Dattus™ fM Meter
Technical Reference Guide

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Dattus™ fM Meter Technical Reference Guide

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Preface

Regulatory Notices

Intrinsic Safety for Hazardous Locations

The design of the Dattus Gas Meter conforms to the UL, CSA ratings of Class 1 Div 1 group C&D and Class 1 Div 2 hazardous locations.

The meter is approved to the CENELEC standards for rating of an IIB T4.

The intrinsic safety includes design constraints on the batteries, electronics board, outputs, and external plastic surfaces.

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Chapter 1 - General Information

This *Dattus™ fM Meter Technical Reference Guide* provides information important to the installation, operation, and maintenance of the Dattus fM Gas Meter. Actaris recommends that you read the entire guide before attempting installation, tests, operation, or maintenance of the meter.

This chapter contains a general description of the meter, information about the meter's features, metering applications, and meter specifications.

In addition to this chapter, this guide contains the following chapters:

Chapter 2	**Theory of Operation**	Describes technical details on the meter design and operation.
Chapter 3	**Installation & Programming**	Contains instructions for installing the meter, as well as information and procedures for programming and starting the meter.
Chapter 4	**Proving**	Contains basic instructions on proving the meter.
Chapter 5	**Differential Pressure Testing**	Contains basic instructions on differential pressure testing.
Chapter 6	**Calibration**	Contains basic instructions on testing and calibrating the temperature probe.
Chapter 7	**Maintenance**	Provides information and instructions for replacing the batteries, an index and a temperature probe.
Chapter 8	**Alarms**	Provides details on the possible alarms generated by the meter.
Chapter 9	**Troubleshooting**	Provides information on how to quickly and effectively identify and resolve typical problems that may be encountered while operating the meter.
Appendix A	**External Connections**	Contains pin-out descriptions of external connectors.
Glossary		Provides a listing of terms and definitions.

Using This Manual

The *Dattus™ fM Meter Technical Reference Guide* provides hardware-related information about the Dattus meter.

Note boxes provide essential information about using the ***Dattus™ fM Meter Technical Reference Guide***.

Cautions provide information that is important to consider when performing certain operations.

Warnings provide special, must-read information. If you ignore a warning, you may omit essential data or make a critical error that could cause bodily harm or severely damage the meter. Warnings are in bold text.

General Description

The Dattus fM Meter (see Figure 1.1) is intended for use in light industrial and commercial sites. Features available in the meter include:

- Volumetric flow measurement
- Temperature Correction
- Fixed Factor Pressure Correction
- Display of the instantaneous flow rate
- Logging of events
- Pulse outputs of corrected and uncorrected volume, and alarm events

Figure 1.1 Dattus fM Meter (*Model fM2 shown here*)

Meter Configuration

Dattus fM gas meters have two typical configurations:

- Basic—the standard meter features and fixed factor capabilities
- ETC—the basic version with a temperature probe mounted in the gas flow

These configurations may vary depending on added options.

In addition to these Dattus options, an fM meter may also be equipped with the *Gas Micro* Electronic Volume Correction plaform. This option gives an fM meter full pressure and temperature correction as well as logging and communications capabilities. For specific information on the capabilities and features of the *Gas Micro* platform please refer to the “Gas Micro Operator’s Manual.”

Standard Features

The basic meter performs volume metering based on the gas pressure and temperature in the meter. The following functions are available:

- Gas volume totaling
- Fixed factor correction
- Volume and alarm pulse outputs
- Non-volatile memory for storing values and data
- Optical communication port for reading/writing of values
- Eight-item programmable display
- Magnetic switch to change display values
- Circular event log
- Power management

Optional Features

In addition to the standard functionality of the basic configuration, the following options can be added:

- Temperature correction using a temperature probe mounted in the gas flow
- Push button to change display values

Meter Parts

The Dattus fM Meter is composed of three main parts: measurement unit, index housing, and external cover.

Measurement Unit

The measurement unit (see Figure 1.2) is the only part of the meter that is exposed to the gas. A series of threaded taps provide convenient access to the various internal gas chambers for monitoring pressure.

This unit is made of an aluminum structure that ensures gas tightness up to line pressures of 150 psi.

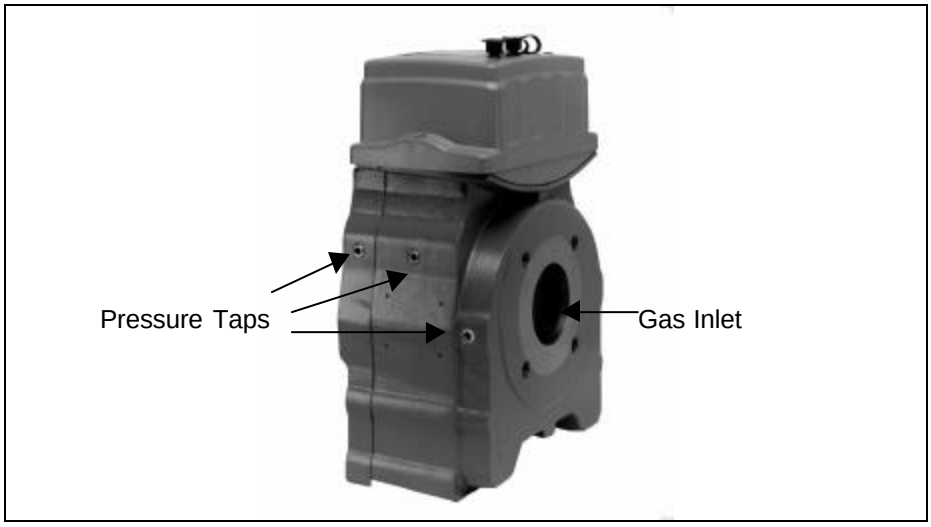


Figure 1.2 Measurement Unit

Index Housing

The index housing (see Figure 1.3) contains the index board and batteries that provide the main functionality of the meter. The housing is made of a UV- stabilized polycarbonate material designed to reduce the risk of damage from significant shock impact. This housing has a configurable index orientation.

Communication with the meter is accomplished through the optical port. To scroll the displayed values, a magnetic switch (or optional push button, if provided) is used.

Figure 1.3 Index Housing Layout

External Cover

The external cover (see Figure 1.4) provides both mechanical and tamper protection to the temperature probe.

Figure 1.4 External Cover

Meter Seals

Various meter seals are available:

- External Cover Seal(s) (optional)—seals the mounting screws on the external cover. Protects access to the temperature probe, pressure transducer, and batteries.
- Index Housing Seal—seals the index housing. Protects access to the index board and other electronic components (e.g., programming switch, temperature probe screwed connection).
- Measurement Unit Seal (optional)—seals the measurement unit. Protects against unauthorized opening of the measurement unit.
- Battery Access Door Seal (optional)—seals the battery access door with a seal wire. Protects against unauthorized access to the batteries.

The locations of the seals are shown in Figure 1.5.

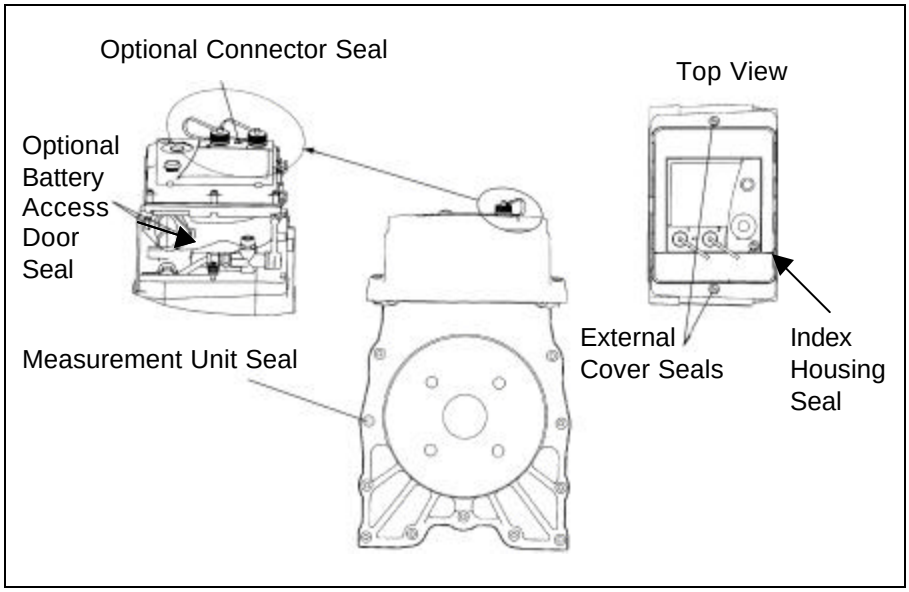


Figure 1.5 Meter Seal Locations

Specifications

Table 1.1 provides the specifications for the meter.

Table 1.1 Meter Specifications

General		
	Meter Type	Dattus
	Meter Model	fM2
	Flanges	2-inch and 3-inch ANSI 125
	Maximum Allowable Operating Pressure (MAOP)	150 psig (10 bar)
	Flange to Flange Length	6.75” (171 mm)
	Display	Programmable up to 8 digits for meter quantities and alarms
	Display Sequence Activator	Magnetic switch or push button option
	Operating Temperature Range	-40°F to 140°F
	Weight	37 lbs.
Construction		
	Measurement Unit	Cast aluminum A356T6
	Index Housing	UV-stabilized polycarbonate
	External Cover	ASA (Acrylonitrile Styrene Acrylate)
Flow Rates		
	Maximum Flow Rate	9,000 acfh (255 m^3/h)
	Comparable Meters	3,000 to 9,000 acfh
	Minimum Flow Rate	22 acfh (.625 m^3/h)
Flow Rate at 0.5 in wc, gas (0.6 specific gravity)		
	2” ANSI 125	2,457 acfth (69.6 m3/h)
	3” ANSI 125	2,750 acfth (77.9 m3/h)
Flange Version	**Flow Rate ft^3/h**	**Pressure Drop, gas (0.6 specific gravity) in w.c.**
2”	**9000**	**6.38**
	7968	5.00
	7000	**3.89**
	5000	**2.06**
	4918	2.00
	3481	1.00
	3000	**0.75**
	2457	0.50

3”	**9000**	**5.06**
	8905	5.00
	7000	**3.14**
	5535	2.00
	5000	**1.64**
	3871	1.00
	3000	**0.61**
	2750	0.50
Dynamic Range	± 2%	400:1
	± 1%	150:1
Temperature Measurement		
	Temperature Probe Type	Type PT1000, platinum resistance thermistor (RTD)
	Typical Probe Accuracy	0.1% of absolute measurement
	Probe Construction	Stainless steel tube, 0.25 in (6 mm) outer diameter
	Probe Cable	0.25 in (6 mm) diameter, 2 conductors with shield
Pulse Outputs		
	Pulse Type	Low frequency, standard Namur
	Form Type	A
	Pulse Duration	250 ms
	Pulse Value	User-scalable
Alarms		
	Temperature	Out-of-range
	Flow Rate	Over-range
	Battery	End-of-life
	Oscillation Sensor	Failure
	Oscillation Sensor	Warning
	Oscillation Sensor	Contamination
Communication		
	Optical Link	Optical port, 2400 baud
Event Logging		
		Stores 178 events Stores 22 “last occurrence” events
Power Supply		
		2 -3.6 V D-Cell lithium batteries; typical operating life of 7-10 years

Overall Dimensions

Figure 1.6 and Table 1.2 show the various outside dimensions and mounting hole thread depths.

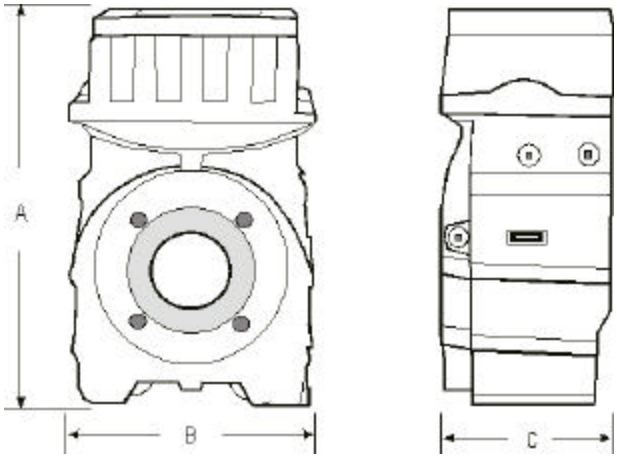


Figure 1.6 Dattus Meter Dimensions

Table 1.2 Dimensions

Dattus Model	A	B	C	Thread Depth	Flange Size
fM2	16.3 in. (41.5 cm)	10.4 in. (26.5 cm)	6.75 in (17.1 cm)	1.0 in.	2 in., 3 in. ANSI 125 Note: Adapter kit is available for 9.5” flange retrofit.

Liquid Crystal Display (LCD)

Figure 1.7 shows the LCD on the Dattus Gas Meter. The LCD provides eight (8) digits and symbols that offer indication of meter values.

The first item on the display will be the primary index. This will be either the uncorrected or corrected volume (as appropriate).

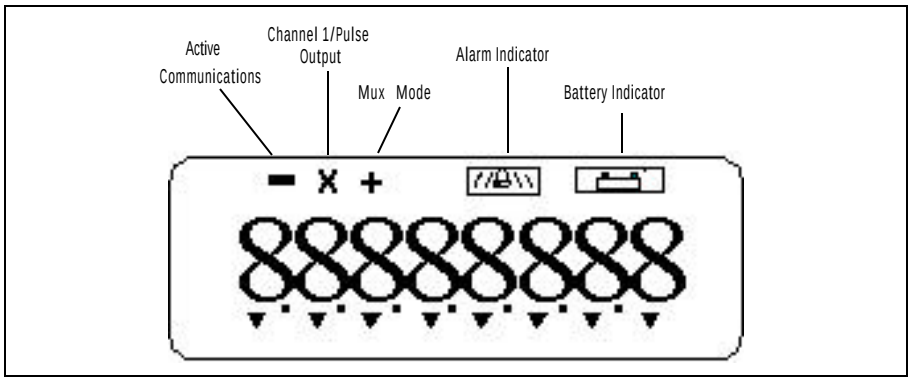
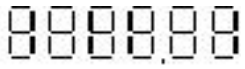
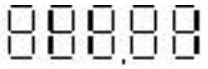
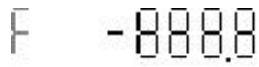


Figure 1.7 LCD Display

Table 1.3 explains each of the 8 possible digits.

Table 1.3 Typical Digit Display Items

Item	Display	Description
Uncorrected Volume		Number of digits is programmable from 4 to 8.
Corrected Volume		Number of digits is programmable from 4 to 8.
Corrected Flow Rate		Metric units - 4 digits left and 2 digits right of decimal point.
Uncorrected Flow Rate		Metric units - 3 digits left and 2 digits right of decimal point.
Corrected Flow Rate		Imperial units- 6 digits, no decimal point.
Uncorrected Flow Rate		Imperial units- 5digits, no decimal point.
Fixed Pressure *F* indicates fixed factor pressure.	 	Metric units- as shown. Imperial units- 3 digits to left and 2 to right of decimal point.
Temperature *F* indicates fixed factor temperature.	 	Metric units- as shown. Imperial units- as shown.
Correction factor		As shown
Alarm codes		As shown

The display updates every 2 seconds, unless the display switch is activated, in which case the display will be updated in the next 0.25 second processing.

The display is powered up continually, and if there is no display switch activation, then the displayed parameter will revert to either the uncorrected volume or corrected volume (configurable in the software). The time-out duration is programmable with 180 seconds default.

The volume display scale can also be programmed to display quantities using decade multipliers. The number of digits 4-8 can also be programmed using the software.

For each parameter the display shows the number of digits indicated. Values that are less than the full number of digits have leading zeros.

Table 1.4 provides a listing of the displayable items in alphabetical order.

All of the registered values in the meter are displayable.

Table 1.4 Displayable Items

Alarm Codes	Flow Rate Threshold
Alarm Passed Volume	Fixed Gas Pressure
Atmospheric Pressure	Gas Temperature
Back-up Corrected Volume	Lifetime Maximum Flow Rate
Back-up Temperature	Lifetime Maximum Temperature
Base Pressure	Meter Volume Per Cycle
Base Temperature	Minimum Temperature Threshold
Battery Life (days)	Monthly Back-up Index
Battery Voltage	Monthly Uncorrected Volume Index
Compressibility Ratio	Monthly Corrected Volume Index
Corrected Flow Rate	Serial Number
Corrected Volume	Station ID
Correction Factor	System Date
Corrected Volume at Alarm	System Time
Decimal of Corrected Volume	Uncorrected Volume at Alarm
Decimal of Uncorrected Volume	Uncorrected Flow Rate
Firmware Version	Uncorrected Volume

A magnetic switch (or optional push button) selects the displayed value. The currently-selected value is indicated by an arrow along the bottom edge of the display.

To change the displayed value, the operator passes a magnetic wand over the switch (see Figure 1.8). With each pass, the selection changes to the next value immediately to the right. The chosen value is indicated by an arrow on the bottom of the display, and points to a number which is indicated on the front panel.

Figure 1.8 Magnetic Switch Operation

Power Supply

Lithium batteries power the meter. These batteries provide a nominal operating life of 7-10 years, based on typical usage.

Remote Pulse Outputs

The meter provides a Form A type pulse output. Two pulse output channels are configurable by using PC Link software, with the choice of uncorrected volume, corrected volume, temperature corrected volume (channel 1 only) or none.

The connected inputs must have the following characteristics:

- be compatible with standard Namur
- be approved as intrinsically safe
- have the following electric limitations (including the connection cable)
- Umax < 16.5 V and Idc max < 50 mA

Pulse Outputs of the Uncorrected Volume

The uncorrected volume output has a programmable pulse weight of 1-1000 volume units per pulse. The pulse has a duration of 250ms. The minimum time between pulses is 250ms.

The maximum output pulse rate of the meter (2 pulses per second) may cause an overflow of output pulses. If this occurs, the pulses will be accumulated in a buffer and trickled out at 2Hz until all accumulated pulses are transmitted.

Pulse Outputs of the Corrected Volume

The corrected volume output has a programmable pulse weight of 1-1000 volume units per pulse. The pulse has a duration of 250ms. The minimum time between pulses is 250ms. The corrected volume pulse is updated every 20 seconds causing pulses to be streamed and so overflow of pulses is possible.

Activating unused output channels or using low pulse weights will reduce battery life.

Pulse outputs of the Temperature Corrected Volume are only available on Channel 1.

Alarm Outputs

The alarm is an open collector output allowing pulse output of the current alarms. If the contact is closed, there is an active alarm. This closure is reset after 20 minutes and remains open until another alarm is activated.

See Chapter *8, Alarms*, for detail information on the alarms.

Event Logger

The event logger is a database function. It checks for an event occurrence every minute. If an event has occurred, the event code, the date, and the time are recorded. The log can contain 178 events and 22 last occurrence events. This log is circular.

The events that are logged are shown in Table 1.5.

Table 1.5 Events Logged

Battery Alarm-- Low Voltage or Days Expired
Battery Change
Calculation Overflow
Change of Correction Parameter or P or T
Change of Parameter
Change of Pulse Output Parameters
Change of Volume Indexes or Meter Pulse Weight
Date/Time Changed
Meter Reset (either power outage or watchdog reset)
Oscillation Sensor Failure--Critical
Oscillation Sensor Contamination
Oscillation Sensor Warning
Over Flow Rate Alarm
Reset Alarm Volumes or Alarm Codes
Reset of Event Log or Last Occurrence Events
Temperature Alarm

Meter Badges and Labels

There are a variety of meter badges and labels offered to meet different market requirements. The standard meter has a metal badge mounted on the meter body and a label mounted on the index cover. There is also a provision for mounting an additional metal plate that can be used to identify the utility's serial number for the meter.

