

Positive Displacement Flowmeters

Operational Manual

For Models
Model 241, 242, 243



240 Helical Series Positive Displacement Flow Meters

Table of Contents



Before You Install	page 3
Meter General Description	page 4
Transmitter General Description	page 5
Meter Specifications.....	page 6
Transmitter Specifications	
Analog.....	page 7
Transmitter Specifications	
Frequency (Pulse).....	page 8
Do and Don'ts.....	page 9
Installation	page 10
Piping Diagrams.....	page 11
ANSI FlangeANSI Flange Stud Torque	page 12
Operation	page 13
Troubleshooting.....	page 16
241 Helical Flow Meter.....	page 17
242 Helical Flow Meter.....	page 18
243 Helical Flow Meter.....	page 19
Contact for Repairs	
& Calibration Services.....	page 20
Custom Instructions for Hazardous Locations/Explosion Proof Housing:	
	http://www.maxmachinery.com/content/explosion-proof-installation-instructions

DO NOT ATTEMPT TO INSTALL OR START FLOW METER WITHOUT READING THIS ENTIRE MANUAL

Max Machinery, Inc. (MMI) reserves the right to make changes to the product in this Instruction Manual to improve performance, reliability, or manufacturability. Consequently, contact MMI for the latest available specifications and performance data. Although every effort has been made to ensure accuracy of the information contained in this Instruction Manual, MMI assumes no responsibility for inadvertent errors.

Before You Install



Thank you for choosing to install a Max Machinery precision flow meter. To ensure the best experience please take a moment to read through this manual prior to installation.

When you purchased this meter a flow engineer helped determine many of the factors that will be reviewed on the following pages. You may find it useful to fill out the form below and keep it in your files for reference.

When you are ready to do the installation there will be a few tools you will need:

Meter Installation:

- The meter and transmitter
- A signal cable (available from factory)
- The display or signal processing device
- Indicator Manual
- Calibration Certificate
- Bypass plumbing supplies

Many Max meters are installed and operate for decades, so having the following information in your records may prove useful. We have provided this outline as a starting point.

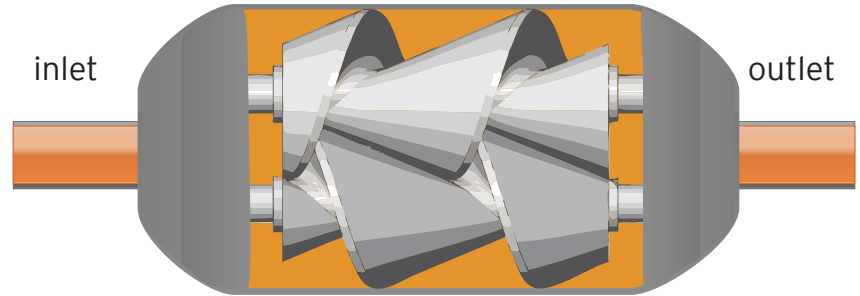
Process Temperatures _____	Fluid Viscosity _____
Operating Range _____	Line Pressure _____
Max Sales # or PO # _____	Installation Date _____
Meter Model # _____	Meter Serial # _____
Transmitter Model # _____	Transmitter Serial # _____

Notes: _____

Meter General Description

The Max 240 Series Flow Meters are positive displacement helical rotor type units capable of precise measurements over a wide range of flow rates and fluid viscosities.

The three sizes of this series (241, 242, and 243) will measure flows from 0.1 L/min to 1400 L/min. Material viscosities between 3 and 1,000,000 centipoise may be accommodated.



In a helical rotor type flow meter, a precise amount of the fluid being measured is trapped between the rotors as they turn. This motion is used to turn a gear coupled to a magnet. An external transmitter senses the motion of the magnet and converts this signal into a voltage, pulse or 4-20 mA current flow rate output. For some transmitter models, the magnet is eliminated and the motion of the gear itself is sensed.

The Max Series 240 Meters are of simple and rugged construction. They can be expected to perform superbly if treated within the confines of the design envelope. For this reason, it is important to read this manual and understand the operational requirements and limits of the meter.

Our Technical Service staff will be happy to answer any questions that this manual does not cover.



Helical Model 241
with transmitter attached



Helical Model 242



Helical Model 243

Transmitter General Description

Max transmitters are designed to work with the entire family of Max Flow Meters to provide extremely precise flow measurement in a cost effective package. Different options of industrial housings or IP66 rated explosion proof enclosures, combined with a choice of one-part and two-part, high temperature designs with remote electronics cover a wide range of application environments - from the laboratory to harsh industrial processes.

This latest generation of transmitters use modern sensor technology coupled with advanced signal processing to deliver high levels of performance and reliability. Hall sensors are used to detect the position of a driven magnet inside a Max Flow Meter. Changes in position are tracked by a microprocessor, which generates an output proportional to the flow rate. Advanced signal processing provides both fine angular resolution (0.36 degrees rotation) and rapid response (output updated every one millisecond).

Max transmitters are typically mated to a mechanical flow meter, configured, and calibrated at the factory as a set. This ensures accuracy and allows quick setup in the field. For field installations where the transmitter has not been set up with a meter at the factory, an optional serial interface kit may be purchased to give full access to configuration options and parameters.

Transmitter Features

High resolution measurement -

Analog Output: Configured output ranges to any value within ± 10 Vdc or ± 20 mA.

