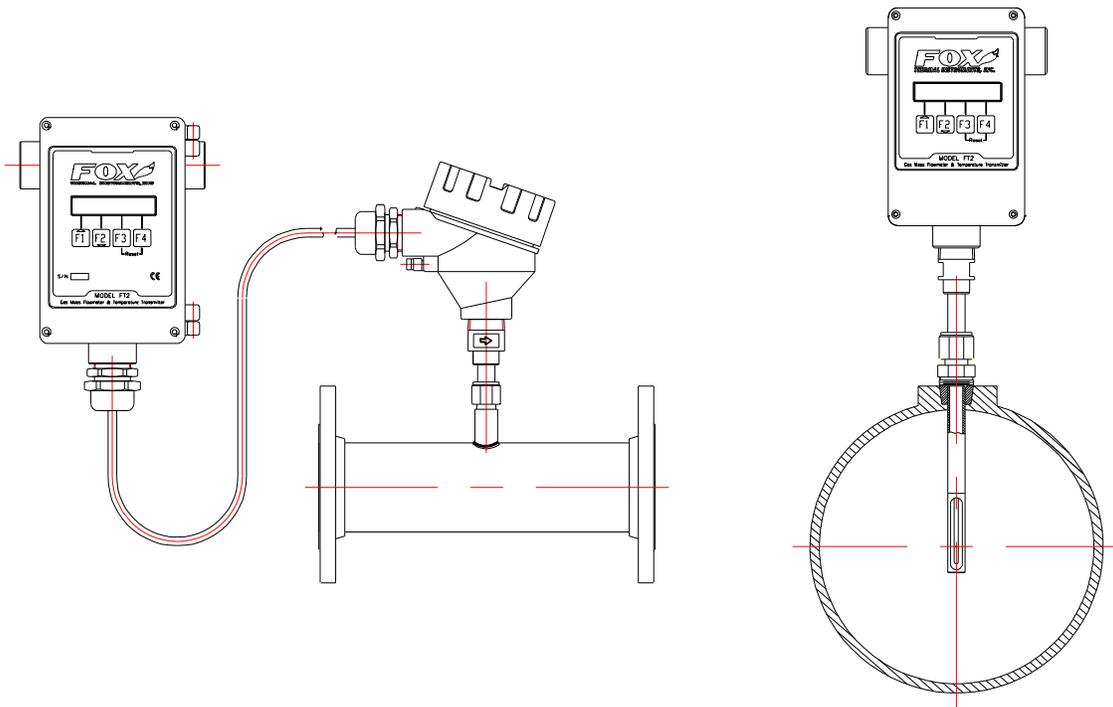


FOX

THERMAL INSTRUMENTS, INC.



MODEL FT2

THERMAL MASS FLOWMETER & TEMPERATURE TRANSMITTER

**399 RESERVATION ROAD
MARINA, CA 93933**

101364 Revision L

Notice

This publication must be read in its entirety before performing any operation. Failure to understand and follow these instructions could result in serious personal injury and/or damage to the equipment. Should this equipment require repair or adjustment beyond the procedures given herein, contact the factory at:

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1. Introduction

1.1. Scope

This Instruction Manual describes the electrical and mechanical considerations involved with installing and maintaining the hardware associated with the Fox FT2 Thermal Mass Flowmeter and Temperature Transmitter.

This manual is divided into the following sections:

- Introduction:
- Installation:
- Start up:
- Programming:
- Preventive maintenance:
- Troubleshooting:

1.2. Product Description

Theory of Operation

The Model FT2 is an advanced thermal mass flowmeter with temperature transmitter. It is microprocessor-based and field programmable. The FT2 thermal sensor operates on the law that fluids absorb heat. Therefore, a heated sensor placed in an air or gas stream transfers heat in proportion to the stream's mass velocity. There are two sensors in different legs of a balanced bridge circuit, one sensor detects the fluid's temperature and a second sensor is maintained at a constant temperature (constant ΔT) above the fluid's temperature. The energy applied to the heated sensor to keep this constant temperature difference is directly proportional to the mass of the flow velocity. The bridge circuit maintains accurate flow measurement over a large temperature and pressure range.

Mass Flow

The Model FT2 measures mass flow, an advantage over most flowmeters, which measure volumetric flow rate. Volumetric flow is incomplete because temperature and pressure are unknown and must be measured separately. For example, the volume of a gas depends on its temperature and pressure. As temperature and pressure changes, the gas volume changes but not its mass. Therefore a device measuring mass flow is independent of temperature and pressure. By defining a Standard at 70° F and 1 Atmosphere (14.7 psia), 1 Standard cubic foot of gas equals the mass that is in 1 cubic foot of this gas at 70° F and 1 Atmosphere.

The Model FT2 provides a direct measurement of Standard or Mass units with no additional temperature and pressure measurements required.

I/O Description

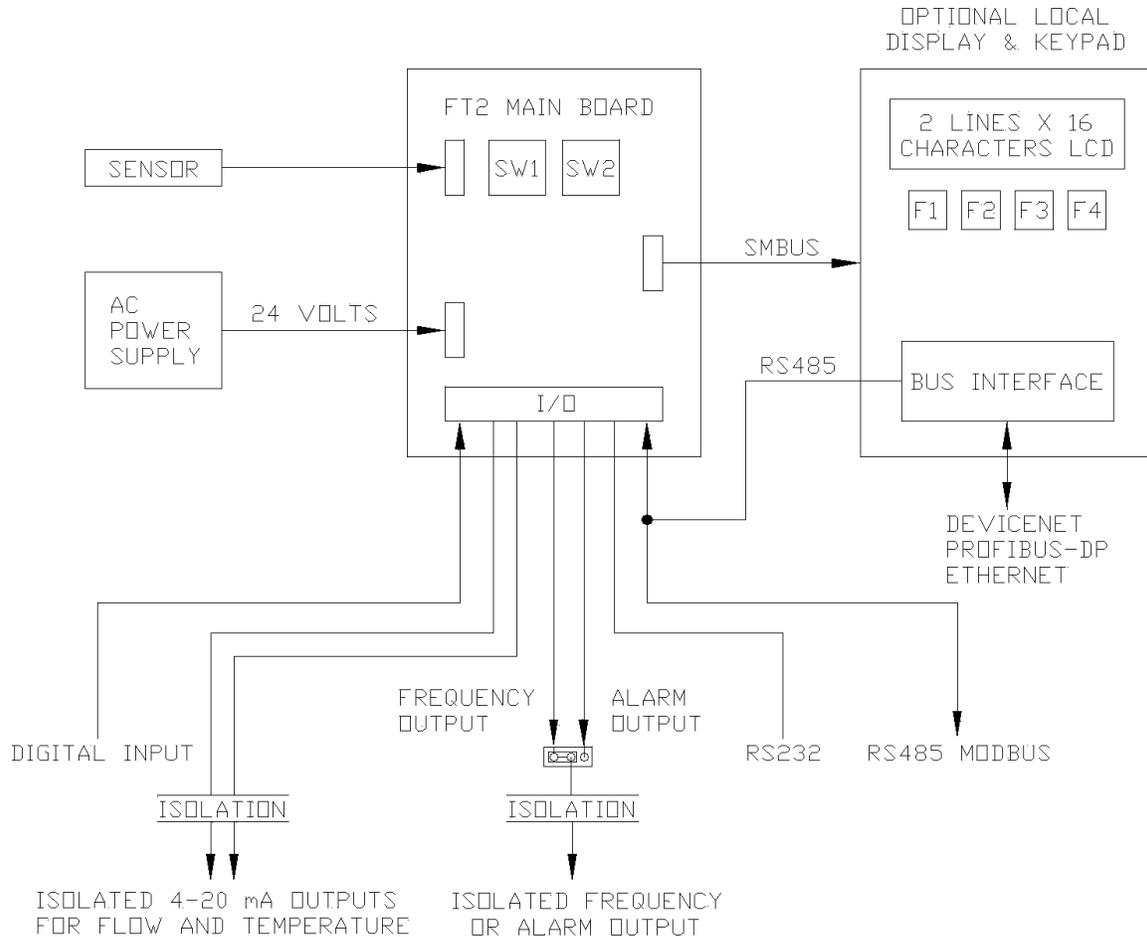
The FT2 comes with two industry standard 4-20 mA isolated analog outputs, one isolated digital output that can be used for frequency or alarm output, one programmable discrete input and a RS232 communication channel that can interface to a Palm™ handheld or a PC. The two 4 -20 mA outputs are scalable for the 4 and 20 mA values and are assigned to flow rate and temperature. The frequency output is programmable to represent flow rate and can be programmed using span/maximum frequency, unit per pulse or pulse per units. The maximum frequency is 100 Hz. An optional Modbus protocol is available in a configurable full or half duplex RS485 interface. In addition, a local display

and keypad for field programming the flowmeter and a serial communication channel for Profibus, DeviceNet or Ethernet are also available as options.

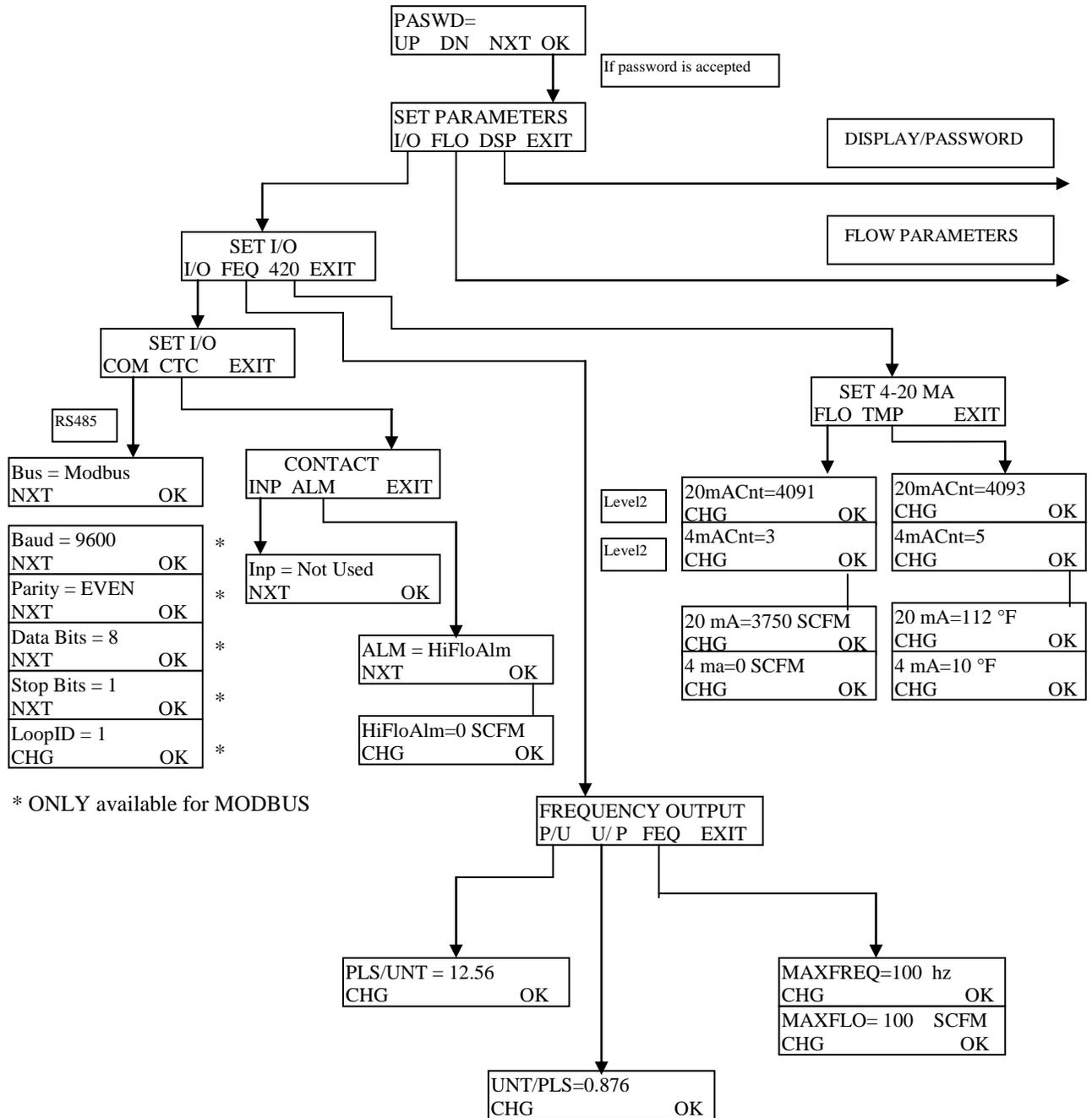
1.3. Block Diagram

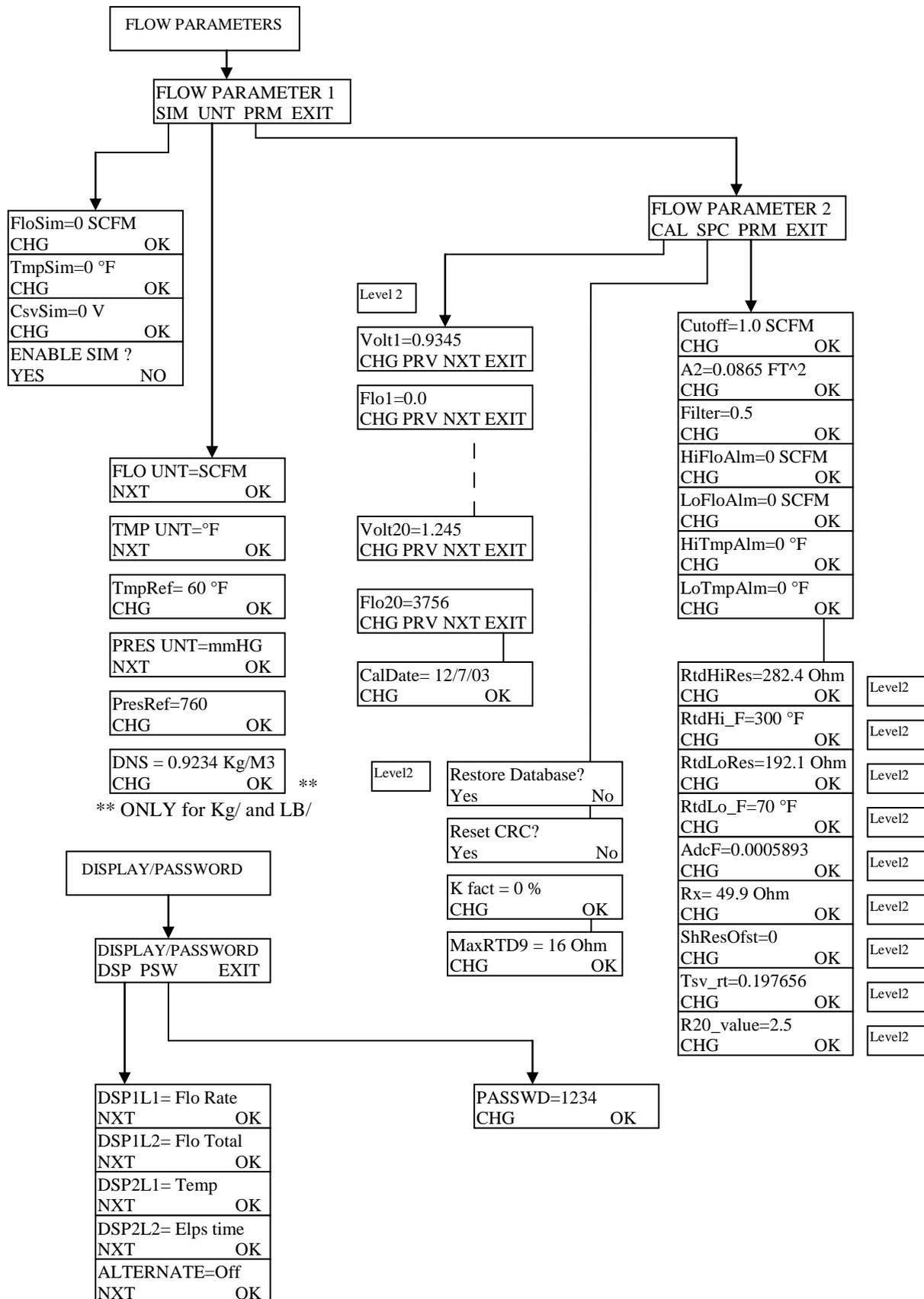
The main parts of the FT2 Mass Flowmeter are: The FT2 main board, the sensor assembly, an optional front panel, and an optional power supply. The two PCBs are mounted inside of the enclosure and the sensor assembly is mounted external to the enclosure. The optional power supply is mounted under the main PCB.

