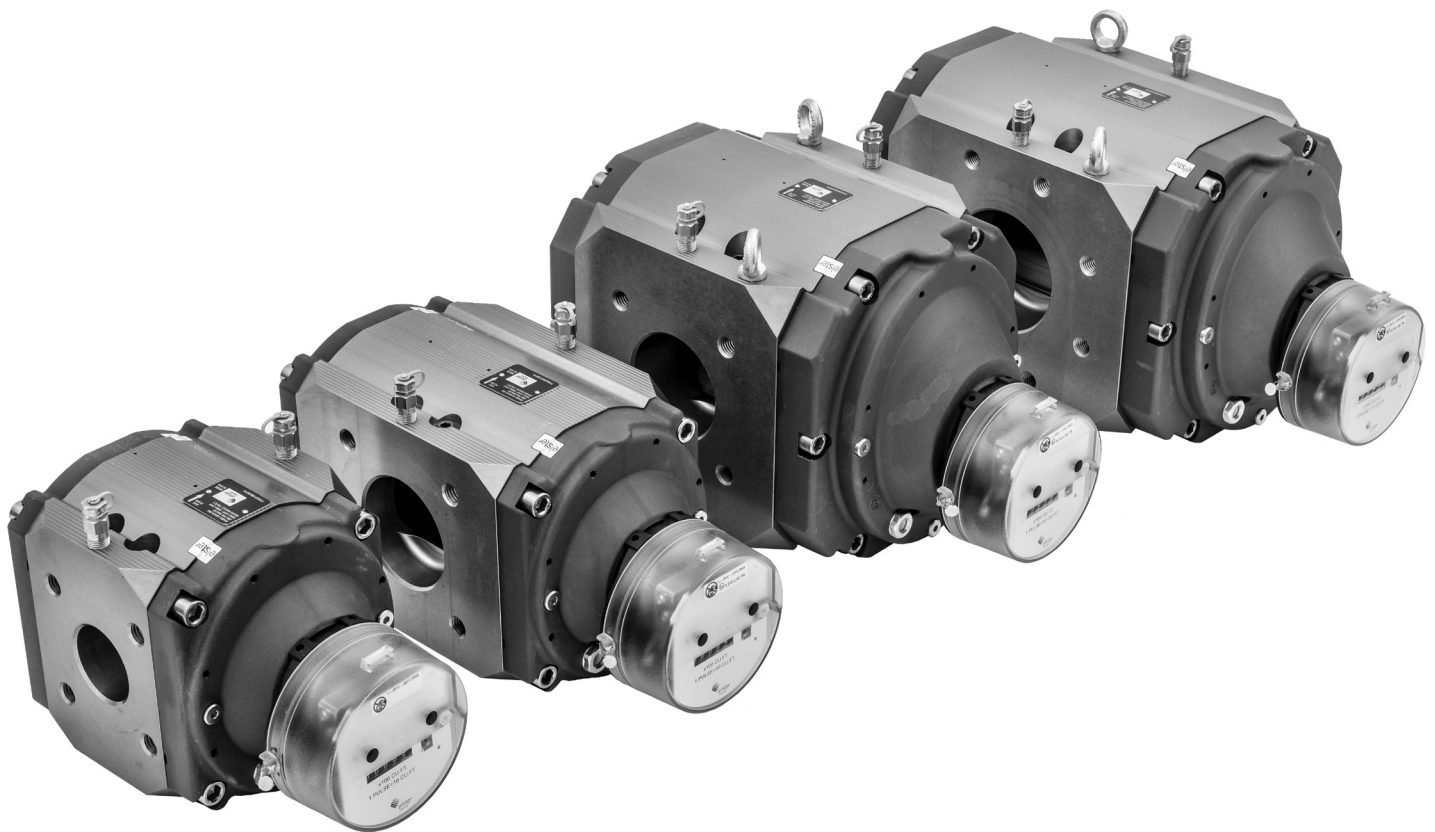


RABO® Rotary Gas Meter

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Instruction Manual



RABO® Rotary Gas Meter

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1. General Information

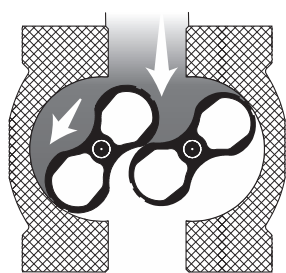
This manual covers the installation, operation and maintenance for the Elster Instramet RABO Rotary Meter. Refer to EAM-TB5900 for additional information.

2. Intended Use and Application

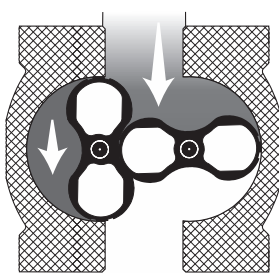
Elster RABO meters are suitable for measuring most types of clean, dry, non-corrosive common gases. They are NOT intended for use on biogas, sewage gas, oxygen, acetylene or liquids of any kind. Product life and measurement accuracy can be affected by contamination in the gas stream. Periodic servicing will prolong the life and performance of the meter.

