Fox Thermal Instruments, Inc.

THERMAL MASS FLOW METER & TEMPERATURE TRANSMITTER

Model FT4X

FOX
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Fox is ISO 9001 certified

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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Download Technical Data Sheets from our website:
www.foxthermalinstruments.com

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Fox FT4X Manuals:
- **Fox FT4X Data Logger Manual**
- **Fox FT4X View™ Manual**

All Fox Manuals and software available in English only.

FOX
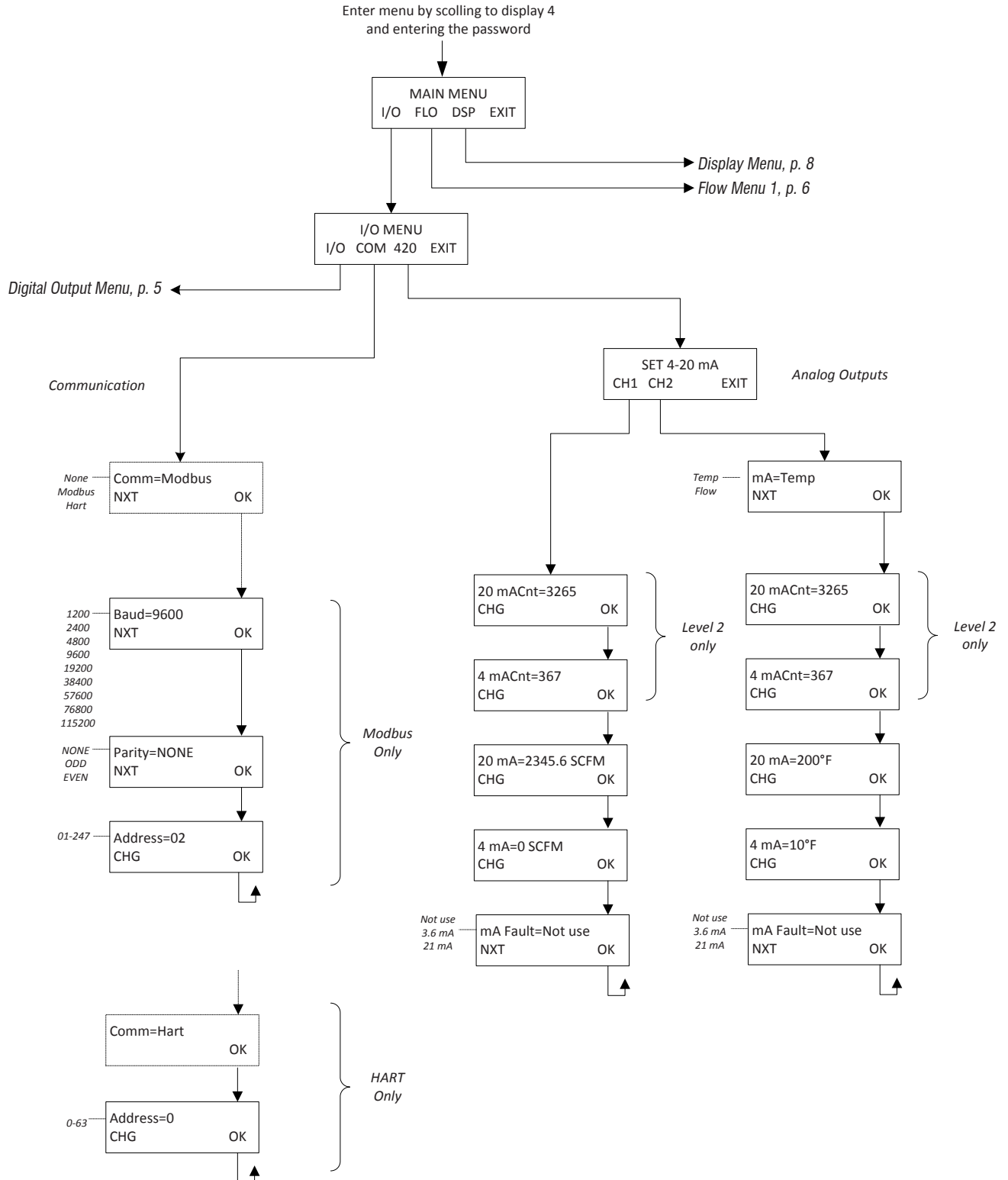*THERMAL INSTRUMENTS, INC.*
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Introduction: Menu Trees

INTRODUCTION

Main Menu

Fig. 1.1: FT4X Menu Tree - Main Menu

Enter menu by scolling to display 4
and entering the password

MAIN MENU
I/O   FLO   DSP   EXIT

Display Menu, p. 8

Flow Menu 1, p. 6

I/O MENU
I/O   COM   420   EXIT

Digital Output Menu, p. 5

Communication

SET 4-20 mA
CH1   CH2   EXIT

Analog Outputs

None
Modbus
Hart

Comm=Modbus
NXT   OK

1200
2400
4800
9600
19200
38400
57600
76800
115200

Baud=9600
NXT   OK

NONE
ODD
EVEN

Parity=NONE
NXT   OK

*Modbus
Only*

01-247

Address=02
CHG   OK

Temp
Flow

mA=Temp
NXT   OK

20 mACnt=3265
CHG   OK

20 mACnt=3265
CHG   OK

*Level 2
only*

4 mACnt=367
CHG   OK

4 mACnt=367
CHG   OK

*Level 2
only*

20 mA=2345.6 SCFM
CHG   OK

20 mA=200°F
CHG   OK

4 mA=0 SCFM
CHG   OK

4 mA=10°F
CHG   OK

Not use
3.6 mA
21 mA

mA Fault=Not use
NXT   OK

Not use
3.6 mA
21 mA

mA Fault=Not use
NXT   OK

Comm=Hart
                   OK

*HART
Only*

0-63

Address=0
CHG   OK

Introduction: Menu Trees

Digital Output Menu

Fig. 1.2: FT4X Menu Tree - Digital Outputs and Input

```
                    MAIN MENU
               I/O   FLO   DSP   EXIT

                    I/O MENU
               I/O   COM   420   EXIT

                     Set I/O
               OUT   INP          EXIT
```

Not used .... OUT= Pulse   Not used .... Inp= Not Used
Pulse   NXT   OK   Tot Reset   NXT   OK
HiFloAlm
LoFloAlm
HiTempAlm
LoTempAlm

Alarm output   *Pulse*

High Flow Alarm

```
OUT= HiFloAlm
NXT          OK
```

Select 1 of 3 methods to scale the pulse output

```
HiFloAlm=500 SCFM
CHG          OK
```

```
    PULSE OUTPUT
P/U   U/P   FEQ   EXIT
```

Low Flow Alarm

```
PLS/UNT=2              UNT/PLS=0.5           MaxFreq=100Hz
CHG          OK        CHG          OK       CHG          OK
```

```
OUT= LoFloAlm
NXT          OK
```

```
LoFloAlm=100 SCFM
CHG          OK
```

```
MaxFlo=5000 SCFM
CHG          OK
```

High Temp Alarm

```
OUT= HiTempAlm
NXT          OK
```

(See Flow Menu 2, p. 7, for more alarm settings)

```
HiTmpAlm=250° F
CHG          OK
```

Low Temp Alarm

```
OUT= LoTempAlm
NXT          OK
```

NOTE! A value of 0 disables the alarms

```
LoTmpAlm=10 F
CHG          OK
```

Introduction: Menu Trees

Flow Menu 1

Fig. 1.3: FT4X Menu Tree - Flow Menu 1

```
                          MAIN MENU
                      I/O   FLO   DSP   EXIT

                          FLOW MENU 1
                      DGN   UNT   FM2   EXIT
```

Flow Menu 2 Menu, p. 7

```
        DIAGNOSTIC                              FLO UNT=SCFM
    SIM   CAL-V        EXIT          SCFM       NXT              OK
                                     SCFH
                                     NM3/H
                                     NM3/M
                                     KG/H
                                     KG/M
        Simulate Flow?               KG/S       TMP UNT=° F
    YES              NO              LBS/H       NXT              OK
                                    LBS/M
                                    LBS/S
                                    NLPH
                                    NLPM
        FloSim=0 SCFM              MMSCFD        TmpRef=60 °F
    CHG              OK             LBS/D        CHG             OK
                                    SLPM
                                    NLPS
                                    MSCFD
                                    SM3/H
        Simulate Temp?              MT/H
    YES              NO             NM3/D        PRES UNT=Psia
                                   MMSCFM        NXT             OK
                                    SCFD
                                    MCFD
                                    SM3/M
        TmpSim=0 ° F                SM3/D
    CHG              OK                           PresRef=14.73
                                                 CHG             OK


        ENABLE SIM?
    YES              NO
```

Deg F
Deg C

mmHG
Psia
bara

CAL-V™ Menu, p. 9

Introduction: Menu Trees

Flow Menu 2

Fig. 1.4: FT4X Menu Tree - Flow Menu 2

```
              MAIN MENU
          I/O   FLO   DSP   EXIT

              FLOW MENU 1
          DGN   UNT   FM2   EXIT

              FLOW MENU 2
          GAS   SPC   PRM   EXIT
```

Gas-SelectX® Menu, p. 10

Parameters

Level 2

```
K fact = 0%
CHG              OK
```

```
Cutoff=12.5 SCFM
CHG              OK
```
Flow cutoff in selected units

```
RESTORE DATABASE?
YES              NO
```

```
Pipe_id=4.026 In
CHG              OK
```
Pipe id in inches or mm

```
RESET CRC?
YES              NO
```

```
Filter=0.8 Sec
CHG              OK
```
Flow Filter in seconds
Min = 0.8, max = 10

```
HiFloAlm=0 SCFM
CHG              OK
```

*These alarms can be used without the digital output assigned to the alarm.
If that is the case, the alarm status will only be shown on the display, through serial communication or FT4X View.
If the digital output is assigned to an alarm, changing the value here will change that setting.
A value of 0 disables the alarm.*

```
LoFloAlm=0 SCFM
CHG              OK
```

```
HiTmpAlm=0°F
CHG              OK
```

```
LoTmpAlm=0°F
CHG              OK
```

Introduction: Menu Trees

INTRODUCTION

Display Menu

Fig. 1.5: FT4X Menu Tree - Display Menu

```
                                    MAIN MENU
                               I/O   FLO   DSP   EXIT

                                   DISP/TIME/PSW
                               DSP   LOG  PSW   EXIT
```

Display 1
Line 1

FLo rate
Total
Elps
Temp
Alarm

```
DSP1L1=FLo rate
NXT              OK
```

Display 1
Line 2

FLo rate
Total
Elps
Temp
Alarm

```
DSP1L2=Total
NXT              OK
```

Display 2
Line 1

FLo rate
Total
Elps
Temp
Alarm

```
DSP2L1=Temp
NXT              OK
```

Display 2
Line 2

FLo rate
Total
Elps
Temp
Alarm

```
DSP2L2=Elps
NXT              OK
```

When alternate "ON", flashes between the 2 displays

On
Off

```
ALTERNATE=Off
NXT              OK
```

On
Off

```
24 Hour log=On
NXT              OK

Date/Time Review
                 NXT

10/12/17   10:33
CHG              OK
```

```
Year Set=17
CHG              OK

Month Set=10
CHG              OK

Day Set=12
CHG              OK

Hour Set=12
CHG              OK

Min Set=51
CHG              OK

Sec Set=0
CHG              OK

   Set Date/Time?
YES              NO
```

```
PASSWD=1234
CHG              OK
```

Contract time for 24 hour total

```
Contr time=12:59
CHG              OK

Contr Hour=12
CHG              OK

Contr Min=59
CHG              OK

Set Contr Time?
YES              NO
```

ℹ **NOTE! All readings updated every second**
- *Flo Rate = Flow rate of process gas*
- *Total = Total flow of process gas*
- *Elps = Elapsed time since reset of flow total*
- *Temp = Temperature of process gas*
- *Alarm = Notification of errors; diagnostic errors*

Introduction: Menu Trees

CAL-V™ Menu

Fig. 1.6: FT4X Menu Tree - CAL-V™ Menu

```
          MAIN MENU
    I/O   FLO   DSP   EXIT
```

```
         FLOW MENU 1
    DGN   UNT   FM2   EXIT
```

```
       DIAGNOSTIC MENU
    SIM   CAL-V        EXIT
```

```
         CAL-V MENU
    VER                EXIT
```

```
        VERIFY CAL-V?
    YES                  NO
```

Choosing "Hold Value" will retain the last flow value while test is being performed.

Hold Value
Go to zero

```
    Flo: Hold Value
    NXT        EXIT    OK
```

```
        Take Control
    off-line     EXIT    OK
```

```
      Verifying CAL-V
      Please Wait
```

```
      Verifying CAL-V
    0.512          T=123
```

Displays a number value during test

Displays the test's count down timer

```
    CAL-V=2.321
    Fail           OK
```

```
    CAL-V=0.259
    Pass           OK
```

```
    CAL-V=0.911
    Warning        OK
```

CAL-V Fail
Greater than ±1.0

CAL-V Pass
Less than ±0.80

CAL-V Warning
Between ±0.80 to ±1.0

INTRODUCTION

Introduction: Menu Trees

Gas-SelectX® Menu

Fig. 1.7: FT4X Menu Tree - Gas-SelectX® Menu

MAIN MENU
I/O   FLO   DSP   EXIT

FLOW MENU 1
DGN   UNT   FM2   EXIT

FLOW MENU 2
GAS   PRM   EXIT

Pure Gas
Mix
O&G Mix

GAS=O&G Mix
NXT   OK

Pure Gas

Be sure mixture equals 100%.

Methane
CO2
Nitrogen
Air
Natural Gas
Argon
Propane
Helium
Oxygen
Butane
Hydrogen

GAS=Methane
NXT   OK

GAS=Mix
NXT   OK

GAS=O&G Mix
NXT   OK

Methane = 65.5 %
CHG   OK

CO2 = 25.5 %
CHG   OK

Nitrogen = 5 %
CHG   OK

Helium = 0 %
CHG   OK

Argon = 0 %
CHG   OK

Hydrogen = 0 %
CHG   OK

Air = 0 %
CHG   OK

Propane = 0 %
CHG   OK

Butane = 0 %
CHG   OK

Oxygen = 0 %
CHG   OK

Ethane = 0 %
CHG   OK

Methane = 45.5 %
CHG   OK

Ethane = 0 %
CHG   OK

Propane = 54.4 %
CHG   OK

i-Butane = 0 %
CHG   OK

n-Butane = 0 %
CHG   OK

Pentanes = 0 %
CHG   OK

Hexanes = 0 %
CHG   OK

CO2 = 0 %
CHG   OK

Nitrogen = 0 %
CHG   OK

Heptanes = 0 %
CHG   OK

Octanes = 0 %
CHG   OK

Nonanes+ = 0 %
CHG   OK

Nonanes+ = Total of all gases C9 and greater.

Err: Mix= 96%
CHG

OR

Gas Mix 100%
CHG   OK

Shows only if gas mix does not equal 100.0%.

Shows only if no error is detected. Pressing OK allows exit to menu.

Err: Mix=99.9%
CHG

OR

O&G Mix 100%
CHG   OK

Shows only if gas mix does not equal 100.0%.

Shows only if no error is detected. Pressing OK allows exit to menu.

The most recent list of available gases can be found on the Fox website:
www.foxthermalinstruments.com

Introduction: Menu Trees

Log Menu 1

Fig. 1.9: FT4X Menu Tree - Log Menu 1

Enter Log Menu: Press F1 & F2 at the same time
Press F4 to return to normal mode

```
     LOG MENU 1
LOG   TOT  ENG  EXIT
```

Log Menu 2, p. 12

Press F1 to navigate up
Press F2 to navigate down
Press F4 to return to normal mode

```
Day1=0 SCF
NXT    PRV        EXIT
```

40 24-hour totals listed

```
Day40=0 SCF
NXT    PRV        EXIT
```

Display	Display Content	Description
Display 10	3124.6 SCFM / csv = 0.3432 Volt	*Flow rate measured by the meter* / *Current Sense Voltage of sensor measurement circuit*
Display 11	Pulse=1234.5 cnt / mA_420=234 cnt	*Digital control counts of Pulse output* / *Digital control count of 4-20mA output*
Display 12	Elp=12.5 HR / Stat(hex)=2800	*Elapsed time of meter operation* / *Meter function and operation status code*
Display 13	Alarm=None / FT4X V5.3	*Meter's active alarms* / *Firmware version of meter*
Display 14	MB_Sn=P23949 / BB_Sn=P23945	*Main board serial number* / *Bridge board serial number*
Display 15	MTR_Sn=123456 / SNS_Sn=234567	*Meter serial number* / *Sensor serial number*
Display 16	FloHi=0.00 SCFM / FloLo=0.00 SCFM	*Alarm setting* / *Alarm setting*
Display 17	TmpHi=0.0 °F / TmpLo=0.0 °F	*Alarm setting* / *Alarm setting*
Display 18	Pwr_Cycl=24 / Err_tot=0	*Total number of power cycles* / *Number of errors in total flow measurement*
Display 19	CAL-V= 0.1 / Pwr Off=48.0	*CAL-V measurement value* / *Elapsed time of meter power off in hours*

NOTE!
- See the FT4X Data Logger Manual for a detailed description of the operation and log fuctions.
- All values in Log Menu 1 are view only. These values cannot be changed from this menu

Reset Total

Fig. 1.10: FT4X Menu Tree - Reset Flow Total

F3 & F4 pressed at the same time will initiate a "Total" reset

```
Reset Total?
NO              YES
```

```
Resetting Total
```
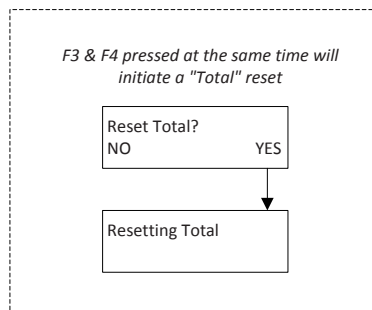
INTRODUCTION

INTRODUCTION

Log Menu 2

Fig. 1.11: FT4X Menu Tree - Log Menu 2

Enter: Press F1 & F2 at the same time
Press F4 to return to normal mode

F3 & F4 pressed at the same time will
initiate a "Total" reset

```
     LOGS MENU 1
LOG   TOT   ENG   EXIT
```

```
     LOGS MENU 2
GAS   CFG   VAL   EXIT
```

Press NXT (F1) to navigate down
Press PRV (F2) to navigate back up

Pure Gas

Air
Argon
Butane
CO2
Methane
Natural Gas
Nitrogen
Oxygen
Helium
Hydrogen
Propane

```
Methane 100%
              OK
```

```
1014.1 BTU/Ft3
NXT   PRV        EXIT
```

```
DNS=0.6800 Kg/M3
        PRV        EXIT
```

```
GAS=Mix
              OK
```

```
Air% = 0.0
NXT   PRV        EXIT
```

```
Argon% = 0.0
NXT   PRV        EXIT
```

```
Butane% = 0.0
NXT   PRV        EXIT
```

```
CO2% = 0.0
NXT   PRV        EXIT
```

```
Methane% = 45.0
NXT   PRV        EXIT
```

```
Nitrogen% = 0.0
NXT   PRV        EXIT
```

```
Oxygen% = 0.0
NXT   PRV        EXIT
```

```
Helium% = 0.0
NXT   PRV        EXIT
```

```
Hydrogen% = 0.0
NXT   PRV        EXIT
```

```
Propane% = 55.0
NXT   PRV        EXIT
```

```
Ethane% = 0.0
NXT   PRV        EXIT
```

```
1972.4 BTU/Ft3
NXT   PRV        EXIT
```

```
DNS=1.4223 Kg/M3
        PRV        EXIT
```

```
GAS=O&G Mix
              OK
```

```
Methane% = 45.0
NXT   PRV        EXIT
```

```
Ethane% = 0.0
NXT   PRV        EXIT
```

```
Propane% = 55.0
NXT   PRV        EXIT
```

```
i-Butane% = 0.0
NXT   PRV        EXIT
```

```
n-Butane% = 0.0
NXT   PRV        EXIT
```

```
Pentanes% = 0.0
NXT   PRV        EXIT
```

```
Hexanes% = 0.0
NXT   PRV        EXIT
```

```
CO2% = 0.0
NXT   PRV        EXIT
```

```
Nitrogen% = 0.0
NXT   PRV        EXIT
```

```
Heptanes% = 0.0
NXT   PRV        EXIT
```

```
Octanes% = 0.0
NXT   PRV        EXIT
```

```
Nonanes+% = 0.0
NXT   PRV        EXIT
```

```
1307.14 BTU/Ft3
NXT   PRV        EXIT
```

```
DNS=0.982 Kg/M3
        PRV        EXIT
```

```
Flow: SCFM
NXT   PRV        EXIT
```

```
Temp: °F
NXT   PRV        EXIT
```

```
Ref Press: Psia
NXT   PRV        EXIT
```

```
Ch1: Flow
NXT   PRV        EXIT
```

```
20 Ma=706.29
NXT   PRV        EXIT
```

```
4 Ma=0.00
NXT   PRV        EXIT
```

```
FloHi=0.00 SCFM
NXT   PRV        EXIT
```

```
FloLo=0.00 SCFM
NXT   PRV        EXIT
```

```
TempHi=0.0 °F
NXT   PRV        EXIT
```

```
TempLo=0.0 °F
NXT   PRV        EXIT
```

```
RefP=14.73 psia
NXT   PRV        EXIT
```

```
RefT=60.00 °F
NXT   PRV        EXIT
```

```
Kfact=0.00%
NXT   PRV        EXIT
```

```
Cutoff=12.5 SCFM
NXT   PRV        EXIT
```

```
PipeID=4.026 In
NXT   PRV        EXIT
```

```
Flt=0.80 Sec
NXT   PRV        EXIT
```

```
MTR_Sn=123456
NXT   PRV        EXIT
```

```
FT4X V5.3
NXT   PRV        EXIT
```

```
Release: 03_22_17
        PRV        EXIT
```

```
CAL-V=0.1
NXT   PRV        EXIT
```

```
CAL-V=Pass
NXT   PRV        EXIT
```

```
P CAL-V=-0.14
NXT   PRV        EXIT
```

```
P CAL-V=Pass
        PRV        EXIT
```

NOTE! See the FT4X Data Logger Manual for a detailed description of the operation and log fuctions.

Introduction: Quick Start Guide

Use the table and images below as a guide while using the worksheet on the next page to record your notes.
NOTE! Please read the entire Quick-start procedure before beginning installation.

1.	Record inside diameter (ID). Ensure the actual pipe ID matches the pipe ID shown on the factory calibration certificate. If IDs do not match, refer to p. 42.	ID · OD
2.	Record upstream and downstream straight-pipe requirements based on Pipe ID and meter style (insertion or inline). [refer to p. 19 for more information] If FC10 Flow Conditioners ordered, refer to document #107679 for further instructions.	Pipe ID min. FLOW → 8X = Inline · 4X = Inline · 15X = Insertion · 10X = Insertion
3.	a. The Flow Direction Indicator must point in the direction of flow. b. The housing can be rotated for a better view of the meter's display. Note that the 2 set screws must be loosened before the housing will turn. [refer to p. 21 for more information]	FLOW ➡ INDICATOR: - POINT IN DIRECTION OF FLOW - LOOSEN SET SCREWS TO ROTATE HOUSING ±90°, ±180° - TIGHTEN SET SCREWS WHEN DONE
4.	Ensure correct probe depth setting. If using 1 ½" size pipe, please see note on p. 21.	PIPE FLOW➡ 0.73" (18.5 mm)
5.	Open the housing. If needed, the orientation of display can be rotated in 90° increments for a better view. [refer to p. 22 for more information]	ACCESS DISPLAY BY UNSCREWING COVER REMOVE SCREWS ON DISPLAY TO ROTATE DISPLAY ±180°
6.	Ensure power wiring and 4-20mA wiring properly connected. [refer to p. 30 - p. 32 for more information]	1 SWITCH INPUT (+) TS1 2 SWITCH INPUT (-) POWER (+) 1 +12 to 28VDC 3 PULSE (+) POWER (-) 2 12 to 28VDC Return 4 PULSE (-) 4-20mA #1 (+) 3 TP1 5 Tx/Rx (+) 4-20mA #1 (-) 4 TP2 6 Tx/Rx (-) 4-20mA #2 (+) 5 7 COMMON 4-20mA #2 (-) 6 W1
7.	Ensure remote wiring is correct if remote option ordered. [refer to p. 38 - p. 39 for more information]	YELLOW YELLOW BLUE BLUE WHITE WHITE RED RED
8.	Verify you have the proper output signal wiring [refer to p. 33 - p. 36 for more information]	1.2K Ohm typical with 12VDC Power TS2 F1 0.75A TS1 SWITCH INPUT (-) SWITCH INPUT (+) POWER (+) Pulse or Alarm Output PULSE/ALARM (-) POWER (-) PULSE/ALARM (+) 4 to 20mA #1 (+) TP1 12 to 28VDC Return COMMON RS-485 4 to 20mA #1 (-) TP2 Tx/Rx (-) RS-485 4 to 20mA #2 (+) Tx/Rx (+) RS-485 4 to 20mA #2 (-) W1 J2 TERMINATION
9.	Power on the flow meter.	FOX THERMAL INSTRUMENTS, INC. Initializing...
10.	Check the remaining flow meter settings by accessing the meter settings either through the front panel of the display or by using the FT4X View™ software tool. Record the settings in the spaces given for items A - E on the following page.	

Introduction: Quick Start Guide

Before powering on your meter, use this worksheet to record your notes.

	Item to verify	*Serial Number:*	*Serial Number:*	*Serial Number:*	*Serial Number:*
1.	What is the Pipe ID?	ID =	ID =	ID =	ID =
2.	Calculate the Upstream/ Downstream straight-pipe requirements	UP = DN =	UP = DN =	UP = DN =	UP = DN =
3.	a. Is the flow indicator pointed in direction of flow? b. Must the housing be rotated for easy viewing?	Y / N Y / N	Y / N Y / N	Y / N Y / N	Y / N Y / N
4.	Is the probe depth setting correct?	Y / N	Y / N	Y / N	Y / N
5.	Have you rotated the display for easier viewing?	Y / N	Y / N	Y / N	Y / N
6.	Verify proper power wiring setup				
7.	Verify proper remote wiring setup (if ordered)				
8.	Verify proper input/output wiring setup				
After powering on your meter, check items A - E below by accessing the meter settings either through the front panel of the meter's display or by using the FT4X View™ software tool.					
A.	Which flow units have been set in meter? (SCFM, KG/H, etc..)				
B.	Correct values for reference temperature and pressure?	Y / N	Y / N	Y / N	Y / N
C.	Confirm the pipe ID listed above same as "Pipe_id="				
D.	Verify the 1st 4mA and 20mA meter settings	4mA = 20mA =	4mA = 20mA =	4mA = 20mA =	4mA = 20mA =
E.	Verify the 2nd 4mA and 20mA meter settings	4mA = 20mA =	4mA = 20mA =	4mA = 20mA =	4mA = 20mA =
F.	Confirm the correct gas is selected for your application in the Gas-SelectX$^{®}$ menu				

Your Notes:

If you are experiencing any problems after completing this procedure, please call the Fox Service Department at 831-384-4300 to review this information.

Introduction

Thank you for purchasing the Model FT4X Thermal Gas Mass Flow Meter from Fox Thermal Instruments. The FT4X is one of the most technically advanced flow meters in the world. Extensive engineering effort has been invested to deliver advanced features, accurate measurement performance and outstanding reliability.

This Instruction Manual contains the electrical and mechanical installation instructions as well as details for programming, maintaining and troubleshooting the meter. This manual is divided into the following sections: Introduction, Installation, Wiring, Operation, Maintenance, Troubleshooting, Appendices, Glossary and Index.

Theory of Operation
The Model FT4X is an innovative Thermal Mass Gas Flow Meter and Temperature Transmitter. It is microprocessor-based and field programmable. The FT4X thermal sensor operates on the law that gases absorb heat. A heated sensor placed in an air or gas stream transfers heat in proportion to the stream's mass velocity. There are two sensor elements. One sensor element detects the gas temperature and a second element is maintained at a constant temperature above the gas temperature. The energy transferred from the heated element is proportional to the mass flow velocity. The FT4X flow meter maintains accurate flow measurement over a large temperature and pressure range.

Mass Flow
The Model FT4X measures mass flow; an advantage over other flow meters which measure volumetric flow rate. Volumetric flow is incomplete because temperature and pressure are unknown and must be measured separately. For example, the mass flow 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 changes. The Model FT4X provides a direct measurement of gas flow in Mass units (kg/hr, lb/hr), standard units (SCFM, SLPM) or normal units (NM3/hr, NLPM) with no additional temperature or pressure measurements required.

Calibration Validation
Validate the calibration of the FT4X in the field using the CAL-V™ test. The goal of Calibration Validation is to provide operators with the ability to verify that the meter is capturing accurate data at scheduled recalibration times - or at any time - instead of sending the meter back to the factory for recalibration. By performing CAL-V™ in the field, operators can verify that the meter is running accurately by testing the functionality of the sensor and its associated signal processing circuitry. This test can be done in the pipe under normal processing conditions.

Flow Calibration
The Fox Calibration Lab maintains instrument calibration data on every flow meter. Calibration files include details on process conditions, customer gas, line size and other information. All NIST-traceable equipment utilized for the calibration procedure is identified on the Calibration Certificate, which is sent with every flow meter.

INTRODUCTION

Introduction

DDC-Sensor™ Technology Description

The Fox DDC-Sensor™, a Direct Digitally Controlled sensor, is a state of the art sensor technology unlike other thermal flow sensors available on the market. Instead of using traditional analog circuitry, the DDC-Sensor™ is interfaced directly to the FT4X microprocessor for more speed and programmability. The DDC-Sensor™ quickly and accurately responds to changes in process variables by utilizing the microprocessor to determine mass flow rate, totalized flow, and temperature.

Fox's DDC-Sensor**™** provides a technology platform for calculating accurate gas correlations.   The FT4X correlation algorithms allow the meter to be calibrated on a single gas in the factory while providing the user the ability to select other gases in the Gas-SelectX® gas menu. Fox's Model FT4X with its DDC-Sensor™, state-of-the-art correlation algorithms, and advanced Data Logger provide an accurate, multi-gas-capable thermal gas flow meter.