Figure 1-1 Block Diagram



1.3.1. Menu Tree





1.4. Analog 4-20 mA outputs

Two industry standard 4-20 mA isolated analog outputs are available to monitor flow rate and temperature. Each output is scalable for the 4 and 20 mA values. See the programming section for details.

1.5. Discrete I/O

One discrete input is available for remote resetting of the totalizer and elapsed time.

One isolated discrete output is available for generating an alarm for High or Low limits for temperature or flow rate, if the output is not used for the pulse output.

1.6. Frequency/Alarm Output

One isolated frequency output is available to monitor flow rate and is typically used for totalization.

The maximum frequency output is 100 Hz. The output can be scaled by using the flow setting and maximum frequency or using the pulse per unit or unit per pulse method of entry. The isolated digital output can be used either as a frequency output or an alarm output but not both. The output type is selected by JP1.

1.7. Local Display Options

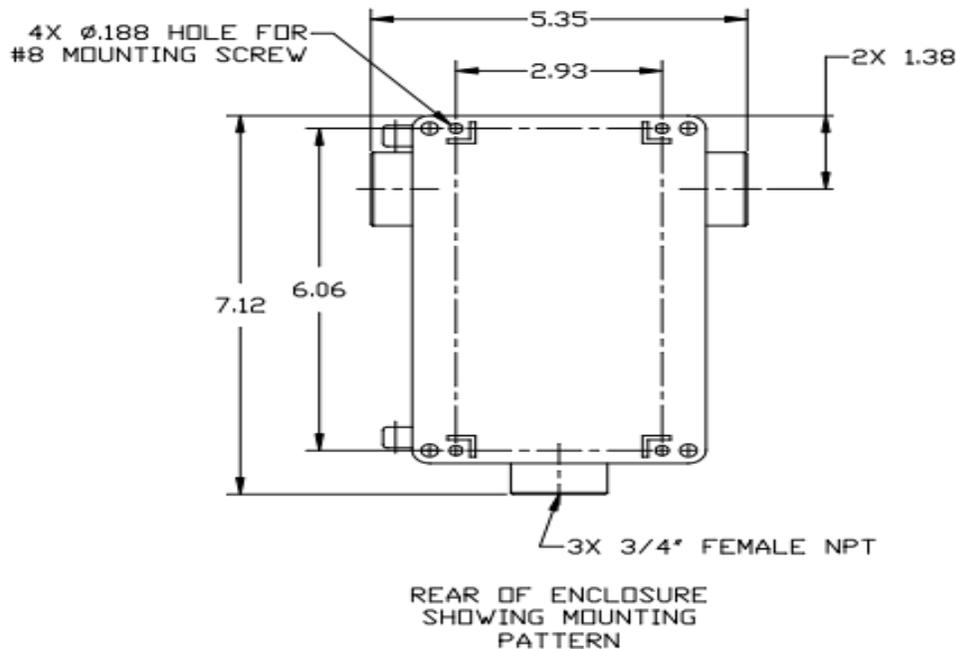
An optional front panel with a LCD display and keypad is available to display measured data and allow field programming of the flowmeter. The display is an easy to read, two-lines, 16 characters backlit LCD and 4 function keys. The local display/keypad module is wired to the FT2 electronics through connector TS6. TS6 is on the main board. Refer to the **Programming** section for a detailed explanation of its usage.

1.8. Communication Features

The FT2 offers a RS232 serial link that communicates to a Palm™ PDA handheld or with a PC application for data display and programming. Also, RS485 is available to connect to the optional front panel with an interface to a specific bus converter (Profibus, DeviceNet or Ethernet). The RS485 can connect directly as an optional Modbus interface. Only one bus protocol is supported at one time.

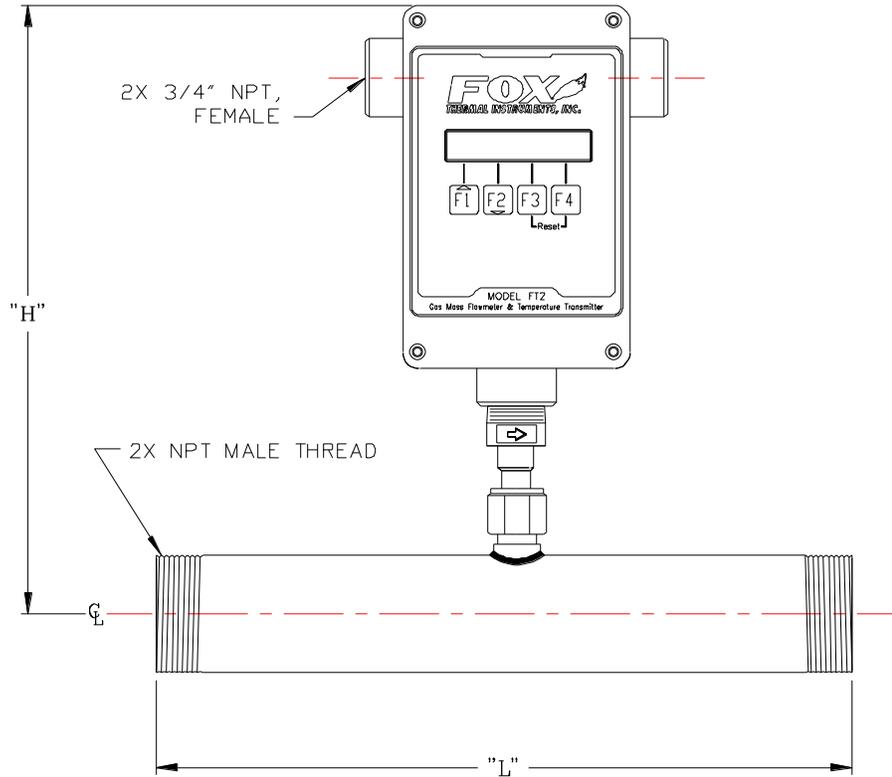
1.9. Dimension Details

Figure 1-2 Enclosure Mounting Dimensions



Rear View of enclosure without sensor or conduit. AC power enters on one side, DC power and signals enter on the other side.

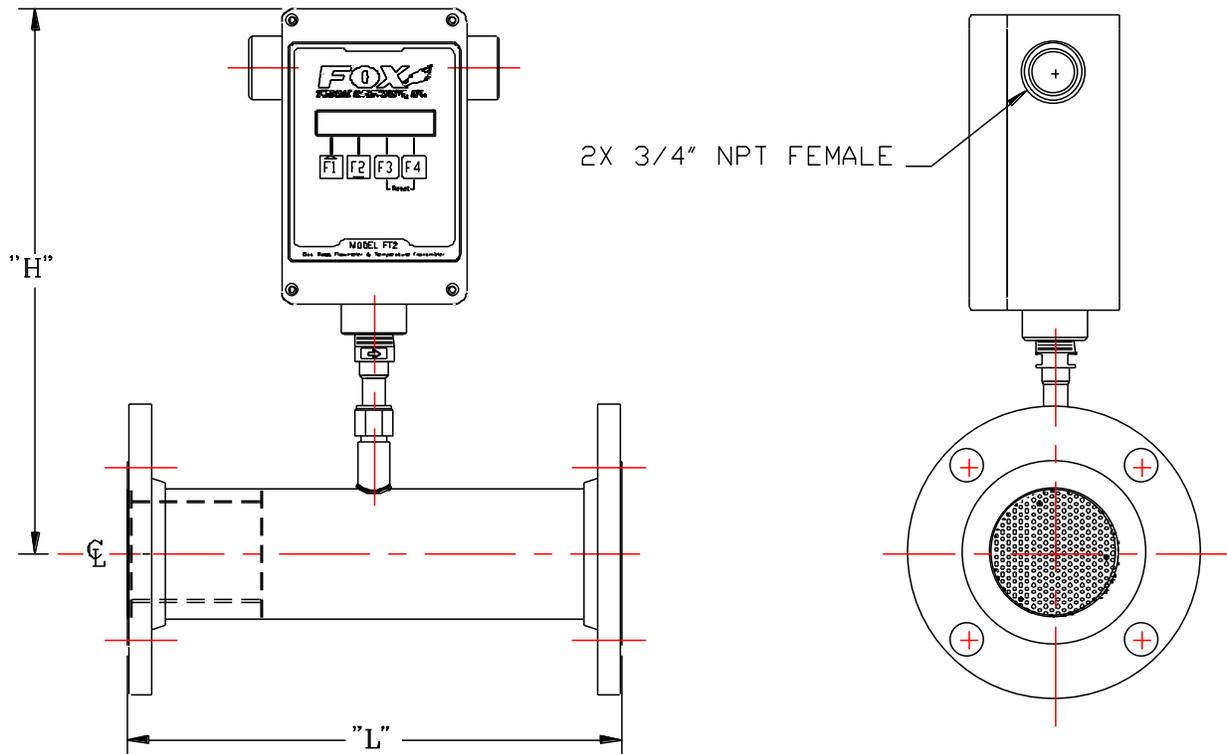
Figure 1-3 Dimensions for Flow Body Style with NPT Connections



NOTE: DIMENSIONS IN PARENTHESIS ARE IN CENTIMETERS.

BODY SIZE	DIMENSION "L"	DIMENSION "H"
1/4-inch	5.80 (14.7)	12.5 (31.8)
1/2-inch	12.0 (30.5)	12.5 (31.8)
3/4-inch	12.0 (30.5)	12.5 (31.8)
1-inch	15.0 (38.1)	12.5 (31.8)
1 1/2-inch	12.0 (30.5)	12.5 (31.8)
2-inch	12.0 (30.5)	12.5 (31.8)
2 1/2-inch	18.0 (45.7)	12.6 (32.0)
3-inch	18.0 (45.7)	12.6 (32.0)
4-inch	18.0 (45.7)	13.1 (33.3)

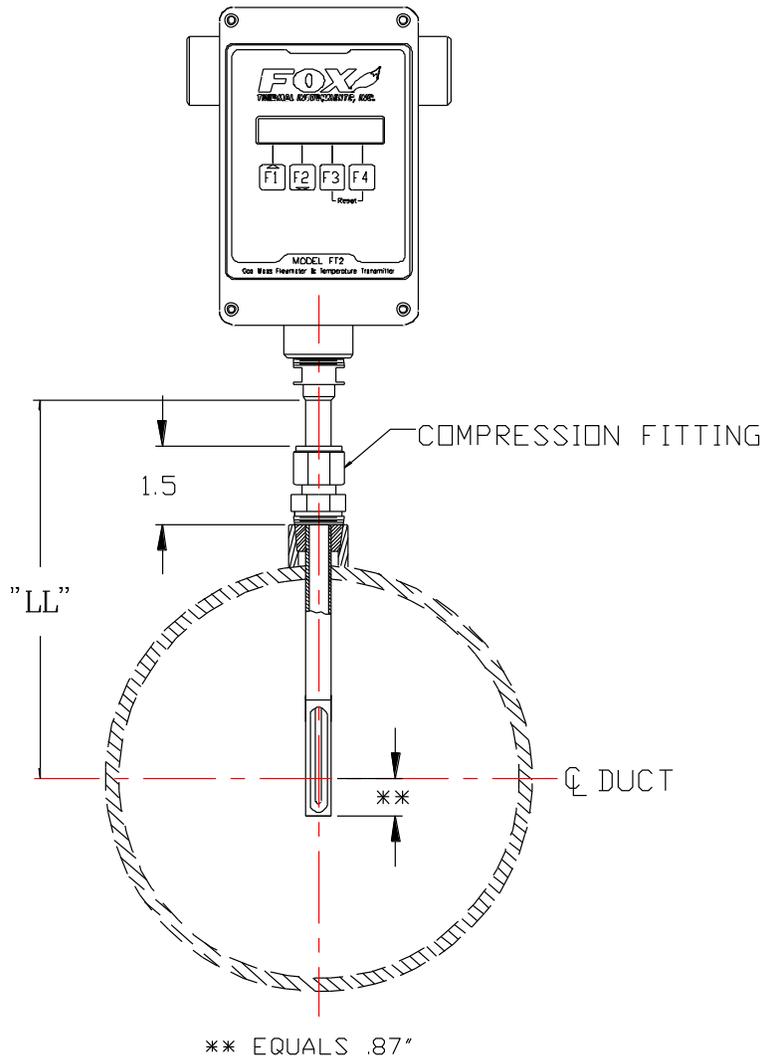
Figure 1-4 Dimensions for Flow Body with Flange Connections



NOTE: DIMENSIONS IN PARENTHESIS ARE IN CENTIMETERS.

BODY SIZE	DIMENSION "L"	DIMENSION "H"
1/2-inch	12.0 (30.5)	12.5 (31.8)
3/4-inch	12.0 (30.5)	12.5 (31.8)
1-inch	15.0 (38.1)	12.5 (31.8)
1 1/2-inch	12.0 (30.5)	12.5 (31.8)
2-inch	12.0 (30.5)	12.5 (31.8)
2 1/2-inch	18.0 (45.7)	12.6 (32.0)
3-inch	18.0 (45.7)	12.6 (32.0)
4-inch	18.0 (45.7)	13.1 (33.3)
6-inch	24.0 (61.0)	14.2 (36.1)

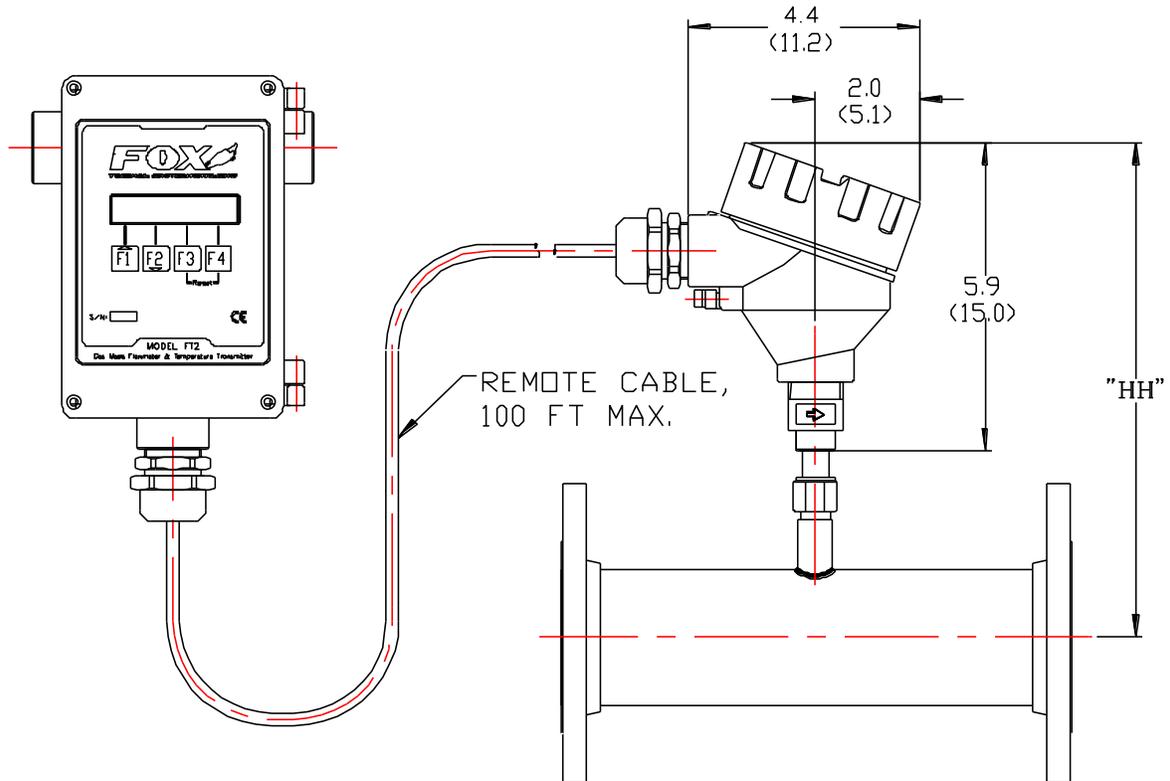
Figure 1-5 Dimensions for Insertion Style



NOTE: DIMENSIONS IN PARENTHESIS ARE IN CENTIMETERS.