3. Operating Principle

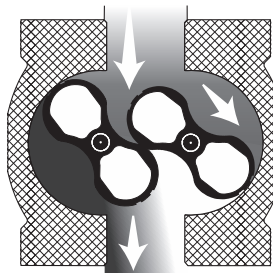
The RABO meter utilizes positive displacement principle of operation which makes volumetric measurements by displacing finite volumes of gas. The positive displacement occurs within a cavity formed between the meter's internal housing and its rotating impellers. The counter-rotating "figure-8" impellers [Figure 1] turn as a result of pressure drop across the meter's inlet and outlet created as downstream gas is consumed. The rotating impellers separate the flowing gas into small, finite volumes and are counted using a mechanical index. The RABO meter has no wearing parts because precision clearances between the impellers and meter body are maintained by timing gears, which are designed to enhance long term accuracy. Combining adequate filtration and periodic maintenance, a RABO meter will remain accurate over many years.



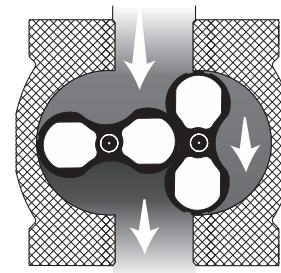
As the left impeller rotates toward the vertical position, gas enters the cavity created between the impeller and the housing.



When the left impeller reaches the vertical position, a finite volume of gas is captured in the left cavity.



As the impellers continue to turn, the volume of gas in the left cavity is discharged. Simultaneously, gas is entering the space between the right impeller and housing.



After further rotation, the right impeller becomes vertical and a finite volume of gas is captured in the right cavity.

Figure 1. Operating Principle

4. Receiving, Handling and Storage

Elster RABO meters should be handled with care to protect the product from damage. If the package shows evidence of damage through mishandling in transit, you should notify the shipper immediately, file a claim with the carrier and notify your Elster supplier.

Damage to internal components may occur without visible external damage. All new meters should be inspected and checked for free rotation of the impellers by lightly blowing into the inlet of the meter. This slight air pressure should cause the impellers to rotate freely and come to a stop slowly.

NOTICE

DO NOT attempt to make any repairs. Tampering with the meter may void warranty coverage.

If a meter shows signs of external damage, or if the impellers do not rotate freely, contact your local Elster sales representative for return instructions.

Elster RABO meters are supplied with oil in a separate container. A material safety data sheet (MSDS) is available upon request. DO NOT put oil in the meter until it is installed and leveled in the gas piping system. Meters containing oil that are transported or not installed level may lead to contamination of the measurement chamber, and will impact accuracy.

Store Elster RABO meters in their original shipping container in a dry location until installation. If prolonged storage is experienced, RABO meters should be tested for accuracy before installation.

5. Installation

Elster RABO meters can be installed in horizontal or vertical (top inlet) piping configurations. Vertical (top inlet) piping is preferred because it enables the meter to pass contaminants more freely through the meter. All piping should be properly supported and aligned to eliminate any strain on the meter, which may cause the impellers to bind.

Recommended piping practices include a filter or strainer on the inlet of the meter and non-lubricated isolation valves. A bypass line will facilitate maintenance and removal of the meter and provide uninterrupted gas supply.

The meter should not be installed lower than the outlet pipe run. If it is necessary to install the meter lower than the outlet pipe run, installation of a drip leg in the outlet piping to capture condensate is recommended. The meter should never be located at the lowest point in the system.

A restricting orifice can also be installed at least 4 pipe diameters downstream of the outlet of the meter to prevent the meter from flowing excess capacity. Warranty does not cover failures due to excess flow conditions.

a) Piping Configurations [Figures 2, 3 and 4]

NOTICE

DO NOT weld piping while meter is installed in the piping system.

NOTICE

If hydro testing, remove the meter from the piping system.

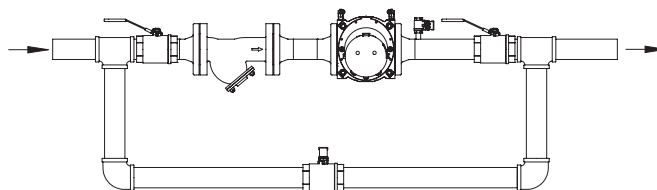


Figure 2. Horizontal installation, side view

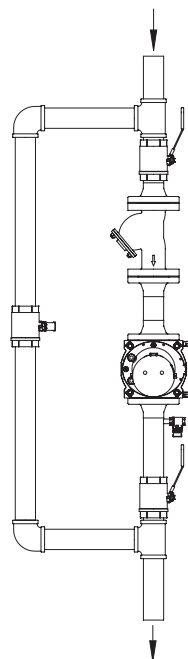


Figure 3. Vertical installation, side view

b) Mounting

- 1) Always follow your company's procedures, and applicable local codes and ordinances.
- 2) Ensure gas valves are closed.
- 3) Ensure the upstream piping is clean and free of any debris.
- 4) Remove protective caps from meter inlet and outlet prior to installation.
- 5) Ensure the impellers turn freely.
- 6) Ensure the direction of flow using the arrow on the nameplate.
- 7) Ensure the meter orientation is correct. Impeller shafts must be horizontal [Figure 4].

