TrendMassTer®

TM6GNX SERIES – GAS MASS FLOW METER

OPERATION AND MAINTENANCE MANUAL

DOCUMENT 6000G-OM-00

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DELTA M CORPORATION®
1003 LARSEN DRIVE
OAK RIDGE, TENNESSEE 37830
PH 865-483-1569
FAX 865-483-1142
TOLL FREE 800-922-0083
www.deltamcorp.com
Email: service@deltamcorp.com

MODEL NO._____

SERIAL NO._____

DATE OF SHIPMENT:_____ INSTALLATION DATE:_____

CUSTOMER TAG NO.:_____ PO NO.:_____

OPTIONS:_____

_____

SPECIAL NOTES:_____

_____


TrendMassTer®
DELTA
CORPORATION
0.0000 lb/m
27.1 C
UP
DOWN
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800-922-0083

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1.0 INTRODUCTION

1.1 THERMAL BASED GAS MASS FLOW MEASUREMENT

The Delta M Corporation TM6GNX TrendMassTer® is a new generation mass flow meter intended primarily for high performance, low cost flow measurement of gas. It uses a patented thermal concept developed by engineers at Delta M Corporation to obtain accurate and stable measurement of mass flow. This concept includes a series of improvements, most of which are covered by Delta M Corporation patents, over conventional mass flow measurement techniques. Key improvements include:

- A Ratio-Thermic® sensor excitation method (instead of constant delta T) that virtually eliminate sensor temperature dependence,
- A dual, 4-wire sensor connection scheme that eliminates unwanted sensor lead resistance which degrades temperature performance,
- A comprehensive thermal model that accounts for gas property dependence and includes critical sensor parameters.

The highly sophisticated microprocessor based electronics of the TrendMassTer® converts measured sensor signals into mass flow and gas temperature by real time calculation of the governing mass flow equation derived from a detailed thermal model. Derived volume flow outputs are also available. Additionally, it gives the user the ability to configure each meter to meet their specific requirements. Selection of gaseous media, line sizes, measurement units, switch settings, 4-20mA loop calibration settings and other parameters is easily accomplished using the Keypad and LCD display or the Windows™ based user Interface.

1.2 PRINCIPLE OF OPERATION

The unique Delta M gas mass flow sensor consists of two thermal resistive sensors. One sensor is self-heated to supply energy to the gas; the other provides a temperature reference. To improve both accuracy and temperature compensation the sensors are configured to provide a constant ratio between their resistances instead of the classic constant temperature difference between them. This patented **Ratio-Thermic®** excitation method, combined with dual four-wire sensor connections, essentially eliminates sensor-based temperature drift while providing precise control of energy to the heated sensors

The heated sensor design is optimized so that high sensitivity is achieved even at very high flow rates. Probe power losses are accounted for and included in the thermal model so that high stability is maintained on the low end of the flow range. Heated and reference sensor signals are converted to mass flow and temperature, using an equation derived from the thermal model. Gas physical properties are included in the calculations so that fluid property based temperature drift is eliminated. This also allows the user to select other gasses without the need to recalibrate simply by inserting a selected K factor from a number of selected gasses.

1.3 TM6000 FEATURES

Direct **Ratio-Thermic®** Measurement of Mass Flow

The patented Delta M method of constant ratio of heated to reference sensor eliminates sensor temperature dependence and provides a stable high heat flux signal to the gas that enables accurate mass flow measurement over a wide flow range. Temperature, volumetric flow and total flow are also available.

Multiple Programmable Calibration for Gasses

Mass flow is computed by the microprocessor from an equation developed from a detailed thermal model of the probe-fluid interaction. The instrument is calibrated in air at the Delta M factory.

Selected common gasses can be used in the computation so transfer from one fluid to another is possible, without recalibration, by entering the Delta M K and D_V factor for that gas. K and D_V media translation factors are included in the configuration menu under MEDIA for common gasses such as Carbon Dioxide, Argon, Nitrogen, Oxygen, Helium, Hydrogen, Ammonia, Propane, and Methane. There is also an option to input customer-selected media translation factors, K and D_V, which can be provided for most other gasses, by contacting Delta M.

Volumetric outputs are referenced to standard conditions of 15°C and one atmosphere (101.325 KPa), except for NCFM, which is referenced to 0°C and one atmosphere.

Smart Digital Filtering of Flow Signal

Two digital filters filter the flow signal at user selected conditions. The amount of filtering is selected from Flow Filter 1 and Flow Filter 2 via the Remote User Interface. The first filter is for the steady state flow signal. The closer the value is to zero, the greater the filtering. The second filter controls the rate of charge of the transient signal when the flow is rapidly changing. Normal values are 0.01 for Filter 1 and 0.5 for Filter 2. For extremely noisy flow signals, Filter 1 can be set as low as 0.001 to provide 10 times more filtering than the normal setting.

Dual 4-20 mA Isolated Outputs

Two 4-20 mA optically isolated outputs are standard. Mass flow, volumetric flow, temperature and sensor current can be selected for each. The output zero can be independently scaled from zero to 10% of full scale (for mass, volume and temperature) and 50% of full scale for sensor current, while the span can be adjusted from the maximum flow range (mass maximum 20 lb/min or 300 SCFM in a 2” line) to 30% of maximum flow range.

Dual Isolated Open Collector Switch Outputs

Two optically isolated open collector switch outputs are available. Mass flow, volumetric flow, temperature, total flow and sensor current can be selected for each and each set point contact can selected to be open or close.

On Line Diagnostics of Sensors and Electronics

An embedded microprocessor continuously monitors key signals of sensors and electronics and performs continuous online diagnostics to determine their health. This guarantees that the meter outputs during normal operation is stable and accurate.

Total Flow Computation

Mass and volume total flow can be obtained when the total flow function is enabled from the output menu. Total flow is computed for the primary variable (mass and volume) selected from the outputs menu. Total flow also has a start delay associated with it that can be programmed from 0-9 seconds for gas meter model TM6GNX from the user interface.

Low Flow Cut-Off

Low flow cut-off values can be configured for the mass and volume flow. This can be programmed in the Low Flow Cut-Off menu under OUTPUTS. Since the instrument is a true mass flow meter volumetric measurements are dependent on mass flow values and therefore the low flow cut-off value for volumetric flow is dependent on the low flow cut-off value for mass flow.

Easy Configuration

Configuration is easily accomplished using an integral LCD display and Keypad (not available on blind units) or with the TrendMassTer® Windows™ based Remote User Interface software. The LCD display, dual 4-20mA outputs and dual switch outputs can be set to the user's specific requirements. A wide range of measurement units are included and the instrument is optionally password protected.

High Turndown Ratio

Because of the highly stable sensor excitation method the standard turndown ratio is 50:1. Optional turndown ratios up to 1000:1 are possible. Consult factory for details.

Low Pressure Drop

The thermal technique inherently provides low pressure drop. Delta M's miniature sensors have minimal impact on the gas flow stream so pressure drop is negligible.

1.4 REMOTE USER INTERFACE SOFTWARE

The TM6000 TrendMassTer® software hosted on a Windows™ based PC can be used to configure and obtain output and diagnostics data from the instrument using an RS485 serial port or Ethernet connections. If the computer does not support an RS485 port RS232-RS485 and USB-RS485 converter kits are available from the factory. TM6000 User Interface software is supplied with the instrument on a CD.

This user interface also can be used by service personnel in the field to adjust sensor and media parameters when needed against an external reference calibration.

1.5 ENCLOSURE OPTIONS

The TM6000 flow meter electronics are mounted in a non explosion proof double sided instrument housing. Explosion proof enclosure is available as an option. The sensor may be mounted directly to the enclosure or remotely mounted up to 100 feet away.

The LCD display and keypad may be installed in the enclosure or the unit may be operated in the blind configuration and can be configured using the TM6000 User Interface Software.

2.0 INSTALLATION

2.1 INSTALLATION PRECAUTIONS

The TM6000 TrendMassTer® standard insertion method is via a stainless steel compression fitting. Optional process connections include flange connections, low flow sensors, and spoolpieces (Consult the factory for details). The probe may be connected directly to the electronic enclosure or may be installed remotely from the electronic enclosure up to 100 feet away.

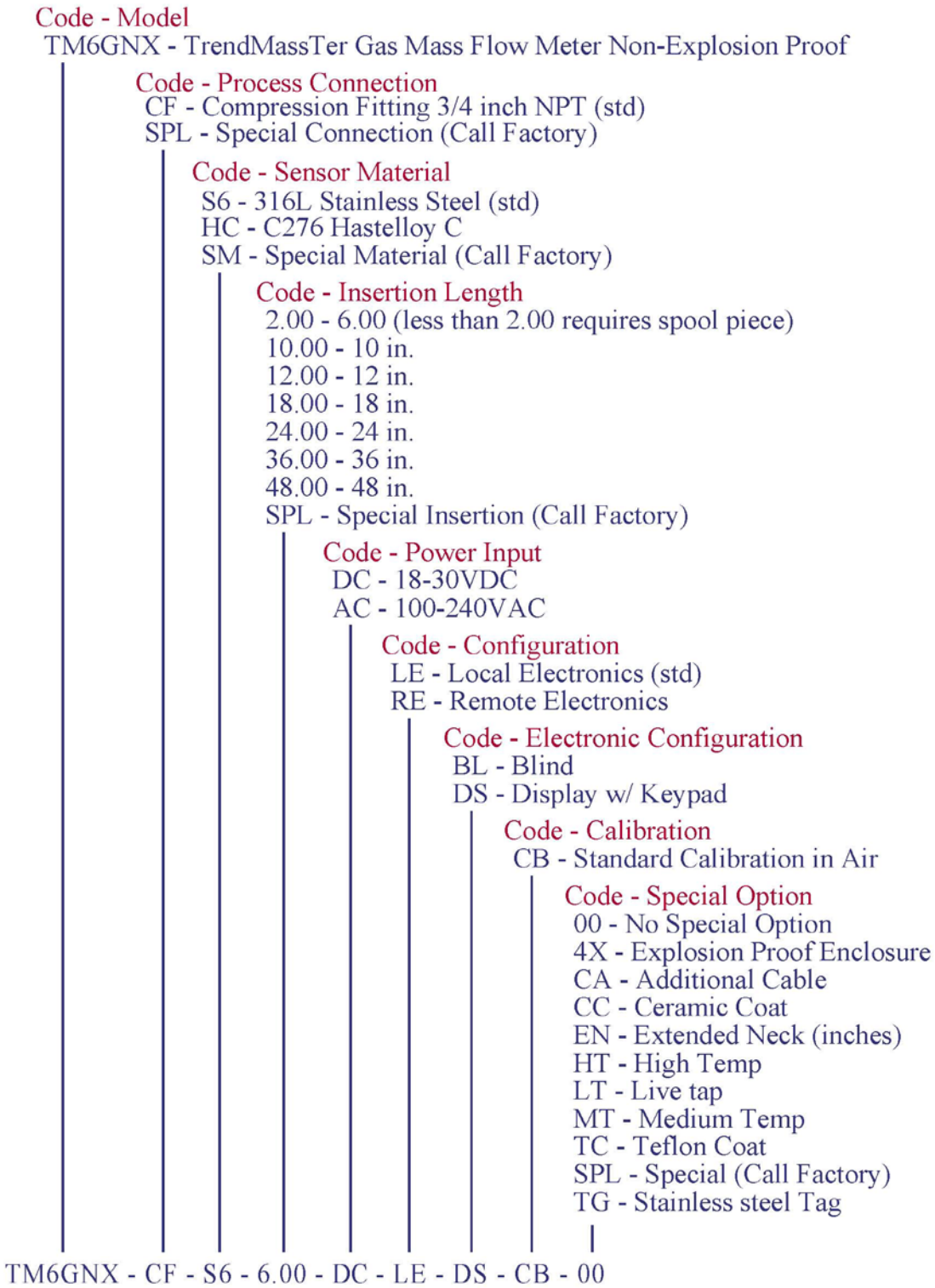
****IMPORTANT****

The following are precautions to observe for the installation:

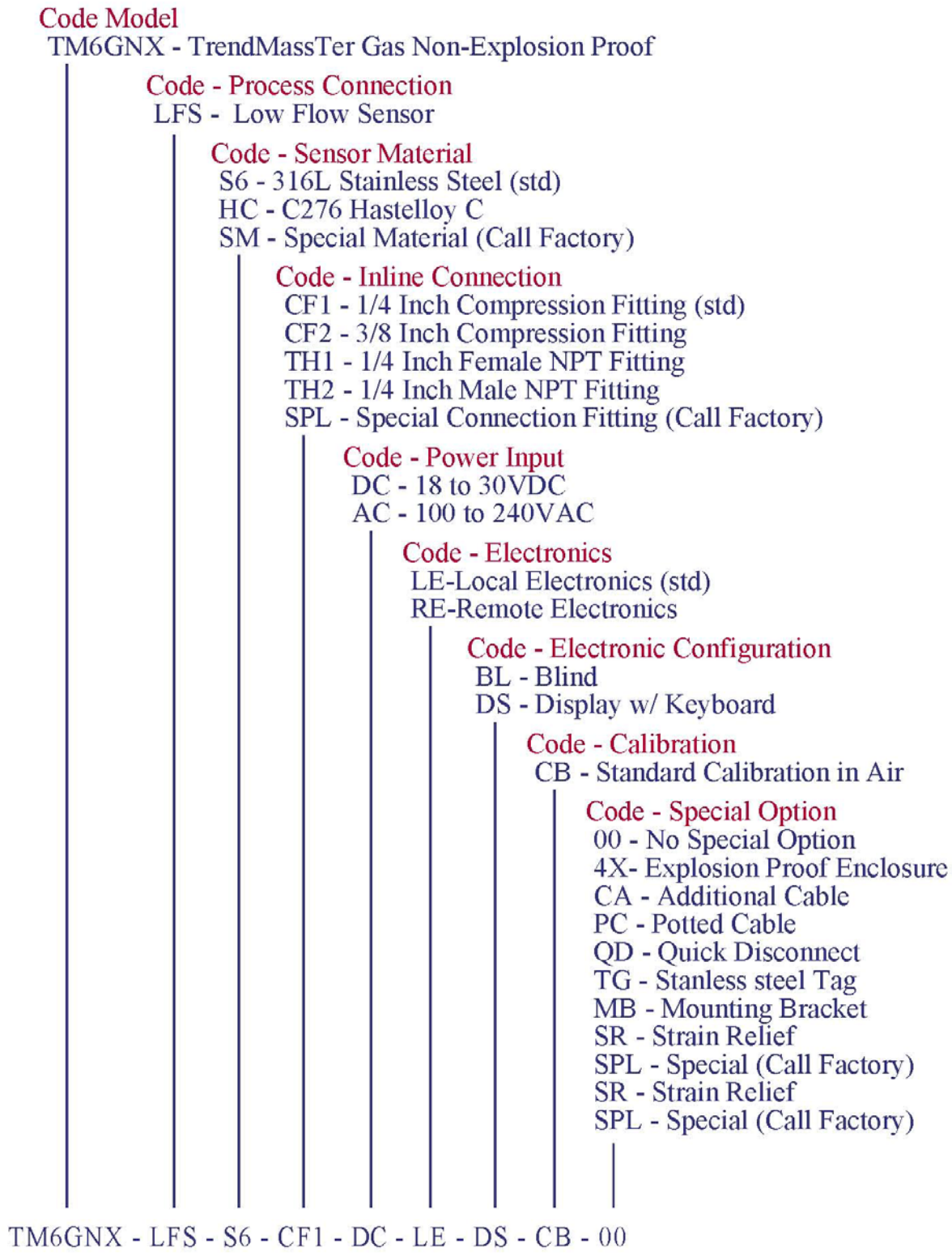
- **Process temperature and pressure must be within the TrendMassTer® specifications of 0 to 350°C (32 to 650°F) for gasses and up to 3000 PSIG.**
- **At least ten (10) straight pipe diameters upstream and five (5) straight pipe diameters downstream are recommended.**
- **There should be no valves, elbows, reductions, expansions or other anomalies within the above mentioned 15 pipe diameter flow path that could adversely affect flow measurement accuracy.**
- **Ensure power to electronics is disconnected before installing or removing probe.**

