring connections. Check F1 test and F2 test to check fuses protecting input wiring. See Figure 8.
No Output signal	4–20 mA output not operational	Verify that 4–20 mA connections are made to the correct terminals on TB3. See section 1.2.
Flow Measurement on display is correct but Output signal always 4 mA	HART Poll Address is not 0	Change HART Poll Address to 0. See section 2.5.12.
Totalizer not operating	Totalizer is Disabled	Ensure that the totalizer operation is enabled. See section 2.5.9.
Flow is measured under a no flow condition	Increased heat transfer. This can occur under no flow with increased pressure.	Increase the low flow cutoff to a value greater than the displayed flow rate. The TA2 will ignore readings lower than this value. Optionally, increase the zero flow signal to match the value indicated under Signal Value. See section 2.5.16.
Flow Rate too high or too low	Instrument configuration does not match actual application	Check values entered for Flow Area under Basic Configuration. Check if Install Factors are entered under Advanced Configuration. Check STP conditions under Advanced Configuration.
	Buildup on sensor	Depending on type and size of buildup, flow readings may either increase or decrease. Clean sensor.
Flow Rate too high	Flow Profile Considerations	The TA2 assumes a specific fully developed flow profile. User can correct for variations in flow profile using the Install Factors found under Advanced Configuration section 2.5.11.
Flow Rate too high, output spiking	Moisture in the Gas	Condensed moisture will cool the sensor more than gas flow. This will temporarily indicate a higher than expected flow rate.

3.4.1 Error Messages

The TA2 Mass Flow Meter utilizes a 3-level hierarchy for reporting diagnostics information: FAULTS, WARNINGS, and INFORMATION. Faults and Warnings can be reviewed on the rotating screen in the Home menu. These screens capture only current conditions. Historic diagnostic information can be viewed in the HISTORY screen of the Diagnostics Menu.

FAULT: The highest level in the hierarchy of diagnostics. A Fault indicates a defect or failure in the circuitry or software, or a calibration condition that makes reliable measurement impossible. The mA value defaults to 3.6 mA, 22 mA, or HOLD and a message is displayed on the rotating screen. Further error information can be obtained by reviewing the Diagnostic Menu screen.

WARNING: This is the second level in the hierarchy of diagnostics. A Warning indicates conditions that are not fatal but may affect the measurement. A message will appear on the Home (rotating) screen when a Warning is detected but will not affect the output current. Further error information can be obtained by reviewing the Diagnostic Menu screens.

INFORMATION: This is the lowest level in the hierarchy of diagnostics. Information messages are for conditions that provide operational factors that are not critical to the measurement. Further error information can be obtained by reviewing the Diagnostics Menu.

3.4.1.1 Fault Messages

Diagnostic	Fault Description/Corrective Action	LCD Message
Non-Volatile Memory corruption	Partial corruption of the Non-Volatile memory stored in the EE-PROM. Data may revert to Default conditions. Re-verify that all calibration and configuration factors in the TA2 match the calibration certificate.	Default Params
No signal from Probe	There is no signal from the sensor. Check the wiring between the probe and the electronics.	No Probe Signals
Temperature Sensor Failure	A short has occured in the RTD measuring the process temperature or in the interconnecting wiring (if remote electronics). Check wiring to the probe.	TempSnsr Shorted
Temperature Sensor Failure	There is an open circuit in the RTD measuring the process temperature or in the interconnecting wiring (if remote electronics). Check wiring to the probe.	Temp Sensor Open
Flow Sensor Failure	A short has occured in the RTD measuring the heated sensor or in the interconnecting wiring (if remote electronics). Check wiring to the probe.	FlowSnsr Shorted
Flow Sensor Failure	There is an open circuit in the RTDs measuring the heated sensor or in the interconnecting wiring (if remote electronics). Check wiring to the probe.	Flow Sensor Open
RTDs Reversed	The wiring connecting the RTDs is reversed. Check probe wiring or interconnecting cable (if remote electronics)	RTDs Reversed
Heater Shorted	The heater has developed a short either in the probe or in the interconnecting cable (if remote electronics). Check probe wiring.	Heater Shorted
Heater Open	There is an open circuit in the wiring going to the heater. Check wiring. Also, check if the two-pin jumper is missing. See section 3.5.1.	Heater Open
Zero Flow Signal is too high	Zero Flow Signal (power) is greater than second data point in the Calibration Table. Check value entered under Factory Config/Cal Parameters/Zero Flow Signal.	ZFS Too High
Too Few Calibration Points	The calibration table does not contain sufficient number of data points for the flow range. Minimum of ten points is required.	Too Few Cal Pts
Air Equivalency Coefficients incorrect	The Air Equivalency factors used result in a non-monotonically increasing curve over the operating range. Check factors.	Air Equiv Coeffs Bad
Install Factors incorrect	Install factors entered under Advanced Configuration result in a non-monotonically increasing curve. Check factors.	User Instl Coeffs Bad
Module Failure	No readings received from the ADCs, or the values out of range. Indicates failure of Analog to Digital converters. Requires replacement of processor board or return of unit to factory.	Module Failure
Velocity is greater than the Upper Sensor Limit	The velocity is greater than established values. Contact Magnetrol.	Vel > UprSnsrLmt

3.4.1.2 Warning Messages

Diagnostic	Warning Description	LCD Message
Initializing	Initialization in progress. The TA2 will begin making flow readings at completion of cycle.	Initializing
AO2 Loop current fixed	The second 4–20 mA loop (AO2) is not responding. The mA signal may be saturated at 20.5 mA or may be fixed and non-responsive. Check informational messages.	AO2 Loop Fixed
TA2 is running diagnostics test	The operator has put the TA2 into one of several diagnostics tests. The mA output is 4 mA.	In Test Mode
Velocity too high	The Flow rate exceeds the calibration range of the instrument. Instrument will continue to operate. Accuracy is uncertain; flow measurements will be repeatable.	Vel > Upr Cal Pt
RTD drift	The RTD drive circuit current has drifted since last calibration. The drift is outside expected range. The TA2 has compensated for the drift, continued drift may affect accuracy. Repeatability will remain.	RTD Drive Ckt
Totalizer Error	There is an error in the Totalizer operation—the Totalizer and Elapsed Time indicator are reset to 0.	Dflt Totalizer
Pulse Multiplier Error	The maximum pulse output exceeds the maximum frequency selected. Increase the Pulse Multiplier.	Pulse Mult Error
Current loop(s) require trimming	The D/A Trim values are factory defaults. Perform D/A Trim of AO1 or AO2 under Advanced Configuration menu.	AO1 Loop Trim Reqd
		AO2 Loop Trim Reqd
Temperature Limit Exceeded	The temperature measured by the sensor exceeds the rated temperature. Continued operation will damage sensor.	Process Temp Hi
Install Factor Error	Check and recalculate the install factors. This message may occur if the units of measurement were changed after install factors were entered.	Check Inst Factors
Electronic Temperature Exceeded	The temperature of the microprocessor board is above +176 °F (+80 °C) or below –40 °F (–40 °C)	Elec Temp Hi
		Elec Temp Lo

3.4.1.3 Information Messages

Diagnostic	Information Description	LCD Message
AO2 Loop not responding	The second 4–20 mA loop (AO2) is fixed and not responding. Check mA output. This informational message will also be activated if the second mA loop output is saturated at 20.5 mA. Check I/O Config/ AO2 Loop Config/LRV and URV.	AO2 Loop Fixed
AO2 Loop Saturated	The second 4–20 mA loop (AO2) is saturated at 20.5 mA. Check I/O Config/AO2 Loop Config/URV.	AO2 Loop Saturated
Upper Range Value Error	The Upper Range Value is greater than the Upper Calibration Point.	SetPt > UprCalPt
Insufficient Span	The URV (Upper Range Value) is too close to the LRV (Lower Range Value). Increase separation.	SetPts Too Close
System Warning	Non-fatal firmware exception. Advise Magnetrol with system code number.	System Code

3.5 Diagnostics Test

The TA2 has several diagnostics tests which may be routinely performed. When conducting these tests, the reported flow rate will be zero.

3.5.1 Heater Setting

The amount of current flowing to the heater is displayed under Diagnostics/Heater Setting. This value can be verified by connecting a multi-meter across the Heater Bypass terminals (J2) shown in Figure 13. This board can be accessed by opening the cover and removing the display module.

The measured value should match the value shown on the display. Any difference between the two values indicates that the heater calibration is incorrect. If the heater circuit is open, a nominal current value will be displayed, but the measured current will be zero.