Meter Badges

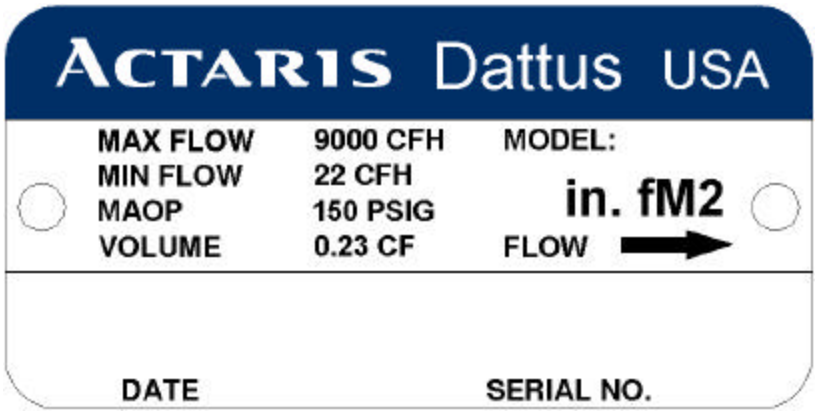


Figure 1.9 Meter Badge

The meter badge is an aluminum plate, mounted permanently to the cast body of the meter. This plate identifies the meter and its service limitations and contains the following information:

- Meter serial number
- Maximum Allowable Operating Pressure (MAOP)
- Maximum flow rate
- Minimum flow rate
- Manufacturer name
- Meter model name
- Date of manufacture
- Meter Volume (CV)

Labels

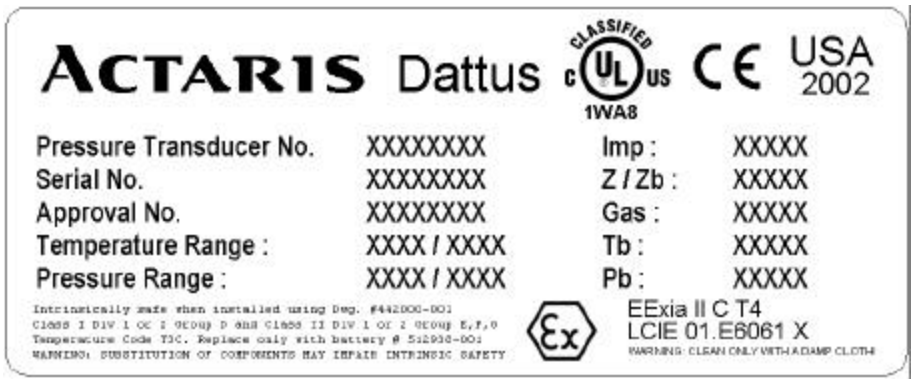


Figure 1.10 Meter Label

The information label is a plastic label on the side of the external cover. This plate identifies the functionality of the index. The meter serial number on the meter body and the index serial number on the label may not be from the same series of numbers. The label contains the following information:

- Manufacturer name
- Index serial number (if needed)
- Year of manufacture
- Temperature range (for correction)
- Pulse outputs (register and weight)
- Gas type
- Intrinsic safety reference and supplementary information
- CE and UL approval information
- Base Temperature
- Country of Origin

Chapter 2 - Theory of Operation

This chapter of the *Dattus fM Meter Technical Reference Guide* describes the operation and conversion principles. It also explains the electronic architecture and provides various calculation formulas for the Dattus fM Gas Meter.

Operating Principle

The operation of the Dattus fM meter is based on the fluidic oscillation principle. This static metering technology is based on Bernoulli's theory—a slow moving high pressure gas becomes a fast moving low pressure gas at the nozzle exit, forming a jet of gas.

The gas jet, once formed, can be controlled by the Coanda effect, using an obstacle in the flow that is designed to optimize the performance of the meter. Controlling the gas jet path enables the formation of feedback pressure nodes on either side of the gas jet, resulting in a predictable oscillation of the gas jet.

The metrology of the meter relates to the mechanical design of the fluidic oscillation chamber and conditioning flow entry. The gas jet oscillations are detected using a thermal sensor device that provides metering data to the meter's electronic index.

The measurement unit consists of three functional elements:

- flow conditioner
- jet nozzle formation
- fluidic oscillation chamber

Figure 2.1 shows the various elements:

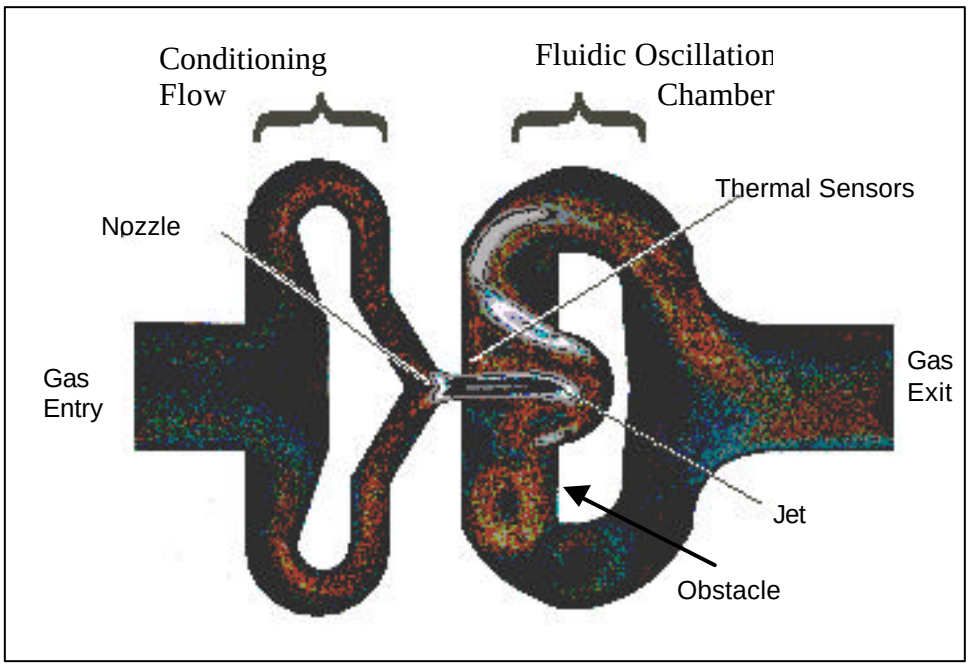


Figure 2.1 Measurement Unit Elements

Figure 2.2 shows the flow of gas through the meter:

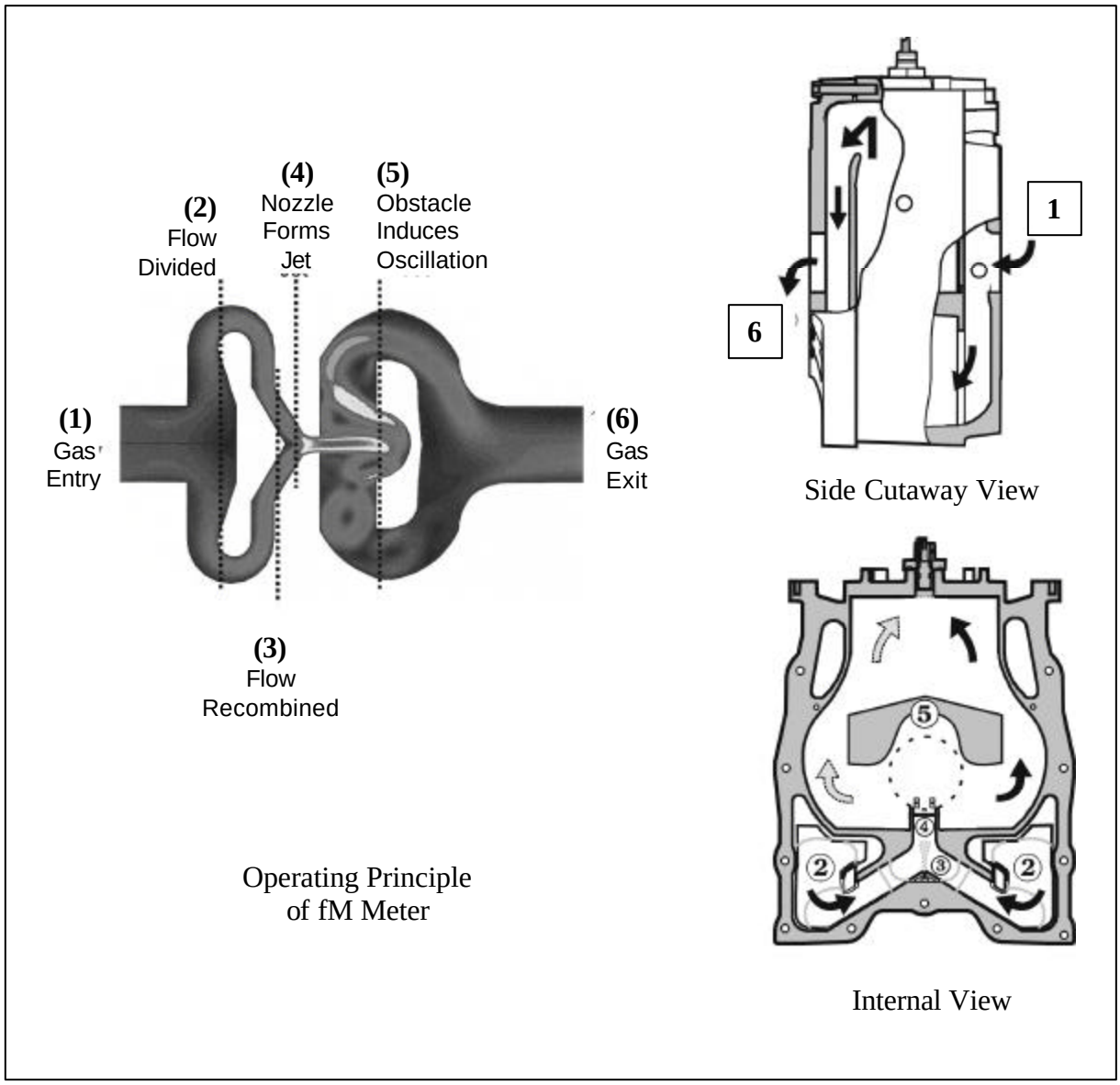


Figure 2.2 Flow Diagram

Gas enters the meter (1) and divides into two separate flow paths (2). These two flows recombine (3) as they exit the flow entries and enter the fluidic oscillation chamber through the nozzle. This process of dividing the flows eliminates upstream disturbances and creates a well-conditioned flow.

In the fluidic oscillation chamber, a jet is formed as the gas enters through the nozzle (4). The jet then starts oscillating back and forth (5).

Thermal sensors, located just after the nozzle (4), detect a temperature variance as the gas jet passes from one side to the other. The volume of gas passed through the meter is obtained by counting the number of oscillations detected by the thermal sensors. The Gas passes around the obstacle and exits the meter (6).

Electronic Architecture

The block diagram shown in Figure 2.3 represents the major functions of the meter. The integrated nature of the electronics of the meter ensures reliable execution of the following functions:

- Management of the volume accumulation
- Management of alarms
- Action of the magnetic switch (or push button) to display the next values
- Storage in non-volatile (permanent) memory of data and values
- Volume and alarm outputs
- Communication with an external device by way of the optical port
- Acquisition of the data for the temperature probe
- Correction of the volume to reference conditions

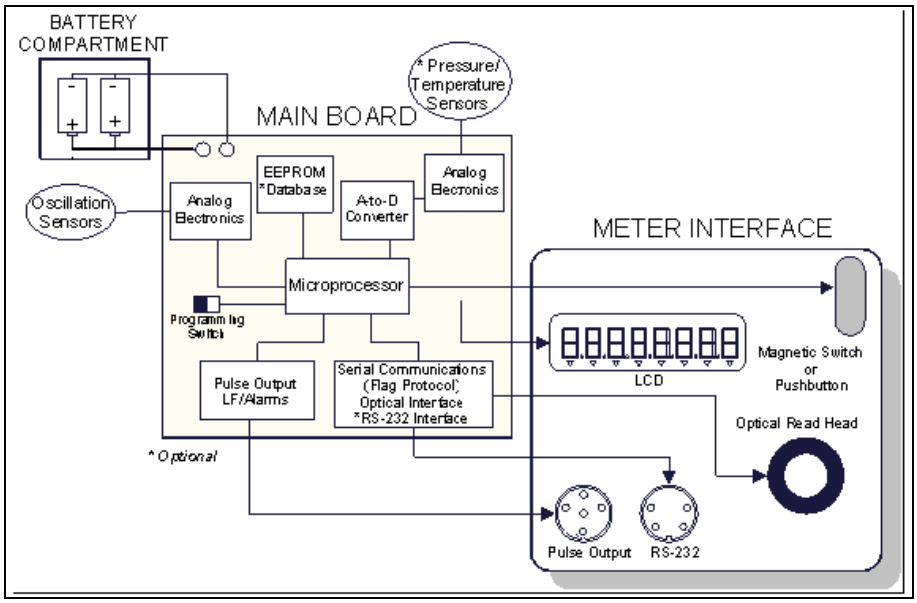


Figure 2.3 Meter Block Diagram

Uncorrected Volume Accumulation

The volume of gas at metering pressure and temperature is totaled by the microprocessor. This is the primary function of the meter and has priority over all other tasks performed by the meter. The accumulated volume is stored in the non-volatile memory every six hours (midnight, 6 A.M., noon, 6 P.M.). If there is a loss of power to the meter, the value will be recalled from the memory.

This accumulated volume register cannot be reset or programmed to a different value.

Corrected Volume Accumulation

The corrected volume accumulation is calculated from the uncorrected volume passed in the previous 20-second interval. The uncorrected volume is multiplied by the correction factors for pressure and temperature which are calculated at the beginning of each interval.

Under alarm conditions, this register is not incremented.

This register value is stored every six hours in non-volatile memory and can be set to any initial value with the proper programming access.

Fixed Pressure Factor Volume Correction

The volume can be corrected to reference conditions using one pre-programmed value for pressure.

The display of the pressure will have an *F* on the far left of the display to indicate that the value is fixed (see Figure 2.4).

Figure 2.4 Fixed Value Display

Calculation of Flow Rate

The uncorrected volume flow rate (Q_M) is calculated from:

$$Q_M = \frac{\text{volume of gas}}{\text{increment of time}}$$

The maximum displayed flow rate will be stored and resettable.

The corrected volume flow rate (Q_C) is calculated from:

$$Q_C = Q_M \times C$$

If variations in Q_M are less than 20%, a smoothing algorithm is applied to generate an average flow rate based on a longer time period.

Calculation of Correction Factor

The correction factor (C) is calculated using the following formula:

$$C = C_P \times C_T$$

where C_P is the pressure correction factor given by:

$$C_P = \frac{P}{P_b}$$

C_T is the temperature correction factor given by:

$$C_T = \frac{T_b}{T}$$

where T_b and T are absolute temperatures.

The parameters P_b, T_b and Z_b allow the measured volume to be translated to the equivalent volume measured under reference conditions.

T_b is typically 60°F; P_b is typically 14.73 psia.

The precision of the correction factor C is ± 0.5%. This factor is re-calculated every 20 seconds.

Chapter 3 - Installation and Programming

This chapter of the *Dattus fM Meter Technical Reference Guide* provides information and instructions to correctly store, unpack, inspect, and install the Dattus fM Meter. Also, this chapter provides general information and procedures for accessing the various programming modes.

When installing meters, follow any guidelines issued by your company in addition to those given in this guide.

Handling and Storage

Store the meter in a clean, dry environment until time of use. The meter is shipped with protection caps on the inlet and outlet sides to prevent foreign matter from entering the measurement unit (see Figure 3.1). Ensure these caps remain in place until mounting the meter in the system.

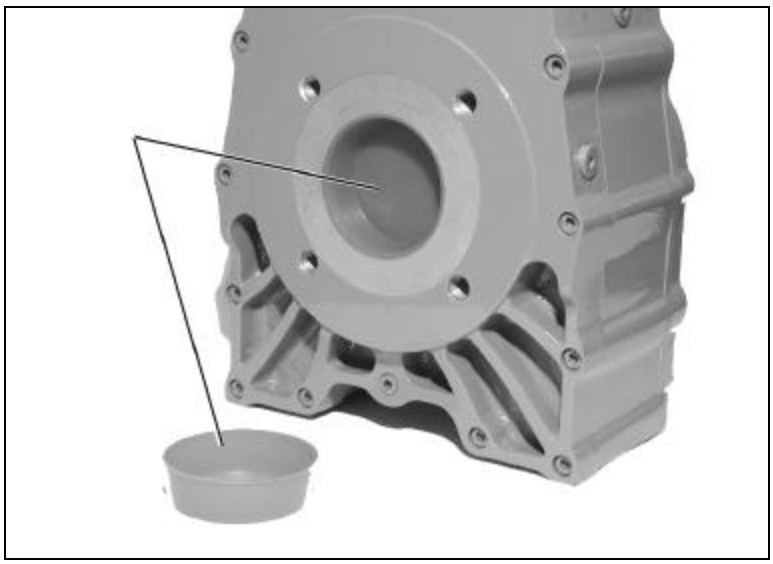


Figure 3.1 Inlet/Outlet Protection Caps

Unpacking and Inspection

The meter is delivered in a well-supported cardboard box that normally arrives in perfect condition; however, if the box is damaged, notify the carrier immediately of a potential mishandling problem.

The meters are packed individually, and each contains the following components:

- Meter with protection caps on the inlet and outlet
- Meter seals
- Installation instructions
- Test certificates

Mechanical Mounting

A Dattus fM meter can be installed in the metering line without any form of special support. It can also be mounted in any orientation; however, Actaris does *not* recommend mounting with gas entry from the bottom. If liquids are present in the metering line, Actaris recommends mounting the meter in a horizontal position and/or the use of a filter designed to remove liquids from the metering line.

Gas Micro EVC equipped meters have vented instrument enclosures. Always ensure that the index is oriented so that the vent is pointing towards the ground.

If the flow direction is specified at the time of order, the meter index will be oriented to facilitate the reading of the display. If no direction is specified, the default of entry from the left is taken.

Four meter index orientations are possible (see Figure 3.2). To change the index orientation, the external cover must be removed; the index housing carefully rotated; and the external cover replaced.

Figure 3.2 Four Possible Index Mounting Orientations

Start-up/Shut-down Procedures

Meter start-up and shut-down procedures depend on the type of installation. Installation procedures with and without a by-pass are described in this section.

Always open and close valves slowly, preventing pressure surges that may damage equipment.

Installation with a By-Pass

Figure 3.3 shows meter installation with a by-pass.

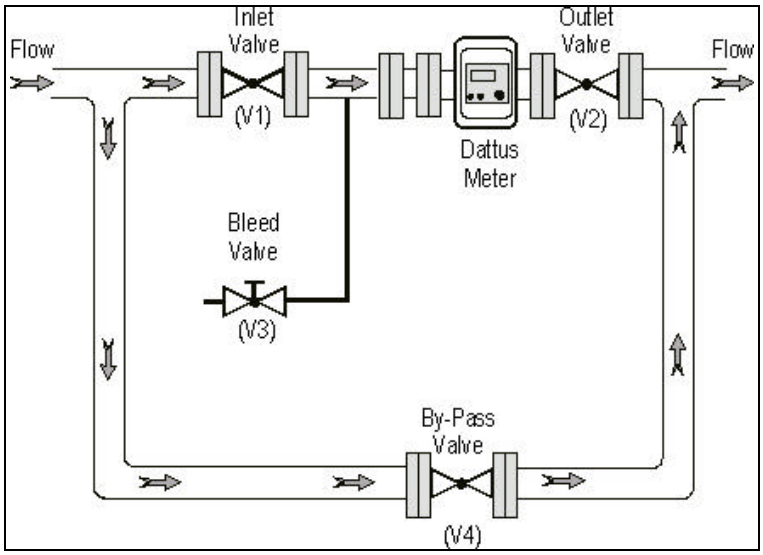


Figure 3.3 Installation with a By-Pass

To Shut Down the Meter:

1 Slowly open the by-pass valve (V4).

2 Close the inlet valve (V1) of the metering line.

3 Close the outlet valve (V2).

4 Depressurize the metering line (not exceeding 4 psi per second) with the small bleed valve (V3).

To Start Up the Meter:

1 Slowly open the outlet valve (V2) to pressurize the metering line (not exceeding 4 psi per second).

2 When the metering line is fully pressurized, fully open the outlet valve (V2).

3 Check for leaks by applying soapy water to the joints and looking for air bubbles.

4 Open the inlet valve (V1).

5 Close by-pass valve (V4).

6 Check that the flow does not exceed the capacity of the meter.

Installation without a By-Pass

Figure 3.4 shows meter installation without a by-pass.