2.2 MODEL IDENTIFICATION

2.2.1 TrendMassTer® Gas Flow Meter Model Number Selection Guide



2.2.2 TrendMassTer® Low Flow Model Number Selection Guide



2.3 MECHANICAL INSTALLATION

The standard TrendMassTer® probe is installed into a pipe as part of a compression fitting. It is important to position the flow sensor at the correct angle with respect to the flow. An arrow on the NPT fitting indicates the proper flow angle. **Ascertain that the flow arrow is pointing in the direction of the flow; see Figure 2.1 below. [Flow is correct when sensors are aligned with pipe and short (cold) sensor tip is upstream]**

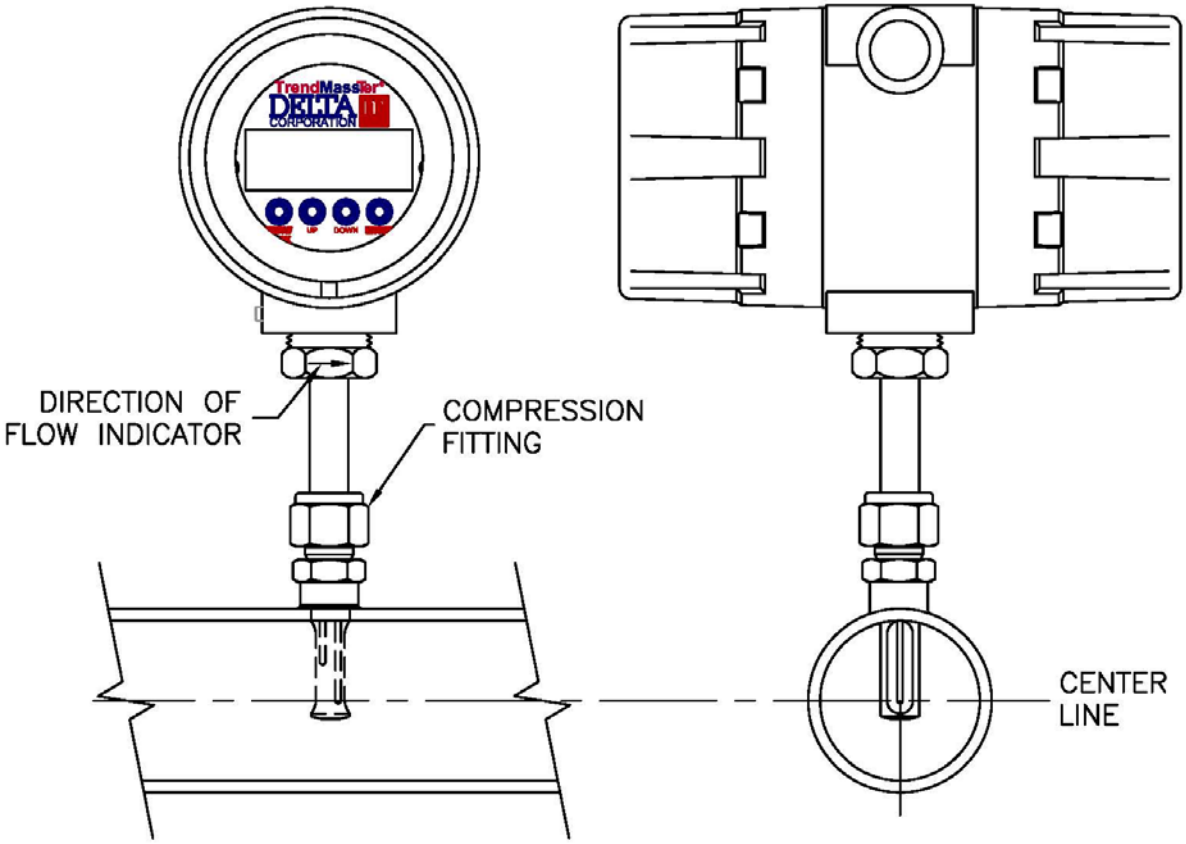


Figure 2.1: Probe Installation

NOTE: The probe and electronics are calibrated as a matched set. The model and serial numbers are indicated on both the electronic enclosure and the probe enclosure in the case of a remote installation. Verify that they match before proceeding.

The electronics should be located in an environment where the temperature is within the range of -20 to 85°C (-4 to 185°F) for a blind (no display) unit or -20 to 70°C (-4 to 158°F) for an integral (display) unit. **Watertight seals must be provided for wiring to the enclosure. For optimum operation power and signal leads must be in separate conduits.**

For remote installations use the optional mounting bracket provided for the enclosure to mount the electronics to a suitable surface. Elevated temperatures, excessive vibration or better accessibility of the electronics may necessitate remoting the electronics.

2.4 ELECTRICAL INSTALLATION

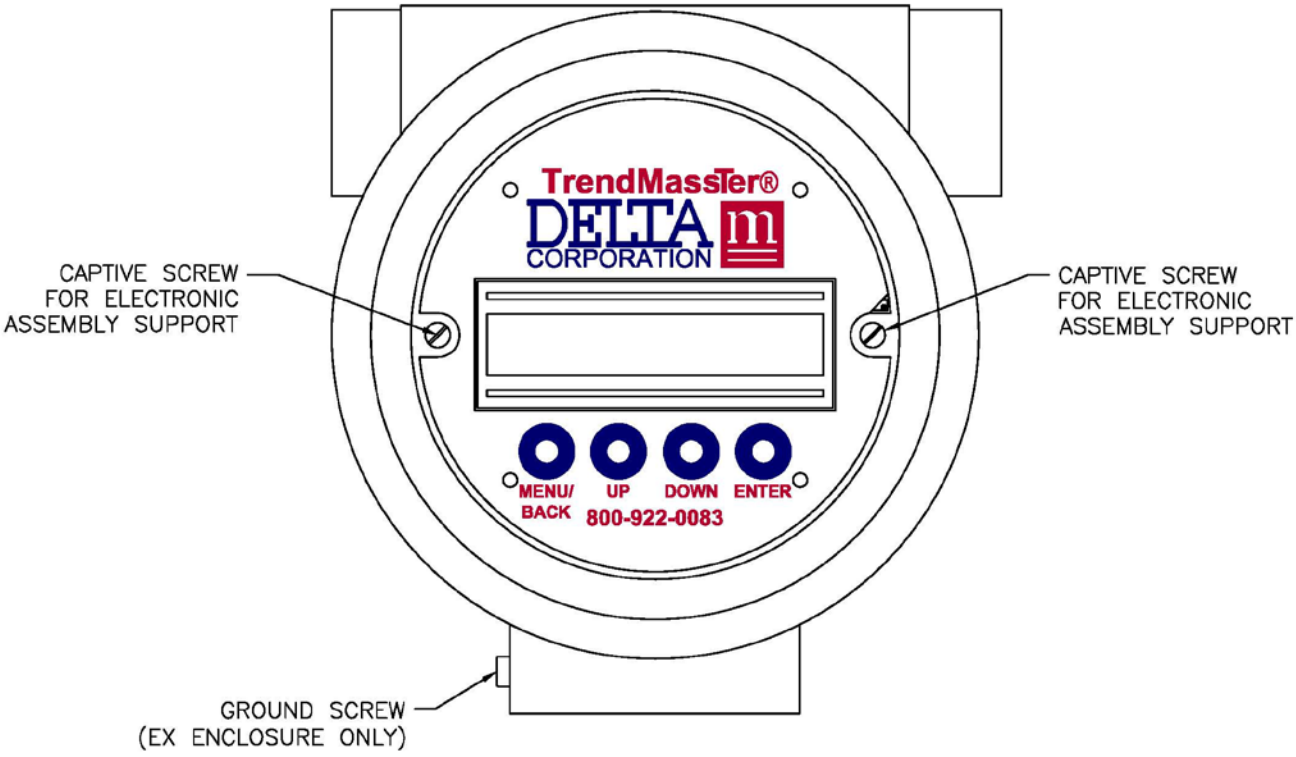


Figure 2.2: TrendMassTer® Electronics Inside the Enclosure

Figure 2.2 shows the electronics side of the double sided head. The enclosure cover has a glass window so that the LCD is visible to provide flow and temperature indication. The cover must be removed if access to the keypad is required. It can be removed by unscrewing in a counterclockwise direction.

The field side of the enclosure is shown in Figure 2.3, for 18-30 VAC power input, and Figure 2.4, for 24 VDC power input. The lid must be removed to gain access to power, communication, transmitter, switch outputs and sensor input connections. It can be removed by unscrewing the electronics cover in a counterclockwise direction.

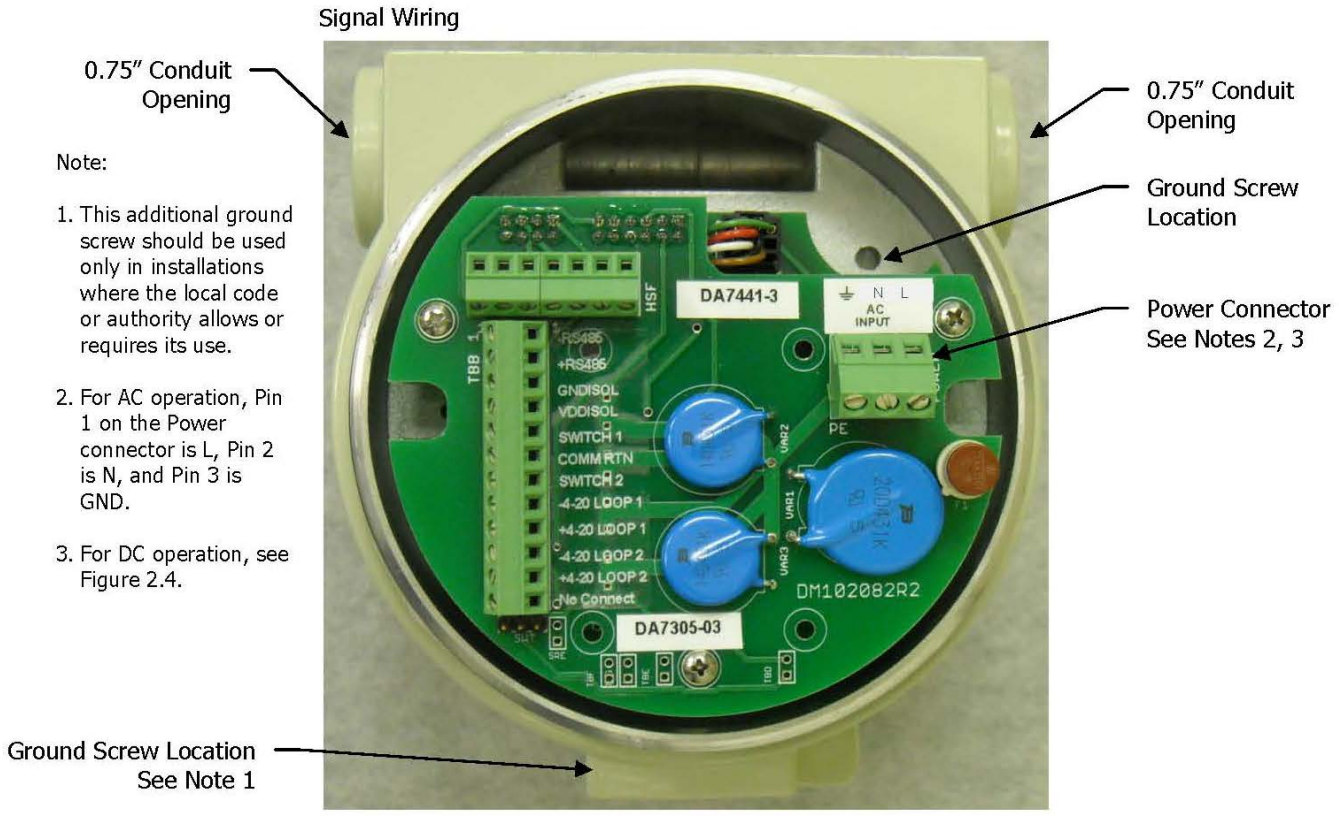


Figure 2.3: TrendMassTer® 18-30 VAC Fieldside Connections Inside the Electronics Enclosure

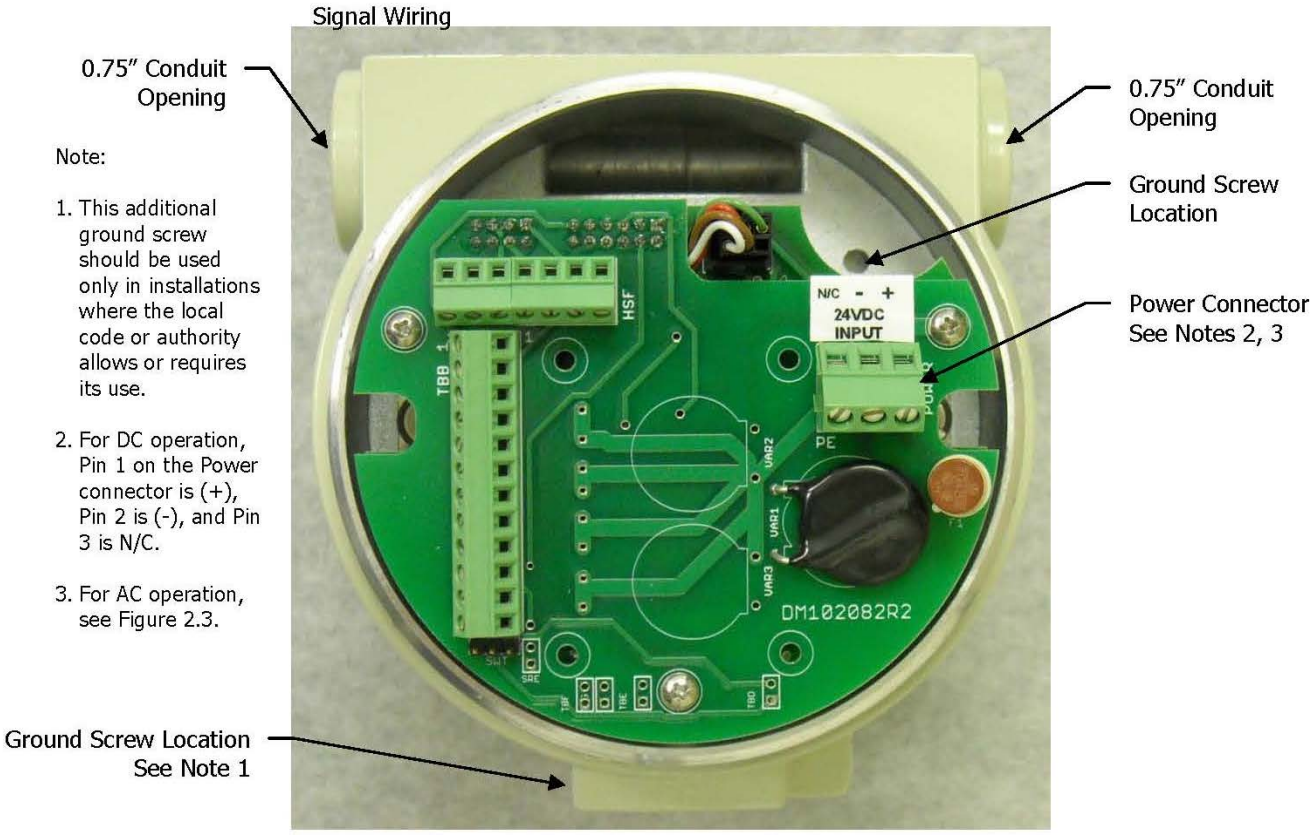


Figure 2.4: TrendMassTer® 24 VDC Fieldside Connections Inside the Electronics Enclosure

2.4.1 Field Power Wiring

NOTE: Ensure power to electronics is disconnected before installing or removing probe.

Figures 2.5 and 2.6 show the various field wiring connections for input power. Figure 2.8 shows the wiring connections for output signals.

The small terminal block labeled POWER on the right side of the connector plate (Figure 2.5) is where the power wiring will be connected. A 14 gauge wire is the maximum size this connector will accommodate. Smaller gauge wire may be used depending upon the distance from the installation to the power source.