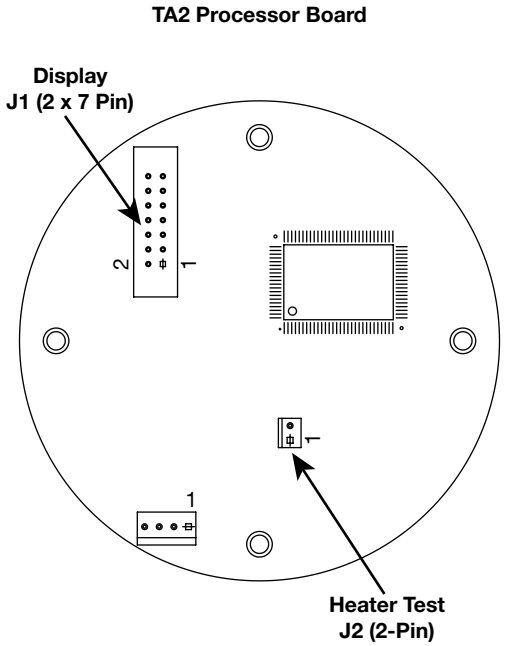


Figure 13

3.5.2 Zero Power Test

This test checks that the resistances of the RTDs have not changed. The heater is turned off and the temperature difference between the two sensors is compared. The test should be performed in a water bath (preferred) or under flowing conditions. Conducting this test in still air will cause the test to time out and provide inconclusive results.

The temperature difference between the two sensors is displayed. Typical values will match within 0.15 °C. Temperature difference may be as high as 0.5 °C depending upon test conditions. If greater than this value, contact the factory as drift in the RTDs may have occurred.

3.5.3 Calibration Verification Procedure

The TA2 measures heat transfer. These procedures are designed to permit the user to verify the calibration by checking the heat transfer characteristics of the sensor. If the heat transfer characteristics are approximately the same when the test is conducted compared with when the same data was collected at the factory during the initial calibration, the unit remains in calibration.

Watch the video for this procedure at www.magnetrol.com/en/downloads

The procedure is performed under two different sets of conditions. Both tests should be conducted at “room temperature”; approximately +70 to +85 °F (+21 to +30 °C). The tests can be performed using the keypad and display, HART, or PACT*ware*™ through the Diagnostics Menu. During the test, the display (or HART or PACT*ware*™) will provide an indication of the measured temperature difference and if the Delta T measurement is stable.



Figure 14

Low Flow Validate—Simulates a low flow condition.

i. Cover sensor tips to isolate from air currents. During the test, the heater power is set and the Delta T (temperature difference) between the two RTDs is measured.

ii. After completion of the test, the value of the temperature difference measured during the test is compared against the previously stored value. (This value can also be compared with the initial calibration found on the original calibration certificate.)

iii. The value from the test should compare with the stored (or original calibration value) within 1.5 °C. This variation in part due to potential variations of the ambient temperature during the test and differences in test methods.

High Flow Validate—Simulates a high flow condition.

i. Support the TA2 vertically in a water bath. See Figure 14. During the test, the heater power is set and the Delta T (temperature difference) between the two RTDs is measured.

ii. After completion of the test, the value of the temperature difference measured during the test is compared against the stored value. (This value can also be compared with the initial calibration found on the original calibration certificate.)

iii. The value from the test should compare with the stored (or original calibration value) within 1.5 °C This variation in part due to potential variations of the ambient temperature during the test and differences in test methods.

If the temperature difference measured during the test is greater than the recommended temperature difference indicated above in item “iii”, then the overall accuracy of the TA2 may be affected. Contact AMETEK LMS Technical support.

4.0 Maintenance

4.1 Circuit Board Replacement

The input wiring board and display module can be replaced without any effect on the performance and operation of the TA2. The processor board contains the calibration information and is matched with the probe. If this circuit board is replaced, re-entry of all the original calibration and configuration information is required. This information is contained on the calibration certificate which can be supplied by Magnetrol. Use of PACT*ware*™ is recommended for re-entry of this data.

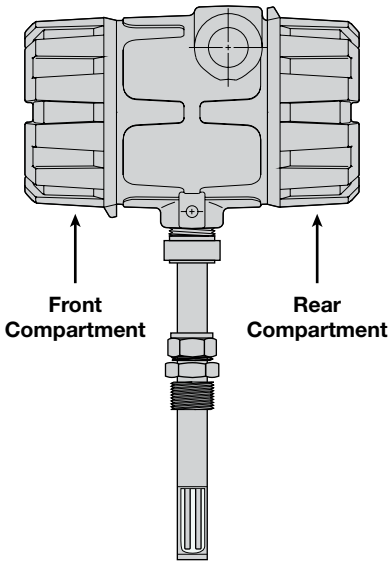


Figure 15

1. Make sure the power source is turned off.
2. The input wiring board is contained in the rear compartment where the input voltage wiring comes into. The display module, power loop board and processor board are contained in the front compartment.
3. Remove cover—refer to Figure 15.
4. If removing boards in the front compartment:
   a. Remove and unplug the display module if provided.
   b. Remove the two hex head fasteners using a ¼" socket. This will remove the electronics module containing the processor board and the power loop board.
   c. Unplug the electrical connection at J1 of the power loop board.
   d. Probe wiring connections are made to TB1 on the same side of the power loop circuit board.
   e. Connect the probe wires as indicated:

Integral Electronics

Wire Color	Connections on TB1
Orange	8
Brown	7
Black	3
Blue	2
White	1

Remote Electronics—see Figure 10 on Page 11.

   f. Reattach the electrical connection to J1.
   g. Reassemble the circuit boards in the enclosure. Make sure that the probe wiring does not get pinched between the standoffs on the circuit board and the attachment lugs in the housing.
   h. Reinstall the display module if provided.
5. If replacing the input wiring board, loosen screws, and remove the electrical connection to J1 on the rear of the circuit board.
   a. Attach electrical connections to J1 on new circuit board and reassemble.
6. Reinstall the cover.
7. Apply power to the instrument.
8. Proceed to section 4.3

4.2 Probe Replacement

The probe and processor board are calibrated together to form a matched set. If a probe needs to be replaced,

Magnetrol will provide a new calibration certificate. The user will be required to re-enter the data from this certificate into the instrument. Use of PACTware™ is recommended for re-entry of this data. A new serial number will be designated to the replacement probe.

Integral Electronics

1. Make sure the power source is off.
2. Access the power loop circuit board following procedure in section 4.1.1
3. Disconnect wiring to the probe.
4. Loosen the two set screws at the base of the housing. One serves as a rotational lock, the other secures the head into place.
5. Unthread the probe.
6. Thread in a new probe.
7. Connect the probe wires to the power loop board as indicated in section 4.1.4., step “e”.
8. Reassemble the electronics following 4.1.1.
9. Align the enclosure with the desired probe position, making sure that the flow arrow indicates the direction of flow.
10. Retighten the two set screws.
11. Reapply power.
12. Proceed to section 4.3.

Remote Electronics

1. Make sure the power source is off.
2. Remove cover of remote electronics housing.
3. Remove bezel.
4. Disconnect the wires from the probe at terminal TB1.
5. Loosen the two set screws at the base of the housing. One serves as a rotational lock, the other secures the head into place.
6. Unthread the probe.
7. Thread in a new probe.
8. Connect the probe wires to Terminal TB1 as shown in fig. 10.
9. Retighten the two set screws.

Remote Electronics

Wire Color	Connections on TB1
White	1
Blue	2
Black	3
Brown	4
Orange	5

10. Reassemble the bezel and install cover.
11. Reapply power.
12. Proceed to section 4.3

4.3 Replacement Calibration

4.3.1 RTD Calibration

If either the probe or the processor board is replaced in the field, calibration of the RTDs in the probe will return the TA2 to like-new performance.

NOTE: If this procedure is not followed, the accuracy will be affected; however, very repeatable flow measurements will be obtained.

Locate the sensor vertically in a water bath with an accurate temperature sensor directly adjacent to the probe tips. It is preferable that the water is stirred during the calibration to ensure the TA2 pins and temperature probe are at the same temperature. Using the keypad and display, select “Factory Config\Probe Params\ Probe Temp Calib” and then press the Enter key. The device will dynamically display the To/Fo readings over a period of time. After 3 minutes, and if the readings are stable enough, the display automatically changes to request entry of a password (126) followed by the ambient water temperature. After the temperature is entered, the device will display if the calibration is OK. The device then automatically resets itself for normal operation. A similar procedure exists for the DD and DTM.

4.3.2 Set Point Adjustment

A new set point must be calculated to complete the reconfiguration.

1. Place the probe in ambient temperature air where there is no flow across the sensor. This can be accomplished by wrapping the sensor tip with a piece of paper.
2. Go into Diagnostics ’ Signal. Allow time for the signal to stabilize to within ±1 mW and record the new signal.
3. Calculate a new set point by using the following formula:

   New set point = set point x (zero flow signal ÷ new signal)

   If replacing the probe, use the set point and zero flow signal (ZFS) shown on the new calibration certificate that came with the probe.

