



ROOTS Meters & Instruments

Installation and Maintenance Manual Series B3-HPC ROOTS® Meters

Models:

Series B3-HPC:

1M740/1480

3M740/1480

5M1480

7M1480

11M1480



WARRANTY

Seller warrants that (i) its products will, at the F.O.B. point, be free from defects in materials and workmanship and (ii) its services will, when performed, be of good quality.

Any claim for failure to conform to the above and foregoing warranty must be made immediately upon discovery, but in any event, within eighteen (18) months following delivery of the specified product at the F.O.B. point or twelve (12) months after installation whichever is earlier, or twelve (12) months after performance of the specified services. Warranties may be extended in time pursuant to Seller's written warranties, provided payment has been received for the extension. Defective and nonconforming items must be held for Seller's inspection and returned at Seller's request, freight prepaid, to the original F.O.B. point.

Upon Buyer's submission of a claim as provided above and substantiation, Seller shall, at its option (i) either repair or replace its nonconforming product or correct or reperform its nonconforming services, as applicable, or (ii) refund an equitable portion of the purchase price attributable to such nonconforming products or services. Seller shall not be liable for the cost of removal or installation of materials or any unauthorized warranty work, nor shall Seller be responsible for any transportation cost, unless expressly authorized in writing by Seller. Any products or materials replaced by Seller will become the property of Seller. Repair or replacement of products, or correction or reperformance of services, or refund of an equitable portion of the purchase price shall be Seller's only obligation and the sole and exclusive remedy of Buyer in the event of a failure to conform to the foregoing warranty.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES (EXCEPT THAT OF TITLE) EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.



ROOTS Meters and Instruments
Dresser, Inc.

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RECEIVING, HANDLING & STORAGE

ROOTS® Rotary Positive Displacement Gas Meters are precision measurement instruments. Although of very rugged construction, reasonable care should be given during handling and storage.

At Time of Delivery

1. Check the packing list to account for all items received.
2. Inspect each item for damage.
3. Record any visible damage or shortages on the delivery record.
 - File a claim with the carrier.
 - Notify your ROOTS® meter supplier immediately.

Do not accept any shipment without making an immediate inspection of the equipment for damage. All new meters should be checked immediately upon arrival because damage can exist without obvious external evidence.

When reporting a suspected problem, please provide the following information:

- Your Purchase Order Number and/or Dresser's Sales Order Number
- Meter Model, Serial Number and Bill of Material Number. (This information is located on the nameplate between the differential plugs on the meter body.)
- Accessory Unit Serial Number
- Description of the problem
- Application information, such as gas type, pressure, temperature, and flow rate

Our Product Services Department offers professional services for all ROOTS® products. A Return Material Authorization (RMA) number is required for all products shipped to the Factory. Please contact your ROOTS® meter supplier to obtain an RMA number. All returns should be packaged in an original-type shipping container or suitable shipping material that will protect the product.

NOTE: Certain packing material may enter and contaminate the measuring chamber so should not be used.

STORAGE/INITIAL TESTING:

If the meter is not tested or installed immediately, store in a dry location in the original shipping container for protection. Make sure the box remains horizontal with the arrow pointing up.

“Checking for free rotation” does not mean the meter will pass a test after sitting on the shelf for a year or two. A small amount of oil is applied to the bearings of new or remanufactured meters, but this is only sufficient for factory testing. The oil in the bearings can coagulate over time. This may impact meter test performance until the bearings rotate freely. Dresser recommends that the meter be run at a flow rate between 80% & 100% of meter capacity for two minutes or until the meter is running smoothly.

INTRODUCTION

Use and Limitations

ROOTS® Meters are suitable for handling most types of clean, dry, common gases at either constant or varying flow rates. Please contact ROOTS® Meters and Instruments for a list of acceptable gases. The meter is not suitable for handling liquids. Measurement accuracy and life expectancy may be affected by dirt or other types of foreign material in the gas stream.

Operating Principle

As shown in Figure 1, two counter rotating impellers of lobed or “figure 8” design are encased within a rigid measuring chamber. Precision timing gears keep the impellers in the correct position. Optimal clearances between the impellers, cylinder, and headplates provide a continuous, non-contacting seal.

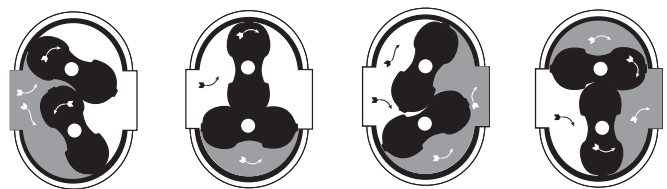


Figure 1 - Impellers rotating inside meter cylinder.

Because of this design, the gas at the meter's inlet is effectively isolated from the gas at the outlet. During impeller rotation, the precision machined measuring chamber traps a known volume of gas between the impeller and the adjacent cylinder wall. The meter will measure and pass four equal gas volumes with each complete revolution of the impellers.

The sum total of the four volumes is the "volume per revolution". The volume is indicated in Engineering units represented in cubic feet (or cubic meters).

Volumetric accuracy of the ROOTS® meter is permanent and non-adjustable. Measurement characteristics are established by the shape and the precise machining of non-wearing fixed and rotating parts.

A meter's rated capacity is the maximum flow rate at which the meter may be operated and is determined by the dynamic loads acting on the moving parts of the meter. These loads are primarily related to meter RPM, and secondarily to the metering pressure. The standard volume capacity of a rotary meter increases directly with changes in absolute line pressure and inversely with changes in absolute line temperature.

GENERAL DESCRIPTION

ROOTS® Meters are manufactured in accordance with the American National Standard specification ANSI/ASC-B109.3 for Rotary Type Gas Displacement Meters. ROOTS® Meters Series B3-HPC have flanged inlet and outlet connections conforming dimensionally to ANSI/ASME B16.5. The operating temperature range is from -40°F to +140° F (-40° C to +60° C).

Every meter pressure vessel is static pressure tested at the factory at 200% its Maximum Allowable Operating Pressure (MAOP) and leak tested at 125 percent of MAOP in accordance with the ASME Boiler and Pressure Vessel Codes. All aluminum parts of the cartridge (i.e., impellers, measurement chamber, and headplates) are hard-coat anodized for added corrosion and abrasion resistance.

Cleansing and lubrication for the main bearings and timing gears is provided by a "splash" lubrication system. Both ends of the cartridge case on the Series B3-HPC meter serve as oil reservoirs. Oil slingers located at either end of the meter cartridge distribute oil for lubrication.

Accuracy is not affected by low or varying line pressures. Series B3-HPC meters may be used

satisfactorily for pressures ranging from a few ounces to full MAOP. The meter base rating is expressed in Actual Cubic Feet per Hour (ACFH), or in Actual Cubic Meters per Hour (Am³H).

Displaced volume measurement is completely independent of the gas specific gravity, temperature, and pressure. Volume measurements can be easily converted to Standard conditions by application of the Basic or Ideal Gas Laws for elevated pressure and varying temperature.

IMPORTANT: The maximum working pressure of a rotary meter is limited by casing design. Meters should not be installed where line pressure can exceed the MAOP. Refer to the pressure vessel nameplate for the MAOP.

SERIES B3-HPC METERS

The 1M and 3M High Pressure Cartridge (HPC) meters are available with a 740PSIG (51BAR) rating with ANSI Class 300# flanges or 1480PSIG (102BAR) rating with ANSI Class 600# flanges. The 5M, 7M and 11M meters are only available with a 1480 MAOP rating and ANSI Class 600# flanges.

The same 1M and 3M cartridges will fit into either the 740 PSIG MAOP housing or the 1480 PSIG MAOP housing. The 1M and 3M cartridges share a common cast-steel housing as do the 5M and 7M cartridges. The 11M cartridge fits into its own housing and does not share a housing with another meter. In all cases the measurement cartridge assembly slides into the housing. Measurement cartridges are field replaceable and can be interchanged between the common housings. An optional, full flow internal bypass and/or optional bypass indicator are available on all HPC meters and/or measurement cartridges. The bypass valve version cartridges are interchangeable with the non-bypass valve version cartridges.

METER INSTALLATIONS

Piping Configurations

Series B3-HPC meters can be installed in either a Top Inlet (vertical gas flow down) or a Side Inlet (horizontal) pipeline configuration as shown in Figures 2 and 3 respectively. The preferred or recommended installation is top inlet in a vertical pipeline with gas flowing downward. Although the design of the impellers tends to make the meter inherently self-cleaning, top inlet mounting enhances the likelihood that dirt, pipe scale, or other debris will pass through the meter.

Piping should be rigid and properly aligned. The meter does not require any direct means of support, but the piping on either side should be supported to eliminate any unnecessary piping strains on the meter case.

A good practice is to install the meter in a side loop with a bypass adjacent to the main line. Also, the installation of tees upstream and downstream of the meter will help facilitate transfer proving with the meter still mounted in the line.

Do not install the meter lower than the discharge pipe run, in order to avoid accumulation of condensate and foreign materials in the metering chamber. Use a Dresser Gasket Strainer, Dresser Pipeline Strainer, or other type strainer upstream of the meter to help remove foreign matter (pipe sealant, tape, weld slag, etc.) from the gas stream. A 100 Mesh screen is recommended for the strainer.

The installation of a lubricated gas valve directly before a meter is not recommended, as excess valve lubricant or other foreign material may stop impeller rotation.

To help prevent over-speed conditions from occurring, a restricting flow orifice plate is shipped with each HPC meter and it should be installed 2 to 4 pipe diameters downstream of the meter. Orifice plates are included with all B3-HPC high pressure meter shipments at no additional cost.

NOTE: Warranty does not cover meter failure due to over-speed conditions.