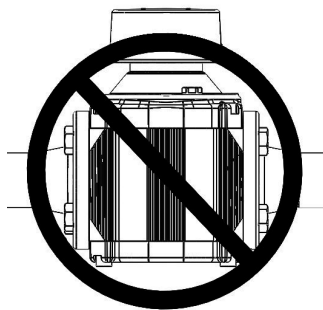


Figure 4. Side view

- 8) Connect the inlet and outlet pipe flanges using appropriate bolts and gaskets. Inlet and outlet pipe flanges should be parallel and should not introduce any bind on the meter body when tightened.
- 9) Level meter to within 1/16" per foot in all directions and tighten flange bolts evenly (maximum 80ft-lbs).

c) Adding Oil

**WARNING**

Add oil only to the index end of the meter.

- 1) Ensure gas valves are closed and meter and piping are depressurized.

**WARNING**

Failure to depressurize the meter prior to removing meter and/or components could result in personal injury and/or property damage.

- 2) Remove oil fill plug in the counter end case cover using a 5mm hex key [Figures 5 and 6].
- 3) Using the supplied syringe and oil, slowly add oil until it is $\pm 1/16"$ of the center of the sight glass [Figure 7]. **DO NOT OVERFILL.** Only use Shell Morlina lubricating oil.

**WARNING**

DO NOT remove any sight glasses. No maintenance can be performed through these openings.

- 4) Reinstall the oil fill plug.

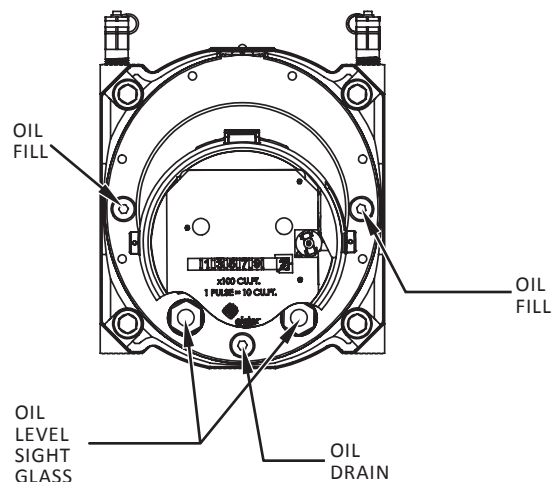


Figure 5. Horizontal installation

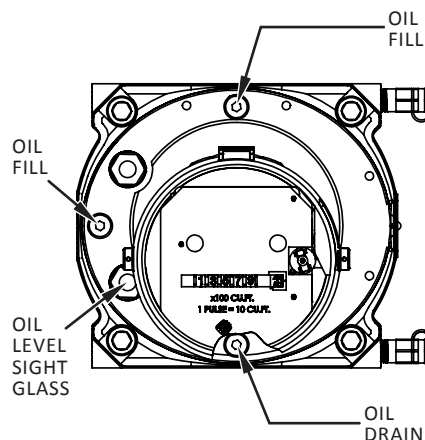


Figure 6. Vertical installation

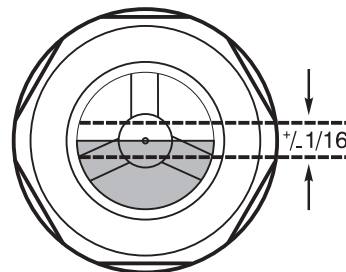


Figure 7. Sight glass

6. Start-up/Commissioning

After the meter has been properly installed, it is important to use extreme care during start-up to mitigate adverse conditions that can damage the meter.

- a) Ensure that the maximum operating pressure of the meter will not be exceeded.
- b) Always follow your company's procedures, and local codes and ordinances.
- c) With the meter run's inlet and outlet valves closed, open the bypass valve and pressurize the piping system.
- d) With the meter outlet valve closed, slowly open the meter inlet valve not to exceed 5 psig per second until pressure is equalized throughout the meter piping system. Rapid pressurization can cause an over-speed condition and can damage the meter. Damage will not be covered under warranty. When the meter piping system pressure is stabilized, open the inlet valve completely.
- e) Slowly open the meter's outlet valve until the meter starts to operate at low speed. Meter speed can be seen through the view port located on the back of the meter [Figure 8].

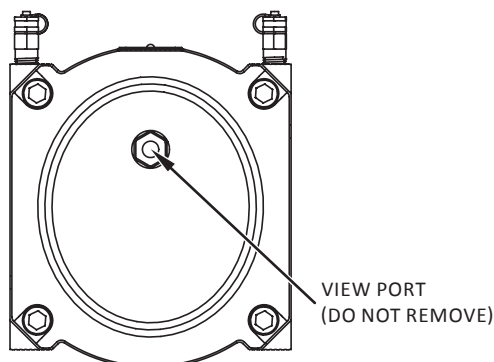


Figure 8. Back of meter

- f) Operate the meter at low flow for 1 to 2 minutes to verify proper operation. If the index does not start registration, or if you hear knocking or scraping sounds coming from the meter, stop the flow and follow appropriate decommissioning procedures before removing the meter from the line.
- g) If operation is satisfactory, gradually open the meter's outlet valve to the full open position.
- h) Slowly close the bypass valve.
- i) Check the meter connections for leaks using common industry practices.
- j) Clock the meter (see Index section 11c) to confirm the flow rate is not exceeding the maximum capacity of the meter.
- k) Perform and record the meter's differential pressure (see Testing section 9b).