   If replacing the processor board, use the set point and ZFS on the original calibration certificate. If the original calibration certificate is not available, contact factory with the serial number of the unit found on the nameplate.

   New signal is the value measured under step 2.

NOTE: If the TA2 is calibrated for a gas other than air, there are two ZFS values on the certificate. One is for air and the other is for the particular gas. Use the ZFS for air when making the adjustment in air.

4. Enter this new set point into the TA2 instead of the value on the calibration certificate under Factory Config ' Cal Parameters A ' Set Point.

5. Return to the signal screen, similar to step 2, ensuring there is no flow over the sensor. The signal value should now agree with the original ZFS within 1%. If desired, steps 2 through 5 can be repeated.

4.4 Flow Recalibration

Calibration of the TA2 requires a flow bench or other method for determining the flow rate. Using this procedure, the user can re-calibrate the unit himself or use a local flow calibration facility rather than returning the unit to the factory for recalibration. With an insertion probe, it is not necessary to calibrate in the same size pipe as the unit is installed in. The TA2 has internal scale-up factors which adjusts the data from the calibration pipe size to the installation pipe size.

Calibration requires the TA2 sensor to be positioned in a test section; the test section should have a sufficient upstream and downstream straight run to ensure the formation of a fully developed flow profile. Calibration should be performed using the same gas which the unit is calibrated for. Optionally, an air equivalency calibration can be performed. In this case, calibrate in air and contact the factory for air equivalency factors and equivalent air calibration rate.

Recalibration Procedure:

1. Select the set point; this is the temperature in degrees Celsius which the TA2 maintains between the two sensors. If the unit is re-calibrated for the same application, then it is probably not necessary to change the original value. If it becomes necessary to change the set point due to change in the calibration velocity or the type of gas:
   a. Record the set point under Factory Configuration/ Cal Parameters (A or B)/Set Point.
   b. Determine the maximum velocity in SFPM which the unit will operate (SFPM equals the SCFM divided by the flow area of the test section in square feet).
   c. Install the probe in the test section and flow gas that is equivalent to the maximum velocity in the calibration range.
   d. Using the display, HART, or PACTware™, obtain the signal value in mW from the Diagnostics menu.

e. Calculate a new set point using the formula:

New set point = old set point * (800/measured signal (mW)). 800 mW is the desired maximum power rating for the TA2.

f. Enter new /set point in TA2 under Factory Configuration/Cal Parameters (A or B) Set Point.

2. Convert the flow rate in the application to the flow rate in the test section using the formula:

Flow in test section = application flow * (flow area of test section/flow area of application)

a. Allow a flow of a known amount of gas through the test section, recording flow rate and TA2 signal (mW).

A minimum of 10 and a maximum of 30 data points including a zero flow value should be obtained. One data point should be taken at a flow rate approximately 20% greater than the expected operating range.

The higher the number of data points, the better the overall accuracy of the instrument.

b. Convert the flow rate in the test section to mass velocity in SFPM (Standard Feet Per Minute). This is equivalent to the flow rate in SCFM divided by the flow area in square feet. Convert from other units of measurement as necessary. Use Magnetrol STP conditions of 70 °F and 1 Atmosphere (14.69 psia).

c. Enter the Power and the corresponding Mass Velocity into the TA2. This is easily performed using PACT*ware*™ but can also be entered directly into the TA2 using the display and keypad or using HART. These values should be entered in increasing order to ensure a monotonically increasing curve.

Note password of 126 is required for entry of calibration data. (Contact factory if issues using this password.)

d. d. After completion of entry of the calibration data, check the display/HART/PACTware™ for the number of points accepted (or table length). If this number is less than the actual number of data points entered, then there is an error in the entry of the calibration data. Ensure that the data is entered so the curve is monotonically increasing. The values of mass velocity and power should always be increasing over the calibration range.

e. A Fault message will occur if there are fewer than ten calibration data points in the calibration table.

3. Enter the flow area of the calibration test section. Units of measurement are the same as selected under Basic Config menu. This value is used in calculating the scale-up factor between the calibration test section and the installation.

3.4 Agency Approvals

AGENCY	APPROVED MODEL	PROTECTION METHOD	AREA CLASSIFICATION
UNITED STATES & CANADA 	TA2-AXXX-X3X TA2-AXXX-X4X with TXR-XXXX-XXX (probe) TFT-XXXX-000 (flow body)	Explosion Proof Dust Ignition Proof Non-Incendive Suitable for Zones	FM17US0310X/FM17CA0159X Class I, Div 1, Groups B, C, D T6 Ta = -40 to +70 °C, T5 Ta = -40 to +80 °C Class II, III, Div 1, Groups E, F, G T6 Ta = -40 to +70 °C, T5 Ta = -40 to +80 °C Class I, II, III Div 2, Groups A,B, C, E, F, G T4 Ta = -40 to +70 °C Integral Transmitter/Remote Probe Housing: Class I, Zone 1, AEx/Ex db qb IIC T4...T3 Gb Class I, Zone 1, AEx/Ex db IIC T4...T3 Gb Zone 21, AEx/Ex Ex tb IIIC T135°C...T200°C Db Remote Transmitter: Class I, Zone 1, AEx/Ex db IIC T6 Gb Zone 21, AEx/Ex Ex tb IIIC T85°C Db All Probes: Class I, Zone 1, AEx/Ex qb IIC T4...T3 Gb Class I, Zone 1, AEx/Ex db IIC T4...T3 Gb T4 Ta = -40 to +70 °C Type 4X, IP 66
ATEX 	TA2-AXXX-X3X TA2-AXXX-X4X with TXR-XXXX-XXX (probe) TFT-XXXX-000 (flow body)	Flameproof	FM ATEX19ATEX0205X Integral Transmitter/Remote Probe Housing: II 2 G Ex db qb IIC T4...T3 Gb II 2 G Ex db IIC T4...T3 Gb II 2 D Ex tb IIIC T135°C...T200°C Db -40 to +70 °C Remote Transmitter: II 2 G Ex db IIC T6 Gb II 2 D Ex tb IIIC T85°C Db -40 to +70 °C All Probes: II 2 G Ex qb IIC T4...T3 Gb II 2 G Ex db IIC T4...T3 Gb -40 to +70 °C Type 4X, IP66
IECEx	TA2-AXXX-X3X TA2-AXXX-X4X with TXR-XXXX-XXX (probe) TFT-XXXX-000 (flow body)	Flameproof	IECEx FMG20.0023X Integral Transmitter/Remote Probe Housing: Ex db qb IIC T4...T3 Gb Ex db IIC T4...T3 Gb Ex tb IIIC T135°C...T200°C Db -40 to +70 °C Remote Transmitter: Ex db IIC T6 Gb Ex tb IIIC T85°C Db -40 to +70 °C All Probes: Ex qb IIC T4...T3 Gb Ex db IIC T4...T3 Gb -40 to +70 °C Type 4X, IP66
EAC	TA2-AXXX-X3X TA2-AXXX-X4X	Consult factory for details	

3.4 Agency Approvals

AGENCY	APPROVED MODEL	PROTECTION METHOD	AREA CLASSIFICATION
BRAZIL **INMETRO TUV**	TA2-AXXX-X3X TA2-AXXX-X4X com TXR-XXXX-XXX (probe) TFT-XXXX-000 (flow body)	Flameproof ABNT NBR IEC 60079-0:2013 ABNT NBR IEC 60079-1:2016 ABNT NBR IEC 60079-5:2016 ABNT NBR IEC 60529:2017	Integral Transmitter/Remote Probe Housing: TA2 com sonda de insersão ou em linha Ex db qb IIC T4...T3 Gb Ex db IIC T4...T3 Gb -40 < Ta < +70 ºC Remote Transmitter: TA2 Ex db IIC T6 Gb -40 < Ta < +70 ºC All Probes: Ex qb IIC T4…T3 Gb Ex db IIC T4…T3 Gb -40 < Ta < +70 ºC IP66W TUV 11.0027 X

NOTE: Consult factory for full list of country approvals.

CE These units have been tested to EN 61326 and are in compliance with the EMC Directive 2004/108/EC.