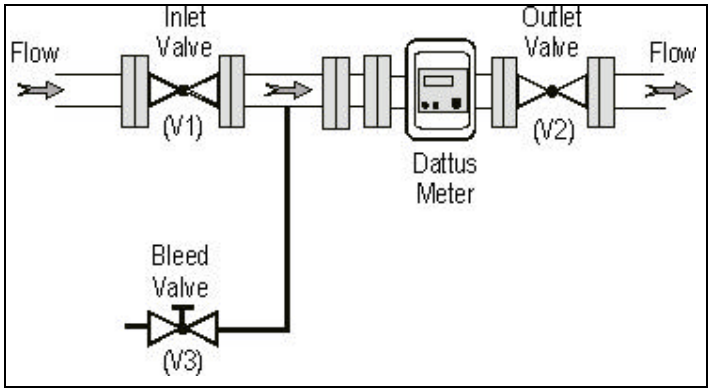


Figure 3.4 Installation without a By-Pass

To Shut Down the Meter:

1 Slowly close the outlet valve (V2).

2 Close the inlet valve (V1).

3 Open the bleed valve (V3) and slowly depressurize the metering line (not exceeding 4 psi per second).

To Start Up the Meter:

1 Slowly open the inlet valve (V1) to pressurize the metering line (not exceeding 4 psi per second).

2 Open the outlet valve (V2) until the outlet pressure is stable.

3 Check for leaks by applying soapy water to the joints and looking for air bubbles.

4 Fully open the outlet valve (V2).

5 Check that the flow does not exceed the capacity of the meter.

Inputs/Outputs

To a Remote Pulse Accumulator

The meter can be fitted with pulse output connectors. These pulses can represent temperature-only corrected volume (Channel 1 only), corrected volume, uncorrected volume, or alarms.

1 Program the desired pulse type and pulse weight using PC Link configuration software (Dattus Parameters/Outputs).

2 Connect the pulse output cable (available from Actaris) to the Pulse Output connector on the meter

Figure 3.5 Remote Pulse Accumulator to Index

3 Connect the appropriate wires to a pulse accumulator device. Table 3.1 identifies each wire on the pulse output cable (Part Number: 442461-003).

Table 3.1 Pulse Output Cable Wire Functions

PIN	Color Wire	Function
1	White	Alarm +
2	Black	Channel 2 +
3	Green	Channel 1 -
4	Orange	Channel 2 - / Alarm -
5	Red	Channel 1 +

4 Test connections using the pulse accumulator's software.

Programming

The Dattus meter can be customer-configured. To program the meter, the following tools are needed:

- Personal Computer
- Actaris optical cable

The Dattus fM meter is programmed using the Actaris *PC Link* software.

For detailed programming information, refer to the *PC Link User's Manual* or the help files accessible within the PC Link software.

Communication

Before you can communicate with a meter, PC COM ports (serial ports) that PC Link will use to communicate with the Dattus meter must be identified. This normally occurs automatically during installation of the *PC Link* software.

Occasionally however, you may need to configure ports if the default choices are not available. Port configuration options can be found under (File/Preferences/Communication Parameters).

The COM ports used by PC Link must be available for use and not dedicated for another application. If another device, such as a PDA (Personal Digital Assistant) has dedicated a COM port for its application, the COM port may appear to be available for use by PC Link, but errors may occur. If a PDA application is running on your PC, it may show up in the active programs area of the Windows Status Bar.

Optical Link

After attaching the optical head, the optical link enables communication between the meter and a portable PC as shown in Figure 3.6. This is a temporary link for reading and writing meter values.

Figure 3.6 Optical Communications Link

Programming Access

Normal Access Mode

To activate Normal Access mode:

1 Connect a personal computer to Optical probe.

2 Access the meter using the PC Link configuration software (Communication/ Logon).

Administrator Access Mode (Canada only)

You can access this mode by the programming switch as described here.

To activate Administrator Access mode:

1 Remove the external cover by loosening and removing two external cover mounting screws and lifting the external cover away from the measurement unit (see Figure 3.7).

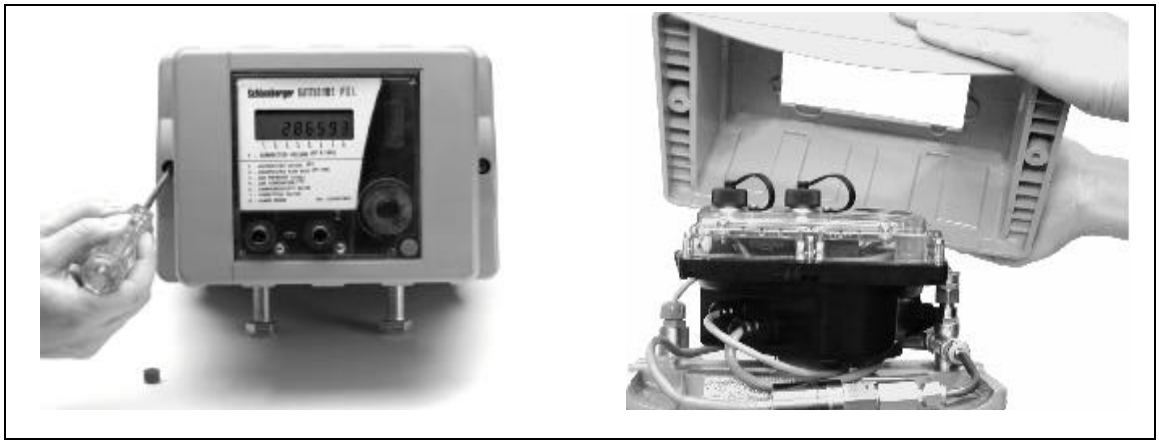


Figure 3.7 Removing the External Cover

2 Remove seals if fitted in the meter.
3 Remove the meter seal on the index housing to expose the mounting screws.
4 Remove the index housing by loosening its nine (9) index housing screws (see Figure 3.8).

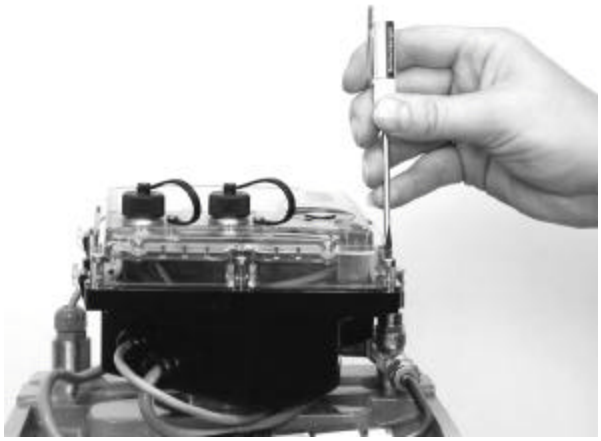


Figure 3.8 Loosen the Index Housing Screws

5 On the exposed index board, set the programming switch (see Figure 3.9) to *ENABLE* position.

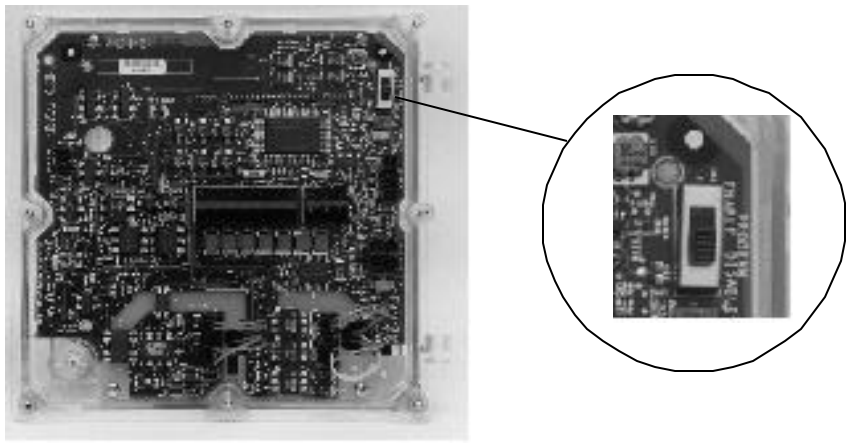


Figure 3.9 Programming Switch Location

7 Verify the *PROG.* message flashing on the display.

8 Program the meter.

9 Return the programming switch to the *OFF* position.

10 Close the index housing and replace seal (if applicable).

11 Re-attach the external cover and replace seal (if applicable).

Installation Verification

To verify the installation, follow this procedure:

1 Verify that no alarm symbols or alarm codes are currently displayed on the meter. (See Chapter *8, Alarms*, for additional alarm details.)

2 Verify that the magnetic wand (or optional push button) increments the displayed values.

3 If applicable, check for the correct temperature display value using either a reference thermometer or an approximate indication.

4 If applicable, check for a reasonable pressure reading display value by making sure that the reading matches the meter's expected pressure.

Chapter 4 - Proving

This chapter of the *Dattus Meter Technical Reference Guide* provides general instructions on how to connect and test a Dattus fM Meter with a rotary transfer prover.

Materials List

- Dattus fM2 Gas Meter
- Rotary Transfer Prover and software
- Rotary Transfer Prover hoses for pressure and temperature
- 25-foot or longest available (4 inch) proving hose
- 3-foot (3 inch) proving hose (available from Actaris)
- Damper (available from Actaris)
- Ball Valve (available from Actaris)
- Allen Wrench, 1/4-inch
- Dattus Optical Probe (available from Actaris)
- Dattus Optical Proving Adapter Box (available from Actaris)
- Dattus Proving Cable (available from Actaris)

Connecting the Meter, Damper, and Rotary Transfer Prover

The rotation of rotary pistons creates pulsations in the gas stream. The pulsation is caused by the effective opening and closing of the gas flow. This effect is known to skew the measured accuracy of turbine meters when a rotary transfer prover is used. Utilities that desire to test turbine meters with rotary transfer provers typically use dampeners to remove some of the pulsation effect and obtain a more accurate test result. The use of a dampener is necessary to test Dattus meters as well.

The dampener is not intended for use as a pressure vessel.

While there are other dampeners available, Actaris has designed a dampener specifically to remove the pulsations while remaining compact and portable for use by field personnel (see Figure 4.1).

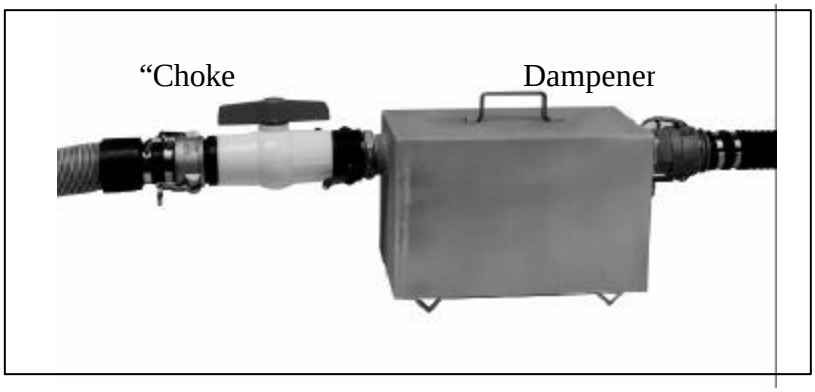


Figure 4.1 Actaris Dampener and Choke Valve

To simulate actual conditions when testing the Dattus with a 2” flange, attach a 2” pipe/flange combination to the meter’s inlet.

Follow Figure 4.2 to properly connect the meter, 25 ft hose, choke valve, dampener, 3 ft hose and transfer prover.

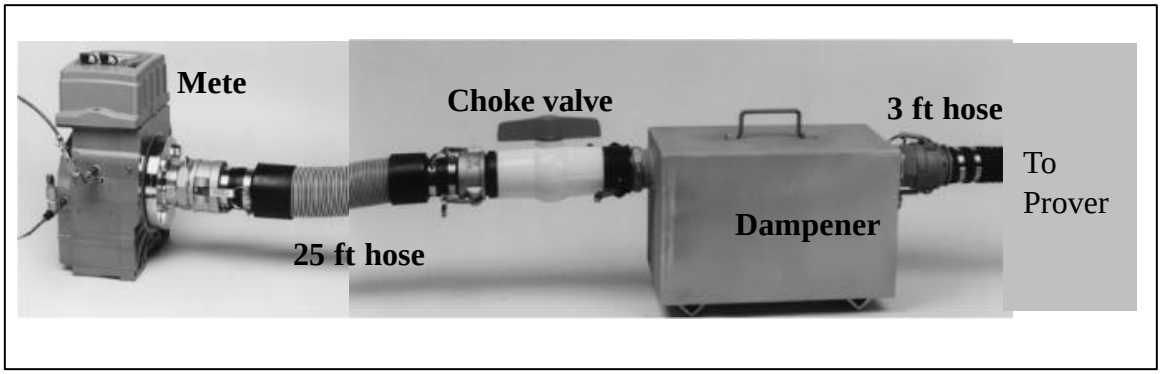


Figure 4.2 Damper Connection Schematic

The addition of the “Choke Valve” provides additional pulsation dampening at lower flow rates. For best performance of the dampener, the Choke Valve should be in the “closed” position for calibration below 3000 acfh.

Table 4.1 Conditions to use the Damper & Position of Ball Valve

Flow Rates	Transfer Prover Reference Meter	Position of Ball Valve
>3,000 CFH	10M	Open
3,000 CFH - 500 CFH	10M	Closed
2,000 CFH - 300 CFH	2M	Closed

Connecting the Pressure, Temperature, and Flow Hoses

The Dattus meter has three pressure taps on each side of the meter that may be used for testing.

1 Choosing either side of the meter, locate the center pressure tap and the one closest to the inlet of the meter as indicated in Figure 4.3.

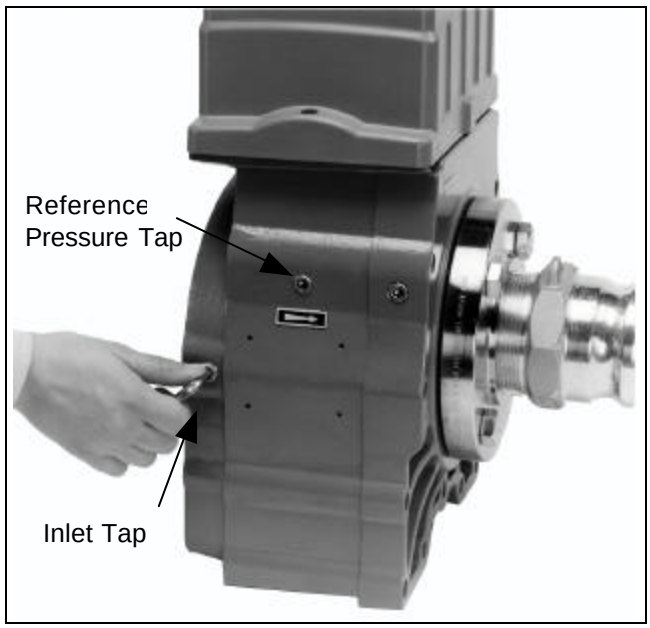


Figure 4.3 Pressure Taps

2 Unscrew and remove the two corresponding plugs with a 1/4-inch (6 mm) allen wrench and place the plugs aside for future reuse.

3 Install the inlet pressure tube in the pressure tap (center) by first wrapping gas pipe sealing tape around the threads and rotating the tube clockwise into the tapped hole until tight (see Figure 4.4).

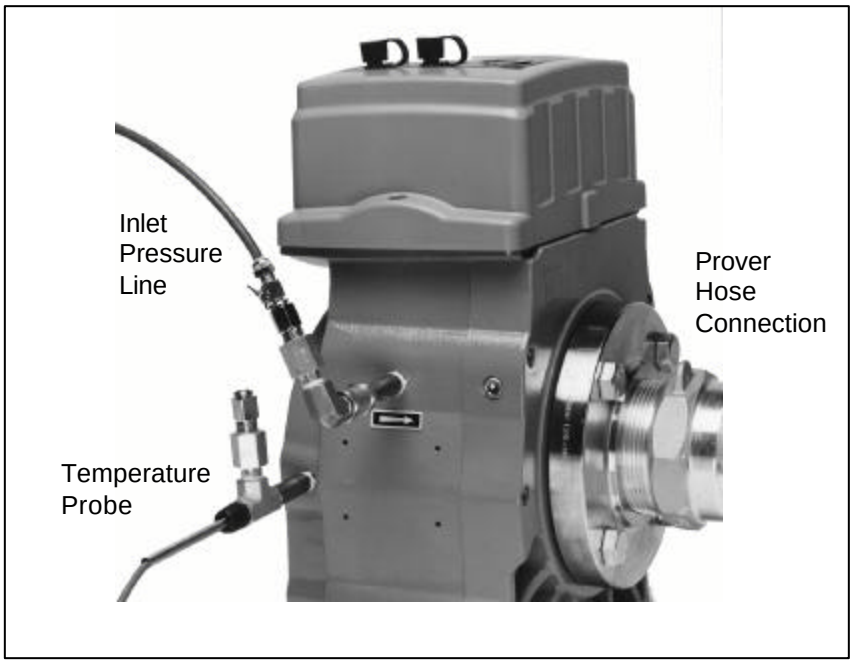


Figure 4.4 and Temperature Tube Installation Pressure

4 In the same manner, install the temperature probe tube in the inlet tap.

5 Finish the assembly by clamping the prover hose to the outlet of the meter.

Volume Pulse Output Connection

6 Connect the optical probe to the DB 9 connector on the adapter box.

7 Place the optical head on the optical port on the meter.

8 Connect the proving cable to the round connector on the adapter box.

9 Connect the Cannon connector end of the proving cable to the pulse input connection box on the proving system (see Figure 4.6).

10 Make sure the Optical Proving Adapter switch is in the “Proving” position.

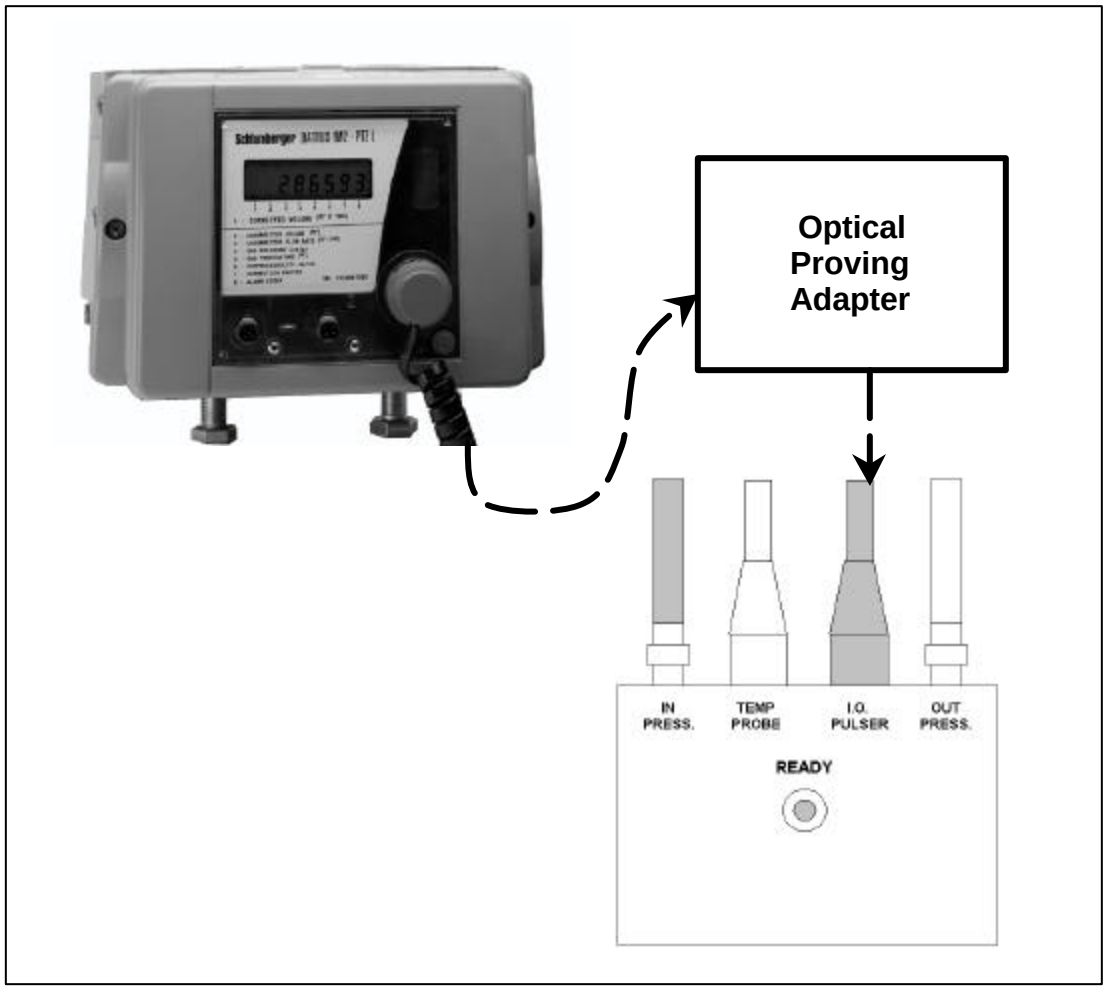


Figure 4.6 Optical Probe Output to Proving System

Recommended Transfer Prover Test Setups

The meter pulse output is factory set to transmit 1 pulse for every 10 actual cubic feet of uncorrected gas passed through the meter. For example, running 100 cubic feet through the meter causes 10 pulses to be transmitted.