PROBE SIZE	DIMENSION LL ±.1"
4-inch	4.0 (10.2)
6-inch	6.0 (15.2)
9-inch	9.0 (22.9)
12-inch	12.0 (30.5)
15-inch	15.0 (38.1)
18-inch	18.0 (45.7)
24-inch	24.0 (61.0)
30-inch	30.0 (76.2)
36-inch	36.0 (91.4)

Figure 1-6 Dimensions for Remote NEMA 4 Enclosure



NOTE: DIMENSIONS IN PARENTHESIS ARE IN CENTIMETERS.

BODY SIZE	DIMENSION HH
1/4-inch	9.9 (25.1)
1/2-inch	9.9 (25.1)
3/4-inch	9.9 (25.1)
1-inch	9.9 (25.1)
1 1/2-inch	9.9 (25.1)
2-inch	9.9 (25.1)
2 1/2-inch	10.0 (25.4)
3-inch	10.0 (25.4)
4-inch	10.5 (26.7)
6-inch	11.6 (29.5)

2. Installation

2.1. Scope

This section describes how to install the FT2 flowmeter and how to get started.

The following, general precautions should be observed:

- Exercise care during handling to avoid damaging the probe, sensor or enclosure.
- The enclosure cover must be closed except during installation and programming.
- Mounting FT2 in direct sunlight can cause the temperature inside the enclosure to increase beyond design limits, resulting in failure of the LCD display and reduced component life. It is recommended that a sunshade be installed to avoid direct sunlight.
- Ensure that the arrow on the flow body is pointing in the direction of flow.
- Do not install the FT2 enclosure near an igniter, igniter controller or switching equipment.
- Do not install an external power supply in a cabinet containing an igniter controller or switching equipment.
- Do not power the power supply with an AC power source that is also used to power an igniter or igniter controller.

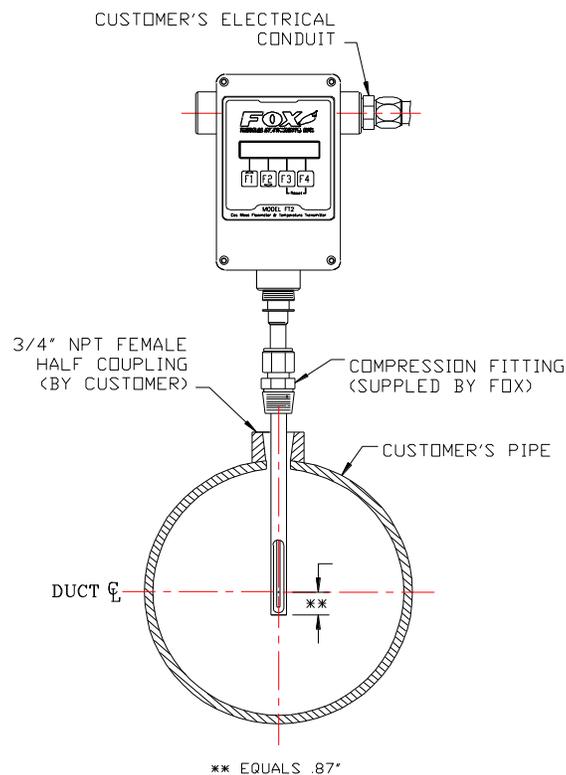
2.2. Insertion Style

2.2.1. Mounting – Insertion Style

The Model FT2 is mounted through a $\frac{3}{4}$ -inch hole and a $\frac{3}{4}$ -inch female NPT half coupling provided in the customer's pipe. Installation procedures must be a combination of end user's best engineering practices, in compliance with local codes, and manufacturer's recommendations.

Insertion style flowmeters are not recommended for pipes smaller than $1\frac{1}{2}$ ".

Figure 2-1 Insertion Style



2.2.2. Installation Depth

Note: Some flowmeters are shipped with sensors that have equal length elements (see Figure 2-2). Others are shipped with the sensor elements that are offset (see Figure 2-3). The sensor type supplied was selected at the factory to be the best suited for your application. Follow the appropriate sensor orientation instructions below. (Refer to Figure 1-5)

- a. Install the compression fitting into the 3/4-inch female NPT half coupling.
- b. When installing in a 2-inch pipe or larger, install the end of the probe 0.87-inch past the centerline of the pipe and tighten the compression fitting nut. Refer to Figure 2-1.
- c. When installing into a 1½-inch pipe carefully install the probe into the pipe until it touches the opposite wall and pull back 0.1-inch. Tighten the compression fitting nut.

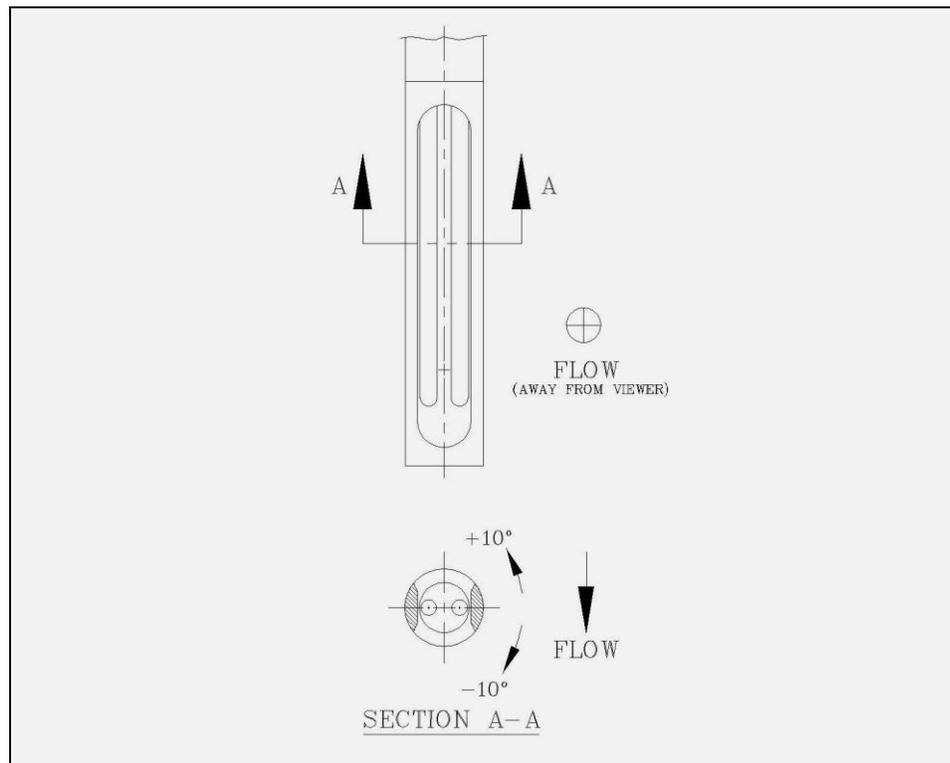
Caution: Once the compression fitting is locked onto the probe, the probe can be removed or rotated, but the insertion depth is locked in place.

2.2.3. Sensor Orientation

Equal length sensor elements:

Install flowmeter with **both sensor elements facing** the flow stream within +/-10 degree.

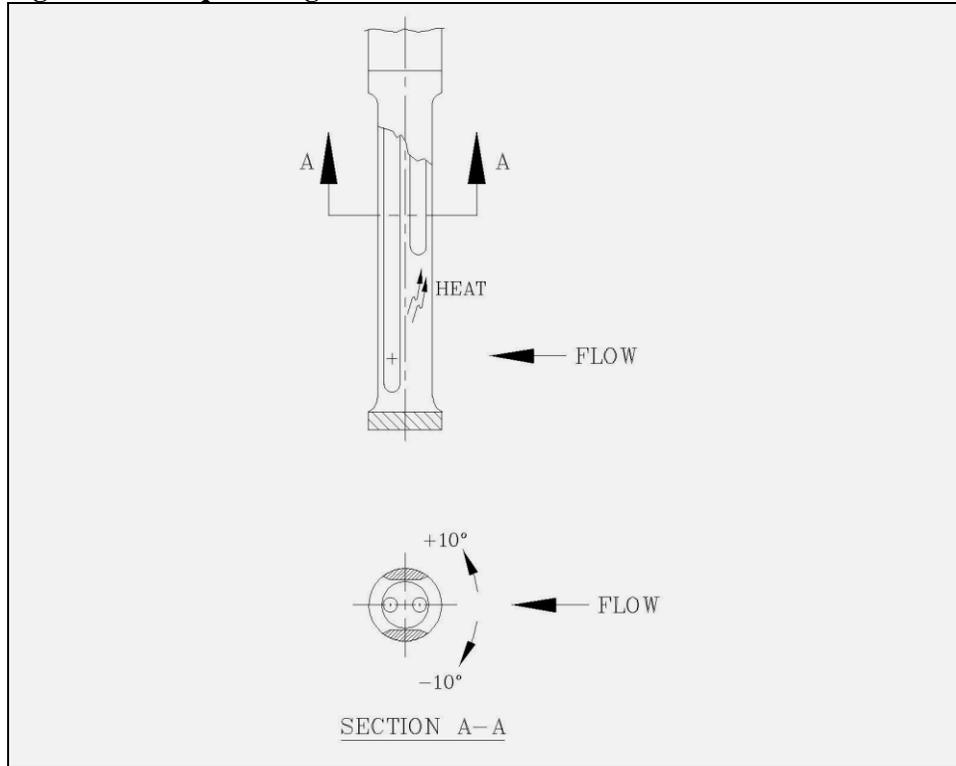
Figure 2-2. Equal Length Sensor Elements.



Unequal length sensor elements:

Install the **shorter sensor element upstream** from the longer one.

Figure 2-3 Unequal Length Sensor Element

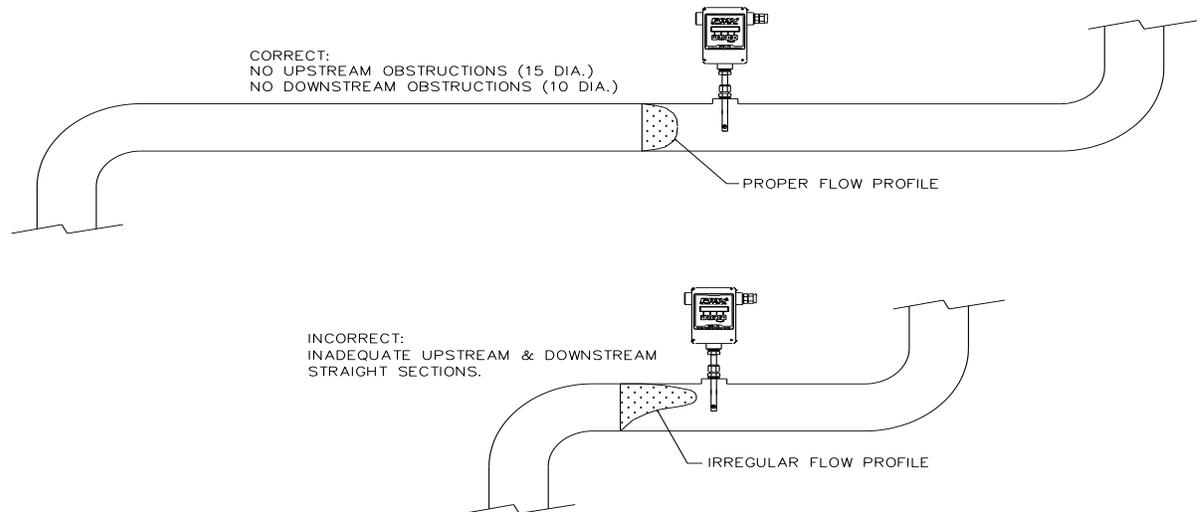


Note: In extreme low flow measurements (below 30 standard feet per minute), convection heat from the longer probe can affect the shorter probe. In these applications, chose a mounting that prevents this from occurring (ex. Horizontal mounting).

2.2.4. Flowmeter Placement - Insertion Style

Install the Model FT2 Insertion style flowmeter so that it is far enough away from bends in the pipe, obstructions, or changes in line sizes to ensure a consistent flow profile. Fifteen diameters of straight pipe upstream and ten downstream are recommended.

Figure 2-4 Flowmeter Placement – Insertion Style



2.2.5. Flowmeter Placement - Flow Body Style

Install the Model FT2 Inline style flowmeter so that it is far enough away from bends in the pipe, obstructions, or changes in line sizes to ensure a consistent flow profile. Eight diameters of straight pipe upstream and four downstream are recommended.

The Model FT2 is welded, threaded or flanged to the customer's pipe. Care should be taken to ensure that the diameter of the mating pipe is the same diameter as the Model FT2 flow body or errors in flow readings can occur. Installation procedure should be a combination of the end user's best engineering practices, in compliance with local codes, and the manufacturer's recommendations.

