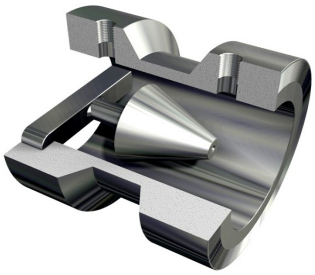
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Advanced
Differential
Pressure
Flow Meter
Technology

Wafer-Cone®





INSTALLATION OPERATION & MAINTENANCE MANUAL

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SECTION 1 - GENERAL

The Wafer-Cone flow meter is a differential pressure type flow measurement device. The patented design utilizes a removable cone positioned in the center of the pipe to increase the velocity of the flowing fluid and create a differential pressure. The pressure difference can be measured and used to accurately interpret flow rate. Two taps are provided to allow sensing of the high and low pressures. The removable cone allows the use of different sizes for different flows without the need to change the meter body.

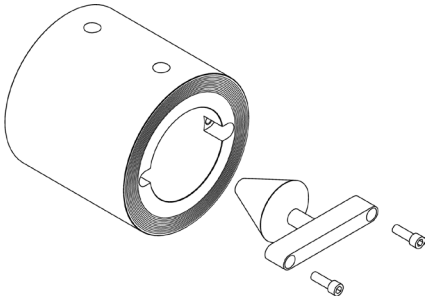


Figure:1 Wafer-Cone Exploded

The cone's central position in the line optimizes the velocity profile of the flow at the point of measurement, assuring highly accurate and reliable flow measurement with reduced upstream and downstream straight run requirements.

The Wafer-Cone is custom-fitted for the intended application. Standard and custom beta ratios are available for a wide range of flow rates, while the available materials of construction allow metering of virtually any liquid or gas.

SECTION 2 - TYPICAL PERFORMANCE SPECIFICATIONS

• Accuracy:	±1% of rate*	**Unique Features**
• Turndown	10:1	No welding required (on pressure vessel body - remote mount only) Interchangeable Wafer-Cone elements
• Repeatability	±0.1%	Reducers for smaller line sizes
• Standard Betas	0.45 through 0.85	**Options** Gas or oil flow calibration
• Headloss	% of Dp, varies with the beta ratio	Materials of construction
• Installation	0-3 diameters upstream 0-1 diameter downstream	

* Each Wafer-Cone is sized for the intended application. Specific performance ratings must be obtained through the sizing process. Wafer-Cones calibrated in a "master body" will deviate no more than +/- 0.83 body to body.

SECTION 3 - WAFER-CONE FLOW MEASUREMENT SYSTEM

3.1 Application Data

The customer must provide application parameters so that the appropriate Wafer-Cone flowmeter may be selected. McCrometer has an extensive meter performance database of fluid properties which can be utilized for sizing purposes.

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3.2 Flow Calculations

Nomenclature

Symbol	Description	English Units	Metric Units
α	Material Thermal Expansion α or α_{cone}, α_{pipe} (alpha)	$°R^{-1}$	$°R^{-1}$
β	Beta Ratio	-	-
C_D	Flowmeter Coefficient	-	-
d	Cone Outside Diameter	in	mm
D	Pipe Inside Diameter	in	mm
ΔP	Differential Pressure (dp)	inWC	mbar
ΔP_{max}	Maximum Differential Pressure on Sizing	See note 4	See note 4
F_a	Material Thermal Expansion Factor	-	-
k	Gas Isentropic Exponent	-	-
k_1	Flow Constant	$\sqrt{\frac{lbm \cdot ft^3}{s^2 \cdot inWC}}$	$\sqrt{\frac{kg \cdot m^3}{s^2 \cdot mbar}}$
k_2	Simplified Liquid Flow Constant	See note 4	See note 4
μ	Viscosity	cP	cP
P	Operating Pressure	psiA	barA
P_b	Base Pressure	psiA	barA
Q	Actual Volume Flow	ACFS	m^3/s
Q_{max}	Maximum Flowrate on Sizing	See note 4	See note 4
Q_{STD}	Standard Gas Volume Flow	SCFS	Nm^3/s
Re	Reynolds Number	-	-
ρ	Flowing Density (rho)	lbm/ft^3	kg/m^3
ρ_{water}	Water Density	62.3663 lbm/ft^3	999.012 kg/m^3
S_g	Specific Gravity of the Gas	-	-
S_L	Specific Gravity of the Liquid	-	-
T	Operating Temperature	°R	K
T_b	Base Temperature	°R	K
T_d	Deviation from Standard Temperature (°R)	$T_d = T - 527.67$	$T_d = \frac{9}{5}T - 527.67$
U_1	Unit Conversion	0.0360912 psiA/inWC	0.001 barA/mbar
U_2	Unit Conversion	144 in^2/ft^2	1,000,000 mm^2/m^2
U_3	Unit Conversion	167.213 lbm /s^2 ft inWC	100 kg/m s^2 mbar
U_4	Unit Conversion	124.0137 cP ft s / lbm	1
U_5	Unit Conversion	2.6988 °R lbm / ft^3 psiA	348.338 K kg / m^3 barA
v	Velocity	ft/s	m/s
Y	Gas Expansion Factor	-	-
Z	Gas Compressibility	-	-
Z_b	Base Gas Compressibility	-	-