4.5.1 Special Conditions of Use

Transmitter

1. The enclosure contains aluminum and is considered to present a potential risk of ignition by impact or friction. Care must be taken during installation and use to prevent impact or friction.
2. To maintain the applicable temperature code, care shall be taken to ensure the “Enclosure Temperature” does not exceed 70°C.
3. The risk of electrostatic discharge shall be minimized at installation, following the direction given in the instructions.
4. Contact the original manufacturer for information in the dimensions of flameproof joints.
5. For Installation with ambient temperature of 70°C, refer to the manufacturer’s instructions for guidance on proper selection of conductors.
6. The T4…T3 temperature code is based on the maximum process temp listed below:

T-Code	Maximum Process Temperature
T4	+135 °C
T3	+200 °C

Probe

1. The Thermal Probe is only for use with the TA2 Thermal Transmitter.
2. The T4…T3 temperature code is based on the maximum process temp listed below:

T-Code	Maximum Process Temperature
T4	+135 °C
T3	+200 °C

4.6 Specifications

4.6.1 Performance

Flow range maximum	10–54,000 SFPM (0.05–275 Nm/s) air reference to standard conditions Contact AMETEK LMS for other gases
Accuracy flow	±1% of reading +0.5% of calibrated full scale
Accuracy temperature	±2 °F (1 °C)
Repeatability	±0.5% of reading
Linearity	Included in flow accuracy
Turn down	100:1 typical (depending on calibrated flow range)
Calibration	NIST traceable
Span	Minimum 0–100 SFPM
Response time	1 to 3 second time constant typical
Cable length	500 feet (150 m); (see page 11 for cable specifications)
SIL	Safe Failure Fraction (SFF) 88%

4.6.2 Transmitter

Display		Two-line alphanumeric LCD, 16 characters per line
Keypad		Four push button
Menu Language		English, French, German, Spanish, Russian
Supply voltage		100–264 VAC, 50–60 Hz ~
		15-30 VDC (lower VDC possible - Consult Factory)
Power consumption		DC = 9 W maximum, AC = 20 VA maximum
Signal Output		4–20 mA (active or passive), HART available (3.8 to 20.5 mA usable—meets NAMUR NE 43)
Analog output signal	Active: Passive:	4–20 mA (isolated) maximum 1000 Ω loop resistance 4–20 mA (isolated) loop resistance dependent on power supply, 11–36 VDC
Diagnostic Alarm		3.6 mA, 22 mA, HOLD
Pulse Output		Active Connection—24 VDC (±10%) Power, 150 mA
		Passive Connection—2.5 to 60 VDC Power, 1.5 AMP
Alarm Output		Active Connection—24 VDC (±10%) Power, 100 mA
		Passive Connection—2.5 to 60 VDC Power, 1 AMP
Ambient temperature		-40 to +176 °F (-40 to +80 °C); display not readable below -22 °F (-30 °C)
Temperature effect		Approximately ±0.04% of reading per °C
Humidity		99% Non-condensing
Housing Material		Aluminum A356 (<0.2% copper); 316 stainless steel
Shock Vibration		ANSI/ISA-S71.03 table 2, level SA1 (Shock), ANSI/ISA-S71.03 table 1, level VC2 (Vibration)

4.6.3 Probe

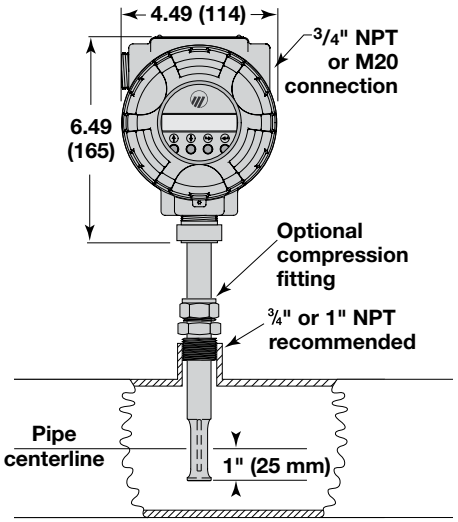
Materials	316/316L stainless steel all welded Hastelloy® C-276/C-22
Process connections	Refer to model number, hot tap optional
Pressure rating	1500 psig @ +70 °F (103 bar @ +20 °C), 1375 psig @ +400 °F (95 bar @ +200 °C)
Temperature rating	-50 to +400 °F (-45 to +200 °C)①

4.6.4 Flow Body

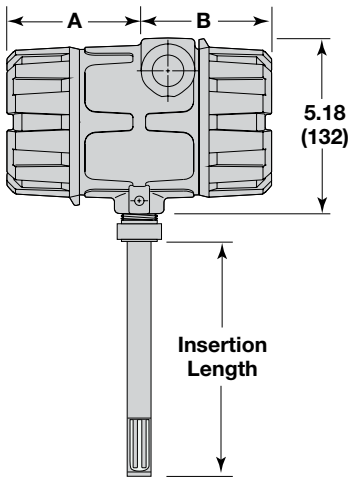
Materials	316/316L stainless steel all welded
	Carbon steel with stainless steel sensor
Process connections	NPT or 150-pound flange – Refer to model number
Pressure rating	1500 psig @ +70 °F (103 bar @ +20 °C), 1100 psig @ +400 °F (76 bar @ +200 °C)
Temperature rating	-50 to +400 °F (-45 to +200 °C) ①

① For operating temperatures between +250 and +400 °F (+120 and +200 °C), either use remote electronics or a longer length insertion probe to provide an additional four inches (100 mm) between the electronics and the compression fitting.

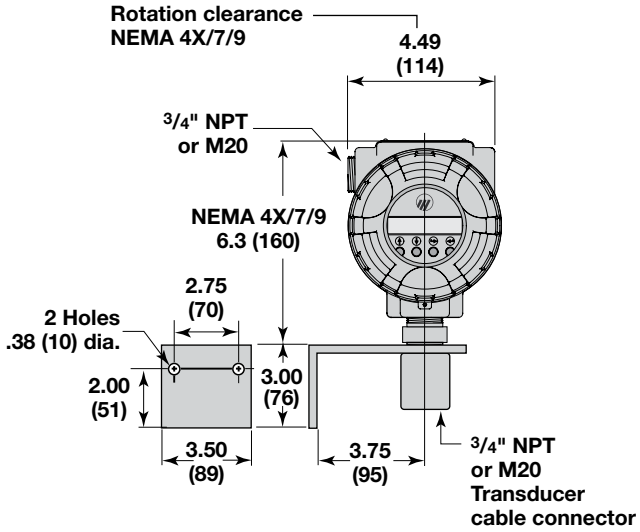
4.6.5 Physical – Inches (mm)