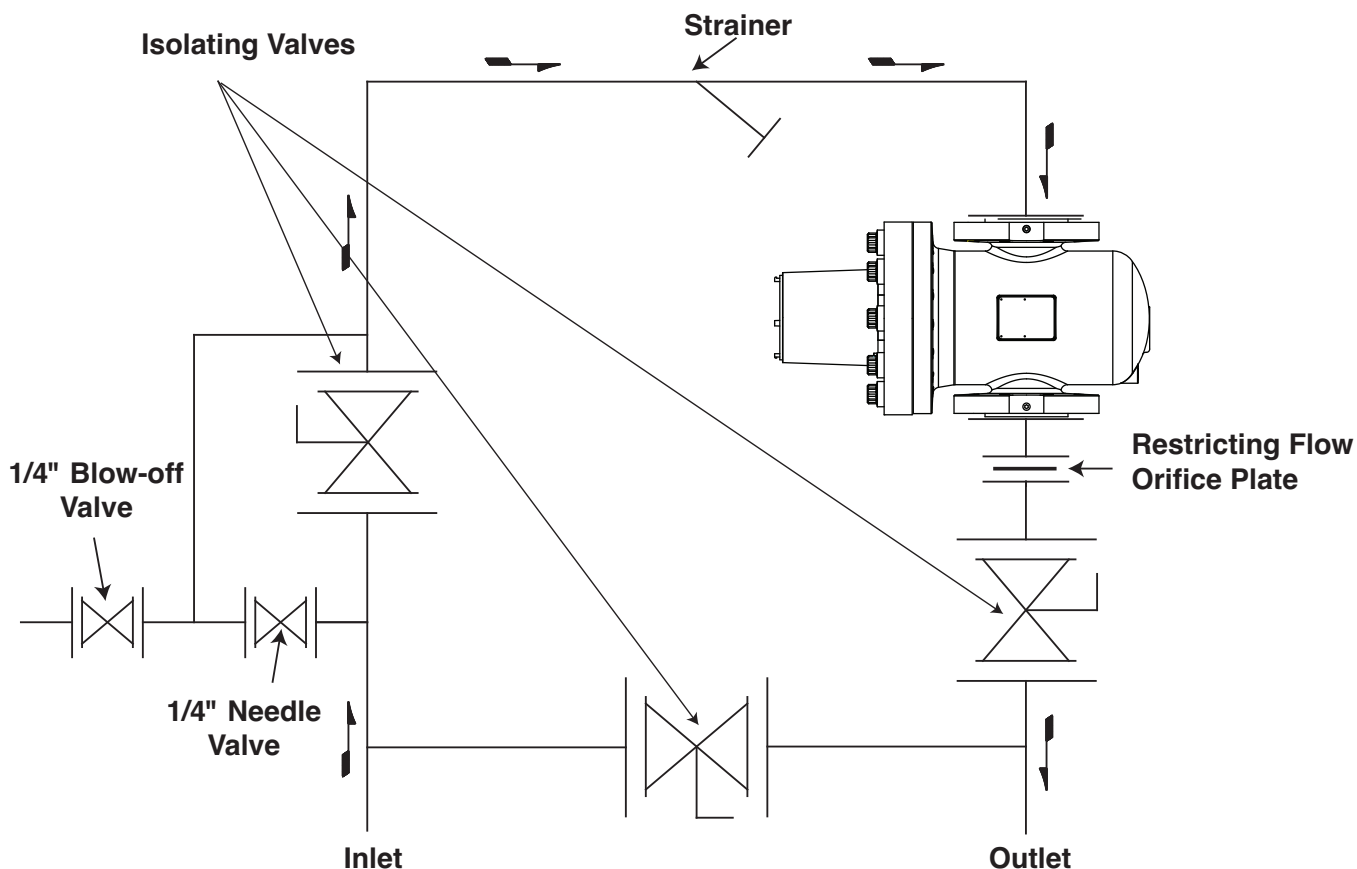


Figure 2 - Top Inlet Configuration for Series B3 Meter.

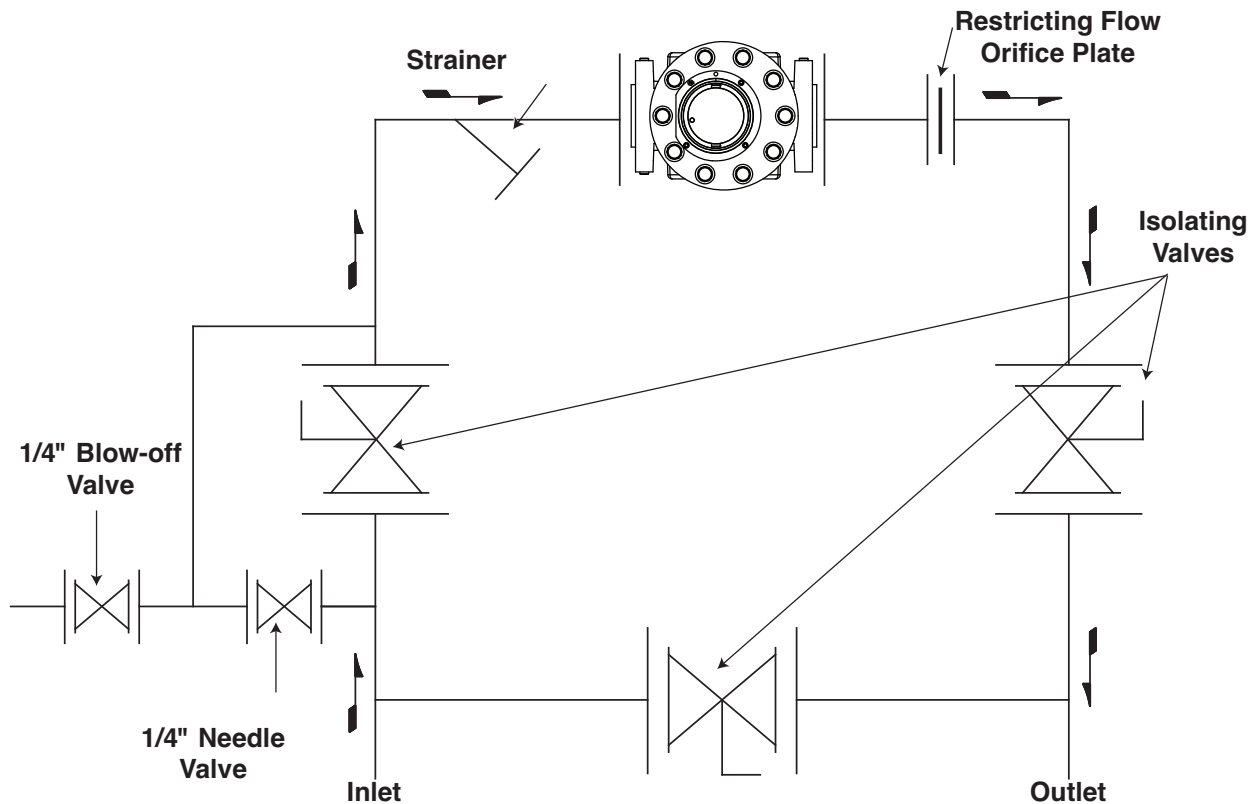


Figure 3 - Side Inlet Configuration for Series B3 Meter.

Placing Meter In Line

1. Before installing a meter:
 - Make sure the upstream piping is clean. During this procedure, use extreme caution and follow recommended company procedures.
 - Ensure the plastic protective caps have been removed from both meter flanges prior to meter installation.
 - Ensure the impellers turn freely and no objects or contaminants are in the measuring chamber.
2. Meter Orientation:
 - Connect meter inlet to the gas supply side of the line, ensuring the gas flow will be in the same direction as the arrow on the meter body nameplate (i.e., arrow pointing downward for Top Inlet).
 - In a proper installation, both meter oil level gauges are parallel to the ground (within 1/16" per running foot) and below the axial centerline of the meter.
3. Install the meter without piping strain. Use pipe supports as required. Level all meters to within 1/16" per running foot (5 mm/m), side-to-side and front-to-back.
4. Tighten flange bolts or stud nuts evenly in a cross-pattern. The maximum recommended torque is 80 foot pounds (108 Newton-Meters) for all HPC Meters.

CAUTION: The meter must NOT be under pressure for this procedure.

5. After the meter is installed, remove the socket head plug in the timing gear end of the meter (as shown in Figure 4) using a hex wrench. Insert a Hex wrench into the timing gear clamp on the end of the impeller shaft and slowly turn the impellers clockwise, checking for free rotation. If binding is present, do not attempt to disengage the impellers. Remove the meter from the set and clear all obstructions or piping strain prior to reinstallation. Replace the plug after verifying free impeller rotation and torque to 9.5 to 10.5 ft. lbs (12,9-14,2 Newton-Meters).

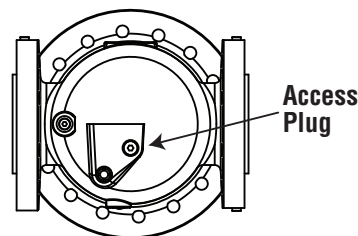


Figure 4 - Remove the access plug to check impeller rotation.



CAUTION: THE METER END COVER IS PRESSURIZED. Bleed off the line pressure before removing the oil fill or drain plugs from the meter.

6. Oil is shipped with each new meter in a quantity sufficient to fill the meter body reservoirs in either a Top Inlet or a Side Inlet configuration. Slowly add oil to the meter body end reservoir until the oil level is to the center of the oil gauge (sight glass) as shown in Figure 5. Refer to Figure 6 for oil fill/drain plugs and sight glass locations. **DO NOT OVERFILL.**

Meter Size	Side Inlet	Top Inlet
1M740/1M1480	4.2 oz. (124 ml)	11 oz. (325 ml)
3M740/3M1480	2.8 oz. (83 ml)	7.2 oz. (213 ml)
5M1480	18 oz. (532 ml)	37 oz. (1094 ml)
7M1480	14 oz. (414 ml)	29 oz. (858 ml)
11M1480	14 oz. (414 ml)	34 oz. (1006 ml)

Table 1- Oil Capacities

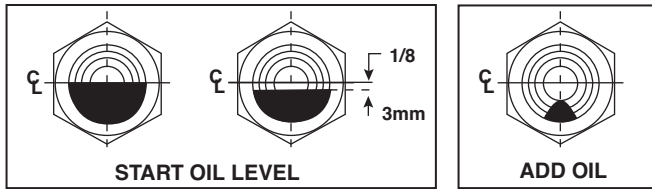


Figure 5 - Fill oil reservoirs to mid level of sight glass.