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General Flow Calculations

3.2.1	V-Cone Beta Ratio	$\beta = \sqrt{1 - \frac{d^2}{D^2}}$	β from sizing report
3.2.2	Flow Constant	$k_1 = \frac{\pi \cdot \sqrt{2 \cdot U_3}}{4 \cdot U_2} \cdot \frac{D^2 \cdot \beta^2}{\sqrt{1 - \beta^4}}$	
3.2.3	Material Thermal Expansion Factor	$F_a = 1 + 2 \cdot \alpha \cdot T_d$	See note 1.
3.2.4	Material Thermal Expansion Factor If cone and main pipe are made of different materials	$F_a = \frac{D^2 - d^2}{\left[\left(1 - \alpha_{pipe} \cdot T_d\right) \cdot D\right]^2 - \left[\left(1 - \alpha_{cone} \cdot T_d\right) \cdot d\right]^2}$	See note 1.
3.2.5	Pipeline Velocity	$v = \frac{4 \cdot U_2 \cdot Q}{\pi \cdot D^2}$	
3.2.6	Reynolds Number	$\mathrm{Re} = U_4 \frac{v \cdot D \cdot \rho}{\mu}$	Dimensionless number which can be used to correlate meter calibration in different fluids
3.2.7	Wafer Gas Expansion Factor	$Y = 1 - (0.755 + 6.78 \cdot \beta^8) \frac{U_1 \cdot \Delta P}{k \cdot P}$	For Liquids Y = 1
3.2.8	Liquid Density	$\rho = \rho_{water} \cdot S_L$	
3.2.9	Gas Density	$\rho = U_5 \frac{S_g \cdot P}{Z \cdot T}$	
3.2.10	Actual Volume Flowrate	$Q = F_a \cdot C_D \cdot Y \cdot k_1 \cdot \sqrt{\frac{\Delta P}{\rho}}$	See notes 2, 3 & 5
3.2.11	Standard Gas Volume Flowrate	$Q_{STD} = Q \cdot \left(\frac{P \cdot T_b \cdot Z_b}{P_b \cdot T \cdot Z} \right)$	Converts actual flow to standard flow at base conditions

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3.3 Simplified Liquid Calculation

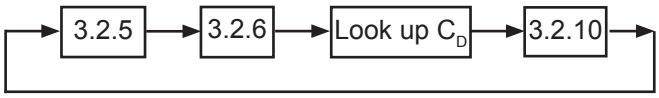
3.3.1	Simplified Liquid Flow Constant	$k_2 = \frac{Q_{max}}{\sqrt{\Delta P_{max}}}$	See note 4
3.3.2	Simplified Liquid Flowrate	$Q = k_2\sqrt{\Delta P}$	See note 4

Notes:
1. Material Thermal Expansion – The thermal expansion equations correct for dimensional changes which occur as the operating temperature deviates from the base temperature of 68° F (see 3.2.3 and 3.2.4) The F_a factor can be excluded from the flow equation if the operating temperature is:

< 100° Fahrenheit , < 559.67° Rankine , < 37.78° Celcius, < 310.93 K.
If the F_a factor is significant and the operating temperature is stable then a constant F_a value can be used. If the F_a factor is significant and the temperature varies then an F_a factor should be calculated prior to every flow calculation.