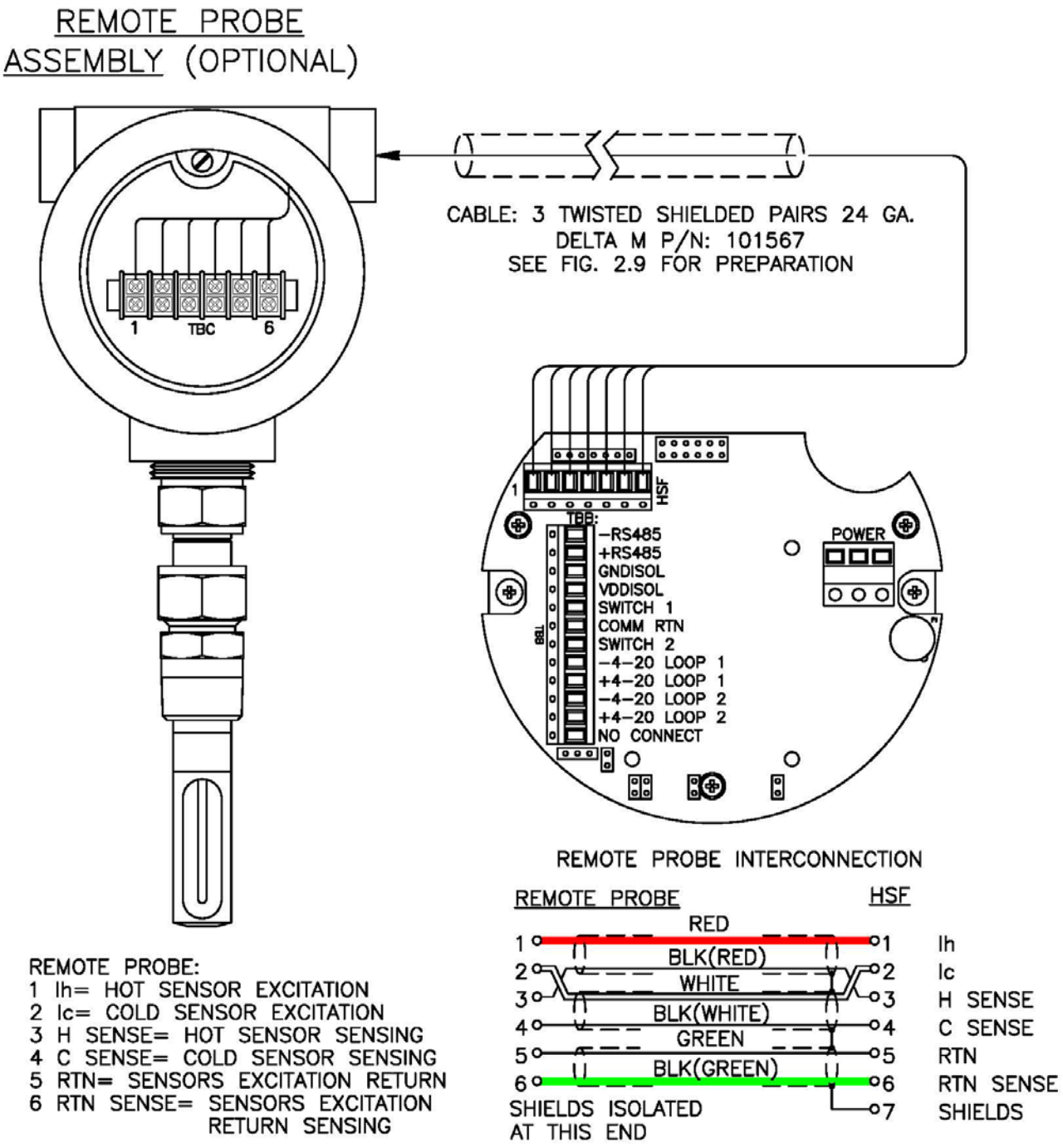


Figure 2.5 TrendMassTer® Field Wiring For Remote Probe

For DC operation, wire the Positive to the (+) terminal and Negative to the (–) terminal.

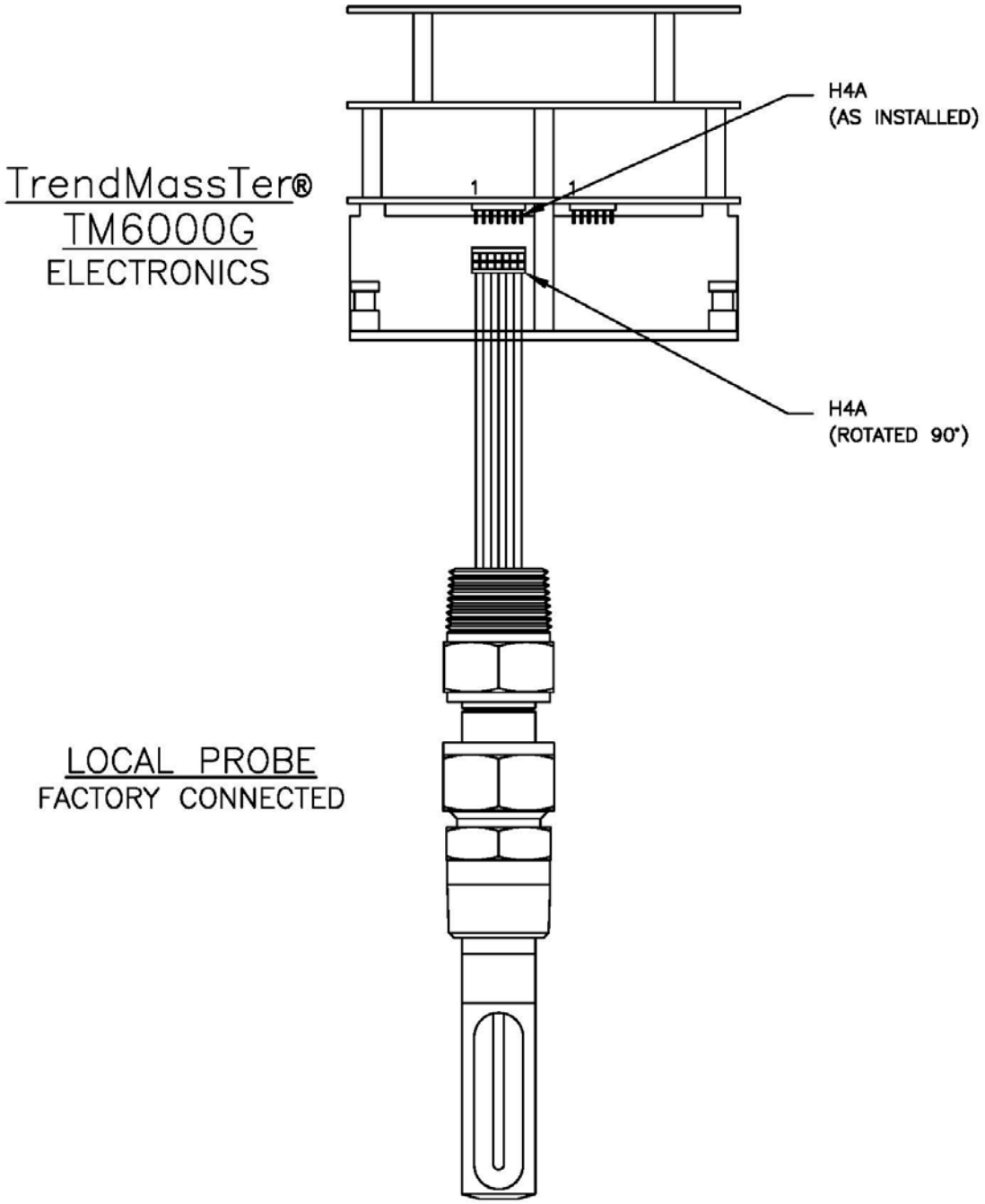


Figure 2.6 TrendMassTer® Local Probe Field Wiring

In the Local Electronic (LE) configuration the sensor probe wiring to terminal block TBA is factory wired as shown in Figure 2.6. For Remote Electronics (RE) see Figure 2.5 and Section 2.4.2.

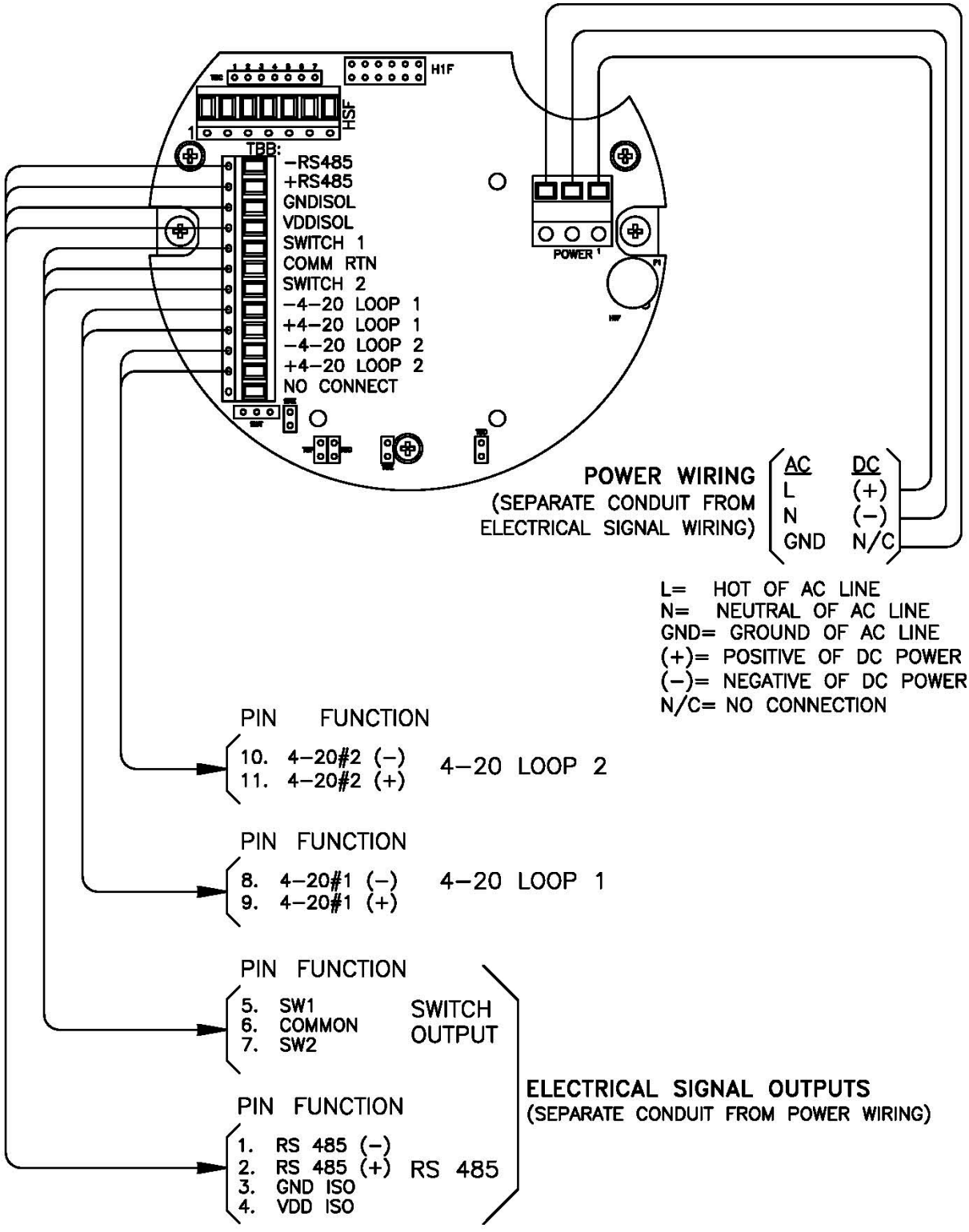


FIGURE 2.7: TrendMassTer® Power And Signal Outputs Wiring

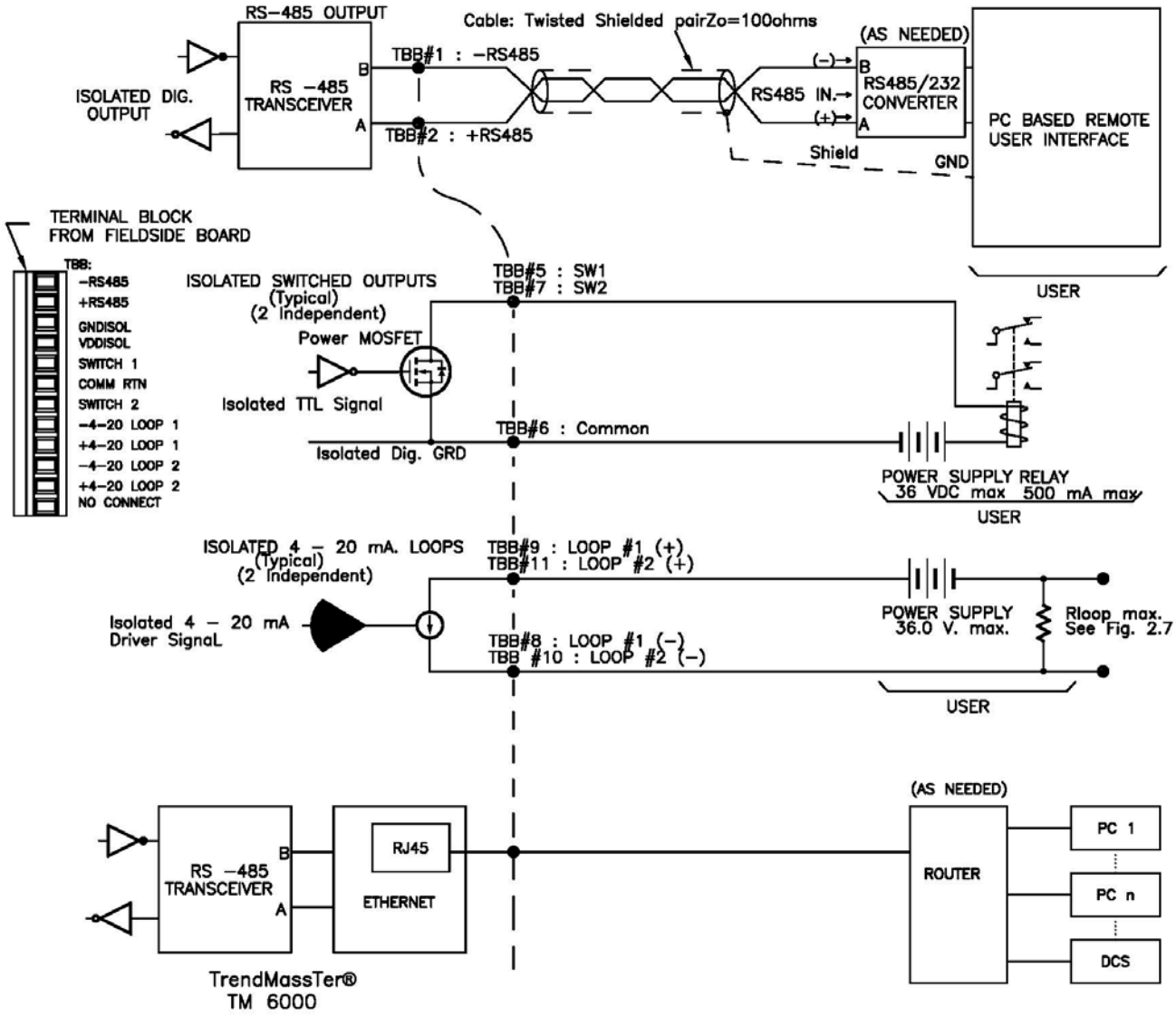


Figure 2.8: TrendMassTer® Outputs Wiring

2.4.2 Remote Electronics (RE) Sensor Probe Wiring

NOTE: Ensure power to electronics is disconnected before installing or removing probe.

The Remote Probe (RP) must be wired through approved conduit with a three pair twisted shielded cable provided with the RE option. Use Figure 2.9 as a guide to prepare the remote cable assembly.