7. Decommissioning and Removal

- a) Always follow your company's procedures, and local codes and ordinances.
- b) Slowly open bypass valve.
- c) Slowly close the meter's outlet valve, then the inlet valve.
- d) Slowly, completely depressurize the meter piping.



Failure to depressurize the meter prior to removing meter and/or components could result in personal injury and/or property damage.

- e) Drain oil from the index end case cover and dispose of the oil in accordance with applicable regulations.
- f) If removing the meter from the piping system, loosen flange bolts. Ensure meter is properly supported before removing bolts completely.

8. Inspection and Maintenance

It is recommended to inspect Elster RABO meters periodically to help ensure accurate performance over a long period of time. Maintenance intervals can be derived from inspection criteria.

Routine inspections should include:

- a) Checking to ensure the meter is level in all planes
- b) Listening for abnormal sounds in the meter
- c) Checking oil level and clarity — oil should be red and clear
- d) Checking index movement if gas is flowing
- e) Checking for leaks
- f) Testing the meter's differential pressure

Routine maintenance should include:

- a) Changing the oil if the color becomes dark
- b) Adding oil if the color is red and clear, but below the recommended level

9. Testing

Elster RABO meters should be tested in accordance with applicable governing standards. The accuracy of a meter can only be determined by comparing results to a traceable reference, typically a sonic nozzle, bell, piston or transfer prover. Accuracy may be done on site using transfer provers, and typically requires removal for testing with other technologies.

Differential pressure testing is a method of determining whether the performance of a rotary meter may have changed over time, and can be done on site while the meter is operating under pressure. Baseline data must be captured during initial start-up to which future data can be compared.

a) Proving

When testing a meter on a prover, the meter temperature, pressure and volume are necessary inputs for the proving device. The meter temperature is obtained by a temperature probe installed near the inlet of the meter. A thermowell can be installed in the meter run piping or on the meter itself to facilitate installation of the temperature probe. The meter pressure should come from the meter differential pressure taps.

Pete's Plugs® are provided for simplified pressure connections [Figure 9]. Typically, when proving a meter, both the meter pressure and meter differential pressure are used and recorded. The RABO meter differential pressure ports are not full bore and most temperature probes will not fit through into the gas stream. Installing the temperature probe in the provided thermowell ports is recommended.



Figure 9. Pete's Plugs®

The meter volume is determined through a device that senses the meter revolutions. An optical pickup can be used on the index proving wheel or an index pulser may be used.

On-site proving, performed in-line, also requires connections that allow air flow through the meter to the prover. This is accomplished by use of pipe Tees upstream and downstream of the meter. A bypass loop is recommended for uninterrupted gas supply to the customer.

While performing an accuracy test, the meter is tested for a specified volume of gas at each flow rate test point. Poor repeatability at a given rate may be caused by a test volume that is too small. If the meter does not repeat within acceptable limits (0.1%), try increasing the test volume and retesting the meter. Most companies have developed test plans that include the volume of gas for each size meter at a given flow rate. Consult your Elster representative for applicable volumes.

b) Differential Pressure Testing

A differential pressure test is not an accuracy test, but it can be used to gauge the relative performance of the meter.

Rotary meters are made from solid parts, machined to tight tolerances with close clearance fits, and the energy it takes to turn the meter is generally used to overcome the friction of the bearings and other rotating parts. If this friction value increases, it will take more energy to overcome it. This additional energy is measured as an increased pressure drop across the meter.

The increased friction is caused by contamination of the measuring chamber and/or bearings.

Contamination in the measuring chamber can cause the meter components to wear against each other. Contamination in the bearings makes them harder to turn.

Comparing the pressure drop reading when the meter is new to the reading collected after time allows the performance to be monitored.

RABO meters are supplied with Pete's Plugs® installed in the meter differential pressure ports [Figure 9]. This facilitates differential meter testing. A differential pressure test is performed using a differential pressure manometer. The test is to measure the pressure drop across the meter at a given flow rate, under known operating conditions at a known date and time.

The meter differential curve of flow rate vs pressure is not linear. Testing at multiple flow rates is suggested. It is preferable to test at 3 rates between 25% and 100% of flow if possible. Differential pressure tests at flow rates under 25% are hard to interpret because the meter differential pressure at the lower flow rates is quite small. The error in measurement is almost as large as the reading itself.

The meter differential pressure is also a function of line pressure and increases as line pressure increases. Testing the meter at the same conditions (line pressure and flow rates) yields comparable data.

A change in the differential pressure indicates a change in performance. Testing has shown that a 50% increase in meter differential pressure (at flow rates over 25%), indicates almost a 1.0% change in meter accuracy.