2. Discharge Coefficient – Discharge coefficients can be implemented in the flow equations via several different methods. Typical methods are average C_D , C_D look up table, or C_D fitted data. If a C_D look up table or fitted data is utilized additional calculations must be made based on the Reynolds number (see example process 3d and 5b).

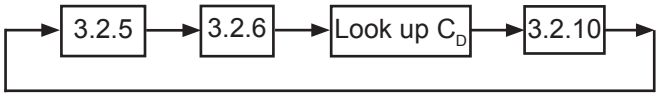
3. Liquid – Typical Calculation Process
   a. Given: D, β, ρ, C_D, and input of ΔP
      Calculate: 3.2.2, 3.2.10
   b. Given: D, β, ρ, C_D, and input of ΔP, T
      Calculate: 3.2.2, 3.2.3 or 3.2.4 if req., 3.2.10
   c. Given: D, β, S_l, C_D, and input of ΔP, T
      Calculate: 3.2.2, 3.2.3 or 3.2.4 if req., 3.2.9, 3.2.10
   d. Given: D, β, μ, ρ, C_D look up, and input of ΔP
      Calculate: initially set C_D = 0.8, 3.2.2, 3.2.3 or 3.2.4 if req., 3.2.10



Iterate until flowrate is <0.01% different from last calculation

4. Simplified Liquid Calculation – The simplified liquid calculation can be used if the operating temperature is stable and the C_D is constant. The simplified flow constant (k_2) can be calculated from equation 3.3.1 using the Wafer-Cone Application Sizing sheet. The flowrate can then be calculated using equation 3.3.2. Units of measure will be the same as those listed on the Wafer-Cone Application Sizing sheet.

5. Gases and steam – Typical Calculation Process:
   a. Given: D, β, μ, S_g, Z, k, C_D, and inputs of ΔP, P, T
      Calculate: 3.2.2, 3.2.3 or 3.2.4 if req., 3.2.7 or 3.2.9, 3.2.10
   b. Given: D, β, μ, S_g, Z, k, C_D look up, and inputs of ΔP, P, T
      Calculate: initially set C_D=0.8, 3.2.2, 3.2.3 or 3.2.4 if req., 3.2.7 or 3.2.9, 3.2.10



Iterate until flowrate is <0.01% different from last calculation

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6. Fluid Properties – Fluid properties such as velocity, compressibility and isentropic exponent vary with temperature and to some extent pressure. The viscosity in the calculations above could effect the selected C_D value, the compressibility directly effects the density and the isentropic exponent effects the Y factor, although to a small degree. The instrumentation industry uses many different approaches to calculate flow. McCrometer application engineering and the customer must determine which fluid properties are calculated at each set of flow conditions and which properties are constant.

3.4 Application Sizing

Each Wafer-Cone is tailored to its specific application. Before manufacturing, every Wafer-Cone will have a "sizing" completed according to the physical parameters of the application. The computer generated sizing uses application data as a basis to predict the Wafer-Cone's performance. Full scale DP, working flow range, expected accuracy, and predicted pressure loss are determined by the sizing process.

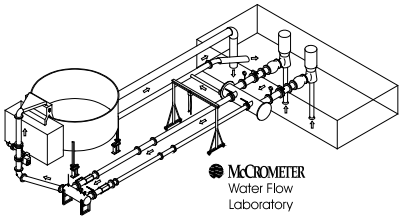
3.5 Calibration

McCrometer has 4 meter test lines and can calibrate meters from 1/2" to 48" with a high degree of accuracy.

Test Lines:

Location	Type	Size Range	Flow Range	Fluid
Hemet, CA	Gravimetric	½" to 3"	195 GPM	Water
Hemet, CA	Gravimetric	3" to 16"	3100 GPM	Water
Hemet, CA	Transfer Standard	½" to 2"	150 SCFM	Air
Porterville, CA	Volumetric	16" to 48"	40,000 GPM	Water

McCrometer recommends calibration of every Wafer-Cone meter. Optimal accuracy is achieved when a full flow range calibration is performed. In high Reynolds number applications this may require an outside gas calibration. As an alternative, McCrometer has developed a proprietary method to accurately extrapolate flow calibration data. In cases where the meter can not be calibrated McCrometer can estimate the meter C_f based on 20 plus years of data.