Frequency Output: Configured output resolution of 1 to 1000 pulses per revolution.

Linearization of up to 16 points to fully describe the flow meter's output curve and achieve the highest system linearity over the meter's entire operating range.

Compensation Algorithm - Compensates for variations in Hall sensor and flow meter characteristics to provide a stable, undamped output that accurately represents the instantaneous flow rate. This feature is factory set when the meter and transmitter are mated together. If the transmitter is changed, the compensation can be performed via a button on the circuit board.

Anti-Dither Buffer - Masks the false output that may occur at very low flow rates in the presence of vibration or hydraulic noise. If the meter reverses direction the output signal will be interrupted for a user selected portion of a meter rotation. Reverse flow exceeding the buffer setting will result in an output proportional to reverse flow rate. The buffer quantity can be set from 1% to 100% of a revolution.



Ex Proof Housing



Model 295
Analog/ Frequency



Model 289

Meter Specifications



Model	241	242	243
¹ Maximum flow rate,			
Gal/min	50	140	370
Liters/min	189	540	1400
Maximum pressure, bar (psi)			
Standard NPT	35, (500)	35, (500)	35, (500)
600 lb ANSI RF flanges	105 (1500)	105 (1500)	105 (1500)
1500 lb ANSI RF flanges	---	245 (3500)	245 (3500)
2500 lb ANSI RF flanges	245 (3500)	---	---
Pressure drop, bar (PSI)			
Operating maximum	10 (150)	7 (100)	5.3 (75)
Absolute maximum	21 (300)	15 (200)	10 (150)
100% flow, 3 CPS	1 (14)	0.7 (10)	0.7 (10)
² Maximum temperature	Up to 265° C (500° F)		
³ Recommended filtration	150 micron		
Displacement, L/Rev	0.062	0.182	0.574
Weight, Kg (Lb)	13.6 (30)	18.2 (40)	45.5 (100)
⁴ Typical K-Factor, (pulses/liter)			
295 Transmitter	15000	5000	1500
289-700 Transmitter	403	219	58.8
Port size			
NPT	1.5"	2.5"	3"
ANSI RF flanges	1.5" (DN40)	2.5" (DN65)	4" (DN100)

Notes:

¹ For viscosities of 3 CPS or less. Derate per pressure drop curves for higher viscosities.

² Limited by meter seal material, transmitter model, orientation and ambient temp. See manual. Consult factory.

³ Some materials may have different filter requirements. Consult factory

⁴ Typical. See flow meter/transmitter calibration sheet for actual K-factor and accuracy data.