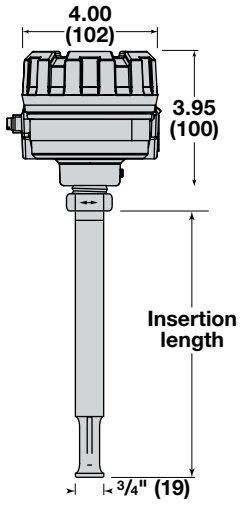
Front View



Side View

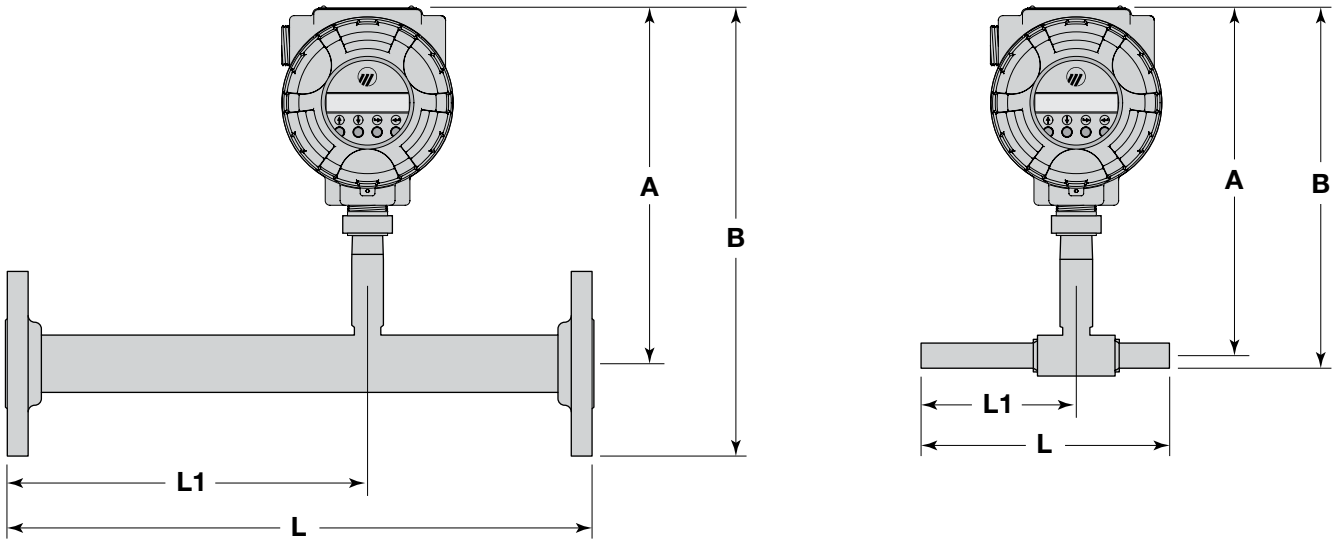


Main Electronics



Remote Probe with Housing

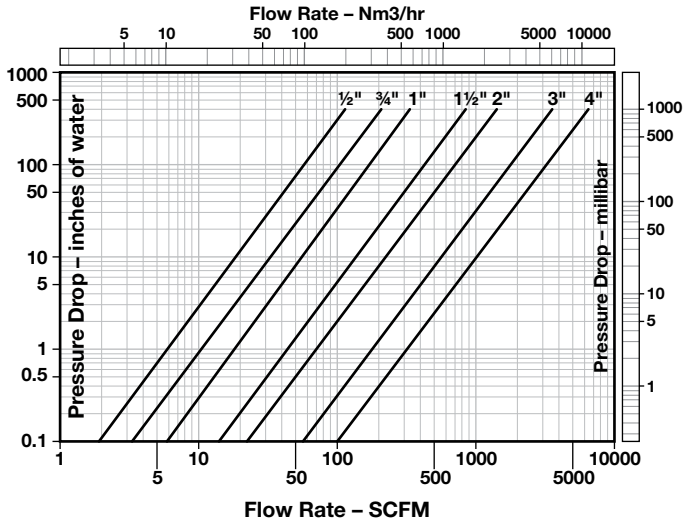
4.6.5 Physical – Inches (mm)



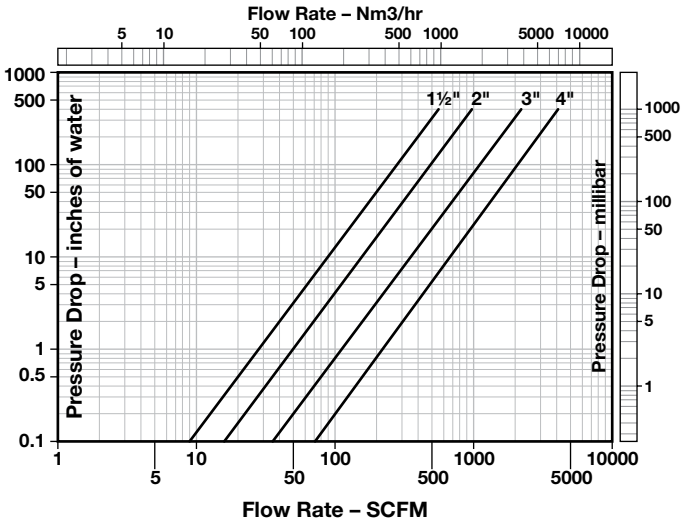
Code	Size	Length (L)		L1		Height to Centerline (A)	Overall Height (B)	
		With Flow Conditioning	Without Flow Conditioning	With Flow Conditioning	Without Flow Conditioning		NPT	Flange
0	½"	8 (203)	—	5 (127)	—	8.0 (203)	8.4 (213)	9.7 (246)
1	¾"	11.25 (285)	—	7.5 (190)	—	8.0 (203)	8.5 (216)	9.9 (251)
2	1"	15 (381)	—	10 (254)	—	8.0 (203)	8.6 (218)	10.1 (257)
3	1½"	19.5 (495)	7.5 (191)	12 (305)	3.75 (95)	8.3 (210)	9.2 (234)	10.8 (274)
4	2"	26 (660)	7.5 (191)	16 (406)	3.75 (95)	9.5 (241)	10.7 (272)	12.5 (318)
5	3"	39 (991)	10 (254)	24 (610)	5 (127)	9.5 (241)	N/A	13.3 (338)
6	4"	52 (1321)	12 (305)	36 (914)	6 (152)	9.5 (241)	N/A	14.0 (356)

Flow conditioning on ½" to 1" is provided due to length of flow body and sensor design.
Optional flow conditioning plate and straight run is available on flow bodies 1½" and larger.

Pressure Drop



Pressure Drop with Flow Conditioning Plate



Pressure drop is based on air at +70° F and 1 atmosphere (density = 0.075 lb/ft3). For other gases, pressure or temperatures, estimate pressure drop by multiplying value from chart by actual density (at operating conditions) divided by 0.075.

4.7 Replacement Parts

NOTE: Replacement of the processor circuit board or the probe requires entry of calibration and configuration data from the Calibration Certificate.

WARNING: EXPLOSION HAZARD
Substitution of components may impair suitability for Class I, Division 2

EXPLOSION HAZARD
Do not disconnect equipment unless power has been switched off, or the area is known to be non-hazardous

Item	Description		Part Number
1	Power Loop Board	HART Version	Z30-3612-001
		Without HART	Z30-3612-002
		HART, 2nd mA and Pulse	Z30-3612-003
		ATEX Zone 0 HART Version	Z30-3612-004
		ATEX Zone 0 Without HART	Z30-3612-005
		ATEX Zone 0 HART, 2nd mA and Pulse	Z30-3612-006
2	Processor Board	GP, FM, FMc, ATEX, Exd	Z30-3611-001
		ATEX Zone 0	Z30-3611-002
	Electronics Module with Processor Board, Power Loop Board with mounting hardware		See table below.
3	Display Module		Z30-3614-001
4	Input Wiring Board	Basic	089-7260-001
		Full Feature *	089-7260-002
5	Enclosure O-ring		012-2201-240
6	Enclosure Base		004-9207-XXX
7	Short Enclosure Cover **		004-9197-007
8	Wiring Enclosure Cover		004-9206-010
9	Enclosure Cover with Window ***		036-4411-001
10	Remote Probe Housing Base		004-9212-XXX
11	Remote Probe Housing Cover		004-9193-002
12	Remote Probe Housing O-ring		012-2101-237
13	Remote PC Board		030-3616-001
14	Probe/Flow Body		See Probe/Flow Body

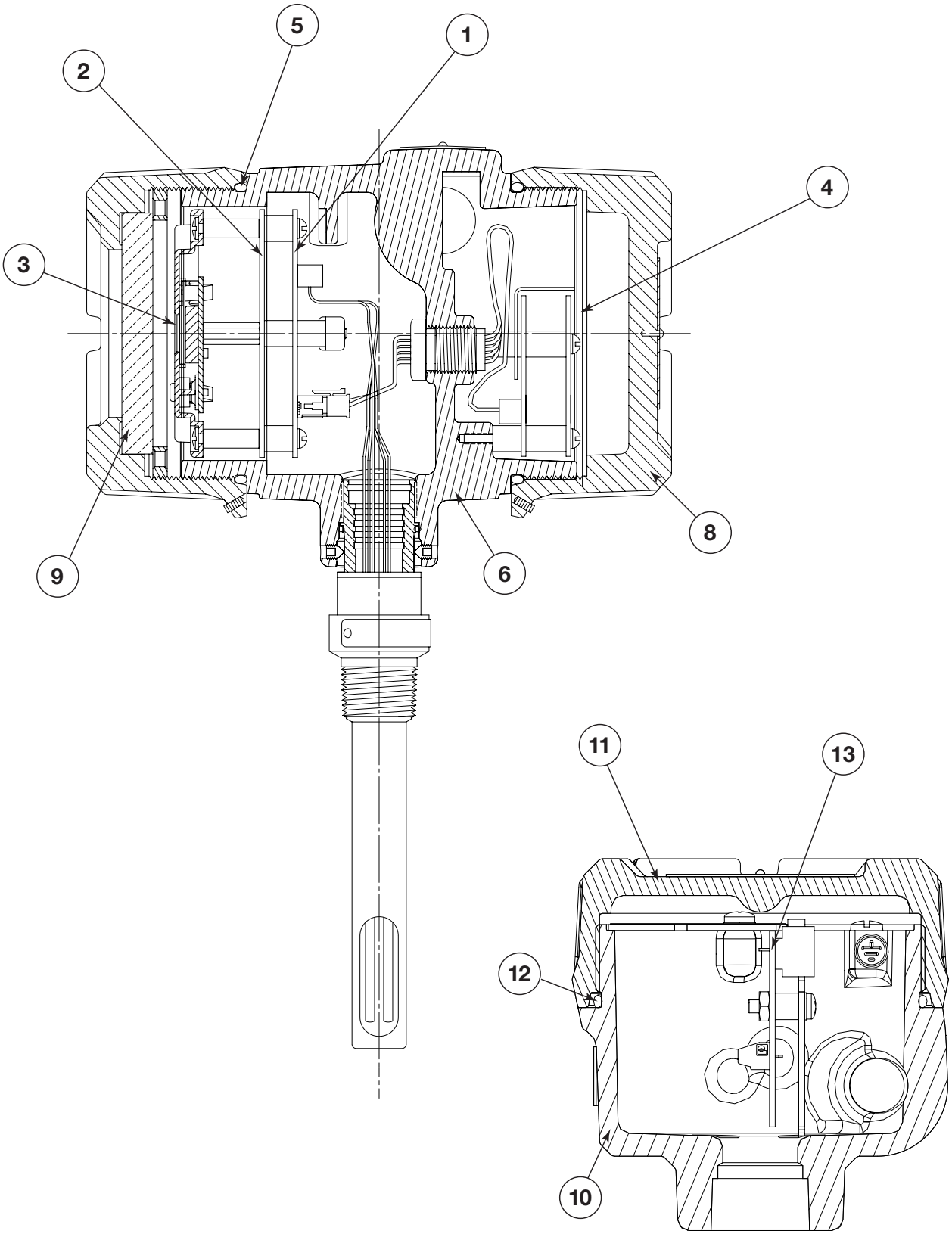
* Includes 2nd mA and pulse output

** Short enclosure cover used with units that do not include display

*** Enclosure cover with window is used with units that do include display

Electronic Module includes Processor Board and the Power Loop Board with Mounting Hardware