To test using TC mode, optic output must be changed from uncorrected volume to temperature corrected volume using PC Link configuraton software (Dattus Paramters/Outputs).

Due to the fact that the resolution from the proving pulse is .25 seconds, it is recommended that a minimum test time of **120 seconds** be used to minimize this quantization error.

Table 4.2 shows examples of prover/test setups using various test flow rates.

Table 4.2 Recommended Transfer Prover Test Parameters

Capacity	Test Control Mode	Meter Output	Pulses/ Test	Test Volume	Flow Rates	Position of Damper Ball Valve
10M or 2M	OPTO	UC	10	100	600	Closed
10M or 2M	OPTO	UC	10	100	1000	Closed
10M or 2M	OPTO	UC	10	100	1400	Closed
10M	OPTO	UC	20	200	3000	Closed
10M	OPTO	UC	20	200	5000	Open
10M	OPTO	UC	20	200	7000	Open

Chapter 5 - Differential Pressure Testing

Differential pressure testing is a simple procedure where pressure drop, expressed in inches of water column, is measured between the inlet of the meter to its outlet. This method has long been used to assess changes in accuracy of a rotary meter while in use in the field. Excessive dirt build-up on the rotary meter's impellers or wear on the bearings will cause an increase in friction resulting in altered accuracy and a high differential pressure. Pressure readings are taken across the meter and indicate whether or not the meter has an acceptable accuracy level. Rotary meter manufacturers as well as individual utilities have established differential limits that infer acceptable/unacceptable meter accuracy.

Differential tests can also be performed on Dattus fM. There is no increase of differential pressure associated with dirt build-up or worn parts because Dattus fM has no moving parts. For Dattus fM, differential pressure will not be a function of friction, but can be linked to the overall accuracy of the meter.

The following table lists differential data at common flow rates. For additional differential data refer to the graphs shown in Figure 5.2 through Figure 5.10.

Table 5.1 Pressure Drop at Atmospheric Pressure, gas (0.6 specific gravity)

Flow Rate ft3/h	2" ANSI 125, in w.c.	3" ANSI 125, in w.c.
9,100	5.60	5.00
9,000	5.48	4.89
8,600	5.00	4.48
7,000	3.28	3.01
5,700	2.17	2.00
5,500	2.00	1.89
5,000	1.67	1.57
3,950	1.05	1.00
3,850	1.00	0.95
3,000	0.61	0.59

Materials List

- Meter to be tested with pressure test connections in the inlet and outlet pressure taps
- Pressure gauge
- Differential pressure gauge or manometer with high enough pressure capability to meet operating meter's demands
- Dattus fM differential pressure curves (from this manual)

Differential Test Procedure

1 Connect the pressure gauge in the pipe and record the line pressure.

2 Attach the differential gauge to the inlet and outlet test connectors (Pete's Plugs) of the meter to be tested.

3 After differential pressure reading is obtained, find the instantaneous flow rate reading from the Dattus index LCD readout. Record both the differential pressure and flow rate.

4 Refer to the graphs shown in Figure 5.2 through Figure 5.7 to determine the approximate accuracy of the meter. Select the graph with the appropriate line pressure and flange size that has the best resolution for the flow rate at which measurement has taken place.

5 To use the graphs, first locate the corresponding differential (inches w.c.) on the Y-axis. Follow across the graph until you reach the curve. Once you find the curve, go straight down to the X-axis to locate the corresponding flow rate. Compare the flow rate on the graph to the flow rate from the index display using the following formula:

[(Flow Rate from Chart – Flow Rate from Index) / Flow Rate from Chart] x 100

For example, using the graph in Figure 5.2, a differential of 0.50 inches w.c. shows a flow rate of 2640 acfh. Compare the reading from Dattus's instantaneous flow rate display. If the meter display shows 2612 acfh, then the approximate meter accuracy is 1.06%. The calculation is shown below:

[(2640 - 2612) / 2640] x 100 = 1.06%

Keeping in mind the overall resolution of the paper differential charts, this is a very good result.