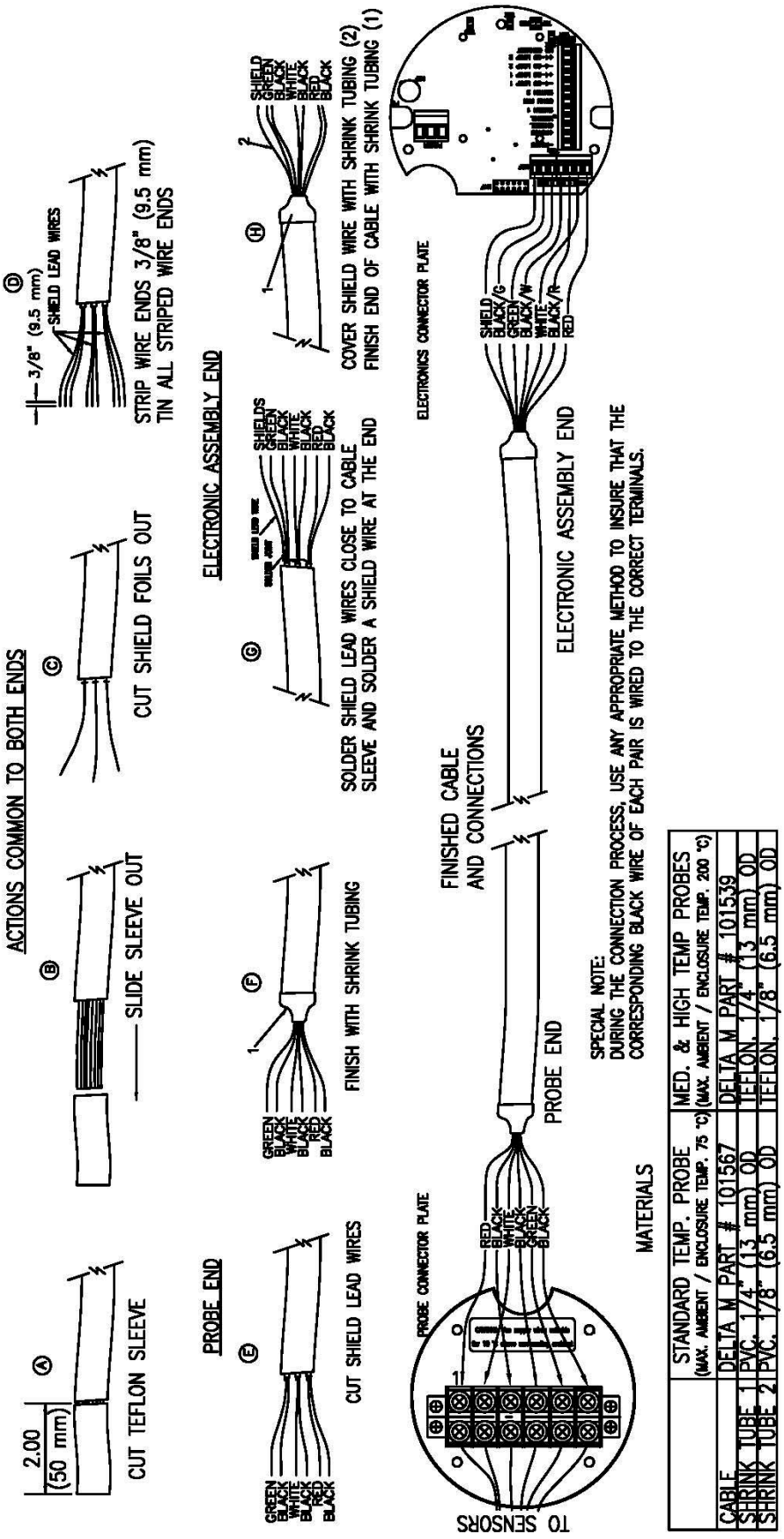


Figure 2.9: Remote Electronics Cable Termination and Connections

Using Figures 2.7 and 2.9 as guides, connect the six wires from terminal block HSF in the Remote Electronic (RE) enclosure to terminal block TBC in the Remote Probe (RP) enclosure. The terminals are labeled 1 through 6 and the wires are color coded.

NOTE: The shields of the three paired wires must be isolated and <u>not</u> connected at terminal block TBC of the Remote Probe (RP) enclosure. However, at the Remote Electronic (RE) enclosure, these 3 shields <u>must</u> be tied together and wired to terminal 7 of terminal block HSF.

2.4.3 Output Signal Wiring

There are dual, isolated open drain outputs for switching relays and 4-20 mA current Loops as well as a single RS-485 output or an optional Ethernet output. The electrical output signal wiring is to terminal block TBB at the left side of the electronic board shown in Figure 2.7.

NOTE: The electrical output signal wiring must be run in a separate conduit from the electrical power wiring.

Using Figures 2.5 and 2.8 as guides, choose the desired outputs for the application and carefully connect wiring to the appropriate terminals shown. Terminal no.12 of TBB is not used.

NOTE: The isolated 4-20mA output loops are externally powered. For normal operation 6V to 36 V DC power is supplied by the user. The maximum loop resistance is dependent upon the supply voltage which is provided in Figure 2.10. R_{MAX} can be obtained from the plot of Figure 2.10 based on supply voltage or can be calculated from: $R_{MAX} = 50*(V_{SUPPLY}-6.0V)$ Connect the external supply and load as shown in Figure 2.8.

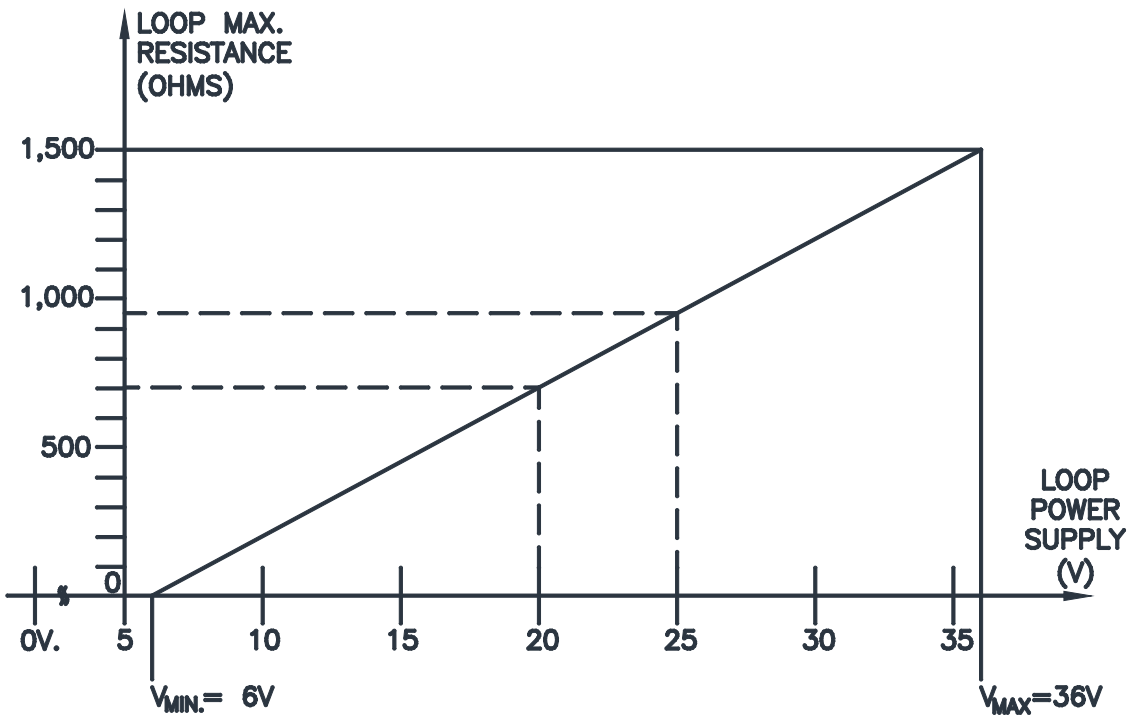


Figure 2.10: Maximum Loop Resistance vs. Supply Voltage

The RS-485 Digital Output requires a twisted shielded pair cable with a characteristic impedance of 100 ohms. **The shield must be grounded at the user interface end of the cable and isolated at terminal TBB of the TM6000 electronics.**

NOTE:	**When the RS-485 and Switched Outputs (SW1/SW2) are used simultaneously in an application, it is important that the user interface ground be connected to the common (-) connection of the relay power supply to avoid a ground loop. The maximum voltage of the Relay Power Supply should be 20 V. DC.**

3.0 OPERATION

This instrument has two modes of operation: Measurement mode and Programming mode. When the Keypad MENU/BACK button is pushed, operation is switched from the Measurement mode to the Programming mode. When in Measurement mode the instrument is performing mass flow, and volume flow measurements along with an associated temperature measurement.

Programming mode is used for configuring the instrument. After configuring the settings, users should exit to Measurement mode for flow and temperature measurements to resume. The instrument returns to measurement mode from programming mode automatically in three and half minutes if there is no activity on the keypad. Mass flow, Volume flow, Temperature, Sensor current and Total flow measurements are stopped when user enters into the CONFIG, OUTPUTS, ADVANCED or DIAGNOSTICS menus. These measurements continue if the user enters into the VIEW menu only. However if the user enters into CONFIG, OUTPUTS, ADVANCED and DIAGNOSTICS menus and then enters into the VIEW menu the measurements are stopped.

When programming switch set points and transmitter 4 mA and 20 mA values an error check is performed on the entered value. If the value is out of range then “invalid entry” is flashed on the display and the user is returned to the switch set points menu or the 4 mA/20 mA setting menu.

When Total flow computations are enabled the total flow for the selected primary variable will be computed (i.e. mass or volume). In addition if the units of measurement are changed Total flow will automatically rescale the value to reflect the units selected. Similarly if the primary variable is changed while Total flow is enabled, Total flow will be cleared to zero before measurements resume. Total flow is not computed when the primary variable selected is sensor current. Total flow also has a start delay of 0 seconds. This can be changed using the TM6000 Remote User Interface to be between 0-9 seconds for gas meter model TM6GNX.

Configuring operation consists primarily of using the LCD display/keypad or Delta M’s Remote User Interface Program to configure the instrument for the user’s specific requirements. In most cases the user’s settings will be loaded into the instrument at the factory so the unit will operate from power-up with these settings. The next several sections discuss the user interface using the LCD/Keypad. The Remote User Interface Program operates with the same menu structure. It is covered in Section 3.4 of this chapter.

The user interface is intuitive and can be operated with little instruction, but more versatility is gained by reviewing the following information.

3.1 LCD DISPLAY AND KEYPAD

The keypad consists of four push button switches; UP, DOWN, ENTER and MENU/BACK as described below. All programming functions are input using the Keypad and all responses are indicated on the LCD.

KEYPAD

UP	UP arrow: Scroll to previous menu item at the same level or used for incrementing a digit during numerical entries.
DOWN	DOWN arrow: Scroll to next menu item at the same level or used for decrementing a digit during numerical entries.
ENTER	ENTER: Enter the current menu level or confirm the selection of the current menu item or enter the current digit during numerical entry.
MENU/BACK	MENU: Menu allows entry into Programming mode from Measurement mode, or allows users to exit sub level or main levels of the menu.

3.2 MENU ORGANIZATION

The MENU is structured into four levels. Each succeeding level provides a subset of functions from the level above it. Figures 3.1 through 3.6 delineate the MENU organization from a block diagram perspective, while Tables 3.1 through 3.7 describe the functional operation of the MENU.

MENU Level 1 is divided into five groups:

CONFIG	Configures mass flow units, volume flow units, temperature units, media and line size
OUTPUTS	Configures loops, switches, display and totalizer
VIEW	View loop and switch set points with units, mass flow units, volume flow units, temperature units, media, line size, alarm status and tag values
ADVANCED	Allows users to trim the loop zero and full scale values to adjust for any loop or hardware tolerances, set user defined password, enable or disable password protection and reset user settings to default values.
DIAGNOSTICS	Allows user to validate the electronics against a factory calibration certificate.

Note: A password protection system restricts access to the menu if password protection is enabled. When the instrument is shipped password protection is disabled. Password is requested whenever the configuration, outputs or advanced menu modes are entered from the measurement mode and it can be changed to any four digit number. Password is not required to enter the view menu. If you have misplaced your password please call the factory for assistance (800-922-0083). Once enabled, password protection can be disabled from the advanced menu.

Figure 3.1 shows the Programming menu structure used in the TrendMassTer®. The UP and DOWN keys are used for scrolling through the items in each level, the ENTER key is used to make a selection at any level or to move to another level, and the MENU/BACK key is used to backup from a menu level, enter data or select a menu item. When at the main level (i.e. Level 1) selecting the MENU/BACK key places the instrument in Measurement mode.

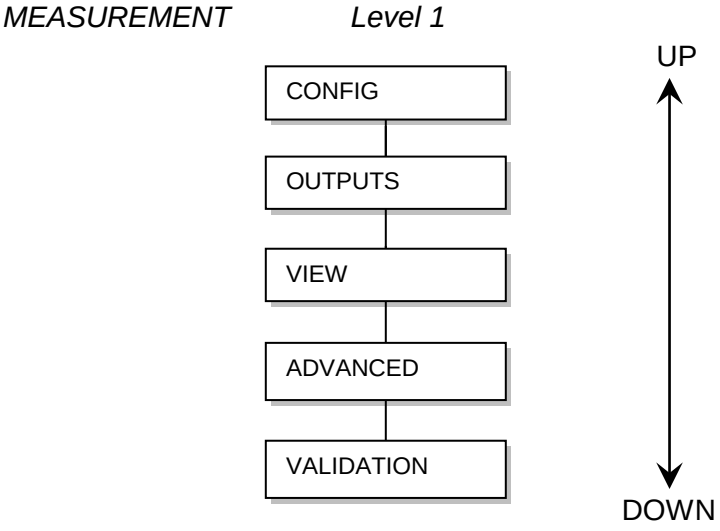


Figure 3.1: Level One Programming Menu Structure

Figure 3.2 Shows the CONFIGURATION MENU structure. Units for mass flow, volume and temperature as well as media and line size can be scrolled through with the UP and DOWN keys. For example, pushing ENTER when the LEVEL 2 items of MASS FLOW UNITS are displayed will move to its corresponding LEVEL 3 selection of specific units. LEVEL 3 is then scrolled with the UP or DOWN keys and a set of units is selected by pushing ENTER. Volume units, temperature units, media and line size are selected in the same way. Pressing the MENU/BACK key will place menu at the previous level.

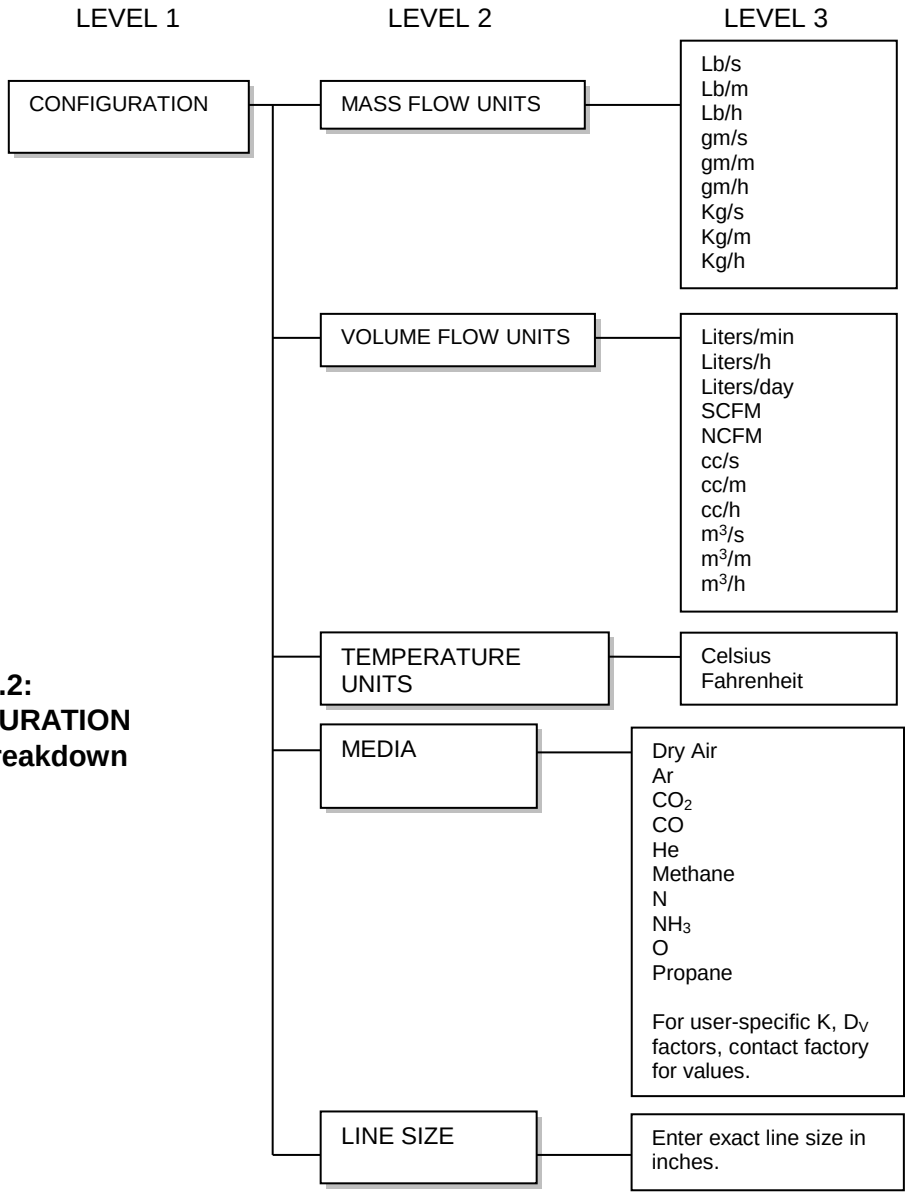


Figure 3.2: CONFIGURATION Menu Breakdown

Figure 3.3 Shows the OUTPUTS MENU structure. It has four levels. LEVEL 2 selects between Loop 1, Loop 2, Switch 1, Switch 2, Display and Totalizer. LEVEL 3 for the Loops selects between which variable to output, Ranging and Alarm settings. The Output settings are then set in LEVEL 4. Similarly, LEVEL 3 for the Switches selects between which variable, the Switch Setpoint and the Status; that is whether the switch is tripped when flow is higher or lower than the setpoint. The display output in LEVEL 2 selects whether mass, volume flow, or sensor current is displayed on the LCD. The Totalizer output lets the user Enable, Disable, or Reset the Totalizer.