NOTE: The meter oil fill plug is located on the gear end side. This meter has oil reservoirs in both ends connected by an oil path tube. Please allow time for the oil to traverse the oil path tube and fill the counter end reservoir before assuming the meter is full of oil.

CAUTION: Perform a Leak Test immediately after placing meter back in service. Refer to meter Start-Up procedures, below. All leak points must be eliminated quickly before leaving the meter site. Otherwise, remove the meter from service by placing on bypass or another method.



IMPORTANT: DO NOT add oil to the permanently lubricated Series 3 Accessory Unit. **DO NOT** drill and tap the Lexan cover.

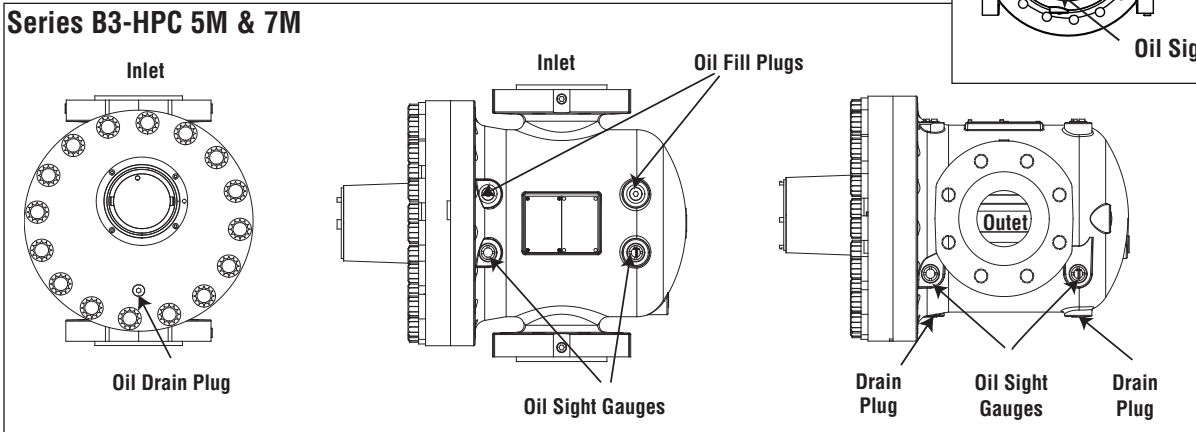
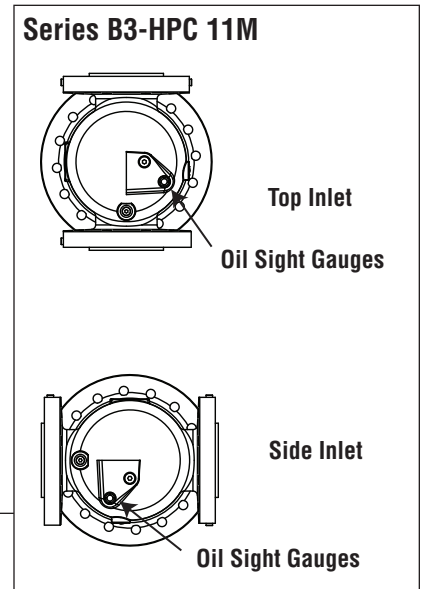
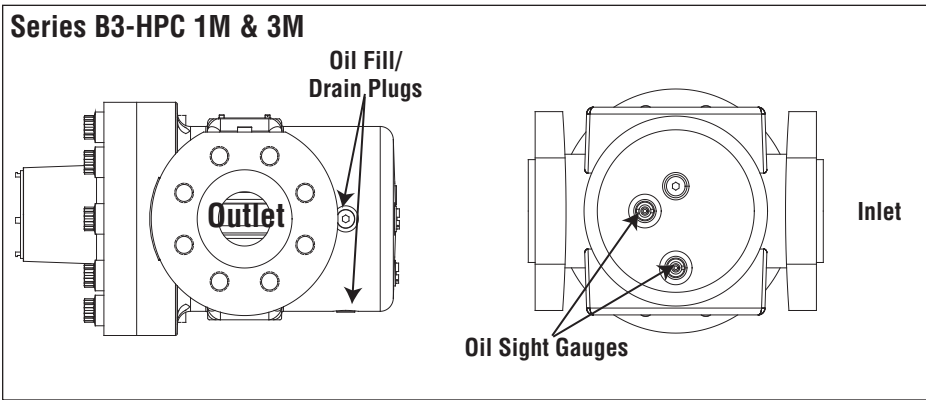


Figure 6 - Oil fill/drain plugs and oil level sight gauge locations.

Meter Start-Up

1. Slowly pressurize the meter in accordance with the following recommendations:

IMPORTANT: Do not exceed 5 psig/second (35 kPa/second) maximum when pressurizing. Rapid pressurization can cause an over-speed condition which may damage the meter. Resulting damage is not covered by warranty.

- a) Open the bypass and outlet (downstream of meter) gas valves.
- b) Partially open the meter inlet gas valve until the meter starts operating at low speed. Throttling the bypass valve may be necessary to initiate gas flow through the meter. Verify gas is flowing through the meter by watching for movement of the black-and white RPM wheel on the Accessory Unit. The wheel, shown in Figure 7, is visible from either the front or the side of the Lexan® cover on a standard counter meter. If movement is present, go to step c). If the RPM dial is not turning, verify gas is being delivered to the meter. If gas is flowing to the meter inlet and the RPM wheel is not moving, go to step e).

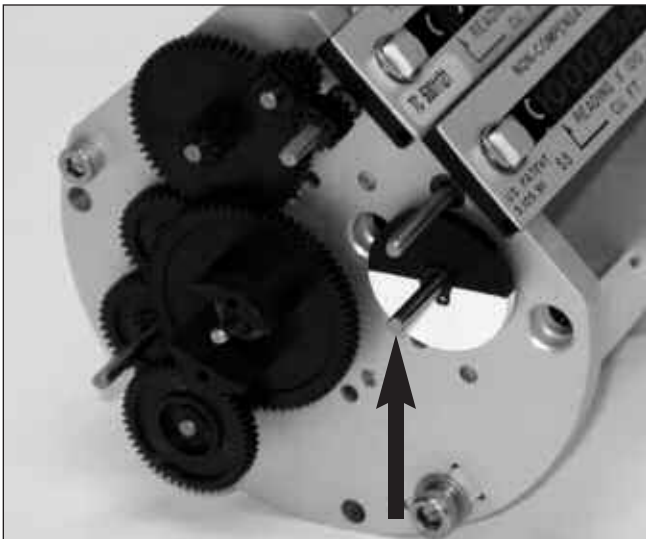


Figure 7 - Movement of the RPM wheel indicates impeller rotation.

- c) Let the meter operate at low speed for several minutes. Listen closely for unusual scraping or knocking sounds.
- d) If operation is satisfactory, go directly to step f).
- e) If unusual sounds are present or the accessory unit's RPM wheel is not turning, place the meter in bypass. Slowly depressurize and vent all pressure from the meter set before checking for problems. (Release pressure at a rate less than 5 psig/second.) Once the problem is resolved, repeat the start-up procedure beginning with step a).

DANGER: Slowly depressurize and vent all pressure from the meter set before working on meter.

- f) Gradually open the inlet valve until full line flow is passing through the meter and the inlet valve is fully open.
- g) Slowly close the bypass valve.
- h) Follow your company's authorized procedures or common industry practices to leak test the meter and all connections. Soapy water, Snoop®, and gas analyzers are commonly used for this procedure.

Snoop is a registered trademark of the Swagelok Company.

Meters installed and maintained in accordance with factory recommendations can be expected to operate dependably for many years. Proper oil level and cleanliness have the greatest effect on meter life expectancy. Visually inspect the oil reservoir for proper mid-gauge oil level once a month until a practical interval is determined. Add oil as necessary.

Oil change frequency will depend upon the cleanliness of the gas being measured. Change oil when the color darkens or when the level increases, indicating an accumulation of foreign liquids. Under favorable conditions, these periods may be from 3 to 5 years, or longer.

DO NOT add oil to the Series 3 Accessory Unit.
No scheduled lubrication maintenance is required.

ACCESSORY UNIT

Totalization of the volume is performed by a magnetically coupled gear reduction unit referred to as the Series 3 Accessory Unit. These units are permanently lubricated for long life and maintenance-free operation. They register displaced volume in actual cubic feet (ACF) or actual cubic meters (Am³). The Series 3 Accessory Unit is isolated from the pressure vessel and is not pressurized. This modular design allows interchangeability of Accessory Units on Series B meter bodies of the same size.

The HPC meters are available with both mechanical and electronic accessory units. The ROOTS® Micro Corrector, Model IMC/W2, can be mounted integrally to the 1M through 11M size meters. For those customers that require the 11M1480 with metric readout, the electronic accessory model IMC/W2 is the only available option.

NOTE: On all sizes of the IMC/W2 accessory unit pressure and temperature connectors must be external. For instructions in installing the IMC/W2 on the HPC meter, request customer Installation Instructions PN 056684-000.

Reading the Odometer

Imperial odometers

The 1M through 11M odometers with Imperial units of measure have five exposed digits. As an industry standard, the first digit on the left of the odometer is typically concealed with an opaque mask. Translucent masks are normally specified to cover the two right-most digits. The odometers for 1M and 7M meters are shown in Figure 8. When reading the odometer, the exposed digits between the arrows are typically multiplied by 100 to read the volume in hundreds of cubic feet. For example, a reading of 2576 would be read as 257,600 cubic feet. If the last two digits to the right of the arrows were included in the reading, and those numbers were 83, the reading would then be 257,683 cubic feet.

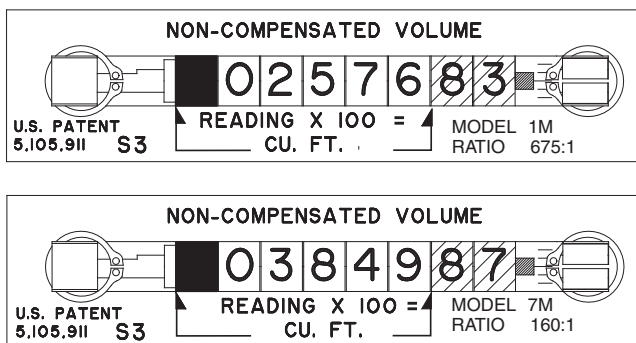


Figure 8 - Non-Compensated Series 3 Imperial unit odometer for 1M (Top) and 7M (Bottom).