Calibration Facility 40k
Gravimetric
Figure: 2

3.6 Valve Manifolds

McCrometer recommends a three valve or five valve manifold as part of a Wafer-Cone flow measurement system. Manifolds allow for in-line transmitter calibrations, isolation of the transmitter from the transmission lines, without depressurizing the line, and in-line purging of transmission lines.

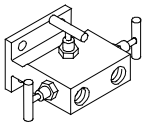


Figure: 3

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SECTION 4 - SITE PREPARATION

4.1 SAFETY

- Any person installing, inspecting, or maintaining a McCrometer flow meter should have an understanding of piping configurations and systems under pressure. Before adjusting or removing any meter, be certain the system has been depressurized completely. Never attempt to remove a meter under pressure!
- Be careful when lifting meters. Meters can cause serious injury if lifted incorrectly or dropped.
- Use only necessary and appropriate tools when working on a meter.
- Properly secure all connections before starting a system. Keep a safe and prudent distance away from the meter during system start-up.

4.2 ACCESS

The Wafer-Cone flow meter should be located where access to the meter and ancillary instruments will be available. Allow access to the differential pressure transmitter if mounted to a support separate from the meter.

4.3 SPACING

Allow an additional 3/16” pull-back expansion space beyond the length of the meter body/reducing rings. Do not rely on the meter bolts to pull the pipe to the meter body or reducing rings. Refer to the Dimension Table, page 7. Be sure to add the gasket thickness to the laying lengths shown.

4.4 PIPING PREPARATION

The axis of the upstream and downstream pipes should have an eccentricity of no greater than 1/8”, and the mating flange faces should be parallel within 1/16” **(Figure 4)**.

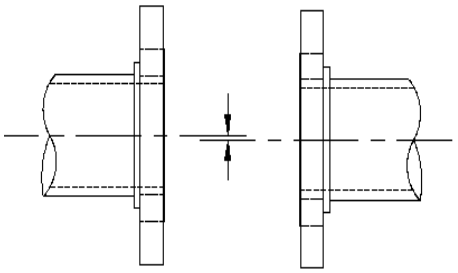
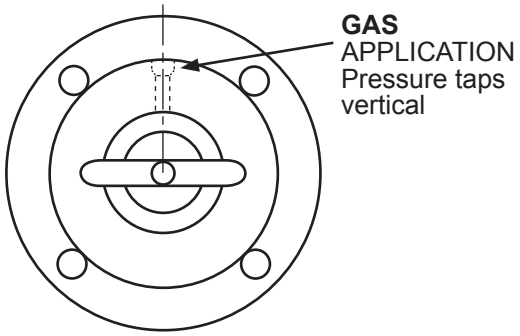


Figure: 4

4.5 FLANGE ORIENTATION

Orient the mating flange bolt holes to allow clearance for plumbing (gauge lines) to the pressure taps (Figure 5).



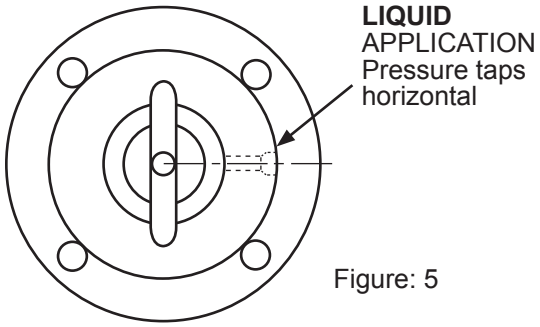


Figure: 5

Provide appropriate pipe support before and after the meter location. Allow for movement in the plumbing gauge lines between the differential pressure transmitter if mounted to a support separate from the meter/ pipeline. Important: Check the inside of the pipe for debris before installation of the meter.

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SECTION 4 - SITE PREPARATION (continued)

4.6 DIMENSION TABLE

Dimension “C” in the drawing and the table below indicates the meter laying length. Be sure to add the gasket thickness to the overall meter length when determining the minimum opening between the mating flanges.