Figure 3.4 shows the VIEW MENU structure. The View function lets the user display the TAG number, Media, Line Size, Loops, Switches, Alarm, Mass flow units, Volume flow units, Temperature units and Software Version.

Figure 3.5 shows the ADVANCED MENU structure. Loop 1 and 2 zero and full scale values can be trimmed and a password can be set or a password feature can be cancelled or enabled.

Figure 3.6 shows the DIAGNOSTICS MENU structure. Validate 1, Validate 2 and Validate 3 perform electronics validation against the factory supplied calibration certificate.

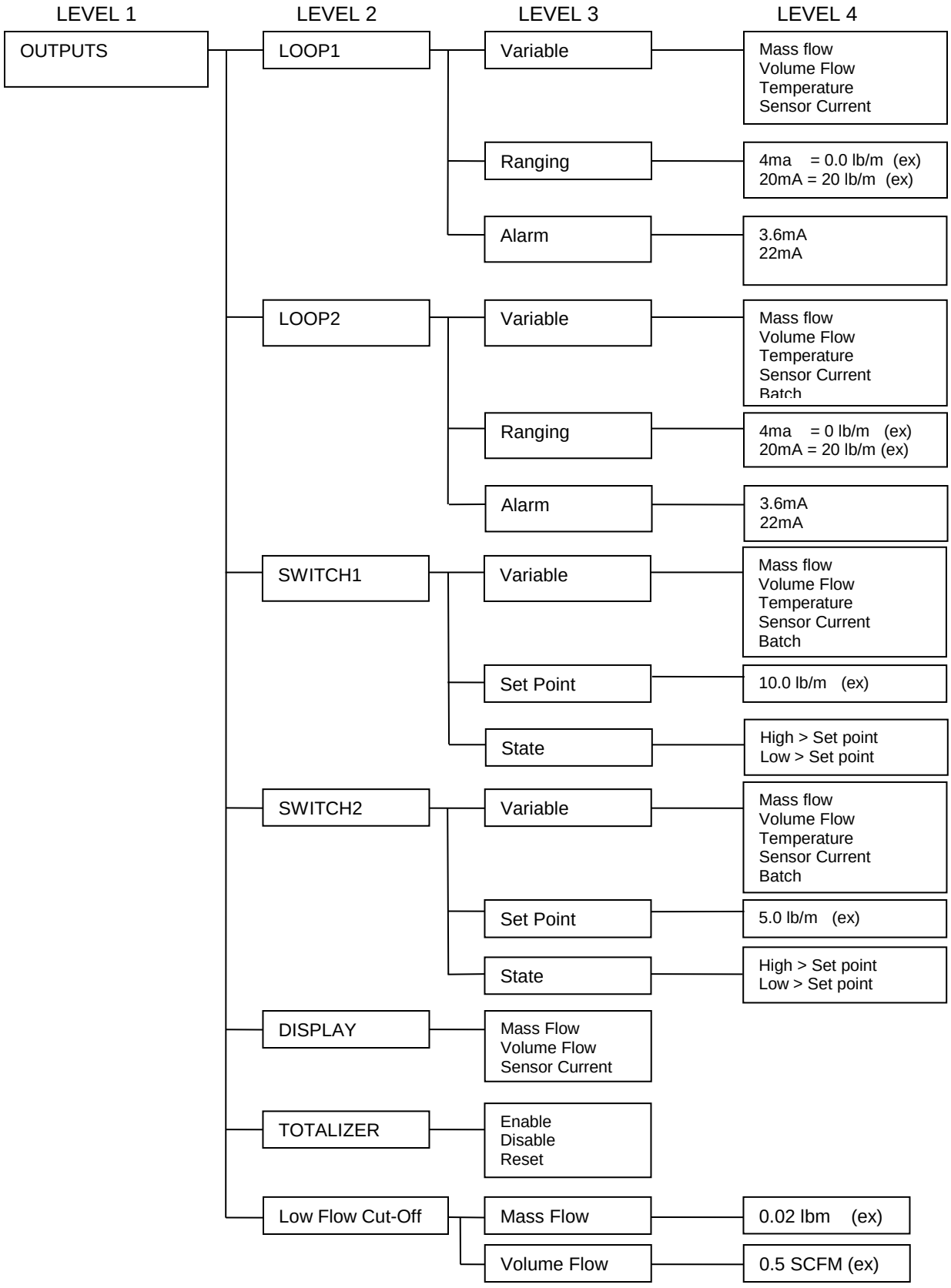


Figure 3.3: OUTPUTS Menu Breakdown
(ex) indicates an example setting rather than a default setting.

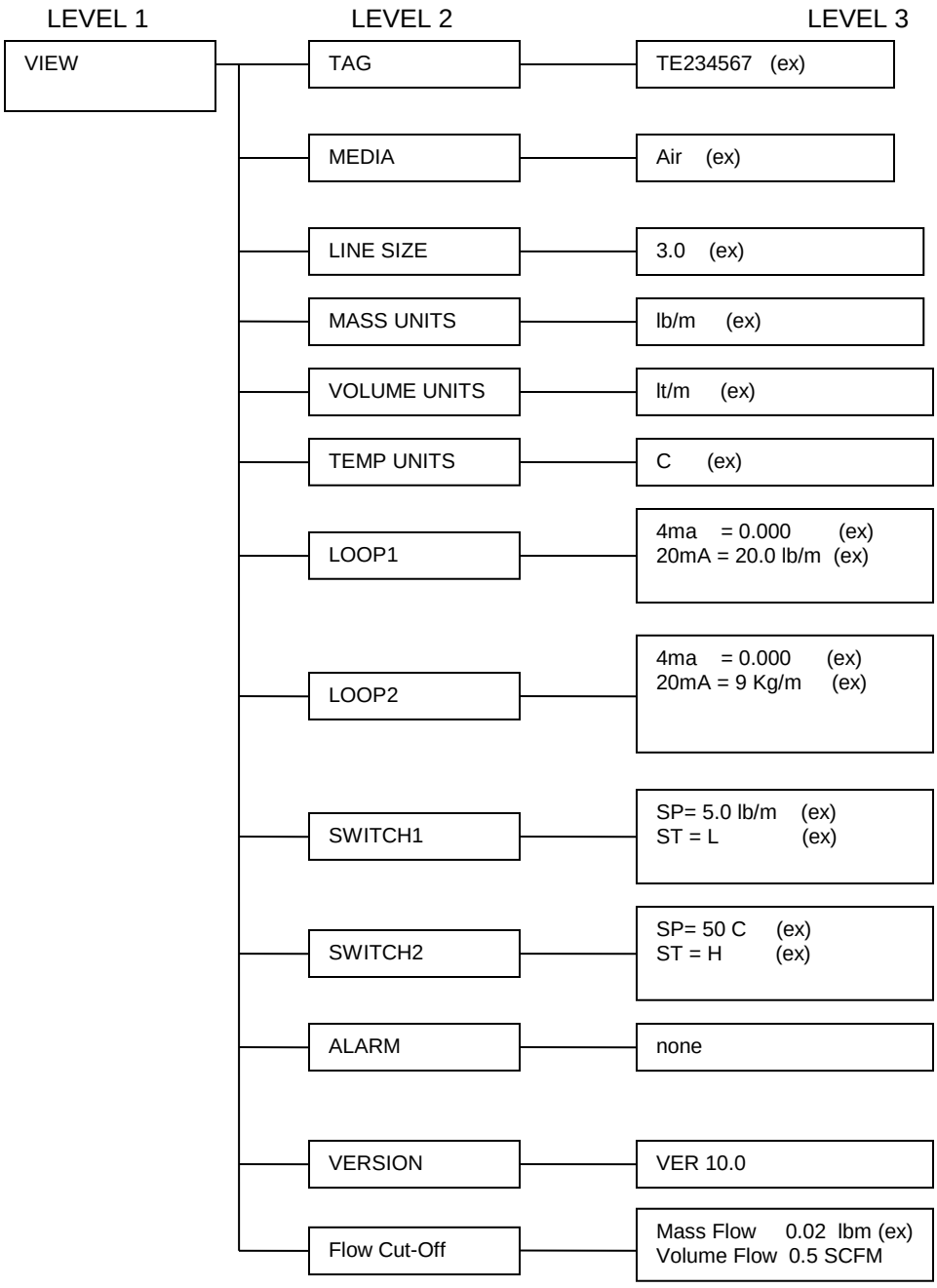


Figure 3.4: VIEW Menu Breakdown.
(ex) indicates an example setting rather than a default setting

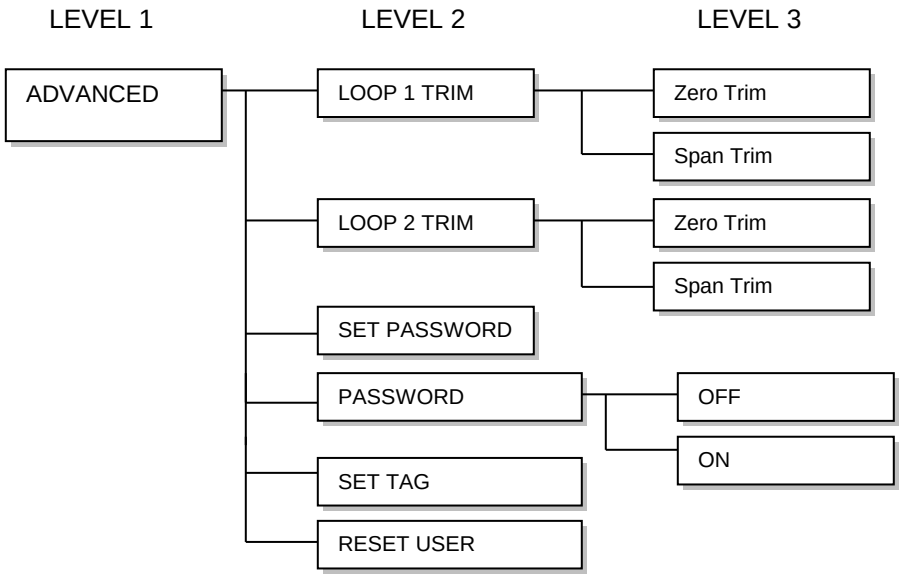


Figure 3.5: ADVANCED Menu Breakdown.

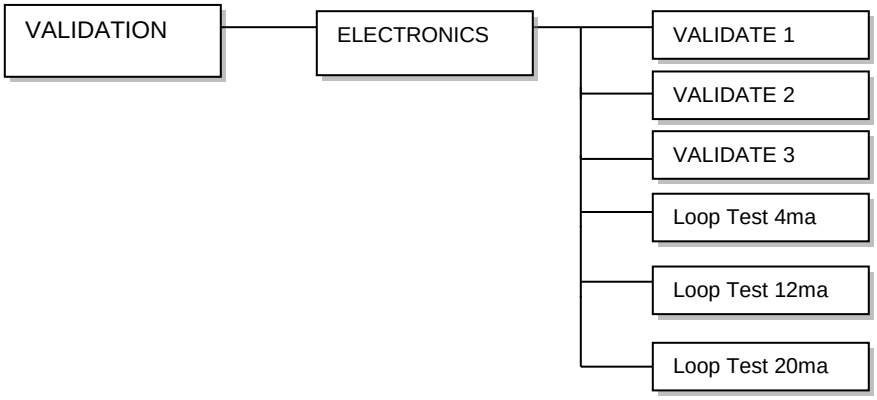


Figure 3.6: VALIDATION Menu Breakdown

3.3 MENU FUNCTIONAL DESCRIPTION

The following Tables define the selection available from the main menu from Level 1 through Level 3 where applicable. The Display column shows the Level 1, 2, or 3 item displayed and the columns to the right detail the options and resulting actions from selecting and option.

LEVEL 1		
Display	**Option**	**Action for ENTER key**
CONFIG	Press ↑ or ↓ to step through level 1 or press ENTER key to enter CONFIGURATION menu	Enter configuration sub menu
OUTPUTS	Press ↑ or ↓ to step through level 1 or press ENTER key to enter OUTPUTS menu	Enter outputs sub menu
VIEW	Press ↑ or ↓ to step through level 1 or press ENTER key to enter VIEW menu	Enter view sub menu
ADVANCED	Press ↑ or ↓ to step through level 1 or press ENTER key to enter ADVANCED menu	Enter advanced sub menu
DIAGNOSTICS	Press↑ or ↓ to iterate through level 1 or press ENTER key to enter DIAGNOSTICS menu	Enter diagnostics sub menu

Table 3.1: Level 1 Functional Menu

Level 2 menu provides system configuration options. Mass, Volume and Temperature are always measured and available. Default values mass, volume or temperature is the first item in the choice list.

LEVEL 2 - CONFIGURATION			
Display	**Option**	**Action for ENTER key**	**Choices**
PASSWORD	Press ↑ or ↓ to increase or decrease the digits, ENT to accept the digit	At the end of the last character being entered the system enters CONFIGURATION mode.	
Mass Flow Units	Press ↑ or ↓ to select next item in Level 2 or ENT to obtain mass flow unit selections **SEE CAUTIONS BELOW**	Cycle through the units using the ↑ or ↓ keys and ENT to select a unit. If MENU key is selected then go to Mass Flow Units	lb/m, lb/s, lb/h, kg/m, kg/s, kg/h, gm/s, gm/m, gm/h
Volume Flow Units	Press ↑ or ↓ to select next item or ENT to obtain volume flow unit selections **SEE CAUTIONS BELOW**	Cycle through the units using the ↑ or ↓ keys and ENT to select a unit. If MENU key is selected then go to Volume Flow Units	lt/m, lt/h, lt/d, m^3/s, m^3/m, m^3/h, cc/s, cc/m, cc/h SCFM, NCFM
Temperature Units	Press ↑ or ↓ to select next item or ENT to obtain volume flow unit selections	Cycle through the units using the ↑ or ↓ keys and ENT to select a unit. If MENU key is selected then go to Temperature Units	C, F
Media	Press ↑ or ↓ to select next item or ENT to obtain volume flow unit selections	Cycle through the units using the ↑ or ↓ keys and ENT to select a media. If MENU key is selected then go to Media	Dry Air, Ar, CO_2, CO, He, Methane, N_2, NH_3, O_2, Propane; For user-specific K, D_V factors - contact factory for values.
Line Size	Press ↑ or ↓ to select next item or ENT to obtain volume flow unit selections	Cycle through the units using the ↑ or ↓ keys and ENT to select a media. If MENU key is selected then go to Line Size	Actual line size in inches

Table 3.2: Level 2 CONFIGURATION Functional Menu

****CAUTION****

<u>CHOICE OF ANY OF THE UNIT COMBINATIONS BELOW WILL CAUSE DISPLAY OVERRUN</u>:

1. **Do not choose lb/h (pounds/hour) unit for mass flow if line size is greater than 8 inches**
2. **Do not choose lt/d (liters/day) unit for volume flow if line size is greater than 2 inches**

Level 2 Output settings allow the user to select either mass or volume to the display and allows the user to assign either mass, volume or temperature to any of the two loops or two switches.