NOTE: Some customers special order Accessory Units with a multiplication factor of 1000. Refer to the marking between the arrows on the Accessory Unit nameplate for verification of the multiplier used, i.e. “Reading X 100 Cu. Ft.”, or “Reading X 1000 Cu. Ft.”

Metric odometers

All 8 digits are exposed on the Metric odometer. On the 1M and 3M metric meters, the portion of the faceplate surrounding the last two digits to the right is typically printed black and a decimal point (comma) is shown just before the printing. The area between the arrows is read as cubic meters. For example, a reading of 202597 between the arrows would be read as 202597 cubic meters. If reading all 8 of the digits, a reading of 202597,39 would then translate to 202597 cubic meters plus a fractional reading of 0,39 cubic meters.

On the 5M and 7M metric meters, the portion of the faceplate surrounding the last digit to the right is printed black and a decimal point (comma) is shown just before the printing. Again, the reading between the arrows is read as cubic meters. Therefore, a reading of 1592432,7 would translate to 1592432 cubic meters plus a fractional reading of 0,7 cubic meters. Examples of metric odometers are shown in Figure 9.

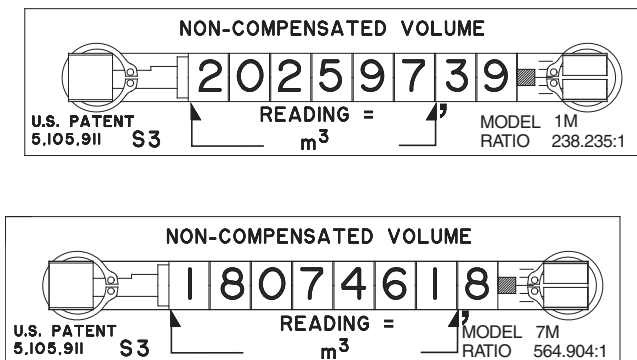


Figure 9 - Non-Compensated Series 3 Metric Unit odometers for 1M (Top), 5M (Bottom).

A test wheel is located on the right side of the odometer. The graduated increments on the test wheel represent 0.2 cubic feet. This allows for accurately estimated readings of 0.1 cubic feet. White reflective marks are located to the left of the graduated increments for prover testing with an optical scanner. For metric versions, the graduated increments on the test wheel represent 0,002 cubic meters for the 1M and 3M meters, and 0,02 cubic meters for the 5M and 7M meters. This allows for accurately estimating readings of 0,001 cubic meters and 0,01 cubic meters respectively.

NOTE: On both Imperial and Metric versions, the high speed, black-and-white proving wheel attached to the end of the RPM drive shaft is visible either from the front or the end of the accessory and can be used for verification of unit operation and meter testing. Refer to “Proving Operations.” The wheel is also shown in Figure 7 in the “Meter Start-Up” section.

Maintenance for the Series 3 Accessory

The CTR, CD, ICEX, and Solid State Pulser do not require scheduled maintenance. To clean the Lexan® cover, use warm water and soap, mineral spirits, isopropyl alcohol, or cleaning products approved for use on Lexan.

Lexan® is a registered trademark of the General Electric Company.

IMPORTANT: Aromatics, Ketones, and Chlorinated hydrocarbons will damage the Lexan® cover.

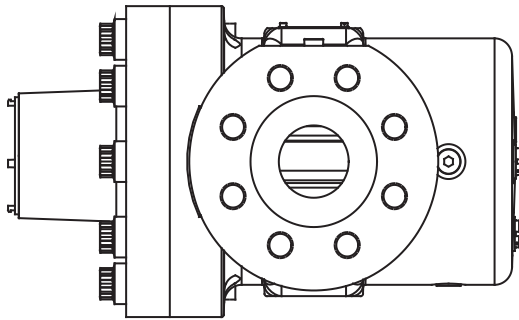


Figure 10 - Series 3 Accessories do not require oil. (CTR Version shown)

Counter (CTR) Version

The Series 3 CTR units register displaced volume in actual cubic feet (ACF) or actual cubic meters (m³) on an 8 digit odometer. The Series 3 CTR cover is molded of optical quality Lexan with a quad ring seal. The cover’s smooth cylindrical design easily sheds rain and resists accumulations of snow, ice and dirt.

NOTE: Reference the “Reading the Odometer” section for instructions on reading the Series 3 Accessory Unit.

Removing the Accessory Unit from the Meter

These general procedures require the following tools and equipment:

- 5/32” Hex wrench
- 9/64” Hex wrench
- A light grade of machine oil, grease or petroleum jelly for lubricating o-rings.
- Adjustable torque wrench with a range of 5-40 in-lbs.

Use the 5/32” hex wrench to remove the four #10-24 screws holding the slip flange on the meter end cover. (Refer to Figure 14). Loosen the screws in a cross or star-like pattern.

Remove the accessory unit by carefully pulling the complete assembly directly away from the meter body, taking care not to damage the male driving magnet on the accessory gear train. Remove the O-ring from the meter end cover, if applicable. Verify which type of o-ring seal is being used on the accessory unit before replacing.

NOTE: The newer Lexan cover will have the quad-seal O-ring installed in the Lexan Cover. If the quad o-ring comes loose from the groove in the Lexan® cover, clean the cover and O-ring with isopropyl alcohol before attempting to replace the O-ring.

For detailed information on removing/installing the accessory unit, request document 053939-000 for CTR, ICEX or Pulser versions or 054429-000 for CD version.

Installing the Accessory Unit on the Meter

Properly align the male driving magnet with the magnet cup in the meter body. (Refer to Figure 11).

While holding the Accessory Unit in place, slide the slip flange over the Lexan cover. Rotate the slip flange until all four holes in the slip flange are aligned with the four screw holes in the meter end cover. A dimple in the non-instrument drive version slip flange should be closely aligned with the odometer.

While holding the slip flange to the meter end cover, insert the four #10-24 screws into position and tighten in a cross or star-like pattern to 20-25 in.-lb. (47-53 in.-lbs. for CD version) When properly installed, the slip flange will be in continuous contact with the meter end cover. For detailed information on removing/installing the accessory unit, request document 053939-000 for CTR, ICEX or Pulser versions or 054429-000 for CD version.

If applicable, follow company procedures for installing tamper-evident security devices.

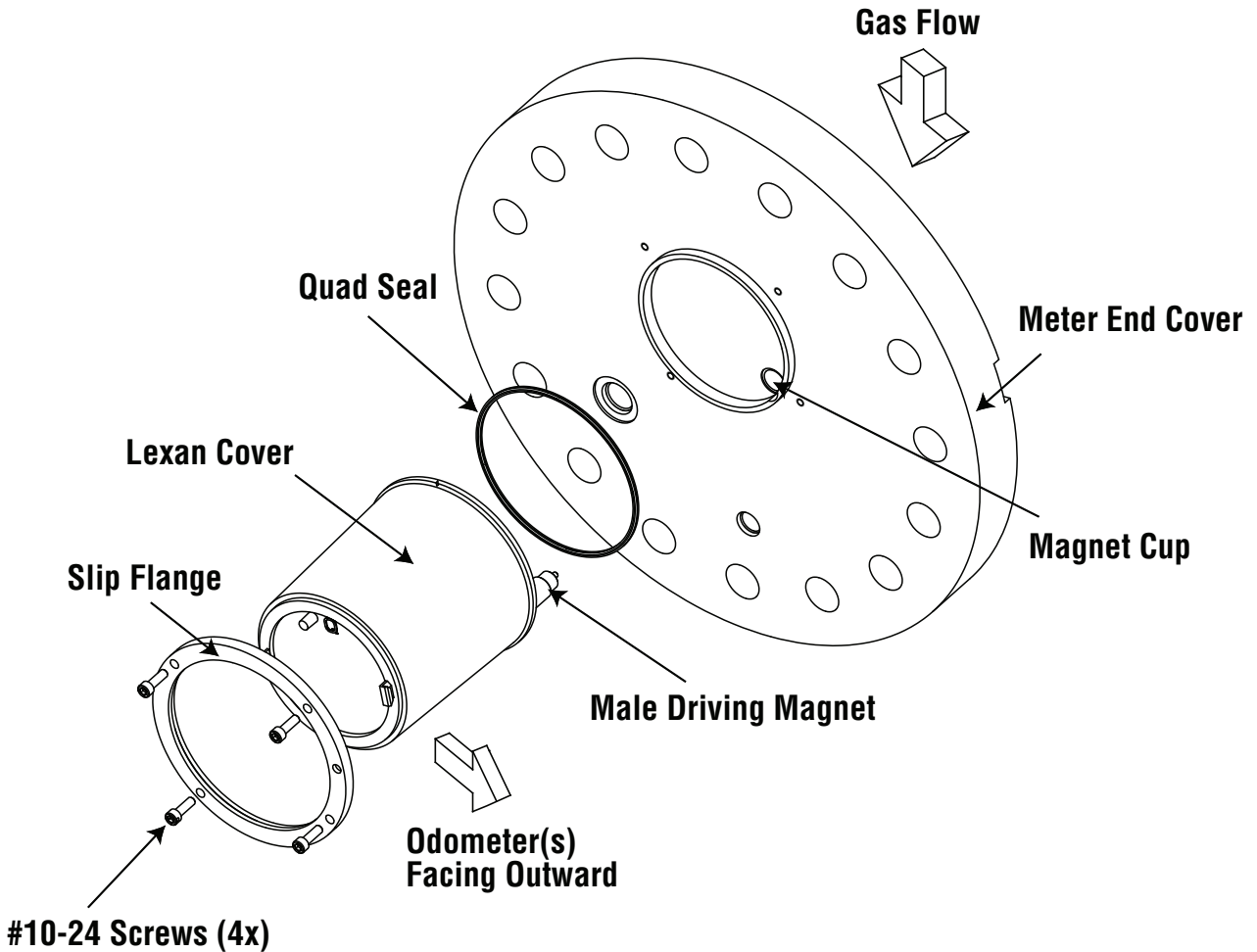


Figure 11- Assembling Series 3 Accessory to meter end cover.