Differential Pressure Calibration Curves
2" Dattus fM2
Atmospheric Pressure

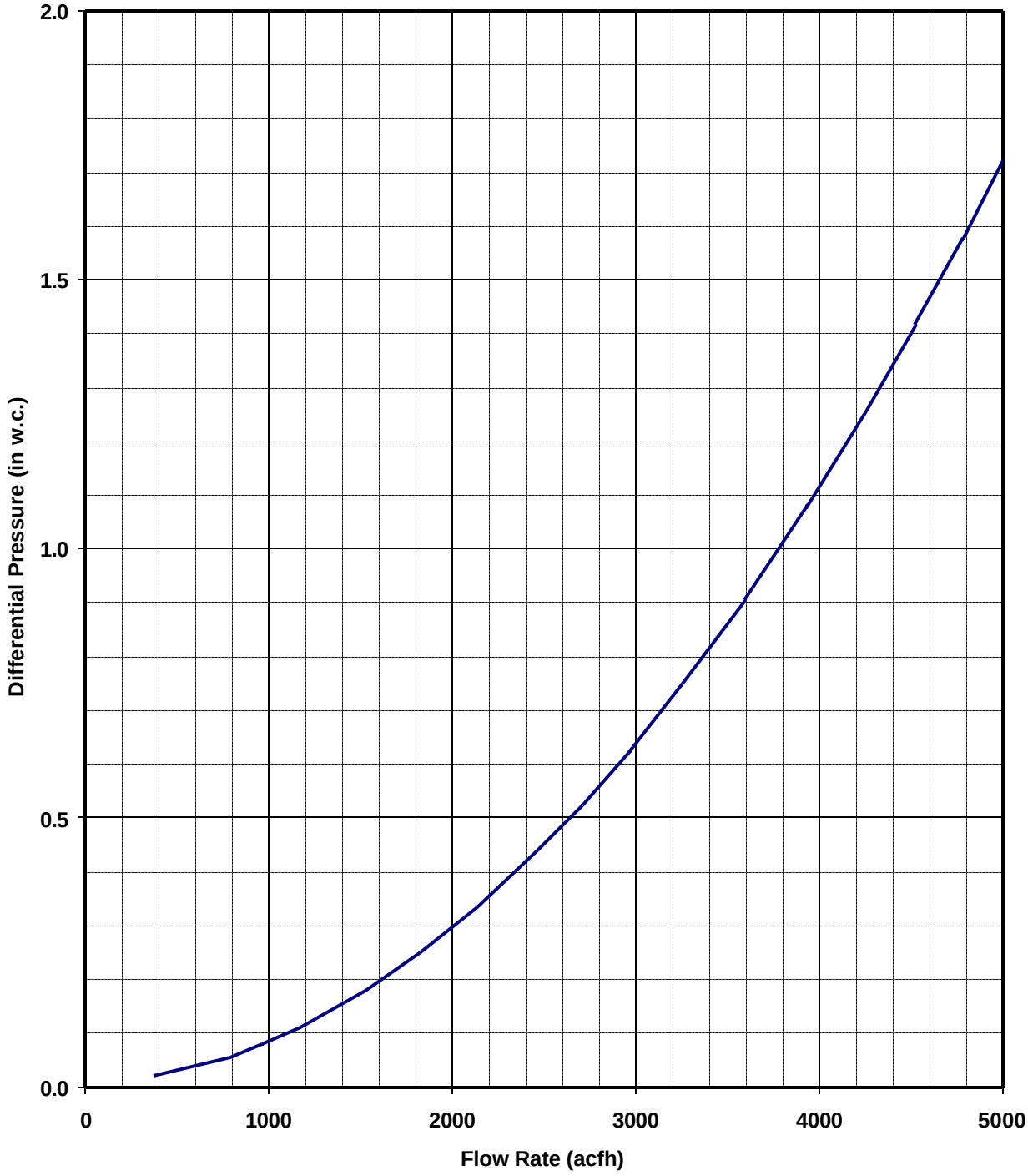


Figure 5.1 2" Dattus fM2 at Atmospheric Conditions

Differential Pressure Calibration Curves
Atmospheric Pressure
3" Dattus fM2

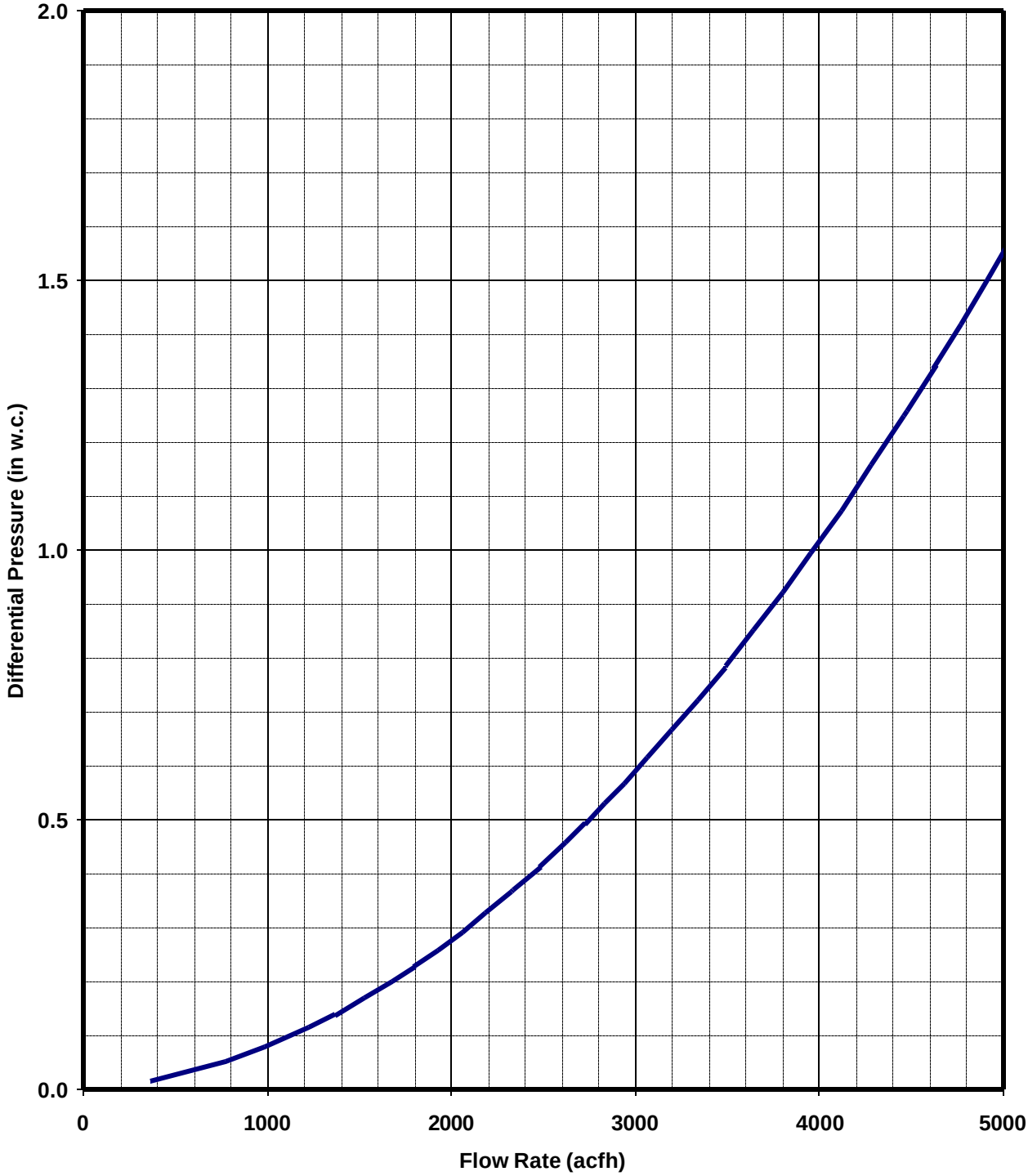


Figure 5.2 3" Dattus fM2 at Atmospheric Conditions

Differential Pressure Calibration Curves
2" Dattus fM2

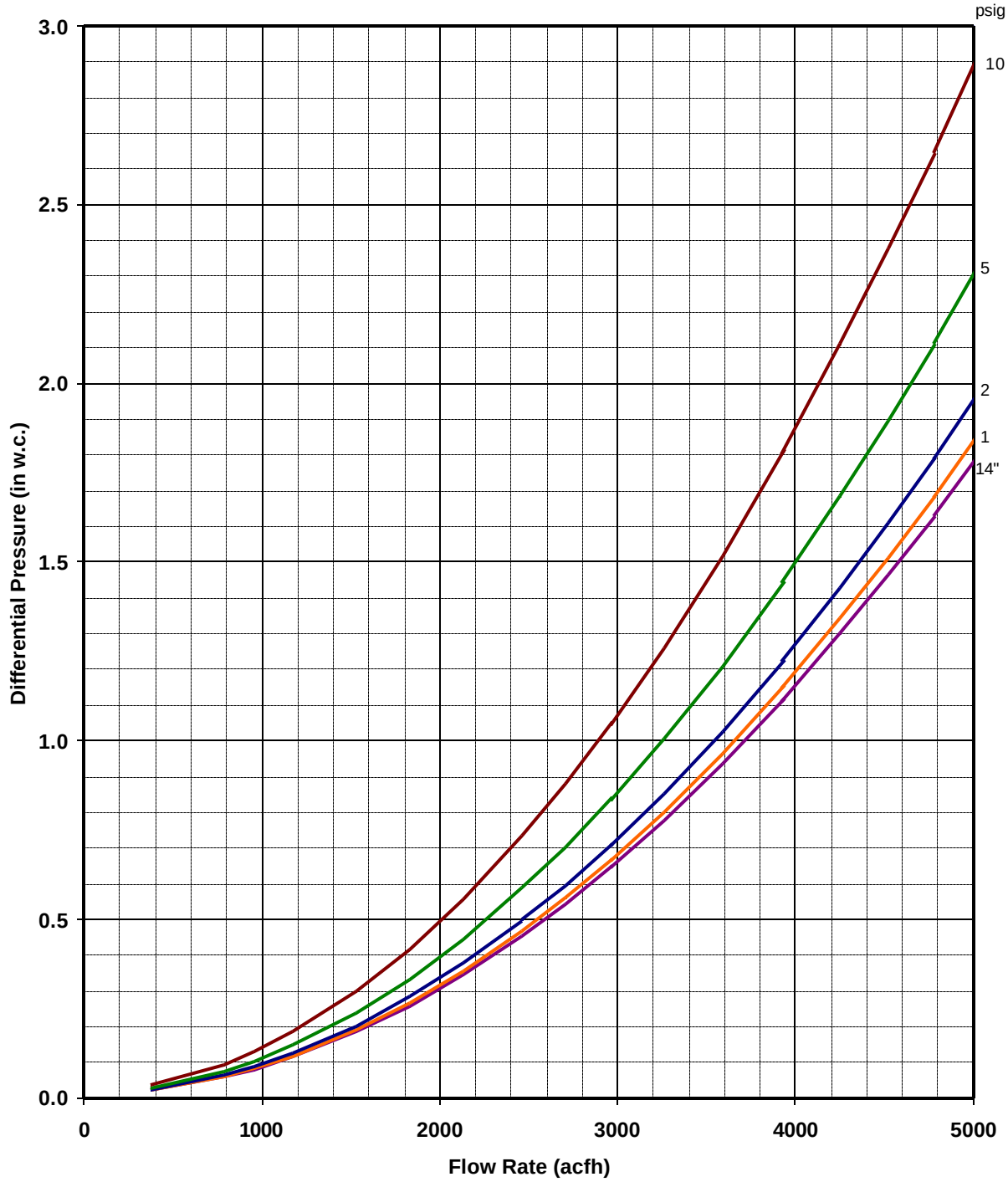


Figure 5.3 2" Dattus fM2 Up To 5,000 cfh Lower Pressures

Differential Pressure Calibration Curves
2" Dattus fM2

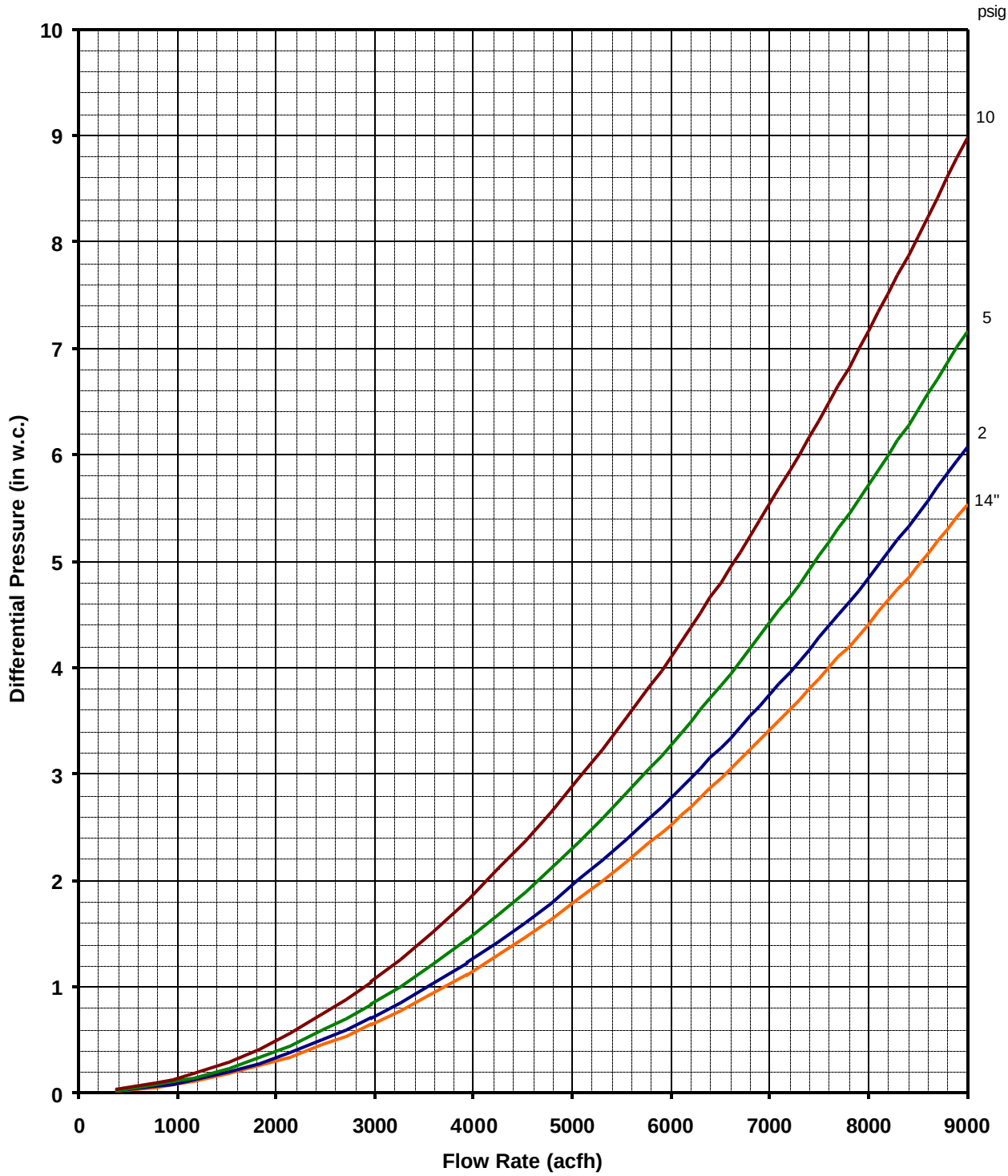


Figure 5.4 2" Dattus fM2
Lower Pressues

Differential Pressure Calibration Curves
2" Dattus fM2

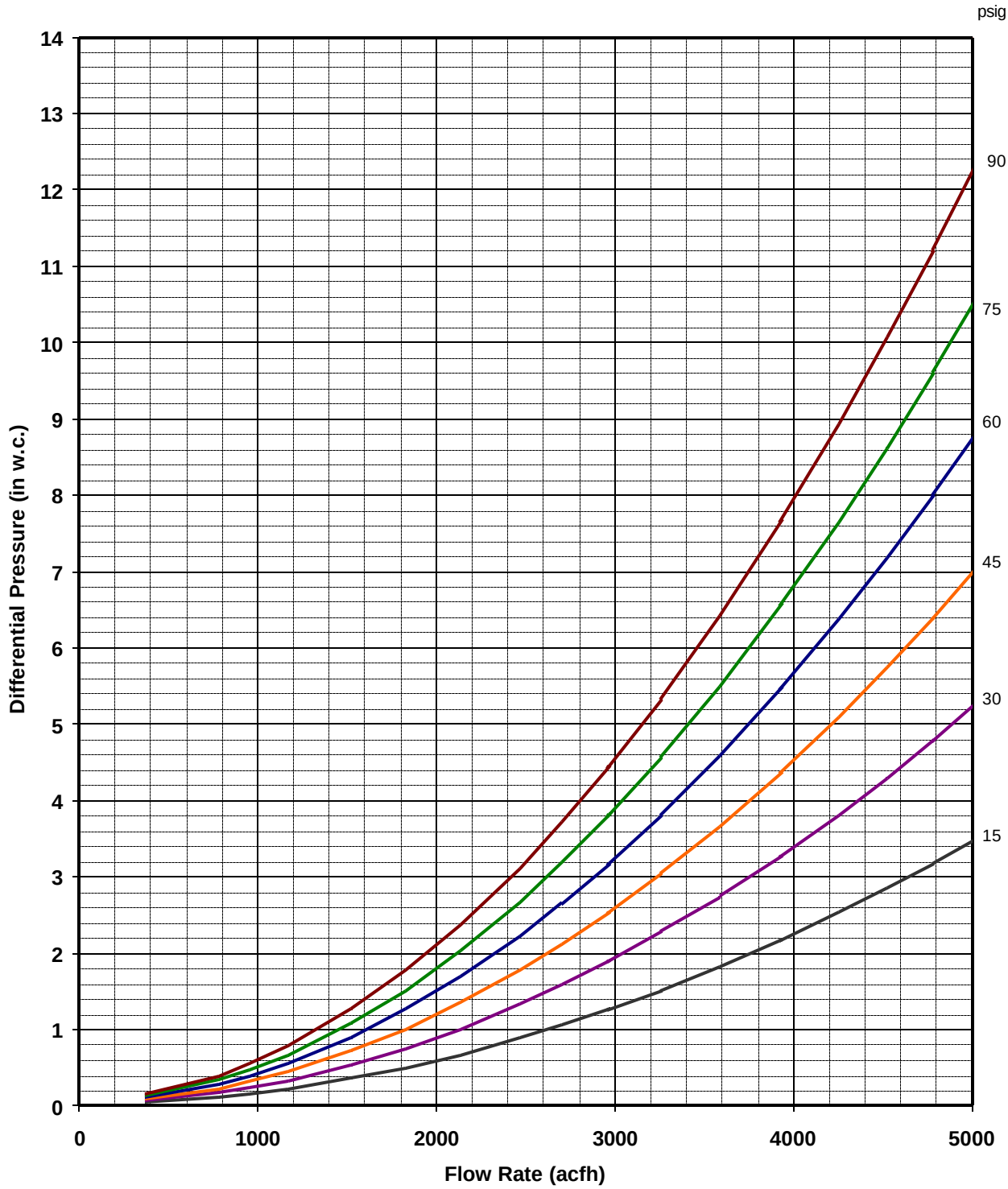


Figure 5.5 2" Dattus fM2 Up To 5,000 cfh
Higher Pressures

Differential Pressure Calibration Curves
2" Dattus fM2

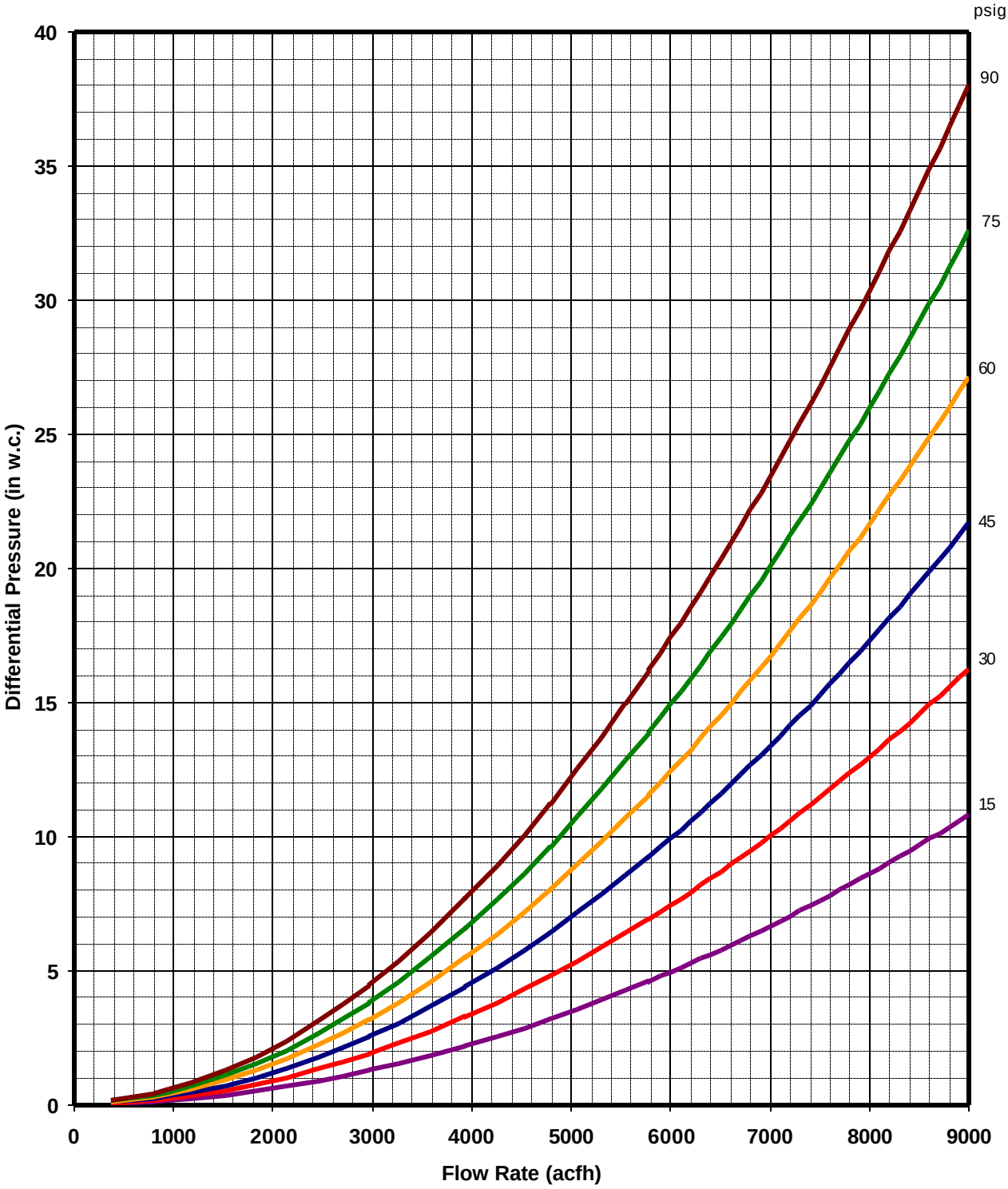


Figure 5.6 2" Dattus fM2
Higher Pressures

Differential Pressure Calibration Curves
3" Dattus fM2

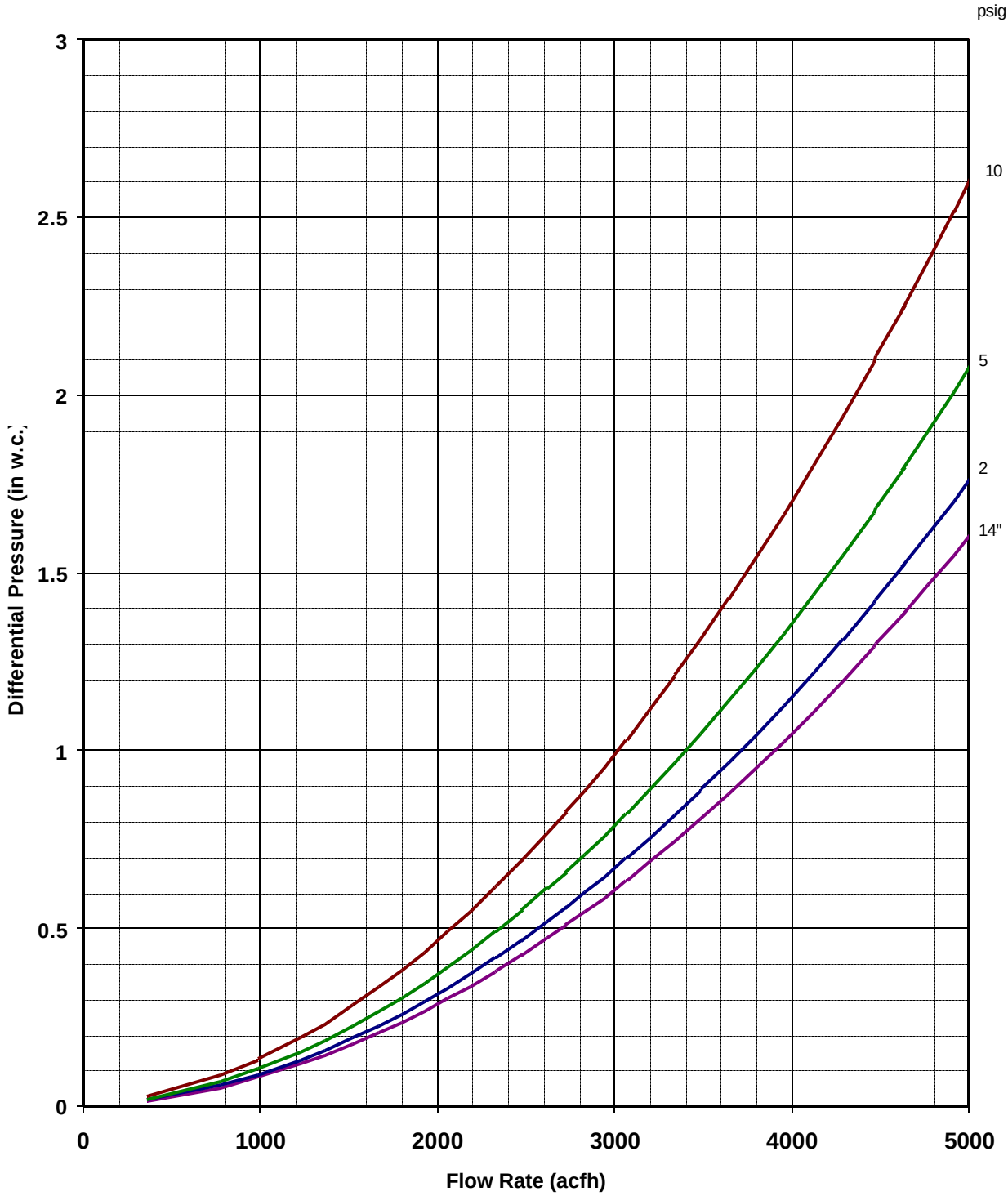


Figure 5.7 3" Dattus fM2 up to 5000 acfh
Lower Pressures

Differential Pressure Calibration Curves
3" Dattus fM2

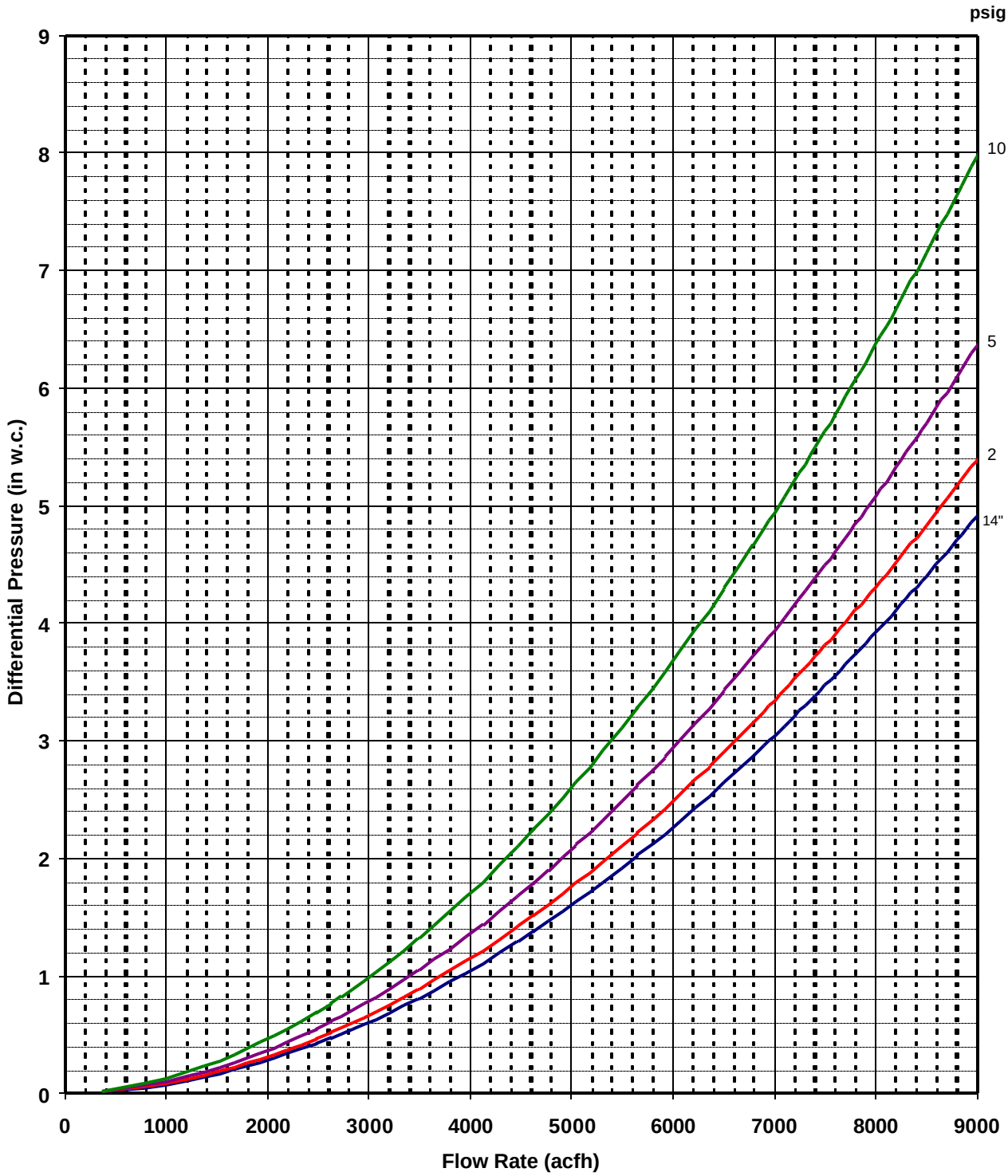


Figure 5.8 3" Dattus fM2
Lower Pressures

Differential Pressure Calibration Curves
3" Dattus fM

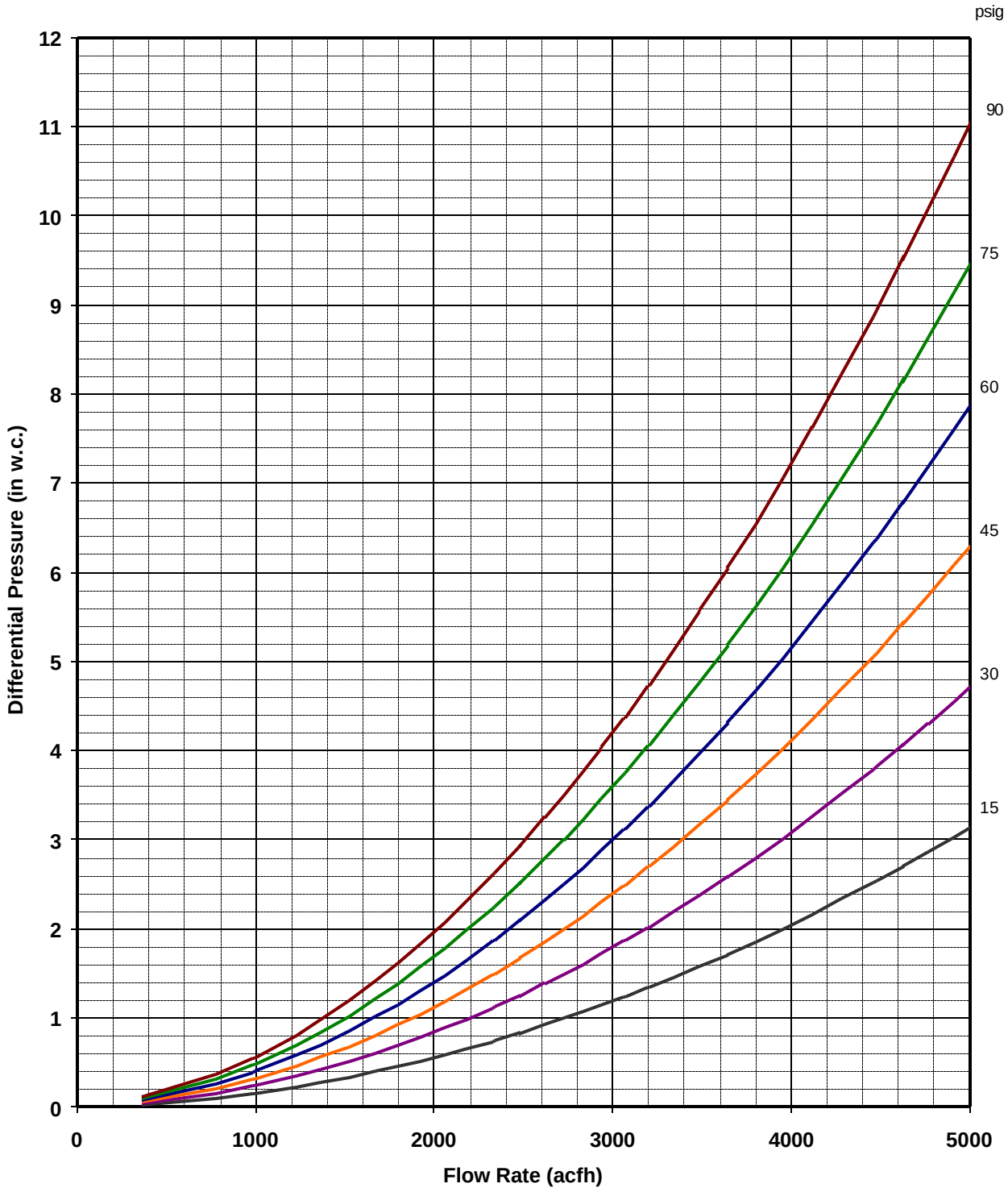


Figure 5.9 3" Dattus fM2 up to 5000 acfh
Higher Pressures

Differential Pressure Calibration Curves
3" Dattus fM2

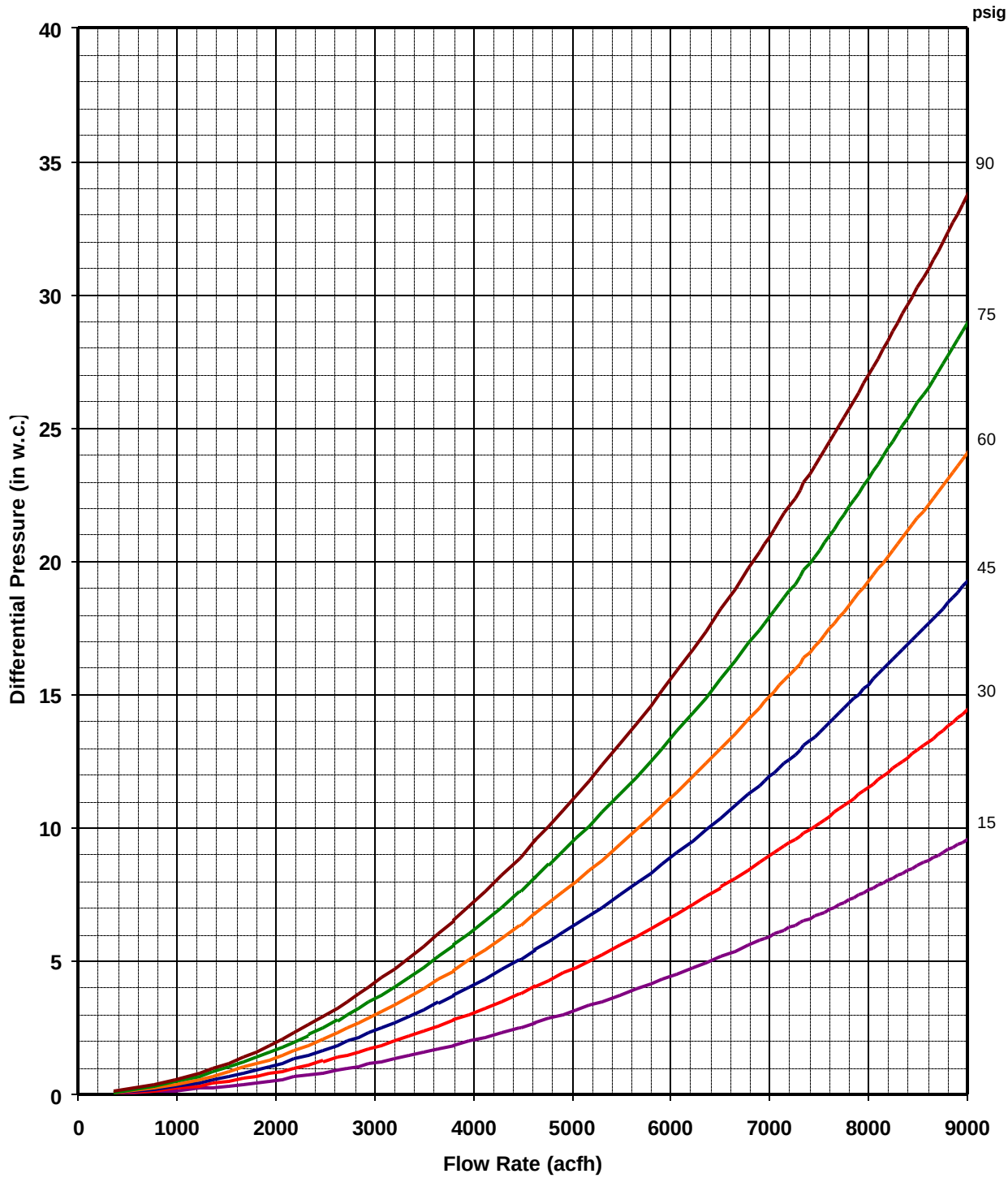


Figure 5.10 3" Dattus fM2
Higher Pressures

Chapter 6 - Temperature Calibration

This chapter of the *Dattus fM Meter Technical Reference Guide* provides general instructions on how to test and calibrate the temperature probe on the Dattus fM meter.