LEVEL 2 - OUTPUT			
Display	**Option**	**Action after ENTER key**	**Operations**
PASSWORD	Press ↑ or ↓ to increase or decrease the digits, ENTER to accept the digit	At the end of the last character being entered the system enters OUTPUT mode.	
LOOP 1	Press ↑ or ↓ to select next item or ENTER to perform LOOP 1 operations	Cycle through the operations using the ↑ or ↓ keys or ENTER to select an operation	Variable Assignment, Ranging, Alarm Setting
LOOP 2	Press ↑ or ↓ to select next item or ENTER to perform LOOP 2 operations	Cycle through the operations using the ↑ or ↓ keys or ENTER to select an operation	Variable Assignment, Ranging, Alarm Setting
SWITCH 1	Press ↑ or ↓ to select next item or ENTER to perform SWITCH 1 operations	Cycle through the operations using the ↑ or ↓ keys or ENTER to enter one of the operations	Variable Assignment, Set Point, Action State
SWITCH 2	Press ↑ or ↓ to select next item or ENTER to perform SWITCH 2 operations	Cycle through the operations using the ↑ or ↓ keys or ENTER to enter one of the operations.	Variable Assignment, Set Point, Action State
PRIMARY VARIABLE	Press ↑ or ↓ to select next item or ENTER to obtain choices for display	Cycle through the options using the ↑ or ↓ keys or ENTER to select one of the choices	Mass Flow, Volume
TOTALIZER	Press ↑ or ↓ to select next item or ENTER to obtain choices for Totalizer.	Cycle through the Total Flow functions using ↑ or ↓ keys. Press ENTER key to implement a function	On, Off and Clear

Table 3.3: Level 2 OUTPUT Functional Menu

Level 3 Output operations allow the loop and switches to be configured for control variable, alarm, calibration and set points.

LEVEL 3 – OUTPUT Operations for Loop 1 & 2			
Display	**Option**	**Action after ENTER key**	**Choices**
Variable	Press ↑ or ↓ to select next item or ENTER to select control variable	Cycle through the control options. using the ↑ or ↓ keys or ENTER to select a control option	Mass Flow, Volume, Temperature
Ranging	Press ↑ or ↓ to select next item or ENTER to set 4-20mA calibration points	Cycle through the options using the ↑ or ↓ keys or ENTER to select 4mA or 20mA calibration and then enter calibration data	4mA, 20mA
Alarm	Press ↑ or ↓ to select next item or ENTER to select alarm choices	Cycle through the choices using the ↑ or ↓ keys or ENTER to select one of the alarm states	3.6mA, 22mA

LEVEL 3 – OUTPUT Operations for Switches 1 & 2			
Display	**Option**	**Action after ENTER key**	**Choices**
Variable	Press ↑ or ↓ to select next item or ENTER to select control variable	Cycle through the control options. using the ↑ or ↓ keys or ENTER to select a control option	Mass Flow, Volume, Temperature
Set Point	Press ↑ or ↓ to select next item or ENTER to set switch set point	Enter the switch set point	
Status	Press ↑ or ↓ to select next item or ENTER to select status choices	Cycle through the choices using the ↑ or ↓ keys or ENTER to select one of the switch states	hi > Set Point, lo > Set Point

Table 3.4: Level 3 Output Functional Menu for Loops and Switches

Level 2 VIEW menu allows users to view the current instrument configuration settings in one location.

LEVEL 2 – VIEW		
Display	**Option**	**Action after ENTER key**
Tag	Press ↑ or ↓ to select next item or ENT to obtain the tag	Tag is displayed
Media	Press ↑ or ↓ to select next item or ENT to obtain current media	Media is displayed
Line Size	Press ↑ or ↓ to select next item or ENT to obtain current line size	Line size is displayed
Mass Units	Press ↑ or ↓ to select next item or ENT to obtain mass flow units	Mass flow units is displayed
Volume Units	Press ↑ or ↓ to select next item or ENT to obtain volume flow units	Volume flow units is displayed
Temperature Units	Press ↑ or ↓ to select next item or ENT to obtain temperature units	Temperature units is displayed
Loop 1	Press ↑ or ↓ to select next item or ENT to obtain loop 1 calibration values	Loop 1 calibration values are displayed
Loop 2	Press ↑ or ↓ to select next item or ENT to obtain loop 2 calibration values	Loop 2 calibration values are displayed
Switch 1	Press ↑ or ↓ to select next item or ENT to obtain switch 1 set point and action state	Switch 1 set point and action state is displayed
Switch 2	Press ↑ or ↓ to select next item or ENT to obtain switch 2 set point and action state	Switch 2 set point and action state is displayed
Alarm	Press ↑ or ↓ to select next item or ENT to obtain current alarm	Displays alarm numbers if any
Version	Press ↑ or ↓ to select next item or ENT to obtain software version	Software version is displayed

Table 3.5: Level 2 VIEW Functional Menu

Level 2 ADVANCED menu allows users to trim zero and full scale current values, set passwords, cancel passwords and enter tag values. Loop zero and span are trimmed using the UP and DOWN keys to set loop current to the desired value.

LEVEL 2 – ADVANCED			
Display	**Option**	**Action after ENTER key**	**OPERATIONS**
Loop 1 Trim	Press ↑ or ↓ to select next item or ENTER to perform Loop 1 trim operations	Cycle through the operations using the ↑ or ↓ keys or ENTER to select an operation	Zero Trim, Span Trim
Loop 2 Trim	Press ↑ or ↓ to select next item or ENTER to perform Loop 2 trim operations	Cycle through the operations using the ↑ or ↓ keys or ENTER to select an operation	Zero Trim, Span Trim
Set Password	Press ↑ or ↓ to select next item or ENTER to enter user password	Enter four digit password	
Password	Press ↑ or ↓ to select next item or ENTER to change password status between ON and OFF	OFF state is displayed. To move between OFF and ON state use ↑ or ↓ keys. To select one of the above states press ENTER key.	
Set Tag	Press ENTER to enter tag value	Cycle through the character A-Z and 0-9 using the ↑ or ↓ keys and the ENTER keys to accept the character.	
Reset User	Press ENTER to reset user default values	Mass flow, Volume flow, Temperature units are set to default units. Air is selected as media. Switch and Loop set points are set to default values and to default controlling variables.	

Table 3.6: Level 2 ADVANCED Functional Menu

LEVEL 2 – ADVANCED operations for Zero & Span Trimming		
Display	**Option**	**Action after ENTER key**
Zero Trim	Press ↑ or ↓ to select next item or ENTER to perform Zero trim operations	4mA is written to loop. Use ↑ or ↓keys to increase or decrease loop current. When desired value is reached press the ENTER key. If you want to retain the old value select the MENU key and the old value is retained.
Span Trim	Press ↑ or ↓ to select next item or ENTER to perform Span trim operations	20mA is written to loop. Use ↑ or ↓keys to increase or decrease loop current. When desired value is reached press the ENTER key. If you want to retain the old value select the MENU key and the old value is retained.

Table 3.7: Level 2 ADVANCED Zero and Span Trim

Level 2 Diagnostic settings allow the user to select electronics test.

LEVEL 2 – DIAGNOSTICS operations		
Display	**Option**	**Action after ENTER key**
Electronics Test	Press ENTER to perform electronics test operations	Select from Validate 1, Validate 2, Validate 3

Table 3.8: Level 2 DIAGNOSTICS Functional Menu

Level 3 Diagnostic settings allow the user to select one of three electronics test.

LEVEL 3 – DIAGNOSTICS operations for Electronics Test		
Display	**Option**	**Action after ENTER key**
Validate 1	Press ENTER to perform electronics test 1, or Press ↑ or ↓ to select next item	Electronics test 1 is actuated
Validate 2	Press ENTER to perform electronics test 2, or Press ↑ or ↓ to select next item	Electronics test 2 is actuated
Validate 3	Press ENTER to perform electronics test 3, or Press ↑ or ↓ to select next item	Electronics test 3 is actuated
Loop Test 4ma	Press ENTER to perform loop transmitter 4ma or Press ↑ or ↓ to select next item	Loop Transmitter 4ma test is enabled
Loop Test 12ma	Press ENTER to perform loop transmitter 12ma or Press ↑ or ↓ to select next item	Loop Transmitter 12ma test is enabled
Loop Test 20ma	Press ENTER to perform loop transmitter 20ma or Press ↑ or ↓ to select next item	Loop Transmitter 20ma test is enabled

Table 3.9: Level 3 DIAGNOSTICS operations Menu

3.4 REMOTE USER INTERFACE PROGRAM

The Remote User Interface Program is a Windows based software package supplied with the instrument that enables communication and configuration with the RS-485 or optional Ethernet link. It includes all the functions that can be performed using the keypad plus indication of calibration and configuration values, physical property coefficients and sensor constants as well as tabular and plotted indication of instrument outputs.

3.4.1 Installation of the Software Package

The Remote User Interface Program is contained on a CD supplied with the instrument. To install it, insert the disk into the appropriate drive on the PC and follow the instructions provided.

3.4.2 Description and Use of the Remote User Interface Program

The Remote User Interface Program is a Windows based software package supplied with the instrument that enables communication and configuration with the RS-485 or optional Ethernet link. It includes most of the functions that can be performed using the keypad plus indication of calibration, configuration values and sensor constants as well as tabular and plotted indication of instrument outputs.

The Remote User Interface (RUI) program is organized somewhat differently than the LUI Keypad. When the “mode” notation is highlighted, several options appear which include:

- All Registers
- Run
- Value Display
- Calibrate
- Show Log

The functions available for each of the options are described in the following sections.

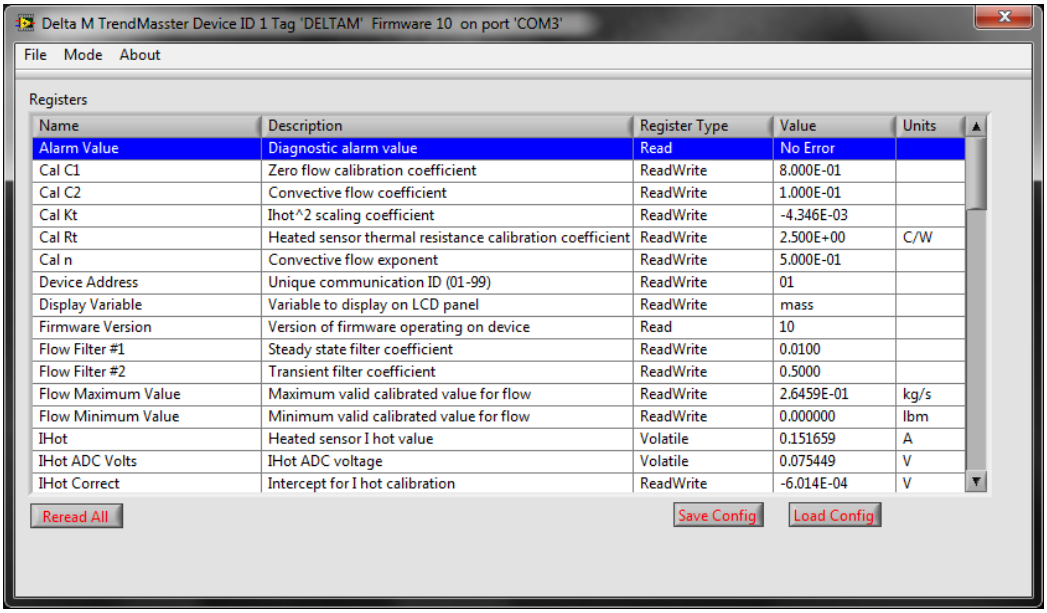
3.4.2.1 All Registers Panel

The All Registers panel is shown in Figure 3.7. The first column, “Name” provides all registers listed alphabetically. The second column “Description” provides a description of each register name. The third column “Register Type” indicates the type of register such as read, write, read/write or volatile. The last column indicates register units. Read/write registers can be updated as required and volatile registers (i.e. temperature or I_H value) are periodically updated.

The All Registers panel includes the same functions as the Keypad described in Section 3.0. The alphabetical organization is designed to enable quick location of a function to view or change. For example, all similar Loop registers are grouped together as:

Loop 1	Variable
Loop 1	4 mA
Loop 1	20 mA
Loop 1	Alarm
Loop 2	Variable
Loop 2	4 mA
Loop 2	20 mA
Loop 2	Alarm

This is true for most registers as that use becomes intuitive.
Table 3.10 includes a listing of the All Registers panel with register names in alphabetical order. It includes register number, register data type, register type, register value (values not shown), register display name and a short description of each register.



Name	Description	Register Type	Value	Units
Alarm Value	Diagnostic alarm value	Read	No Error	
Cal C1	Zero flow calibration coefficient	ReadWrite	8.000E-01	
Cal C2	Convective flow coefficient	ReadWrite	1.000E-01	
Cal Kt	Ihot^2 scaling coefficient	ReadWrite	-4.346E-03	
Cal Rt	Heated sensor thermal resistance calibration coefficient	ReadWrite	2.500E+00	C/W
Cal n	Convective flow exponent	ReadWrite	5.000E-01	
Device Address	Unique communication ID (01-99)	ReadWrite	01	
Display Variable	Variable to display on LCD panel	ReadWrite	mass	
Firmware Version	Version of firmware operating on device	Read	10	
Flow Filter #1	Steady state filter coefficient	ReadWrite	0.0100	
Flow Filter #2	Transient filter coefficient	ReadWrite	0.5000	
Flow Maximum Value	Maximum valid calibrated value for flow	ReadWrite	2.6459E-01	kg/s
Flow Minimum Value	Minimum valid calibrated value for flow	ReadWrite	0.000000	lbm
IHot	Heated sensor I hot value	Volatile	0.151659	A
IHot ADC Volts	IHot ADC voltage	Volatile	0.075449	V
IHot Correct	Intercept for I hot calibration	ReadWrite	-6.014E-04	V

Figure 3.7: ALL REGISTERS Panel

3.4.2.2 Calibration Values and Sensor Functions Panel

The Run Panel, shown in Figure 3.8, provides for output indications. It has options of mass or volume flow, Temperature, Totalizer output, I_H,SHREF, IHADC VOLTS, and SHREFADC VOLTS. Any of these can be selected to plot versus time.

An additional function, “Parameter Adjust”, enables user adjustment of specific functions or constants including Flow Filters #1 and #2, I_H CORRECT, I_H sense Resistor, mass flow units, media selection, Temp. Cal., Temp. units, Totalizer enable and reset, validate direct DAC enable and value, and volume flow units. When a plot option has been chosen, one of the above Parameter Adjust functions or constants can be changed to change the indications on the plot. A digital readout indicator also indicates the plotted value. An example of use of this is adjustment of Temperature to match a calibrated loop Temperature using Temp Cal.