I/O Description

The FT4X features two galvanically isolated 4-20mA analog outputs, HART communication, a pulse output, switch input and RS485 Modbus RTU. There is also a USB port for interfacing with a laptop or computer. The first 4-20mA output can be used for HART communication. The second 4-20mA output can be configured for flow rate or process gas temperature and can be scaled by the user. The pulse output can be used for pulse or alarm and is programmable to represent flow rate. The switch input can be configured to reset the flow totalizer and elapsed time.

FT4X View™ interfaces to the USB port and is a free Fox PC-based software program that displays flow meter readings and permits flow meter configuration. The software is available for download on the Fox website.

FT4X Data Logger

The Model FT4X has a Data Logger board used to record daily totals and configuration changes/events (i.e. power on/off, alarms).

The FT4X Data Logger supports 40 daily total records. The meter is shipped with this function turned off and must be activated by the user after the unit is powered on. When the number of samples exceeds 40, the old data will be overwritten. Only the most recent 40 records are kept and day #1 is always the latest total recorded.

For operation of the Data Logger, please refer to Document 107699 FT4X Data Logger Manual.

Introduction

FT4X Functional Diagram

An on-board 2 line x 16 character backlit LCD display shows flow rate, total flow, elapsed time, process gas temperature, and alarms. The display is also used in conjunction with the Configuration Panel for field configuration of flow meter settings such as gas selection, 4-20mA scaling, pulse output scaling, pipe area, zero flow cutoff, flow filtering, display configurations, diagnostics, communication parameters, data logging, and alarm limits.

Fig. 1.12: FT4X Function Diagram

Standard I/O
4 to 20 mA Flow
4 to 20 mA Flow or Temperature
Pulse or Alarm
Switch Input

Standard Digital Communications
USB
(Free FT4X View Software)

Optional Digital Communications
RS485 Modbus RTU
HART Communication

Outputs and Communications are Galvanically Isolated

12-28VDC Input Power

Standard Display and Configuration Panel
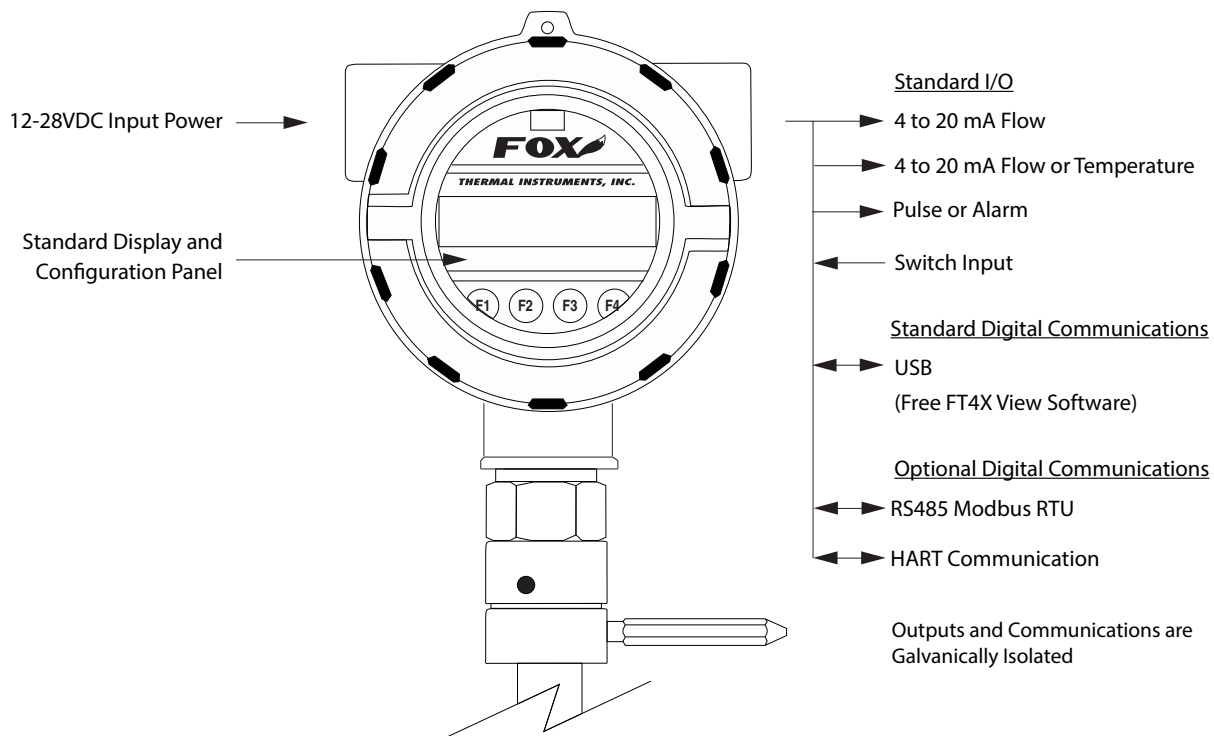
Special Conditions of Use:
- Consult the manufacturer if dimensional information on the flameproof joints is necessary.
- The flamepaths of the equipment are not intended to be repaired. Consult the manufacturer if repair of the flamepath joints is necessary.
- Follow the manufacturer's instructions to reduce the potential of an electrostatic charging hazard.

Installation: General

General Precautions

The following general precautions should be observed:

1. Exercise care when handling the flow meter to avoid damaging the probe, sensor or enclosure.
2. The enclosure cover must be closed except during configuration or at times during installation.
3. Mounting FT4X in direct sunlight can cause the temperature inside the enclosure to increase beyond design limits, resulting in failure of LCD display and reduced component life. It is recommended that a sunshade be installed to avoid direct sunlight (see maximum enclosure operating temperature specification).
4. Ensure the flow direction indicator/pointer for the meter is in line with the direction of flow in the pipe.
5. Do not install the FT4X enclosure near an igniter, igniter-controller or switching equipment.
6. Do not install an external power supply in a cabinet containing an igniter controller or switching equipment.
7. For accurate flow measurement: review flow meter placement instructions before installation to ensure a proper flow profile in the pipe.
8. For safety reasons, Teflon ferrules are only appropriate for applications with pressures of 60 psig or less. At higher pressures, use of a Teflon ferrule risks unwanted probe movement or ejection of the probe from the pipe. For all applications above 60 psig, the standard stainless steel ferrule is required.

Scope

This section describes how to install the Fox Model FT4X Flow Meter and how to get started:

For Insertion Types:

1. Determine lateral position on the pipe
2. Verify sensor installation depth
3. Determine sensor orientation in relation to sensor length and direction of flow
4. Changing the display orientation.
5. Ensure proper tightening of compression fitting for mounting meter

For Insertion type meters with FC10 Flow Conditioners:

Please refer to Document #107679, FC10 Installation Instructions for more information about how to install insertion meters with the FC10 Flow Conditioners.

For Inline Types:

1. Determine lateral position on the pipe
2. Flow body orientation in relation to direction of flow in pipe
3. Changing the display orientation.
4. Proper tightening of compression fitting

Installation procedures must be performed using a combination of the end user's best engineering practices, in compliance with local codes, and with manufacturer's recommendations.

Installation: Lateral Placement

Instructions for Flow Meter Lateral Placement

Install the Model FT4X flow meter so that it is far enough away from bends in the pipe, obstructions, or changes in line sizes to ensure a consistent flow profile. See Fig. 2.1 below for your meter type.

NOTE! Pipe ID = Inside Diameter.

Fig. 2.1: Upstream and Downstream Pipe IDs for Insertion and Flow Conditioners

INSERTION

Irregular Flow Profile

Proper Flow Profile

Branch Outlet (installed by customer)

FLOW →

15X Pipe ID min. — 10X Pipe ID min.

INLINE

Irregular Flow Profile

Proper Flow Profile

FLOW →

8X Pipe ID — 4X Pipe ID
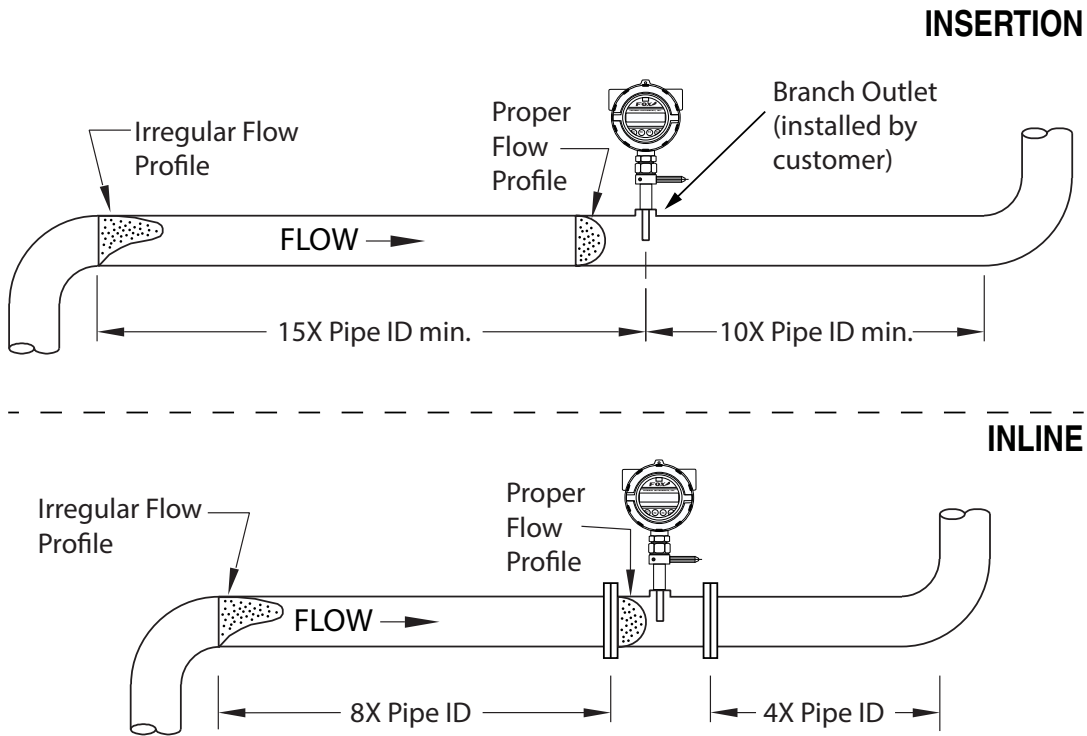
NOTE!
- The probe diameter is ¾"
- An irregular flow profile will affect sensor accuracy

INSTALLATION

Installation: Insertion Type

Welding NPT Female Fitting to Pipe
The probe of the FT4X must be installed perpendicular in the pipe to measure flow accurately. Use the following steps to ensure that the 1" NPT female fitting is correctly welded to the pipe.
Directions:
1. Drill a 0.781-inch hole inside the fitting through the wall of the pipe (1 wall only).
2. Assemble the compression fitting and NPT fitting hand tight onto the probe of the FT4X.
3. Insert the probe into the hole in the pipe and use the FT4X probe and compression fitting to align the NPT fitting with the hole and the probe perpendicular to the pipe.
4. Tack-weld the NPT female fitting carefully onto the pipe.
   - Before welding the fitting completely, verify the probe is aligned to the center of the pipe and the hole is centered in the NPT fitting (see Figure 2.2).
5. To verify that the correct hole position has been achieved,carefully slide the 0.75-inch sensor in and out of the NPT female fitting and 0.781-inch hole.

WARNING! Do not force the 0.75-inch sensor through the 0.781-inch hole. Forcing it through the 0.781-inch hole can damage the probe!

6. Verify that the temporary weld of the NPT female fitting positions the probe window on the pipe's centerline.
   - Figure 2.2 shows an incorrect welding of the NPT female fitting, causing the 0.75-inch sensor to be "off center".
7. Once the NPT fitting is aligned properly, remove the 0.75-inch sensor from the NPT female fitting and finish welding. Then verify the probe is still aligned with the center of the pipe.
8. Set the depth of the flow meter (see "Fig. 2.3: Cross Section of Insertion Sensor Depth in Pipe" on page 21).
   - Do not tighten Swage fitting until proper depth of flow meter is determined. See Fig. 2.3.

Fig. 2.2: Alignment of NPT Female Fitting
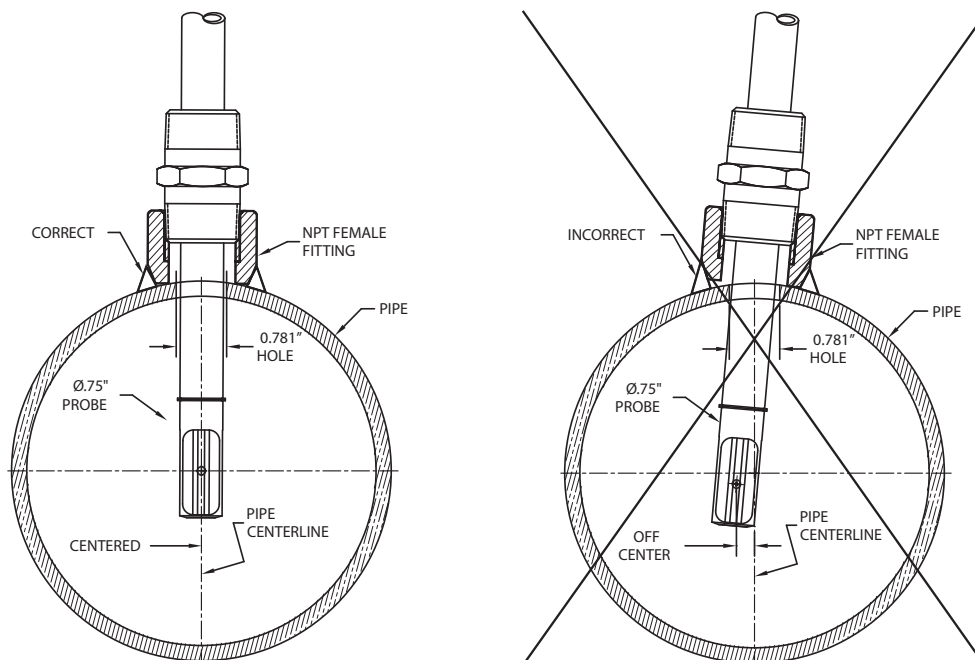
Installation: Insertion or Inline Type

Installation Depth

The installation depth of the sensor in the pipe is dependent on the pipe size. To get the most accurate reading, proper placement of the sensor window within the pipe is necessary. As shown in Fig 2.3, the end of the sensor window should be 0.73" (18.5 mm) past the center line of the pipe. Review the dimensional drawing below with the following equation to calculate insertion depth: $L + D/2 + .72" = insertion\ depth$. Insertion depth is measured from the top of the compression fitting.

> **CAUTION!** For a 1½" pipe, do not tighten compression fitting without 0.2" distance from wall or damage to probe will occur.

Fig. 2.3: Cross Section of Insertion Sensor Depth in Pipe

COMPRESSION FITTING
(SUPPLIED BY FOX)

HALF COUPLING, 1" NPT,
(SUPPLIED BY CUSTOMER)

"L"

"D/2"

.73

"D"

D/2 + L + .73" = INSERTION DEPTH
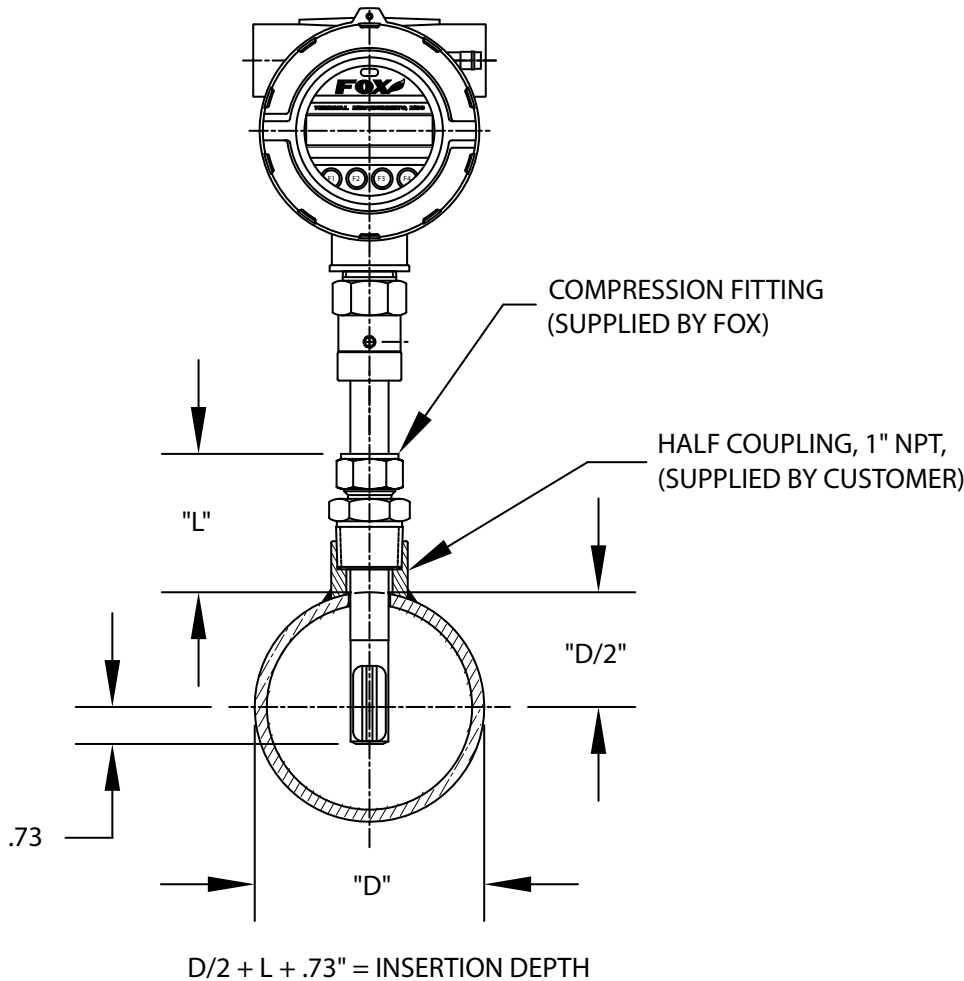
Rotating the Enclosure

The Model FT4X enclosure has been designed to allow the enclosure to rotate for optimal viewing of the display. To rotate the enclosure, first loosen the two set screws near the Flow Direction Indicator. Then rotate the enclosure into the desired position and tighten the set screws. Do not rotate the enclosure more than 360 degrees.

Installation: Insertion or Inline Type

Direction of Flow and Orientation of the Probe
Install the meter with the flow direction indicator pointing in the direction of flow and centered on the middle of the pipe. The rotational misalignment of the flow direction indicator must be less than 5 degrees.

Fig. 2.4: Orientation of Flow Meter

SIDE VIEW

SET SCREW

FLOW DIRECTION INDICATOR

CUSTOMER PIPE

FLOW

TOP VIEW

CUSTOMER PIPE

FLOW

+5°

-5°

Note: Rotational misalignment should not exceed ±5°

FLOW DIRECTION INDICATOR
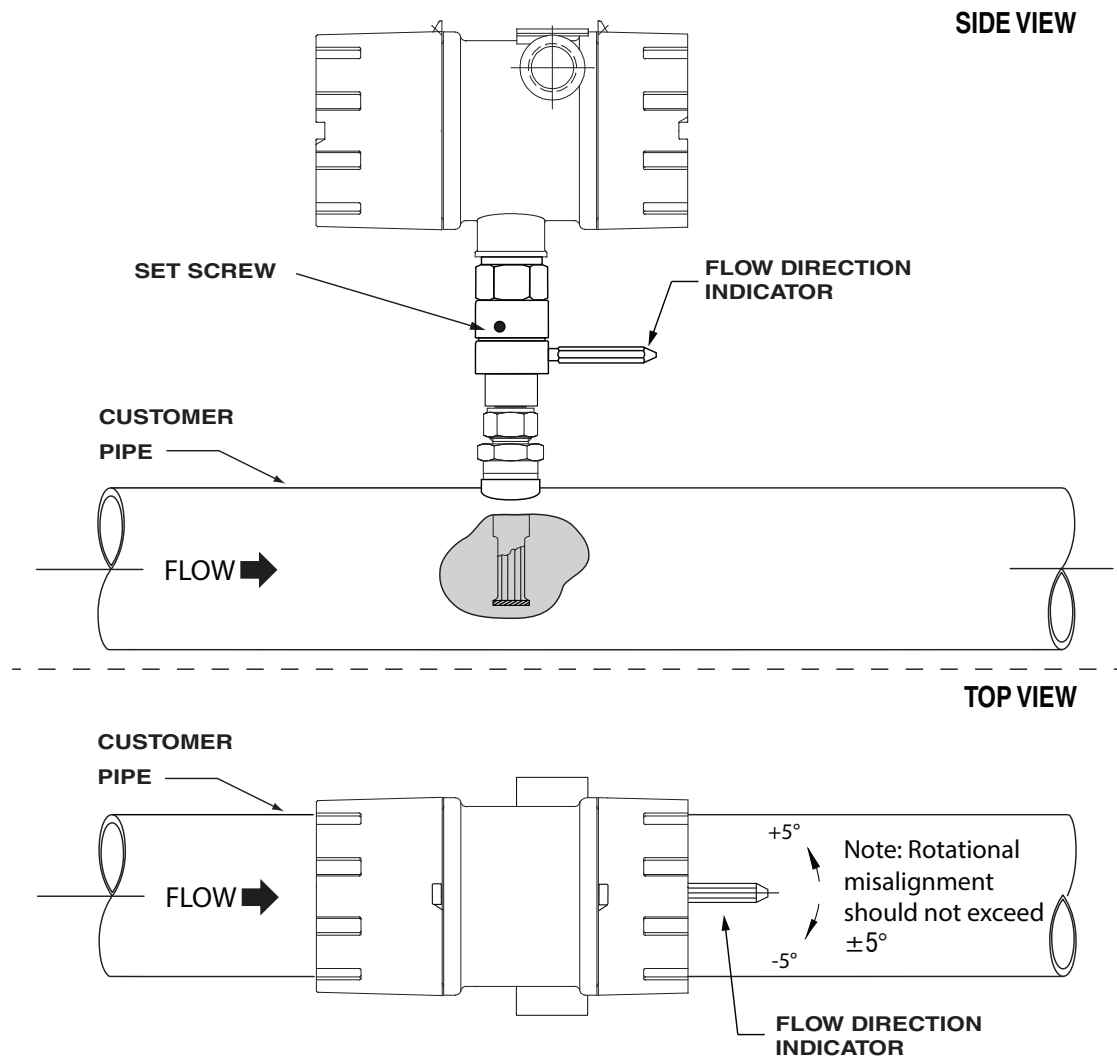
Mounting Instructions - Compression Fittings
The Model FT4X is mounted through a 0.781" hole and a 1-inch female NPT half coupling in the customer's pipe. Insertion style flow meters are not designed for use in pipes smaller than 1½".
- Install the compression fitting into the 1-inch female NPT half coupling.
- When installing in a 2" pipe or larger, install the end of the probe 0.73" (18.5 mm) past the center line of the pipe and tighten the compression fitting nut (refer to figure 2.3).
- When installing into a 1½" pipe carefully install the probe into the pipe until it touches the opposite wall and pull back 0.2". Tighten the compression fitting nut.
- While holding the fitting body steady, tighten the nut one and one-quarter (1 ¼) turns to the 9 o'clock position. See Figure 2.5.

INSTALLATION

Installation: Insertion or Inline Type

Fig. 2.5: Proper Tightening of the Compression Fitting Nut
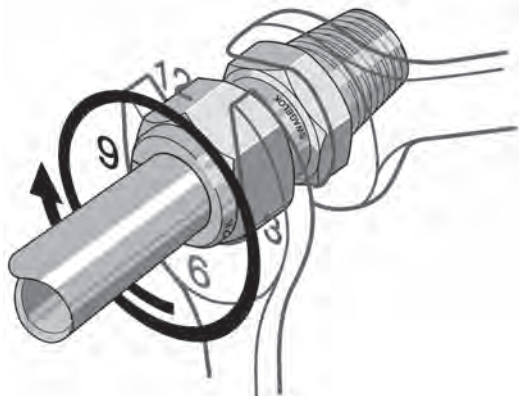
CAUTION! For a 1½" pipe, do not tighten compression fitting without 0.2" distance from wall or damage to probe will occur.

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

CAUTION! If the stainless steel or teflon ferrules are not properly tightened, and/or the recommended pressure is exceeded, the ferrules can slip on the stainless steel tubing causing damage to the meter or bodily harm.

Changing the Orientation of the FT4X Display

The display can be rotated in 90° increments for optimum viewing of the screen. First, open the enclosure by unscrewing the enclosure cap and loosen the two captive screws to open the display assembly. Detach the display board from the metal shield by loosening the three screws on the back of the round shield. Rotate the display board to the desired orientation. Ensure that the display cable is routed flat and straight through the display hinge to prevent binding. Reattach the display board to the metal shield by tightening the three screws. Close the display assembly and secure it to the enclosure with the two captive screws. Finally, install the enclosure cover back on the front of the enclosure.

Fig. 2.6: Rotating the Display Orientation

Loosen these two screws to open the display.

Loosen these three screws to rotate the display in 90° increments (±180°).
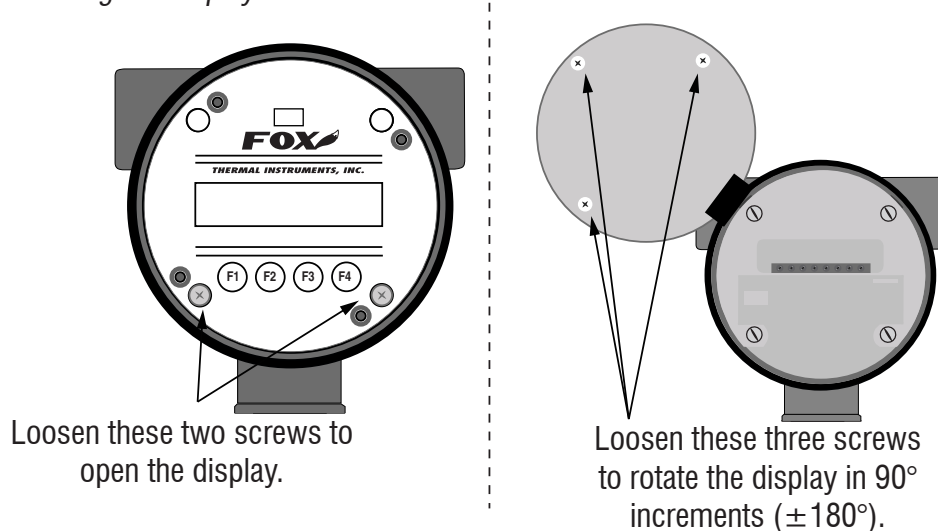
Installation: Retractor Option

Installation of a New Retractor Assembly

1. Remove collar clamp from probe using a 3/16" Hex Key.
2. Remove meter probe from retractor assembly and leave the ball valve open. Keep the collar spacer on the probe so it is not misplaced.
3. Install the valve assembly on the pipe, by tightening the Hex Nipple with a 1 3/8" wrench.

Fig. 2.7: Retractor Assembly With and Without Probe Installed
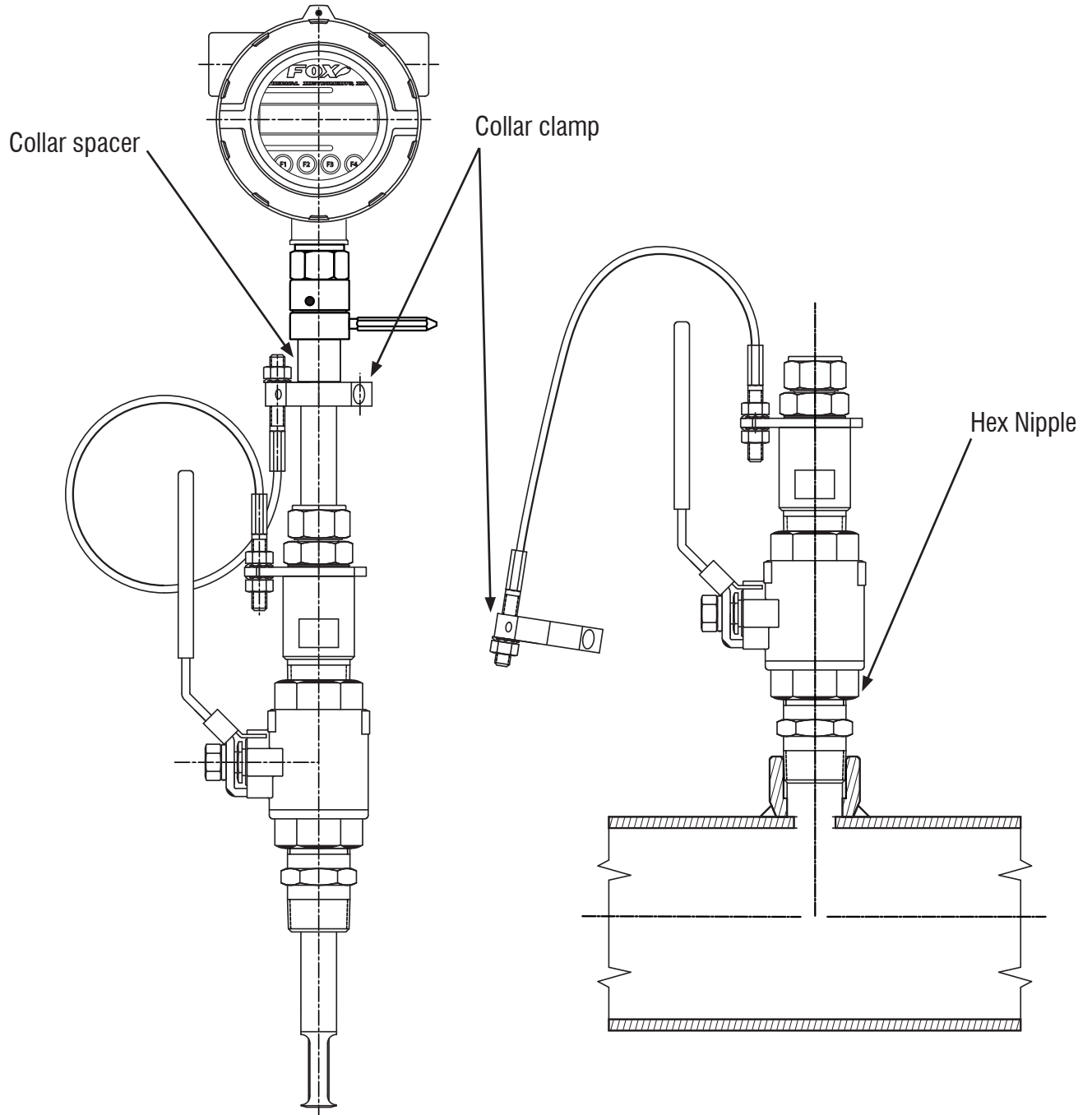
Installation: Retractor Option

4. Carefully slide the probe through the retractor assembly and through the hole to see if there is interference by touching the pipe wall with the end of the probe on the far side or until the probe cannot go deeper. Remove the probe. Remove the retractor and rework the hole, if required.