GP/Explosion Proof, no HART	089-7261-001
GP/Explosion Proof, HART	089-7261-002
GP/Explosion Proof, HART, 2nd mA and Pulse Output	089-7261-003
Zone 0 (Ex d + ib), no HART	089-7261-004
Zone 0 (Ex d + ib), HART	089-7261-005
Zone 0 (Ex d + ib), HART, 2nd mA and Pulse Output	089-7261-006


5
1
2
4
3
8
9
6
11
13
12
10

4.6 Model Numbers

4.6.1 Transmitter

SIGNAL OUTPUT

0	4-20 mA
1	4-20 mA with HART
4	4-20 mA with HART, Pulse/Alarm, second mA Output

DISPLAY

0	None
B	Plug-in display with keypad (with window)

CALIBRATION–INSERTION PROBE CALIBRATION – FLOW BODY

Actual Gas Calibration		Actual Gas Calibration	
0	Special ①	**A**	Special ①
1	Air	**B**	Air
2	Nitrogen	**C**	Nitrogen
3	Hydrogen	**D**	Hydrogen
4	Natural Gas	**E**	Natural Gas
6	Digester Gas ②	**G**	Digester Gas ②
7	Propane	**H**	Propane
8	Oxygen	**J**	Oxygen
Air Equivalency / Correlation		**Air Equivalency / Correlation**	
5	Gas Correlation ①	**F**	Gas Correlation ①
9	Air Equivalency	**K**	Air Equivalency

① Consult factory for approval

② Standard composition is 65% methane and 35% carbon dioxide; consult factory for additional options

HOUSING LOCATION / AGENCY APPROVAL

3	Integral, general purpose, non-incendive, & explosion proof cFMus/ATEX/IECEx
4	Remote, general purpose, non-incendive, & explosion proof cFMus/ATEX/IECEx

ENCLOSURE TYPE

0	Aluminum, ¾" NPT
1	Aluminum, M20
2	Stainless Steel, ¾" NPT
3	Stainless Steel, M20

T	A	2	–	A			0	–			
1	2	3		4	5	6	7		8	9	10

4.6.2 Insertion Probe

THERMATEL PROBE

TE	Probe length in tenth of inches
TM	Probe length in centimeters

PROBE TYPE

R	¾" diameter probe

MATERIALS OF CONSTRUCTION

A	316/316L Stainless Steel
B	Hastelloy C

PROCESS CONNECTION SIZE

00	Compression Fitting Utilized (customer supplied)
03	¾" NPT SS compression fitting with Teflon Ferrules
04	¾" NPT SS compression fitting with Stainless Steel Ferrules
05	1" NPT SS compression fitting with Teflon Ferrules
06	1" NPT SS compression fitting with Stainless Steel Ferrules
11	¾" NPT
21	1" NPT
22	G1 (1" BSP)

ANSI FLANGES

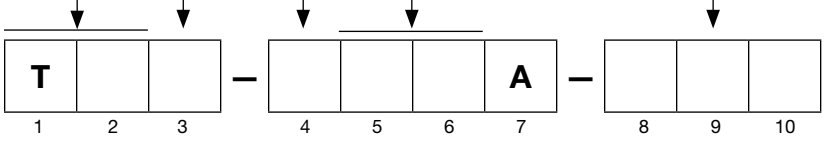
23	1" 150# ANSI raised face flange
24	1" 300# ANSI raised face flange
33	1½" 150# ANSI raised face flange
34	1½" 300# ANSI raised face flange
43	2" 150# ANSI raised face flange
44	2" 300# ANSI raised face flange

DIN FLANGES

BB	DN 25 PN 16/25/40 EN 1092-1, Type A
CB	DN 40 PN 16/25/40 EN 1092-1, Type A
DA	DN 50 PN 16 EN 1092-1, Type A
DB	DN 50 PN 25/40 EN 1092-1, Type A

INSERTION LENGTH

2.6 to 99.9 inches (example 8.5" = 085) Minimum lengths: 2.6" (026) with threaded process connection 2.8" (028) with flanged process connection 4.5" (045) with compression fitting process connection
7 to 253 centimeters (example: 18 cm = 018) Minimum lengths: 7 cm (007) with NPT or flanged process connection 9 cm (009) with BSP threaded process connection 11 cm (011) with compression fitting process connection



4.6.3 Flow Body

MATERIALS OF CONSTRUCTION

A	All stainless steel
1	Carbon steel body with stainless steel sensor

SIZE

0	½ inch
1	¾ inch
2	1 inch
3	1½ inch
4	2 inch
5	3 inch
6	4 inch

PROCESS CONNECTION TYPE

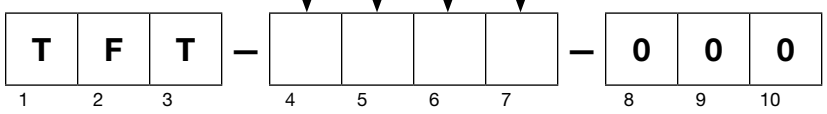
1	NPT Threads ①
3	150# Flange

① Only when digit 5 = 0, 1, 2, 3, or 4

FLOW CONDITIONING PLATE (stainless steel)

A	Not provided
B	Provided ②

② Only when Digit 5 = 3, 4, 5, or 6. Flow conditioning on ½" to 1" is already provided due to length of flow body and sensor design. Optional flow conditioning is available on flow bodies larger than 1" which includes additional straight run and conditioning plate.

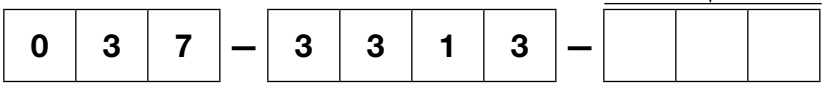


4.6.4 Connecting Cable

FOR CABLE LENGTHS UP TO 150 FEET

037-3313-XXX (Cable length in feet)—10 feet minimum,
150 feet maximum length

Example: 50 feet = 050



FOR CABLE LENGTHS UP TO 45 METERS

037-3314-XXX (Cable length in meters)—3 meters minimum,
45 meters maximum length

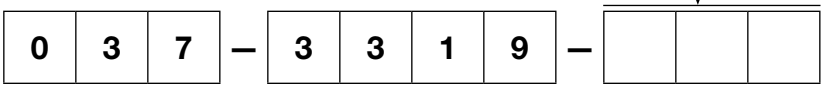
Example: 8 meters = 008



FOR CABLE LENGTHS BETWEEN 150 AND 500 FEET

037-3319-XXX (Cable length in feet)—10 feet minimum,
500 feet maximum length

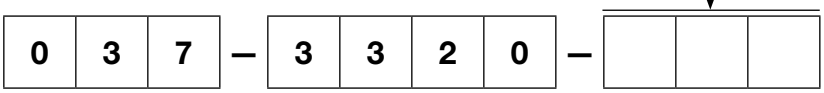
Example: 300 feet = 300



FOR CABLE LENGTHS BETWEEN 45 AND 150 METERS

037-3320-XXX (Cable length in meters)—3 meters minimum,
150 meters maximum length

Example: 80 meters = 080



Appendix A

The flow measurement of the TA2 assumes that the end of the probe is one inch past the centerline and the presence of a fully developed flow profile. See Figure A.

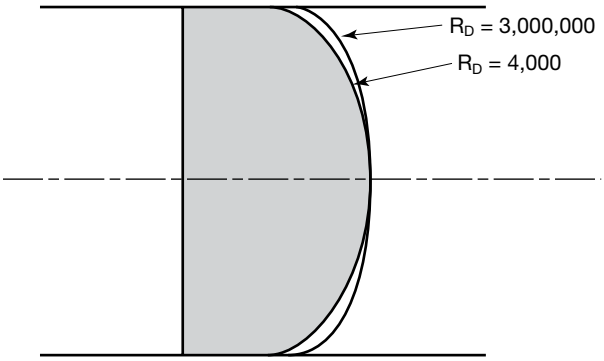


Figure A
Turbulent Flow Profile

As gas flows in a pipe or duct, the flow profile will change with obstructions and changes in flow direction. As the gas flows around an elbow, the momentum causes the gas velocity on the outside of the elbow to increase and the velocity on the inside to decrease. See figure B.