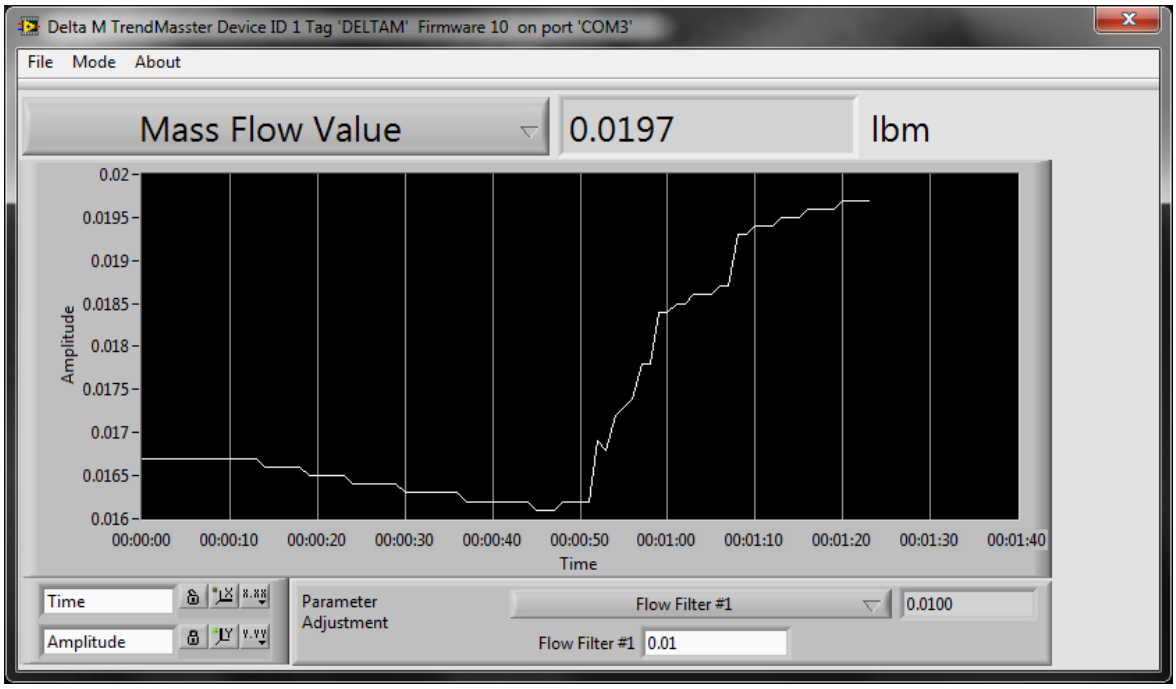


Figure 3.8: Run Panel

3.4.2.3 Value Display Panel

The Value Display panel, shown in Figure A2.3 provides for simultaneous display of mass flow, volume flow, Temperature and Totalizer. Units can be chosen for mass and volume flow and Temperature. A Totalizer clear button is also included

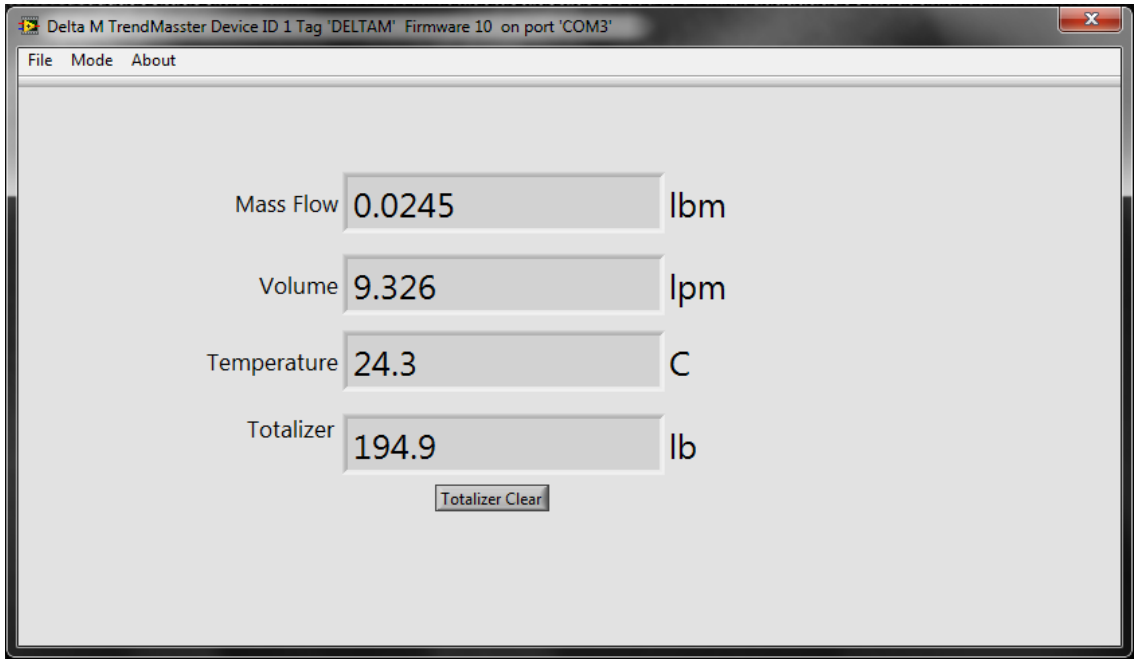


Figure 3.9: VALUE DISPLAY Panel

3.4.2.4 Calibrate Panels

The Calibrate panel, shown in Figure A2.4, enables the factory to calibrate the instrument. The device constants are displayed for the installed sensor. Calibration is using the “Set Point” button. The calibrated mass flow value, IH and temperature are loaded into the calibration file for each point when the “Add Point” button. The calibrated mass flow value, IH, and temperature are loaded into the calibration file for each point. After all required values are imported, the “calibrate” button is activated. This results in completion of a non linear regression of the data to calculate the calibration values, which are indicated after the regression is complete.

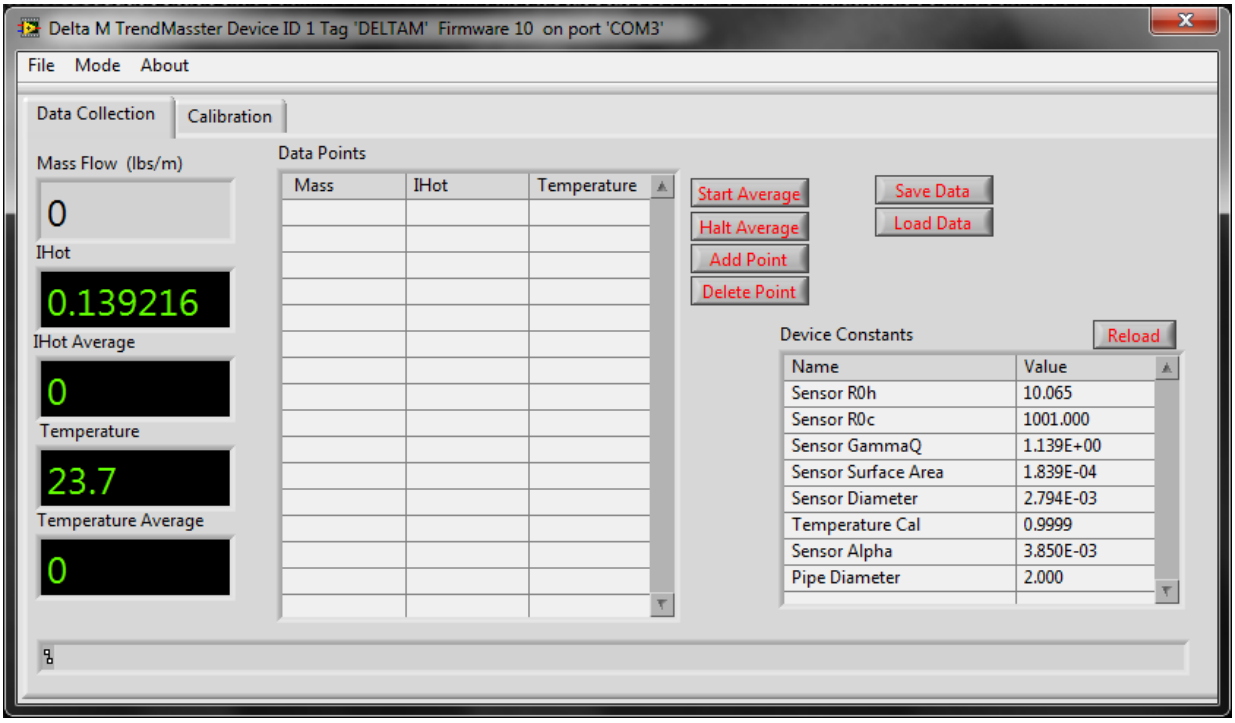


Figure 3.10A: Calibrate Panel

The calibration panel, shown in Figure 3.10B, includes plots of the calibrations and indicates all calibration constants. It provides a measure of the “goodness of fit” model to the calibration data.

3.5 INSTRUMENT VALIDATION

The sensor probe and electronics can be independently validated. If needed, these validation procedures can be performed to confirm that the instrument is working properly and within calibration specifications.

Sensor validation must be completed first. It is accomplished by measuring the resistance of the mass flow and reference sensors, calculating their temperatures using NIST-

traceable sensor constants supplied with the flowmeter and comparing the temperature calculations.

The electronics are validated by using the LCD display/Keypad or Remote User Interface Program to provide a known input to the validated sensors and confirm that the value provides expected values of mass flow and temperature. This test confirms that the analog input electronics, current sources, analog-to-digital converter, microprocessor and mass flow/temperature computation software are all operating within specifications.

****CAUTION****

The sensor must be immersed in fluid during the validation process. If the sensor surface is dry, the sensor may be damaged.

The following equipment and documents are required to perform the validation procedure:

- A digital multimeter with the ability to read with a resolution of 0.01 ohms or better
- The Delta M calibration certificate provided with the instrument.
- A digital multi-meter that can read current between 0-25ma.
- A DC power supply source that can provide at least 9VDC up to a maximum of 36VDC at 50ma.

3.5.1 Sensor Probe Validation

1. Turn the multimeter on and let it warm up for a minimum of five minutes.
2. Turn power to the flow meter off. Allow a minimum of two minutes for the mass flow sensor to reach ambient temperature.
3. Remove the enclosure field side cover.
4. With the multimeter on ohms and the range on automatic or low ohms, short the leads and read and record the meter lead resistance.
5. Locate terminal HSF. With the multimeter on ohms and the range on automatic or low ohms, connect the leads to terminals 1 and 3. Read and record the sensor lead resistance.
6. Move the multimeter leads to HSF terminals 3 and 5. Read and record the mass flow sensor plus lead resistance.
7. Move the multimeter to HSF terminals 4 and 5. Change to a resistance range capable of reading 1K ohm if needed. Read and record the reference sensor plus lead resistance.
8. To obtain the mass flow and sensor resistances subtract meter lead and sensor lead resistances from the resistances obtained in steps 6 and 7. Record as R_H and R_C.
9. Using the R_O and alpha information for the sensor from the Delta M calibration certificate, calculate the temperature of the two sensors as follows:

$$T = \frac{R - R_O}{ALPHA * R_O}$$ Example: $$T = \frac{1090.0 - 1000.0}{0.00385 * 1000.0} = 23.38^{\circ}C$$

   Where
   - T = Temperature in degrees C
   - R = Measured resistance of mass flow or reference sensor (R_H or R_C)
   - R_O = Reference or mass flow or reference sensor resistance at zero degrees C (refer to Calibration Certificate)
   - ALPHA = Reference or mass flow sensor temperature coefficient (refer to Calibration Certificate)

10. Compare the two calculated values. If they are within 5 degrees C of each other, sensor validation is complete.
11. Disconnect multimeter and reinstall the field side enclosure cover.

3.5.2 Electronics Validation

1. Verify that the sensor is immersed in gas.
2. Turn the instrument on and allow five minutes for it to warm up.
3. Verify that the instrument is set to the calibration settings for media, line size and factory full scale listed on the Calibration Certificate. If the Loop outputs are to be checked, verify the loop settings also and ascertain that both loops are externally powered and connected to a calibrated multi-meter in mA mode. Select sensor current as the primary variable.
4. Using the LCD Display/Keypad, go to the DIAGNOSTICS menu and set the instrument to VALIDATE 1 or using the Remote User Interface (RUI) program, go to the VALIDATE mode and set the instrument to VALIDATE 1.
5. Read and record Temperature and sensor current on the LCD Display or RUI View Panel. Reset the instrument to VALIDATE 2 and repeat steps 3 and 4.
6. Reset the instrument to VALIDATE 2 and repeat steps 3 and 4.
7. Reset the instrument to VALIDATE 3 and again repeat steps 3 and 4.

8. Compare the readings with the INSTRUMENT VALIDATION SETTINGS on the Calibration Certificate. If they are within the specification of ±2% of reading, and ±0.2% of full scale, the instrument sensor control and data acquisition electronics have been validated.

3.5.3 Loop Transmitter Electronics Validation

1. Wire out one of the transmitter loops. Connect the DC power supplies positive input to the transmitter + connection, connect the transmitter – connection to the multi-meter + A terminal and finally connect the multi-meter's common terminal to the DC power supplies negative terminal. Turn on the DC power supply and turn on the meter.
2. The meter should be reading the current loop variables current.
3. Select the Diagnostics menu and select loop test 4ma. Verify that the meter reads 4ma±0.010ma. If the meter does not read 4ma contact the factory.
4. Now repeat the loop test for 12ma. Verify that the meter reads 12ma±0.010ma. If the meter does not read 12ma±0.004, contact the factory.
5. Repeat the final loop test for 20ma. Verify that the meter reads 20ma±0.010ma. If not contact the factory.

4.0 MAINTENANCE, TROUBLESHOOTING & REPAIR

4.1 SENSOR MAINTENANCE

The sensor probe can be cleaned by soaking, spraying solvents or detergent-and-water onto the sensor or by ultrasonic cleaning.

Lime deposits can be safely removed by soaking in 20% hydrochloric acid. Warming to 65°C (150°F) is permissible to speed this process.

For unusual cleaning problems, call DELTA M and determine the exact materials of construction and chemical compatibility before using strong acids or unusual cleansers.

****IMPORTANT****
DO NOT SANDBLAST OR ABRASIVE CLEAN THE SENSING PROBES. THE SENSING PROBES COULD BE DAMAGED BY ABRASIVES.

4.2 TROUBLESHOOTING AND REPAIR

4.2.1 Installation Verification

Before troubleshooting the instrument verify that facilities supporting the instrument are proper. Correct operation of the meter can be affected by any of the following:

A. Verify that power to the unit is of the correct voltage and polarity.
B. Verify mechanical installation is correct per section 2.3.
C. Verify that electrical installation is correct per section 2.4.

4.2.2 Instrument Diagnostics Resolution

If the flow meter display is indicating a diagnostic message on the display then use the table below for determining and correcting the problem.

Message	Description of Error	Corrective Action
Line1: Current OR Line2: > 0.350 A	The hot sensor current has exceeded its allowed maximum value.	Run validation test #1 and #2. IF Current displayed on line 2 changes, then sensor control & data acquisition electronics are okay. ELSE IF Current does not change when running validation test, then electronics is in error. Replace electronics. ELSE Replace sensor.
Line1: Current OR Line2: > 0.350A E1	Sensor Error	Replace sensor.
Line1:Current UR Line2: < 0.060A	The hot sensor current is less than the minimum value.	Run validation test #1 and #2. IF Current displayed on line 2 changes between test #1 and test #2, then sensor control & data acquisition electronics are functioning. ELSE IF Current does not change, electronics is in error. Replace electronics. ELSE Go to Section 4.2.3.2
Line1:Current UR Line2:< 0.060A E1	Sensor error	Replace sensor.
Line1: Sensor Line2: Any value E1	Sensor error	Replace sensor.
ADC	The data acquisition sub system is not working.	Reset the power to the instrument to correct the error. If the same error immediately reoccurs, then a hardware error has occurred and the hardware may need to be replaced. Please call factory for further assistance.
Software	A software data error has occurred.	This error occurs if there is non-volatile data corruption in the instrument. This type of data corruption rarely occurs if at all. If this error occurs, then reset the power to the device. If the error reoccurs, then please consult factory for further instructions.

4.2.3 Additional Troubleshooting

If the error remains after verifying the facilities, components and diagnostics, follow the troubleshooting procedures below. If the instrument needs to be returned to the Factory for repair, follow the return instructions indicated in Section 6.2.

4.2.3.1 Power Verification

A. Remove the field side enclosure cover by unscrewing it counter-clockwise.
B. Check the serial number tag and label above the power terminal (Figure 2.3) to ascertain whether the instrument is AC or DC.
C. Apply power and measure the voltage at the Terminals of the Power Terminal (See Figure 2.3), verifying that the type (AC or DC), voltage and polarity are correct.

4.2.3.2 Sensor Verification

It will be necessary to obtain a measurement of the ambient temperature of the gas in which the sensor is placed, preferably with some gas flow. That measurement, designated Ta, needs to be accurate within ± 1°C. With the power off, remove the Field side cover and measure resistance between the HSF pins shown in Table 4.1. Verify that the measured values at room temperature (20-25°C or 68-77°F) are correct.