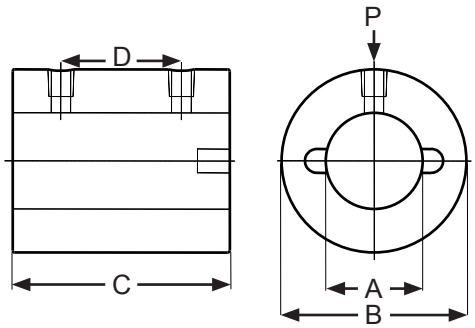


Figure: 6

DIMENSION TABLE

	MATING FLANGE TYPE													
	ANSI Class 150-2500 AWWA CL D					DIN, JIS				DIN 2576 DIN 2633	DIN 2635	JIS 10k	Pressure Ports	
Model	Size inch	A inch	**C inch**	D inch	B inch	Size mm	A mm	**C mm**	D mm	B mm	B mm	B mm	P NPT	P RC
VH01	1”	0.957	**2.25**	1.25	2.00	25	24,31	**60**	31.8	68	68	67	1/8	1/8
VH0C	1½”	1.500	**3**	1.7	2.88	40	38,10	**80**	43.2	88	88	81	1/8	1/4
VH02	2”	1.939	**3.38**	1.88	3.62	50	49,25	**85**	47.6	102	102	96	1/4	1/4
VH0D	2½”	2.323	**4**	2.5	4.12	65	59,00	**100**	63.5	122	122	116	1/4	1/4
VH03	3”	2.900	**4.75**	2.75	5.00	80	73,66	**120**	69.9	138	138	126	1/4	1/4
VH04	4”	3.826	**6**	3.5	6.19	100	97,18	**150**	88.9	158	162	151	1/4	1/4
VH06	6”	5.761	**9.5**	6.0	8.50	150	146,33	**240**	152.4	212	218	212	1/4	1/4

4.7 REDUCING ADAPTERS

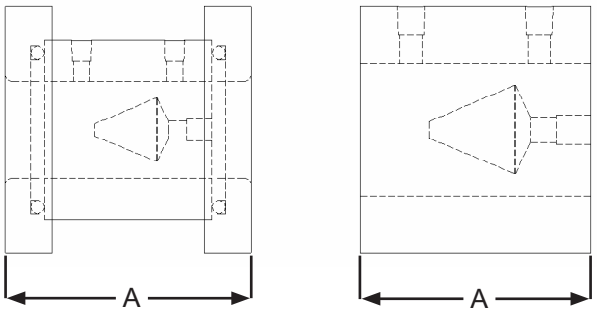


Figure: 7

NOTE: Reducing adapters are available to allow the use of meters smaller than the pipe size in certain applications. Using reducing adapters with a smaller meter does not increase the laying length for the original pipe size. Dimension “**A**” for the two meters shown above are identical **(Figure 7)**.

The following reductions are available:

6 X 4 - 6” pipe with a 4” meter (same laying length as a 6” meter)
4 X 3 - 4” pipe with a 3” meter (same laying length as a 4” meter)
3 X 2 - 3” pipe with a 2” meter (same laying length as a 3” meter)
3 X 1 - 3” pipe with a 1” meter (same laying length as a 3” meter)

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SECTION 5 - INSTALLATION

5.1 CONE INSTALLATION

Verify that the cone is correct for the intended application - the meter size and BETA ratio are indicated on the cross-support **(Figure 8)**. The cone can be inserted into the body rotated 180° - the orientation of the cone in the meter body will not affect the performance or accuracy.
The small end of the cone always points upstream *(Figure: 9)*. The flow direction is indicated on the outside of the meter body.

After seating the cross support into the body, secure it in place with provided screws. Use of an anti-seizing compound prior to securing the set screws is recommended. Firmly secure the set screws before installation of the meter in the line. When properly seated the screws should be recessed just below the face of the cross support so it does not interfere with the mating of the flanges. The cone cross-support should be flush with the end of the meter body when inserted *(Figure 10)*. Check the cross-support and the cross-support slot in the meter body for debris or damage if the cross-support does not seat fully.

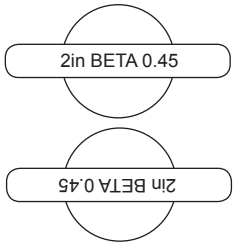
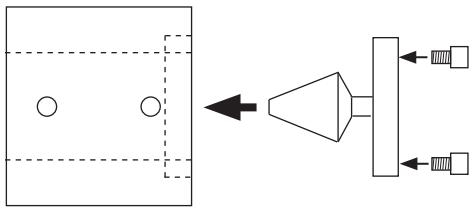
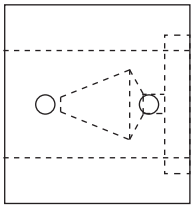


Figure: 8


Figure: 9


Figure: 10

5.2 METER COMPONENTS

Check that the necessary components and attaching hardware are available. Examples of Wafer-Cone meter assemblies with and without reducing adapters are shown below *(Figure 11)*.