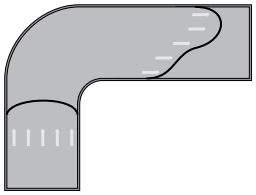


Figure B
Flow Profile Following Single Elbow

Figure C, below, indicates the minimum recommended straight-run distances required to obtain the desired fully developed flow profile. If these straight-run distances are not available, the overall accuracy of the flow measurement will be affected; however, the repeatability of the measurement will be maintained.

The user has the ability to enter correction factors to compensate for non-ideal flow profile conditions.

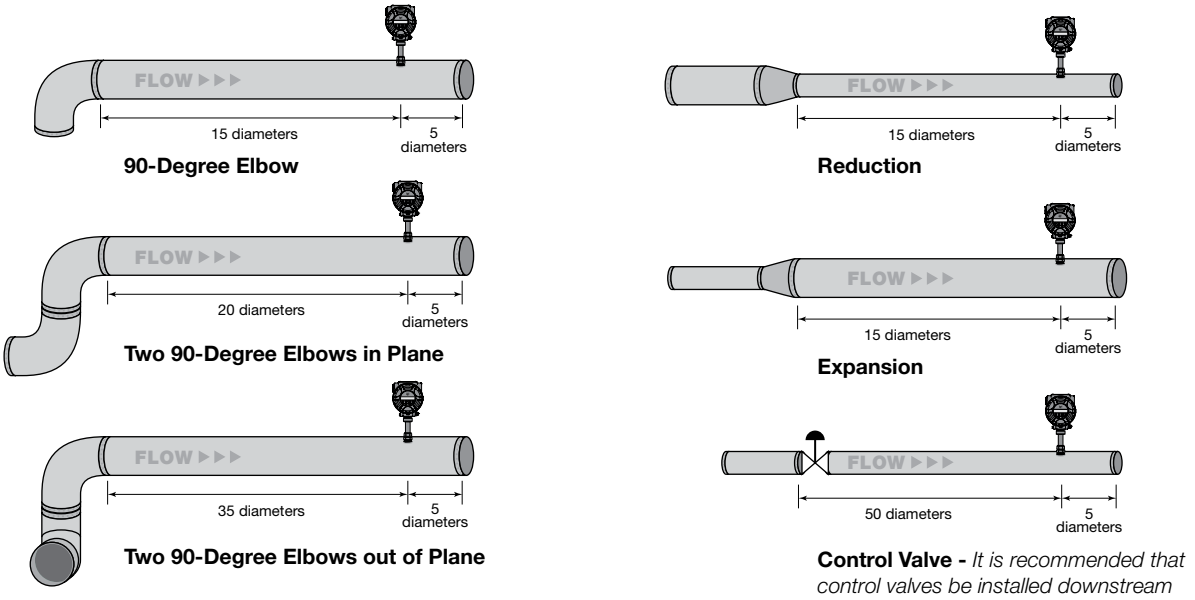


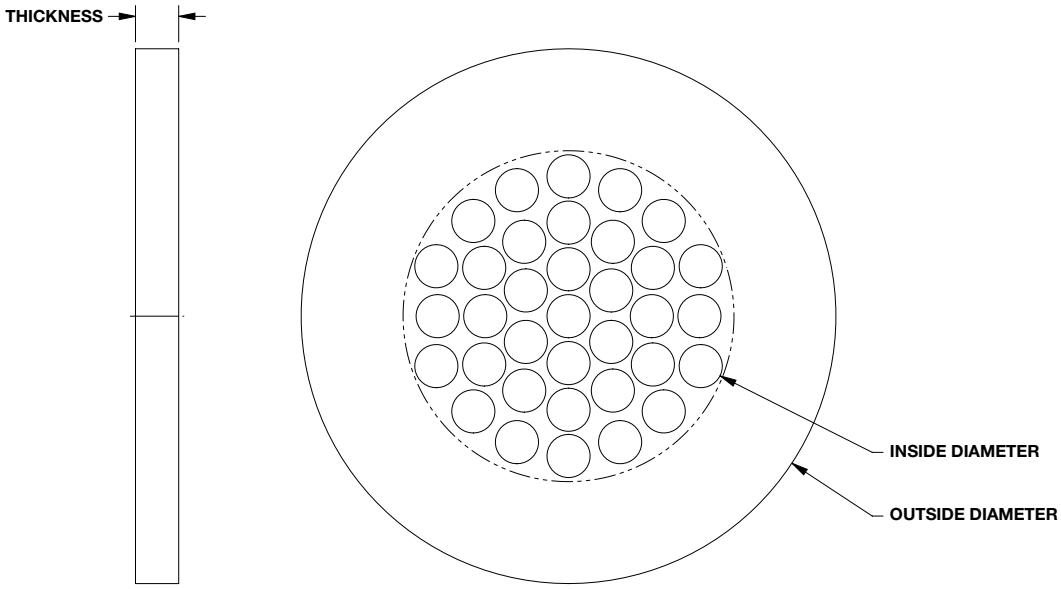
Figure C
Probe Installations

Conditioning Plates

Flow conditioning plates may be provided in applications where limited straight run is available. Plates are available in flow body type sensor designs (TFT) from 1.5” to 4” pipes. Plates may be purchased separately for pipe sizes 4” to 12” when using insertion probes (TXR).

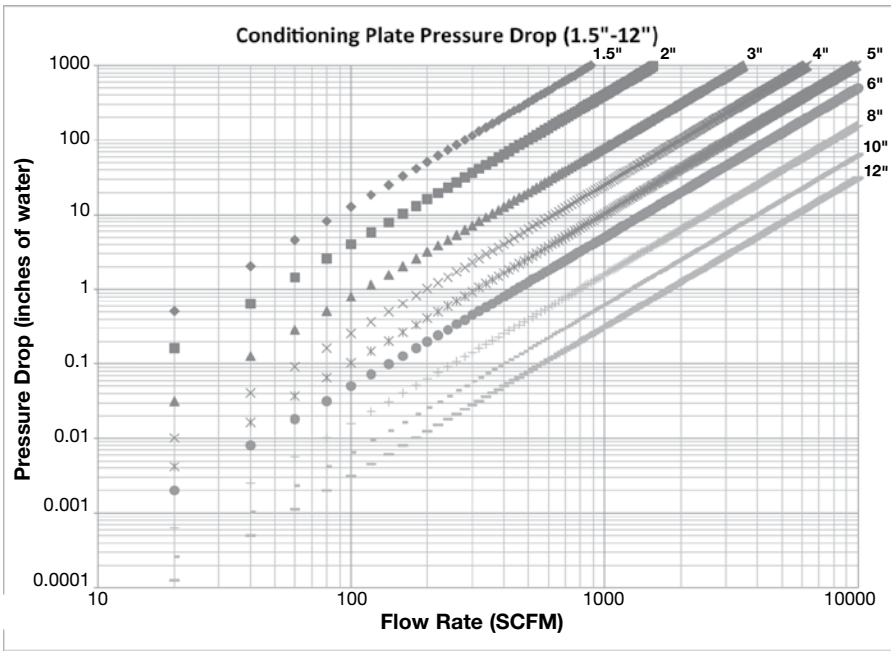
The plate should be installed 2-5 diameters downstream of the nearest obstruction, change in pipe inside diameter or change in flow direction. For TXR designs, the insertion probe can be installed 8 pipe diameters downstream of the plate with 5 diameters required downstream of the TXR. For TFT designs with the plate at the entrance, the downstream is provided in the length of the TFT.