Fig. 2.8: Verify Probe Insertion
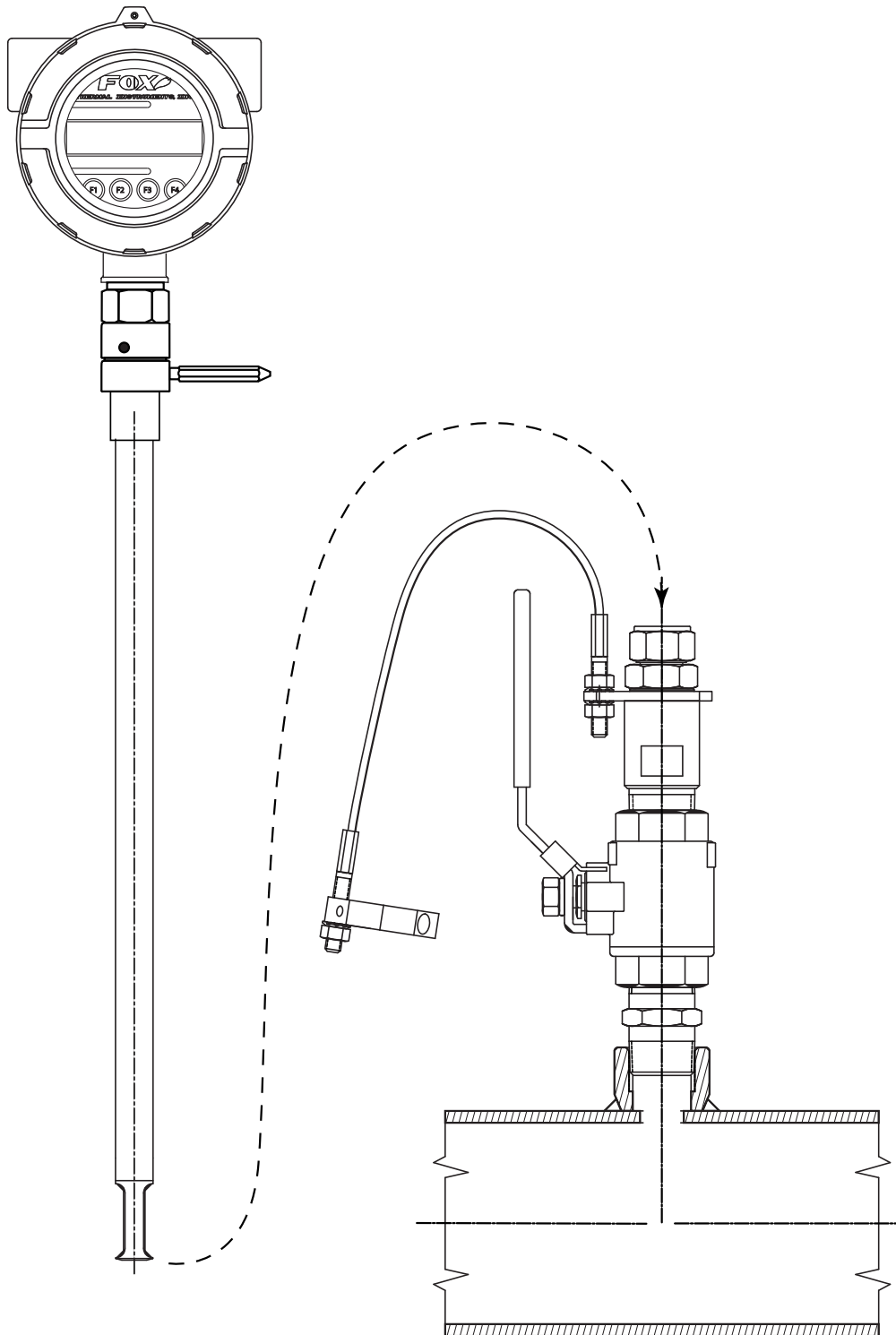
Installation: Retractor Option

5. Using the equation (L + D/2 + 0.73") from Figure 2.9, calculate the insertion depth and mark on the probe while measuring from the end of the probe.
6. The Retractor Clearance table of Figure 2.9 lists the space required to remove the meter from the retractor. Use the model code of your meter to determine the dimension.

Fig. 2.9: Determining and Marking Insertion Depth

RETRACTOR CLEARANCE	
CODE	"RC" DIMENSION
15R	23.9" [60.7 CM]
18R	26.5" [68.3 CM]
24R	32.5" [83.6 CM]
30R	38.5" [98.8 CM]
36R	44.5" [114.0 CM]
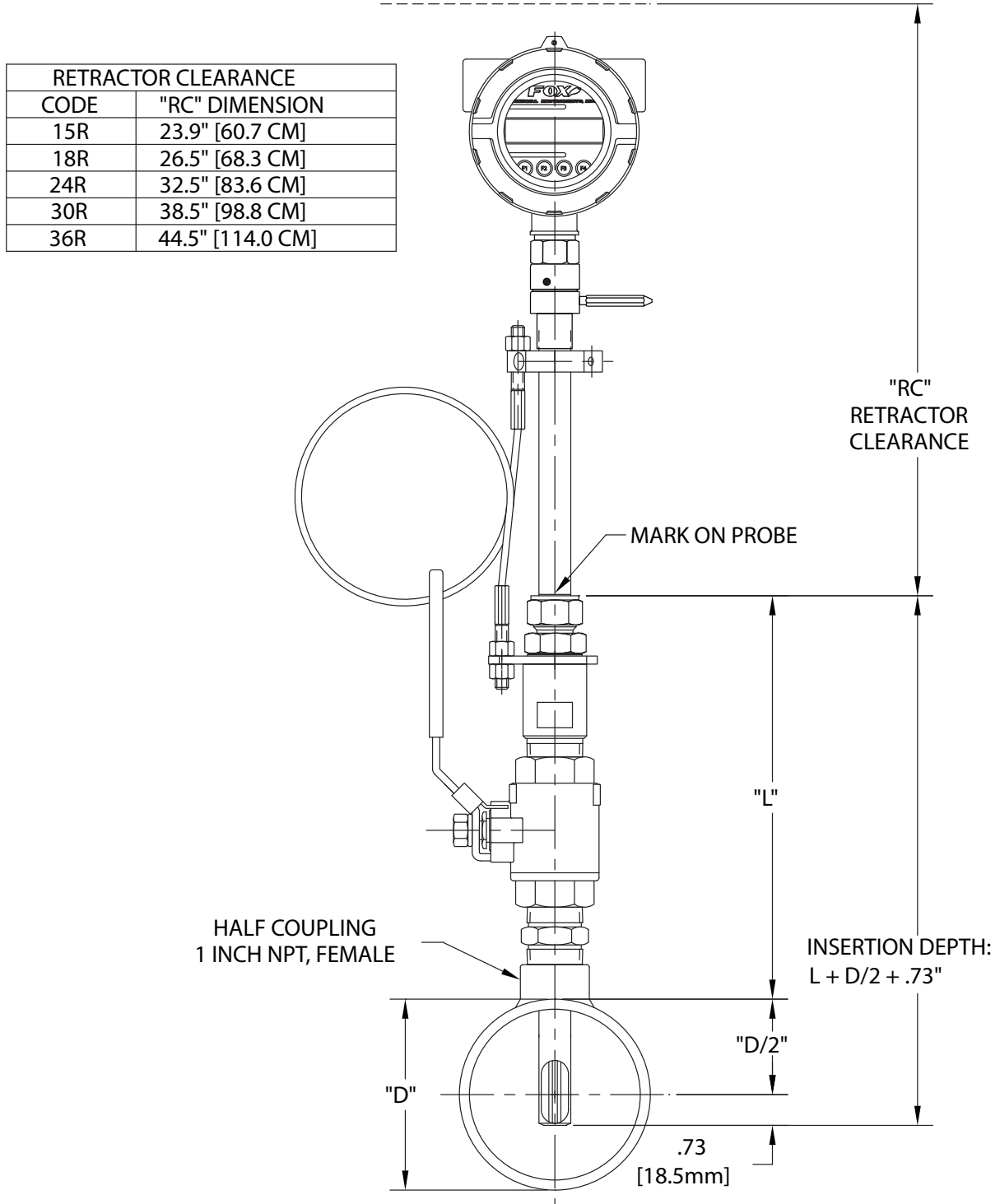
INSTALLATION

Installation: Retractor Option

7. Insert probe back into the retractor to the depth mark and hand-tighten the compression fitting. Make sure collar spacer is in place on the probe.
8. Verify that flow direction indicator is in line with pipe and in the direction of flow.

Fig. 2.10: Installed Retractor

Flow Direction Indicator

Collar Spacer
Collar Clamp

Swage Nut & Ferrules

Swage Fitting
Bracket
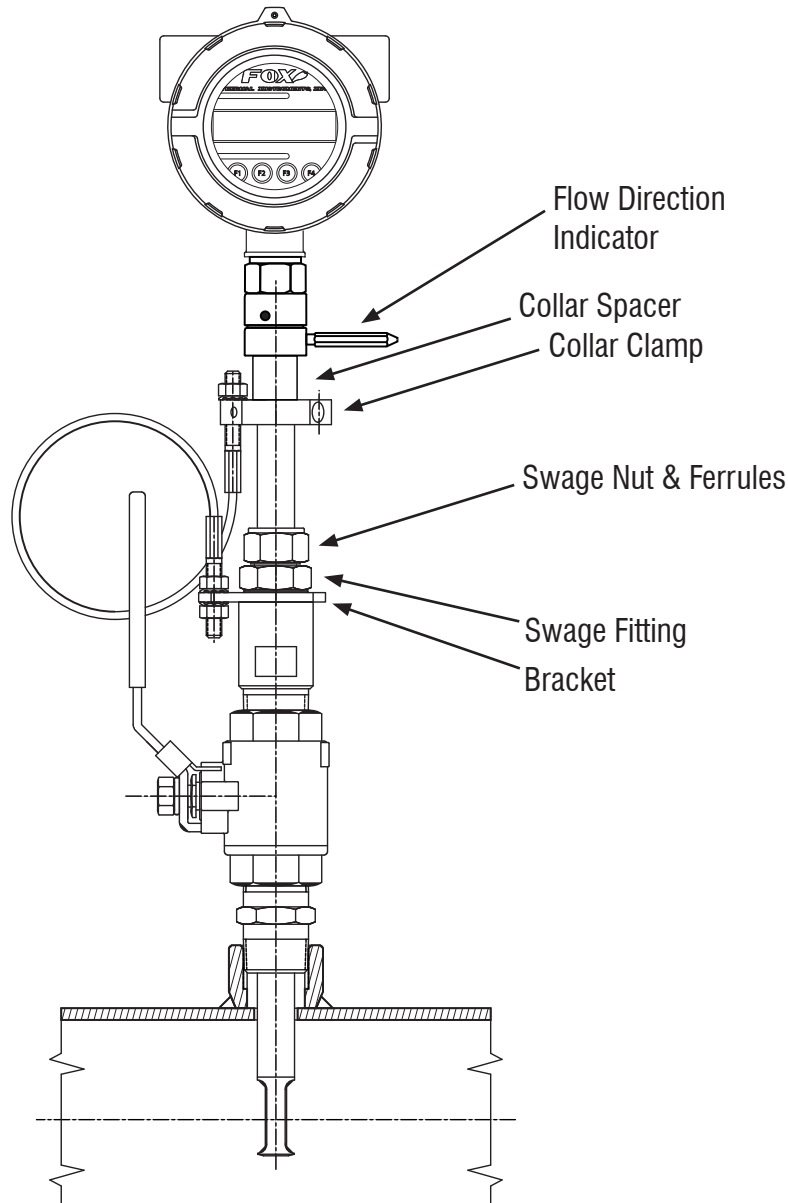
9. Fully tighten compression fitting (refer to the instructions on p. 22 and "Fig. 2.5: Proper Tightening of the Compression Fitting Nut" on page 23).
10. Install collar clamp back on probe just below the collar spacer. Install collar so that the cable mounting hole is in line with the mounting hole on the bracket.

NOTE! For instructions on how to properly remove and replace the meter from a retractor, please refer to "Instructions for Removing and Inserting the Meter from a Pressurized Pipe using the Retractor" on page 79.

Wiring: General

WIRING

Wiring Instructions

To wire the FT4X connect the power and signal wires to the terminal blocks according to the label and instructions on the following pages.

Fig. 3.1: FT4X Wiring Access

Front Enclosure Cap

Unscrew front enclosure cap to access the display and configuration panel.

Display front panel

Rear of display

Unscrew two bottom screws and swing open display to access remote or sensor wiring
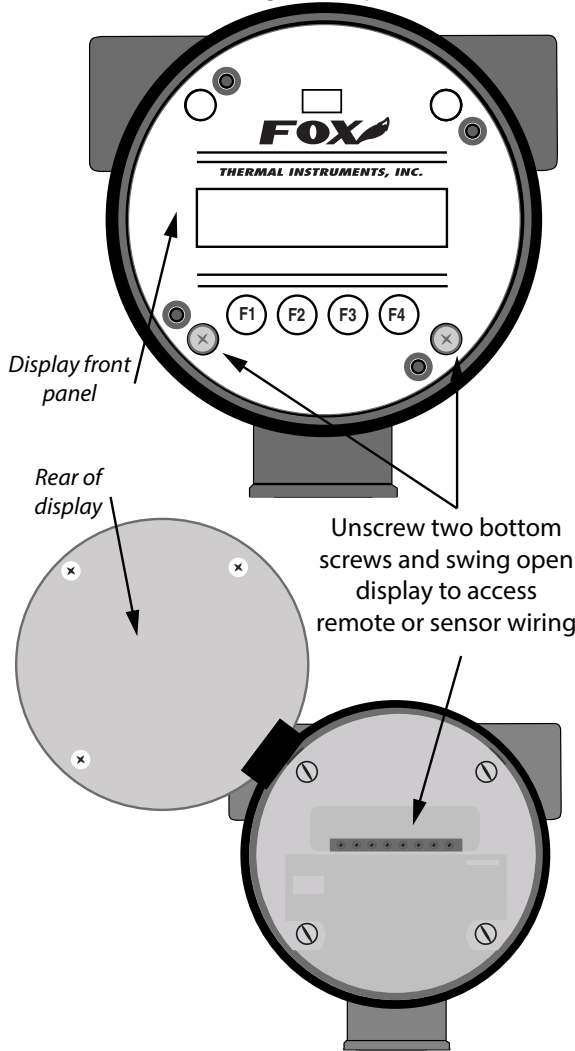
Rear Enclosure Cap

Unscrew the rear enclosure cap to access wiring terminals for power, inputs/outputs, pulse, 4-20mA, remote switch, and the USB port.

Earth Ground

TS2
1 SWITCH INPUT (+)
2 SWITCH INPUT (-)
3 PULSE (+)
4 PULSE (-)
5 Tx/Rx (+)
6 Tx/Rx (-)
7 COMMON
W1
TERMINATION
J1
USB

TS1   F1   0.75A
POWER (+) 1
POWER (-) 2
4-20mA #1 (+) 3
4-20mA #1 (-) 4
4-20mA #2 (+) 5
4-20mA #2 (-) 6
TP1
TP2
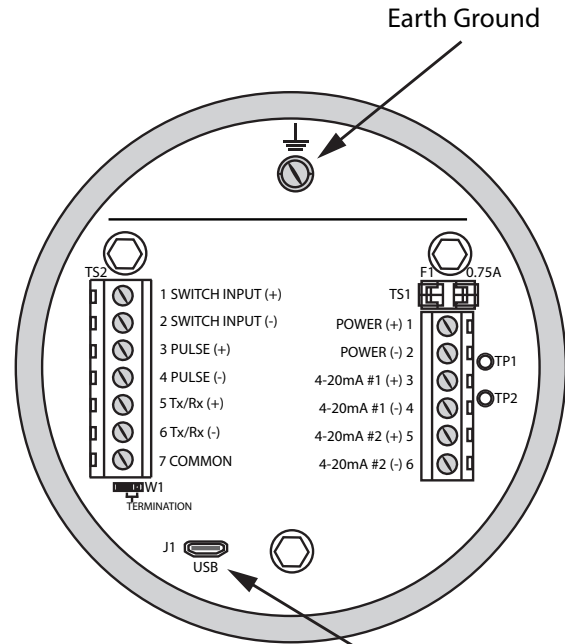
TS1 Terminals:
 • Power
 • 4-20mA CH 1
 • 4-20mA CH 2

USB Port

TS2 Terminals:
 • Switch input
 • Pulse
 • Communications

NOTE! Cut all wires as short as allowable for a minimum service loop. Obtain the correct length for the FT4X wires using one of these methods:

- Trim the wires to extend 2.5" out of the enclosure after the conduit and wires are routed to the FT4X.
- Trim the wires to extend 6" from the end of the conduit before attaching them to the FT4X.

Wiring: General

Wiring Precautions

- **WARNING!** - DO NOT OPEN THE ENCLOSURE WHEN ENERGIZED OR AN EXPLOSIVE ATMOSPHERE IS PRESENT.
- All plumbing and electrical installations of flow meters must be in compliance with local codes, the end user's best engineering practices, and manufacturer's recommendations.
- Do not install the FT4X enclosure near an igniter, igniter-controller or switching equipment to eliminate the possibility of noise interference.
- Do not install an external power supply in a cabinet containing an igniter controller or switching equipment.
- This flow meter contains components that can be damaged by static electricity. You must discharge yourself by touching a grounded steel pipe or other grounded metal prior to working inside this flow meter.
- For the remote sensor option, the serial number of the electronics enclosure must match the remote sensor probe.
- Close any unused conduit entries using suitably certified plugs

Power Wiring

For wiring the 12 to 28VDC power, use stranded copper wire, no larger than 16-gauge. Twisted pair shielded cable is recommended. Supply connection wiring must be rated for at least 90°C.

Grounding

The enclosure must be properly grounded with a quality earth ground. 16 gauge, stranded wire is recommended.

Signal and Serial Communication Wiring

For signal and serial communication wiring, the recommended wire gauge is 18 to 22 AWG. Always use twisted pair shielded cable.

Modbus Cable Specs

A shielded 22 to 18 gauge three conductor cable is recommended for Modbus communication wiring.
Two of the wires in the cable should be twisted pair and used for the Modbus transmit and receive signals. The third wire is for the Modbus common signal.
The shield drain wire of the cable should be connected to chassis or earth ground at the Modbus modem.
Belden number 3106A or a similar type of cable is recommended, depending on the environment or temperature requirements of the application.

Remote Sensor Wiring

NOTE! Remote wiring is only required when the Remote Electronics option is provided.
NOTE! Serial Numbers: If you have more than one meter, you must ensure that the serial numbers of the probe/remote enclosure, electronics enclosure, and flow body match one another. These items have been manufactured and calibrated to operate as a unit and cannot be mismatched.

Eight wire shielded cable is required, the recommended wire gauge is 18 AWG. Make sure that the cable length does not exceed 100 feet and the wire resistance does not exceed one ohm. Connect the cable shield at the remote enclosure end.

Wiring: Input Power

Power Input Requirements: 12 to 28VDC
External DC power supply must provide 12 to 28VDC (10 to 30VDC full input power range) at 6 Watts minimum.
(With 12VDC power, the FT4X can use up to 500mA. With 24VDC power, the FT4X can use up to 250mA.)

A 20 Watt or greater power supply is recommended to ensure it can provide enough current under all temperature, ventilation, and power on conditions.

The enclosure must be properly grounded with a quality earth ground. Sixteen (16) gauge, stranded wire, is recommended for earth ground.

Connect the power wiring as shown in the diagram below.

Fig. 3.2: Connections for 12 to 28VDC Supply
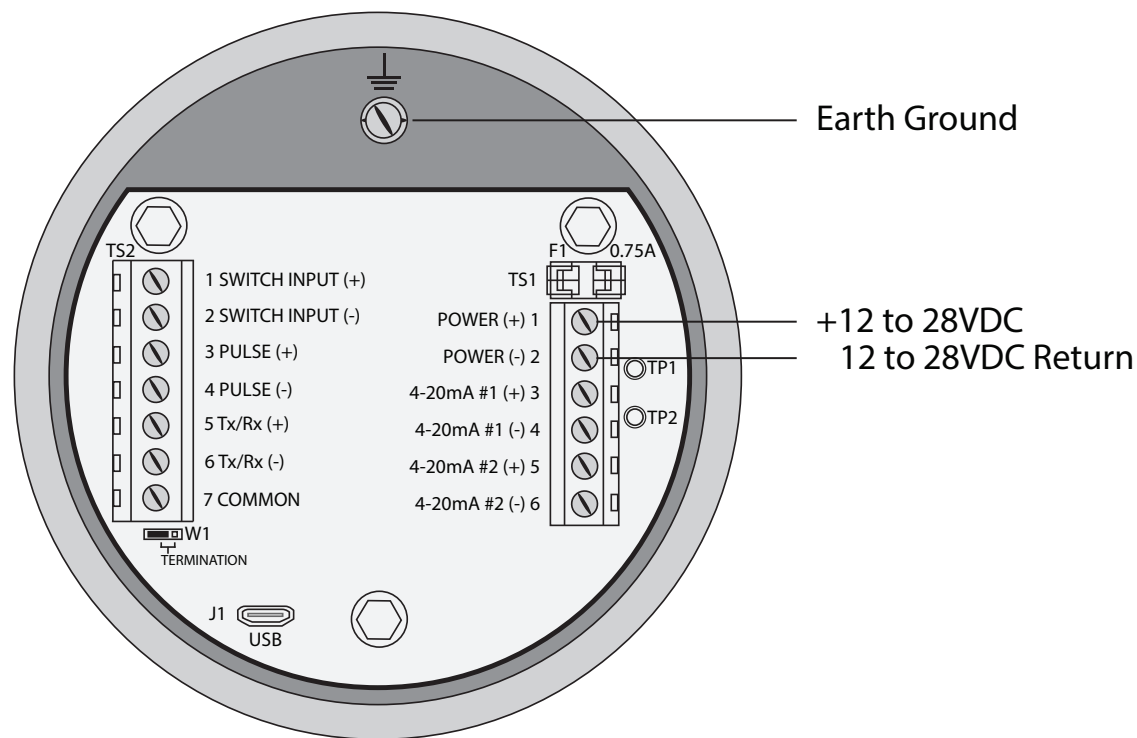
CAUTION!
  • Supply connection wiring must be rated for at least 90°C.

Wiring: 4-20mA and HART Communication Wiring

4-20mA Output and HART Comm. Wiring: Customer-Supplied Power Source (Recommended)
Bring the wiring in through either conduit hub. Connect the 4-20mA flow rate, 4-20mA temperature, and HART communication option wiring as shown in the diagram below.

Fig. 3.3: 4-20mA Output Wiring for Isolated Customer-Supplied Power Source
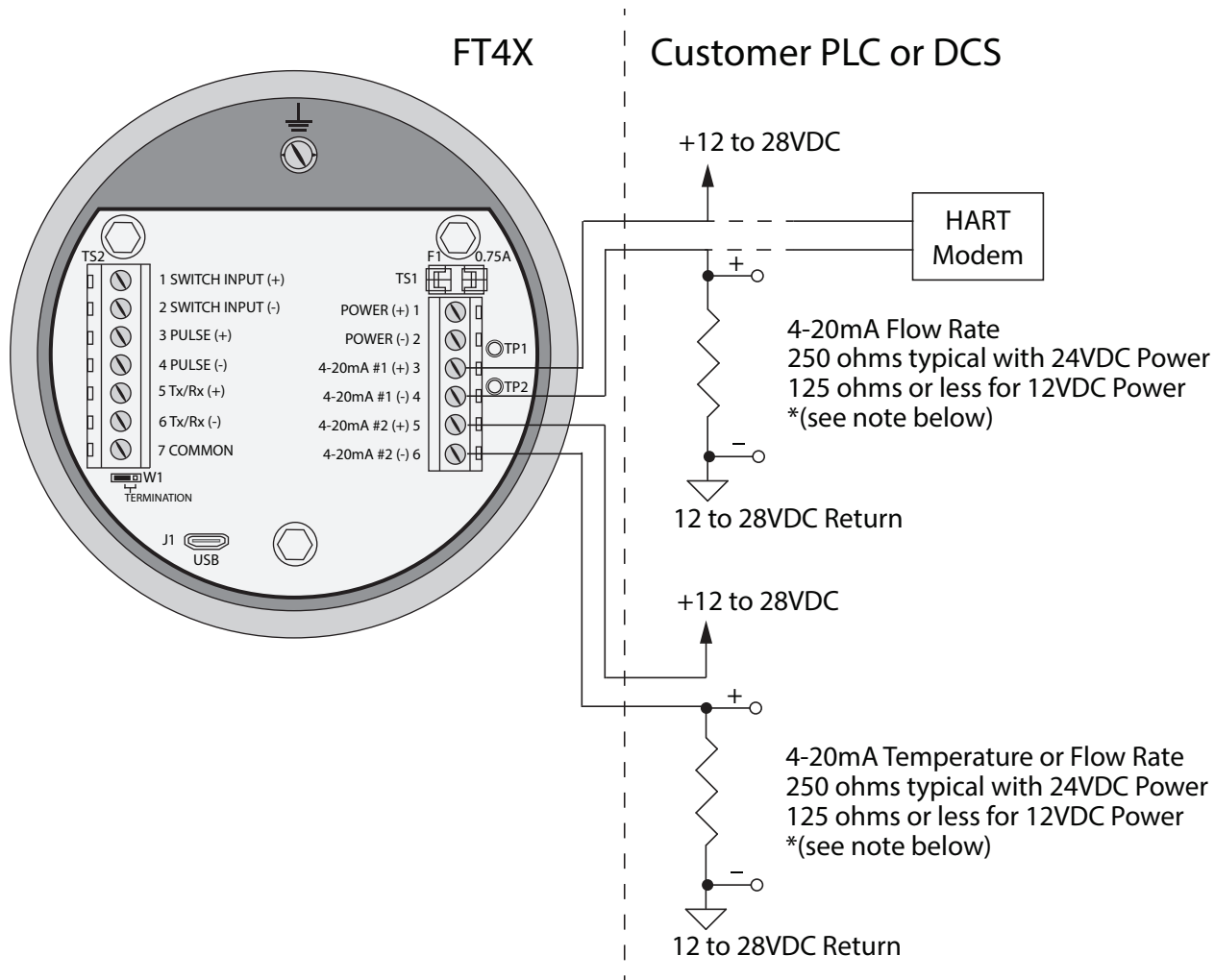
WIRING

NOTE!
- When using a 12 volt power supply, the load resistor on the 4-20mA output must be 125 ohms or less to operate properly.
- When using 24 volt power, the load resistor is typically 250 ohms. A 250 ohm resistor in the 4-20mA circuit will result in a 1 to 5 volt signal to the PLC or DCS.
- When using a 24 volt power supply, the load resistor on the 4-20mA output must be 600 ohms or less.
- Some PLC and DCS equipment have built in load resistors, please refer to the technical manuals of such equipment.

Wiring: 4-20mA and HART Communication Wiring

WIRING

4-20mA Output and HART Comm. Wiring: Loop Power Provided by FT4X

Bring the wiring in through either conduit hub. Connect the 4-20mA flow rate, 4-20mA temperature, and HART communication option wiring as shown in the diagram below.

Fig. 3.4: 4-20mA Output Wiring for Loop Power Provided by FT4X
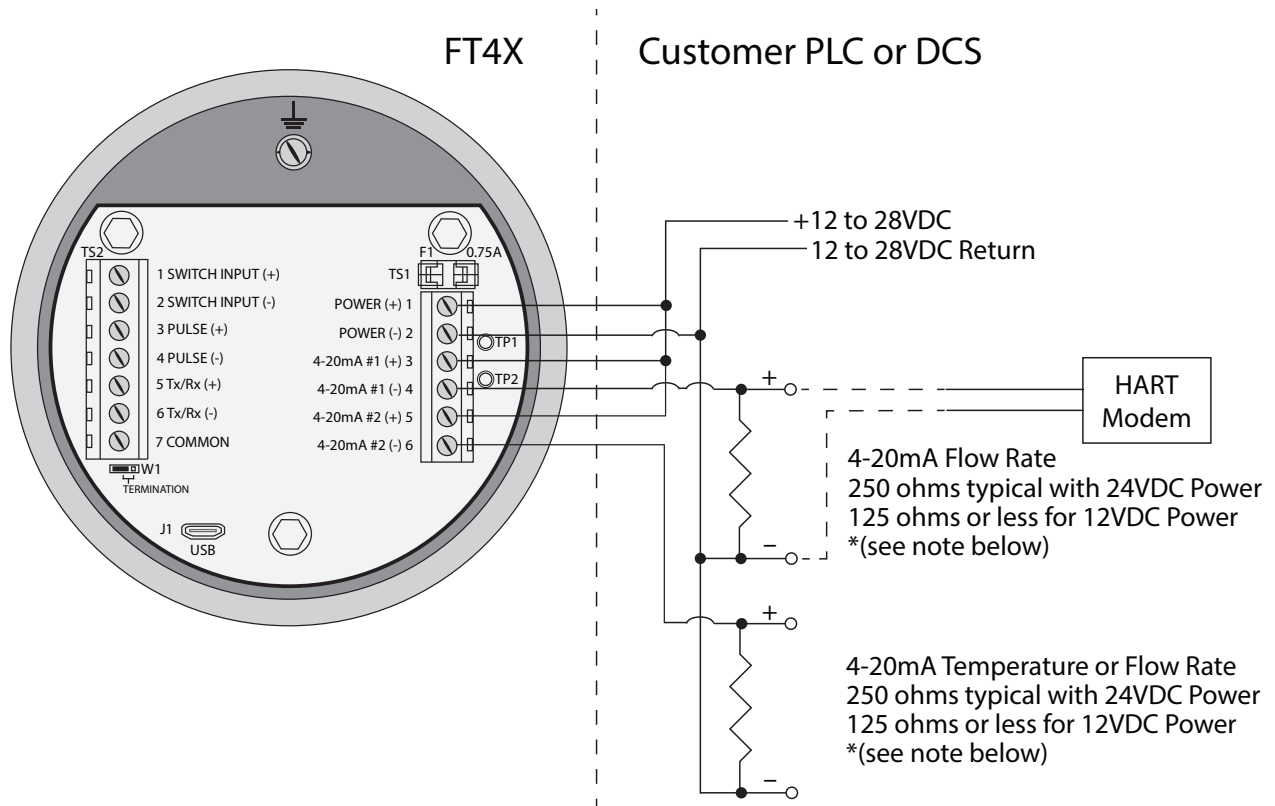
NOTE!