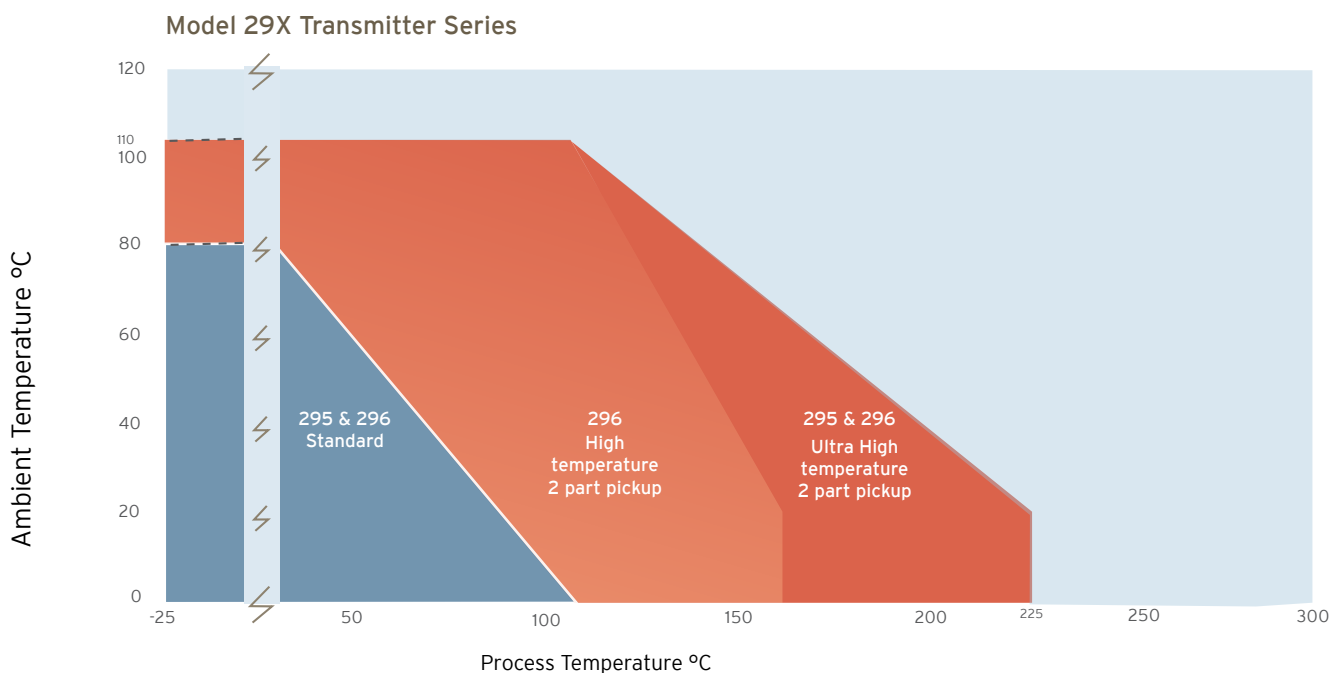
Transmitter Specifications

Analog

Supply Voltage	12 Vdc (Models 29X-XXX-100) 24 Vdc (Models 29X-XXX-000)
Supply Current	90 mA max@ 12 Vdc, 45 mA max@ 24 Vdc
Short Circuit Current	21 mA
¹ Output Update Rate	1 ms
Resolution	Adjustable without recalibration to any range of ± 10 Vdc Model 29X-3XX-XXX or ± 20 mA Model 29X-2XX-XXX
Ambient Temperature Range	Transmitter (Storage)-40°C to 85°C (-40°F to 185°F) ² Transmitter (Operation)-40°C to 80°C (-40°F to 175°F)
Maximum Temperature, Process Fluid	
For explosion proof models see: http://www.maxmachinery.com/content/explosion-proof-installation-instructions (20°C Ambient, 5V supply)	Standard Model 90°C (195°F) - Models 295 & 296 High Temp Model - Model 296 Ultra-High Temp Model 225°C (435°F) - Models 295 & 296
Anti-dither Range	Software selectable from 1-100% of 1 revolution. 50% of a meter revolution - unidirectional 2% bidirectional are typical default settings
Signal Filtering	Software selectable from 1 ms to 64 sec. time constant

¹ Full step change is subject to signal damping

² Temperature of metered fluid will affect transmitter temperature, see graph below



Transmitter Specifications

Frequency (Pulse)

Supply Voltage	5-26 Vdc	
Supply Current	25-30 mA typical	
Output (5.0 Volt Supply) (TTL and CMOS compatible)	No Load	0.00 / 4.80 Volts
	2.5K Load to Common	0.00 / 4.60 Volts
	2.5K Load to +5 Volts	0.25 / 4.80 Volts
Short Circuit Current	45 mA	
Output Impedance	100 Ω	
Rise/Fall Time	0.2 μSec	
¹ Output Update Rate	1 ms	
Min/Max Frequency	0-60 kHz	
Resolution	1 - 1000 pulses/rev, Single Phase	
	1 - 500 pulses/rev/phase, Quadrature	
Ambient Temperature Range	Transmitter (Storage)-40°C to 85°C (-40°F to 185°F)	
	² Transmitter (Operation) -40°C to 80°C (-40°F to 175°F)	
Maximum Temperature, Process Fluid		
For explosion proof models see:	http://www.maxmachinery.com/content/explosion-proof-installation-instructions	
(20°C Ambient, 5V supply)	29X-X0X-XXX Standard Model 90°C (195°F)	
	29X-X5X-XXX High Temp Model – 2 part model 225°C (435°F)	
Anti-dither Range	Software selectable from 1-100% of 1 revolution.	
	50% of a meter revolution - unidirectional	
	2% bidirectional are typical default settings	
Signal Filtering	Software selectable from 1ms to 250ms time constant	

¹Full step change is subject to signal damping

² Temperature of metered fluid will affect transmitter temperature, see graph on previous page

Do and Don'ts



DO:

Install bypass plumbing around the flow meter. This is useful during start up for removing dirt and air from the plumbing or when measuring fluid that may freeze inside the line and need to be remelted before it can pass through the meter. It also allows removing the

flow

meter for service without disabling the system.

DO:

Be very careful to keep parts clean during installation or teardown. A little dirt can look like a truckload compared to the 150 micron filtration requirement for series 240 Meters.

DO:

Clean the filter on a regular basis.

DON'T:

Run water or aqueous solutions not approved by Max through your flow meter because of internal galling.

DON'T:

Steam clean the meter (bypass or remove the meter if necessary).

DON'T:

Blow down the meter with compressed air or gas because it may over-speed and damage the meter.

DON'T:

Remove the Transmitter from the flow meter body. The transmitter is phased to the meter and a measurement error will result. Re-calibration will be necessary; see the transmitter interface software manual.

DON'T:

Disassemble the flow meter. These are precision devices which require special tools and techniques.

DON'T:

Turn on the pump in a system filled with material that is solid at room temperature. Wait until the material is completely melted and use the flow meter bypass valve during start up.

DON'T:

Apply excessive differential pressure across the flow meter as it will cause internal failure (see the pressure drop curves for safe area operation).

DON'T:

Over pressurize the meter. Maximum pressure is either 35 bar (500 PSI), 105 bar (1500 PSI) or 245 (3500 PSI) depending on model purchased

DON'T:

Exceed the maximum flow rates for the material viscosity.

DON'T:

Allow materials which solidify in air to set up in the flow meter. These may be impossible to remove. If the meter needs to be removed for repair and cannot be completely cleaned. Plug the inlet and outlet ports at once.

Installation

For optimum performance, install the flow meter on the discharge side of the pump, in one of the configurations shown on page 11.