HSF to HSF		Resistance* (OHMS)	Comments
1	3	0 to 1.0	Sensing
2	4	0 to 1.0	Sensing
5	6	0 to 1.0	Sensing
3	5	10.7 to 11.0+ sensing	Hot Sensor
4	5	1070 to 1100+ sensing	Cold Sensor

* Values for local probe.

Table: 4.1 HSF Resistance Measurements

For a Remote Probe there is an added resistance approximately one ohm per 50 feet of cable to the table values. The cable resistance will be measured on the first three measurements of Table 4.1 (HSF 1-3, 2-4 and 5-6). To obtain an accurate resistance of the hot and cold sensors, subtract the average cable resistance of the three sensing measurements from the total resistance obtained for the hot and cold sensors.

If the sensors are at a Temperature other than that indicated, calculate the expected resistance by the following equation

$R_T = R_O (1 + ALPHA * T_a)$ where:

Example: $R_T = 1000.0(1+0.00385*25.0) = 1096.25$ ohms

R_T = Resistance of the sensor at temperature T_a in degrees C.
R_O = Sensor characteristic resistance: See calibration certificate for values.
ALPHA = Sensor temperature coefficient of resistance in ohm/ohm/°C.
T_a = Sensor actual temperature in degrees C.

If the measured and calculated resistances of either or both sensors differ by more than a few percent, the sensor probe is likely faulty.

4.2.3.3 Output Field Wiring Verification

4.2.3.1.1 Switched Outputs: With the switched output external Power supply on, verify that TBB Terminals no.5(+) and no.6(-) and terminals no.7(+) and no.6(-) each are less than +20 VDC.

4.2.3.1.2 4-20 mA Loops: With the power supply of each loop on verify that TBB terminals no.9(+) and no.8(-) and TBB terminals no.11(+) and no.10(-) have a supply voltage of 6 to 36 VDC.

4.2.3.1.3 RS 485 output: With the Remote User Interface connected to a PC, open the program and click on “mode”. Choose “System Calibration”. After a short delay the system configuration units and constants should be returned.

4.2.3.4 Process or Application Issues

Most problems should have been determined by the procedures outlined previously. If not, additional scenarios are listed below. If the instrument needs to be returned, please refer to Section 6.0 for instructions.

PROBLEM	POSSIBLE CAUSE	POSSIBLE FIX
MASS FLOW INDICATION IS ERRATIC	SENSOR IS IN WRONG POSITION	CHECK SENSOR DEPTH AND ORIENTATION (Section 2.3)
	FLOW IS NON UNIFORM OR FLUCTUATING	ADD FLOW CONDITIONER, LONGER PIPE LENGTH BEFORE SENSOR, OR SELECT ANOTHER LOCATION FOR INSTRUMENTATION
	GROUND LOOP	CHECK WIRING (SECTION 2.4)
MASS FLOW INDICATION IS IN ERROR	SENSOR IN WRONG POSITION	CHECK SENSOR DEPTH AND ORIENTATION
	LINE SIZE WRONG	SELECT PROPER LINE SIZE
	WRONG MEDIA	SELECT PROPER MEDIA

5.0 SPECIFICATIONS

TrendMassTer® TM6000 MULTIVARIABLE MASS FLOW METER

5.1 PERFORMANCE SPECIFICATIONS

DESCRIPTION	SPECIFICATIONS
FLOW MEDIA	AIR ONLY, OTHER SELECTED GASSES USING K-FACTOR
LINE SIZES	1/2, 3/4, 1, 1.5, 2, 3, 4, 6, 8, 10, 12 INCH OPTIONALLY GREATER THAN 12 INCHES
FLOW RANGE	0-60 NM/S FOR AIR
FLOW ACCURACY	± 1% OF READING AND ± 0.2% FULL SCALE
TURNDOWN	50:1 STANDARD, OPTIONALLY UP TO 1000:1
REPEATABILITY	± 0.5% OF READING FOR GASSES
TEMPERATURE ACCURACY	± 1°C (± 1.8°F) ACROSS RANGE OF 0 TO 350°C (32 TO 650°F)
TEMPERATURE EFFECT	±0.1%/°C (± 0.06%/°F) WITHIN ±20°C (±36°F) FROM CALIBRATION TEMPERATURE for 50:1 TURNDOWN
TIME RESPONSE	0.5 TO 10 SECONDS (MEDIA DEPENDENT)
CALIBRATION	NIST TRACEABLE OR EQUIVALENT
POWER	18-30 VDC STANDARD, 24 W MAX, 100 – 240 VAC, 47 – 63 HZ OPTIONAL, 15W
TEMPERATURE RATING–ELECTRONICS	-20 TO 85°C (-4 TO 185°F) FOR NON-DISPLAY AND/OR DC POWER, -20 TO 70°C (-4 TO 158°F) WITH DISPLAY AND/OR AC POWER. FOR LOWER TEMPERATURES CONSULT FACTORY.
OUTPUTS	MASS FLOW VOLUMETRIC FLOW TEMPERATURE TOTAL FLOW BATCH FLOW FLOW ALARMS DIAGNOSTIC ALARMS

OUTPUT TYPE	ANALOG: DUAL 4-20 mA, ISOLATED, WITH EXTERNAL LOOP POWER DIGITAL: ISOLATED RS-485 SWITCHED: DUAL OPEN DRAIN OUTPUTS, 36V/500mA MAXIMUM DISPLAY: 2 LINES, 16 CHARACTERS PER LINE
USER INTERFACE	TM6000 INTERFACE: WINDOWS® BASED INTERFACE OR OPTIONAL LOCAL DISPLAY/KEYPAD
REMOTE USER INTERFACE CABLE LENGTH	2000 FEET MAX, CONSULT FACTORY FOR LONGER LENGTHS
SENSOR AND FLUID PROPERTIES CONFIGURATION AND CALIBRATION	PERFORMED VIA TM6000 INTERFACE USING RS-485 LINK
VALIDATION	SYSTEM ELECTRONICS AND SOFTWARE ARE VALIDATED BY SOFTWARE CONTROLLED INJECTION OF KNOWN INPUTS AT THREE LEVELS AND OBTAINING MASS FLOW, TEMPERATURE AND LOOP OUTPUTS AT EXPECTED VALUES.
DIAGNOSTICS	SENSOR AND ELECTRONICS ARE MONITORED AT ONE SECOND INTERVALS. FAULT SIGNAL CAN BE CONFIGURED FOR SWITCH OR LOOP OUTPUTS. USER SELECTABLE 22mA OR 3.2 mA FAULT SIGNALS ARE AVAILABLE FOR LOOP OUTPUTS. SWITCH OUTPUTS CAN BE CONFIGURED FAIL-SAFE HIGH OR LOW.
INSTRUMENT ENCLOSURE	STANDARD: DOUBLE-SIDED, NON-EXPLOSION PROOF, CAST Al. OPTIONAL: DOUBLE-SIDED, EXPLOSION PROOF, CAST Al; CSA-UL-FM APPROVED CLASS I GROUP B,C,D, CLASS II GROUP E,F,G, CLASS III, TYPE 4X; CLASS I, ZONE I, AEx d IIB+H2; Ex d IIB+H2 IEC60529 IP66
OTHER OPTIONS	REMOTE ELECTRONICS LINE SIZES GREATER THAN 12 INCHES
MECHANICAL CONFIGURATION	ROTATION OF DISPLAY TO PROVIDE DISPLAY ORIENTATION IN 90 DEGREE INCREMENTS

5.2 PROBE SPECIFICATIONS

DESCRIPTION	SPECIFICATIONS
SENSOR TYPE	STAINLESS STEEL PROBE WITH HASTELLOY C TWIN TIP
REMOTE SENSOR CABLE LENGTH	100 FEET MAX, CONSULT FACTORY FOR LONGER LENGTHS
MATERIALS	HASTELLOY C SENSOR TIPS WITH 316L SS PROBE BODY STANDARD. CONSULT FACTORY FOR ADDITIONAL MATERIAL OPTIONS.
PROCESS CONNECTION	MNPT FITTING STANDARD; OPTIONAL SWAGELOK OR 150 TO 300 LB FLANGES. SPOOLPIECES AVAILABLE FOR ½ TO 4 INCH LINE SIZES. SENSOR FOR LOW FLOW APPLICATIONS AVAILABLE
TEMPERATURE RATING	GAS: STANDARD: -58° TO 300°F (-50° TO 150°C) MEDIUM TEMP.: TO +480°F (250°C) HIGH TEMP.: TO 650°F (350°C) *Note: Temperature rating has been verified at the factory up to 50°C. Instrument has been used in various applications up to 180°C.
PRESSURE RATING	TO 3000 PSIG

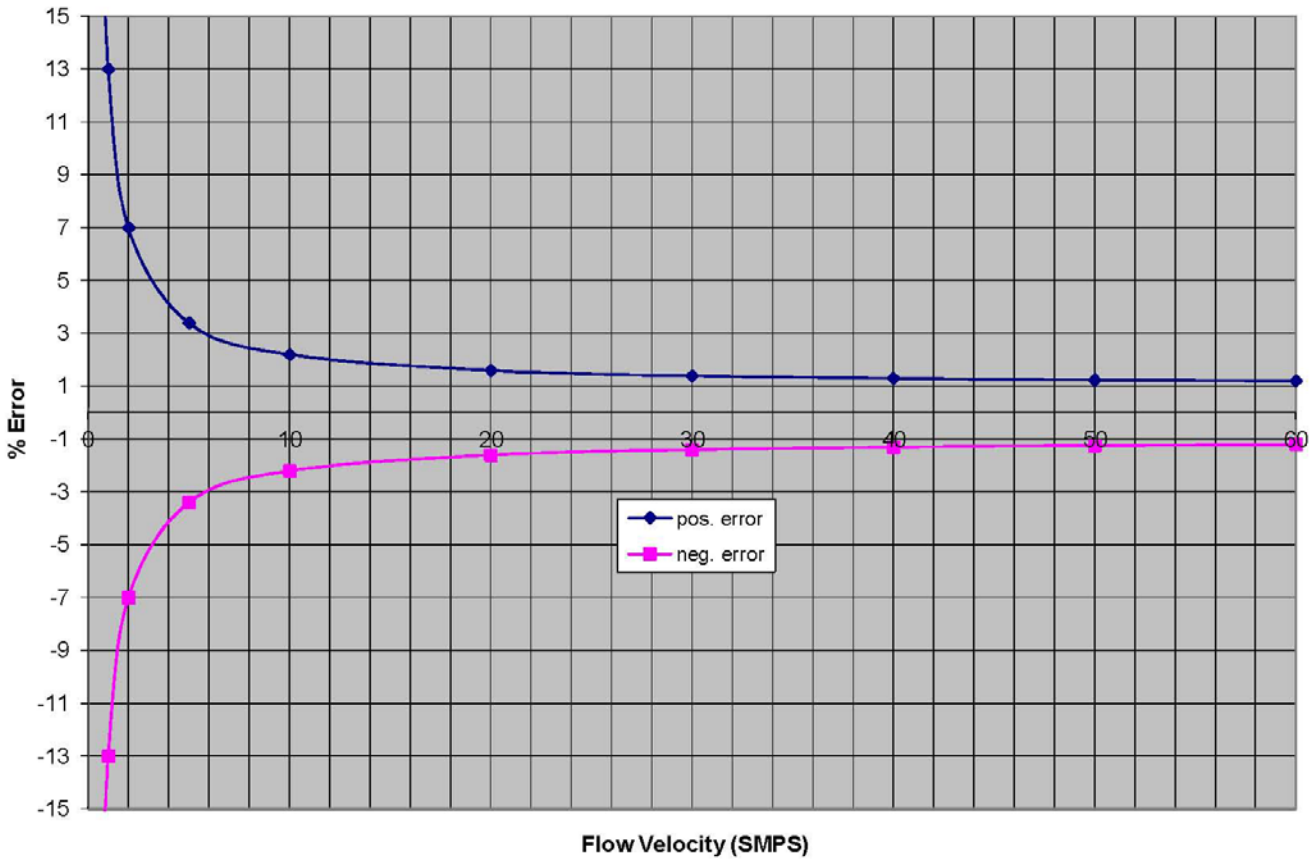


Figure 5.1: Total Error Plot for the TrendMassTer® in Air Based on 1% of Rate +0.2% of Full Scale

Figure 5.1: Shows the percent error plot of the instrument versus flow velocity. It is based on the specification of ±1% of reading ±0.2% of full scale for air.

6.0 Warranty and Service

6.1 Warranty

For a period of one year from the date of shipment DELTA M Corporation will repair or replace this product in the event of a defect in materials or workmanship. To have a product repaired, it should be returned at customer's expense, after obtaining a return authorization as described in Section 6.2 to a repair facility designated by Delta M. After repair, Delta M will prepay transportation for the return of the product to the customer. This limited warranty only covers failures due to defects in materials or workmanship which occur during normal use.

LIMITS AND EXCLUSIONS

DELTA M CORPORATION SHALL NOT BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, LOSS OF USE, LOSS OF SALES, OR INCONVENIENCE) RESULTING FROM THE USE OF THESE PRODUCTS, OR ARISING OUT OF ANY BREACH OF THIS WARRANTY. EXCEPT AS SET FORTH ABOVE, THERE ARE NO EXPRESSED OR IMPLIED WARRANTIES OR WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

6.2 Service

To receive prompt service call DELTA M's Customer Service Department at (865) 483-1569 or toll free 1-800-922-0083. A representative will assist you in determining if the unit must be returned to the factory. A Return Authorization Number (RAN) will be given and should be clearly visible on the outside of the returning package. **Prior to calling, be sure to have the model number and serial number information for quick identification and service response.**

In addition to the RAN, the Return Shipment Form should be attached to the packing list. This form is available at Delta M's website (www.deltamcorp.com), from the Customer Service Representative, or on page 46 of this manual. **The package will be returned unopened to the customer at the customer's expense if the Return Shipment Form and RAN are not present on the outside of the package.**

Because we serve a diverse customer base, there is a risk of receiving contaminated returned material from our customers. **When uncleaned material is received at Delta M, the item will be returned to the customer for cleaning at the customer's expense.**

NOTE:
TO ENSURE THE SAFETY OF SHIPPING CARRIERS AND DELTA M PERSONNEL, ANY PACKAGE THAT DOES NOT HAVE THE RETURN SHIPMENT FORM AND RETURN AUTHORIZATION NUMBER PRESENT ON THE OUTSIDE OF THE PACKAGE WILL BE RETURNED TO THE CUSTOMER AT THE CUSTOMER'S EXPENSE.

RETURN SHIPMENT

If you believe your unit is not working properly, contact the Delta M Customer Service Department. Please have the following information ready to give to the Delta M Customer Service Representative:

Ship to: Delta M Corporation
1003 Larsen Drive
Oak Ridge, TN 37830
Phone: (800) 922-0083
Fax: (865) 483-1142

*Defective Unit's Model Number:

*Date:

*Defective Unit's Serial Number:

*Description of Application Unit was used in:

*Description of Type of Environment Unit was used in:

Description of Perceived Problem:

Special QA Requirements (nuclear or military application, oxygen service, special calibration or certification, etc.):

*Technical Contact's Name:

*Technical Contact's Phone Number:

*Complete Shipping Address:

*Complete Billing Address:

You will then be issued a RAN number. **Delta M personnel will refuse to accept return material shipments if a RAN number is not visible on the outside surface of the shipping container.**

*RAN (Return Authorization Number)

Cleaning of Material to be Returned

Thoroughly clean all material to be returned to Delta M. Because we serve a diverse customer base, there is a risk of receiving contaminated returned material from our customers. **When uncleaned material is received at Delta M, the item will be returned to the customer for cleaning at the customer's expense.**

Shipping Material to be Returned

Securely package cleaned material. **(When uncleaned material is received at Delta M the material will be returned.)** A packing list referencing the RAN number, model number and serial number should be in the sturdy shipping container with the return address and RAN number clearly marked on the outside surface of the container. **Delta M personnel will refuse to accept returns if a RAN number is not visible on the outside surface of the shipping container.**

*Required Fields

QSP-7.2-3

Typical RETURN SHIPMENT FORM