- When using a 12 volt power supply, the load resistor on the 4-20mA output must be 125 ohms or less to operate properly.

- When using 24 volt power, the load resistor is typically 250 ohms. A 250 ohm resistor in the 4-20mA circuit will result in a 1 to 5 volt signal to the PLC or DCS.

- When using a 24 volt power supply, the load resistor on the 4-20mA output must be 600 ohms or less.

- Some PLC and DCS equipment have built in load resistors, please refer to the technical manuals of such equipment.

Wiring: Pulse/Alarm Wiring

Pulse/Alarm Output Wiring: Customer Supplied Power Source (Recommended)

Bring pulse/alarm wiring in through either conduit hub. Connect the pulse/alarm wiring as shown in the diagram below. The pulse/alarm output is an open collector circuit capable of sinking a maximum of 10mA of current. Pulse or alarm selection is programmed using the display or FT4X View™. Only one option, pulse or alarm, can be active at a time.

Fig. 3.5: Pulse/Alarm Output Isolated (Recommended)
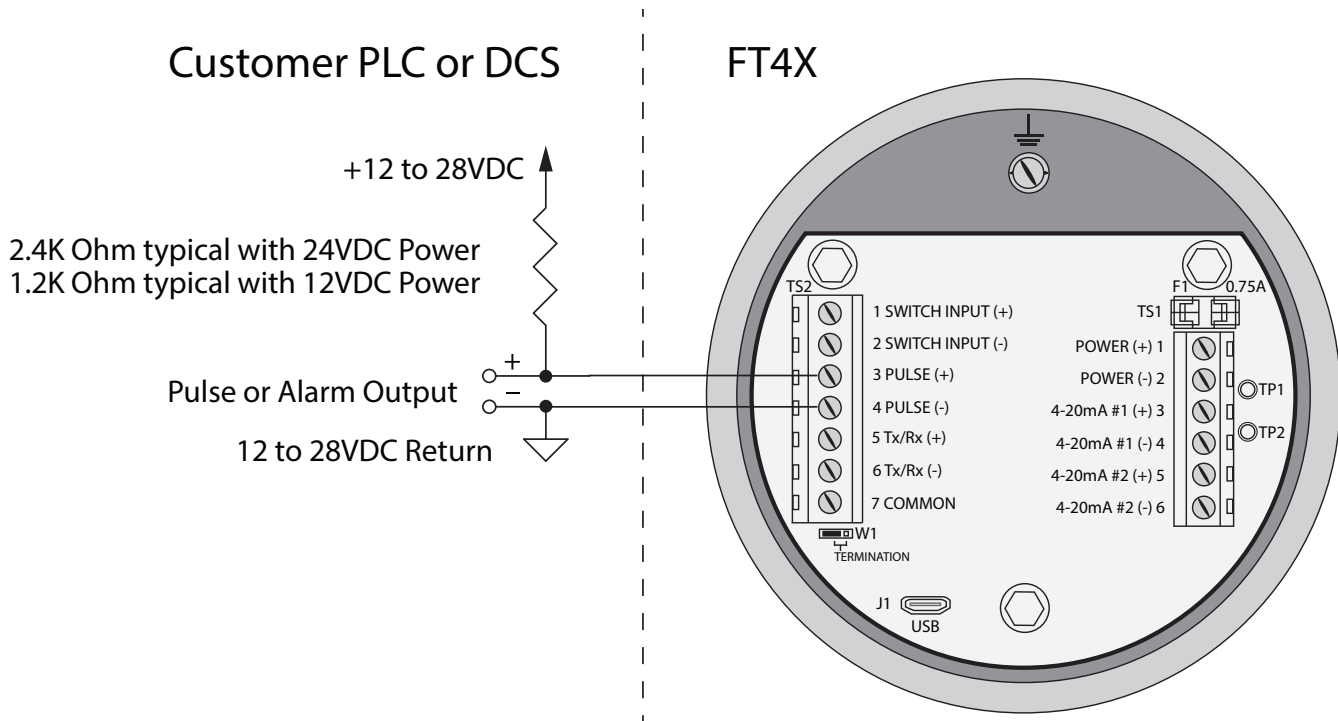
NOTE!

- The FT4X Pulse/Alarm output is typically used to drive digital circuitry or solid-state relays. The output of a solid state relay may, in turn, operate loads such as electromechanical relays or alarm indicators.

- The maximum load current of the Pulse/Alarm output is 10mA. Choose a load resistance that provides approximately 10mA with the power supply operating voltage.

- When the output is configured for Alarm and an alarm is not active, the output will be on (0 volts output). When an alarm is active, the output will be off (12 to 28 volts output).

Wiring: Pulse/Alarm Wiring

WIRING

Pulse/Alarm Output Wiring: Power Provided by FT4X

Bring pulse/alarm wiring in through either conduit hub. Connect the pulse/alarm wiring as shown in the diagram below. The pulse/alarm output is an open collector circuit capable of sinking a maximum of 10mA of current. Pulse or alarm selection is programmed using the display or FT4X View™. Only one option, pulse or alarm, can be active at a time.

Fig. 3.6: Pulse/Alarm Output Power Provided by FT4X
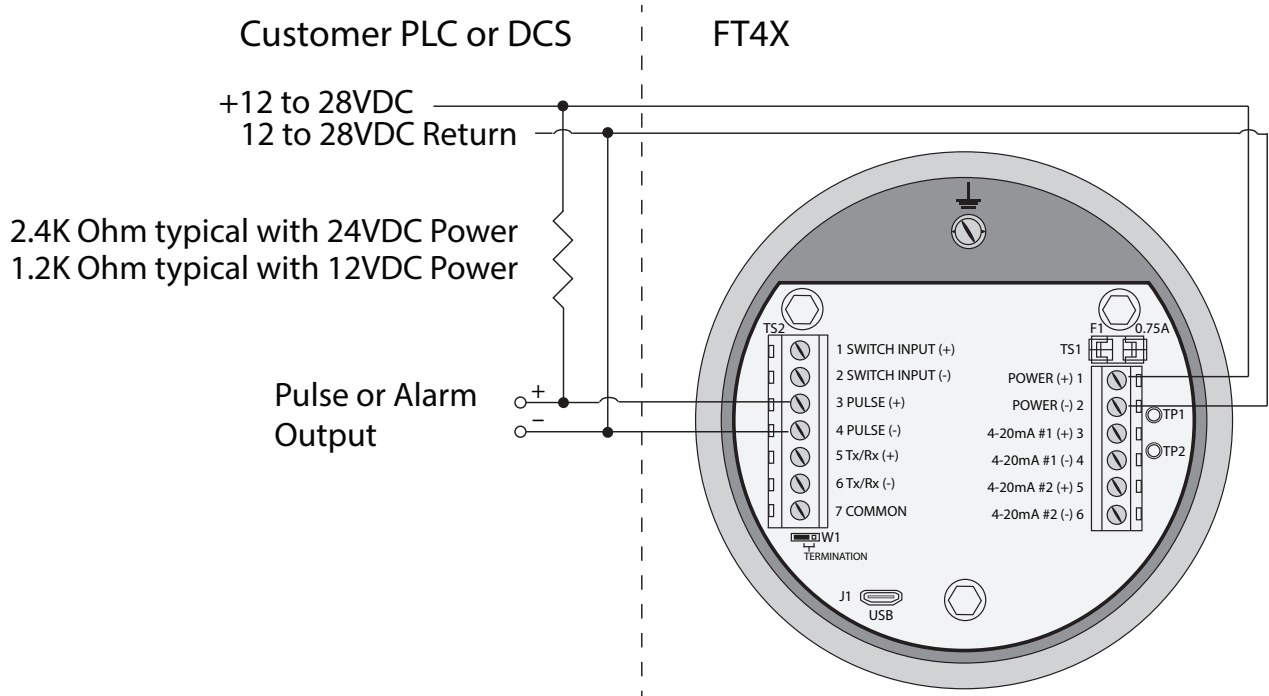
NOTE!
- The FT4X Pulse/Alarm output is typically used to drive digital circuitry or solid-state relays. The output of a solid state relay may, in turn, operate loads such as electromechanical relays or alarm indicators.

- The maximum load current of the Pulse/Alarm output is 10mA. Choose a load resistance that provides approximately 10mA with the power supply operating voltage.

- When the output is configured for Alarm and an alarm is not active, the output will be on (0 volts output). When an alarm is active, the output will be off (12 to 28 volts output).

Wiring: Switch Input

Switch Input Wiring

A remote switch can be used to reset the Totalizer and elapsed time, if enabled in the programming settings. Connect the switch input wiring as shown in the diagram below.

Fig. 3.9: Switch Input Wiring

Model FT4X
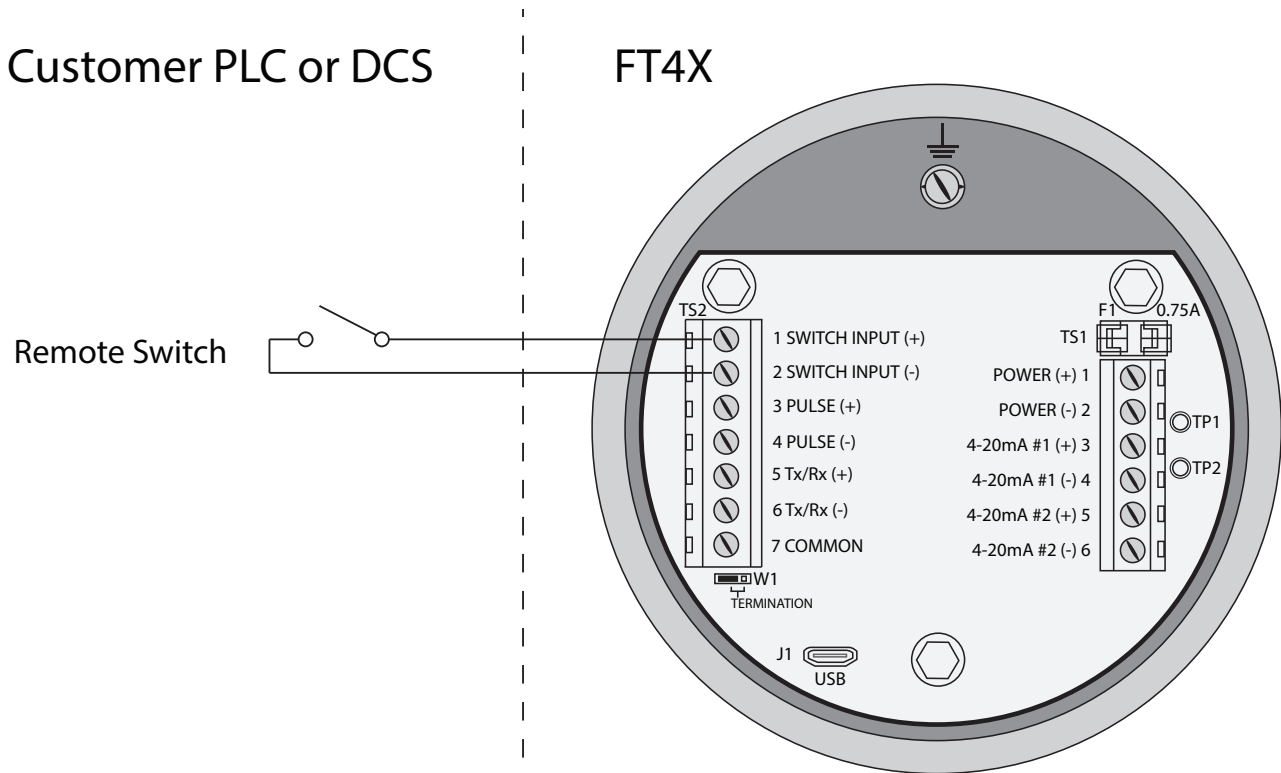
Wiring: RS485 Modbus RTU

WIRING

RS485 Wiring for RS485 Modbus RTU
Wiring connections are made as shown in the diagram below for Modbus communication.

Termination Resistor
Connect a termination resistor across the receive/transmit signals of the last device on the communication line. To connect the 121 ohm termination resistor on the FT4X, set jumper W1 to the TERM position.

Disconnect the termination resistor on all other external RS485 devices. The termination resistor of the FT4X is disconnected by setting jumper W1 to the OPEN position.

Fig. 3.7: RS485 Wiring

Tx/Rx(+)
Tx/Rx(−)
Communication Common
Shield

Termination Resistor Jumper W1

Termination Resistor Jumper (detail)

No Termination (Open)   Terminated
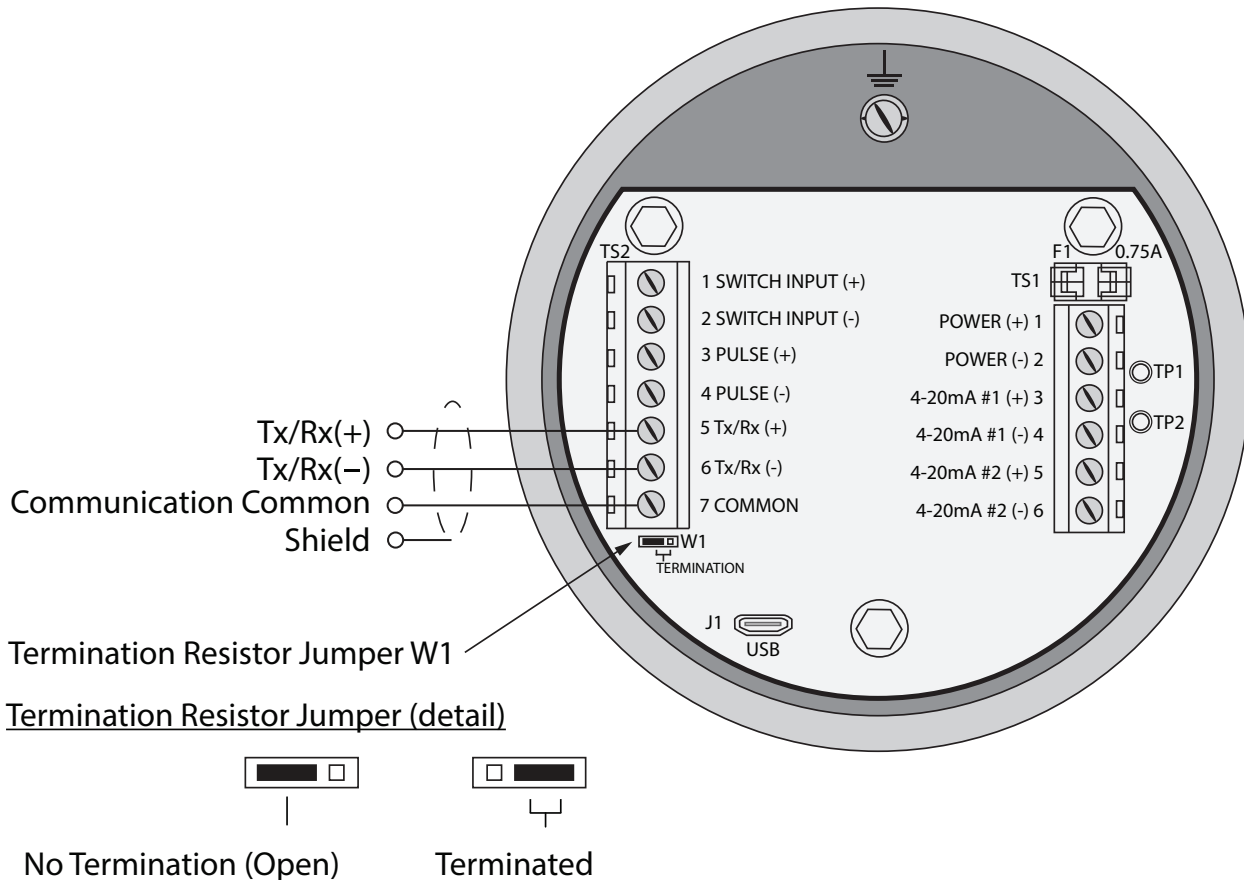
NOTE!
- W1 jumper will either be in the open or terminated position. It should be in the terminated position on the last meter in the series.

FOX
THERMAL INSTRUMENTS, INC.
Fox is ISO 9001 certified

Wiring: HART Handheld Wiring

HART 4-20mA Output Wiring: Handheld Communicator

The 4-20mA current loop and HART modem connections are made as shown on p. 31 and p. 32.
A handheld HART communicator can be connected to test points TP1 (+) and TP2 (-) with clip leads or to the 4-20mA terminal block.

Fig. 3.8: HART 4-20mA Output Wiring, Handheld Communicator
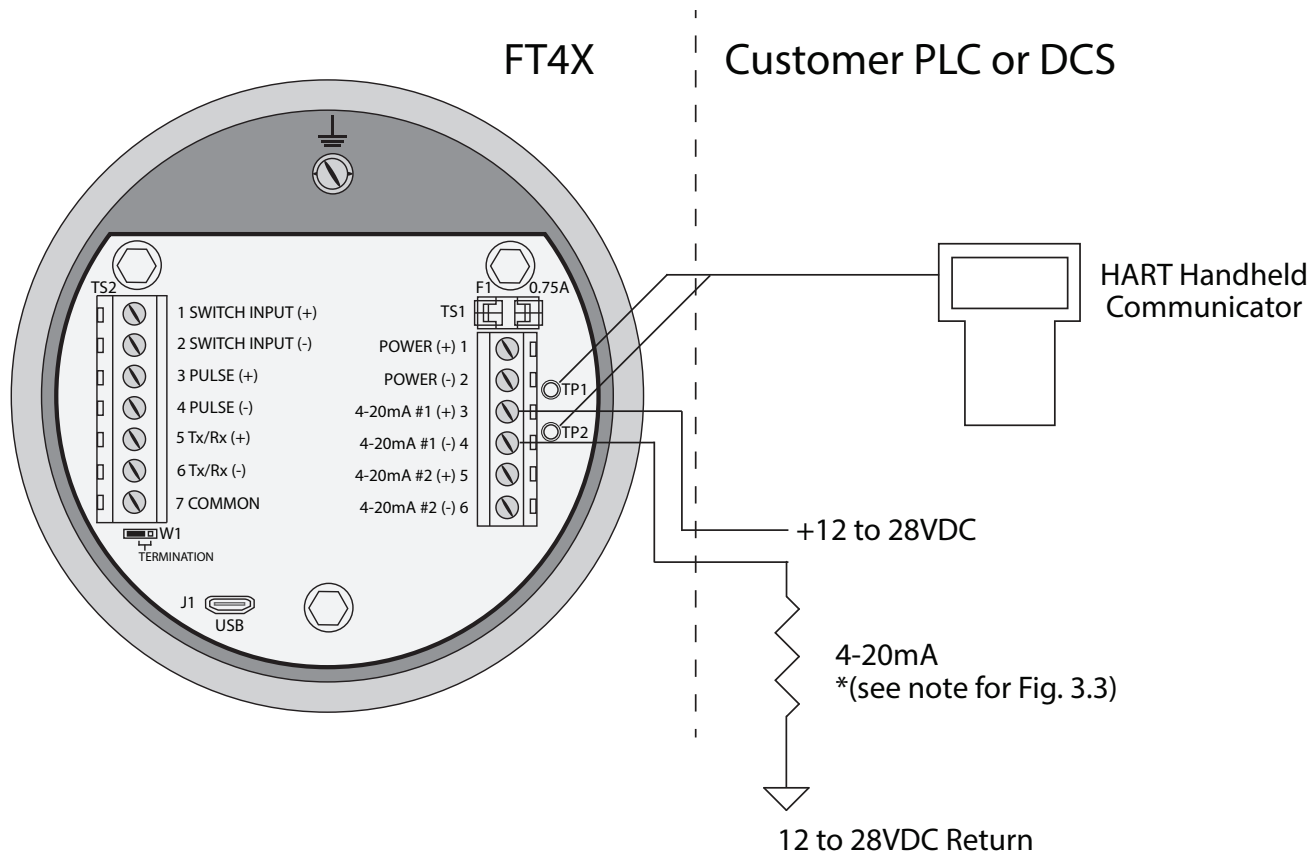
Wiring: Remote Sensor Option

WIRING

Remote Wiring

Remote wiring is only necessary when the remote sensor option has been ordered.

Fig. 3.9: Remote Wiring

2X 3/4 " NPT, Female

Remote Wiring

Remote Cable, 8 Conductor, Shielded, 100ft (30.48m) Max.
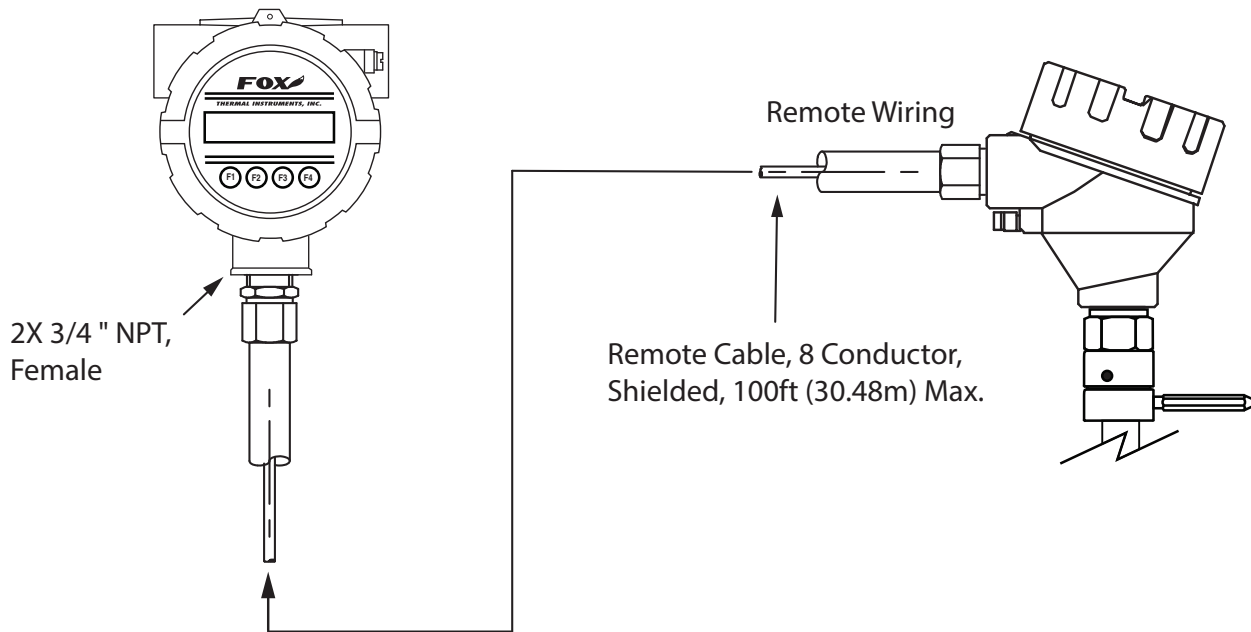
Eight wire shielded cable required. The shielded cable should be run through a separate grounded steel conduit (no other cables or wires in the conduit). If you are using your own cable, make sure that the cable length does not exceed 100 feet and has a wire resistance that does not exceed one ohm (18 AWG recommended).

NOTE! Do not connect the cable shield at the electronics enclosure end. Connect the cable shield at the remote sensor terminal.
NOTE! The enclosures must be properly grounded with a quality earth ground. 16 gauge, stranded wire is recommended.

Use an extension cable to connect the terminals of the remote sensor enclosure to connector TS3 of the electronics enclosure as shown in Figure 3.10 and Table 3.1 on the following page.

NOTE!
 Serial numbers: If you have more than one meter, you must ensure that the serial numbers of the probe/remote enclosure, electronics enclosure, and flow body match one another. These items have been manufactured and calibrated to operate as a unit and cannot be mismatched.

Wiring: Remote Sensor

Fig. 3.10: Remote Sensor Wiring

Electronics Enclosure   Detail Remote Wiring Terminal   Remote Enclosure
(located inside J-Box hinged cover panel)

Remote Wiring Terminal

YELLOW YELLOW BLUE BLUE WHITE WHITE RED RED

1 2 3 4 5 6 7 8 9

Cable Shield

Customer Wires

Sensor Wires
Probe Sensor Wired By Fox
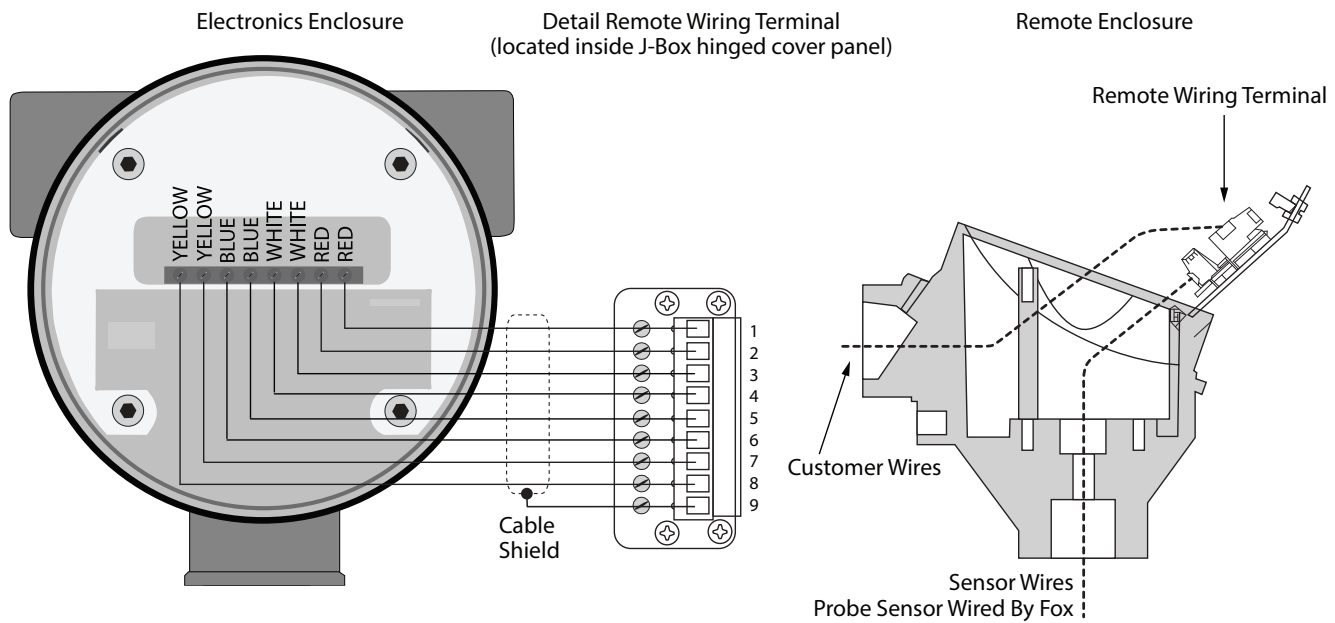
WIRING

*Wire colors listed here represent the wire colors of cables supplied by Fox. Colors may vary if customer is supplying their own cable.

Remote Sensor Cable Wiring

Table 3.1: Remote Sensor Cable Wiring

Electronics Enclosure Terminals	Extension Cable Wire Color	Remote Enclosure Terminal Numbers	Sensor Wire Color
Red	Red	1	Red
Red	Brown	2	Red
White	White	3	White
White	Black	4	White
Blue	Blue	5	Blue
Blue	Green	6	Blue
Yellow	Yellow	7	Yellow
Yellow	Orange	8	Yellow
No Connection	Shield	9	

Operation: Start Up

OPERATION

Start Up Sequence
The program automatically enters the Run/Measure mode after power up. The screen will show the software version of the FT4X during power up.

USB Interface
The USB interface is a standard feature which allows communication with a PC to monitor readings and configure settings. FT4X View™, is a free application program from Fox that connects to the USB interface and allows data monitoring, configuration setting, data logging to Excel, and an option to save and recall FT4X configuration data.

FT4X Display and Configuration Panel
The FT4X has a 2 line x 16 character display with 4 mechanical buttons.   The meter can be programmed by using the display and configuration panel. The configuration panel can be accessed by removing the FT4X cap. Be sure to replace the cap after you are done configuring the FT4X.

Fig. 4.1: FT4X Display and Configuration Panel

Display Screen

Mechanical (Push) Buttons
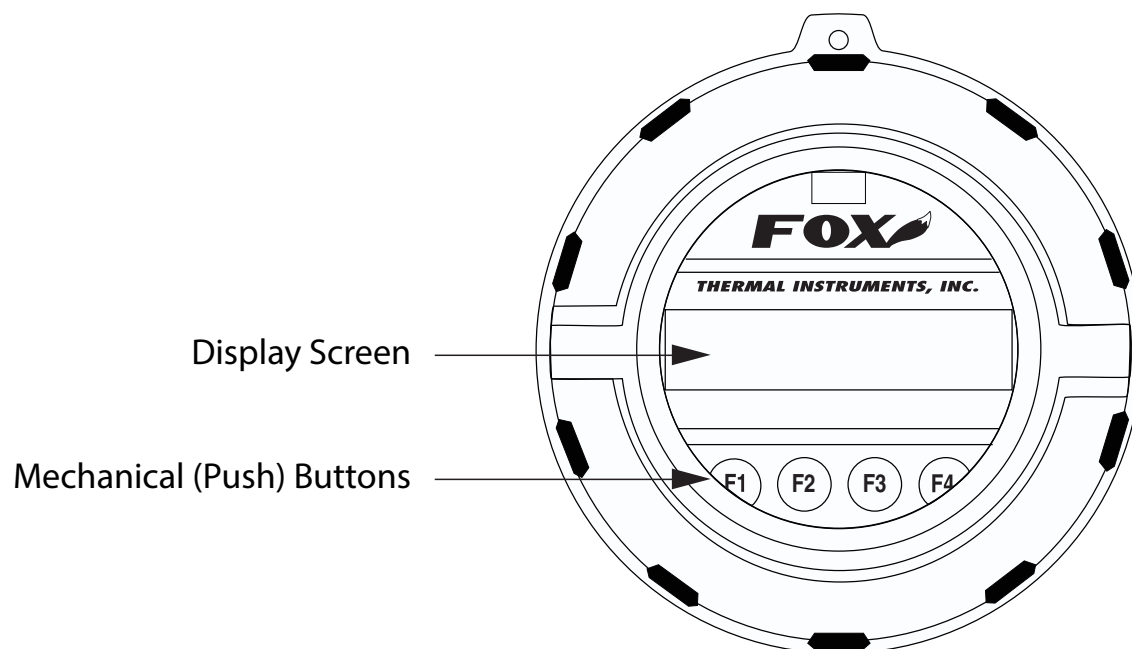
Operation: Display Screens

Measurement Mode Display Screens

In the measurement mode, there are four different display screens (display 1, 2, 3 and a prompt screen to enter the programming mode). Two display screens are user programmable (refer to Display Setup p. 48). 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 Log Menu and Engineering Menu screens (refer to p. 11).