Removing the Gear Reduction Assembly from the Lexan® Cover

Use a 9/64" hex wrench to remove the mounting screw holding the accessory unit in the Lexan® cover. The screw can be accessed through the Tool Access Port as shown in Figure 12.

Slide the gear reduction unit out of the Lexan® cover.

Counter with Instrument Drive (CD) Version

The Counter with Instrument Drive (CD) unit utilizes the CTR gear reduction assembly, a specially designed Lexan cover, and an Instrument Drive support assembly. The Instrument Drive (ID) support is mechanically linked to the gear reduction of the CTR unit and drives the instrument 'drive dog' at the ID output. One revolution of the instrument drive dog represents 10CF for imperial meters (0,1M3 for Metric meters).

NOTE: Lubrication is not required for the ID support housing.

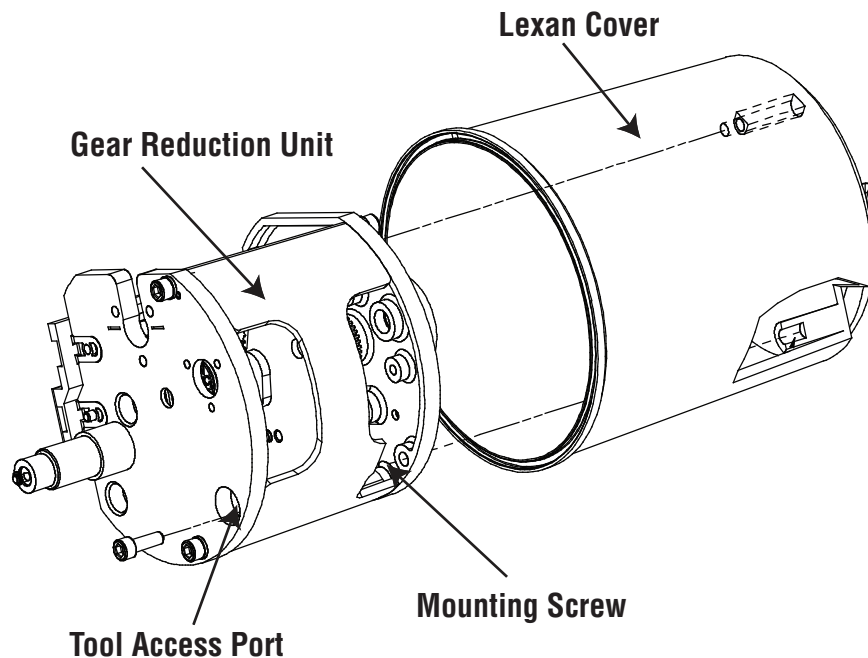


Figure 12 - Exploded view of Gear Reduction Assembly and Lexan® Cover.

Replacing the Gear Reduction Unit in Lexan® Cover

1. Slide the gear reduction unit into the Lexan cover. Align the odometer with the large, clear window on the cover. When the gear reduction unit is properly installed, the pin that is molded into the bottom of the Lexan cover will engage a hole in the bottom of the plate. (Refer to Figure 12)
2. Using a 9/64" hex wrench, insert the screw into the threaded boss on the Lexan cover and torque to 20-25 in.-lb. Do not over tighten to avoid damage to the threaded boss.

Instrument Drive Side Inlet to Top Inlet Conversion

The following procedures are required to change the orientation of the instrument drive assembly. Refer to Figures 13 and 14 for component locations.

NOTE: Regardless of the meter being mounted in either a Side Inlet or Top Inlet orientation, the Instrument Drive Accessory must always remain in a vertical (or upright) position during operation. Refer to the "METER INSTALLATION - Piping Configurations" section of this manual for proper meter mounting practices.

1. Use a flat blade (slotted) screwdriver to remove the two #1/4-20 screws holding the Universal Instrument Adapter Plate to the ID support assembly.
2. Using a 5/32" hex wrench, remove the four #10-24 screws holding the neck of the ID Support Assembly to the ID Housing.
3. Using a 5/32" hex wrench, remove the two #10-24 screws holding the Side Cover Plate onto the ID housing. Remove the cover plate.
4. Install the ID support assembly in the vertical mounting position (where the cover plate was removed). Torque the screws to 40 in.-lb.
5. Install the Side Cover Plate so it covers the open hole left by the relocation of the ID Support. Torque the screws to 5 in.-lb.
6. Using a 5/32" hex wrench, remove the two #10-24 screws holding the Front Cover Plate onto the ID housing. Remove the cover plate.
7. Using a 5/32" hex wrench, remove the two #10-24 screws holding the Modular Bevel Gear Train Assembly in place. Make sure the O-ring seal for the Modular Bevel Gear Train Assembly remains installed in the groove on the back of the assembly. Do not allow sand, dirt, or other debris to contaminate the O-ring.
9. Ensure the rotation is set as desired and the modular gear assembly meshes properly with the ID drive shaft. Refer to figure 15 for rotational direction. Windmill the meter or rotate the modular assembly a minimum of one revolution to ensure proper rotation of the Drive Dog.
10. Re-install the Front Cover and torque the screws to 5 in.-lb.
11. If applicable, follow company procedures for installing tamper-evident security devices
12. Re-install the Instrument Adapter Plate onto the ID Support Housing.

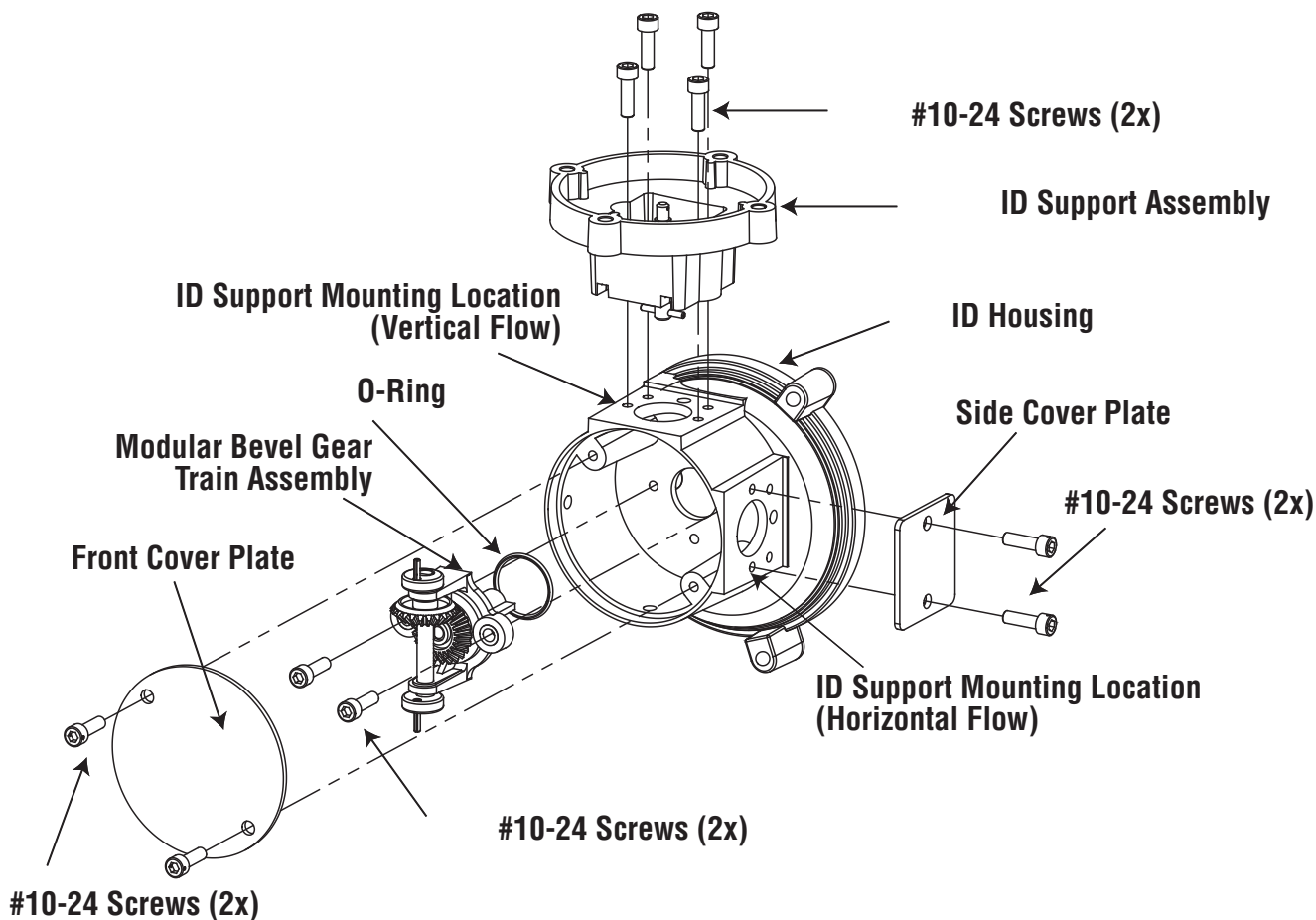


Figure 13 - Exploded View of Instrument Drive (ID) Assembly.