Baseline data must be captured during initial start-up to which future data can be compared.

If the differential pressure test shows an increase in the meter pressure drop at a given flow rate of more than 50% from the original value (1.5 x original value), then it is recommended that the meter be removed and serviced.

The frequency of differential testing is at the discretion of the user.

10. Technical Data

a) Performance

	Units	3.5M/G65	5.5M/G100	9M/G160	14M/G250
Rangeability		90:1	160:1	160:1	160:1
Start Rate	acfh [am ³ /h]	1.3 [0.04]	0.9 [0.03]	2.5 [0.07]	2.5 [0.07]
Stop Rate	acfh [am ³ /h]	1.1 [0.03]	0.8 [0.02]	1.9 [0.05]	2.3 [0.07]
Flow Rate at ½" w.c. DP	acfh [am ³ /h]	2,715 [77]	4,074 [115]	5,722 [162]	6,740 [191]
Differential Pressure at 100% Flow Rate	in. w.c. [mBar]	1.46 [3.64]	1.23 [3.06]	1.70 [4.23]	2.65 [6.60]

b) Sizing Chart

Using the chart below, select the appropriate meter by using the Maximum Instantaneous Flow Rate (scfh) and the Minimum Operating Pressure (psig) at any given point in time.

Example: A flow rate of 25,000 scfh and an operating pressure range of 75–100 psig would require a 5.5M meter based on a 75 psig minimum inlet pressure.

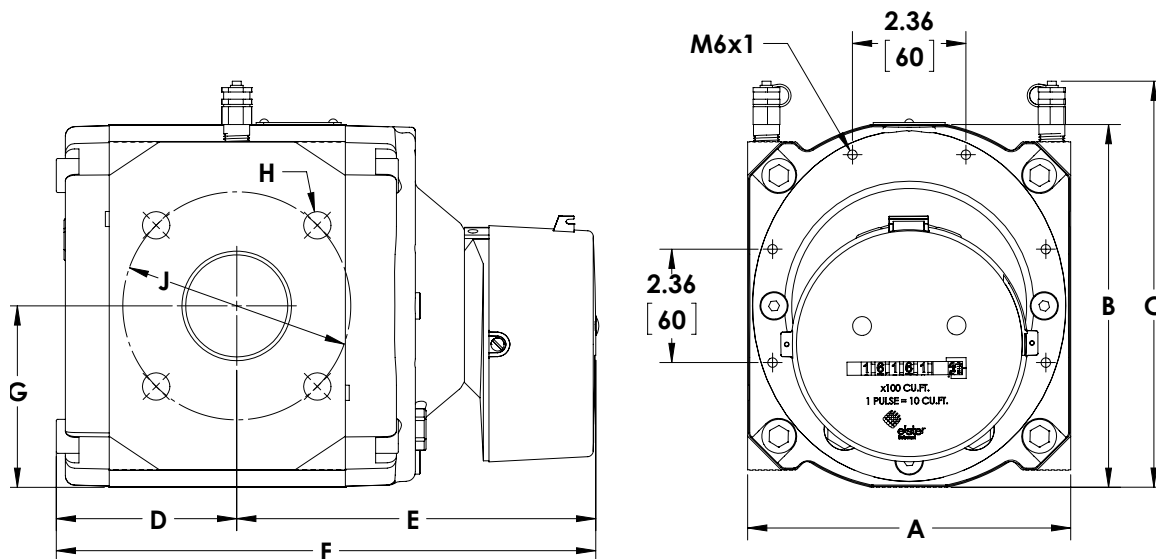
Model	3.5M/G65	5.5M/G100	9M/G160	14M/G250
psig [Barg]	Corrected Capacity in scfh [sm ³ /h]			
0.25 [0.0]	3,500 [100]	5,500 [160]	9,000 [250]	14,000 [400]
2 [0.1]	3,900 [110]	6,100 [170]	10,000 [280]	15,600 [440]
5 [0.3]	4,600 [130]	7,200 [200]	11,900 [340]	18,400 [520]
10 [0.7]	5,800 [160]	9,100 [260]	14,900 [420]	23,200 [660]
20 [1.4]	8,200 [230]	12,800 [360]	21,000 [590]	32,700 [930]
30 [2.1]	10,500 [300]	16,600 [470]	27,100 [770]	42,200 [1,190]
40 [2.8]	12,900 [370]	20,300 [570]	33,200 [940]	51,700 [1,460]
50 [3.4]	15,300 [430]	24,000 [680]	39,300 [1,110]	61,200 [1,730]
60 [4.1]	17,700 [500]	27,800 [790]	45,500 [1,290]	70,700 [2,000]
75 [5.2]	21,200 [600]	33,400 [950]	54,600 [1,550]	85,000 [2,410]
100 [6.9]	27,200 [770]	42,700 [1,210]	69,900 [1,980]	108,700 [3,080]
150 [10.3]	39,100 [1,110]	61,400 [1,740]	100,400 [2,840]	156,300 [4,430]
175 [12.1]	45,000 [1,270]	70,700 [2,000]	115,700 [3,280]	180,000 [5,100]
250 [17.2]	62,800 [1,780]	98,700 [2,790]	161,500 [4,570]	251,300 [7,120]
290 [20.0]	72,300 [2,050]	113,700 [3,220]	186,000 [5,270]	289,300 [8,190]