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

Fig. 4.2: FT4X Measurement Mode Display Screen Navigation
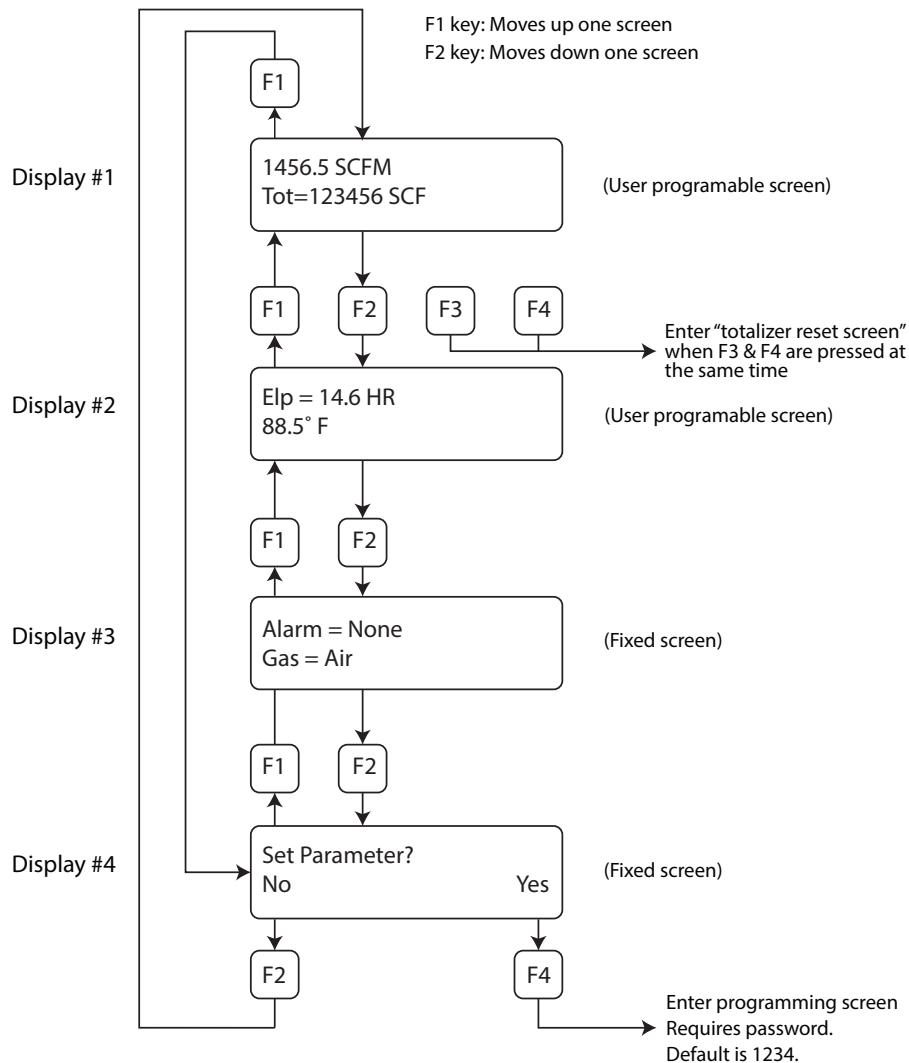
OPERATION

Operation: Programming Your Meter

Data Entry using the Display and Configuration Panel
There are 2 basic types of menu entries: one for changing value or string and one for selecting from a selection list.

To Change a Value or String :

```
VALUE = 0.91234
CHG                    OK
```
[F1] [F2] [F3] [F4]
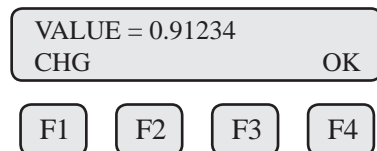
Press **CHG (F1)** key to change the value, **OK (F4)** to accept the value.
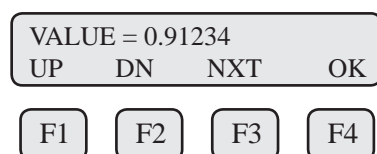
```
VALUE = 0.91234
UP      DN      NXT       OK
```
[F1] [F2] [F3] [F4]

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.

To Select from a List:

```
FLO UNT = SCFM
NXT                    OK
```
[F1] [F2] [F3] [F4]
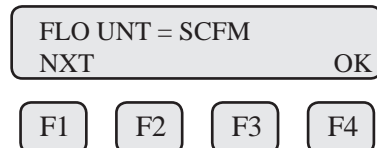
Press **NXT (F1)** key repeatedly until the correct selection is made and **OK (F4)** key to accept the entry.

Entering the Programming Mode
To enter the programming mode and access the Main Menu, press the **F1** or **F2** key in the normal running mode until the following screen is shown:

```
  SET PARAMETERS ?
No                    Yes
```
[F1] [F2] [F3] [F4]
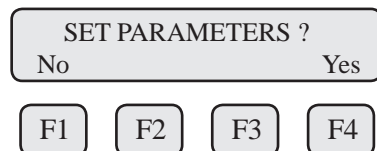
Press **YES (F4)** and the following screen will prompt user to enter password:

```
PASWD:_
UP      DN      NXT       OK
```
[F1] [F2] [F3] [F4]
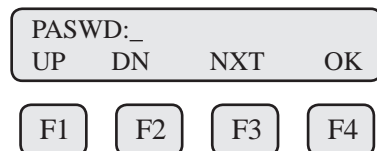
Enter the correct password, then follow the instructions for changing a value as specified on page p. 42. The default Level 1 password is "1234".
If the wrong password is entered, the message "Wrong Password" will display and then return to the programming entry screen.

OPERATION

Operation: Programming Inputs/Outputs

Main Menu

If the password is accepted, the Main Menu screen will be shown:

```
        MAIN MENU
I/O     FLO     DSP     EXIT
```
[F1]   [F2]   [F3]   [F4]

This is the Main Menu screen for the programming mode. Press **EXIT (F4)** repeatedly until "Normal Mode" is seen briefly to exit the programming mode.

Analog 4-20mA Outputs

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

```
        I/O MENU
I/O     COM     420     EXIT
```
[F1]   [F2]   [F3]   [F4]

Two 4-20mA outputs can be programmed: **CH1 (F1)** and **CH2 (F2)**. To program the first channel choose **(F1)**:

```
        SET 4-20mA
CH1     CH2             EXIT
```
[F1]   [F2]   [F3]   [F4]

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

```
20 mA =  3500 SCFM
CHG                     OK
```
[F1]   [F2]   [F3]   [F4]

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

```
4 mA =  0  SCFM
CHG                     OK
```
[F1]   [F2]   [F3]   [F4]

> **NOTE!** 4mA is normally set to 0.

Then the following screen will display:

```
mA Fault = Not use
NXT                     OK
```
[F1]   [F2]   [F3]   [F4]

Operation: Programming Inputs/Outputs

This menu allows the user to select an alarm fault level on the 4-20mA output. The alarm is activated when a serious issue is detected preventing the calculation of the correct flow rate. The 3.6mA and 21mA alarm outputs are related to the NAMUR alarm feature.

> The options are:
>> mA Fault=3.6 mA (Force the 4-20mA signal to 3.6mA on alarm)
>> mA Fault=21 mA (Force the 4-20mA signal to 21mA on alarm)
>> mA Fault=Not use (4-20mA signal alarm fault not used)

To program the second 4-20mA channel, choose **CH2 (F2)**:

```
          SET 4-20mA
 CH1     CH2              EXIT
```
```
[ F1 ]   [ F2 ]   [ F3 ]   [ F4 ]
```

Only the 4-20mA output on Channel 2 is programmable for flow or temperature:

```
mA=Flow
NXT                       OK
```
```
[ F1 ]   [ F2 ]   [ F3 ]   [ F4 ]
```

Selections for the 4-20mA **CH 2** output are:
> Flow
> Temp

Select **NXT (F1)** to select Flow or Temperature and then press **OK (F4)**.

```
20 mA =   3500 SCFM
CHG                       OK
```
```
[ F1 ]   [ F2 ]   [ F3 ]   [ F4 ]
```

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

From any screen, press **(F4)** repeatedly until "Normal Mode" is seen briefly to exit the programming mode.

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

Operation: Programming Pulse/Alarms

Pulse/alarm Output

The Pulse/alarm feature can be accessed from the main menu, press **I/O (F1).**

```
        SET       I/O
 OUT    INP            EXIT
```
| F1 | F2 | F3 | F4 |
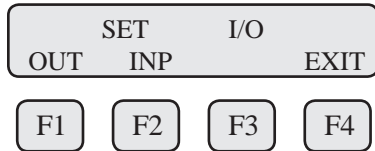
Press **OUT (F1)** to select the pulse output. The following screen will show:

```
 OUT = Pulse
 NXT                   OK
```
| F1 | F2 | F3 | F4 |
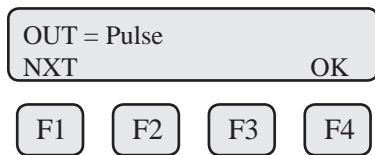
Press **NEXT (F1)** to cycle through output options until you have the selection for "OUT=Pulse" and press **OK (F4).**

The pulse output can be configured in one of three ways:

1. Specifying how many pulses per unit, P/U (i.e., 10 pulses per SCF)
2. Specifying how many flow units total per pulse, U/P (i.e., 0.1 SCF per pulse)
3. Specifying a maximum frequency to a defined maximum value of flow rate

All of these approaches are equivalent.

```
 PULSE OUTPUT
 P/U     U/P     FEQ    EXIT
```
| F1 | F2 | F3 | F4 |
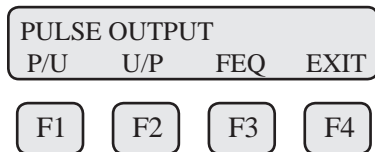
Use **P/U (F1)** to enter pulse per unit, **U/P (F2)** for unit per pulse or **FEQ (F3)** to enter the flow and maximum frequency to scale the pulse/alarm output.

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

Entering data in Pulse per Unit:

From the Pulse/alarm Output Menu above, press **P/U (F1)** and the following screen will show:

```
 PLS/UNT = 2
 CHG                   OK
```
| F1 | F2 | F3 | F4 |
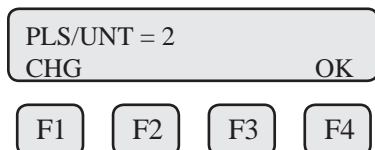
Press **CHG (F1)** to change the setting and then **OK (F4)** to accept entry.

The value entered is in pulse per selected flow unit total (i.e., 2 pulses per SCF).

OPERATION

Operation: Programming Pulse/Alarms

Entering data in Unit per Pulse:
From the Pulse/alarm Output Menu, press **U/P (F2)** and the following screen will show:

```
UNT/PLS = 0.5
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. 0.5 flow unit total per pulse)

Entering data with flow and maximum frequency:
From the Pulse/alarm Output Menu, press **FEQ (F3)** and the following screen will show:

```
MaxFreq=100  Hz
CHG                    OK
```

[F1] [F2] [F3] [F4]

Enter the maximum pulse rate (frequency) and press **OK (F4).**

CAUTION! Maximum pulse rate (frequency) cannot exceed 100 Hz.

The next screen will show:

```
MaxFlo=5000 SCFM
CHG                    OK
```

[F1] [F2] [F3] [F4]

NOTE! If the flow rate exceeds the maximum pulse rate (frequency), the output will stay at 100 Hz and the FT4X will issue an alarm code.

Alarm Output
To access the Pulse/alarm feature, press **I/O (F1)** key from the Main Menu screen. The screen will show:

```
          SET       I/O
OUT     INP             EXIT
```

[F1] [F2] [F3] [F4]

Then press **OUT (F1)** and the screen may show:

```
OUT = HiFloAlm
NXT                    OK
```

[F1] [F2] [F3] [F4]

Then press **NXT (F1)** to select the correct alarm and press **OK (F4).**

Operation: Programming Inputs/Outputs

Selections are:
>   Not used
>   Pulse
>   HiFloAlm =   High Flow Alarm
>   LoFloAlm =   Low Flow Alarm
>   HiTempAlm =   High Temperature Alarm
>   LoTempAlm =   Low Temperature Alarm

When the output is set to Alarm and there is no alarm condition, the output will be on (0 volts). When an alarm is active, the output is turned off (12 to 24 volts).

```
HiFloAlm=500 SCFM
CHG                     OK
```
| F1 | F2 | F3 | F4 |

Enter the value for the limit by pressing **CHG (F1)** and then **OK (F4).** A value of 0 disables the alarm.

NOTE! There is only one output to operate as a pulse output or an alarm output. Both cannot operate at the same time.

For Switch Input Settings:
From the main menu, press **I/O (F1)** and then **I/O (F1)** and then **INP (F2)** key to select input. The following menu will display:

```
     INP=Not Used
NXT                     OK
```
| F1 | F2 | F3 | F4 |

Press **NXT (F1)** until the correct selection is shown and then press **OK (F4)** to accept the setting.
>   Selections are:
>   Not used
>   Tot Reset   Reset the totalizer

Press **EXIT (F4)** repeatedly until you exit programming mode.

Serial Communication Settings
If RS485 Communication feature was purchased, the Serial communication settings can be programmed by pressing **I/O (F1)** key from the Main Menu. The screen will show:

```
        I/O MENU
 I/O    COM    420    EXIT
```
| F1 | F2 | F3 | F4 |

Press **COM (F2)** to select Serial communication.

OPERATION

Operation: Programming Display, Password, & Date/Time

The screen may show:

```
Comm=MODBUS
NXT                    OK
```
F1   F2   F3   F4
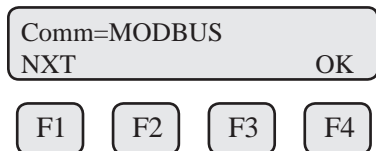
Options for serial communication are:
    None
    MODBUS
    HART

NOTE! Any selection other than "None" requires the communication option for the selected communication type. If enabling a communication option, see the Communications Protocols section of this manual.

Display Setup
There are four display screens that you can cycle through in normal operating mode (see Figure 4.2 on p. 41). Two of the four display screens are fixed and cannot be changed (displays #3 & 4). The other two screens are programmable to show the information that you prefer and is discussed in this section.

Display #1
```
DSP1L1
DSP1L2
```
F1   F2   F3   F4

Display #2
```
DSP2L1
DSP2L2
```
F1   F2   F3   F4
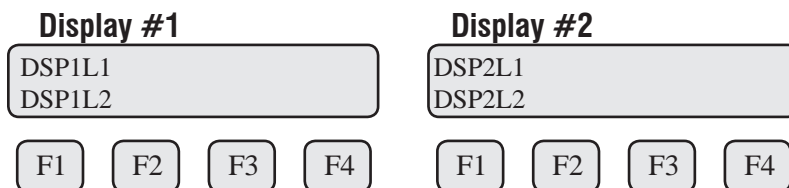
Selections are:
    DSP1L1   Display 1, Line 1
    DSP1L2   Display 1, Line 2
    DSP2L1   Display 2, Line 1
    DSP2L2   Display 2, Line 2

To Program Display Screens #1 & 2:
From the Main Menu press **DSP (F3)** to select the display menu:

```
DISP/TIME/PSW
DSP    LOG    PSW    EXIT
```
F1   F2   F3   F4
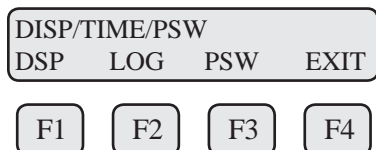
Press **DSP (F1)** key. The display will show:

```
DSP1L1 = Flo rate
NXT                    OK
```
F1   F2   F3   F4
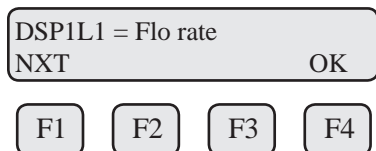
Operation: Programming Display, Password, & Date/Time

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

Selections are:

Flo rate	Flow rate
Total	Total mass or volume
Elps	Elapsed time
Temp	Temperature
Alarm	Error codes

When the selection is correct, press **OK (F4)** to accept. The display will then 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.

To Program the Date/Time for 24 Hour Logs and Contract Time:

```
DISP/TIME/PSW
DSP    LOG    PSW    EXIT
```
F1   F2   F3   F4

Press **LOG (F2)** key to select perform a Date/Time Review. Turn the 24 Hour log on or off with **NXT (F1)**.

```
      24 Hour log=On
NXT                OK
```
F1   F2   F3   F4

Selections are: On or Off

The following screen will cycle through Year, Month, Day, Hour, Minute, and Seconds to set the Date/Time in the following format: MM/DD/YY HH:MM. To change the value of these, press **CHG (F1)** then **OK (F4)** to set the value and move to the next:

```
Year Set = 17
CHG                OK
```
F1   F2   F3   F4

To set the final value, choose **YES (F1)** or **NO (F4)**:

OPERATION

```
        Set Date/Time?
YES                      NO
```
[F1] [F2] [F3] [F4]

The screen will show:

```
        11/14/17 11:18
CHG                      OK
```
[F1] [F2] [F3] [F4]

Press **OK (F4)** to set the Contract Time.

NOTE! Contract Time will only be set if the 24 Hour Log has been selected to be "On".

The following screen will cycle through Hour and Minute to set the Time in the 24-Hour Clock format: HH:MM. To change the value of these, press **CHG (F1)** then **OK (F4)** to set the value and move to the next:

```
Contr Hour = 22
CHG                      OK
```
[F1] [F2] [F3] [F4]

```
Contr Min = 45
CHG                      OK
```
[F1] [F2] [F3] [F4]

To set the final value, choose **YES (F1)** or **NO (F4)**:

```
Set Contr Time?
YES                      NO
```
[F1] [F2] [F3] [F4]

Password
There are two user level passwords, only **Level 1** is programmable and gives access to all the normal settings. The second password is used to allow access to calibration factors and should normally never be changed unless advised by the Fox service department, or 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 Main Menu press **DSP (F3)** to select the display menu.

Operation: Programming Measurement Units

To Program the Password:

```
DISP/TIME/PSW
DSP     LOG     PSW     EXIT
```
[F1] [F2] [F3] [F4]
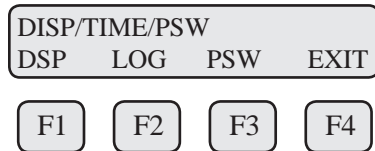
Press **PSW (F3)** key to select password.

```
PASSWD = 1234
CHG                    OK
```
[F1] [F2] [F3] [F4]
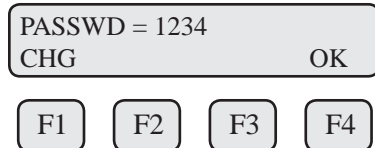
This screen displays the current **Level 1** password.
Press CHG (F1) key to change the password and enter new value.

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.

Units Settings Menu
This menu is used to set the units for flow, temperature, and pressure.
Reference temperature and reference pressure settings can be accessed also.

These values will be set at Fox using information supplied by the customer. These values can be changed to match a new application. The units setting is accessed from the Main Menu. To access the Unit Settings Menu:

```
        MAIN MENU
I/O     FLO     DSP     EXIT
```
[F1] [F2] [F3] [F4]

Press **FLO (F2)**:

```
        FLOW MENU 1
DGN     UNT     FM2     EXIT
```
[F1] [F2] [F3] [F4]
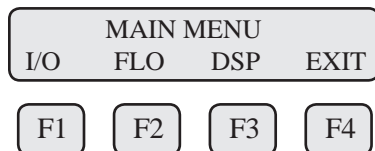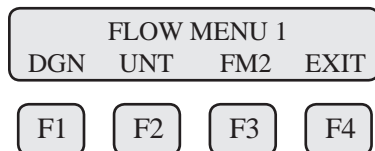
Press **UNT (F2)** for Unit selection. The screen will show:
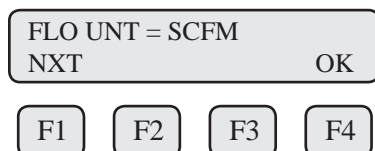
```
FLO UNT = SCFM
NXT                    OK
```
[F1] [F2] [F3] [F4]

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

Operation: Programming Measurement Units

OPERATION

NOTE! The totalizer (total flow measured) will roll over when reaching a certain value. The maximum value is dependent on the flow units selected (see Totalizer Rollover p. 58).

Flow Units

Selections for flow units are:

SCFM	LBS/H	SM3/M	MSCFD (MCFD)
SCFH	LBS/M	SM3/H	MMSCFD (MMCFD)
NM3/H	LBS/S	SM3/D	MCFD (MSCFD)
NM3/M	LBS/D	NM3/D	MMSCFM (MMCFM)
KG/H	NLPH	SLPM	MT/H
KG/M	NLPM	SCFD	
KG/S	NLPS		

WARNING! The FT4X re-calculates area, 4 and 20mA values, maximum flow for the pulse output and zero flow cutoff when changing flow units.

Temperature Units

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

```
TMP UNT= ° F
NXT                OK
```

| F1 | F2 | F3 | F4 |

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

Selections for Temperature units are: °C or °F

Reference Temperature

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

```
TmpRef = 60 °F
CHG                OK
```

| F1 | F2 | F3 | F4 |

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

Operation: Programming Measurement Units

Pressure Units

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

```
PRES UNT= Psia
NXT                OK
```
| F1 | F2 | F3 | F4 |
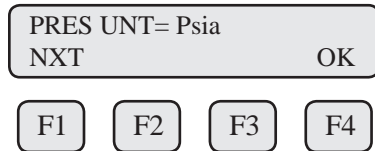
Press **NXT (F1)** to select next entry and OK (F4) to accept.

Selections are:
mmHG	Millimeters of mercury (absolute)
Psia	Pounds per square inch absolute
bara	Bar absolute

Reference Pressure

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

```
PresRef= 14.7
CHG                OK
```
| F1 | F2 | F3 | F4 |
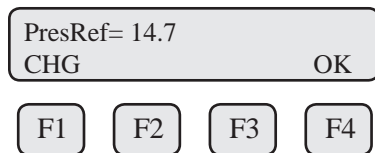
Press **CHG (F1)** to change it and **OK (F4)** to accept.

Flow Parameters

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

NOTE! The parameters in this menu are factory-set and should not be changed.

```
        MAIN MENU
I/O     FLO     DSP     EXIT
```
| F1 | F2 | F3 | F4 |
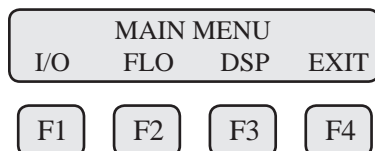
The menu is accessed from the Main Menu by pressing **FLO (F2)**:

```
        FLOW MENU 1
DGN     UNT     FM2     EXIT
```
| F1 | F2 | F3 | F4 |
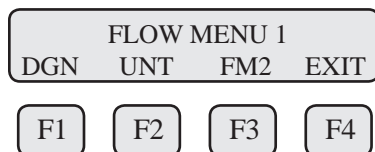
Then press **FM2 (F3)**:

OPERATION

```
        FLOW MENU 2
GAS     SPC     PRM     EXIT
```
[F1] [F2] [F3] [F4]

NOTE! The **SPC** function key will only appear and be accessible from a **Level 2** password.

Then press **PRM (F3)**.

The first parameter is **Flow Cutoff**:

```
CUTOFF = 2.0  SCFM
CHG                  OK
```
[F1] [F2] [F3] [F4]

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

To set the **Pipe Diameter**

```
Pipe_id  = 3.068  In
CHG                  OK
```
[F1] [F2] [F3] [F4]

Enter the pipe diameter in inches or **millimeters** and then press **OK (F4)**.
Use millimeters for metric flow unit selections and inches for English flow unit selections. If the pipe/duct is a square or rectangle, the hydraulic diameter (equivalent value for a round pipe) must be entered for the pipe ID.

The **Filter Value** is entered in seconds. The allowable time constant range is 0.8 to 10 seconds. The filter time interval is proportional to the dampening.

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

```
FILTER = 0.8 sec
CHG                  OK
```
[F1] [F2] [F3] [F4]

High Flow Rate Alarm
This is the upper flow limit alarm value that can be associated with the alarm output. An alarm code is generated when the flow value exceeds this limit. If no alarm is needed, set this value to zero.

To set the parameters for a high flow rate alarm, press **CHG (F1)**:

Operation: Programming Flow Parameters

```
HiFloAlm = 1234  SCFM
CHG                        OK
```

| F1 | F2 | F3 | F4 |

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

Low Flow Rate Alarm
This is the lower flow limit alarm value that can be associated with the alarm output. An alarm code is generated when the flow value is below this limit. If no alarm is needed, set this value to zero.

To set the parameters for a low flow rate alarm, press **CHG (F1)**:

```
LoFloAlm = 100 SCFM
CHG                        OK
```

| F1 | F2 | F3 | F4 |

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

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

To set the parameters for a high temperature alarm, press **CHG (F1)**:

```
HiTmpAlm = 200 F
CHG                        OK
```

| F1 | F2 | F3 | F4 |

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

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

To set the parameters for a high temperature alarm, press **CHG (F1)**:

```
LoTmpAlm = 20 F
CHG                        OK
```

| F1 | F2 | F3 | F4 |

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

OPERATION

Operation: Programming Simulation

Simulation

This menu allows for simulation of flow rate and temperature. 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.**

CAUTION! If the 4-20mA and/or the pulse/alarm outputs are connected to controllers, set the controllers to "manual" to ensure that the simulated signals do not cause false controller action.

The menu is accessible from the main programming menu by pressing **FLO**, and **DGN (F1)**:

```
        FLOW MENU 1
DGN     UNT     FM2    EXIT
```
[F1] [F2] [F3] [F4]

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

```
      DIAGNOSTIC
SIM    CAL-V          EXIT
```
[F1] [F2] [F3] [F4]

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

```
Simulate Flow?
YES                     NO
```
[F1] [F2] [F3] [F4]

Press **YES (F1)** to continue.

```
FloSim = 0 SCFM
CHG                     OK
```
[F1] [F2] [F3] [F4]

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

NOTE! Enter zero to disable this feature.

```
Simulate Temp?
YES                     NO
```
[F1] [F2] [F3] [F4]

Press **YES (F1)** to continue.

OPERATION

Operation: Programming K-Factor

```
TmpSim = 0 C
CHG                    OK
```

F1   F2   F3   F4

Enter the value and then press **OK (F4)**. Enter zero to disable this feature.

```
ENABLE SIM?
YES                    NO
```

F1   F2   F3   F4

Press **YES** (**F1**) to start the simulation mode, otherwise press **NO** (**F4**). Upon pressing either key, the program will return to the FLOW MENU 1 screen.

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

K Factor
The K Factor allows the user to adjust the meter's calibration. The Fox flow meter increases the calculated flow rate by the K Factor. This results in a direct scaling of the meter's output across the entire full range.

The K Factor parameter is accessed from the "Flow Menu 2" menu by entering a **Level 2** password "9111" and pressing the **SPC** key (**F2**).

```
        FLOW MENU 2
GAS      SPC     PRM    EXIT
```

F1   F2   F3   F4

The following screen will be displayed:

```
K fact=0%
CHG                    OK
```

F1   F2   F3   F4

Press **CHG (F1)**. Add the correction factor and press OK (F4).

If you want the flow meter to read 5% higher, enter 5.0%.
If you want the flow meter to read 5% lower, enter -5.0%.
If an existing K Factor is present, add the additional K Factor to the existing value.

Upon pressing **OK (F4)**, an option to restore the database will follow.

OPERATION

Operation: Restore and Reset

OPERATION

Restore Database

In case of user error, the ability to restore the meter to the original factory settings can be achieved in this menu. The display will show:

```
RESTORE DATABASE?
YES                    NO
```
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 green LP3 LED will flash at a faster pace until the recall is performed. The "RESET CRC" screen will follow "RESTORE DATABASE".
Upon pressing **OK (F4)**, an option to reset the NVRAM CRC will follow.

Reset CRC

If the NVRAM CRC check fails (Error Code 36), the programmed settings 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.

Reset Total and Elapsed Time

Enter the flow totalizer and elapsed time screen by pressing the **F3** and **F4** keys at the same time in the normal running mode (password required).

```
RESET TOTAL ?
NO                    YES
```
F1 F2 F3 F4

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

NOTE! This feature is not available on non-resettable units.

Totalizer Rollover: The FT4X has an automatic roll-over function. The total flow count of the FT4X will roll over after the following values:

Most flow units:	99,999,999,999
MSCFD:	999,999,999
MMSCFM:	9,999,999
MMSCFD:	999,999

Operation: CAL-V™

Performing the CAL-V™ Calibration Validation Test

During the CAL-V™ test, the FT4X measurement circuit converts to "test" mode where the sensor electrical characteristics are measured and compared. CAL-V™ measurements within established tolerances confirms the meter is accurate. This test can be performed under normal flow conditions. The test takes five minutes to complete. At the conclusion of the test, the meter will return to normal measuring mode and a Pass, Warning, or Fail message will be displayed. Press F4 to terminate the test or to return to the normal display screen after the test is complete.

Press **FLO (F2)** from the main menu. The display will show:

```
FLOW MENU 1
DGN     UNT    FM2     EXIT
```
| F1 | F2 | F3 | F4 |

Press **DGN (F1).** The display will show:

```
        DIAGNOSTIC MENU
SIM     CAL-V              EXIT
```
| F1 | F2 | F3 | F4 |

CAUTION!
- The FT4X will stop measuring flow when performing the CAL-V™ test
- For applications with temperature exceeding 250°F (121°C), CAL-V™ test results may vary.
- Periodic inspection for damage and cleaning of the sensor elements is required.

Press **CAL-V (F2).** The display will show:

```
        CAL-V MENU
VER                    EXIT
```
| F1 | F2 | F3 | F4 |

Press **VER (F1)** to perform the CAL-V™ verification test.

NOTE! The FT4X will stop measuring flow when performing this test. **Press EXIT (F4)** to exit if you do not wish to continue.