The following items and conditions should be considered:

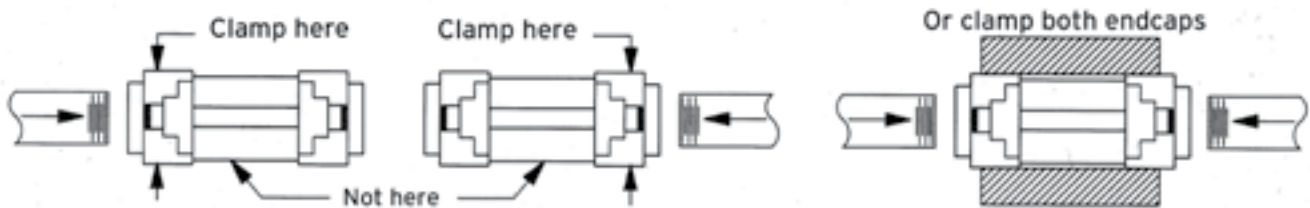
Location: Install the flow meter in a clean, dry area if possible. Avoid areas with high vibration levels.

Line and Bypass Valves: These valves allow filter cleaning or flow meter removal without completely shutting the system down and draining the lines. They are important for system start up under conditions which could damage the meter, such as: air in the lines, solid materials (at room temperature), high temperature materials, or initial line surges.

Filtration: Any dirt present in the system can jam or damage the meter. A 150 micron filter is generally recommended, although materials with very high viscosities may require a coarser filter. For bidirectional flow applications, use a filter on each side of the flow meter. Materials with fibrous or non abrasive particulate matter may have to be run without filters. Follow the recommendation of your Max Sales Engineer or consult Technical Service.

Clean Plumbing: Before installing the flow meter, clean the inside of the pipe line with compressed air or steam (especially when using new pipe). Don't use water, steam, or compressed air on the meter itself! Remove any protective covering from the flanges (if applicable).

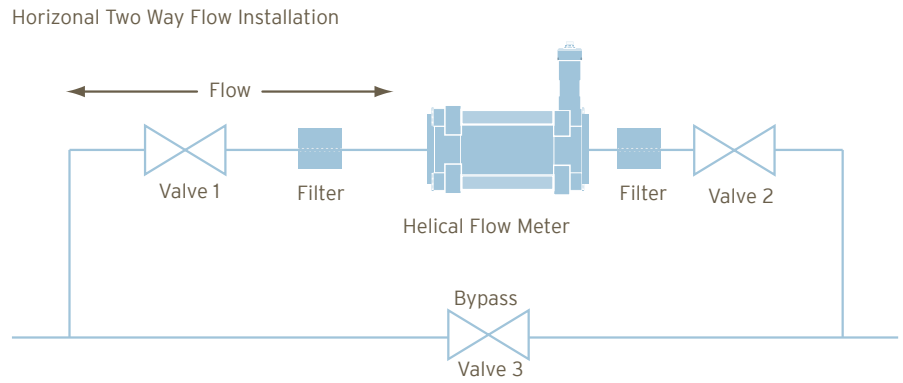
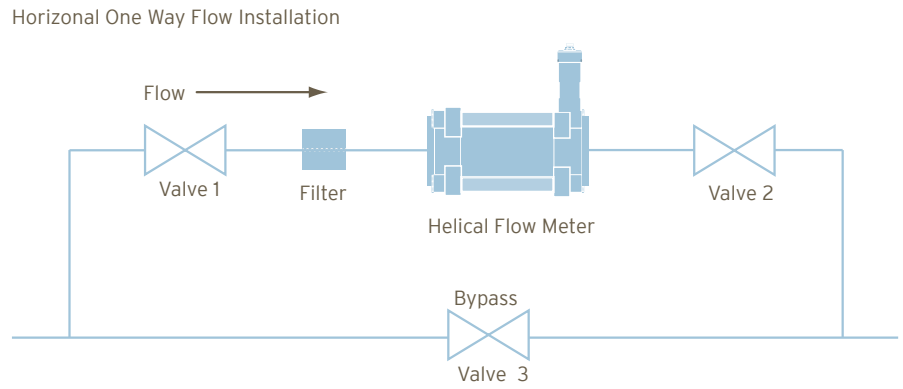
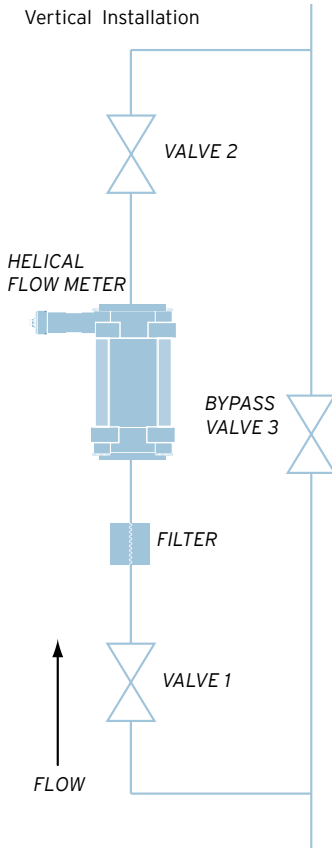
Pipe Threading: When installing pipe to the flow meter, support the nearest end cap or both end caps (as in a vise). Don't clamp the flow meter body. This avoids possible misalignment of flow meter components when the pipe is screwed tight. Check for proper flow meter operation by rotating the timing gear through the transmitter mounting hole. It should move freely and without noise.



High Temperatures: Use the "Vertical Installation" drawing. This minimizes heat transfer by convection from the flow meter to the transmitter. The transmitter is the most heat sensitive element in the system and the transmitter manual should be consulted for specific limits. Optional heating fluid ports are available for the flow meter to keep it at operating temperature during standby conditions. For substances that are solid at room temperature, these ports are generally required to keep the material molten and flowing through the meter.