Note: All capacities based on 14.4 psia atmospheric pressure, 14.73 psia base pressure, and 60°F base temperature.

c) Dimensions and Weights

	Units	3.5M/G65		5.5M/G100		9M/G160		14M/G250	
A	in. [mm]	6.75	[171]	6.75	[171]	9.5	[241]	9.5	[241]
B	in. [mm]	7.56	[192]	7.56	[192]	10.08	[256]	10.08	[256]
C	in. [mm]	8.63	[219]	8.63	[219]	10.75	[273]	10.75	[273]
D	in. [mm]	3.78	[96]	5.43	[138]	5.16	[131]	6.14	[156]
E	in. [mm]	7.52	[191]	9.17	[233]	10.67	[271]	11.65	[296]
F	in. [mm]	11.26	[286]	14.61	[371]	15.83	[402]	17.76	[451]
G	in. [mm]	3.78	[96]	3.78	[96]	5.04	[128]	5.04	[128]
Nom. Pipe Size*	in. [mm]	2		3		3		4	
Bolt Size, H		5/8" - 11		5/8" - 11		5/8" - 11		5/8" - 11	
# Bolts/Flange		4		4		4		8	
Bolt Circle, J	in. [mm]	4.75	[121]	6.00	[152]	6.00	[152]	7.50	[191]
Shipping Weight	lbs. [kg]	29.8	[14]	37.7	[17]	73.9	[34]	82.3	[37]
Carton Size	in.	18.3L x 1.6W x 12.6H				23.6L x 13.0W x 13.4H			
	[mm]	465L x 270W x 320H				600L x 330W x 340H			

*ANSI Class 125/150 flat face flange connection



11. Index

All RABO meters are equipped with a non-resettable totalizing odometer-style index that displays volume in actual cubic feet. The index is sealed by an ultraviolet-resistant Lexan cover, requires no maintenance and is completely isolated from gas pressure.

a) Rotatable

The RABO index can rotate 355 degrees to facilitate desired reading angle, depending on the installation orientation. To rotate, simply grasp the index with both hands and turn to the desired position.

b) How to Read

The odometer index is masked to expose the desired digits and units of measure to meet individual requirements. On all meters, the right-most digit will be highlighted with a red square on the index mask, and will always increment in cubic feet. This digit is typically not included in the meter read and is primarily used to indicate flow rate.

When reading an odometer, record all the digits except the digit surrounded by the red square on the index mask, and multiply it by the factor shown on the index face plate. In the example on the next page, the reading would be 1357900 cubic feet. [Figure 10].

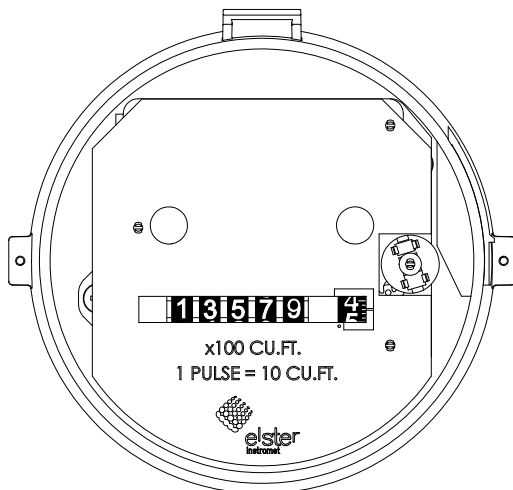


Figure 10. Index

c) How to "Clock" a Meter

The odometer index can be used to calculate the instantaneous flow rate by using the right-most digit (test dial). Each number on this dial represents one (1) cubic foot, and one complete revolution of this dial represents ten (10) cubic feet. You will need a stop watch or a watch with a sweep second hand to calculate flow rate.

1. Measure the time, in seconds, that it takes the test dial to make one complete revolution (10 cubic feet).
2. Use the following formula to calculate flow rate:

$$\text{Flow Rate (acfh)} = (10 \div \text{"time"}) \times 3600$$

Note that the odometer index does not compensate for elevated pressure or temperature. Correction factors will need to be applied to adjust the flow rate to standard conditions (scfh).

d) Removal, Installation and Replacement

Steps to replace the RABO meter index:

1. Cut the seal wires and remove from the holes [Figure 11].
2. Remove (unscrew) the two brass screws on the sides of the index cover [Figure 11].

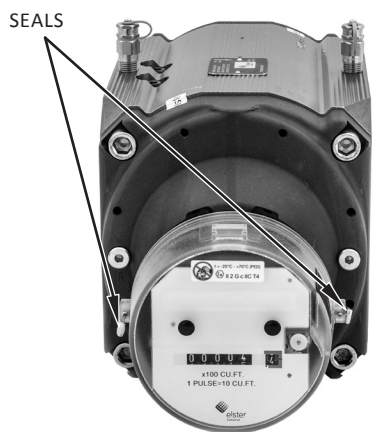


Figure 11. Index cover seals

3. Pull off the index cover.
 - It helps to rock it slightly.
 - Be careful not to damage the masking plate and index when removing the cover.
4. Carefully pull off the index masking plate [Figure 12].