Figure 2-5 Flowmeter Placement - Flow Body Style

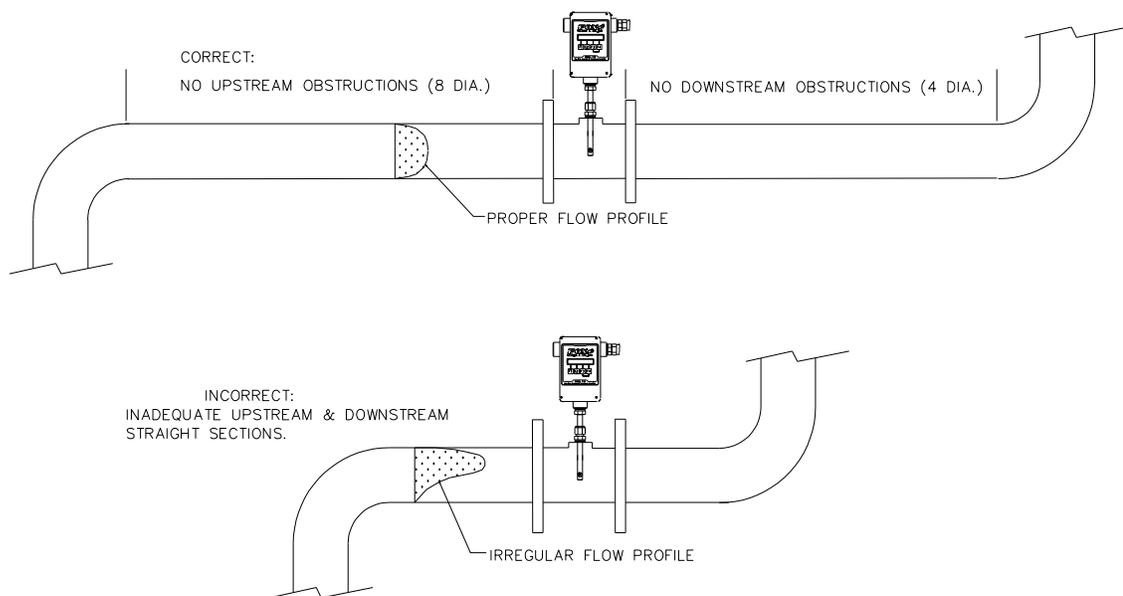
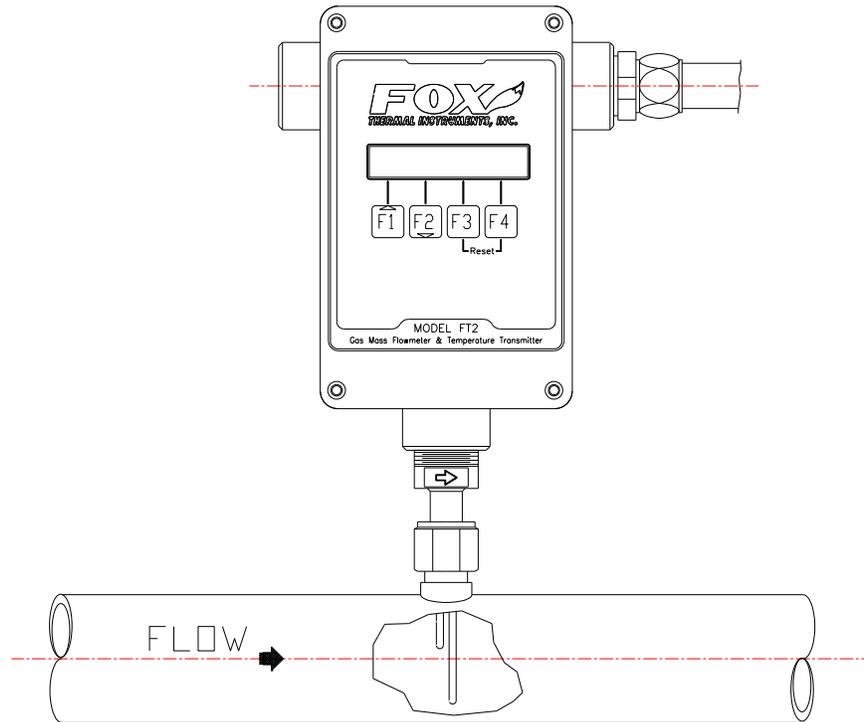
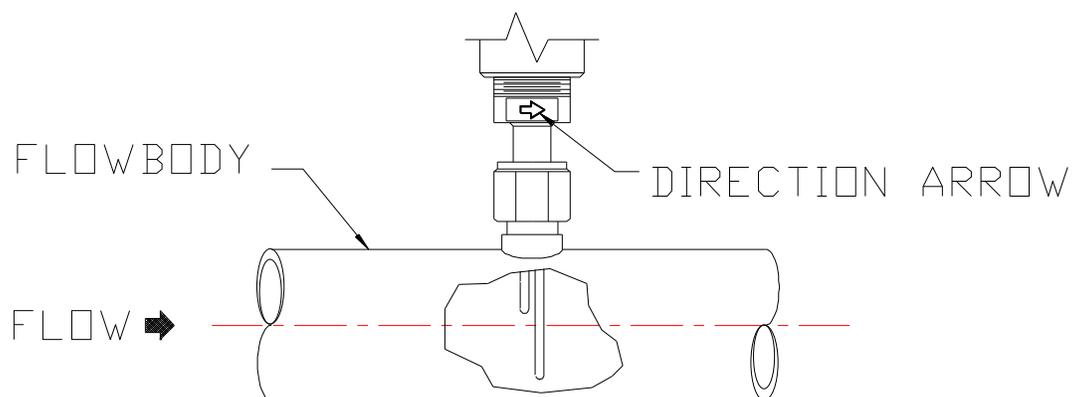


Figure 2-6 Flow Body Style

2.2.6. Flow Body Orientation

Install the flow body so that the arrow on the outside of the flow body is in the direction of flow. This will ensure the correct sensor orientation.

Note: In extreme low flow measurements (below 30 standard feet per minute), convection heat from the longer probe may affect the shorter probe (see Figure 2-3, View A-A). In these applications, choose a mounting orientation that prevents this from occurring (ex. horizontal mounting).

Figure 2-7 Flow Body Orientation

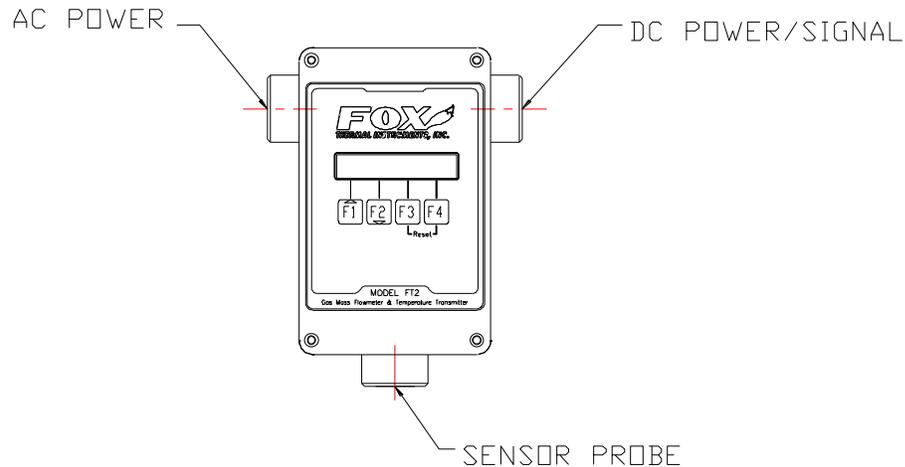
3. Start Up

3.1. Scope

This section describes the steps needed to get the FT2 Flowmeter running.

The enclosure has two separate conduit entries to maintain separation between AC input power and output signal wiring. To eliminate the possibility of noise interference, use a separate cable entry for AC power and signal lines.

Figure 3-1 Input Wiring



Note: All references to conduit orientation are from the Front Panel perspective.

3.2. Wiring

Warning! All installation procedures must be performed with power Off.

All plumbing and electrical installations of flow meters must be a combination of the end user's best engineering practices, in compliance with local codes, and the manufacturer's recommendations.

- Do not install the FT2 enclosure near an igniter, igniter controller or switching equipment.
- Do not install an external power supply in a cabinet containing an igniter controller or switching equipment.
- Do not power the power supply with an AC power source that is also used to power an igniter or igniter controller.

Wiring Installation

Warning! This flowmeter contains components that can be damaged by static electricity. You must discharge yourself by touching a grounded steel pipe or other grounded steel material prior to working inside this flowmeter.

Wiring is accomplished by loosening the 4 captive screws holding the cover of the enclosure to expose the electronic circuit boards. Bring customer supplied wires into the enclosure through the conduit access on the sides of the enclosure. Cut wires for a 2-inch service loop. Use stranded copper wire, no larger than 16-gauge. If you are using the optional AC power supply, connect the two AC wires and the safety ground to the TS7 connector marked as AC (bring AC wires in through the left-hand conduit hub). If an external 24 VDC power source is used, it is recommended that a twisted shielded pair cable be used. Connect the wires to connector TS1 being careful to connect with the correct polarity (bring DC wires in through the right-hand conduit hub).

Signal Wires

Always use a separate shielded cable for each output signal, select the proper wire gauge. The recommended wire gauge is 18 to 22 AWG. The cable shield should not be connected at the flowmeter, the shield should be connected at the AC ground terminal at the power supply or instrumentation AC ground terminal.

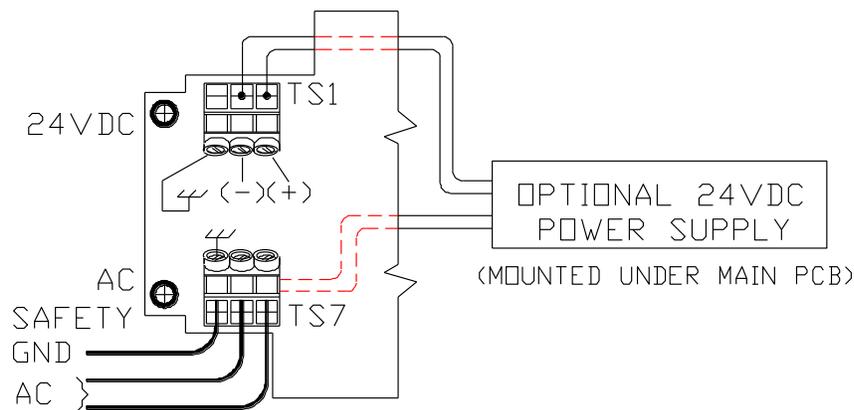
3.2.1. Power Input Wiring and Grounding

If the optional AC power supply is supplied by FOX, the input power can be 85 to 250 VAC. If the customer supplies an external power supply, it must supply 24 VDC +/- 10 %, with a minimum of one amp.

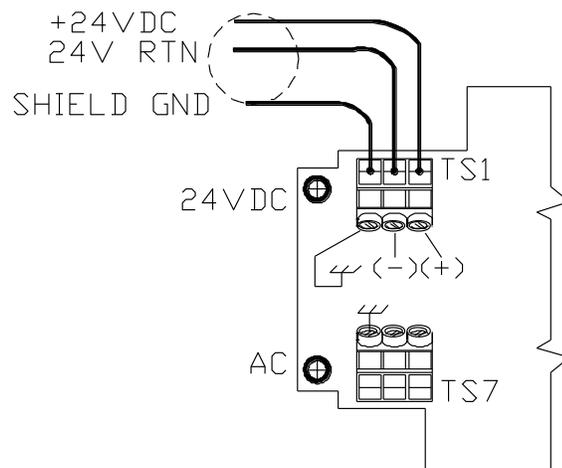
The enclosure must be properly grounded with a quality earth ground to protect the electronics from static discharges. It is recommended that 16 gauge, stranded wire be used.

Figure 3-2 Power Input Wiring

CONNECTIONS FOR OPTIONAL 24VDC POWER SUPPLY



CONNECTIONS FOR EXTERNAL 24VDC POWER SUPPLY



3.2.2. 4 to 20 mA Output Wiring

Bring the 4 to 20 mA wiring in through the right-hand conduit hub. Connect FLOW RATE 4 to 20 mA output to TS2, 1(+) & 2(-). Connect TEMPERATURE 4 to 20 mA output to TS2, 3(+) & 4(-).

Figure 3-3 Isolated Wiring for the 4-20mA Outputs

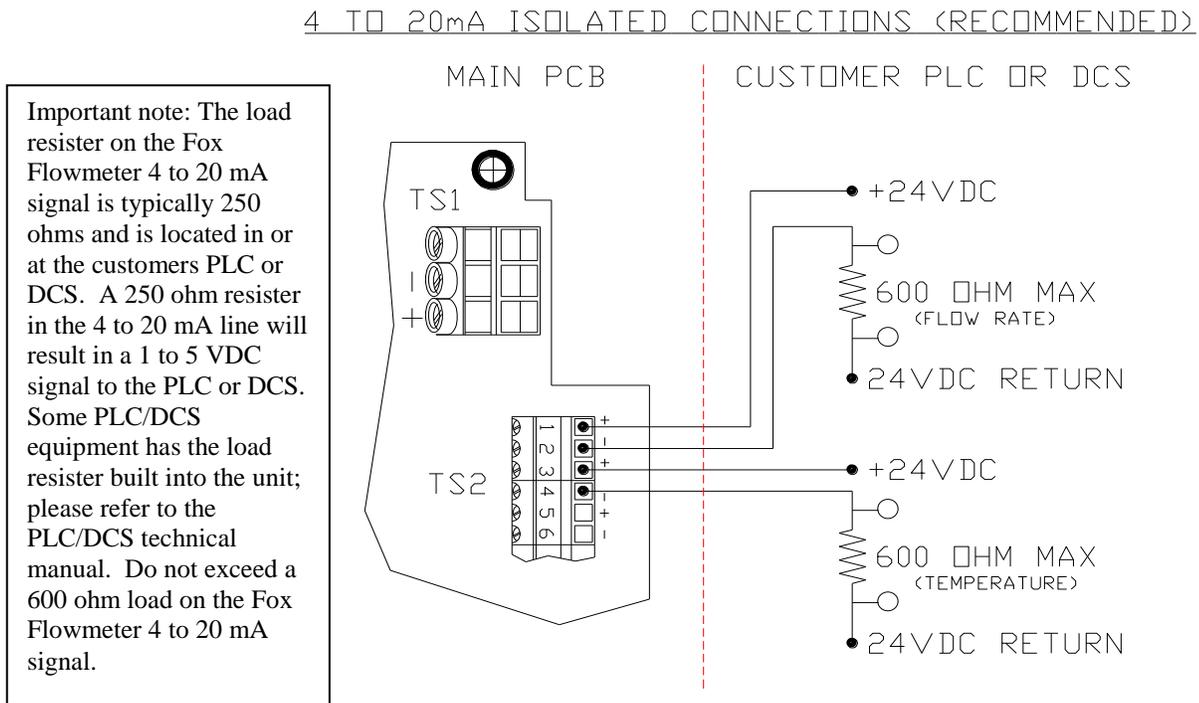
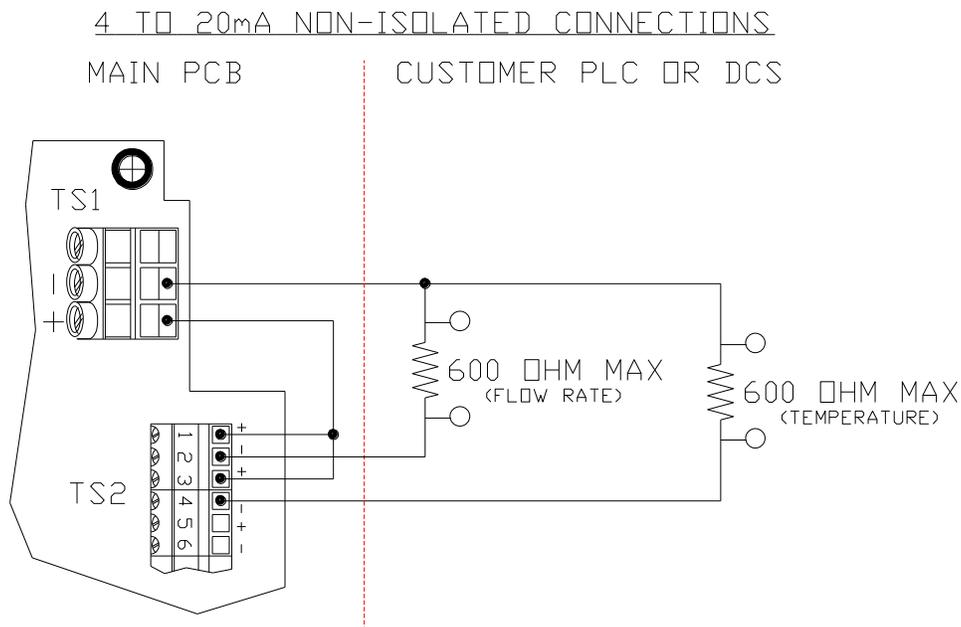