ANSI Flanges: Using the 241, 242 or 243 meters at pressures greater than 500 psi will also require flanges. See the specifications and bolt torque table on page 12. Max has bolt kits available for flange installations.

Piping Diagrams



ANSI Flange Stud Torque

240 Series ANSI Flange Stud Torque Requirements. This table shows the minimum torque required for a 2:1 tightening factor at the indicated pressures using zinc plated studs and nuts. These values were calculated using studs with a yield strength of $S_y = 75,000$ psi.

Meter (Flange)	Studs		Torque For Line Pressure ft-lb (N-m) See notes below					Absolute Max Torque ft-lb (N-m)	Stress at Max Torque (psi)*
	Qty	Size	500	1000	1500	2500	3500		
241 (600# Flange)	4	3/4-10	24 (33)	49 (67)	73 (99)			200 (271)	47,904
241 (2500# Flange)	4	1-1/8-7	37 (50)	73 (99)	110 (149)	183 (248)	256 (247)	681 (924)	47,789
242 (600# Flange)	8	3/4-10	24 (33)	47 (64)	71 (96)			200 (271)	47,904
242 (1500# Flange)	8	1-8	31 (42)	63 (86)	94 (128)	157 (213)	219 (297)	483 (656)	47,822
243 (600# Flange)	8	7/8-9	53 (72)	106 (144)	159 (216)			322 (437)	47,972
243 (1500# Flange)	8	1-1/4-7	76 (103)	151 (205)	227 (308)	378 (513)	529 (718)	965 (1310)	47,802

Notes:

Using the 241, 242 or 243 meters at pressures greater than 500 psi *will require flanges*. Max has bolt kits available for flange installations.

For unplated non-lubricated nuts and studs, multiply the above torque by 1.5.

For lubricated nuts and studs, multiply the above torque by 0.9.

For cadmium plated nuts and studs, multiply the above torque by 0.8.

*Stress in bolt calculated for thread root diameter.

Operation



Determine that the following parameters of your flow metering system are within specifications for the specific 240 Series Meter being used:

Maximum System Pressure	(Specifications)
Differential Pressure across meter	(Pressure Drop Curves)
Maximum Flow Rate	(Pressure Drop Curves)
Metered Fluid Temperature	(Sales specification, transmitter manual)

If the metered fluid is greater than 80°F (28°C) over ambient, see the “High Temperature Start Up” section.

With valves one and two closed, slowly open valve three (bypass) to clear the lines of foreign particles and air. Slowly open the inlet valve (# 1). Slowly open the outlet valve (# 2). Completely close the bypass valve.

No routine maintenance, cleaning, or lubrication of the flow meter is required. A routine filter cleaning schedule should be established. The system should be shut down if abnormal noises occur or if unusual differential pressures across the meter are encountered.

High Temperature Start Up: For fluids above 150°F (82°C) based on 70°F ambient, a special procedure is required to prevent thermal shock and permanent damage to the flow meter.

The warm up time is determined by the equation below:

$$\text{TIME (minutes)} = \frac{\text{connector size (in inches)} \times (\text{operating temperature (F)} - 125)}{10}$$

–OR–

$$\text{TIME (minutes)} = \frac{\text{connector size (in inches)} \times (\text{operating temperature (C)} - 52)}{10}$$

Valves one and two must be closed. Open the bypass valve (# 3) in gradual steps until the bypass piping is stabilized at operating temperature. Open valve one slightly and allow the temperature to stabilize around the flow meter. Valve one can then be opened completely. Open valve two slightly. The flow meter may make unusual noises or bind at this point. Leave the valve at this setting until normal meter operation occurs, at which point valve two can be gradually opened all the way. Slowly close the bypass valve (# 3).

Electrical Installation - Wiring

290 Series Transmitters

Removal note: The transmitter does not need to be removed from the flow meter for any field servicing or adjustments. Normally, the flow meter and transmitter are shipped back to the factory for calibration or service as a unit. If the transmitter needs to be removed from the flow meter for installation, be sure to retighten the transmitter snugly in order to ensure proper sensor alignment.

Mechanical Installation

1. The transmitter is attached to the flow meter's threaded magnet shield. Hand tighten only. (~ 3 ft-lb)
2. The transmitter lid has four thread paths. To realign the cable, remove the lid and rotate up to 180° and retighten using an alternate starting point. Tighten to compress the O-ring seal.

Removal

1. Remove electrical connections
2. Unscrew transmitter, using a wrench if necessary.



WARNING

Installation and removal should only be facilitated by trained personnel
Verify transmitter output type (ANALOG or FREQUENCY) before wiring, inappropriate wiring could result in damaging the circuit.

Moisture Seal Protection

On all models, the housing is designed as a liquid and vapor-tight enclosure. There are O-ring seals at the lid and possibly also the base of the housing – these need to be fully seated. A properly sealed transmitter will prevent the formation of damaging moisture inside the housing.

Turck connector Model: The connector is sealed to the lid at the factory and is ready for use.

NPT Model: To ensure a moisture-tight seal, apply appropriate sealant to the threads at installation.