```
        VERIFY CAL-V?
YES                    NO
```
| F1 | F2 | F3 | F4 |

Press **YES (F1)** to continue.

```
Flo:Go to zero
NXT             EXIT    OK
```
| F1 | F2 | F3 | F4 |

Operation: CAL-V™

To select what the flow output will do during CAL-V™, choose from these options:

> Go To Zero: Flow output will be zero during the test (ie 4mA)
> Hold Value: Flow will hold last value during the test

Select the option and press **OK (F4)**.

```
Take Control
off-line              EXIT      OK
```
[F1] [F2] [F3] [F4]

⚠️ **WARNING!** If you are using closed loop control, the system needs to be taken off-line during the test.

Press **OK (F4)** to start CAL-V™. CAL-V™ test screen:

```
Verifying CAL-V
4.7                    T=123
```
[F1] [F2] [F3] [F4]

This test will take 5 minutes and will show the CAL-V™ value changing as signals to the sensor are adjusted. The T=xxx is a CAL-V™ timer indicating how much time is left in the test.

Upon test completion, the final CAL-V™ value will be displayed along with a Pass, Fail, or Warning message:
- Pass: less than ±0.80
- Warning: between ±0.80 to ±1.0
- Fail: greater than ±1.0

If a "Warning" or "Fail" result is displayed, Fox recommends that the probe be removed from the pipe, the sensor cleaned, and the test be performed again. Performing the test in flowing gas will give the most accurate results.

If a "Warning or "Fail" result is displayed after repeating the test, please call Fox Service at (831) 384-4300 for assistance.

```
CAL-V = 0.51
Pass                            OK
```
[F1] [F2] [F3] [F4]

Press **OK (F4)** to exit the menu when the test is complete.

ℹ️ **NOTE!** For best results, perform a visual inspection of the sensor window for damage/deformity and condition of sensor elements before starting the test.

OPERATION

Operation: Gas-SelectX®

Gas-SelectX® Available Gases and Gas Mix Menus

This menu allows the user to select a gas or gas mix from a pre-calibrated list of gases/gas mixtures available in the Fox Model FT4X Flowmeter. When entering the FT4X gas menu the user will have three choices:

1. Pure Gas Menu - a list of 11 gases
2. Gas Mix (MIX) - a mixture of any gases available in the Pure gas menu (total must equal 100%)
3. Oil & Gas Mix (O&G) Menu - any combination of the 12 gases in the Oil & Gas menu (total must equal 100%)

Pure Gas Menu	Mixed Gas Menu**	O & G Gas Menu**
Air	Air	Methane (C1)
Argon	Argon	Ethane (C2)
Butane	Butane	Propane (C3)
Carbon Dioxide	Carbon Dioxide	i-Butane (C4)
Methane	Ethane	n-Butane (C4)
Natural Gas *	Methane	Pentanes (C5)
Nitrogen	Nitrogen	Hexanes (C6)
Oxygen	Oxygen	Carbon Dioxide (CO2)
Helium	Helium	Nitrogen
Hydrogen	Hydrogen	Heptanes (C7)
Propane	Propane	Octanes (C8)
		Nonanes+ (C9+)***

Natural gas refers to pipeline-quality dry natural gas, whereas naturally occurring gas from oil fields constitutes a special gas mix of which the composition is to be entered in the O&G gas menu.
*** The molar percentages of the gases are programmable in 0.1% increments. Gases may be mixed in any proportion equaling 100%. Round compositions to the nearest 0.1 percent; rounding errors to be added/subtracted to Hexanes (C6).*
**** Total of all gases C9 & greater (C9+).*

> **NOTE!** For the latest gas and gas mix menu, visit the Fox Website: www.foxthermalinstruments.com

After installing your FT4X flowmeter, power up the device. When the meter finishes initializing, it will begin to monitor flow in the assigned gas and flow units.

Operation: Gas-SelectX®

Accessing the Gas-SelectX® Gas Selection Menu Feature

Enter the programming mode on the meter (refer to p. 42) and then follow these instructions to access the Gas-SelectX® feature:

```
        MAIN MENU
  I/O    FLO    DSP    EXIT
```
[F1] [F2] [F3] [F4]
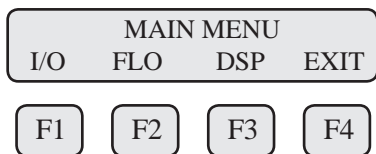
Press **FLO (F2)** from the Main Menu to enter Flow Menu 1.

```
        FLOW MENU 1
  DGN    UNT    FM2    EXIT
```
[F1] [F2] [F3] [F4]
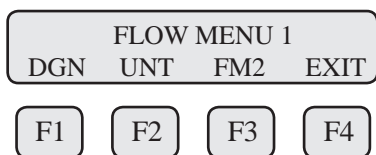
Press **FM2 (F3)** to get to Flow Menu 2.

```
        FLOW MENU 2
  GAS    SPC    PRM    EXIT
```
[F1] [F2] [F3] [F4]
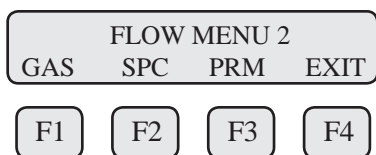
Press **GAS (F1)** to access the Gas-SelectX® feature. The display will show the gas setting (Pure Gas, Mix, or O&G Mix):

```
  GAS =O&G Mix
  NXT                OK
```
[F1] [F2] [F3] [F4]

Press NXT (1) repeatedly until the correct selection is shown and then press **OK (F4)** to accept the setting.

Selections are: Pure Gas
                         Mix
                         O&G Mix

In the Pure Gas menu, the user can choose from a list of 11 pure gases. The Mix menu is used for programming a specific mixture of gases. The O&G Mix menu is used for programming a specific mixture of common gases found in the Oil & Gas industry.

NOTE! Switching between Pure Gas, Mix, or O&G Mix settings will clear the previous gas settings.

See previous page for gases available in each menu.

Operation: Gas-SelectX®

Gas-SelectX® Single Gas Menu
To select a pure gas, choose **"Pure Gas" (F1)** and then press **"OK" (F4)** to accept the setting:

```
GAS=Air
NXT                    EXIT
```
[F1] [F2] [F3] [F4]

To choose any pure gas, press **NXT (F1)** to cycle through until the correct gas is displayed and press **OK (F4)** to select the gas. Choices are listed in full in "Gas-SelectX® Available Gases and Gas Mix Menus" on page 61.

Choosing a Gas: Gas Mix Menu and Oil & Gas Menu
To create a gas mix, choose either **"Mix"** or **"O&G Mix"** from the GAS menu.

```
GAS =Mix
NXT                      OK
```
[F1] [F2] [F3] [F4]

The screen will show the first gas available in the menu:

```
Methane=0%
CHG                      OK
```
[F1] [F2] [F3] [F4]

This screen shows the percentage of the gas mixture allocated to Methane. In this case, it shows 0%. To program the specific mixture of Methane, press **CHG (F1)**.

```
Methane=30.5%
  UP      DN     NXT     OK
```
[F1] [F2] [F3] [F4]

To set the percentage of methane in the gas mix, press **UP (F1)** or **DN (F2)** to choose the first digit of the percentage. Press **NXT (F3)** to move to the next digit in the percentage and then use **UP (F1)** or **DN (F2)** again to choose the next digit of the percentage. Once the desired methane percentage is displayed, press **OK (F4)**. The display will move to the view of the concentration of each of the subsequent list of gases.

```
Ethane=0%
CHG                      OK
```
[F1] [F2] [F3] [F4]

Operation: Gas-SelectX®

Once the desired gas percentages are programmed, press **OK (F4)**. One of the following messages will appear:

Gas Mix (100%)	
CHG	OK

-or-

Err: Mix=(110%)
CHG

[F1] [F2] [F3] [F4]   [F1] [F2] [F3] [F4]
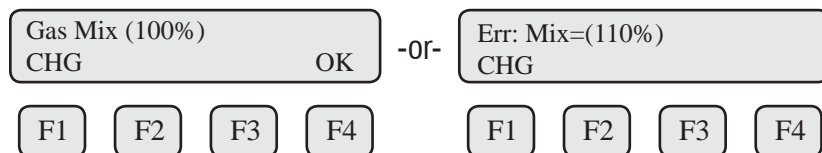
If the gas mix does not equal 100%, press **CHG (F1)** to return to the gas entry menu.

Once the "Gas Mix (100%)" message appears, you have successfully programmed the gas mix in Gas-SelectX® and can exit. Press **OK (F4)** to set the mixture.

After the gases are programmed, the FT4X will begin to monitor flow based on the pre-calibrated algorithm for the gas/gas mix selected in the Gas-SelectX® feature. The screen will show the flow in units and the total flow similar to the example below:

1162.52 SCFM
Tot=6205012.50 SCF

[F1] [F2] [F3] [F4]
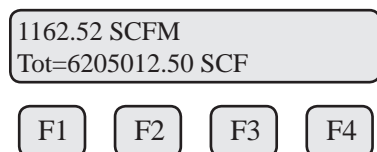
NOTE!
- Gas mix must equal 100%
- Any gases not included in the gas mix should have percentages set to 0%.
- The entry for Nonane+ in the Oil and Gas menu includes all gases C9 and higher.

In normal operating mode, the gas selection can be seen on display 3 .

Communications: Modbus

Scope
This portion of the manual describes the Modbus implementation using RS485 serial communication physical layer for the Fox Thermal Instruments FT4X Mass flow meter based on the Modicon Modbus Protocol (PI-MBUS-300 Rev. J).

Modbus Protocol
MODBUS Protocol is an application layer messaging protocol that provides client/sever communications between devices. MODBUS is a request/reply protocol and offers services specified by function codes.

The size of the MODBUS Protocol Data Unit is limited by the size constraint inherited from the first MODBUS implementation on Serial Line network (max. RS485 Application Data Unit = 256 bytes).

Therefore, MODBUS PDU for serial line communication = 256 – Server address (1 byte) – CRC (2 bytes) = 253 bytes.

RS485 ADU = 253 + Server address (1 byte) + CRC (2 bytes) = 256 bytes.

For more information on MODBUS go to the web site http://www.modbus.org/.

Command Request:
<Meter Address> <Function code> <Register start address high> <Register start address low> <Register count high> <Register count low> <CRC high> <CRC low>

Command Response:
<Meter Address> <Function code> <Data byte count> <Data register high> <Data register low> ... <Data register high> <Data register low> <CRC high> <CRC low>

NOTE! The data shown in brackets < > represents one byte of data.

Modbus Indicators
LED indicator LP3 cycles on and off to indicate that the FT4X is operating. LED indicator LP2 blinks when Modbus signals are received and LP1 blinks when Modbus signals are transmitted. The LEDs are located behind the display panel.

FT4X Commands Supported
The FT4X supports the following commands:
    1) Command 03: Read holding registers
    2) Command 04: Read input register.
    3) Command 06: Preset single register

Read Holding Registers (command 03)
This command reads the basic variable from the FT4X and has the following format:

Request:
<Meter Address> <Command code=03> <Register start address high> <Register start address low> <Register count high> <Register count low> <CRC high> <CRC low>

Response:
<Meter Address> <Command code=03> <Byte count> <Data high><Data low> ... <Data high><Data low> <CRC high> <CRC low>

Example: Request data register at starting address 0x0000 and specifying only 1 register

<0x01> <0x03> <0x00> <0x00> <0x00> <0x01> <0x0a> <0x84>

Response:
<0x01> <0x03> <0x02> <xx> <xx> <CRC high> <CRC low>

Where xx xx is the data register value.

Table 5.1: FT4X Modbus Holding Registers

Register Address	Modbus Address	Data Type	Scaling	Comment
0x00	40001	Flow in Eng units (integer format, low)	No	Mass flow in selected units
0x01	40002	Flow in Eng units (integer format, high)	No	
0x02	40003	Total (integer format, low)	No	Total in selected units
0x03	40004	Total (integer format, high)	No	
0x04	40005	Temperature (integer format, low)	*10	Temperature in selected units * 10
0x05	40006	Temperature (integer format, high)	*10	
0x06	40007	Elapsed time (integer format, low)	*10	Elapsed time in hours * 10
0x07	40008	Elapsed time (integer format, high)	*10	
0x08	40009	Spare/not used		
0x09	40010	Spare/not used		
0x0A	40011	Flow in Eng units * 10 (integer format)	10	Mass flow in selected units * 10
0x0B	40012	Flow in Eng units *100 (integer format)	100	Mass flow in selected units * 100
0x0C	40013	Total *100 (integer format)	100	Total in selected units * 100
0x0D	40014	Spare/ Not used		
0x0E	40015	Spare/ Not used		
0x0F	40016	Status (integer format)	No	Status
0x10	40017	Status 2 (integer format)	No	

Communications: Modbus

Register Address	Modbus Address	Data Type	Scaling	Comment
0x11	40018	Control Register (Write Only): (integer format) Reset total =2 Perform_CAL_V = 173 Abort CAL-V = 174 Reset 24hr total log =180 Generate 24 hrs event=182 Set RTC clock=185 Read RTC clock=186	No	Control Register
0x12	40019	Spare/ Not used		
0x13	40020	Flow in Eng units (float format, upper 16 bits)	No	Mass flow in selected units
0x14	40021	Flow in Eng units (float format, lower 16 bits)	No	Mass flow in selected units
0x15	40022	Total in Eng units (float format, upper 16 bits)	No	Total in selected units
0x16	40023	Total in Eng units (float format, lower 16 bits)	No	Total in selected units
0x17	40024	Spare/ Not used		
0x18	40025	Spare/ Not used		
0x19	40026	Temperature in selected units (float format, upper 16 bits)	No	Temperature in selected units
0x1A	40027	Temperature in selected units (float format, lower 16 bits)	No	Temperature in selected units
0x1B	40028	Elapsed time in hours (float format, upper 16 bits)	No	Elapsed time in hours
0x1C	40029	Elapsed time in hours (float format, lower 16 bits)	No	Elapsed time in hours
0x1D	40030	CAL-V (float format, upper 16 bits)	No	
0x1E	40031	CAL-V (float format, lower 16 bits)	No	
0x1F	40032	TOT24 Rec select (integer format, low register)	No	Total 24 record select
0x20	40033	TOT24 Rec select (integer format, hi register)	No	Total 24 record select
0x21	40034	TOT24 Rec buffer (float format, LSB)	No	Total 24 record buffer
0x22	40035	TOT24 Rec buffer (float format, MSB)	No	Total 24 record buffer
0x23	40036	TOT24 current total (float format, LSB)	No	Total 24 current total
0x24	40037	TOT24 current total (float format, MSB)	No	Total 24 current total
0x29	40042	TOT24 contract time, hour (integer format)	No	Total 24 contract time, hour
0x2A	40043	TOT24 contract time, minute (integer format)	No	Total 24 contract time, minute
0x2C	40045	Second time set (integer format, low register)	No	Second time set
0x2D	40046	Second time set (integer format, high register)	No	Second time set
0x2E	40047	Minute time set (integer format, low register)	No	Minute time set
0x2F	40048	Minute time set (integer format, high register)	No	Minute time set
0x30	40049	Hour time set (integer format, low register)	No	Hour time set
0x31	40050	Hour time set (integer format, high register)	No	Hour time set
0x32	40051	Day time set (integer format, low register)	No	Day time set
0x33	40052	Day time set (integer format, high register)	No	Day time set
0x34	40053	Month time set (integer format, low register)	No	Month time set
0x35	40054	Month time set (integer format, high register)	No	Month time set
0x36	40055	Year time set (integer format, low register)	No	Year time set
0x37	40056	Year time set (integer format, high register)	No	Year time set

COMMUNICATIONS

Register Address	Modbus Address	Data Type	Scaling	Comment
0x38	40057	Gas Select (integer format, low register)	No	Gas select: single gas, mix gas or O&G mix
0x39	40058	Gas select (integer format, high register)	No	Gas select: single gas, mix gas or O&G mix
0x38	40059	CH4 percent (float format, LSB)	No	CH4 percent
0x3B	40060	CH4 percent (float format, MSB)	No	CH4 percent
0x3C	40061	CO2 percent (float format, LSB)	No	CO2 percent
0x3D	40062	CO2 percent(float format, MSB)	No	CO2 percent
0x3E	40063	N2 percent (float format, LSB)	No	N2 percent
0x3F	40064	N2 percent (float format, MSB)	No	N2 percent
0x40	40065	Air percent (float format, LSB)	No	Air percent
0x41	40066	Air percent (float format, MSB)	No	Air percent
0x42	40067	Argon percent (float format, LSB)	No	Argon percent
0x43	40068	Argon percent (float format, MSB)	No	Argon percent
0x44	40069	Propane percent (float format, LSB)	No	Propane percent
0x45	40070	Propane percent (float format, MSB)	No	Propane percent
0x46	40071	Helium percent (float format,LSB)	No	Helium percent
0x47	40072	Helium percent (float format, MSB)	No	Helium percent
0x48	40073	Oxygen percent (float format, LSB)	No	Oxygen percent
0x49	40074	Oxygen percent (float format, MSB)	No	Oxygen percent
0x4A	40075	Butane percent (float format, LSB)	No	Butane percent
0x4B	40076	Butane percent (float format, MSB)	No	Butane percent
0x4C	40077	Hydrogen percent (float format, LSB)	No	Hydrogen percent
0x4D	40078	Hydrogen percent (float format, MSB)	No	Hydrogen percent
0x4E	40079	ISO butane percent (float format, LSB)	No	Iso Butane percent
0x4F	40080	ISO butane percent (float format, MSB)	No	Iso Butane percent
0x50	40081	Ethane percent (float format, LSB)	No	Ethane percent
0x51	40082	Ethane percent (float format, MSB)	No	Ethane percent
0x52	40083	Pentane percent (float format, LSB)	No	Pentane percent
0x53	40084	Pentane percent (float format, MSB)	No	Pentane percent
0x54	40085	Hexane percent (float format, LSB)	No	Hexane percent
0x55	40086	Hexane percent (float format, MSB)	No	Hexane percent
0x56	40087	Heptane percent (float format, LSB)	No	Heptane percent
0x57	40088	Heptane percent (float format, MSB)	No	Heptane percent
0x58	40089	Octane percent (float format, LSB)	No	Octane percent
0x59	40090	Octane percent (float format, MSB)	No	Octane percent
0x5A	40091	Nonane percent (float format, LSB)	No	Nonane percent
0x5B	40092	Nonane percent (float format, MSB)	No	Nonane percent

NOTE! Registers 0xA, 0xB & 0xC are provided to get more resolution for low flow and total. When value exceeds the 16 bit registers, they will be frozen with all 16 bits set.

Communications: Modbus

Read Input Register (FT4X Status, Command 04)
This command is used to report the FT4X status information.

Request:
　　<Meter Address> <Command code=04> <Register address =0> <Register address =0>
　　<Register count =0> <Register count =1> <CRC high> <CRC low>

Response:
　　<Meter Address> <Command code=04> <Byte count =2> <Status High><Status Low> <CRC
　high> <CRC low>

Table 5.2: Status Bits Definitions for Command 04, Modbus Address 30001

Bit	Definition	Comment
0	Power up indication	Cleared when out of the power up sequence
1	Flow rate reached high limit threshold	Set limit to zero to disable
2	Flow rate reached low limit threshold	Set limit to zero to disable
3	Temperature reached high limit threshold	Set limit to zero to disable
4	Temperature reached low limit threshold	Set limit to zero to disable
5	Sensor reading is out of range	Check sensor wiring
6	Gas mix error	Gas mix must total 100%
7	Incorrect Settings	Check settings
8	In simulation mode	Set simulation value to 0 to disable
9	Pulse/alarm output is out of range	Check pulse/alarm output settings
10	Analog CH1 4-20mA is out of range	Check analog output settings
11	Analog CH2 4-20mA is out of range	Check analog output settings
12	Not used	Not used
13	Not used	Not used
14	CRC error	Check parameters and reset CRC
15	Error in Total	Reset total to clear alarm

COMMUNICATIONS

Communications: Modbus

Table 5.3: Status 2 Bits Definitions for Command 04, Modbus Address 30002

Bit	Definition	Comment
0	Pulse hardware	
1	Busy	
2	HART hardware	
3	FT4X	
4	CAL-V in process	
5	CAL-V fail	
6	CAL-V aborted	
7	CAL-V warning	

Preset Single Register (Command 06)

This command is used to perform miscellaneous functions such as clearing the totalizer and elapsed time. The register address is Modbus=40018 and the data to write is described in table 5.1.

Request:

<Meter Address> <Command code=06> <Register address high=0x00> <Register address low=0x11> <Register data high=0x00> <Register data low =0x02> <CRC high> <CRC low>

Response:

<Meter Address> <Command code=06> <Register address =0x00> <Register address =0x11> <Register data=0x00> <Register data =0x02> <CRC high> <CRC low>

Enter the Programming Mode - RS485 Modbus RTU

Press the **F1** or the **F2** key repeatedly, in the normal running mode, until the following screen is shown. This enters the programming mode:

```
SET PARAMETERS?
NO                YES
```

```
F1    F2    F3    F4
```

Press **YES (F4)** and then the following screen will prompt the user to enter the password if enabled:

```
PASWD:_
UP     DN    NXT    OK
```

```
F1    F2    F3    F4
```

Enter the correct password. Default password for Level 1 is 1234.

Press the **UP (F1)** or **DN (F2)** key to select a new digit or character, the cursor points to the selected digit.

Communications: Modbus

Press **NXT (F3)** to select the next digit and **OK (F4)** to accept the entry.

If the wrong password is entered, the message "Wrong Password" will be displayed for a few seconds and then return to the programming entry screen. If the password is accepted, the following screen will be shown:
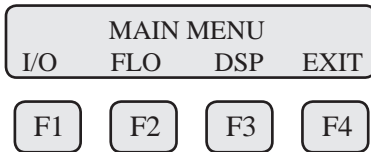
```
        MAIN MENU
I/O     FLO     DSP     EXIT
```
| F1 | F2 | F3 | F4 |

This is the Main Menu for the programming mode. To exit the programming mode, press **EXIT (F4)** repeatedly until "Normal Mode" is seen briefly.

Communication Protocol and Parameters
To program the communication parameters, start at the Main Menu:

```
        MAIN MENU
I/O     FLO     DSP     EXIT
```
| F1 | F2 | F3 | F4 |
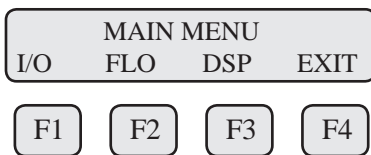
Then press **I/O (F1)** to set Inputs/Outputs:

```
        SET I/O
COM            420     EXIT
```
| F1 | F2 | F3 | F4 |
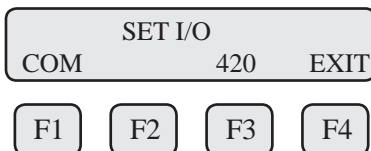
Then press **COM (F1)** to select communication parameters.

Set Bus protocol for Modbus:

```
Comm=Modbus
NXT                    OK
```
| F1 | F2 | F3 | F4 |
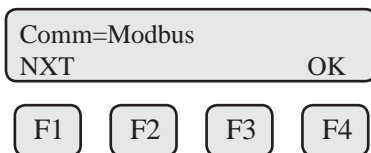
Press **NXT (F1)** repeatedly until Modbus is selected as shown and then press **OK (F4)** to accept the setting.

The following communication parameters are only available for MODBUS:

```
Baud=9600
NXT                    OK
```
| F1 | F2 | F3 | F4 |
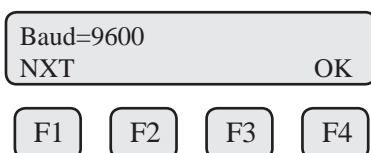
Press **NXT (F1)** repeatedly until the correct selection is shown then press **OK (F4)** to accept the setting.

Communications: Modbus

Selections are: 115200
                   76800
                   57600
                   38400
                   19200
                   9600
                   4800
                   2400
                   1200

```
Parity=EVEN
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: NONE
                 ODD
                 EVEN

```
Address=02
CHG                    OK
```
[F1] [F2] [F3] [F4]

Press **CHG (F1)** to change the address and then press **OK (F4)** to accept the setting.

Selections are between 01 and 247.

NOTE! Power cycle is required for the new settings to take effect.

Scope
The Fox Thermal Instruments' Model FT4X transmitter complies with HART Protocol Revision 7.1. This section of the manual specifies all the device-specific features and documents HART Protocol implementation details (e.g., the Engineering Unit Codes supported). The functionality of this Field Device is described sufficiently to allow its proper application in a process and its complete support in HART-capable Host Applications.

Purpose
This specification provides a complete description of this Field Device from a HART Communication perspective.
The specification is designed to be a technical reference for HART capable Host Application Developers, System Integrators and knowledgeable End Users. It also provides functional specifications (e.g., commands and performance requirements) used during development, maintenance and testing. This document assumes the reader is familiar with HART Protocol requirements and terminology.

References
HART Smart Communications Protocol Specification. HCF_SPEC-12. Available from the HCF.

Device Identification

Manufacturer Name:	Fox Thermal Instruments	Model Name:	FT4X
Manufacture ID Code:	24635	Device Type Code:	57583 (EOEF Hex)
HART Protocol Revision:	7.1	Device Revision:	1
No. of Device Variables:	None		
Physical Layers Supported:	FSK		
Physical Device Category:	Transmitter, DC-isolated Bus Device		

Product Overview
The FT4X HART communication option can be monitored and configured using a HART master device or a hand-held communicator.

Process Flow Rate 4-20mA Analog Output
The 4-20mA output of the FT4X HART represents the process flow rate measurement, linearized and scaled according to the configured range of the instrument. This output corresponds to the Primary Variable. HART Communication is supported on this loop.

The 4-20mA output of the FT4X should be configured for flow rate when using HART. If the 4-20mA output is set to report temperature, HART communication will report the 4-20mA value for temperature rather than flow.

HART Indicators
Green LED indicator LP3 cycles on and off to indicate that the FT4X is operating.
Orange LED indicator LP2 blinks when HART signals are received and Yellow LP1 blinks when HART signals are transmitted. The LEDs are located behind the display panel.

The orange LED indicator LP2 will be on continuously when HART communication is enabled and the 4-20mA wiring is not connected.

Communications: HART

FT4X HART Communication Setup

HART communication must be selected in the FT4X Serial Communication menu for HART communication to operate. When this communication parameter is changed, power to the FT4X must be cycled for it to take effect.

Enter the Programming Mode - HART

Press the F1 or the F2 key repeatedly, in the normal running mode, until the following screen is shown. This enters the programming mode:

```
SET PARAMETERS?
NO                    YES
```
[F1] [F2] [F3] [F4]

Press **YES (F4)** and then the following screen will prompt the user to enter the password if enabled:

```
PASWD:_
UP      DN      NXT     OK
```
[F1] [F2] [F3] [F4]

Enter the correct password. Default password for Level 1 is 1234.

Communication Protocol and Parameters

To program the communication parameters, press **I/O (F1)** key from the main menu.

```
        MAIN MENU
I/O     FLO     DSP     EXIT
```
[F1] [F2] [F3] [F4]

This is the main menu for the programming mode. To exit the programming mode, press **EXIT (F4)** repeatedly until "Normal Mode" is seen briefly. Choose I/O (F1) to access the communication output.

```
          SET I/O
COM     PUL     420     EXIT
```
[F1] [F2] [F3] [F4]

Then press **COM (F1)** to select communication parameters

Set Bus protocol for HART:

```
Comm=HART
NXT                   OK
```
[F1] [F2] [F3] [F4]

Press **NXT (F1)** until HART is selected as shown and then press **OK (F4)** to accept the setting.

Communications: HART

NOTE! Power cycle is required for the new settings to take effect.

Dynamic Variables
Four Dynamic Variables are implemented.

	Meaning	Units
PV	Flow Rate	In Selected Units
SV	Total	In Selected Units
TV	Temperature	In Selected Units
QV	Elapsed Time	In Hours

Status Information
Device Status
Bit 4 ("More Status Available") is set when any failure is detected. Command #48 provides additional detail.

Extended Device Status
This bit is set if a sensor error is detected. "Device Variable Alert" is set if the Primary Variable (PV) is out of limit.

Additional Device Status (Command 48)
Command #48 returns 2 Device-Specific Status bytes of data, with the following status information:
These bits are set when an alarm or error condition is present. The bit automatically clears when the condition returns to its normal state.

Byte	Bit	Meaning	Class
0	0	Power Up Indication	Status
	1	High Flow Limit Alarm	Alarm
	2	Low Flow Limit Alarm	Alarm
	3	High Temperature Limit Alarm	Alarm
	4	Low Temperature Limit Alarm	Alarm
	5	Sensor out of range	Error
	6	Velocity out of range	Error
	7	Check Parameter Settings	Error
1	0	In Simulation Mode	Alarm
	1	Frequency output out of range	Alarm
	2	CH 1 4-20mA out of range	Alarm
	3	CH 2 4-20mA out of range	Alarm
	4	Busy	Alarm
	5	Bridge shutdown	Error
	6	CRC database error	Error
	7	Error with Total	Error

Communications: HART

Common-Practice Commands, Supported Commands

The following common-practice commands are implemented:

34	Write Primary Variable (PV) Damping Value
35	Write PV Range Value
36	Set PV Upper Range Value
37	Set PV Lower Range Value
38	Reset "Configuration Changed" Flag
40	Enter/Exit Fixed Current Mode
44	Write PV Units
45	Trim Loop Minimum
46	Trim Loop Maximum
48	Read Additional Device Status (Command #48 returns 2 bytes of data)
59	Write Number of Response Preambles

Common-Practic Commands, Unsupported Commands

Burst Mode - This device does not support Burst Mode.
Catch Device Variable - This device does not support Catch Device Variable.
Device-Specific Commands - No Device-Specific commands are implemented.