Figure 3-3A Non-Isolated Wiring for the 4-20mA Outputs

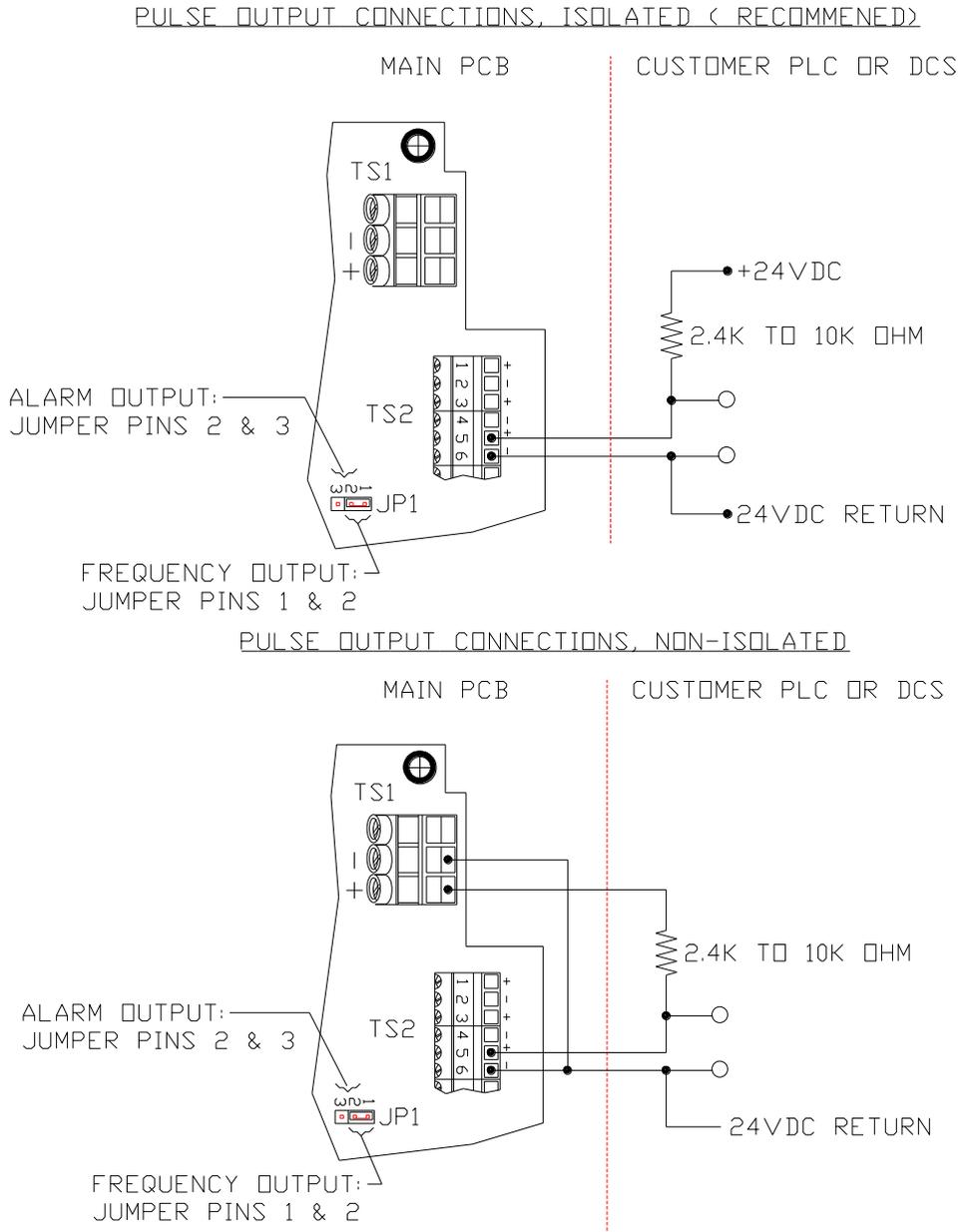


3.2.3. Frequency/Alarm Output Wiring

Bring frequency/alarm wiring in through the right-hand conduit hub. Connect to TS2, 5(+) & 6(-). The frequency/alarm output is an open collector circuit capable of sinking a maximum of 10 mA of current.

The frequency output is selected when JP1 pins 1 & 2 are connected together using the shunt provided. The alarm output is selected when JP1 pins 2 & 3 are connected together. Only one of the options can be active at one time.

Figure 3-4 Frequency/Alarm Output Wiring

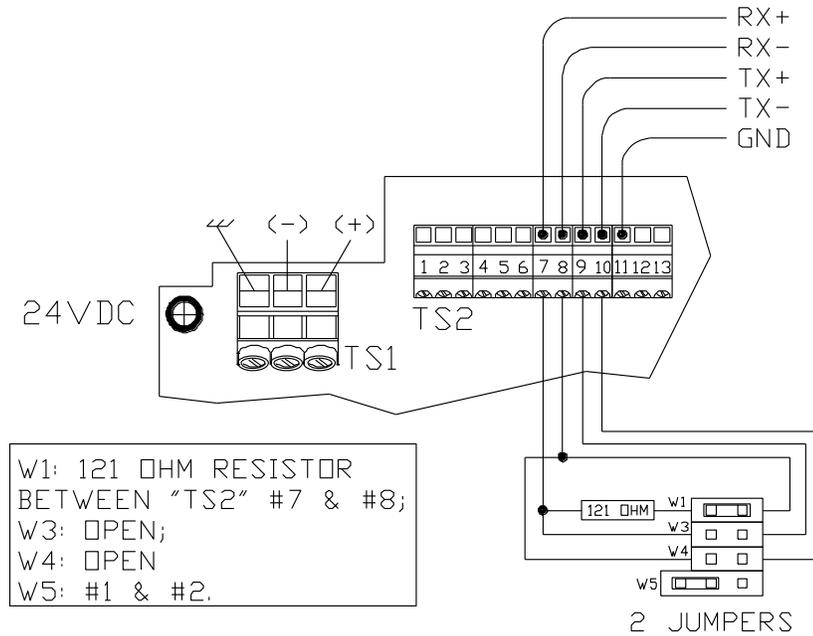


3.2.4. RS485 Wiring

W1 jumper is to terminate the bus with a 121ohm resistor and should **only** be installed on the **last** instrument of the daisy chain. W3 and W4 are used for half duplex operation. (W3 connects TX+ & RX+, W4 connects TX- & RX-).

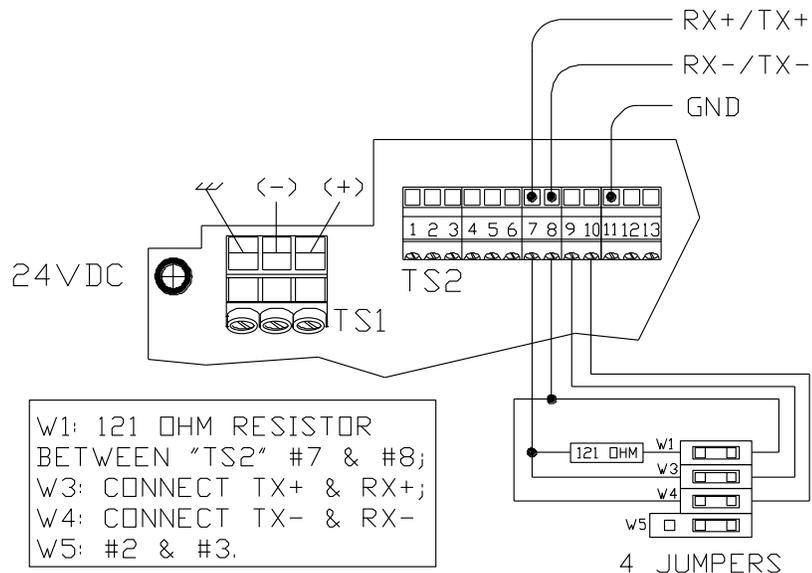
Figure 3-5 RS485 Wiring and Configuration

4-WIRE CONFIGURATION



2 JUMPERS

2-WIRE CONFIGURATION



4 JUMPERS

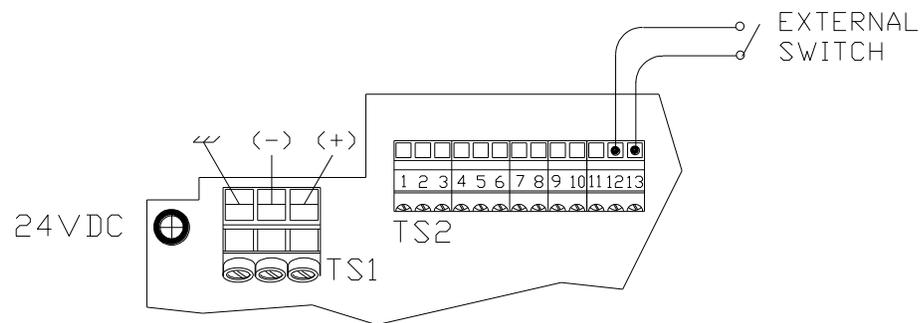
3.2.5. Remote Switch Wiring

A remote switch can be used to reset the Totalizer and elapsed time, if enabled by the programming mode. The switch contacts are de-bounced on the FT2 board. There is no polarity requirement on these connections. Use TS2-12 and TS2-13.

When the 2 curve option is ordered the switch can be used to switch between curves.

Figure 3-6 Remote Switch Wiring

REMOTE SWITCH WIRING

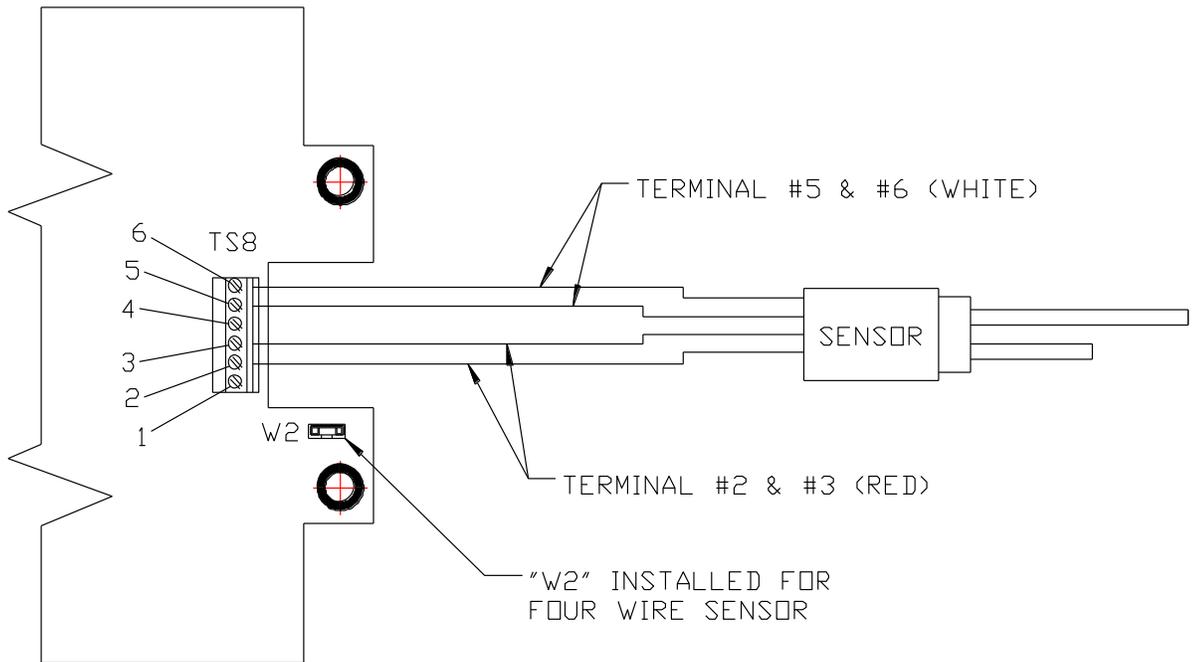


Note: Remote switch functionality needs to be enabled using the display front panel. See programming section 4.1.5.1

3.2.6. Local Sensor Wiring (4 wires)

Note: Sensor terminations are performed at the factory except when Remote Electronics are provided.

Figure 3-7 Local Sensor Wiring (4 Wire)

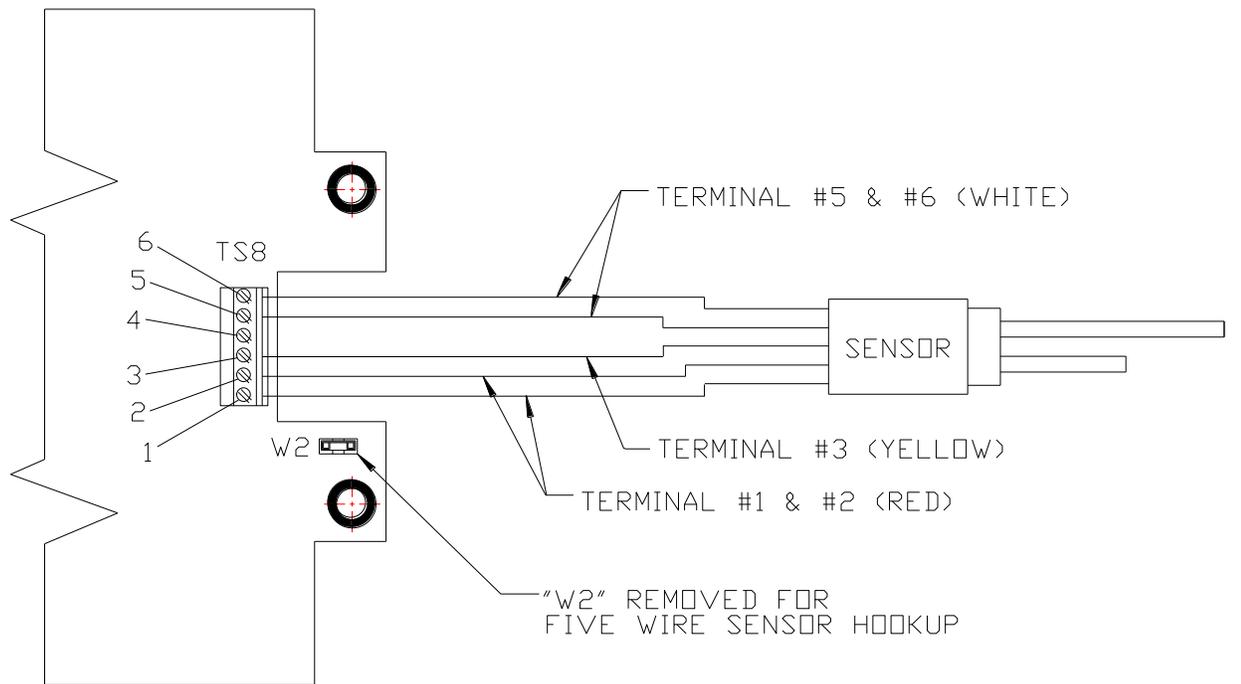


FOUR WIRE SENSOR HOOKUP

3.2.7. Local Sensor Wiring High Temperature (5 Wire)

Note: Sensor terminations are performed at the factory except when Remote Electronics are provided.