Wiring ANALOG

The electrical connector versions are pre-wired inside the transmitter and ready to accept a mating cable (available from the factory). The liquid-tight, NPT models need to be wired during installation as shown in the table below:

Analog	294 NPT model	All Other Models	Mating Cable Wire Color	Turck Pin #
Case Ground	In-lid	Case	Blue	3
Common	1	Com	Black	4
Power *	2	V+	Brown	1
Signal Output (+)	3	Sig	Grey	5
Signal Output (-)**	4	Ret	White	2

*Model 29X-xxx-000, 24vdc powered, Model 29X-xxx-100, 12vdc powered

** Signal output is fully isolated: If attached to a true differential input a 10K Ohm pulldown resistor should be installed between (–) and common at the receiving end.

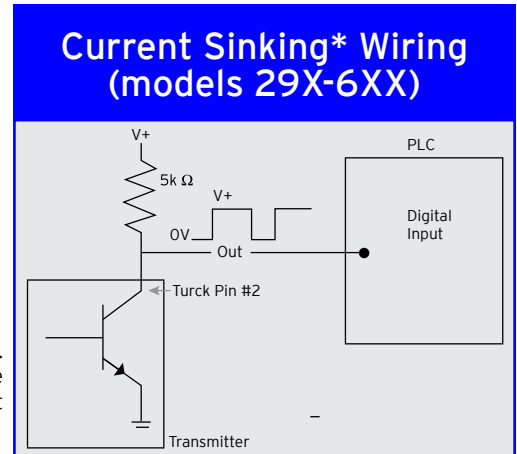
Electrical Installation - Wiring

Wiring FREQUENCY

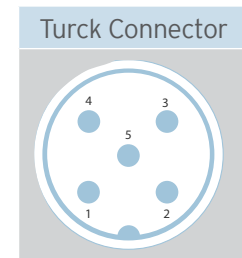
The electrical connector versions are pre-wired inside the transmitter and ready to accept a mating cable (available from the factory). The liquid-tight, NPT models need to be wired during installation as shown in the table below:

Frequency Single Phase	All Other Models	Mating Cable Wire Color	Turck Pin #
Case Ground	Case	Blue	3
Common	Com	Black	4
Power 5-26 Vdc	V+	Brown	1
Pulse Output	Ph A	White	2
N/A	NC	Grey	5

* A current sinking device produces an output pulse which is the opposite of a sourcing device. A positive DC voltage must be applied to the wire running between PhA and your PLC. When the output is triggered, this voltage will be grounded to zero volts. Note: use a 5k ohms resistor to limit the current flow in the signal line.



Frequency Quadrature	All Other Models	Mating Cable Wire Color	Turck Pin #
Case Ground	Case	Blue	3
Common	Com	Black	4
Power 5-26 Vdc	V+	Brown	1
Output Phase A	Ph A	White	2
Output Phase B	Ph B	Grey	5

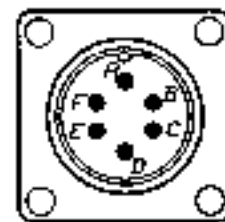


Electrical Installation - Wiring 280 Series Transmitters

Wiring

The 6-pin connector version is pre-wired inside the transmitter and is ready to accept a mating cable (available from the factory). The Liquid-Tight and NPT models need to be wired during installation as shown in the table below:

	NPT Models	6-Pin Connector	
	Circuit Board Terminal #	Mating Cable Wire Color	Pin #
Case Ground	1	Green	A
Common	2	Black	B
Power (+5-24 VDC)	3	Red	C
Pulse Output	4	White	D



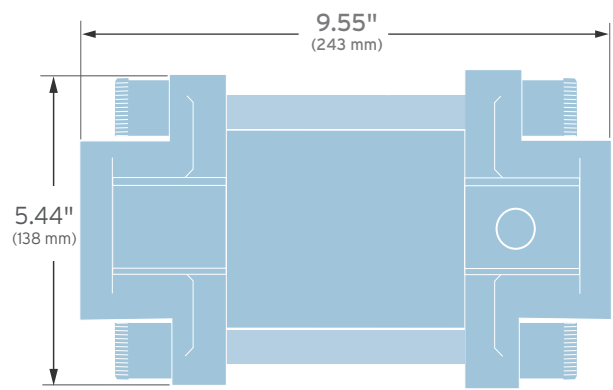
Troubleshooting



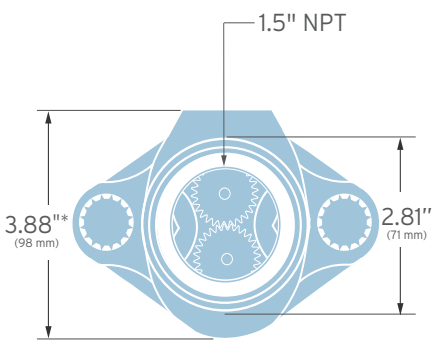
Trouble	Corrective Action
No Flow through meter or high pressure drop across meter	
Solidified material blocking rotation	Heat meter to melt material.
Debris blocking rotation	Remove meter from line. Flush with an organic solvent or petrochemical. Try to work debris out of the meter.
Meter broken	If you find damaged parts in the meter, return the meter to the factory for repair.
Fluid is passing through the meter, but there is no indication of flow	
Improper hook-up of transmitter	Verify that DC power is present at the PCA. Use a multi-meter to measure the transmitter output independent of the display or PLC. Inspect cabling.
Indicated flow does not agree with expected readings	
Air in the line	Air bubbles displace the meter just as a liquid would. If you are over-reporting, verify that there is no air in the lines.
Indicator not calibrated properly	Verify the K-Factor for the meter in use and compare this value to the setting used in the display.
Excessive reverse flow in system	Max transmitters have anti-dither functions which can buffer up to 1 revolution of reverse flow. An incorrect flow total can be reported if the pumping causes a flow and ebb of greater than 1 meter revolution.