Temperature Probe Testing

Temperature probe testing involves applying one or more known reference temperatures to the meter temperature probe. If the meter temperature probe does not agree with the references, it must be adjusted using the PC Link configuration software, or replaced with another probe. (For details on replacing the probe, see Chapter *7, Maintenance*).

Materials List

- Magnetic wand
- Reference temperature source(s)
- Computer with PC Link calibration software
- 19/32-inch (15 mm) wrenches (2)
- Medium blade slotted screwdriver

Testing Procedures

1 Remove the external cover by loosening and removing two external cover mounting screws. (For additional details on removing the cover, refer to Chapter *3, Installation and Programming*).

2 Lift the cover away from the measuring unit.

3 Loosen the cable gland cap using two 19/32-inch (15 mm) wrenches. If necessary, use one wrench to loosen the nut while using the other wrench to prevent the base of the cable gland from also rotating.

4 Lift the probe up-and-out of the thermal well (see Figure 6.1). Place the temperature probe in the reference temperature source (see Figure 6.2).

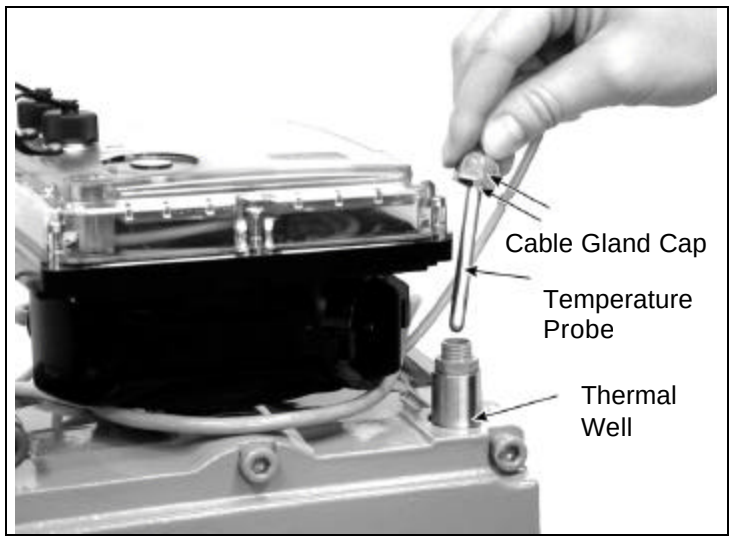


Figure 6.1 Removing the Probe from Thermal Well

Figure 6.2 Reference Temperature Source.

5 Attach the optical probe to both the computer and the meter.

6 Run the PC Link configuration software and select **Communications | Logon**.

7 Once communications are established with the meter, select **T Calibration**.

8 Type the reference pressure temperature in the appropriate window on the screen.

9 Click **Acquire** to read the meter temperature.

11 If a multiple point calibration is to be performed, repeat steps 8 and 9 at additional reference temperature points.

12 Click **Calculate** to determine calibration coefficients. To accept these new calibration factors click **Program**, other wise click **Cancel.**

13 Return the temperature probe to the thermal well making sure it is seated as deeply as possible and tighten its fastening nut.

14 Re-attach the external cover.

Chapter 7 - Maintenance

This chapter of the *Dattus fM Meter Technical Reference Guide* discusses processes needed to maintain the meter. The Dattus fM meter typically requires only minor scheduled maintenance routines such as replacing internal batteries.

In addition to battery replacement procedures, this chapter also provides information and instructions for replacing the index and replacing the temperature probe should it become necessary.

The Dattus fM meter contains several tamper seals to protect the unit against unauthorized access to its internal components. Make sure you have replacement seals readily available prior to performing the reassembly procedures described in this chapter. For seal ordering information, contact your Actaris Sales Representative.

Battery Replacement

When the battery alarm triggers (see Chapter *8, Alarms*), replace the batteries as soon as possible.

Two 3.6V lithium (D-Cell) batteries power the meter and are contained in a separate battery compartment inside the index housing (see Figure 7.1). To access the battery compartment, the external cover must first be removed.

The batteries run in parallel so that one old battery can be removed and a new battery installed before the second old battery is removed. This configuration maintains full meter functionality during the battery change.

The meter is also equipped with a back-up battery. It has a 3 month life. The back-up battery will prevent loss of power in the event both batteries are disconnected or if batteries have not been replaced promptly after appearance of a battery alarm.

To ensure the intrinsic safety of the device, use only batteries recommended by Actaris.

When replacing old batteries, verify the type, rating, and date code of the new batteries. Check the manufacture date to ensure that batteries are not older than twelve (12) months.

Replacing the Batteries

1. Remove the external cover by loosening and removing two external cover mounting screws. (For additional details on removing the cover, refer to Chapter 3, *Installation and Programming*).
2. Lift the cover away from the measuring unit, and locate the battery compartment access door (see Figure 7.1).
3. Rotate the index head as necessary to access the battery compartment.
4. Open the battery compartment access door by grasping the door handle and rotating the door counter-clockwise (see Figure 7.1).

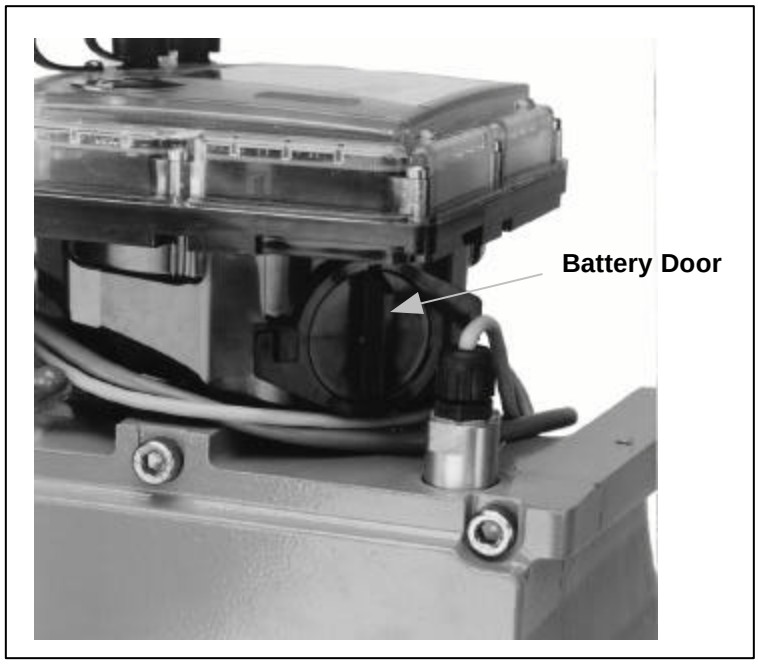


Figure 7.1 Battery Compartment Access

5. Remove the old batteries from the compartment.

- Disconnect the first battery and attach a fresh battery making sure the connectors snap securely in place (**Figure 7.2**). Repeat with the second battery.
- The meter will detect the presence of a battery on each connector and the lifetime counter will reset automatically. An event will be logged to indicate that the battery has been changed. At midnight on the day of the battery change, the lifetime counter will be adjusted.

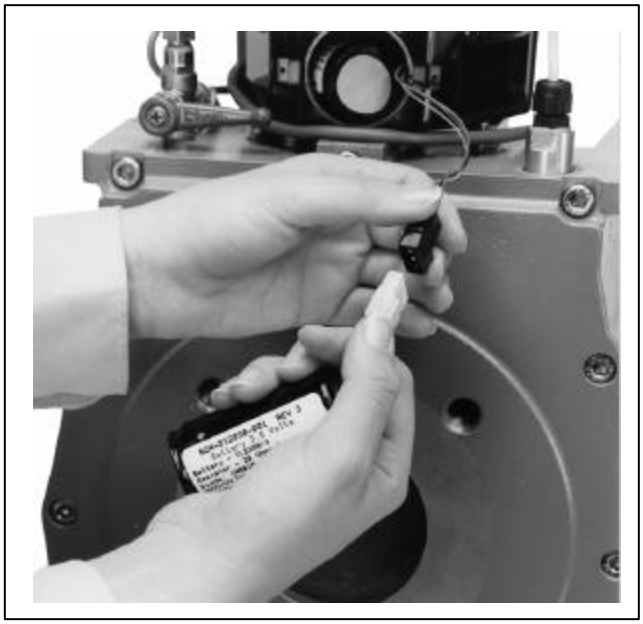


Figure 7.2 Connecting Batteries

6. Properly discard the old batteries.

The product you have purchased contains lithium batteries. The batteries are recyclable. At the end of their useful life, under various state and local laws, it may be illegal to dispose of these batteries into the municipal waste stream. Check with your local area solid waste officials for details about recycling options or proper disposal.

7. Re-insert the fresh batteries into the battery compartment (see **Figure 7.3**).

Figure 7.3 Inserting Fresh Batteries

If the battery alarm symbol does not disappear, refer to ***Chapter 9, Troubleshooting,*** for recommended corrective action.

8. Close the battery compartment door by pushing the door into the opening and rotating the door clockwise until it locks in place.
9. If applicable, refit a new tamper seal to the battery compartment.
10. Re-attach the external cover.

Index Head Replacement

From time to time it may be necessary to replace the index on a Dattus fM meter. The following procedure describes the necessary steps to perform this operation in the field.

Materials List

- Small flat-blade screwdriver
- External Snap Ring Pliers
- Computer with PC Link configuration software installed

1. Remove the external cover by loosening and removing two external cover mounting screws. (For additional details on removing the cover, refer to Chapter 3, *Installation and Programming*).
2. Using a pointed device, remove the red security seal. **See Figure 7.4.**

Figure 7.4 Security Seal Removal

3. Using a small standard screwdriver, back out the 8 screws around the perimeter of the index cover and the 1 screw behind the red security screw removed in the previous step. These screws will not fall out, as they are captive in the cover. **See Figure 7.5.**

Figure 7.5. Loosen Index Cover Screws

4. Unplug the backup battery cable/connection on the board. Next unplug the main battery cable. **See Figure 7.6**

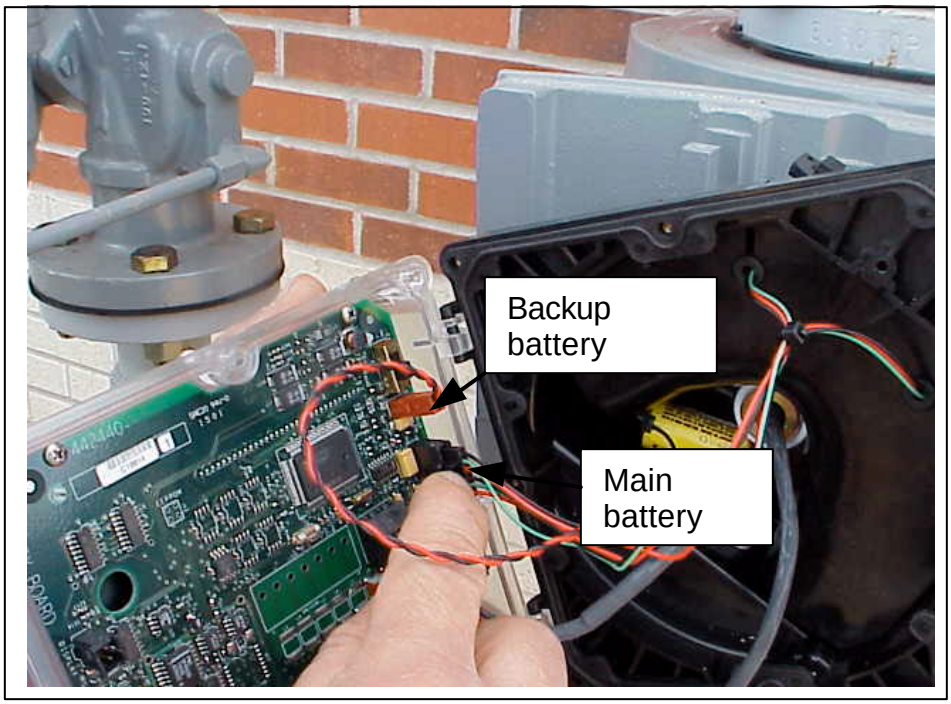


Figure 7.6 Battery connections

5. Unplug the two sensor connectors. **See Figure 7.8**

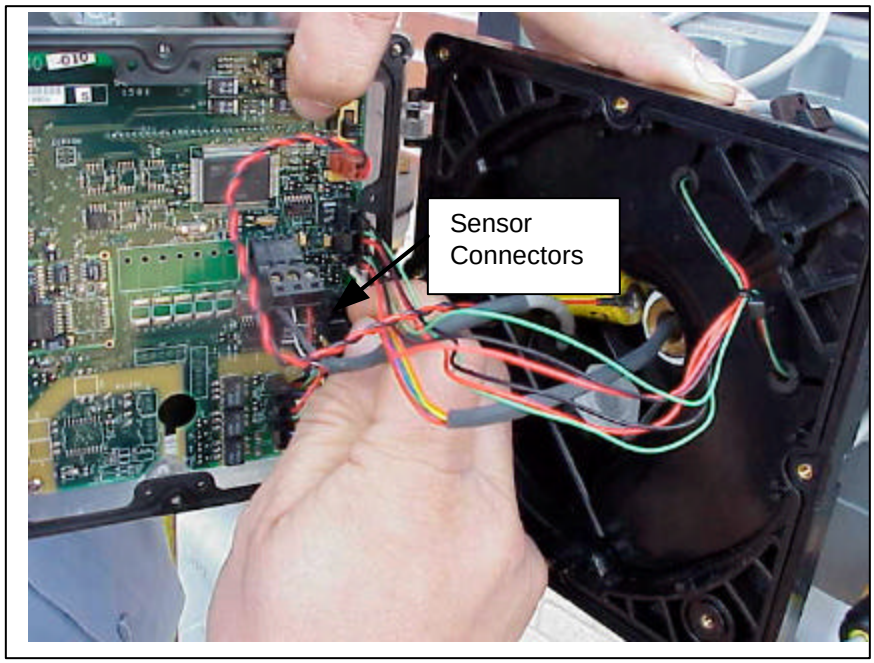


Figure 7.8 Sensor Connections

6. If the Dattus fM meter is equipped with a temperature probe for Electronic Temperature Compensation, remove the probe from the thermal well as shown in **Figure 7.7**

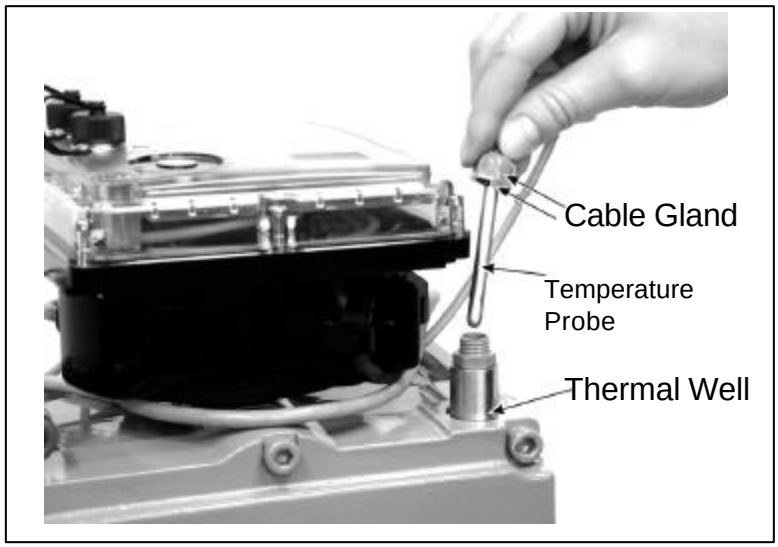


Figure 7.7 Temperature Probe Removal

7. Using a pair of retaining ring pliers with a .038" tip, remove the ring holding on the head unit. **See Figure 7.8**

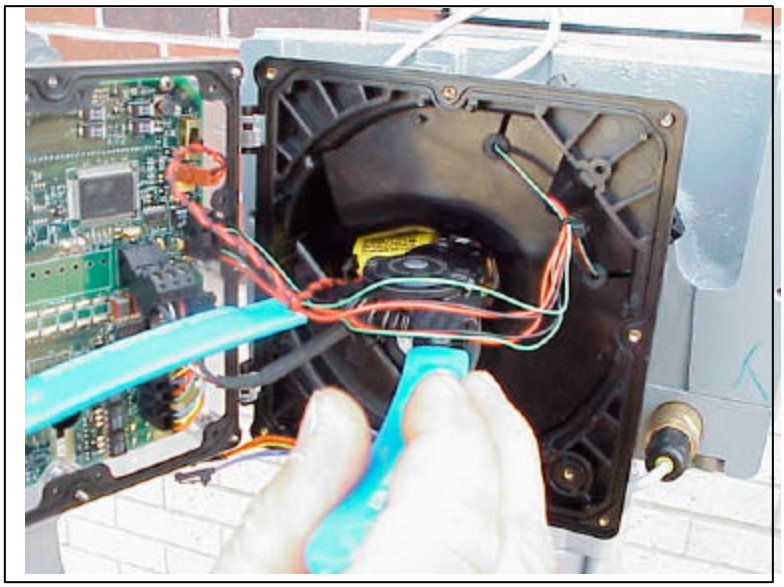


Figure 7.8 Retainer Ring Removal

8. Remove the Teflon washer exposed by removal of #7.

9. Lift off the index head, carefully pushing wires through opening in bottom of the head. **See Figure 7.9**

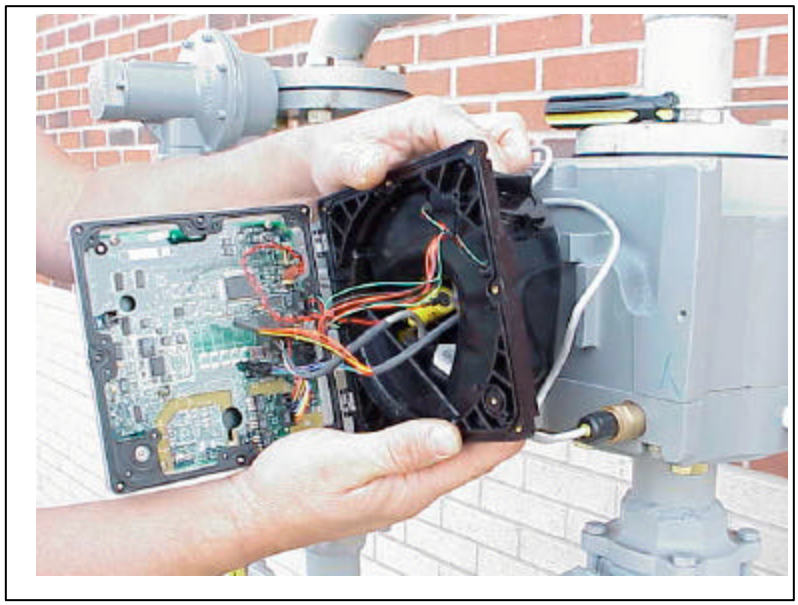


Figure 7.9 Remove Index

10. Look to ensure there is a large Teflon washer on the meter side of the housing and that the blue “O” ring is still in tack on the brass connection shaft. **See Figure 7.10**