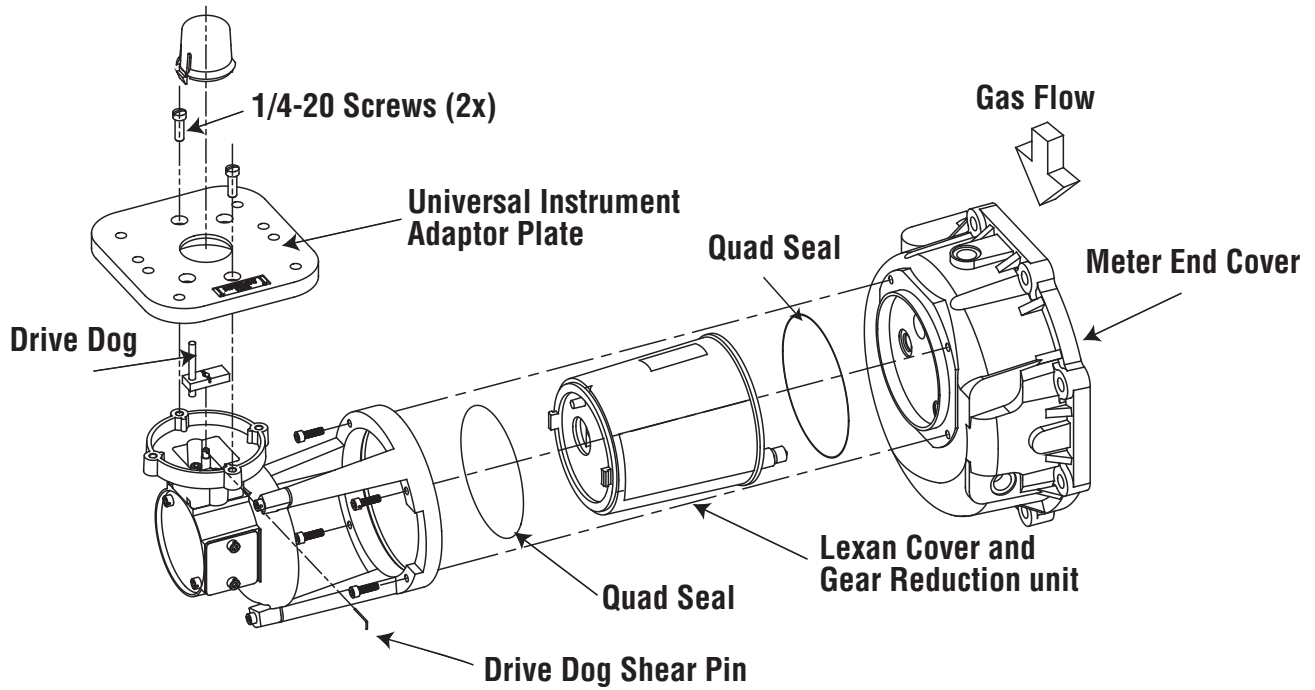


Figure 14 - Assembly Instrument Drive to meter end cover.

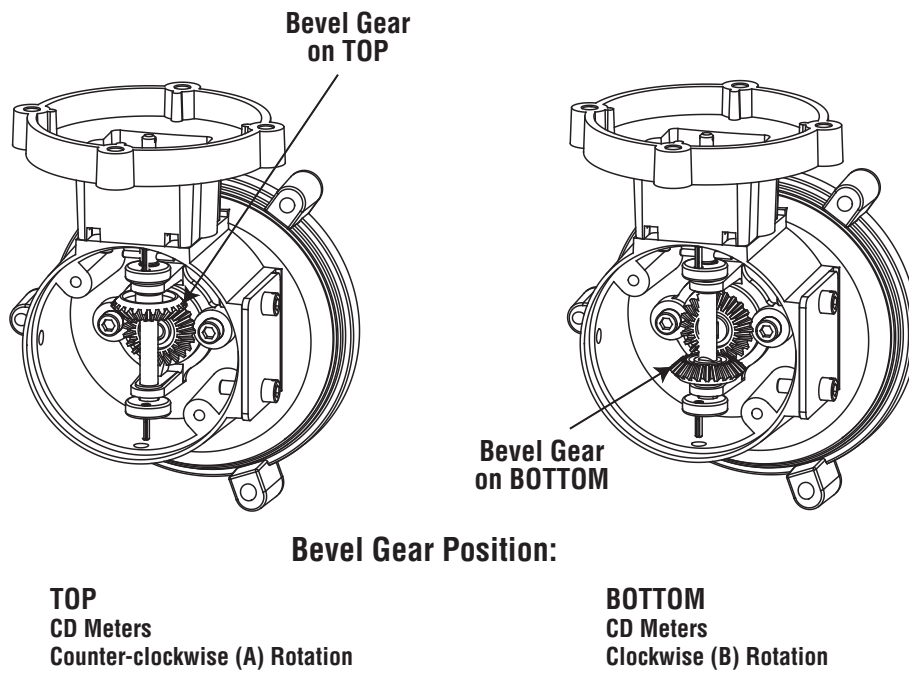


Figure 15 - Placement of bevel gears determines rotational direction.

Changing the Rotation of the Instrument Drive

Unless otherwise specified, all meters with an instrument drive are shipped from the Factory where the drive dog will turn in a Clockwise direction (CW-B). To change to Counter-clockwise (CCW-A), use the following procedure:

1. Using a 5/32" hex wrench, remove the two #10-24 screws holding the Front Cover Plate onto the aluminum ID housing. Remove the cover plate. (Refer to Figure 13 for component identification.)
2. Remove the two #10-24 screws holding the Modular Bevel Gear Train Assembly in place. Make sure the O-ring seal for the Modular Bevel Gear Train Assembly remains installed in the groove on the back of the assembly. Do not allow sand, dirt, or other debris to contaminate the O-ring.
3. Rotate the modular drive assembly 180° to obtain the proper Drive Dog rotation (refer to Figure 15). Making sure the O-ring behind modular assembly remains in place, re-install the modular gear assembly in the vertical position. Torque the screws to 5 in.-lb.
4. Ensure the rotation is set as desired and the modular gear assembly meshes properly with the ID drive shaft. Windmill the meter to rotate the modular assembly a minimum of one revolution to ensure proper rotation of the Drive Dog.
5. Re-install the Front Cover and torque the screws to 5 in.-lb.
6. If applicable, follow company procedures for installing tamper-evident security devices.

Pulsar Version

ROOTS® Pulsers generate low frequency pulses representing volumetric information for remote data collection. Pulsers are available with Single or Dual MS style circular connectors, a conduit port, or a cable gland fitting. The CTR unit's pulse output represents Non-Compensated volume only. See Table 2 for Pulse output rates. See table 3 for the wiring guide.

Table 2 - The Pulse Outputs for Series 3 Pulsers

Series B Meter Size	Series 3 Accessory	Imperial (Cubic Feet) Non-Compensated	Metric (Cubic Meter) Non-Compensated
1M-3M	CTR	10 cf	0,1 m ³
5M-11M	CTR	10 cf	1,0 m ³

Table 3- The Wiring Guide for Series 3 Pulsers

Pulsar Type	Pulsar Connection Type	Non-Compensated Signal		
		Normally Open (Signal)	Common	Normally Closed
ICPWS MSC	MS Style Circular Connection	A	B	C
ICPWD MSC	Two MS Style Circular Connections	A	B	C
ICPWS CBG	Cable Gland with Leads (Pig Tail)	Brown	Green	Red
ICPWD CBG	Two Cable Glands with Leads (Pig Tail)	Brown	Green	Red
ICPWX CND	Conduit Coupling with Lead (Pig Tail)	Brown	Green	Red

Installing a Solid State Pulser on a CTR Meter

1. The CTR Accessory must be removed from the meter. See: Removing the Accessory Unit from the Meter above. Then, remove the CTR accessory from its housing by loosening the screw inside the housing. **SEE:** Removing the Gear Reduction Assembly from the Lexan® Cover above.
2. Install Magnet and associated parts that are supplied with this conversion assembly.
3. To Install the gear train back into the housing see: Replacing the Gear Reduction Unit in Lexan Cover above. To re-install completed Pulser assembly on meter see: Installing a Complete Accessory Unit on the Meter above. **NOTE:** For detailed information on the field installation of Solid State Pulsers, request documents 057162-000 and 054190-090.

Counter with Electronic Transmitter (ICEX) Version

Like the ROOTS® Solid State Pulsers, Counters with Electronic Transmitters have a magnetically driven pulser installed internally in the Counter (CTR) cover. The system generates a single channel high frequency pulse directly from the impeller's revolution taken off of the high speed dial. This in turn allows for remote collection of volume while also providing a high frequency pulse rate suitable for an accurate determination of flow rate. Pulse rates are shown in Table 4.

The solid state construction eliminates mechanical switches and ensures maximum reliability. No battery or maintenance is required. The standard ICEX is supplied with a single MS style circular connector, a conduit port or a cable gland fitting. Table 4 provides Pulse rates for the ICEX and Table 5 provides wiring information for the ICEX.

Table 4 - Pulse outputs for ICEX Accessory Units in relation to meter sizes.

Meter Type	Freq. (Hz)	Volume per Pulse		Pulses per Volume*		Flow Rate (ACFH)
		(CF)	(m3)	(CF)	(m3)	
1M740	75.00	0.003704	0,000104877	270	9535	1,000
3M740	166.67	0.005000	0,000141584	200	7063	3,000
1M1480	75.00	0.003704	0,000104877	270	9535	1,000
3M1480	166.67	0.005000	0,000141584	200	7063	3,000
5M1480	100.00	0.013889	0,000393290	72	2543	5,000
7M1480	124.45	0.015625	0,000442451	64	2260	7,000
11M1480	97.78	0.03125	N/A	32	N/A	11,000

* Pulse per volume rounded to nearest whole number. For calculation purposes, use volume per pulse.

Table 5 - Wiring guide for Series 3 ICEX.

ICEX Connection Type	Normally Open (Signal)	Common
MS Style Circular Connection	A	B
Conduit with Leads	White	Black
Cable Gland with Leads	White	Black

Installing a Counter with Electronic Transmitter (ICEX) to a CTR Accessory

1. The CTR Accessory must be removed from the meter. **SEE:** Removing the Accessory Unit from the Meter above. Then, remove the CTR accessory from its housing by loosening the screw inside the housing. **SEE:** Removing the Gear Reduction Assembly from the Lexan® Cover above.
2. Install Magnet and associated parts that are supplied with this conversion assembly.
3. To Install the gear train back into the housing see: Replacing the Gear Reduction Unit in Lexan Cover above. To re-install completed Pulser assembly on meter see: Installing a Complete Accessory Unit on the Meter above. **NOTE:** For detailed information on the Installation of the ICEX, request document #056098-100.