Figure 12. Index masking plate

5. Remove the three index retaining screws using a Torx T20 driver [Figure 13].

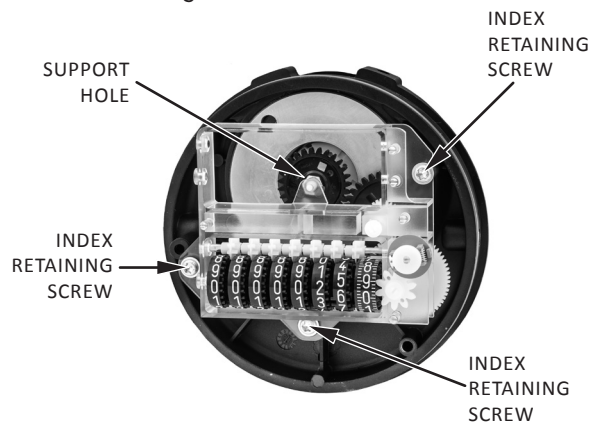


Figure 13. Index retaining screws

6. Carefully remove the index.
 - Pay attention to the driven magnet — it is supported by the index.
 - Leave the magnet on the meter.
7. Transfer the change gear from the damaged index to the replacement [Figures 14 and 15].
 - Remove the change gear on the damaged index.
 - Pry the locking collar off with a knife blade or other sharp object.
 - Unscrew the change gear.



WARNING

Each meter size uses a common index that has unique colored gears. Interchanging colored gears will result in inaccurate readings. Ensure the replacement index has the same color gears. [Refer to Table 1]

- If the replacement index has a change gear, remove and discard it.
- Attach the change gear from the damaged index to the same shaft on the replacement index.
 - Secure gear on shaft.
 - Snap on the locking collar.

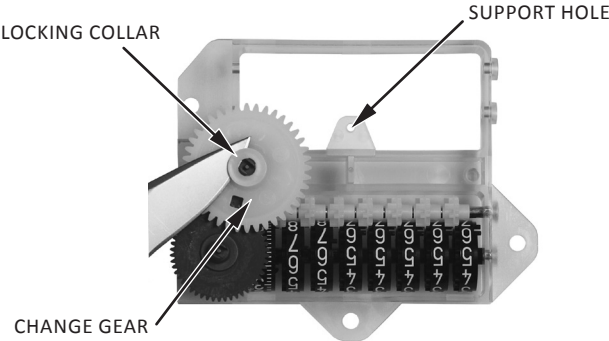


Figure 14. Change gear removal

Meter	Gear Color
3.5M/G65	White
5.5M/G100	Dark Green
9M/G160	Green
14M/G250	Red

Table 1

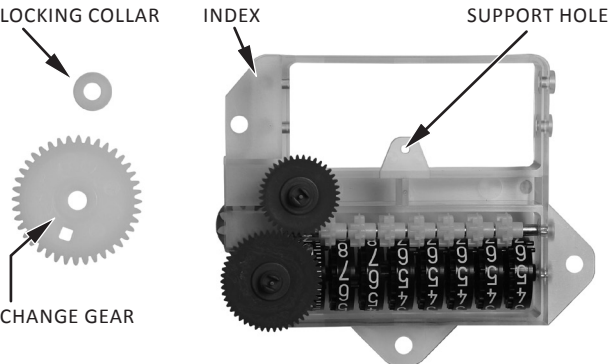


Figure 15. Index, change gear and locking collar

8. Install the replacement index.
 - Orient the index so the mounting holes line up with the posts in the base plate.
 - Carefully ensure the shaft on the magnet holder is in the support hole on the index frame [Figure 13].
 - Install the three screws to retain the index to the base plate. Tighten to snug.
9. Install index masking plate.
10. Install index cover.
11. Install security seals.

12. Pulser

All RABO meter indexes can be easily outfitted with a pulse output device to interface with auxiliary equipment. Installation of a pulser is quick and easy, and requires no disassembly. To install a pulser, simply slide the pulser into the slot on the index cover [Figure 16], and connect the wires to the desired auxiliary devices [Figure 17]. The pulser can be secured to the index cover screw with a seal wire to mitigate and indicate tampering.



WARNING

Explosion Hazard
Auxiliary equipment and interconnecting wiring must be in accordance with local and national codes for hazardous areas.