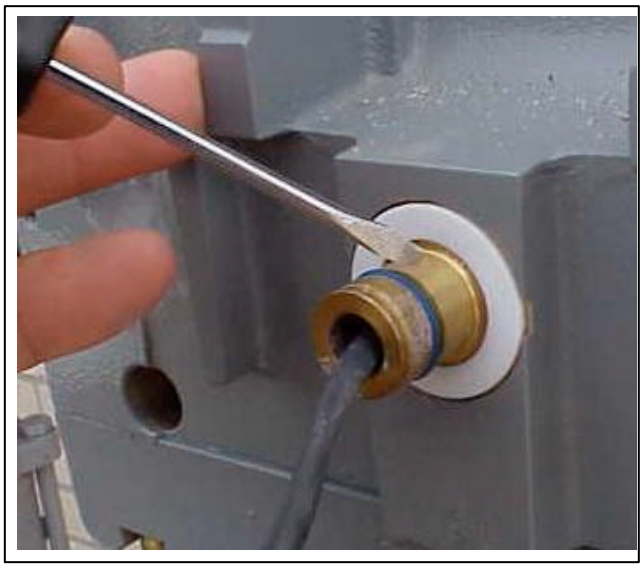


Figure 7.10 Brass Index Connection

11. Place the new head on over the brass connector, onto the large white Teflon washer on the meter housing.

12. Replace the top Teflon washer over the meter housing shaft on the new index housing and Install retaining ring to secure the new index head to the meter. **See Figure 7.11**

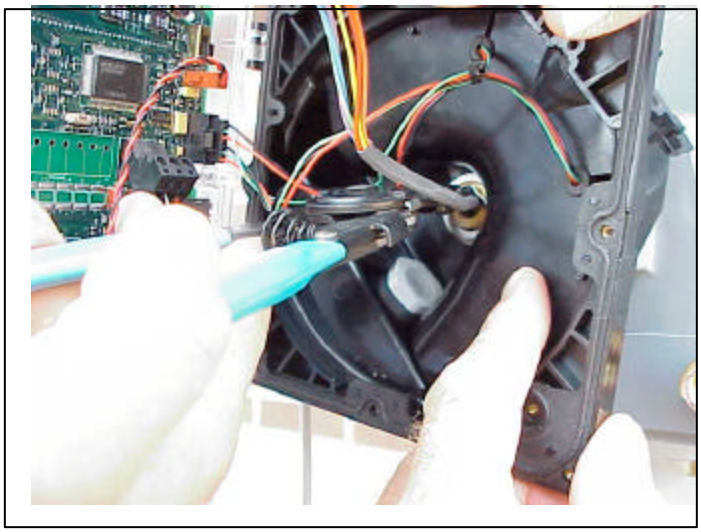


Figure 7.11 Snap Ring Replacement

13. Plug in meter sensors to new index (Connector with Orange/Yellow replaced closest to battery connection) board. **See Figure 7.12**

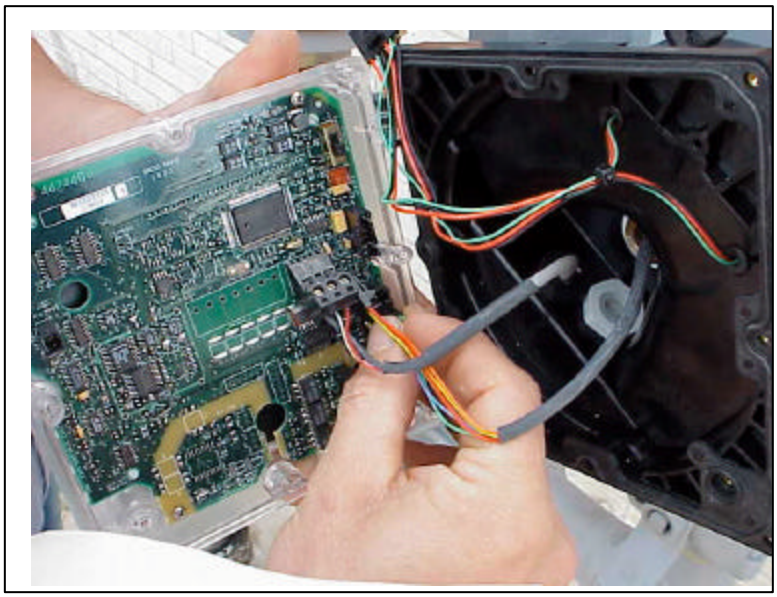


Figure 7.12 Sensor Connection

14. Plug the main Battery cable/connection on the board of the new head. Next plug in the back-up battery cable. The index will count down/Reset.
15. Place new desiccant bag in the new index head. **See Figure 7.13**

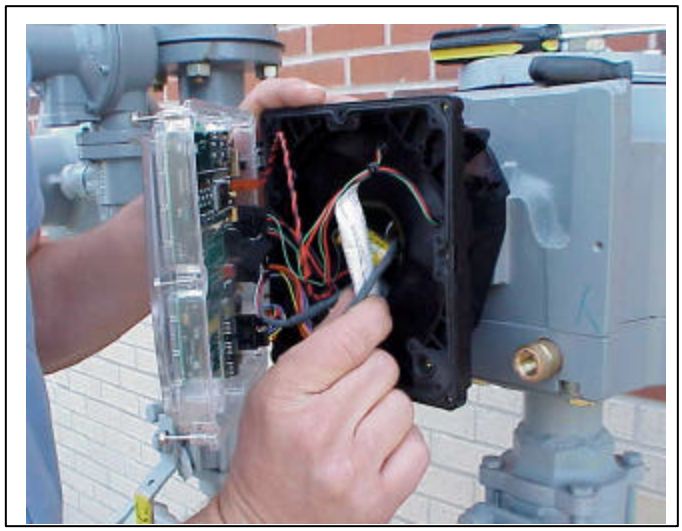


Figure 7.13 Desiccant Replacement

16. Close the lid while ensuring no cables are caught between the lid, seal and housing. If seal came loose during opening, push seal back onto guide tabs. Tighten the 8 outer screws and the one placed behind the red security seal (9 Total). Insert Red security seal into index face. See Figure 7.14.

Figure 7.14 Security Seal Replacement

17. If ETC version, insert RTD into meter housing and secure gland onto connection with wrench. Orient head, tuck RTD wiring in place around new head and prepare for cover.
18. Replace meter cover and fasten with 2 Phillips-head screws.
19. Reset meter alarms using PC Link Configuration software. **(Communication / Device Rests).**

Temperature Probe Replacement

Very few events ever occur that require replacing a temperature probe. However, probe failure as indicated by persistent and unresolved alarm indications may require a replacement:Should either of thisoccur and replacement be necessary, refer to the following procedure.

To replace the temperature probe, you will need the following materials:

Materials List

- Small flat-blade screwdriver
- 5/8 inch (15 mm) open-end wrench
- 19/32 inch (15 mm) wrench (2)
- Computer with PC Link configuration software installed

1. Remove the external cover by loosening and removing two external cover mounting screws. (For additional details on removing the cover, refer to Chapter 3, *Installation and Programming*).
2. Lift the cover away from the measuring unit, and locate the temperature probe assembly.

Do not loosen the resident portion of the probe cable gland that is mounted to the base of the meter. Use an additional 5/8-inch (15 mm) open-end wrench to hold the base nut in place while loosening the cable gland cap nut.

3. Loosen the temperature probe cable gland cap nut on the outside of the index housing (see Figure 7.15) using a 5/8-inch (15 mm) open-end wrench.

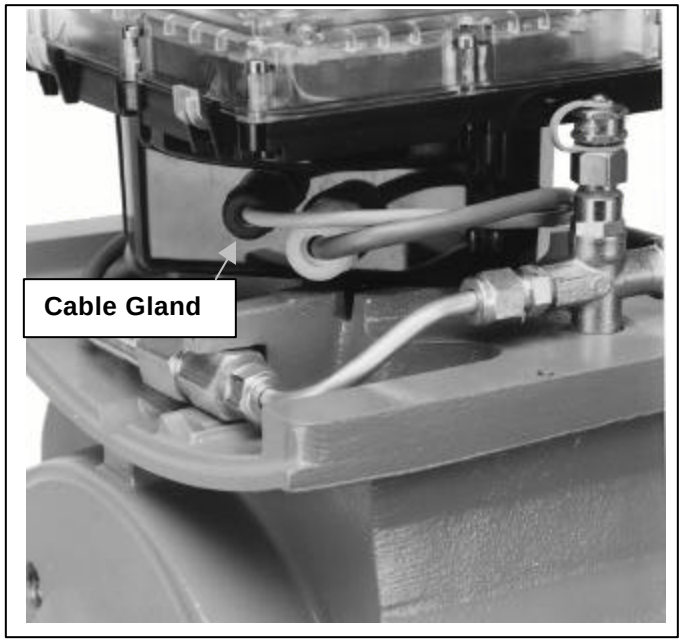


Figure 7.15 Temperature Probe Cable Gland

4. Open the index housing by loosening and removing its nine (9) slotted screws (see Figure 7.16).

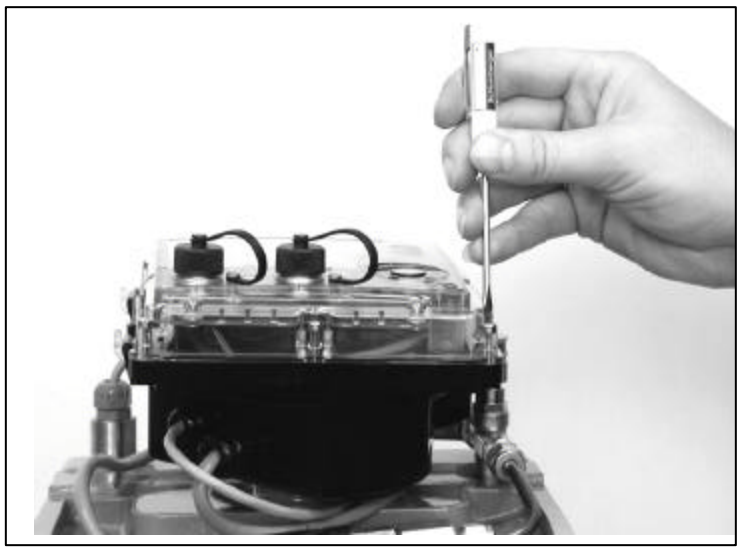


Figure 7.16 Opening the Index Housing

5. Identify and remove the temperature probe connector from the index board socket (see Figure 7.17).

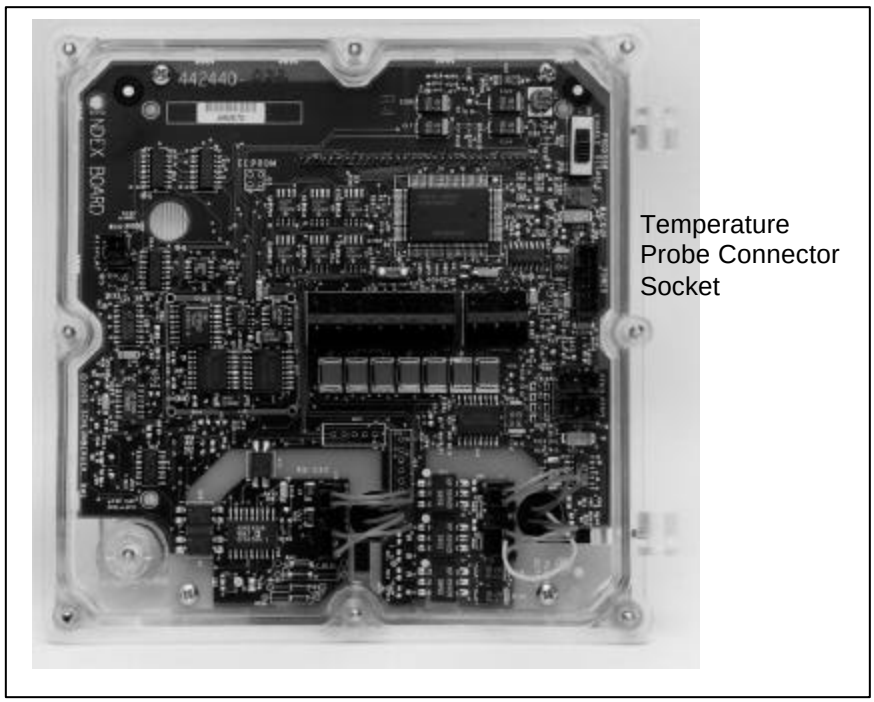


Figure 7.17 Temperature Probe Connector on Index Board

6. With a small flat-head screwdriver, loosen each of the three-wire terminal screws and remove the wires from the connector.

7. Remove the old probe from the thermal well by loosening its fastening using two 19/32 inch (15 mm) wrenches. If necessary, use one wrench to loosen the nut while using the other wrench to prevent the base of the thermal well from also rotating.

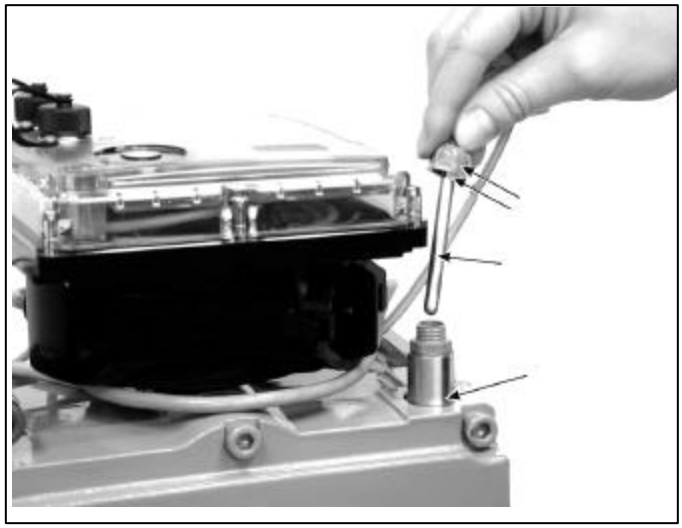


Figure 7.18 Removing Probe from Thermal Well

8. Pull the temperature probe cable through the cable gland on the index housing.
9. Pull the new probe cable through the cable gland.
10. Connect the three wires to the screw terminals according to color scheme shown in Figure 7.19 and Table 7.10.

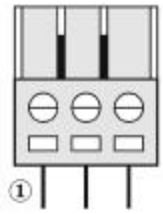


Figure 7.19 Temperature Probe 3-Terminal Connector (Top View)

Table 7-10 Temperature Probe Connector Wire Colors

Terminal No.	Wire Color
1	Shield
2	White
3	Red

11. Snap the temperature probe connector to the system board.
12. Tighten the probe cable gland fastening nut around the cable and then 1/2 turn.
13. Reset any alarms using the PC Link configuration software.
14. Verify that no alarm indication appears on the meter display.

If the alarm indicator appears, refer to ***Chapter 8, Alarms***, and ***Chapter 9, Troubleshooting,*** for details on identifying and correcting problems indicated by alarm messages.

15. Place the new temperature probe as deeply as possible into the thermal well and tighten its fastening nut.
16. Close and fasten the index housing.
17. Re-seal the index housing (if required).
18. Re-attach the external cover.

Chapter 8 - Alarms

This chapter of the *Dattus fM Meter Technical Reference Guide* provides details on the possible alarms generated by the meter.

Alarm Operation

As a result of detecting an alarm condition, the Dattus fM meter display shows an alarm symbol (see Figure 8.1) that remains active until the alarm is no longer valid.

The nature of the alarm can be further defined by viewing alarm codes on the display. Figure 8.1 represents a sample display where the left-hand side shows the code number of the *current* alarm, and the right-hand side the *stored* code number. Stored numbers represent all alarm events that have occurred since the last time alarm memory was reset.

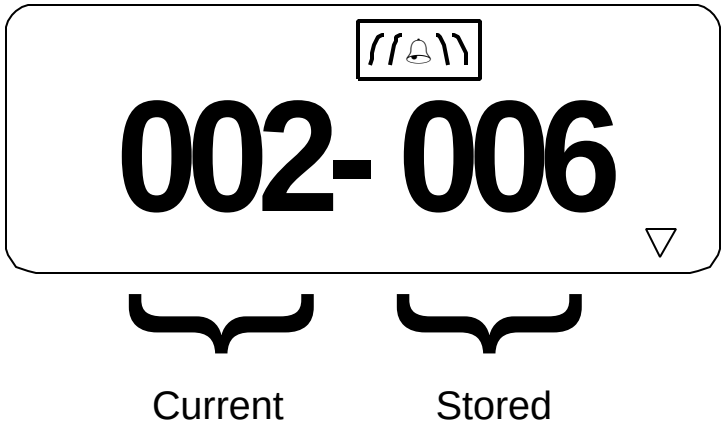


Figure 8.1 Displayed Alarm Codes

If the user prefers the alarm symbol and code not appear on the display, it may be turned off for individual events using PC Link confguration software under **Dattus Parameters/ Alarms**.

The Dattus meter records ***all*** alarm code occurrences in an event log that is accessible using PC Link configuration software. Alarm memory can be reset using the software.

Alarm Causes

The meter manages the following alarm types:

- Temperature probe failure
- Uncorrected flow rate exceeded maximum for more than 20 seconds
- Batteries need to be replaced
- Oscillation sensor warning
- Oscillation sensor(s) failure
- Oscillation sensor (s) contamination

Current vs. Stored Alarms

Current alarm codes appear on the display as long as the source of the alarm persists. However, once the cause of the alarm is resolved, the current alarm automatically resets, and the alarm code disappears from the left side of the display.

The Alarm symbol also remains on the display when an alarm event has been stored in memory but has not yet been reset.

Alarms are automatically stored and remain in memory until the alarms are reset. However, the alarm event will remain recorded in the Event Log.

Alarm Consequences

There are three levels of consequence, depending on the type of problem detected and the likely impact on uncorrected data. Problems that will affect the accuracy of the metrology are classified as Metrological Alarms. Problems that could render the meter non-operative are classified as Critical. Alarm conditions that may indicate a problem with the installation, violation of contract terms, or may be indicative of a more substantial problem in the future are classified as Normal alarms.

Normal Alarm Consequences

When normal alarms are detected, the alarm code is available on the display. The alarm icon is shown if so programmed, and the alarm output is activated if so programmed. The alarm is entered in the event log. The meter will continue to operate normally during this alarm since there should be no effect on accuracy of the meter.

Critical Alarm Consequences

When a Critical Alarm is detected, the alarm code is available on the display. The alarm icon is shown if so programmed, and the alarm output is activated if so programmed. The alarm is entered in the event log. In addition, special steps are taken to preserve the integrity of the meter for as long as possible.

If there is a sensor error, the screen locks and displays SEn-Err. The alarm codes are therefore not available on the display but local communication is still active.

Metrological Alarm Consequences

When a metrological alarm is detected, the same steps are take to indicate the alarm as mentioned above, and the meter stops incrementing the Corrected Volume register. The Volume under Alarm conditions register is incremented so that a bill can be estimated based on the best information available.

Alarm Codes

Table 8-2 lists the alarm codes and their consequences.

Table 8-2 Alarm Codes and Consequences

Code	Type	Consequence
1	Temperature alarm	Metrological
4	Flow rate alarm	Normal
8	Battery alarm	Critical
16	Oscillation sensor warning	Normal
32	Oscillation sensor failure	Critical
64	Oscillation sensor contamination	Normal (Critical after 24 hours)

A single code number may at times represent multiple alarm types occurring simultaneously. For example, Code 9 represents a combined temperature and battery alarm.