SERIES B3-HPC CARTRIDGE REPLACEMENT AND CHANGEOUT

Cartridge Change-out / Replacement

Meter cartridges are field replaceable for ease of maintenance and repair. The 1M and 3M cartridges will fit in either the 740 PSIG or 1480 PSIG meter housing while the 5M and 7M cartridges share a common 1480 PSIG meter housing. Within a family size, a cartridge can be exchanged for a different size cartridge if the meter capacity requirements change; for example, the 1M and 3M cartridges are interchangeable as a family. The 5M and 7M belong to a separate family but these cartridges are also interchangeable within that family. The 11M is a separate meter and does not share parts with any others. When changing measurement cartridges, ensure the Accessory Unit matches the cartridge size. A 3M cartridge must be used in conjunction with a 3M HPC Accessory Unit, etc. The Accessory Unit model (size) is identified on the lower right-hand corner of the accessory nameplate, while the cartridge is identified on the cartridge headplate. Special Tooling is required for the removal and installation of cartridges. For 1M and 3M meters, use the

Cartridge Removal Kit P/N 057954-000. For the 5M, 7M and 11M meters, use the Cartridge Installation/Removal Kit P/N 057954-100. The Cartridge Installation/Removal Kits are reusable tooling. If the Cartridge is being removed for inspection purposes only, please replace all cartridge seals. For 1M and 3M meters use Seal Kit P/N 058439-000. For 5M, 7M and 11M meters use Seal Kit P/N 058439-100. For detailed information on changing or converting a 1M or 3M cartridge request document 054523-000. For detailed information on changing or converting the 5M, 7M and 11M cartridges, request document 056352-000.

IMPORTANT: Verify that the model size written on the bottom right of the Accessory face plate matches the model size stamped on the Cartridge Data nameplate.

TESTING

Rotary meters can be tested for accuracy by several industry standard accepted methods. These test methods include, but are not limited to, bell or piston Provers, transfer Provers, sonic nozzle Provers, and critical flow proving. The Differential Test is unique to rotary meters and is an accurate and convenient method of comparing a meter's performance to previous or original performance records. Differential testing is accepted by many State Utility Commissions as a means of periodically substantiating that the original accuracy of a meter has remained unchanged.

Differential Test

A change in the meter's internal resistance can affect rotary meter accuracy. Any significant increase in the meter's internal resistance to flow will increase the pressure drop between the inlet and outlet of the meter, thus increasing the differential. Therefore, the meter differential pressure appears as a prime indicator of meter condition. A test under actual operating conditions will provide the most reliable data for future checks of a meter's operating condition. Although accuracy cannot be directly determined by differential testing, independent test results have shown that an increase of up to 50 percent in differential pressure, at the higher flow rates, can be tolerated without affecting meter accuracy by more than 1 percent.

A differential test consists of a series of differential pressure readings taken across the meter's differential taps at several gas flow rates within the meter's capacity range. Location of meter differential taps is shown in Figure 16. Testing should be performed when the meter is first installed and under the actual conditions of gas line pressure and specific gravity that will exist in service. This is particularly important when the line pressure is higher than 15 PSIG (200 kPa Absolute). Since the meter differential pressure increases with line pressure, multiple curves may be necessary for meters under varying pressure conditions. Refer to Figure 17.

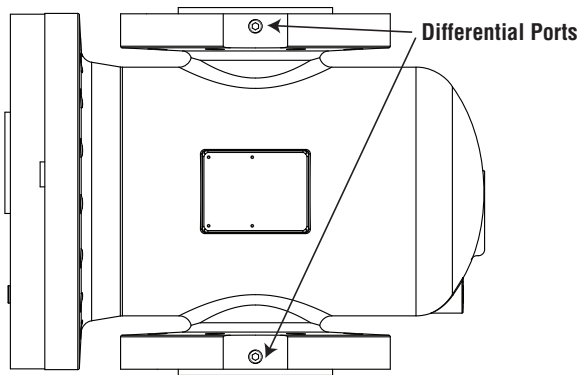


Figure 16 - Differential pressure taps are located above and below the meter nameplate.

Establishing Baseline Curves

Developing an original differential baseline curve is recommended at the time of meter initial installation. Since an increase in flow rate, line pressure or specific gravity will cause an increase in the differential, at least three (3) test points are required at gas flow rates from 25% to 100% of meter capacity. As shown in Figure 17, the resulting data points will be non-linear, so a minimum of three points is necessary to establish a curve. Plot the points on a graph and then connect the points to form a curve. This provides an accurate baseline for comparison to later tests. To help with record keeping, a chart like the one shown in Figure 18 will allow the technician to compare new test data to older data.

NOTE: The line pressure, specific gravity of the gas, and line temperature should also be recorded. If the application is under varying pressure conditions, plot multiple curves for various pressure ranges (e.g., 150, 300, 450 and 600 psig).

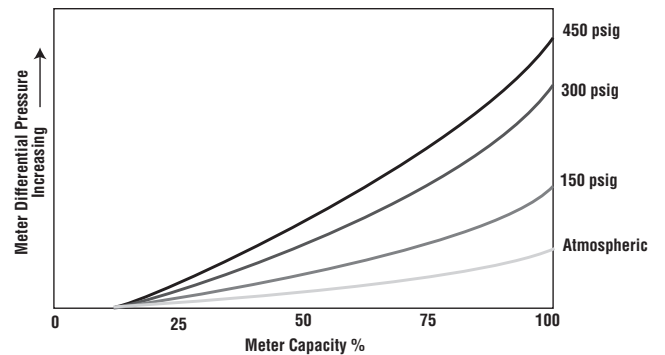


Figure 17 - Differential Curves change as pressure increases.

Differential - Rate Test Data - SAMPLE SHEET									
Meter Model:				Mfg. Serial No.:			Utility Serial No.:		
Location:				Date Installed:			Register Reading:		
Line Pressure	Gas Temp	Specific Gravity	Volume Measured	Run Time	Rate (ft³)	Differential Pressure In. W.C.	% Change	Date	Tester
Initial Tests - New Meter									
Periodic Check Tests									

Figure 23 - Having a single data chart for each meter provides a detailed history of differential rate tests for future use.

After developing a baseline curve, meter condition and performance can be checked periodically by running a similar differential test at a single selected point. This does not give the overall characteristics for the meter, but does provide a quick reference check. Differentials taken at varying flow rates are needed to give an overall picture. If the differential pressure increases by more than 50 percent of the original value, inspect the meter for causes of increased resistance. Principal causes are binding of impellers, worn bearings, contaminants in the metering chamber and, too much or too heavy oil.

Test Procedure

The test is performed using a manometer, or differential pressure gauge with an indicating scale range of about 200 inches of water column (7.2PSI or 50kPa). The testing device should have inlet, outlet, and bypass valving and must be pressure rated for the maximum allowable pressure of the meter (740 or 1480PSIG). Pressure lines should be connected to the 1/4" meter inlet and outlet pressure taps located on the meter's flanges. A pressure gauge is used to verify pressure readings. A stop watch is used to "clock" the meter RPM for calculating gas flow rate.

CAUTION: When the meter is pressurized, follow applicable safety rules and wear appropriate protective apparatus.

1. Install the differential pressure gauge into the meter inlet and outlet differential taps. Follow the manufacturer's instructions for proper installation and operating procedures. On the upstream side of the meter, install a pressure gauge or other pressure standard if not a component of the test equipment.
2. Adjust the meter bypass and the meter inlet valves until the meter is operating at a predetermined or selected flow rate in the lower capacity range, no less than 25 percent of the meter's rated capacity. Let the flow rate stabilize.
3. Time or "clock" the passage of a predetermined volume of gas as registered on the odometer or instrument to determine the Flow Rate in Actual Cubic Feet per Hour (or m3/h):

$$\text{Index Rate} = \frac{(\text{Test Volume in CF}) \times (3600)}{(\text{Test Time in Seconds})}$$

Convert the calculated flow rate to a percentage of meter rated capacity:

$$\% \text{ Meter Capacity} = \left(\frac{\text{Index Rate}}{\text{Meter Base Rating}} \right) \times 100$$

NOTE: The base rating for a meter can be found on the nameplate located on the body of the meter. The rating is designated in both "CFH Max" and "m3/h Max".

4. Record the pressure differential, line pressure, and gas specific gravity. Repeat the test to obtain an accurate average reading.

NOTE: At the time of meter start-up in a new installation, repeat Steps 2 - 3 at a minimum of three different flow rates, each between 25% and 100% of meter capacity. The original baseline curve should be drawn using data at a constant pressure for all three tests.

5. Remove the differential test equipment and pressure standard.
6. If the pressure differential is within acceptable limits, return the meter to full operation. If the pressure differential is higher than recommended, remove the meter for inspection and service.

For Factory repairs and/or inspection, please call our Product Services Department, your Customer Service Representative or your local Sales Representative or Distributor and request a Return Material Authorization (RMA).

Proving Operations

The accuracy of a ROOTS® meter is easily verified using standard transfer proving techniques. A Model 5 ROOTS® Prover allows for virtually hands free testing and offers four different methods for collecting field meter volume data. The first two methods, which utilize original equipment included with the Model 5 Provers, are performed using the Manual Start/Stop Switch and the field meter Instrument Drive Pulser. With the manual Start/Stop switch, the operator will input the desired test volume into the Model 5 program. After the flow and temperature have stabilized, the operator will use the switch to start the test. After the field meter odometer has reached the predetermined volume, the operator again pushes the switch to stop the test.

For non-compensated meters with an Instrument Drive, the field meter Instrument Drive Pulser mounts directly to the instrument drive and provides a more accurate automated test. The desired volume is selected and the Prover will automatically start the test after conditions have stabilized and will then automatically stop the test at the predetermined test volume.

Optional equipment for the Model 5 Provers include the ROOTS-Scanner and a Field CTR Pulser Module. Like the Instrument Drive Pulser, these options also automate the control of the test. The Scanner uses a light beam to focus on any high contrast moving target like the white squares on the right side of the odometer or the high speed RPM dial at the end of the Series 3 Accessory Unit. The shift from white to black (and vice versa) triggers a pulse relating to a specific volume. A hardware kit is included with the ROOTS-Scanner Assembly to ease the task of securing and focusing on the Series 3 Accessory Unit. These items may also be purchased separately. For “pulser ready” CTR meters, the Field CTR Pulser Module is installed by “snapping” the pulser onto the end of the Series 3 Accessory Unit. Test results derived from the instrument drive, non-compensated odometer, RPM dial, or the Field CTR Pulser Module will all provide the “Uncorrected Accuracy” of the meter.