Figure 3-8 Local Sensor Wiring High Temperature (5 Wire)



HIGH TEMP FIVE WIRE SENSOR HOOKUP

3.2.8. Remote Sensor Wiring Installation

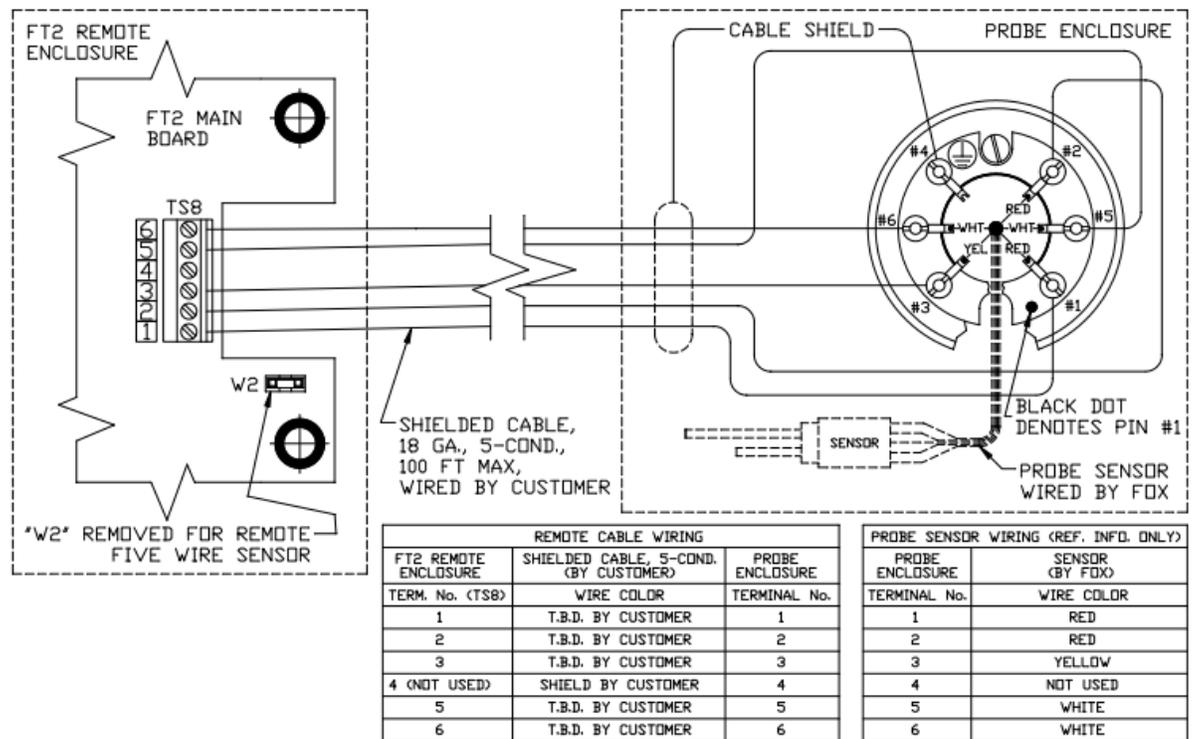
Note: Remote wiring is only required when the Remote Electronics options is provided.

Five wire shielded cable required. The shielded cable should be ran through a separate grounded steel conduit. (No other cables or wires in the conduit.)

Connect sensor wires as follows: Red wires to terminals # 1 and # 2, white wires to # 5 and # 6 and yellow wire to # 3, cable shield to # 4 (see Figure 3-8).

Connect other end to connector TS8 (see Figure 3-7) on the main FT2 board as follows: Red wires to TS8 pin 1 & 2, white wires to TS8 pins 5 & 6 and yellow wire to TS8 pin 3. If you are using your own cable, make sure that the cable does not exceed 100 feet and has a wire resistance that does not exceed one ohm (18 AWG recommended). **Do not connect the shield at the FT2 enclosure end.** On the the FT2 board, make sure that the jumper W2 is not across both pins when a 5-wire sensor is supplied (see Figure3-8).

Figure 3-9 Remote Sensor Wiring (5 wire) (see also Figure 1-6)



REMOTE FIVE WIRE CABLE HOOKUP

3.3. Start Up Sequence

The program automatically enters the Run/Measure mode after power up. If the Local display is installed, the screen will show the software versions for the FT2 and the display module.

Refer to section **4.1 Programming using the Local Display**. Programming of the flowmeter can also be accomplished using a Palm™ handheld or a Windows-based PC program. The PC requires a null modem connection.

The device used to program the unit must have FOX software installed, prior to beginning the programming operation. **FT2 View** required for Windows.

3.4. Measurement Mode

In the measurement mode, there are 4 different display screens (display 1, 2, 3 and a prompt screen to enter the programming mode), 2 display screens are user programmable (refer to section 4.1.7).

Scrolling through the display is accomplished by pressing the F1 or F2 key to view the next or previous screen. Pressing the F1 and F2 keys at the same time enters the Engineering Menu screens (display 10 through 22). Keys F1 and F2 are used to scroll through the different screens and key F4 to EXIT to the normal menu screen.

Pressing the F3 & F4 keys at the same time brings up the Total Reset screen prompt.

3.5. 4 to 20 mA Outputs

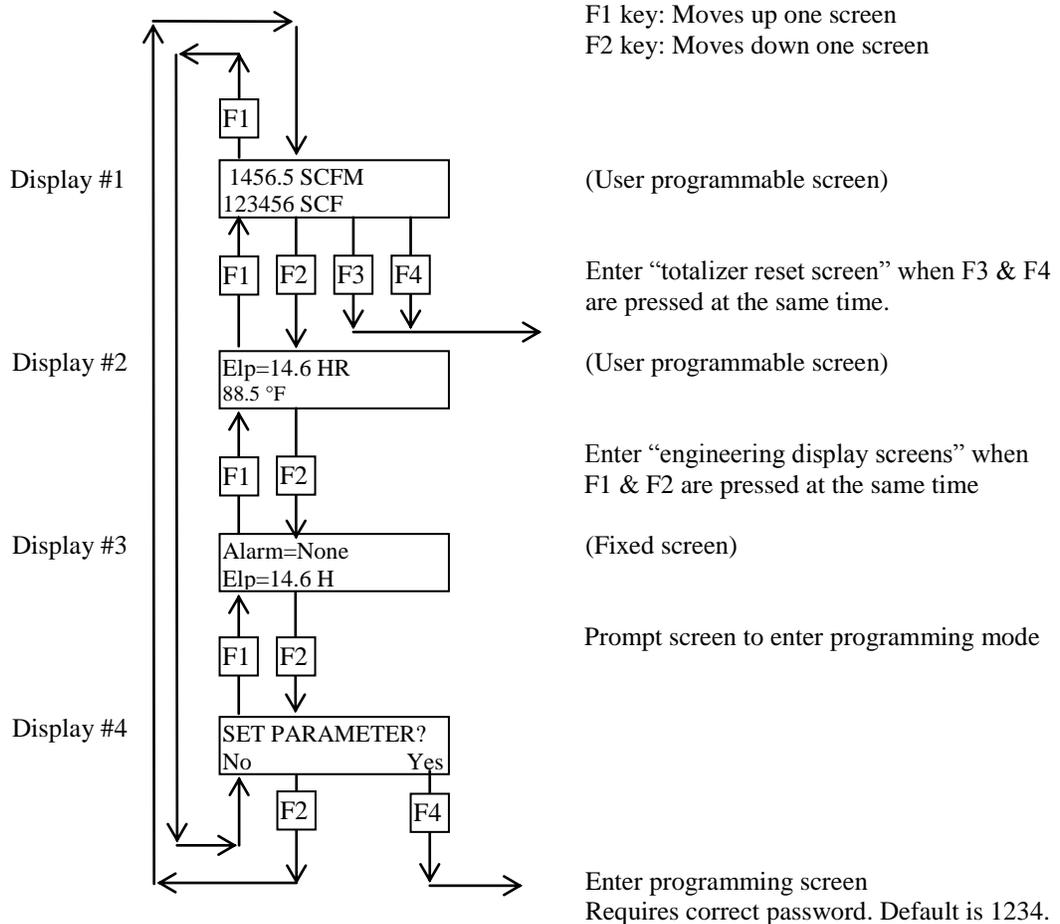
The two isolated analog 4-20 mA outputs are available at connector TS2. Pins 1(+) & 2(-) are used for the analog output associated with the flow rate. Pins 3(+) & 4(-) are used for the 4-20 mA output associated with the temperature. Both require power for the loop to operate. Refer to Figure 3-3 for wiring.

3.6. Frequency/Alarm Output

The frequency or alarm isolated output is available at connector TS2 pins 5(+) & 6(-). When using the frequency output, it can be scaled to represent flow rate for totalizing or flow rate indication. Refer to Figure 3-4 for wiring.

3.7. Local Display Screens

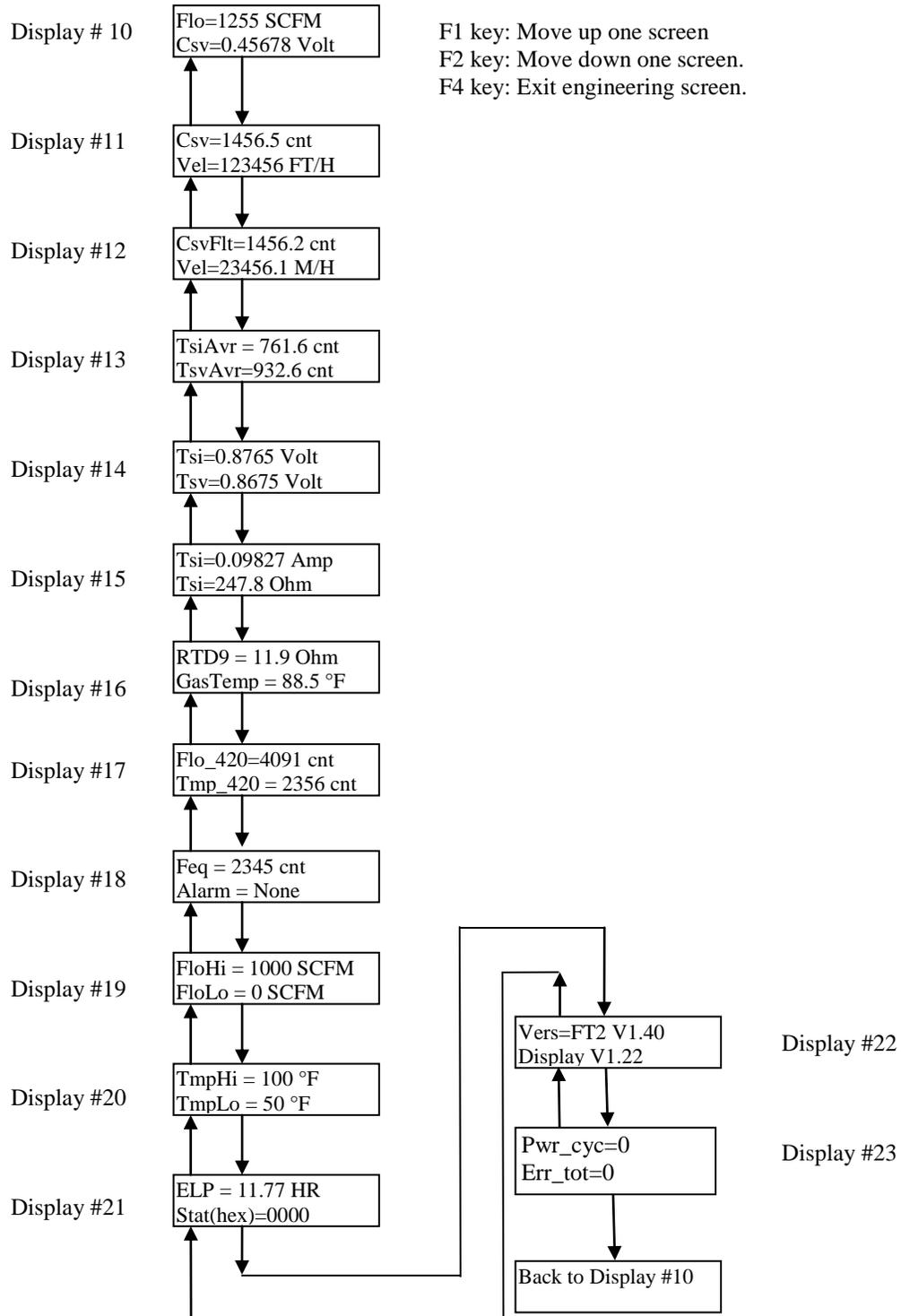
3.7.1. Display Screens



Note: CRC ERROR will flash on the display if a CRC Error is detected while reading the EEPROM. Alarm Code 36 will be displayed in the Alarm Display. Refer to 4.1.14 RESET CRC.

3.7.2. Engineering Screens

Pressing F1 and F2 keys at the same time in the normal mode, brings the engineering screens. These screens display internal parameters of the FT2, which are used by Fox service personnel.



3.8. Resetting Total and Elapsed Time

Pressing F3 and F4 at the same time in the normal running mode brings the prompt to reset the totalizer and elapsed time:

Reset Total ?			
NO			YES

F1	F2	F3	F4
----	----	----	----

If the password is active the program will prompt the user to enter the password:

PASWD:			
UP	DN	NXT	OK

F1	F2	F3	F4
----	----	----	----

If the password is correct, the reset will be performed, otherwise a “Wrong Password” message will be displayed briefly before returning to the normal mode.

Note: To disable the programmable password set it to “0”.

3.9. Alarm Indications

Alarm indications are provided to indicate any malfunctions, out of range values or saturated analog outputs.

The following list is a description of alarm codes:

Code	Description
12	Power up Initializing
13	Flow rate above high limit
14	Flow below low limit
15	Temperature above high limit
16	Temperature below low limit
22	Sensor out of range
23	Velocity out of calibration table range
24	Check settings
25	Simulation mode
26	Frequency output over range
32	4 to 20 mA for flow rate is out of range
33	4 to 20 mA for temperature is out of range
34	ANYBUS communication error
35	RTC Error
36	EEPROM CRC Error
37	Totalizer error detected

4. Programming

4.1. Programming using the Local Display

4.1.1. Data Entry using the local display module

There are 2 basic types of menu entries: one for changing value or string and one for selecting from a selection list.

4.1.1.1. To Change a Value or String :

VALUE = 0.91234			
CHG			OK

F1	F2	F3	F4
----	----	----	----

Press **CHG (F1)** key to change the value, **OK (F4)** to accept the value.

VALUE = 0.91234			
UP	DN	NXT	OK

F1	F2	F3	F4
----	----	----	----

Press the **UP (F1)** or **DN (F2)** key to select a new digit or character, the cursor points to the selected digit. Press **NXT (F3)** to select the next digit and **OK (F4)** to accept the entry.

Note: If the **UP (F1)** or **DN (F2)** key is held down for more the 1 second, the program will progressively select new digits at increasing speed as time increases.

4.1.1.2. To Select from a List:

FLO UNT = SCFM			
NXT			OK

F1	F2	F3	F4
----	----	----	----

Press **NXT (F1)** key repeatedly until the correct selection is made and **OK (F4)** key to accept the entry.

4.1.2. Entering the Programming Mode

To enter the programming mode, press the **F1** or **F2** key repeatedly in the normal running mode until the following screen is shown:

SET PARAMETERS ?	
No	Yes

F1	F2	F3	F4
----	----	----	----

Press **YES (F4)** and the following screen will prompt the user to enter the password if it is active:

PASWD:_			
UP	DN	NXT	OK

F1	F2	F3	F4
----	----	----	----

Enter the correct password, follow the instructions for changing a value as specified in section 4.1.1. The default Level 1 password is “1234”.

If the wrong password is entered, the message “Wrong Password” will be displayed for a few seconds and then returns to the programming entry screen.

If the password is accepted, the following screen will be shown:

SET PARAMETERS			
I/O	FLO	DSP	EXIT

F1	F2	F3	F4
----	----	----	----

This is the base screen for the programming mode.

Press **EXIT (F4)** repeatedly until “Normal Mode” is seen briefly to exit the programming mode.

4.1.3. Analog 4-20 mA Output

The following menu allows the scaling of the analog 4-20 mA outputs. From the base screen, press **I/O (F1)** and then in the next screen press **420 (F3)**.

SET I/O			
I/O	FEQ	420	EXIT

F1	F2	F3	F4
----	----	----	----

Then select either **FLO (F1)** or **TMP (F2)** for flow rate or temperature channel.

SET 4-20 MA			
FLO	TMP	EXIT	

F1	F2	F3	F4
----	----	----	----

20 mA = 3751 SCFM		OK	
CHG			

F1	F2	F3	F4
----	----	----	----

Enter the value for the 20 mA and press **OK (F4)** key to accept setting.

Then the following screen will show:

4 mA = 0 SCFM		OK	
CHG			

F1	F2	F3	F4
----	----	----	----

Enter the value for the 4 mA and press **OK (F4)**.

Note: 4 mA is normally set to 0.