241 Helical Flow Meter

CONNECTIVITY/DIMENSIONS



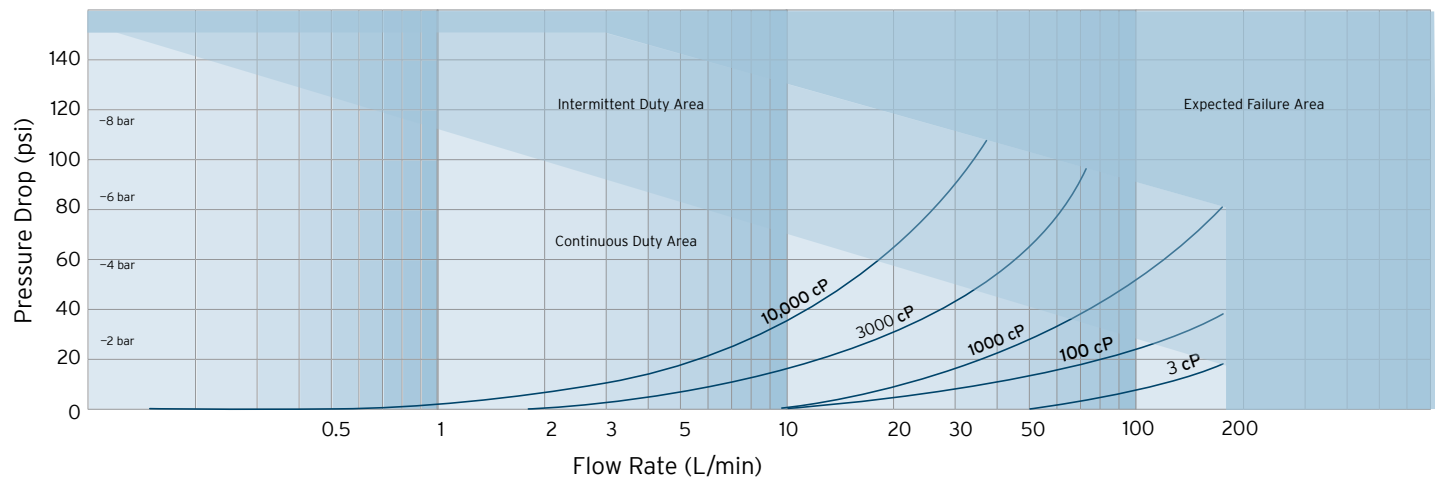
- Top View -



*Add 0.4" (10mm)
for high pressure body

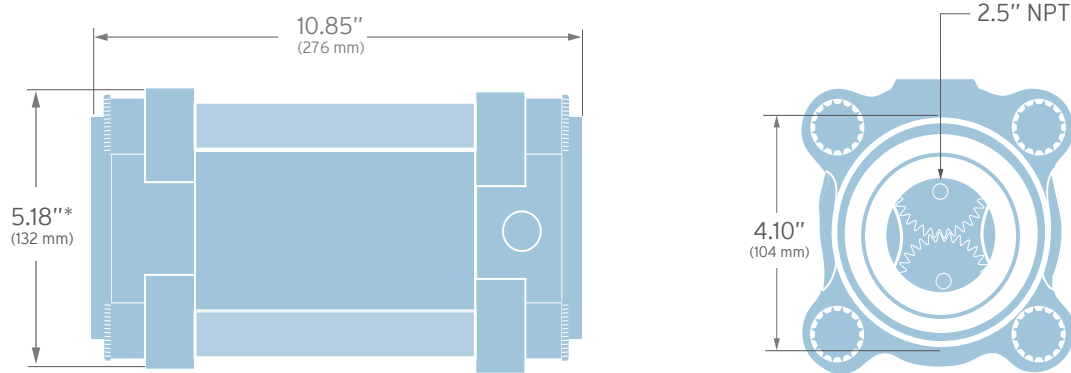
- End View -

TYPICAL PRESSURE DROP (Delta P versus Flow rate for various viscosities)