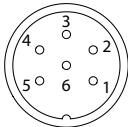
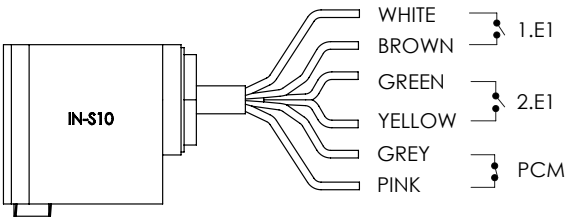


Figure 16. IN-S10 pulser installed

Technical Specifications

Description	Min.	Typ.	Max.	Unit
Voltage (U)			24	V
Current (I)			76	mA
Power (P)			1.1	W
Static Contact Resistance			200	mΩ
Insulation Resistance	10 ⁹			Ω
Breakdown Voltage	100		100	VDC
Switching Time Including Bounce		0.5		ms
Release Time		0.1		ms

Temperature range: -40°C ... +70°C
IP-Class: IP67
Explosion protection: Ex II 2 G EEx ia 2C T4



Pulser Pin-Out Connections			
Connector	1.E1 Pulse Out 1	2.E1 Pulse Out 2	PCM Tamper Circuit
IN-S11	1 + 2	5 + 6	3 + 4
IN-S12	1 + 2 (Back)	1 + 2 (Front)	3 + 4 (Front)

Figure 17. Pulser connections

13. Thermowell

All RABO meters come equipped with two (2) 1/4" NPT auxiliary ports on the meter body (Figure 18), which can be used for sensing pressure and temperature of the flowing gas. A thermowell is required when using a temperature sensing device. Thermowells are available as accessories to the meter.

NPT AUXILIARY PORTS

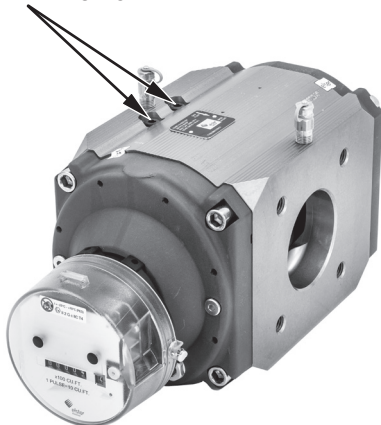


Figure 18. Auxiliary ports

a) Installing a Thermowell

1. If meter is not installed in the gas piping, go to Step 5.
2. Slowly open bypass valve.
3. Slowly close the meter's outlet valve, then the inlet valve.
4. Slowly, completely depressurize the meter piping.
5. Remove one of the plugs in the meter body by using a 1/4" hex key.
6. Apply Teflon tape or pipe dope to the male threads of the thermowell. Wipe excess pipe dope off the thermowell probe and leading threads to ensure no pipe dope enters the metering chamber.
7. Screw the thermowell into the meter and tighten to 18 ft-lbs.
8. Re-pressurize the meter as instructed in Start-up/Commissioning (see section 6).

15. Troubleshooting

Problem	Probable Cause	Suggested Action
Excessive vibration	Build-up of foreign material on impellers	Clean by flushing, or replace worn parts
	Misalignment	Level meter in piping
	Worn bearings	Replace bearings
	Worn timing gears	Replace timing gears
	Impellers contacting body	Rotate manually to verify impellers spin freely
High differential pressure	Heavyweight or too much oil	Check oil level and condition
	Dirt deposits on impellers	Remove dirt by flushing
	Impellers out of time	Retime impellers
	Impellers contacting body	Rotate manually to verify impellers spin freely
Low registration	Upstream or bypass leak	Check all valves for leakage
Non-registration	Broken or binding index odometer	Replace odometer
	Obstruction in meter	Remove meter, remove obstructions, flush meter

14. Auxiliary Equipment Mounting

All RABO meters are equipped with threaded holes for mounting compact, lightweight auxiliary equipment (Figures 19 and 20). All holes are M6 x 1 by 10mm deep. Heavier equipment should be pipe or wall mounted adjacent to the meter. Elster provides customized brackets for commonly used equipment (Figure 21). Please contact your local Elster representative for details.

ACCESSORY
MOUNT HOLES

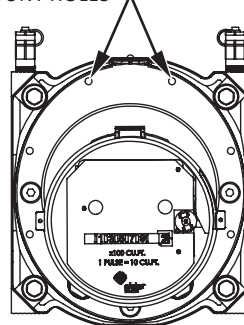


Figure 19. Horizontal installation

ACCESSORY
MOUNT HOLES

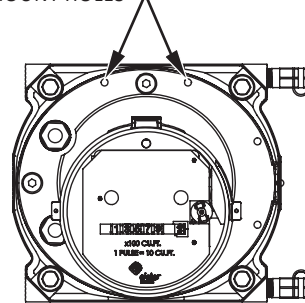


Figure 20. Vertical installation

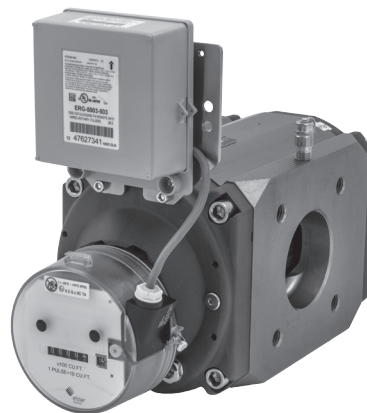


Figure 21. Auxiliary equipment mounted

About Elster Gas

Elster provides best-in-class measurement and regulation products, systems and solutions for the safe control and delivery of natural gas across the globe.

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