Specific testing information can be found in the Model 5 Prover “Help Files.”

TROUBLE SHOOTING CHECKLIST

Trouble	Item	Possible Cause	Remedy
No Flow Registered	1	Obstruction in piping or meter.	Check piping and valves to assure an open flow path. Check for impeller rotation. Refer to Step #5 in the "Placing Meter in Line" section of this manual.
	2	Index or RPM wheel does not turn.	No gas flow. Open valve or remove obstruction per Item #1.
Low Volume Registration	3	Meter oversized for load.	Use proper meter size.
	4	Leak at meter bypass.	Check bypass and valves.
	5	Meter internal friction.	See High Differential, Item #6.
High Differential	6	Build-up of deposits in measuring chamber.	Flush meter.
	7	Worn bearings or gears.	Replace or Return to Dresser's Product Services Dept.
	8	High oil level or heavy oil.	Check oil level and cleanliness.
	9	Impellers rubbing cylinder or headplates, or meter out of time.	Rotate impellers manually to check for binding or rubbing. Remove obstructions.
Vibration/Noise	10	Impellers rubbing casing.	See items #7 & #9.
	11	Contaminants in measuring chamber.	See item #6.

Imperial Sizing Charts

HIGH PRESSURE METERS							
MODEL	1M740	1M1480	3M740	3M1480	5M1480	7M1480	11M1480
RATING	1000	1000	3000	3000	5000	7000	11000
PSIG	Corrected Capacity at Metering Pressure — in MSCFH						
1	1.0	1.0	3.1	3.1	5.2	7.3	11.5
25	2.7	2.7	8.0	8.0	13.4	18.7	29.4
50	4.4	4.4	13.1	13.1	21.9	30.6	48.1
75	6.1	6.1	18.2	18.2	30.3	42.5	66.8
100	7.8	7.8	23.3	23.3	38.8	54.4	85.4
125	9.5	9.5	28.4	28.4	47.3	66.2	104.1
150	11.2	11.2	33.5	33.5	55.8	78.1	122.8
175	12.9	12.9	38.6	38.6	64.3	90.0	141.4
200	14.6	14.6	43.7	43.7	72.8	101.9	160.1
225	16.3	16.3	48.8	48.8	81.3	113.8	178.8
250	17.9	17.9	53.8	53.8	89.7	125.6	197.4
275	19.6	19.6	58.9	58.9	98.2	137.5	216.1
300	21.3	21.3	64.0	64.0	106.7	149.4	234.8
325	23.0	23.0	69.1	69.1	115.2	161.3	253.5
350	24.7	24.7	74.2	74.2	123.7	173.2	272.1
375	26.4	26.4	79.3	79.3	132.2	185.1	290.8
400	28.1	28.1	84.4	84.4	140.7	196.9	309.5
425	29.8	29.8	89.5	89.5	149.2	208.8	328.1
450	31.5	31.5	94.6	94.6	157.6	220.7	346.8
475	33.2	33.2	99.7	99.7	166.1	232.6	365.5
500	34.9	34.9	104.8	104.8	174.6	244.5	384.1
550	38.3	38.3	114.9	114.9	191.6	268.2	421.5
600	41.7	41.7	125.1	125.1	208.6	292.0	458.8
650	45.1	45.1	135.3	135.3	225.5	315.7	496.2
700	48.5	48.5	145.5	145.5	242.5	339.5	533.5
740	51.2	51.2	153.6	153.6	256.1	358.5	563.4
800		55.3		165.9	276.4	387.0	608.2
850		58.7		176.0	293.4	410.8	645.5
900		62.1		186.2	310.4	434.5	682.9
950		65.5		196.4	327.4	458.3	720.2
1000		68.9		206.6	344.3	482.1	757.5
1050		72.3		216.8	361.3	505.8	794.9
1100		75.7		227.0	378.3	529.6	832.2
1150		79.0		237.1	395.2	553.3	869.5
1200		82.4		247.3	412.2	577.1	906.9
1250		85.8		257.5	429.2	600.9	944.2
1300		89.2		267.7	446.2	624.6	981.6
1350		92.6		277.9	463.1	648.4	1018.9
1400		96.0		288.1	480.1	672.2	1056.2
1450		99.4		298.2	497.1	695.9	1093.6
1480		101.5		304.4	507.3	710.2	1116.0

NOTE: All capacities listed are Standard Cubic Feet per Hour (SCFH) and based upon Average Atmospheric Pressure (14.4 PSIA), Base Pressure (14.73 PSIA), and Base Temperature (60°F). Tables do not take into account Supercompressibility. Please refer to RM-135 for further information on the Application of Temperature and/or Pressure Correction Factors in Gas Measurement.

SIZING INSTRUCTIONS

To select the proper meter size, use the Minimum Operating Pressure and the Maximum Instantaneous Hourly Flow Rate. Do not exceed meter's maximum allowable operating pressure.

To prevent oversizing of a meter, sizing should be based upon the total connected load giving consideration to the load diversity. When using this method to size a meter, a selected diversity factor times the total connected load will be used as the Maximum Instantaneous Flow Rate for sizing purposes.

A diversity factor of 0.85 is commonly used for a single application where two or more major appliances are in use (i.e., boilers, furnaces, space heaters, etc.).

As the number of appliances considered when determining a connected load increases, the diversity factor will typically decrease. For applications such as multiple ranges and water heaters, some examples of commonly used diversity factors are:

Qty	Factor	Qty	Factor*
0-5	1	6	0.9
7	0.85	8	0.83

* The diversity factors listed above are estimates. For proper sizing, consult your company or industry standards for determining accepted values.

ENERGY VALUE

Gas	BTU/Cu. Ft.
Acetylene	1498
Butane	3200
Ethane	1758
Ethylene	1606
Methane	997
Natural	965/1055
Propane	2550

Metric Sizing Charts

HIGH PRESSURE METERS - METRIC									
MODEL RATING			1M740	1M1480	3M740	3M1480	5M1480	7M1480	11M1480
			28,3	28,3	85,0	85,0	141,6	198,2	311,5
PSIG	Bar	kPa	Corrected Capacity at Metering Pressure - in Nm ³ /H						
1	0,1	6,9	29,6	29,6	88,9	88,9	148,0	207,2	325,7
25	1,7	172,4	75,7	75,7	227,4	227,4	378,8	530,1	833,2
50	3,4	344,7	123,7	123,7	371,6	371,6	619,1	866,5	1361,9
75	5,2	517,1	171,8	171,8	515,9	515,9	859,4	1202,9	1890,6
100	6,9	689,5	219,8	219,8	660,1	660,1	1099,7	1539,3	2419,3
125	8,6	861,8	267,8	267,8	804,4	804,4	1340,1	1875,7	2947,9
150	10,3	1034,2	315,9	315,9	948,7	948,7	1580,4	2212,1	3476,6
175	12,1	1206,6	363,9	363,9	1092,9	1092,9	1820,7	2548,5	4005,3
200	13,8	1379,0	411,9	411,9	1237,2	1237,2	2061,0	2884,9	4534,0
225	15,5	1551,3	459,9	459,9	1381,5	1381,5	2301,4	3221,3	5062,7
250	17,2	1723,7	508,0	508,0	1525,7	1525,7	2541,7	3557,6	5591,4
275	19,0	1896,1	556,0	556,0	1670,0	1670,0	2782,0	3894,0	6120,0
300	20,7	2068,4	604,0	604,0	1814,3	1814,3	3022,3	4230,4	6648,7
325	22,4	2240,8	652,1	652,1	1958,5	1958,5	3262,7	4566,8	7177,4
350	24,1	2413,2	700,1	700,1	2102,8	2102,8	3503,0	4903,2	7706,1
375	25,9	2585,5	748,1	748,1	2247,0	2247,0	3743,3	5239,6	8234,8
400	27,6	2757,9	796,2	796,2	2391,3	2391,3	3983,6	5576,0	8763,4
425	29,3	2930,3	844,2	844,2	2535,6	2535,6	4224,0	5912,4	9292,1
450	31,0	3102,6	892,2	892,2	2679,8	2679,8	4464,3	6248,7	9820,8
475	32,8	3275,0	940,3	940,3	2824,1	2824,1	4704,6	6585,1	10349,5
500	34,5	3447,4	988,3	988,3	2968,4	2968,4	4944,9	6921,5	10878,2
550	37,9	3792,1	1084,4	1084,4	3256,9	3256,9	5425,6	7594,3	11935,5
600	41,4	4136,9	1180,4	1180,4	3545,4	3545,4	5906,2	8267,1	12992,9
650	44,8	4481,6	1276,5	1276,5	3833,9	3833,9	6386,9	8939,9	14050,3
700	48,3	4826,3	1372,5	1372,5	4122,5	4122,5	6867,6	9612,6	15107,6
740	51,0	5102,1	1449,4	1449,4	4353,3	4353,3	7252,1	10150,9	15953,5
800	55,2	5515,8		1564,7		4699,5	7828,9	10958,2	17222,4
850	58,6	5860,5		1660,7		4988,1	8309,5	11631,0	18279,7
900	62,1	6205,3		1756,8		5276,6	8790,2	12303,7	19337,1
950	65,5	6550,0		1852,9		5565,1	9270,8	12976,5	20394,5
1000	68,9	6894,8		1948,9		5853,6	9751,5	13649,3	21451,8
1050	72,4	7239,5		2045,0		6142,2	10232,1	14322,1	22509,2
1100	75,8	7584,2		2141,0		6430,7	10712,8	14994,8	23566,6
1150	79,3	7929,0		2237,1		6719,2	11193,4	15667,6	24623,9
1200	82,7	8273,7		2333,2		7007,7	11674,1	16340,4	25681,3
1250	86,2	8618,4		2429,2		7296,3	12154,7	17013,2	26738,7
1300	89,6	8963,2		2525,3		7584,8	12635,4	17686,0	27796,0
1350	93,1	9307,9		2621,4		7873,3	13116,0	18358,7	28853,4
1400	96,5	9652,7		2717,4		8161,8	13596,7	19031,5	29910,8
1450	100,0	9997,4		2813,5		8450,4	14077,3	19704,3	30968,1
1480	102,0	10204,2		2871,1		8623,5	14365,7	20107,9	31602,6

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