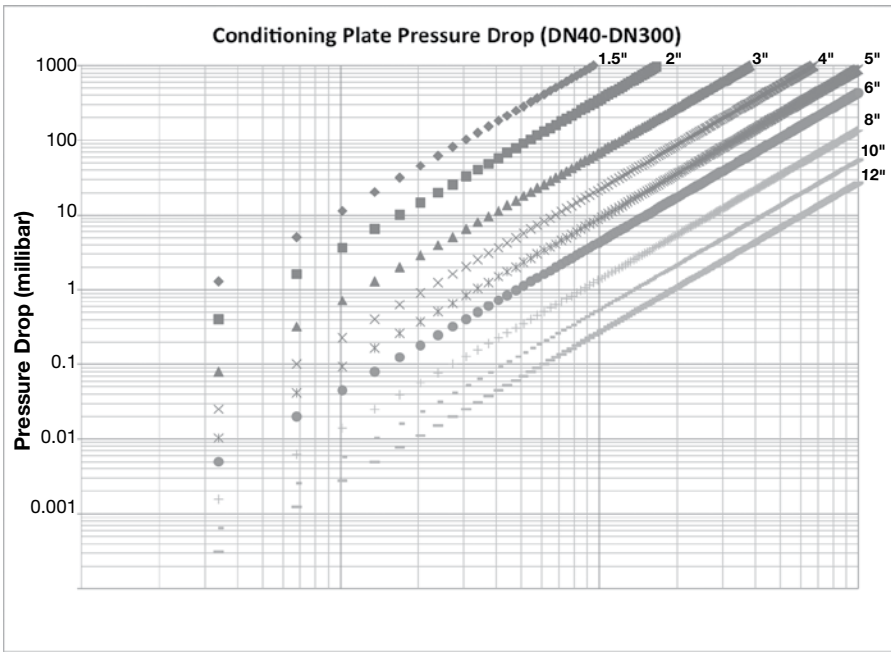
Plates are to be fitted with gaskets (customer supplied) in between flanges. If plates are not included and recommended straight run is not adhered to, the TA2 will provide repeatable measurement and the installation factors can be utilized.



Part Number	Description	OD in (mm)	ID in (mm)	Thickness in (mm)
004-8986-001	4" 316 Stainless Steel	6.19 (157.2)	3.83 (97.3)	0.50 (12.7)
004-8986-002	4" Carbon Steel	6.19 (157.2)	3.83 (97.3)	0.50 (12.7)
004-8986-003	4" PVC	6.19 (157.2)	3.83 (97.3)	0.50 (12.7)
004-8986-004	5" 316 Stainless Steel	7.31 (185.7)	4.81 (122.2)	0.63 (16)
004-8986-005	5" Carbon Steel	7.31 (185.7)	4.81 (122.2)	0.63 (16)
004-8986-006	5" PVC	7.31 (185.7)	4.81 (122.2)	0.63 (16)
004-8986-007	6" 316 Stainless Steel	8.50 (215.9)	5.76 (146.3)	0.75 (19.1)
004-8986-008	6" Carbon Steel	8.50 (215.9)	5.76 (146.3)	0.75 (19.1)
004-8986-009	6" PVC	8.50 (215.9)	5.76 (146.3)	0.75 (19.1)
004-8986-010	8" 316 Stainless Steel	10.62 (269.7)	7.63 (193.7)	1.00 (25.4)
004-8986-011	8" Carbon Steel	10.62 (269.7)	7.63 (193.7)	1.00 (25.4)
004-8986-012	8" PVC	10.62 (269.7)	7.63 (193.7)	1.00 (25.4)
004-8986-013	10" 316 Stainless Steel	12.75 (323.9)	9.56 (242.9)	1.25 (31.8)
004-8986-014	10" Carbon Steel	12.75 (323.9)	9.56 (242.9)	1.25 (31.8)
004-8986-015	10" PVC	12.75 (323.9)	9.56 (242.9)	1.25 (31.8)
004-8986-016	12" 316 Stainless Steel	15.00 (381)	11.37 (288.9)	1.50 (38.1)
004-8986-017	12" Carbon Steel	15.00 (381)	11.37 (288.9)	1.50 (38.1)
004-8986-018	12" PVC	15.00 (381)	11.37 (288.9)	1.50 (38.1)

Pressure Drop Charts





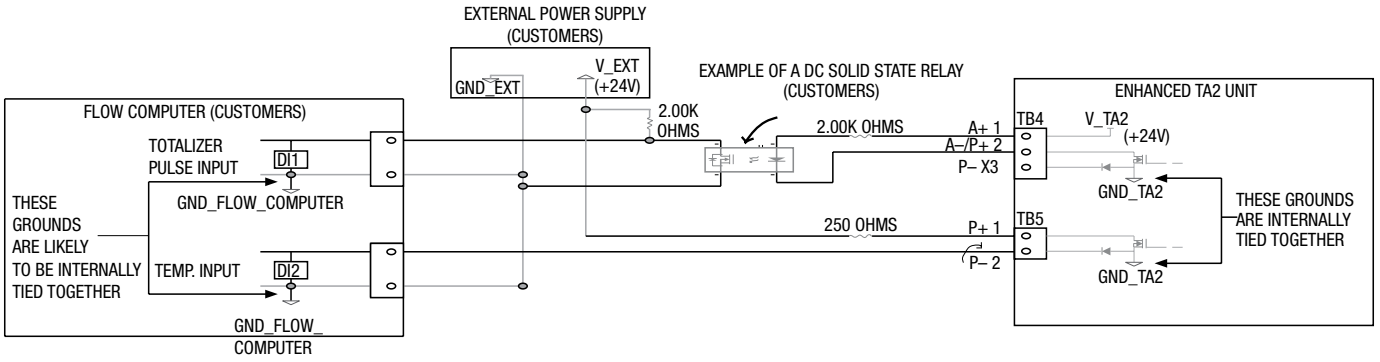
Appendix B

TA2 Mass Flow Meter – Using both Pulse and 2nd mA connections

The pulse output and second mA output (commonly used for Temperature) in the TA2 share a common ground. They are isolated from the remaining input and output connections of the instrument.

A flow computer or other receiving device may have common ground for the various input signals. This may cause difficulties when using both the TA2 pulse and second mA output with an external power supply or the power supply in the flow computer. AMETEK LMS refers to the use of a separate power supply as a passive connection from the TA2 as compared to an active connection where the TA2 provides power for the output signal (sometimes referred to as self-powered).

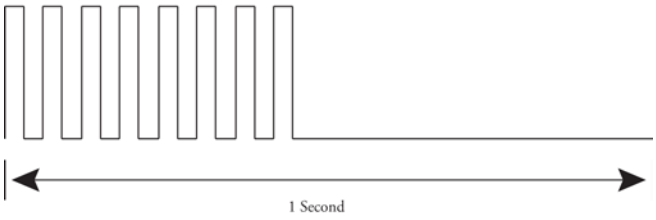
Isolation problems may be encountered if the user wants to connect both the passive pulse output and the second mA output (always passive connection) from the TA2 to a flow computer or other input device with common grounds. The attached illustration shows a recommended solution using a solid state relay between the flow computer and the active TA2 pulse output.



Appendix C

Enhanced TA2 Pulse Output

The Enhanced TA2 has an option for providing a pulse output. The Pulse is an open collector output; the output can be either a powered (active) connection or a passive connection using an external power supply. With an active output the voltage will go from 0 to 24 VDC (± 10%) with each pulse. The voltage on the passive connection will depend on the power supply used.



One pulse will correspond to a specific amount of flow. There are several factors which need to be configured to obtain the desired operation.

Multiplier: The multiplier value is a factor which relates the amount of flow per pulse. For instance a factor of 0.01 with units set to SCF means that each pulse will correspond to 0.01 SCF or conversely there will be 100 pulses for every SCF.

Frequency: Represents the maximum frequency of the pulses. This is selectable from 10 to 10,000 Hz. This value should not exceed the maximum input rate of the device receiving the pulses. If the actual pulse output based on the flow measurement exceeds the maximum frequency selected a Warning Message indicating “Pulse Multiplier error” will appear on the display and be communicated over HART. The pulse width is fixed based on the value selected. For instance with a selected maximum frequency of 1,000 each pulse occur every 1/1000 seconds (1 ms). Each pulse is a square wave with a 50% duty cycle; half of each pulse width is on with voltage applied and half off with no voltage. This results in a pulse width of 0.0005 seconds (0.5 ms). The pulses are transmitted at a fixed rate for a fraction of a second with no pulses for the remaining time.

When configuring the frequency, calculate the pulse rate by using a Time Factor which is equivalent to the number of seconds in the time period. If flow rate is in units/minute the Time Factor = 60; if the flow rate is in units/hour the Time Factor = 3600.

The formula for determining the pulse rate is:

Pulse rate = Flow rate/(Time Factor * multiplier)

Example:

Flow rate = 2,000 SCFH

Time factor = 3600

Multiplier = 0.001 (0.001 SCF/pulse)

The frequency will be equal to 2,000/(3600 * 0.001) = 555 Hz and the maximum frequency can be set to either 1,000 or 10,000.

NOTES

Service Policy

Owners of AMETEK LMS controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by Prepaid transportation. AMETEK LMS will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a “Return Material Authorization” (RMA) number be obtained from the factory, prior to the material’s return. This is available through an AMETEK LMS local representative or by contacting the factory. Please provide the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

NOTE: See Electrostatic Discharge Handling Procedure on page 6.

MAGNETROL® / AMETEK®

705 Enterprise Street • Aurora, Illinois 60504-8149 USA
630.969.4000 • info.magnetrol@ametek.com • ametek-measurement.com

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