Table 8-3 Alarm Codes

Code	Temperature Alarm (1)	Flow Rate Alarm (4)	Battery Alarm (8)	Oscillation Sensor Warning (16)	Oscillation Sensor Failure (32)	Oscillation Sensor Contamination (64)
1	X					
4		X				
5	X	X				
8			X			
9	X		X			
12		X	X			
13	X	X	X			
16				X		
17	X			X		
20		X		X		
21	X	X		X		
24			X	X		
25	X		X	X		
28		X	X	X		
29	X	X	X	X		
32					X	
33	X				X	
36		X			X	
37	X	X			X	

40			X		X	
41	X		X		X	
44		X	X		X	
45	X	X	X		X	
48				X	X	
49	X			X	X	
52		X		X	X	
53	X	X		X	X	
56			X	X	X	
57	X		X	X	X	
60		X	X	X	X	
61	X	X	X	X	X	
64						X
65	X					X
68		X				X
69	X	X				X
72			X			X
73	X		X			X
76		X	X			X
77	X	X	X			X
80				X		X
81	X			X		X
84		X		X		X
85	X	X		X		X
88			X	X		X
89	X		X	X		X
92		X	X	X		X
93	X	X	X	X		X
96					X	X
97	X				X	X
100		X			X	X
101	X				X	X
104			X		X	X
105	X		X		X	X
108		X	X		X	X
109	X	X	X		X	X
112				X	X	X
113	X			X	X	X
116		X		X	X	X
117	X	X		X	X	X
120			X	X	X	X
121	X		X	X	X	X
124		X	X	X	X	X
125	X	X	X	X	X	X

Temperature Alarm

The meter triggers a temperature alarm when it detects a non-acceptable reading from the temperature probe.

The temperature alarm is updated every 20 seconds whenever temperature measurements are made.

Display

The meter displays the following information during a temperature alarm. However, all of this information is viewable in PC Link (**Dattus Parameters/ Alarms)** if it is not on the display.

- a reading of *999.9* if there is no accepted measurement
- correction factor displayed (00.0000).
- an alarm symbol (if so programmed) and code

Consequence

- The method of storing data changes:
  - The corrected volume index stops accumulating during the alarm.
  - The value of the corrected and uncorrected volume index when the alarm appeared are stored in non-volatile registers along with the alarm code.
- The pulse output of corrected volume stops while the alarm is active.
- The alarm pulse output is activated (if so programmed) and remains active for a duration of 20 minutes unless the source of the alarm disappears. The last alarm to appear resets the 20 minute counter.

Flow Rate Alarm

The flow rate alarm that applies only to *uncorrected* volume activates if the uncorrected volume flow rate is greater than the maximum flow rate. The flow rate alarm triggers after 20 seconds of continuously exceeding the programmed maximum threshold (Q_{max}).

Display

The meter displays the following information during a flow rate alarm:

- Alarm symbol and code (if so programmed)

Consequence

- The alarm pulse output is activated (if so programmed) and remains active for 20 minutes unless the source of the alarm disappears. The last alarm to appear resets the 20-minute counter.
- There is no effect on storage.

Battery Alarm

The basic meter has a typical battery life of 10 years (3,650 days). This is decremented each day until it reaches 90 (or another programmable value) days from the theoretical end of the battery life where

the alarm is then activated. Additionally, if the battery voltage falls to less than 2.0V, this alarm is activated. The battery alarm is triggered either by the life-time counter that is decremented at midnight each day, or if the battery voltage falls below the accepted minimum.

Display

The meter displays either of the following information during a battery alarm (if so programmed):

- "Lo Bat" appears on the index, if so programmed.
- Alarm codes 008 appear, if so programmed.

Consequence

- The alarm output is activated and remains active for 20 minutes. The last alarm to appear resets the 20-minute counter.
- The output pulses if programmed will be disabled.
- There is no effect on the indexes
- The alarm condition will not reset itself even if the battery voltage recovers to above the threshold, 2.0V.

On changing the battery, the counter is reset to 3,650 (days) at midnight if two batteries are present or 1,825 (days) if only one battery is present.

Oscillation Sensor Diagnostics

The sensor alarm will be triggered if the oscillation sensors become unbalanced, including, open circuit. The active sensors are verified each hour, backup set is verified each day (at midnight). If there is an error with either the primary or backup, the sensor warning will be set. If the remaining sensor gives an alarm, then the sensor failure alarm is set.

The primary sensor is evaluated for contamination each day. If the primary sensor is evaluated to be contaminated, then the test is done every hour. If the contamination persists for 24 hours, then the critical alarm is set.

Consequences

Sensor Warning

- Continue to accumulate uncorrected volume (Vm) and corrected volume (Vc).
- Display alarm code 16
- Pulse outputs continue

- Alarm output is triggered
- Event log entry is set

Sensor Failure

- Registration stops in all registers
- LCD index locked to display “SenErr”
- Pulse output stops
- Alarm output set
- This alarm can not be reset
- Event in the event log

Sensor Contamination

- Registration stops in all registers
- Display alarm code 064
- Pulse output stops
- Alarm output set
- Event in the event log

Resetting Alarms

Current alarms automatically reset themselves as soon as the cause of the alarm ceases.

Stored alarms can only be reset by programming the meter memory with PC Link configuration software. (**Communications / Device Resets).**

The alarm symbol on the display remains visible whenever the meter contains a stored alarm event.

With current alarms, the stored alarms cannot be reset until the source of the alarm has been properly addressed.

Chapter 9 - Troubleshooting

This chapter of the *Dattus fM Meter Technical Reference Guid*e provides information on how to quickly and effectively isolate and resolve typical problems that may be encountered while operating the meter.

Table 9.1 provides a listing of common symptoms, possible causes and recommended corrective action. Refer to Chapter 8 for a detailed description of meter alarms and possible causes.

Table 9.1 Troubleshooting

Common Symptoms		
Temperature Alarm 999.9 Displayed as Temperature	Temperature probe malfunction.	Test the temperature probe in a reference bath(s); replace if necessary.
Flow Rate Alarm	Flow Rate exceeded the maximum programmed threshold.	Verify that the flow rate at the meter set does not exceed the maximum rated flow rate of the meter.
Oscillation Sensor Warning	Primary internal oscillation sensor has malfunctioned and the meter is now using the backup sensor: Sensors are damaged or defective.	Contact Actaris technical support.
Oscillation Sensor Failure	Primary & backup internal oscillation sensors have malfunctioned: Sensors are damaged or defective.	Contact Actaris technical support.
Oscillation Sensor Contamination Alarm	Primary or backup internal oscillation sensor is contaminated. Battery voltage falls below the accepted minimum for meter operation.	Contact Actaris technical support. Actaris will recommend the use of a filter in that meter site Replace with fresh batteries as soon as possible.
No Display on Meter	Batteries are dead.	Replace with fresh batteries.
Uncorrected Volume is Not Updating on the Display.	Batteries are dead. No gas flow Sensor Error Alarm	Replace with fresh batteries. Check the meter set Internal Fluidic Oscillations sensors have failed. Contact Actaris Customer Service.

Corrected Volume is Not Updating on the Display.	Temperature Alarm	Test the temperature probe in a reference bath(s); replace if necessary.
	Batteries are dead.	Replace with fresh batteries.
	No gas flow	Check the meter set.
No Uncorrected Volume Pulse Generation	Pulse output is not configured.	Program pulse output.
	The wrong pulse output channel is configured.	Check channel pulse output setting using PC Link configuration soft-ware.
	Batteries are dead.	Replace with fresh batteries.
	Pulse Output cable is not correctly connected to meter or external pulse accumulator	Verify meter connection and wiring.
No Corrected Volume Pulse Generation	Pulse output is not configured.	Program pulse outputs.
	The wrong pulse output channel is configured.	Check channel pulse output setting using PC Link Configuration software.
	Temperature alarm	Verify Temperature Probe
	Pulse Output cable is not correctly connected to meter or external pulse accumulator	Verify meter connection and wiring.
Alarm Pulse Output is Not Generated	Alarm pulse output is not configured.	Program the meter's alarm pulse output. NOTE: The conditions that trigger alarm pulse output depend on how the meter is programmed.
	Pulse Output cable is not correctly connected to meter's External Connector	Connect pulse output cable to Dattus' External Connector #1.

Alarm Re-transmission Starts		Note: Conditions that trigger alarm pulse output depend on how the meter is programmed.
	Temperature probe malfunction	Test the temperature probe in a reference bath(s); replace if necessary.
	Flow Rate exceeded the maximum threshold.	Verify the flow rate at the meter set does not exceed the meter's maximum rated flow rate.
	Battery voltage falls below the accepted minimum for meter operation.	Replace with fresh batteries as soon as possible.
No Optical Communication	Optical communication probe is in the wrong position on the index housing.	Modify the orientation of the probe. The probe cable should be placed between the two raised position indicators in the index cover, at approximately the 6 o'clock position.
	Incorrect personal computer (PC) serial COM port is selected.	Make sure the PC serial COM port is properly configured.
	PC set up with another application using COM port (such as palm pilot).	Deactivate application and re-boot.

Appendix A - External Connections

This appendix of the *Dattus fM Meter Technical Reference Guide* provides technical details for the meter's pulse output connections (see Figure A.1).

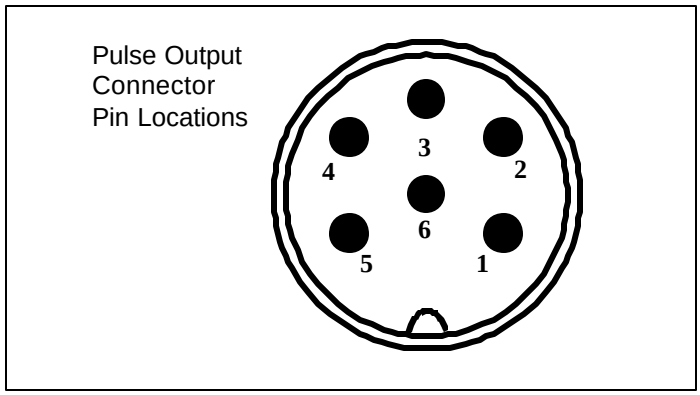


Figure A.1. Pulse Output Connector Pin Locations

Figure A.2 shows a schematic of the pulse output cable with its pin locations.

Pin	Channel	Wire Color
1	Alarms Positive	White
2	Channel 2 - Positive	Black
3	Channel 1 - Negative	Green
4	Channel 2 & Alarms - Negative	Orange
5	Channel 1 - Positive	Red
6	Not used	

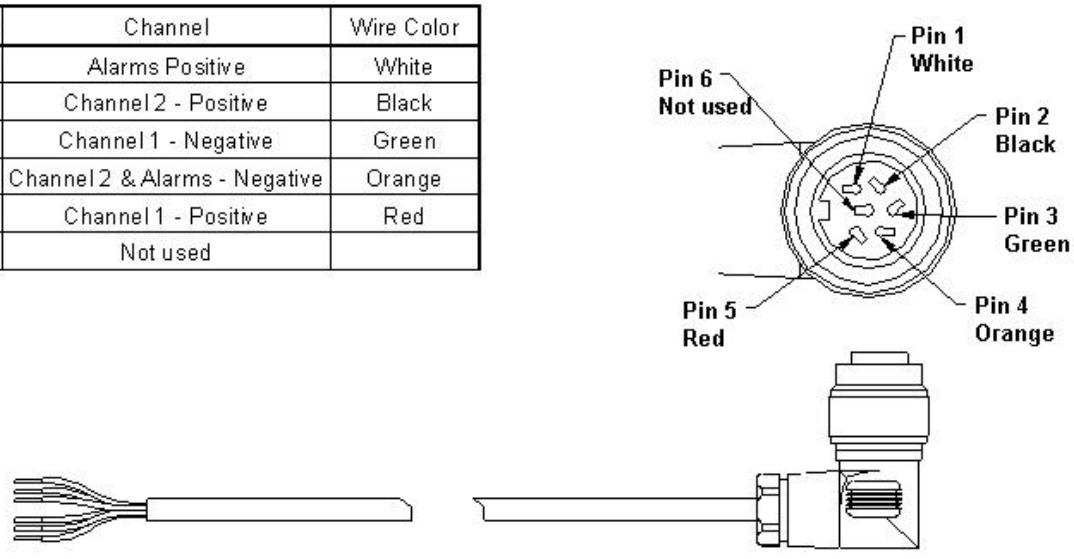


Figure A.2. Pulse Output Cable

Electrical Connection for Pulse Output.

This schematic assumes that there is a connection between the ground of the power supply and the ground of the scada unit. Sometimes it is just not possible to separate these two grounds. The Dattus will accept floating ground connection.

Global connection:

- The negative of the Scada unit is connected to the negative of the power supply
- The positive of the same power supply is connected to the negative of the Dattus
- The positive of the Dattus is directly connected to the positive of the Scada unit

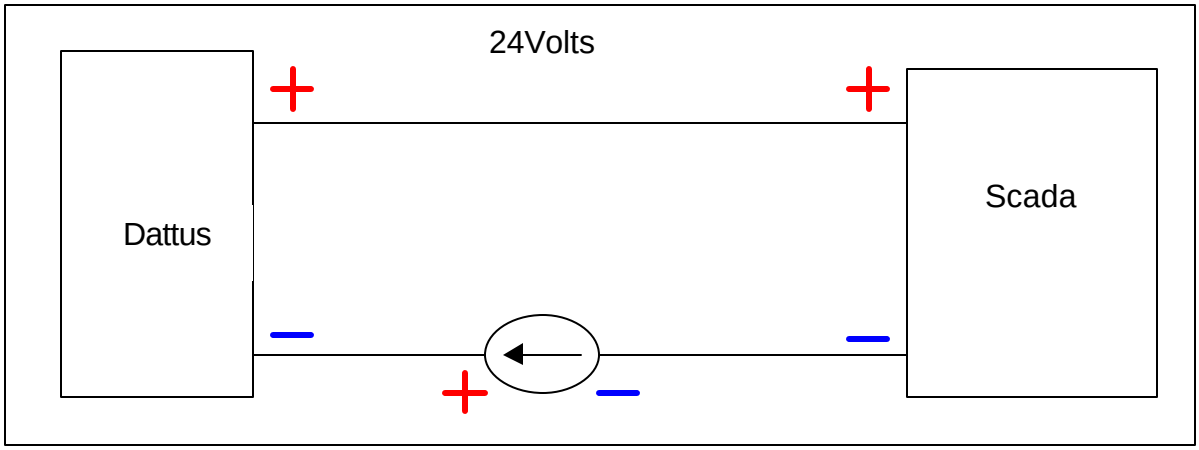


Figure A.3. Dattus to Scada Connection Schematic

Dattus Pulse Output Electrical Schematic

- The resistor (R) limits the current to avoid a destructive short on the output.
- The zener diode (D) protects the pulse output from reverse current.

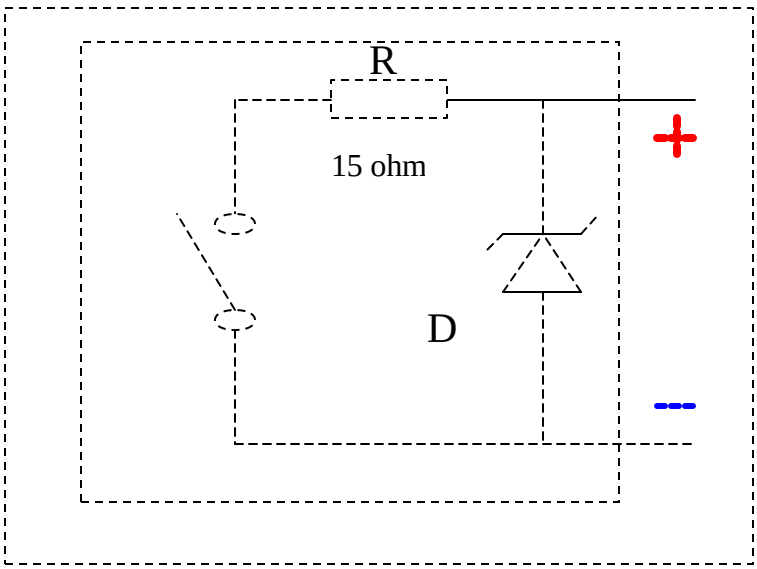


Figure A.4. Pulse Output Electrical Schematic

Glossary

Term	Definition
% Accuracy	The ratio of the volume registered by the meter divided by the volume registered by the reference multiplied by 100. % Accuracy = (meter volume / reference volume) x 100
% Error	The ratio of the volume registered by the meter minus volume registered by the reference divided by the reference volume multiplied by 100 % Error = {(meter volume- reference volume) / reference volume} x 100
% Proof	The ratio of the volume registered by the reference divided by the volume registered by the meter multiplied by 100 % Proof = (reference volume /meter volume) x 100
Absolute Pressure	Atmospheric pressure plus gauge pressure; abbreviated as psia. Absolute pressure is used in all gas law equations.
Absolute Temperature	That temperature obtained in degrees Rankin by adding 459.67 to a reading of a Fahrenheit thermometer, or in degrees Kelvin by adding 273.15 to that of a Celsius thermometer reading. °R = 459.67 + °F K = 273.15 + °C
Absolute Zero	Temperature at which all molecular movement stops (0°R).
Accuracy Curve	Graphical expression of accuracy of a meter as a function of flow.
ACFH	Actual cubic feet per hour. The meter reading without pressure, temperature, or compressibility correction.
Ambient Temperature	The temperature of the atmosphere surrounding the equipment or area.
Atmospheric Pressure	Measure of the weight of the earth's atmosphere at a given place and time. At sea level, atmospheric pressure is approximately 14.696 psia.
Base Conditions	The standard base conditions of pressure and temperature for the volumetric measurement of natural gas. ANSI/API 2562-1969 has established 14.73 psi as the base pressure, and 60°F as the base temperature, to which all volumes are commonly referred.
Base (Standard) Pressure	The standard base condition of pressure used for the volumetric measurement of natural gas. ANSI/API 2562-1969 has established 14.73 psia as the base pressure to which all volumes are commonly referred. Base pressure is normally defined in gas measurement contracts.
Base (Standard) Temperature	The standard base condition of temperature used for the volumetric measurement of natural gas. ANSI/API 2562-1969 has established 60°F as the base temperature to which all volumes are commonly referred.
Compressibility	In gas measurement, volume decreases when there is an increase in pressure. Compressibility (Z) is the variance from the ideal gas law behavior.
Correction Factor	Numerical factor (single constant or coming from a mathematical function) by which the uncorrected result of a measurement is multiplied to compensate for systematic error.
Differential Pressure	The difference in pressure (DP) between the inlet and outlet of a metering or

	regulating device.
Drift	Slow change of a metrological characteristic of a measuring instrument.
Energy	The capacity to do work/heat (measured in the same units as work). Energy may be transferred from one form into another.
Gauge Pressure	Measured pressure relative to atmospheric pressure taken as zero; abbreviated as psig. Measured pressure above atmospheric pressure.
Index	The device that displays the volume of gas that has passed through the meter.
MAOP	Maximum Allowable Operating Pressure. The maximum safe operating pressure.
Maximum Flow	The maximum flow (Q_{max}) capacity of a meter.
Meter Accuracy	The degree to which a meter correctly measures the volume of gas passing through it, determined by comparing the volume registered by the meter with that registered by the prover.
Meter Connections	The integral parts of the meter designed for attachment to meter swivels, pipe, or other piping components.
Minimum Flow	The minimum flow rate (Q_{min}) at which the accuracy falls in a defined tolerance range.
Non-volatile Memory	Data memory that is not dependent on battery voltage for persistence.
Optical Port	Port located on the front face of the meter through which the meter can be programmed and communicated.
Pressure	Force per unit area applied to a surface. Pressure = Force / Area
Prover	Device for measuring the accuracy of gas meter registration.
Rangeability	A ratio (Q_{max}/Q_{min}) expressing the range of flow in which a meter accurately measures within a defined set of accuracy parameters (i.e., a range of 50:1 for 100 ± 1% accuracy range).
Rated Capacity	The maximum flow rate at which a meter may be operated.
SCF	Standard Cubic Foot. That quantity of gas which under an absolute pressure of 14.73 psia and at a temperature of 60°F (base conditions) occupies a volume of one cubic foot.
Seal(s)	A device designed to give evidence of meter tampering.
Specific Gravity	Ratio of the density of gas to the density of air (under equivalent pressure and temperature conditions).
Start Flow	The minimum flow rate required to have registration of gas flow.
Temperature Compensating Index	A meter index used to display corrected volume under flowing gas conditions to a base temperature, commonly 60°F.
Transfer Prover	A device for determining the accuracy of a meter under test by comparing its reading against the reading obtained from a calibrated reference meter connected in series with the meter under test.
Transition Flow Rate	The flow rate (Qt) at which the error channel will open up to a wider band.