Modes

Fixed current mode is implemented, using Command 40. This mode is cleared by power loss or reset.

Damping

Damping is standard, affecting only the PV and the loop current signal.

Capability Checklist

Manufacturer, model	Fox Thermal Instruments, FT4X
Device Type	Transmitter
HART revision	7.1
Device Description available	No
Number and type of sensors	1
Number and type of actuators	0
Number and type of host side signals	1 : 4-20mA analog
Number of Device Variables	0
Number of Dynamic Variables	4
Mappable Dynamic Variables	No
Number of common-practice commands	17
Number of device-specific commands	0
Bits of additional device status	8
Alternative operating modes	No
Burst mode	No
Write-protection	Yes

Maintenance: Precautions & Conditions of Use

PRECAUTIONS

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...).

WARNING! EXPLOSION HAZARD. DO NOT REMOVE OR REPLACE COMPONENTS OR FUSES UNLESS POWER HAS BEEN SWITCHED OFF WHEN A FLAMMABLE OR COMBUSTIBLE ATMOSPHERE IS PRESENT.

WARNING! EXPLOSION HAZARD. DO NOT DISCONNECT EQUIPMENT WHEN A FLAMMABLE OR COMBUSTIBLE ATMOSPHERE IS PRESENT.

Access to Electronics

Accessing electronics is not normally required for maintenance purposes. If a loose connection is suspected, unscrew the rear cap of the meter to access the wiring terminations.

CAUTION! BE SURE POWER TO METER IS SWITCHED OFF BEFORE ATTEMPTING TO ACCESS ELECTRONICS. If there is a problem and a loose connection is not found, please contact Fox Customer Service for technical assistance at (831) 384-4300.

Specific Conditions of Use:

1. The flamepaths of the equipment are not intended to be repaired. Consult the manufacturer if repair of the flamepath joints is necessary.

2. Refer to the manufacturer's instructions to reduce the potential of an electrostatic charging hazard on the equipment enclosure.

3. The equipment temperature code ratings are dependent on the enclosure configuration (local or remote). Refer to the following table for specific temperature code markings.

Model Code	Temperature Code Marking- Divisions (All)		Temperature Code Marking-Zones (Gas)		Temperature Code Marking-Dust	
Enclosure (variable "b")	Main Enclosure	Remote Enclosure	Main Enclosure	Remote Enclosure	Main Enclosure	Remote Enclosure
E1	T4	N/A	T4	N/A	T135°C	N/A
E3	T6	T4	T6	T4	T85°C	T135°C

MAINTENANCE

MAINTENANCE

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 "Returning Your Meter" on p. 103.

Flow Calibration and Calibration Validation
To ensure high accuracy of your Model FT4X Flow Meter, Fox Thermal Instruments provides a full NIST traceable calibration. It is recommended that the meter's accuracy be checked annually by performing the CAL-V™ Calibration Validation test.

Fuse Replacement

WARNING! Turn input power OFF before removing or installing a 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). Replacement fuse is Littelfuse part number 0454.750MR

To replace the fuse:
The fuse F1 is located near the power terminal block and can be removed by using tweezers or needle-nose pliers.

Sensor Cleaning
The sensor is insensitive to small amounts of residue, but continued use in dirty environments will require periodic cleaning. To inspect the sensor, remove power from electronics and remove the unit from the pipe or duct, exposing the sensor elements. If they are visibly dirty, clean them with water or alcohol (ethanol) using an appropriate brush until they appear clean again. Even though the sensor elements are rugged, avoid touching them with any solid object and use a light touch while cleaning them.

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Fox is ISO 9001 certified

Maintenance: Retractor Operation (Removal)

Instructions for Removing and Inserting the Meter from a Pressurized Pipe using the Retractor

> ⚠ **WARNING!** Possible injury or damage to equipment may occur if the retractor is not used correctly. Please read the following instructions carefully prior to using the retractor.

> ⚠ **CAUTION!** Never remove the restraint cable without first closing the Ball Valve and bleeding off pressure.

> ⚠ **WARNING!** When working with the retractor, do not stand or position any part of your body in the path of the flow meter. An injury may occur if the probe is forced outward by system pressure.

How to Remove the Meter from the Retractor (System Pressurized)

Step 1 - Remove the Probe from the Flow Stream

1. Disconnect power from the meter.

> ⓘ **NOTE!** At 150psig of max system pressure, the probe will have approximately 66 lbs. of force pushing it out.

2. System pressure may force the probe out of the retractor when the Swage Nut is loosened. Hold the flow meter to counteract the force of the system pressure, and carefully loosen and unscrew the Swage nut.

3. While supporting the meter, slowly slide the probe out of the retractor until the restraint cable is tight.

4. Close the ball valve all the way.

> ⚠ **CAUTION!** <u>At this point there is still pressure inside of the retractor.</u>

Figure 8.1

Swage Nut,
1 1/8" Wrench
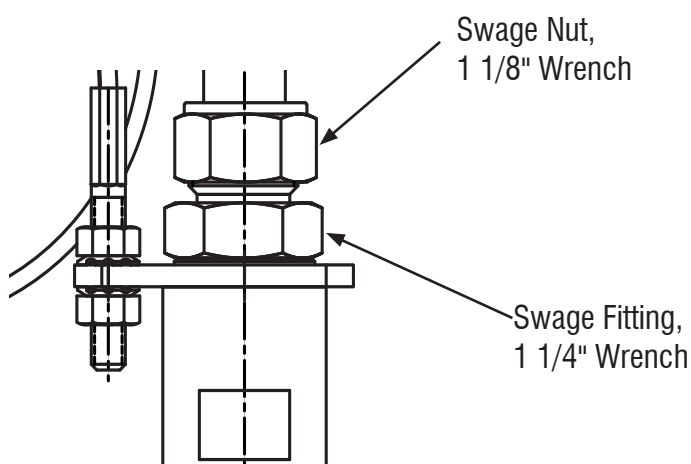
Swage Fitting,
1 1/4" Wrench

Step 2 - Remove the Probe from the Retractor Body

5. After removing the probe from the flow stream (#1-4 on previous page), slowly loosen the Swage Fitting (see figure 8.2), until the pressure in the retractor is relieved.

6. Retighten the Swage Fitting.

7. Remove the Collar Clamp by using a 3/16" Hex Key.

8. Carefully slide the probe out of the retractor while supporting the meter.

Figure 8.2

COLLAR SPACER

COLLAR CLAMP

SWAGE NUT

SWAGE FITTING

BALL VALVE
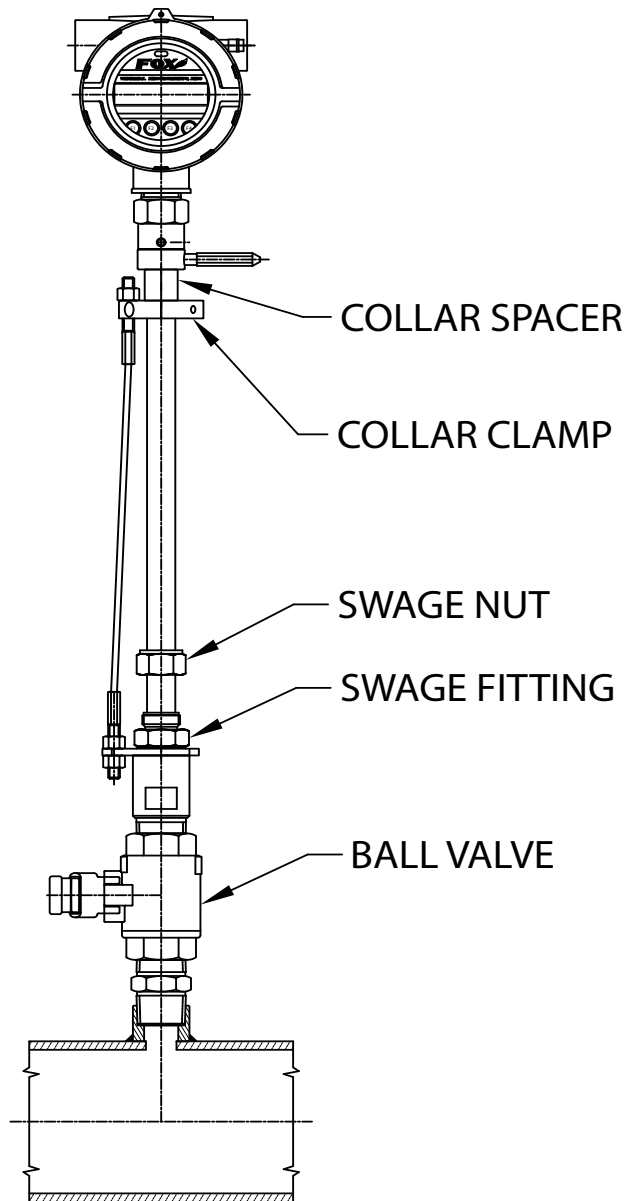
Maintenance: Retractor Operation (Re-insertion)

How to Insert the Probe into the Flow Stream (Valve closed, System Pressurized)

1. Carefully, slide the probe into the retractor.

2. Install the collar clamp just below the collar spacer, and tighten it in place on the probe. Slide the probe back out of the retractor until the cable is straight and taut.

Figure 8.3

COLLAR SPACER

COLLAR CLAMP

SWAGE NUT

SWAGE FITTING
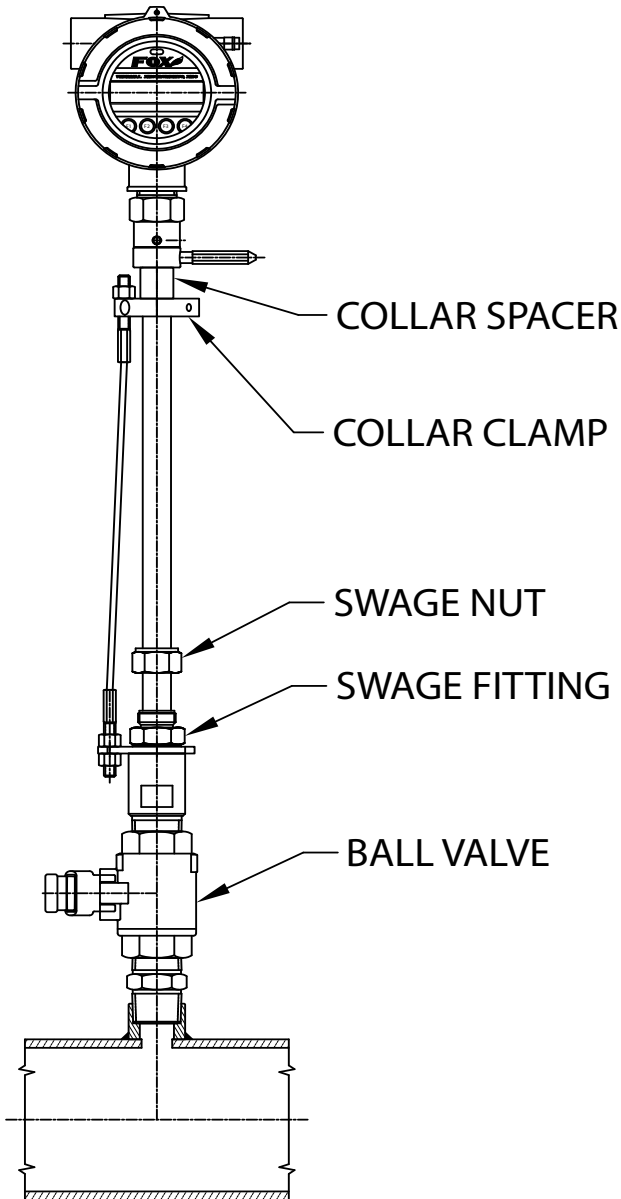
BALL VALVE

NOTE! At a maximum system pressure of 150psig, the force required to push the probe in place to tighten the Swage Nut will be approximately 66 lbs.

3. Slowly open the ball valve to the full open position. Push the meter and probe into the pipe, then hand tighten the Swage Nut onto the Swage Fitting.

Maintenance: Retractor Operation (Re-insertion)

4. Verify that the probe is aligned with the centerline of the pipe, and pointed in the direction of flow.

Figure 8.4

SWAGE NUT & FERRULES
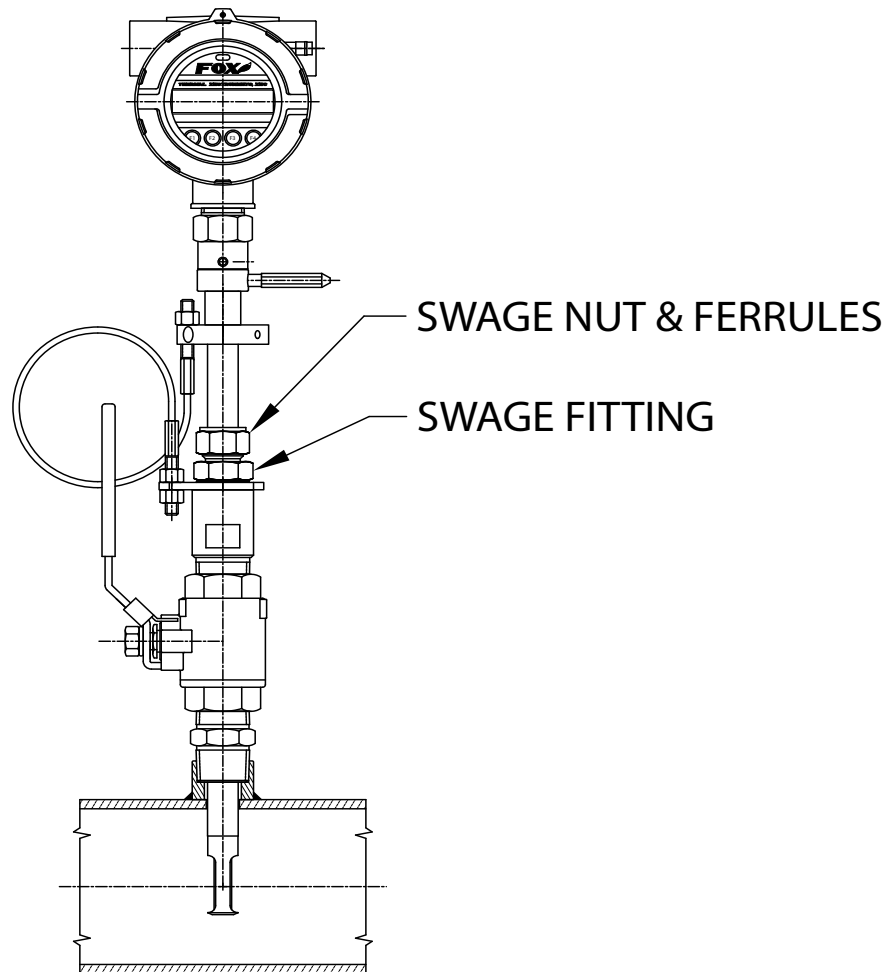
SWAGE FITTING

5. Secure the probe in place by tightening the Swage Nut with a 1 1/8" wrench and a 1 1/4" wrench on the Swage Fitting. for detailed instructions to tighten the swage nut.
6. Power may now be applied to the meter.

Troubleshooting: General

Troubleshooting

CAUTION! The electronics and sensor supplied by Fox are calibrated as a single precision mass flow meter. Interchanging sensors will decrease the accuracy of the flow meter. If you experience any problem with your Model FT4X Flow meter, call Fox Customer Service Department, Technical Assistance at (831) 384-4300.

Problem	Possible Cause(s)	Action(s)
Display Error	1. Loose or damaged ribbon cable 2. Damaged electronics 3. Ambient temperature	1. Visual inspection. 2. Return the meter or display for repair. 3. Operate meter between -20 to 70°C
Flow measurement seems low	1. Probe not oriented properly 2. Sensor dirty	1. Orient probe per installation sections: Insertion (p. 20), 2. Clean sensor (p. 78)
Unit will not power-up	1. No power input 2. Bad fuse 3. Bad Power supply	1. Check fuse (F1) located next to TS1 on main board. 2. Check for correct power supply voltage at TS1 on main board. If fuse is OK and unit still won't power up, call Fox for additional assistance

TROUBLESHOOTING

Troubleshooting: General

TROUBLESHOOTING

Problem	Possible Cause	Action
Meter does not initialize	1. Malfunction in flow meter 2. Electromechanical interference	1. Return flow meter to Fox for repair (Refer to p. 103 for shipping instructions) 2. Check meter power cycles. 3. Press and release F1 and F2 at the same time; the display will enter Engineering screens. 4. Press F1 to get to screen #23; record power cycle value. 5. Press F4 to return to normal operation; monitor meter until problem returns. 6. Return to screen #23 to see if power cycles have increased; microprocessor is resetting due to EMI electrical noise entering the meter. 7. Check Power input and output cables grounding and routing.
Flow measurement is erratic or fluctuating	1. Very turbulent flow 2. Sensor dirty 3. Sensor broken 4. Probe not mounted securely 5. Malfunction in flow meter 6. Meter installed incorrectly	1. Increase dampening (see filter settings in "Flow Parameters" on p. 53) 2. Clean sensor (Refer to Maintenance section, p. 78) 3. Return flow meter to Fox for repair (Refer to p. 103 for shipping instructions) 4. Remount probe (see Installation section, p. 20); must be mounted securely without vibration. If vibration persists, choose a new mounting location without vibration. 5. Return flow meter to Fox for repair (Refer to p. 103 for shipping instructions) 6. Re-install meter according to instructions (Refer to installation section, p. 20)

Troubleshooting: CAL-V™

Troubleshooting CAL-V™

If the FT4X Meter fails a CAL-V™ Calibration Validation test, there are a few reasons that could be the cause:

1. The sensor may be dirty or damaged
   - Visually inspect the meter for damage. If damage is found, meter may need to be serviced. Contact Fox Technical Assistance at 831-384-4300 for more information
   - Try cleaning the sensor and try the test again
   - If the meter fails again, move to #2

2. The meter may not have stabilized properly
   - Make sure the meter is not being affected by vibration or other movement
   - Allow the meter to stabilize without being moved or touched for 15 minutes
   - Try the test again
   - If the meter fails again, contact Fox Technical Assistance at 831-384-4300

TROUBLESHOOTING

Installation Problems

The following is a summary listing of problems that may be encountered with the installation of the FT4X Thermal Mass Flow Meter.

1. *Improper wiring connections.*
   Refer to Figures 3.1 to 3.13 and "Wiring Precautions" in Wiring section (p. 30) for further guidance.

2. *Inadequate power source.*
   The FT4X requires 12 to 28VDC at to 6 Watts to operate. A 20 Watt power supply is recommended for powering the FT4X to ensure it operates properly under all temperature ventilation, and power on conditions. If the voltage supplied at the input terminals of the FT4X is not within the range of 10VDC to 30VDC, a variety of problems can occur including a dim display, inaccurate flow readings or faulty 4-20mA, pulse and communication interface.

3. *Flow measurement seems inaccurate.*
   - Check to ensure that the flow meter is installed so that the Flow Direction Indicator is pointing in the direction of flow. Refer to Figure 2.3 (p. 22). If not, change orientation of meter.
   - Check that the insertion depth of the sensor/probe is correct. The end of the probe should be adjusted as per Figure 2.2 (p. 21).
   - Ensure that there are a minimum of fifteen diameters of straight pipe upstream of the sensor and ten diameters downstream. If complex flow disturbances are upstream of the sensor, extension of the straight pipe may be required to ensure accurate flow measurement. Contact Fox for assistance.
   - Ensure that pipe inside diameter in the meter matches data on the Fox Calibration Certificate. The pipe inside diameter is programmed into the flow meter through the front panel (see Flow Parameters, p. 53).

4. *Erratic flow reading (especially a flow reading spiking high).*
   This may be a symptom of moisture in the flow stream. Fox flow meters are designed to work in relatively dry gas applications only. Contact Fox to discuss resolutions to this problem.

5. *Flow meter is not responding to flow.*
   - Check to ensure adequate power is supplied to the flow meter. If things appear to be correct, perform this functional test before calling Fox. Carefully remove the probe and sensor from the pipe. For those flow meters with a display - and if the 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.

6. *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.

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THERMAL INSTRUMENTS, INC.
Fox is ISO 9001 certified

Troubleshooting: Alarm Codes

Alarm Codes

Information to diagnose and clear alarm codes is on p. 7 under the Menu Tree section. Enter password (9111) and follow the block diagram to get to the section affected by the error code.

Alarm Code	Reason	Action
13	Flow rate above high limits	Refer to the FLOW MENU 2 section on p. 53 of this Manual to verify limit is within range. Check ALM = HiFloAlm under PRM.
14	Flow rate below low limits	Refer to the FLOW MENU 2 section on p. 53 of this Manual to verify limit is within range. Check ALM = LoFloAlm under PRM.
15	Temperature above high limits	Refer to the FLOW MENU 2 section on p. 53 of this Manual to verify limit is within range. Check ALM=HiTempAlm under PRM.
16	Temperature below low limits	Refer to the FLOW MENU 2 section on p. 53 of this Manual to verify limit is within range. Check ALM = LoTempAlm
22	Sensor out of range	Refer to the ENGINEERING DISPLAY MENU on p. 11 of this Manual and the Fox factory Calibration Certificate to check CSV voltage. Compare Display 10 value to Calibration Certificate CSV voltage and verify it's within range.
23	Gas mix error	Gas mix must equal 100%.
24	Check settings	One or more internal settings are corrupted or out of spec. Contact Fox Service for instructions to verify settings.
25	Simulation mode	Meter is in Simulation Mode. Refer to the FLOW MENU 1 section on p. 58 of this Manual. Use the SIM Section under Diagnostics to return to normal operation.
26	Pulse/alarm output over range	Refer to the DIGITAL OUTPUT MENU on p. 5 of this Manual. Verify the Pulse/alarm Output settings are within limits.
32	4-20mA is out of range	Refer to the MAIN MENU on p. 4 of this Manual. Use the Set I/O section to verify range limits.
34	Busy	Meter is recalculating new parameters.
36	Database CRC Error	Refer to the Reset CRC section on p. 58 of this manual. Verify the programmed values are verified and corrected before clearing the error. Contact Fox Service Department for possible causes.

TROUBLESHOOTING

Appendices: Specifications

Performance Specs

Flow Accuracy:
 Insertion Meter:
  Air: ±1% of reading ±0.5% of full scale
  Other gases: ±1.5% of reading ±0.5% of full scale
  Accuracy specification applies to customer's selected flow range
  Maximum range: 15 to 60,000 SFPM (0.07 to 280 NMPS)
  Minimum range: 15 to 1,000 SFPM (0.07 to 4.7 NMPS)
  Straight, unobstructed pipe requirement
    Insertion Meters: 15 diameters upstream; 10 downstream
    Inline Meters: 8 diameters upstream; 4 downstream

Flow Repeatability: ±0.2% of full scale

Flow Response Time: 0.8 seconds (one time constant)

Temperature Accuracy: ±1° F (±0.6° C)

Calibration:
 Factory Calibration to NIST traceable standards
 CAL-V™: In situ, operator-initiated calibration validation

Operating Specs

Gas-SelectX® Gas Selections:
 Pure gas menu, Gas Mix Menu, and Oil & Gas Mix Menu. See the Fox website for more information on availability of current gases.

Units of Measurement (field selectable):
 SCFM, SCFH, NM3/M, NM3/H, NM3/D, NLPS, NLPM, NLPH, MCFD, MSCFD, SCFD, MMSCFD, MMSCFM, SM3/D, SM3/H, SM3/M, LB/S, LB/M, LB/H, LB/D, KG/S, KG/M, KG/H, SLPM, MT/H, SFPM, NMPS, SFPS

Gas Pressure (maximum):
 Insertion meter: 740 psig (51.02 barg) max*
 Inline meter: NPT 500 psig (34.5 barg), 150# flange 230 psig (16 barg)
 Retractor: 150 psig (10.3 barg) max
 Check with factory for higher pressure options.
  ***NOTE!** When teflon ferrule option ordered, gas pressure is 60psig (4.1 barg) maximum

Relative Humidity: 90% RH maximum; non-condensing
  NOTE! Condensing liquids contacting the sensor can cause erratic flow indication.

Altitude: 6,562ft (2,000m) max.

Temperature:
 DDC-Sensor™: -40 to 250°F (-40 to 121°C)
 Enclosure: -40 to 158°F (-40 to 70°C)*
 Remote Sensor Enclosure: -40 to 158°F (-40 to 70°C)
 ***NOTE!** Display dims below -4˚F (-20˚C), function returns once temperature rises again.

Appendices: Specifications

Flow Velocity Range:
   15 to 60,000 SFPM (0.07 to 280 NMPS)
   Turndown: up to 1000:1; 100:1 typical

Typical Flow Ranges for Insertion Flow Meters			
Pipe Diameter	SCFM	MSCFD	NM^3/hr
1.5" (40mm)	0-840	0-1,220	0-1,325
2" (50mm)	0-1,400	0-2,020	0-2,210
3" (80mm)	0-3,100	0-4,440	0-4,890
4" (100mm)	0-5,300	0-7,650	0-8,360
6" (150mm)	0-12,000	0-17,340	0-18,930
8" (200mm)	0-20,840	0-30,020	0-32,870
10" (250mm)	0-32,800	0-47,250	0-51,740
12" (300mm)	0-46,600	0-67,180	0-73,500

NOTE! To determine if the FT4X will operate accurately in other pipe sizes, divide the maximum flow rate by the pipe area. The application is acceptable if the resulting velocity is within the velocity range above. Check Fox website for velocity calculator.

Typical Flow Ranges for Inline Flow Meters			
Size	SCFM	MSCFD	NM^3/hr
1.5" (40mm)	0-840	0-1,220	0-1,325
2" (50mm)	0-1,400	0-2,020	0-2,210
2.5" (63mm)	0-2,000	0-2,880	0-3,150
3" (80mm)	0-3,100	0-4,440	0-4,890
4" (100mm)	0-5,300	0-7,650	0-8,360
6" (150mm)	0-12,000	0-17,340	0-18,930

NOTE! Standard conditions of air at 70°F and one atmosphere. Consult factory for other gases and for flow ranges above those listed. Inline meters above 5,000 SCFM (7,900 NM3/H) air may require third party calibration. Contact Fox.

APPENDICES

Appendices: Specifications

Input Power: 12 to 28VDC, 6 watts max.
Full Input Power Range: 10 to 30VDC.
A 20 Watt or greater power supply is recommended to power the FT4X.

Class I Equipment (Electrical Grounding Required for Safety).

Installation (Over-voltage) Category II for transient over-voltages.

Inputs/Outputs:

  4-20mA Channel 1:

  • Standard isolated 4-20mA output configured to indicate flow; fault indication per NAMUR NE43. HART serial communication option.

    The 4-20mA load resistance must be 125 ohms or less when operating on 12 volt power and 600 ohms or less on 24 volt power.

  4-20mA Channel 2:

  • Standard isolated 4-20mA output configured to indicate either flow or temperature

  Pulse/Alarm:

  • Isolated open collector output rated for 5 to 24VDC, 10mA maximum load, 0 to 100Hz (the pulse output can be configured to either transmit a 0 to 100Hz signal proportional to flow rate or an on/off alarm).

  Remote Switch Input:

  • Can be configured to reset the flow totalizer and elapsed time.

  Serial Communication

  • Isolated RS485 Modbus RTU option

  • Isolated HART communication option

  USB Communication:

  • Isolated USB 2.0 for interfacing with a laptop or computer is standard.

  • FT4X View™: A free PC-based software tool that provides complete configuration, remote process monitoring, and data logging functions through USB communication.

4-20mA and Loop Verification:
  Simulation mode used to align 4-20mA output with the input to customer's PLC/DCS.

Physical Specs
Sensor material:
  316 stainless steel

Enclosure:
  NEMA 4X (IP67), aluminum, dual ¾" FNPT conduit entries. Cabling to remote enclosure: 8-conductor, 18 AWG, twisted, shielded, 100 feet maximum.

Flow Meter Installation:
  Fox-supplied compression fitting connects to customer-supplied ¾" female coupling welded to pipe.

Appendices: Approvals

Agency Approvals

CE: Approved
   EMC Directive; 2014/30/EU
   Emissions and Immunity Testing: EN61326-1:2013
   Pressure Equipment Directive: 97/23/EC
   Weld Testing: EN ISO 15614-1 and EN ISO 9606-1, ASME B31.3

FM (FM17US0061X) and FMc (FM17CA0032X): Approved
   Class I, Division 1, Groups B,C,D;
   Class II, Division 1, Groups E,F,G;
   Class III, Division 1; T6 or T4, Ta = - 40˚C to +70˚C;
   Class 1, Zone 1, AEx/Ex db IIB + H2 T6 or T4 Gb; Ta= -20˚C to +70˚C; Type 4X, IP67

ATEX (FM17ATEX0015X): Approved
   II 2 G Ex db IIB + H2 T6 or T4 Gb Ta = - 20˚C to +70˚C; IP67
   II 2 D Ex tb IIIC T85˚C or T135˚C Db Ta = - 20˚C to +70˚C; IP67

IECEx (IECEx FMG 17.0008X): Approved
   Ex db IIB + H2 T6 or T4 Gb Ta = - 20˚C to +70˚C; IP67
   Ex tb IIIC T85˚C or T135˚C Db Ta = - 20˚C to +70˚C; IP67

   ATEX and IECEx Standards:
   EN 60079-0: 2012 + A11:2013   IEC 60079-0: 2011
   EN 60079-1: 2014   IEC 60079-1: 2011
   EN 60079-31: 2014   IEC 60079-31: 2013
   EN 60529: 1991 +A1: 2000   IEC 60529: 2001

Enclosure (variable 'b')	Temperature Code Marking - Divisions (All)		Temperature Code Marking - Zones (Gas)		Temperature Code Marking - Zones (Dust)	
	Main Enclosure	Remote Enclosure	Main Enclosure	Remote Enclosure	Main Enclosure	Remote Enclosure
E1	T4	N/A	T4	N/A	T135°C	N/A
E3	T6	T4	T6	T4	T85°C	T135°C

Temperature code ratings for Zones are dependent on external process temperature factors and equipment enclosure configuration. See the table above for specific temperature code ratings.

NOTE! The EU Pressure Equipment Directive (PED) requires that the minimum ambient and fluid temperature rating for carbon steel flow bodies not be below -29C.