Press **EXIT (F4)** repeatedly until “Normal Mode” is seen briefly to exit the programming mode.

Note: When the flow rate exceeds the programmed value for the 20 mA set point, the analog output will stay at 20 mA and an alarm code will be generated.

4.1.4. Frequency Output

The frequency output can be configured in three different ways: (1) specifying a maximum frequency to a defined maximum value of flow rate, (2) specifying how many flow unit total per pulse, U/P (i.e. 0.1 lb per pulse) or (3) specifying how many pulses per unit, P/U, of mass. All these approaches are equivalent.

From the base screen, press **I/O (F1)** and then **FEQ (F2)**

FREQUENCY OUTPUT			
P/U	U/P	FEQ	EXIT

F1	F2	F3	F4
----	----	----	----

Use **P/U (F1)** to enter pulse per unit, **U/P (F2)** for Unit per pulse and **FEQ (F3)** to enter the flow and maximum frequency to scale the frequency output.

When data is entered with any of the 3 methods, the other values will be re-calculated according to the settings.

4.1.4.1. Entering data in Pulse per Unit:

Press **P/U (F1)** and the following screen will show:

PLS/UNT = 100		
CHG		OK

F1	F2	F3	F4
----	----	----	----

Press **CHG (F1)** to change the setting and then **OK (F4)** to accept entry.
The value entered is in pulse per selected flow unit total (i.e. 10 pulses per SCF)

4.1.4.2. Entering data in Unit per Pulse:

Press **U/P (F2)** and the following screen will show:

UNT/PLS = 0.01		
CHG		OK

F1	F2	F3	F4
----	----	----	----

Press **CHG (F1)** to change the setting and then **OK (F4)** to accept entry.
The value entered is in unit per pulse (i.e. 0.01 flow unit total per pulse)

4.1.4.3. Entering data with flow and maximum frequency:

Press **FEQ (F3)** and the following screen will show:

MaxFreq=98.52 Hz		
CHG		OK

F1	F2	F3	F4
----	----	----	----

Enter the maximum frequency and press **OK (F4)**
(Maximum frequency should not exceed 100 Hz)

The next screen will show:

Maxflo=2000 SCFM		
CHG		OK

F1	F2	F3	F4
----	----	----	----

Note: When the flow rate exceeds the maximum frequency set point, the output will stay at that maximum frequency but the FT2 will issue an alarm code.

4.1.5. Discrete Input/Output

To program the discrete input or output, press **I/O (F1)** key from the base menu

SET I/O			
I/O	FEQ	420	EXIT
F1	F2	F3	F4

Then press **I/O (F1)** again:

SET I/O			
COM	CTC		EXIT
F1	F2	F3	F4

Then press **CTC (F2)** to select contact input/output

CONTACTS			
INP	ALM		EXIT
F1	F2	F3	F4

4.1.5.1. For Discrete Input Settings:

Press **INP (F1)** key to select input, then menu will display:

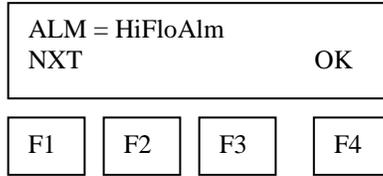
INP = Not Used			
NXT			OK
F1	F2	F3	F4

Press **NXT (F1)** repeatedly until the correct selection is shown and then press **OK (F4)** to accept the setting.

Selections are: Not used
 Tot Reset to reset the totalizer
 Switch Crv Multi Curve Option Only

4.1.5.2. For Discrete Output Setting:

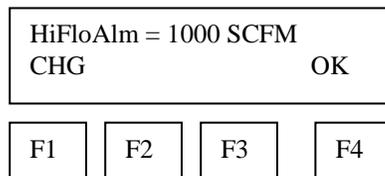
Press **ALM (F2)** key to select alarm output, then menu will display:



Press **NXT (F1)** repeatedly until the correct selection is shown and then press **OK (F4)** to accept the setting.

- Selections are:
- Not used
 - HiFloAlm for High Flow Alarm
 - LoFloAlm for Low Flow Alarm
 - HiTempAlm for High Temperature Alarm
 - LoTempAlm for Low Temperature Alarm

If a Limit type is selected, then the menu will display:



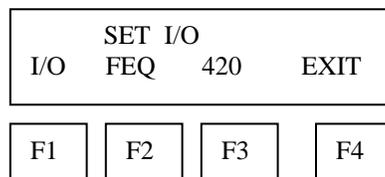
Enter the limit value to trigger the contact alarm output and then press **OK (F4)** to accept the setting.

Press **EXIT (F4)** repeatedly until “Normal Mode” is seen briefly to exit the programming mode.

The JP1 selection jumper needs to be installed between pin 2 & 3 on the main FT2 board to select the isolated digital output for the alarm.

4.1.6. RS485 Serial Communication Settings

To program the RS485 settings, press **I/O (F1)** key from the base menu



Then press **I/O (F1)** again:

SET I/O			
COM	CTC		EXIT

F1	F2	F3	F4
----	----	----	----

Press **COM (F1)** to select RS485 communication bus type and then **OK (F4)**

Bus=Modbus		
NXT		OK

F1	F2	F3	F4
----	----	----	----

Selections are: None
Modbus
Profibus
Ethernet
DeviceNet

Note: Special hardware is needed to use Profibus, DeviceNet and Ethernet

Baud=9600	
NXT	OK

For Modbus selection only

F1	F2	F3	F4
----	----	----	----

Press **NXT (F1)** to select the baud rate and press **OK (F4)**

Selections are: 19200
9600
4800
2400
1200

Parity=None	
NXT	OK

For Modbus selection only

F1	F2	F3	F4
----	----	----	----

Press **NXT (F1)** to select the parity and press **OK (F4)**

Selections are: NONE
ODD
EVEN

Data Bit=8 NXT	OK
-------------------	----

For Modbus selection only

F1	F2	F3	F4
----	----	----	----

Press **NXT (F1)** to select the data bit and press **OK (F4)**

Selections are: 7 or 8

Stop Bit=1 NXT	OK
-------------------	----

For Modbus selection only
(Should always be 1)

F1	F2	F3	F4
----	----	----	----

Press **NXT (F1)** to select the stop bit and press **OK (F4)**

Selections are: 1 or 2

Loop ID = 1 CHG	OK
--------------------	----

For Modbus selection only

F1	F2	F3	F4
----	----	----	----

Press **CHG (F1)** to change the Modbus address and then press **OK (F4)**. To avoid conflicts on the Modbus this must be a unique address.

NOTE: If any parameter for MODBUS is changed the unit requires a **RESET** or **power cycle** for the new parameters to be loaded.

4.1.7. Display Setup

From the base programming menu press **DSP (F3)** to select the display menu:

DISPLAY/PASSWORD DSP PSW	EXIT
-----------------------------	------

F1	F2	F3	F4
----	----	----	----

4.1.7.1. To Program the Display:

Press **DSP (F1)** key. The display will show:

DSP1L1 = Flo Total NXT	OK
---------------------------	----

F1	F2	F3	F4
----	----	----	----

These are the selections for the display #1 line #1.

Selections are: Flo rate for Flow rate
 Flo Total for Total mass
 Elps time for elapsed time
 Temp for temperature
 Errors for error codes

When the selection is correct, press **OK (F4)** to accept it and then the display will go through the same process for all 4 lines of the 2 programmable displays (DSP1L1, DSP1L2, DSP2L1 and DSP2L2).

After the last line of display 2 is accepted, the display will show the following menu:

ALTERNATE = Off			
NXT			OK

F1	F2	F3	F4
----	----	----	----

This menu allows you to alternate between menu display 1 and 2 every few seconds.

Selections are: On or Off

Press **OK (F4)** to accept selection.

Press **EXIT (F4)** repeatedly until “Normal Mode” is seen briefly to exit the programming mode.

4.1.8. Password

There are 2 user level passwords, only **Level 1** is programmable and gives access to all the normal settings. The second one is used to allow access to calibration factors, that should normally never be changed, and to set a new password in the event that the user forgets the **Level 1** password.

Default **Level 1** password is “1234”, and **Level 2** password is “9111”.

The **Level 1** programmable password can be disabled by setting it to “0”.

From the base programming menu press **DSP (F3)** to select the display menu:

DISPLAY/PASSWORD			
DSP	PSW		EXIT

F1	F2	F3	F4
----	----	----	----

4.1.8.1. To Program the Password:

Press **PSW (F2)** key to select password.

PASSWD = 1234			
CHG			OK

F1	F2	F3	F4
----	----	----	----

This screen displays the current **Level 1** password.

Press **CHG (F1)** key to change the password and enter new value accordingly to 4.1.1 description of entering data.

Press **OK (F4)** to accept new data and exit programming by pressing **EXIT (F4)** key repeatedly until out of the programming mode.

Note: Password can be number or letter characters up to 4 digits.

4.1.9. Units Settings

This menu is used to set the units for mass flow, temperature, pressure reference and the settings of reference temperature, reference pressure and density of gas when using Lbs/time or Kg/time. These values will be set at FOX, using the Application Data Sheet values. If the customer changes the application, these values can be changed to match the new application. Check with FOX customer service before changing the application gas.

The unit setting is accessed from the base programming menu by pressing **FLO (F2)** key:

SET PARAMETERS			
I/O	FLO	DSP	EXIT

F1	F2	F3	F4
----	----	----	----

FLOW PARAMETERS 1			
SIM	UNT	PRM	EXIT

F1	F2	F3	F4
----	----	----	----

Press **UNT (F2)** for Unit selection:

FLO = SCFM			
NXT			OK

F1	F2	F3	F4
----	----	----	----

Press **NXT (F1)** key to change selection and **OK (F4)** to accept it

Selections for Flow unit are:

- SCFM
- SCFH
- NM3/H
- NM3/M
- KG/HR
- KG/M
- KG/S
- LBS/H
- LBS/M
- LBS/S
- NLPH
- NLPM
- SMPS
- NMPS
- SFPM
- MMSCFD
- LBS/D
- SLPM
- NLPS
- MSCFD
- SM3/H
- MT/H
- NM3/D
- MMSCFM

WARNING:

The FT2 re-calculates area, 4 & 20 ma values, Maximum flow for the frequency output and zero flow cutoff when changing flow units, going to and from volumetric and mass flow. When going to and from Velocity or velocity to velocity, the FT2 will not re-calculate these values and these values must be re-entered manually.

After pressing **OK (F4)** to accept the Flow unit the display will prompt for the temperature unit setting:

TMP UNT= Deg C	
NXT	OK

F1	F2	F3	F4
----	----	----	----

Press **NXT (F1)** key to change selection and **OK (F4)** to accept it.

Selections for Temperature unit are: DEG C
DEG F

After pressing **OK (F4)** to accept the temperature unit setting, the display will prompt for temperature reference in selected unit.

TmpRef = 60 C	
CHG	OK

F1	F2	F3	F4
----	----	----	----

Press **CHG (F1)** to change the reference and **OK (F4)** to accept it.

After pressing **OK (F4)** to accept the reference temperature, the display will prompt for the pressure unit selection:

PRES UNT= mmHG			
NXT			OK
F1	F2	F3	F4

Press **NXT (F1)** to select next entry and **OK (F4)** to accept it.

Selections are: mmHG
Psia
bara

After the pressure unit selection is made, the display will show a menu to enter the pressure reference:

PresRef= 760			
CHG			OK
F1	F2	F3	F4

Press **CHG (F1)** to change it and **OK (F4)** to accept.

After the pressure reference is accepted, the display will prompt for the gas density if LBS or KG was selected for flow unit:

DNS = 0.988876 KG/m3			
CHG			OK
F1	F2	F3	F4

Press **CHG (F1)** to change and **OK (F4)** to accept.

Note: The density entry is only used when KG/time or LBS/time is selected for flow rate units. Density conditions are referenced to 0 C° at 760 mmHg.

4.1.10. Flow Parameters

This is the menu used to set various flow parameter values. They are:
Flow cutoff, pipe area, filter, high and low alarm for flow and temperature.

The menu is accessed from the base programming menu by pressing **FLO (F2)** key:

SET PARAMETERS			
I/O	FLO	DSP	EXIT
F1	F2	F3	F4

FLOW PARAMETER 1			
SIM	UNT	PRM	EXIT
F1	F2	F3	F4

Then press **PRM (F3)** key:

FLOW PARAMETER 2			
CAL	SPC	PRM	EXIT
F1	F2	F3	F4

Note: The CAL and SPC function key will only appear and be accessible from a **Level 2** password.

Then press **PRM (F3)** key:

CUTOFF = 2.0 SCFM			
CHG			OK
F1	F2	F3	F4

Enter the value for the percent low flow cutoff and then press **OK (F4)** key.
When the flow rate falls below the zero flow cutoff, the flowmeter will display a flow value of zero.

A ² = 0.05672 Ft ²			
CHG			OK
F1	F2	F3	F4

Enter the pipe area in **square meters** or **square feet** and then press **OK (F4)** key.
Use square meter for metric flow unit selection and square feet for English flow unit selection.

FILTER = 0.8			
CHG			OK
F1	F2	F3	F4

The filter value is also referred to as a dampening factor and is used to quiet the readings.
The filter value is an exponential filter that dampens the noise and is used as follows:

Flow Value = (FA * new value) + (FB * average) where
FA = filter value, FA + FB is equal to 1.0.

For example if we enter a filter of 0.8, the weight ratio for new average is:
 New average = (80% new sample) + (20% last average)

Filter range is 0.01 to 1.0, 0.01 being a high filter value and 1.0 = no filter.

Filter	Response (sec) (65% of target)
0.9	0.10
0.8	0.15
0.7	0.20
0.6	0.25
0.5	0.30
0.4	0.35
0.3	0.40
0.2	0.60
0.1	1.00
0.05	2.00
0.03	3.00
0.01	10.3

Enter the filter value and then press **OK (F4)** key.

HiFloAlm = 1234 SCFM
 CHG OK

F1

F2

F3

F4

This is the upper flow limit alarm value that can be associated with a discrete output. An alarm code is generated when the flow value exceeds this limit. If no checking is needed, this value should be set to zero.

Press **OK (F4)** to accept the value.

LoFloAlm = 100 SCFM
 CHG OK

F1

F2

F3

F4

This is the lower flow limit alarm value that can be associated with a discrete output. An alarm code is generated when the flow value is below this limit. If no checking is needed, this value should be set to zero.

Press **OK (F4)** to accept the value.

HiTmpAlm = 230 C
 CHG OK

F1

F2

F3

F4

This is the upper temperature limit alarm value that can be associated with a discrete output. An alarm code is generated when the temperature value exceeds this limit. If no checking is needed, this value should be set to zero.

Press **OK (F4)** to accept the value.

LoTmpAlm = 50 C			
CHG			OK

F1	F2	F3	F4
----	----	----	----

This is the lower temperature limit alarm value that can be associated with a discrete output. An alarm code is generated when the temperature value is below this limit. If no checking is needed, this value should be set to zero.

Press **OK (F4)** to accept the value.

Note: If the programming menu was entered with a **Level 2** password, then more menus will be shown that deal with factory set parameters that should not be changed.

4.1.11. Calibration Parameters

This menu allows changing the factory calibrated setting of the flowmeter and is accessible with a **Level 2** password. Calibration parameters values are set for temperature and pressure at 0 degree C and 760 mmHg.

These settings should normally never be changed except by Fox Thermal Instrument personnel at the factory.

This menu is entered from the base menu and pressing **FLO, PRM** and **CAL**.

FLOW PARAMETER 2			
CAL	SPC	PRM	EXIT

F1	F2	F3	F4
----	----	----	----

Press **CAL (F1)** then the display will show:

Volt1 = 0.92367			
CHG	PRV	NXT	EXIT

F1	F2	F3	F4
----	----	----	----

Flo1 = 0			
CHG	PRV	NXT	EXIT

F1	F2	F3	F4
----	----	----	----

Use the **CHG (F1)** key to change the entry, **PRV (F2)** to move to the previous entry, **NXT (F3)** to move to the next entry and **EXIT (F4)** to return.