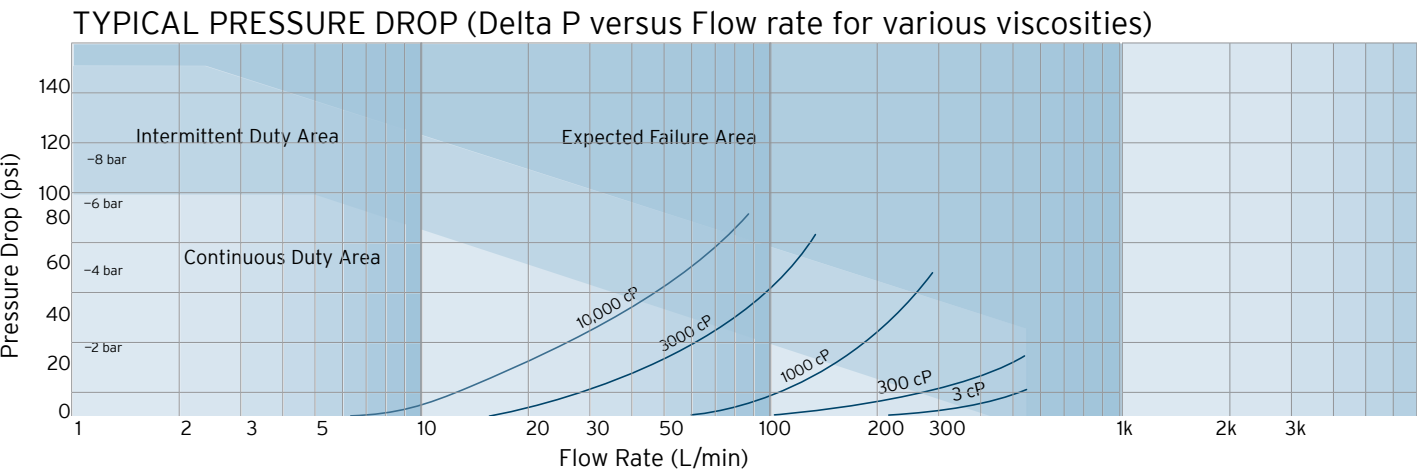


242 Helical Flow Meter

CONNECTIVITY/DIMENSIONS

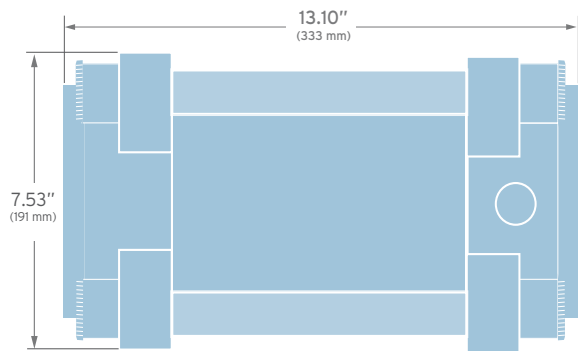


*Add 1.32" (34mm) for high pressure body

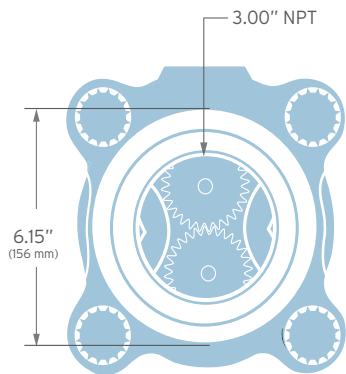


243 Helical Flow Meter

CONNECTIVITY/DIMENSIONS

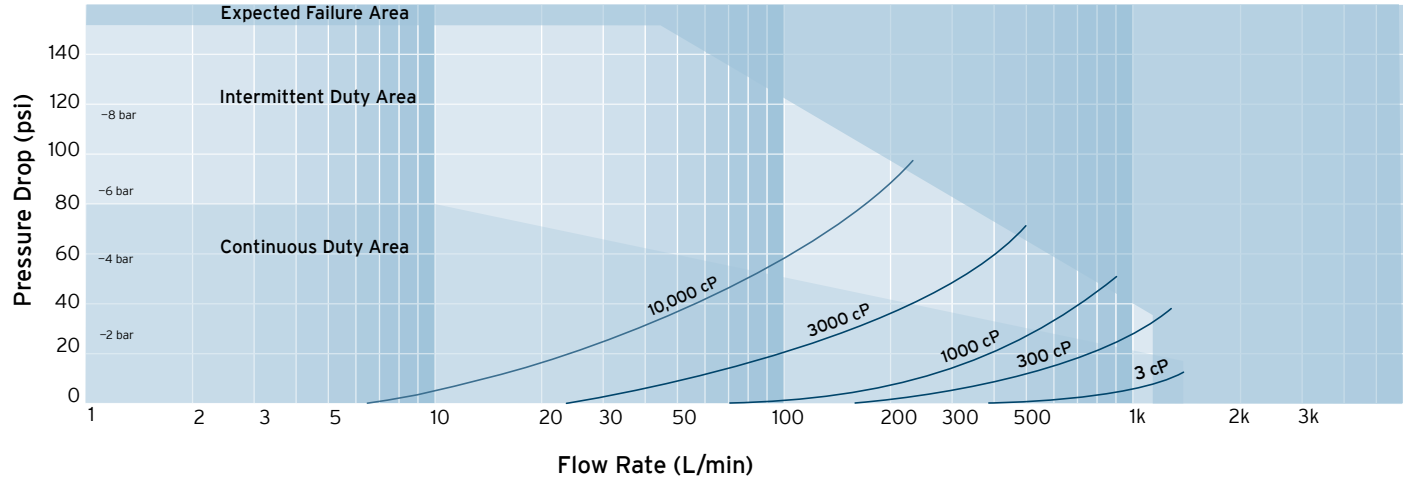


- Top View -



- End View -

TYPICAL PRESSURE DROP (Delta P versus Flow rate for various viscosities)



Contact for Repairs & Calibration Services



Your Max 240 Series Meter should be repaired at the factory or under the direct supervision of the Max Technical Service Department. Unauthorized repair work may damage the meter and will void the product warranty. Please make note of model and serial numbers on the flow meter before calling the factory. A return goods authorization number (RMA) will be issued if the flow meter has to be sent back for repair.

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