Appendices: Installation Variations (moisture)

Tilt Installations

These variations on installations help prevent moisture and condensation from forming on the sensor and disrupting accurate flow measurement. Fox recommends 180° installation, if possible.

When restricted physical installation space exists, the FT4X can also be installed at a 45° angle. Please note that the display's orientation will remain aligned with the top of the meter.

NOTE! <u>Displays</u> are rotatable only in 90° angle increments.

For more information about installation variations, contact a Fox application specialist at (831) 384-4300 or sales@foxthermalinstruments.com.

-90° Tilt Installation
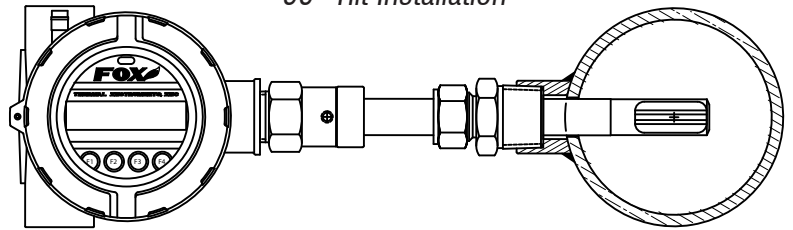
90° Tilt Installation
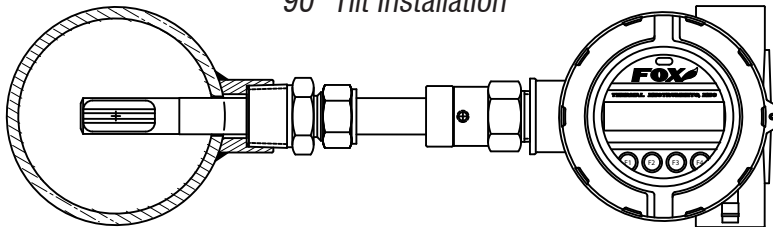
180° Tilt Installation
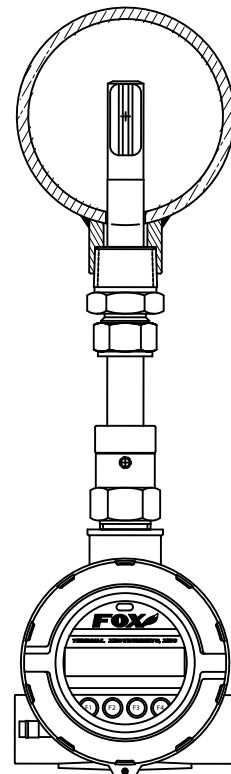
45° Tilt Installation
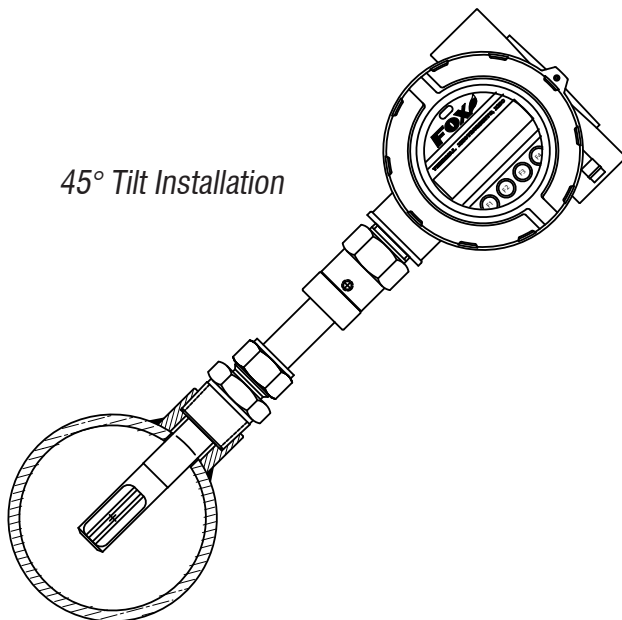
Appendices: Dimensions

Fig. 7.1 Insertion Meter with Retractor Dimensions
Measurements shown in inches (millimeters).

4.6
(11.7)

8.1
(20.6)

3.9
(9.9)

7.9±.2
(20.1±.5)

2X 3/4" NPT,
FEMALE

"HH"

"LL"

9.3±0.3
(23.6±.76)

Ø.75 PROBE
(Ø1.90)

.73"
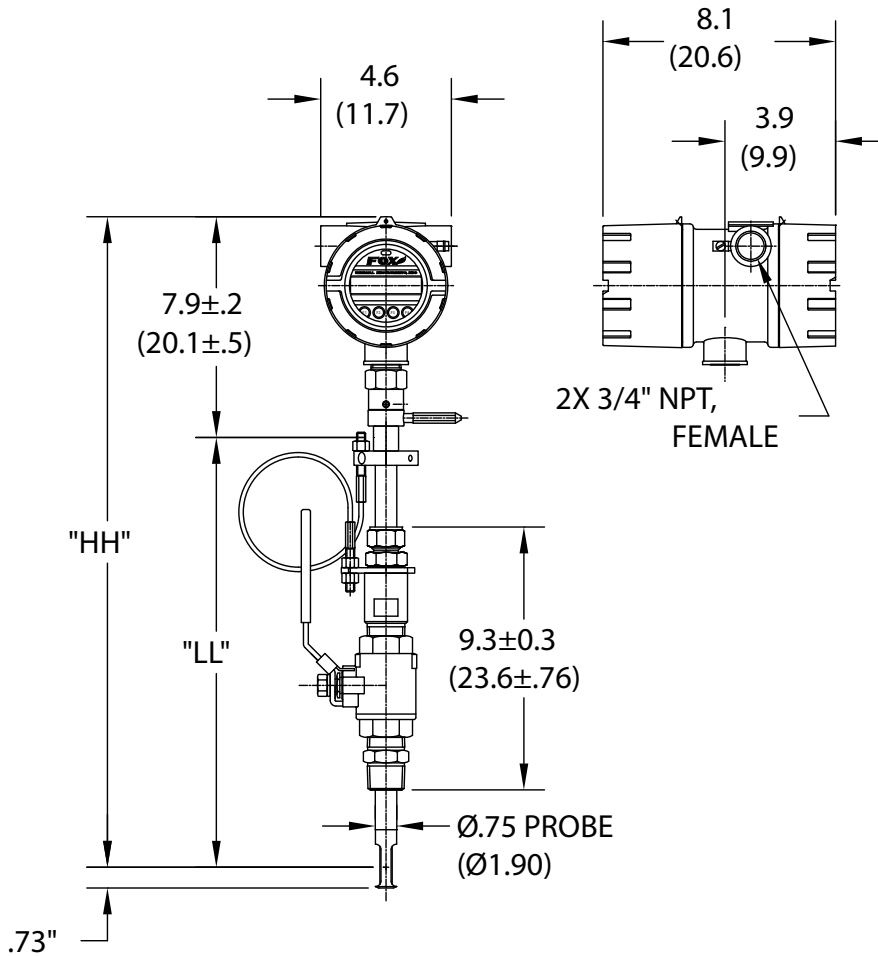
Table 7.1 Insertion Meter with 316 stainless steel probe

Probe Size	Probe Size	Dimension "LL" ± .01	Dimension "HH" ±.01
[model code]	[inches]	[inches / centimeters]	[inches / centimeters]
15R	15"	15.0" (38.1cm)	22.9" (58.2cm)
18R	18"	18.0" (45.7cm)	25.9" (65.8cm)
24R	24"	24.0" (61.0cm)	31.9" (81.0cm)
30R	30"	30.0" (76.2cm)	37.9" (96.3cm)
36R	36"	36.0 " (91.4cm)	43.9" (111.5cm)

Fig. 7.2 Remote Insertion Meter with Retractor Dimensions

Ø3.6
(Ø9.1)

4.4
(11.2)

2.0
(5.1)

4.6
(11.7)

8.1
(20.6)

3.9
(9.9)

REMOTE
ENCLOSURE

7.2±.2
(18.3±.5)

5.2
(13.2)

ELECTRONICS
ENCLOSURE

"HH"

"LL"

9.3±0.3
23.6±7.6

2X 3/4" NPT,
FEMALE

CONDUIT, 3/4", METAL

SHIELDED CABLE,
8-CONDUCTOR,
100FT (30.48m) MAX.

Ø.75 PROBE

.73
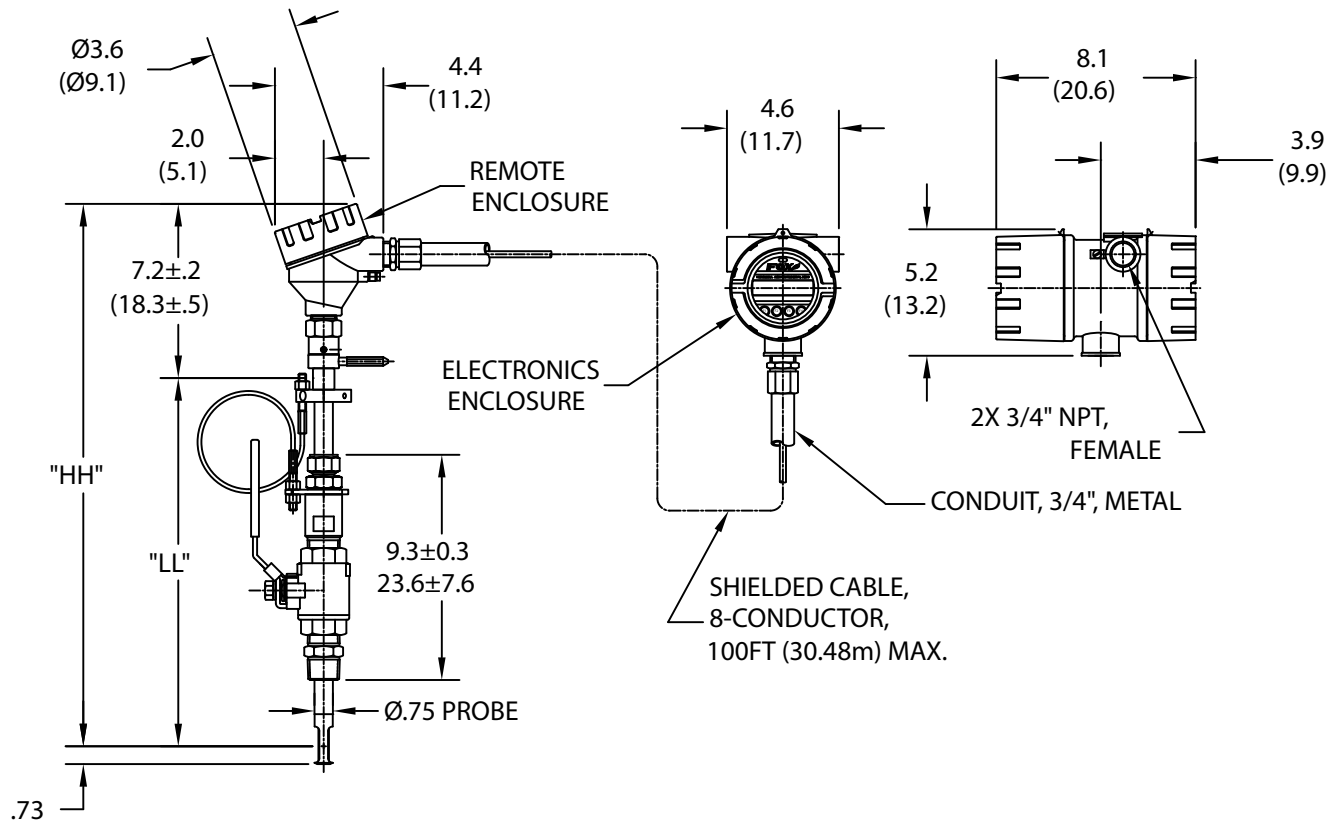
Table 7.2 Remote Insertion Meter with Retractor

Probe Size	Probe Size	Dimension "LL" ± .01	Dimension "HH" ±.01
[model code]	[inches]	[inches / centimeters]	[inches / centimeters]
15R	15"	15.0" (38.1cm)	22.2" (56.4cm)
18R	18"	18.0" (45.7cm)	25.2" (64.0cm)
24R	24"	24.0" (61.0cm)	31.2" (79.2cm)
30R	30"	30.0" (76.2cm)	37.2" (94.5cm)
36R	36"	36.0 " (91.4cm)	43.2" (109.7cm)

Appendices: Dimensions

Fig. 7.3 Remote Mounting Kit Dimensions

BRACKET

SIDE VIEW

2x U-BOLT
W/NUT

JAM NUT
SEE DETAIL

PROJECTIONS

DETAIL 'A'

ADAPTER

Ø2.38
2 IN. PIPE

4x
WASHER

THREADS

FRONT VIEW

FT4X ENCLOSURE

4x Ø.344

2.81

2.81

MOUNTING
HOLE DETAIL
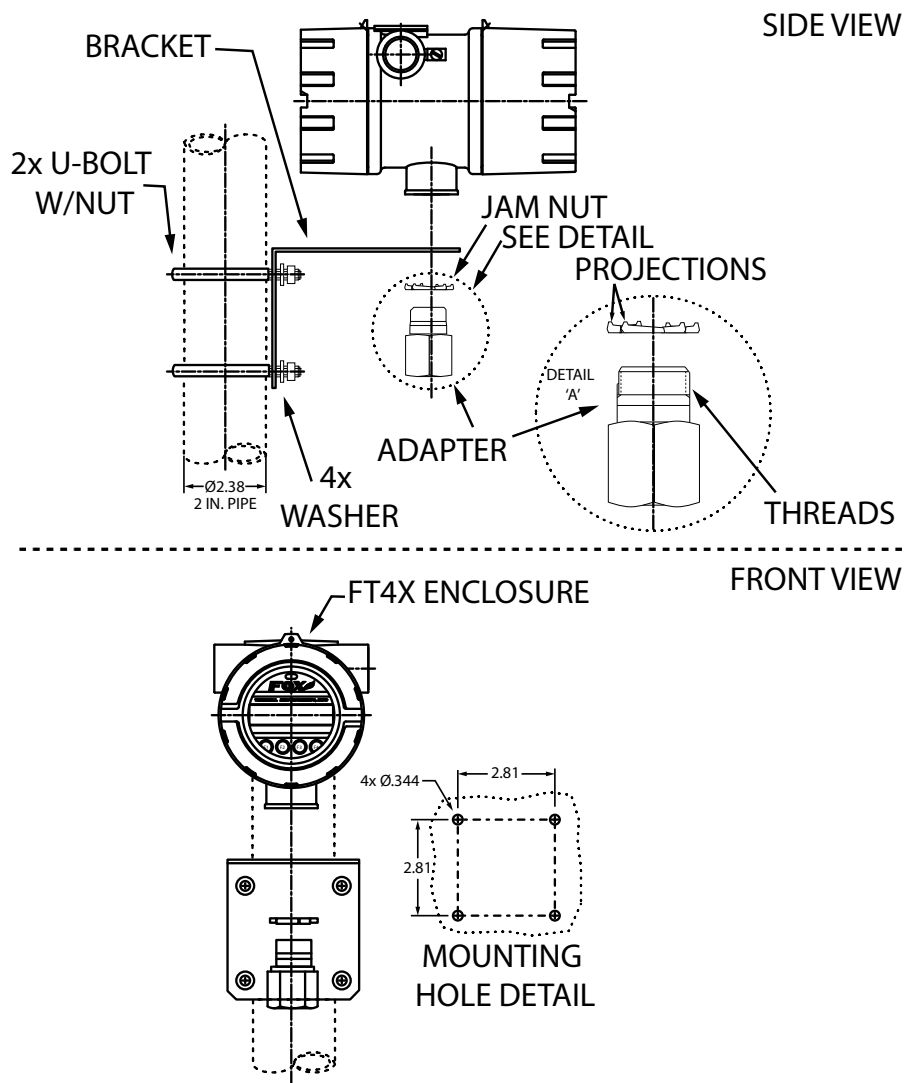
Appendices: Dimensions

Fig. 7.4 Insertion Meter Dimensions
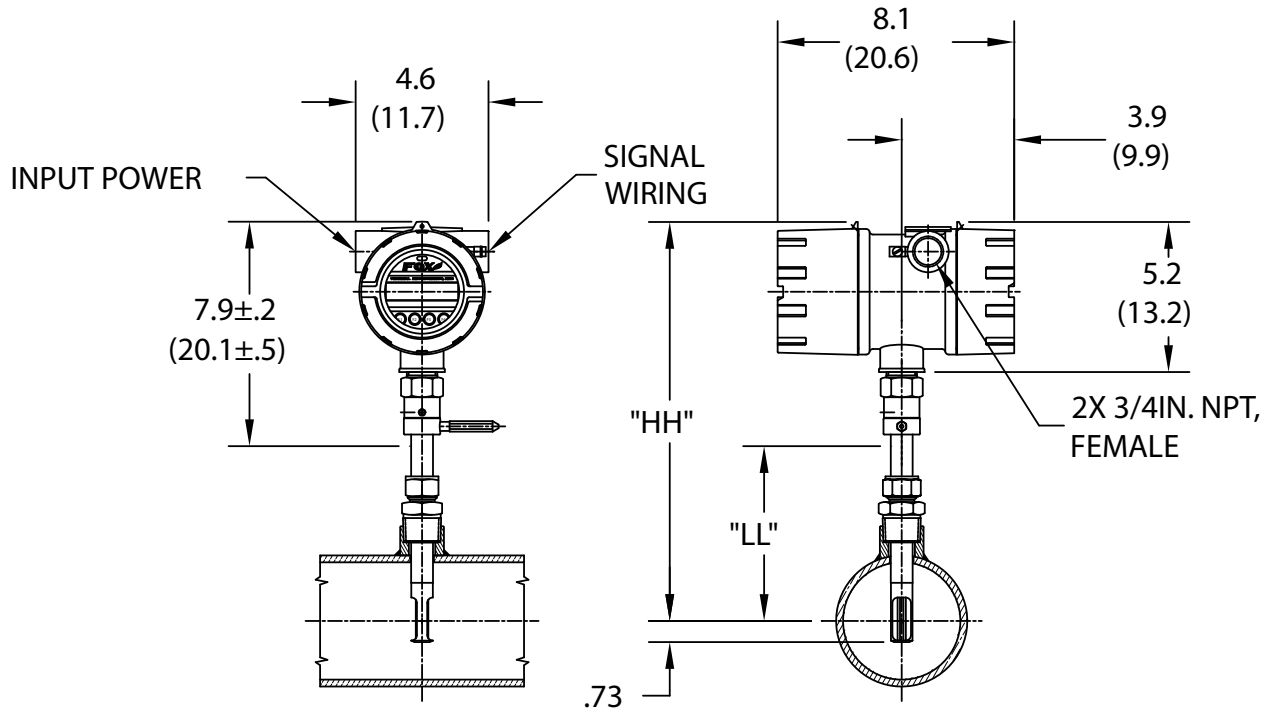
Table 7.4 Insertion Meter with 316 stainless steel probe

Probe Size	Probe Size	Dimension "LL" ± .01	Dimension "HH" ± .01
[model code]	[inches]	[inches / centimeters]	[inches / centimeters]
06I	6"	6.0" (15.2cm)	13.9" (35.3cm)
09I	9"	9.0" (22.9cm)	16.9" (42.9cm)
12I	12"	12.0" (30.5cm)	19.9" (50.5cm)
15I	15"	15.0" (38.1cm)	22.9" (58.2cm)
18I	18"	18.0" (45.7cm)	25.9" (65.8cm)
24I	24"	24.0" (61.0cm)	31.9" (81.0cm)
30I	30"	30.0" (76.2cm)	37.9" (96.3cm)
36I	36"	36.0 " (91.4cm)	43.9" (111.5cm)

Appendices: Dimensions

Fig 7.5: Insertion Remote Meter Dimensions
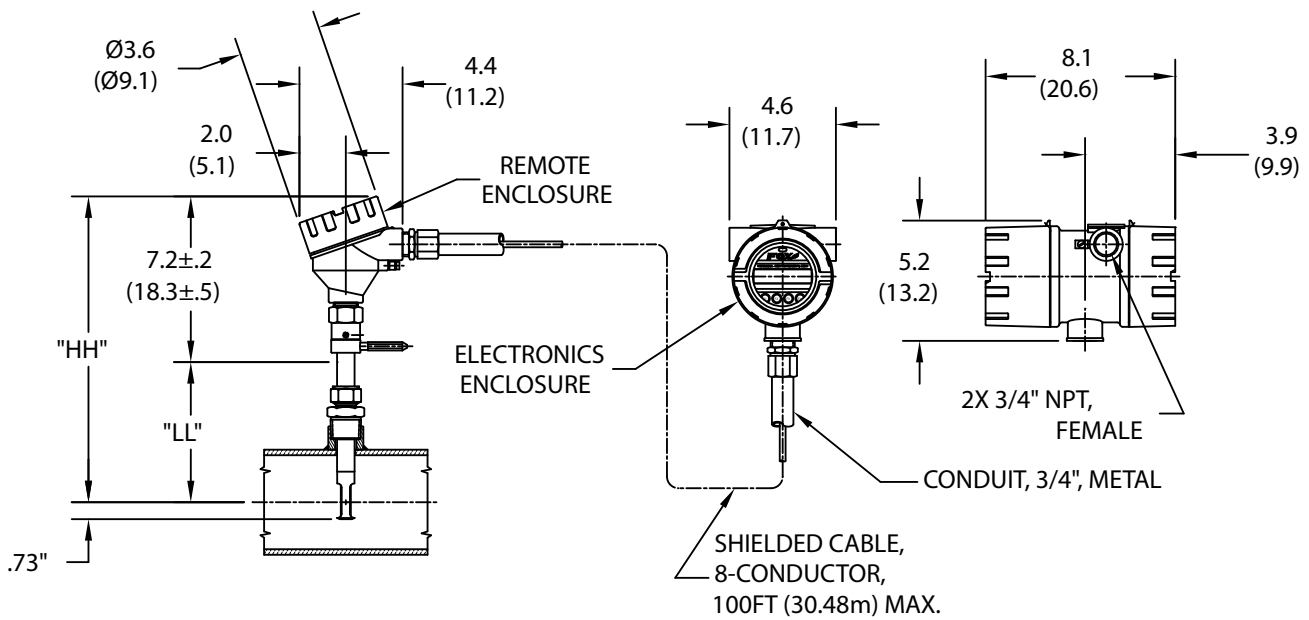
Table 7.5 Insertion Remote Meter with 316 stainless steel probe

Probe Size	Probe Size	Dimension "LL" ± .01	Dimension "HH" ± .01
[model code]	[inches]	[inches / centimeters]	[inches / centimeters]
06I	6"	6.0" (15.2cm)	13.2" (33.5cm)
09I	9"	9.0" (22.9cm)	16.2" (41.1cm)
12I	12"	12.0" (30.5cm)	19.2" (48.8cm)
15I	15"	15.0" (38.1cm)	22.2" (56.4cm)
18I	18"	18.0" (45.7cm)	25.2" (64.0cm)
24I	24"	24.0" (61.0cm)	31.2" (79.2cm)
30I	30"	30.0" (76.2cm)	37.2" (94.5cm)
36I	36"	36.0" (91.4cm)	43.2" (109.7cm)

APPENDICES

Appendices: Dimensions

Fig. 7.6 Inline Meter with 316 Stainless Steel Flow Body and NPT End Connections Dimensions

Table 7.6 Inline Meter with 316 Stainless Steel Flow Body and NPT End Connections

Body Size	Body Size	Dimension "L"	Dimension "H"
[model code]	[inches]	[inches]	[inches / centimeters]
15P	1.50"	12"	10.5" (26.7cm)
20P *	2.00"	12"	10.5" (26.7cm)
25P *	2.25"	18"	10.6" (26.9cm)
30P *	3.00"	18"	10.6" (26.9cm)

also available in A106 Grabe B Carbon steel pipe

Appendices: Dimensions

Fig 7.7: Inline Remote Meter with 316 Stainless Steel Flow Body and NPT End Connections Dimensions

Table 7.7 Inline Remote Meter with 316 Stainless Steel Flow Body and NPT End Connections

Body Size	Body Size	Dimension "L"	Dimension "HH"
[model code]	[inches]	[inches]	[inches / centimeters]
15P	1.50"	12"	10.5" (26.7cm)
20P *	2.00"	12"	10.5" (26.7cm)
25P *	2.25"	18"	10.6" (26.9cm)
30P *	3.00"	18"	10.6" (26.9cm)

also available in A106 Grabe B Carbon steel pipe

Appendices: Dimensions

Fig. 7.8 Inline Meter with 316 Stainless Steel Flow Body and 150# RF Flange End Connections Dimensions

Table 7.8 Inline Meter with 316 Stainless Steel Flow Body and 150# RF Flange End Connections Dimensions

Body Size	Body Size	Dimension "L"	Dimension "H"
[model code]	[inches]	[inches]	[inches / centimeters]
15F	1.50"	12"	10.5" (26.7cm)
20F *	2.00"	12"	10.5" (26.7cm)
25F *	2.25"	18"	10.6" (26.9cm)
30F *	3.00"	18"	10.6" (26.9cm)
40F *	4.00"	18"	11.1" (28.2cm)
60F	6.00"	24"	12.2" (31.0cm)

*also available in A106 Grabe B Carbon steel pipe + A105 Flanges

Appendices: Dimensions

Fig 7.9: Inline Remote Meter with 316 Stainless Steel Flow Body and 150# RF Flange End Connections Dimensions

Table 7.9 Inline Remote Meter with 316 Stainless Steel Flow Body and 150# RF Flange End Connections Dimensions

Body Size	Body Size	Dimension "L"	Dimension "HH"
[model code]	[inches]	[inches]	[inches / centimeters]
15F	1.50"	12"	10.5" (26.7cm)
20F *	2.00"	12"	10.5" (26.7cm)
25F *	2.25"	18"	10.6" (26.9cm)
30F *	3.00"	18"	10.6" (26.9cm)
40F *	4.00"	18"	11.1" (28.2cm)
60F	6.00"	24"	12.2" (31.0cm)

*also available in A106 Grabe B Carbon steel pipe + A105 Flanges

Appendices: Warranty

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 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 modifications by the Customer without the written approval of FOX. 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 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 these products is under exclusive control of the purchaser and FOX specifically denies any responsibility for the calibration of units and/or accuracy of work performed or the safety of the system in which FOX products is used. EXTERNAL SAFETY DEVICES MUST BE USED WITH THIS EQUIPMENT.

(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 PRODUCTS AND IS IN LIEU OF ALL OTHER WARRANTIES, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, LIABILITIES, AND REMEDIES. EXCEPT AS THUS PROVIDED, FOX, DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Appendices: Returning Your Meter

Returning Your Meter

The Fox Thermal Instruments, Inc. Customer Service Department
(PH: 831- 384-4300 or FAX: 831-337-5787) can help you through the process of returning a meter for service.

If it becomes necessary to return a Fox flow meter for service or recalibration, please follow these steps:

1. A Return Material Authorization (RMA) Number must be obtained from the Fox Customer Service Department prior to returning any Fox meter(s).
2. Please have your meter's serial number(s) available.
3. Read and complete the Fox RMA Customer Information Form. Be sure to initial the decontamination statement as well as provide complete return shipping instructions (we cannot deliver to post office boxes).
4. The entire flow meter must be returned, including all electronics (unless specifically instructed to do otherwise). **ALL** serial numbers must match their corresponding meters. This is especially necessary when returning flow body models.
5. Clean and decontaminate all wetted parts before returning to Fox.
6. Ship the meter to the following address:

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

NOTE! Be sure to review all of the information on the Customer Information Form before sending your meter to the Fox Customer Service Department. The Fox Shipping/Receiving Department cannot accept meters that have not been prepared appropriately.

What to expect while your meter is being serviced

Depending on the type of service required when returning your Fox meter, there are varying turnover times for servicing a meter. The average time needed to service the meter is 7-10 days (not including shipping or peak production times).

If you have already shipped your meter to Fox for servicing and would like to check the status of your meter, please fill out our online Service Order Status form located at www.foxthermalinstruments.com and you will hear from a Customer Service Rep within 1 business day of your requested update.

Rush recalibration service is available for a fee. Restrictions apply.

Definitions

DEFINITIONS

Glossary of Terms and Definitions

AWG	American Wire Gauge
Bara	Bar absolute
CTC	Contact
CAL	Calibration
CHG	Change
COM	Communication
CSV	Current Sense Voltage
DC	Direct Current
DN	Down
DSP	Display
ELP	Elapsed time
Feq	Frequency
Ft^2	Square Feet
I/O	Input/Output
INP	Input
LB	Pound
LB/D	Pound per Day
LB/H	Pound per Hour
LB/M	Pound per Minute
LB/S	Pound per Second
LCD	Liquid Crystal Display
KG	Kilogram
KG/H	Kilogram per Hour
KG/M	Kilogram per Minute
KG/S	Kilogram per Second
M^2	Square Meter
mmHG	Pressure in millimeters of mercury
MMSCFD	Million Standard Cubic Feet per Day
MXFLO	Maximum Flow
NEMA	National Electrical Manufactures Association
NIST	National Institute of Standards and Technology
NL	Normal Liter
NLPH	Normal Liter per Hour
NLPM	Normal Liter per Minute
NM3	Normal cubic Meter
NM3/H	Normal cubic Meter per Hour
NM3/M	Normal cubic Meter per Minute
NPT	National Pipe Thread
PDA	Personal hand held computer

PC	Personal Computer
P/U	Pulse per Unit
PIP A^2	Pipe Area
PLC	Programmable Logic Controller
PRM	Parameters
PRS	Pressure
PSIA	Pounds per Square Inch Absolute
Pt	Point
PSW	Password
SIM	Simulation
SCF	Standard Cubic Feet
SCFM	Standard Cubic Feet per Minute
SCFH	Standard Cubic Feet per Hour
SCFD	Standard Cubic Feet per Day
SPC	Special Control
STP	Standard Temperature and Pressure
TMP	Temperature
TSI	Internal Variable
TSV	Internal Variable
UNT	Unit
U/P	Unit per Pulse
420	4-20mA output

FOX THERMAL INSTRUMENTS, INC.
Fox is ISO 9001 certified

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Notes and Information

WARNING! is used to indicate a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION! is used to indicate a hazardous situation which, if not avoided, could result in minor or moderate injury.

Indicates compliance with the WEEE Directive. Please dispose of the product in accordance with local regulations and conventions.

Indicates compliance with the applicable European Union Directives for Safety and EMC (Electromagnetic Compatibility Directive 2014/30/EU).