The calibration table can hold up to 20 data pair points. Each data point has a voltage and mass velocity associated with it.

Pressing the **NXT (F3)** key will show the data point voltage and then mass velocity and then go to the next data point. The number after Volt (ie. Volt1) or Flo (i.e. Flo1) indicated the data point number.

Upon exiting the menu, the display will prompt for a calibration date as follows:

CalDate=2/24/03		OK	
CHG			

F1	F2	F3	F4
----	----	----	----

4.1.12. Reset Total and Elapsed Time

The resetting of the totalizer and elapsed time is accomplished by pressing the **F3** and **F4** keys at the same time in the normal running mode.

RESET TOTAL ?		YES	
NO			

F1	F2	F3	F4
----	----	----	----

Press **YES (F4)** to reset total and **NO (F1)** to cancel.

If you entered the programming menu with a **Level 2** password, The following menu **Restore Database** will be displayed:

4.1.13. Restore Database

Before restoring the factory default, please contact the Fox's service department for advice.

Restoring the original factory settings is accomplished from the "Flow Parameter 2" menu by entering a **Level 2** password "9111" and pressing the **SPC** key (**F2**).

RESTORE DATABASE ?		NO	
YES			

F1	F2	F3	F4
----	----	----	----

Press **YES (F1) ONLY** if you want to restore your database to the initial factory setting that the meter was shipped with. All current user-entered settings will be overwritten.

The F1 key must be pressed while the push button S2 on the FT2 main board is pressed. The green LP1 LED will flash at a faster pace until the recall is performed.

4.1.14. Reset CRC

If the EEPROM CRC check fails (Error Code 36), the EEPROM values will need to be verified and corrected before clearing the error. Call FOX Customer Service if you need assistance.

RESET CRC?	
YES	NO

F1	F2	F3	F4
----	----	----	----

Press **YES (F1) ONLY** if you want to reset the CRC and generate a new CRC value.

4.1.15. Simulation

This menu allows for the simulation of flow rate, temperature and flow input voltage. It should only be used for testing and demonstration purposes.

Make sure to return all of these simulation values to zero, before returning to the normal mode of operation.

Note: Simulated values are only enabled when not set to zero.

Caution:

If the 4 to 20 mA and/or the pulse outputs are connected to controllers, set the controllers to “manual”. This will ensure that the simulated signals do not cause false controller action.

The menu is accessible from the main programming menu by pressing **FLO**, and **SIM**:

FLOW PARAMETER 1			
SIM	UNT	PRM	EXIT

F1	F2	F3	F4
----	----	----	----

Pressing **SIM (F1)** will show:

FloSim = 0 SCFM	
CHG	OK

F1	F2	F3	F4
----	----	----	----

Enter the value and then press **OK (F4)**.

Note: Enter zero to disable this feature.

TmpSim = 0 C	
CHG	OK

F1	F2	F3	F4
----	----	----	----

Enter the value and then press **OK (F4)**.

Note: Enter zero to disable this feature.

CsvSim = 0 V		OK	
CHG			
F1	F2	F3	F4

Enter the value and then press **OK (F4)**.

Note: This value is used to simulate the Current Sense Voltage (CSV) and should be set to zero for normal mode.

Enable SIM ?		NO	
YES			
F1	F2	F3	F4

Press **YES (F1)** to start the simulation mode, **NO (F4)** otherwise.

Upon pressing either key, the program will return to the FLOW PARAMTER 1 menu.

NOTE: Simulation Mode will be cleared if the power is cycled.

5. Preventative Maintenance

Warning! Before attempting any maintenance, take the necessary safety precautions before removing the probe from the duct (example: purge lines of toxic and/or explosive gas, depressurize, etc...)

Turn **OFF** input power before removing or installing a circuit board assembly from the enclosure.

5.1. Access to Electronics

After turning **OFF** the power, loosen the 4 captive screws from the cover plate to expose the circuit boards. This should give access to the TS2 connector.

Caution needs to be exercised to not damage the cable connecting the LCD/Keypad board to the main board.

5.2. Sensor Cleaning

Even though the sensor is insensitive to small amount of contamination, continued use in dirty environments will necessitate periodic cleaning. **Remove power** before removing the unit from duct, exposing the sensor elements. If they are visibly dirty, clean them with water or alcohol (ethanol) using an artist's brush until they appear clean again. Even though the sensor elements are rugged and breakage resistant, avoid touching them with any solid object and use a light touch while cleaning them.

5.3. Broken or Damaged Probe

If the sensor is broken or damaged, the probe and electronics must be returned to the factory. A new sensor will be installed and calibrated. Refer to Section 6.2, Return Procedure.

5.4. Calibration

To insure continuing high accuracy of your Model FT2 Flow Meter, Fox Thermal Instruments Inc. provides a full NIST traceable calibration. The minimum re-calibration interval is 2 years, unless otherwise recommended by FOX.

5.5. Fuse Replacement (Standard and NFP version)

Warning! Turn input power OFF before removing or installing a circuit board assembly from the enclosure and before removing or installing the fuse. Use only recommended fuse replacements.

Verify the fuse is defective by measuring it with an Ohm Meter (Two replacement fuses are provided with each unit).

To replace the fuse:

The fuse **F1** is located on the edge of the main circuit board and can be removed by using a sharp instrument or a small screwdriver (wrist watch type screwdriver).

6. Troubleshooting

Caution! The electronics, sensor and sensor interconnect wires supplied by Fox are calibrated as a single precision mass flowmeter. Interchanging sensors or sensor wiring will impair the accuracy of the flow meter. If you experience any problem with your Model FT2 Flow Meter, call Fox's Customer Service Department, Technical Assistance at (831) 384-4300.

Problem	Possible Cause	Action
Unit will not power-up	a) No power input b) Bad fuse c) Bad Power supply	a) Turn power on b) Replace fuse. See section 5.5 c) Verify 24 VDC input power.
Velocity Measurement seems low	a) Probe not oriented properly b) Sensor dirty	a) Orient probe per Section 2.2.3 b) Clean sensor. (Refer to section 5.2, Preventative Maintenance)
Velocity measurement is erratic or fluctuating	a) Very turbulent flow b) Sensor dirty c) Sensor broken d) Probe not mounted securely e) Malfunction in flow meter f) Verify Installation guidelines (see Figure 2-4).	a) Adjust dampening per section 4.1.10 b) Clean sensor (refer to section 5.2) c) Return flow meter to Fox for repair (refer to section 6.2 for shipping instruction) d) Probe must be mounted securely without vibration e) Return flow meter to Fox for repair (refer to section 6.2 for shipping instruction) f) Install meter accordingly to guidelines.

The following is a summary listing of problems occasionally encountered with the FT2 Thermal Mass Flowmeter and it's installation.

1. Inadequate power source.

For those models that are powered by 24VDC, a 24VDC \pm 1VDC, 25-watt power supply is recommended. If the voltage supplied is not within this range or if the power supply is not rated for 25 watts minimum, a variety of problems can occur including inaccurate flow readings, dim display and faulty programming action. The input voltage must be within the range of 23 to 25 VDC as measured at the power input terminals of the flowmeter electronics.

2. Improper wiring connections for power and/or 4-20mA output signal.

The FT2 requires a separate power source for the main board and the two 4-20mA output signals. Two wires supply 24VDC power to the main board. Two wires are used for each of the 4-20 mA output signals. Refer to Figure 3-2 and Figure 3-3.

3. Improper 4-20mA wiring.

The FT2 flowmeter can have the 4-20mA signal connected in an "isolated configuration" or "non-isolated configuration". In the isolated configuration, the customers signal receiving equipment (PLC, DCS, etc.) powers the 4-20 mA loop. Refer to Figure 3-3.

In the non-isolated configuration, the 24 VDC power supplied to board power input connector (TS1) can be connected to the 4-20 mA (+) input supply voltage. The 24 VDC return wire and the (-) connection of the 4-20mA output must be connected back to the customer's measuring device.

4. Improper sensor wiring

The FT2 monitors the sensor signals and will issue an Error Code 22 when a sensor is out of range. If the temperature of the probe is excessive it will shut down the current to the sensor in order to protect it. The display indicating flow may fluctuate on and off from 0 to some value every ten seconds.

5. Flow measurement seems inaccurate.

Ensure that the flowmeter is installed so that the Flow Direction Arrow engraved on the flat surface of the fitting below the electronics housing is properly pointing in the direction of flow. Refer to Figure 2-6.

If you have a Fox Insertion Flowmeter, verify that the insertion depth of the sensor/probe is correct. The end of the probe should be adjusted as per section 2.2.2. Refer to Figure 2-1.

Ensure there is a minimum of ten diameters of straight pipe upstream of the sensor and five diameters downstream. If complex flow disturbances are upstream of the sensor, extension of the straight pipe may be required. Contact Fox for assistance.

The internal cross sectional area of the pipe is programmed into the flowmeter through the front panel (see section 4.1.10 Flow Parameters). This area is programmed in square feet or square meters. The Calibration Certificate delivered with the flowmeter contains the area that was programmed into the flowmeter at the Fox factory. Verify that this area was entered correctly.

6. Erratic flow reading especially a flow reading spiking high.

This is a symptom of moisture in the flow stream. Fox flowmeters are designed to work in relatively dry gas applications only. Contact Fox to discuss resolutions to this problem.

7. The FT2 flowmeter is not responding to flow.

This problem could be caused by a number of items. First check to ensure adequate power is supplied to the flowmeter as described above. If things appear to be correct, an easy functional test can be performed. Carefully remove the probe and sensor from the pipe or flow body. Caution: the sensor is **HOT**. For flowmeters with a display is reading zero, blow on the sensor to see if a response occurs. If nothing happens, take a damp rag or sponge and place it in contact with the sensor. A reading should occur. Contact Fox Customer Service with this information.

8. Display and/or 4-20mA signal reading above zero flow when no flow is occurring in the pipe.

If the reading is less than 5% of full scale, it is likely this is a normal condition caused by convection flow created by the heated sensor. It does not mean that the zero of the instrument is improperly set. The Fox sensor is extremely sensitive to gas flow and can even read the small flow caused by convection. If this is an unacceptable condition, please contact Fox Customer Service for alternatives.

6.1. Replacements Parts

F1 – Fuse. FOX Part Number 100045. Digi-Key Part Number F1142CT-ND.
Front Panel Display Module.

6.2. Return Procedure

The Fox Thermal Instruments, Inc. Customer Service Department can be reached at (831) 384-4300. Please have the model and serial number available when you call.

If it becomes necessary to return a Model FT2 Mass Flow Meter to Fox Thermal Instruments, obtain a Return Material Authorization Number from Customer Service Department.

Unless specially instructed to do otherwise, the entire flow meter must be returned, including all electronics.

Clean and decontaminate all wetted parts.

Please include information describing the difficulties experienced, purchase order number under which the equipment was purchased, and a contact name and phone number.

Be sure to include complete return shipping instructions. We cannot deliver to post office boxes. Ship to the following address:

**Fox Thermal Instruments, Inc.
399 Reservation Road
Marina, CA 93933
Attn: Service Dept.
RMA Number**

Warranty

- a. FOX warrants that the products furnished under this Agreement will be free from defects in material and workmanship for a period of one year from the date of shipment. The customer shall provide notice of any defect to FOX, within one week after the Customer's discovery of such defect. The sole obligation and liability of FOX under this warranty shall be to repair or replace, at its option, without cost to the Customer, the defective product or part.
- b. Upon request by FOX, the product or part claimed to be defective shall immediately be returned at the Customer's expense to FOX. Replaced or repaired products or parts will be shipped to the Customer at the expense of FOX. FOX shall have the right of final determination as to the existence and cause of defect.
- c. There shall be no warranty or liability for any products or parts that have been subject to misuse, accident, negligence, failure of electric power or modification by the Customer without the written approval of FOX. This warranty does not cover damage caused by Customer's exposure of the goods to corrosive or abrasive environments. Final determination of warranty eligibility shall be made by FOX. If a warranty claim is considered invalid for any reason, the Customer will be charged for services performed and expenses incurred by FOX in handling and shipping the returned unit.
- d. The liability of FOX shall be limited to replacing or repairing, at its option, any defective parts which are returned. Labor and related expenses incurred by the Customer to install replacement parts are not covered by this warranty.
- e. As to replacement parts supplied or repairs made during the original warranty period, the warranty period for the replacement or repaired part shall terminate with the termination of the warranty period of the original product or part.
- f. The use of FOX products are under exclusive control of the buyer. No warranty, express or implied, is given for the calibration, accuracy or workmanship of end-use product into which Fox products are installed. FOX can only be held responsible for the calibration and accuracy of product supplied by FOX. FOX specifically denies any liability arising from the buyer's application of FOX products including any physical injuries or death arising directly or indirectly out of or in connection with the manufacture, sale, use, or defect of the products sold hereunder.
- g. No warranty is made with respect to custom equipment or products produced to Buyer's specifications except as specifically stated in writing by FOX and contained in the agreement.
- h. **THE FOREGOING WARRANTY CONSTITUTES THE SOLE LIABILITY OF FOX AND THE CUSTOMER'S SOLE REMEDY WITH RESPECT TO THE PRODUCT AND IS IN-LIEU OF ALL OTHER WARRANTIES. FOX DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

In no case are products to be returned without first obtaining permission and a Return Material Authorization number from FOX.

Glossary of Terms and Abbreviations

AC	Alternating Current	NM3	Normal cubic Meter
AWG	American Wire Gauge	NM3/D	Normal cubic Meter per Day
Bara	Bar absolute	NM3/H	Normal cubic Meter per Hour
CTC	Contact	NM3/M	Normal cubic Meter per Minute
CAL	Calibration	NPT	National Pipe Thread
CHG	Change	NXT	Next
COM	Communication	OUT	Output
CSV	Current Sense Voltage	PDA	Personal hand held computer
DC	Direct Current	PC	Personal Computer
DN	Down	PCB	Printed Circuit Board
DSP	Display	P/U	Pulse per Unit
ELP	Elapsed time	PIP A ²	Pipe Area
Feq	Frequency	PLC	Programmable Logic Controller
Ft ²	Square Feet	PRM	Parameters
Hz	Hertz	PRS	Pressure
I/O	Input/Output	PSIA	Pounds per Square Inch Absolute
INP	Input	Pt	Point
LB	Pound	PSW	Password
LB/D	Pound per Day	RTD9	9 Ohm RTD Resistance
LB/H	Pound per Hour	SIM	Simulation
LB/M	Pound per Minute	SCF	Standard Cubic Feet
LB/S	Pound per Second	SCFM	Standard Cubic Feet per Minute
LCD	Liquid Crystal Display	SCFH	Standard Cubic Feet per Hour
KG	Kilogram	SPC	SPecial Control
KG/H	Kilogram per Hour	STP	Standard Temperature and Pressure
KG/M	Kilogram per Minute	TMP	Temperature
KG/S	Kilogram per Second	TSI	Internal Variable
M ²	Square Meter	TSV	Internal Variable
mA	milliamps	UNT	Unit
mmHG	Pressure in millimeters of mercury	U/P	Unit per Pulse
MMSCFD	Million Standard Cubic Feet per Day	VDC	Volts of Direct Current
MMSCFM	Million Standard Cubic Feet per Minute	420	4 to 20 mA output
MSCFD	Thousand Standard Cubic Feet per Day		
MT/H	Metric Ton per Hour		
MXFLO	Maximum Flow		
NEMA	National Electrical Manufactures Association		
NIST	National Institute of Standards and Technology		
NLP	Normal Liter		
NLPH	Normal Liter per Hour		
NLPM	Normal Liter per Minute		

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