Item	Description
1	Customer supplied mating flange (2 required)
2	Gasket (2 required)
3	Centering ring (2 required)
4	Reducing adapter (2 required) -for meter body smaller than pipe size
5	O-ring (2 required) - only used with reducing adapters

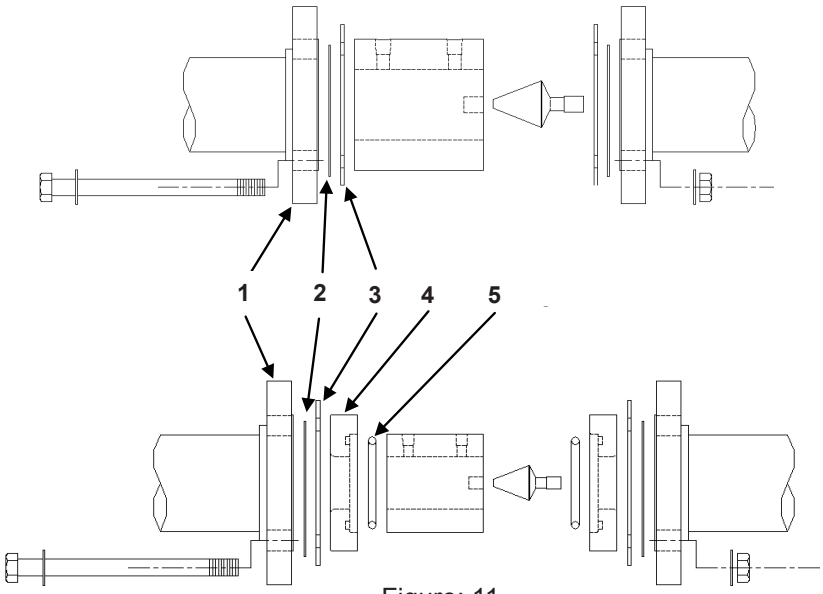


Figure: 11

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SECTION 5 - INSTALLATION (continued)

5.3 BOLT LENGTH CHART

The chart below can be used as a guide for establishing the minimum bolt lengths required for typical mating flange configurations. Flanges and gaskets with dimensions other than those indicated in the chart may require different lengths. All attaching hardware should be of suitable material and have the appropriate rating for the intended application.

METER SIZE (inches)	Flange Thickness x 2 [1]	Body Length	Body With Adapters	Gasket Thickness x 2 [2]	TOTAL	BOLT LENGTH [3]	Bolt Dia.	Qty Req'd
1	1.125	**2.25**		.250	**3.625**	**5"**	.5	4
1 ½	1.375	**3.00**		.250	**4.625**	**6"**	.5	4
2	1.50	**3.38**		.250	**5.13**	**7"**	.625	4
2 ½	1.75	**4.00**		.250	**6.0**	**7 ½"**	.625	4
3	1.875	**4.75**		.250	**6.875**	**8 ½"**	.625	4
3 to 2	1.875		**4.75**	.250	**6.875**	**8 ½"**	.625	8
3 to 1	1.875		**4.75**	.250	**6.875**	**8 ½"**	.625	8
4	1.875	**6.00**		.250	**8.125**	**10"**	.625	8
4 to 3	1.875		**6.00**	.250	**8.125**	**10"**	.625	8
6	2.00	**9.50**		.250	**11.75**	**13 ½"**	.75	8
6 to 4	2.00		**9.50**	.250	**11.75**	**13 ½"**	.75	8

[1] Flange thicknesses are for ANSI B Class 150 flanges.
[2] Gasket thickness is 1/8" each.
[3] Bolt length is measured from under the head. The threaded portion is 2 times the bolt diameter plus ¼".

5.4 METER BODY INSTALLATION

NOTE: An assistant should help with the installation of the larger Wafer-Cone meters due to the increased weight. A suitable lifting device should also be employed. Have all specified components on hand before starting the installation.

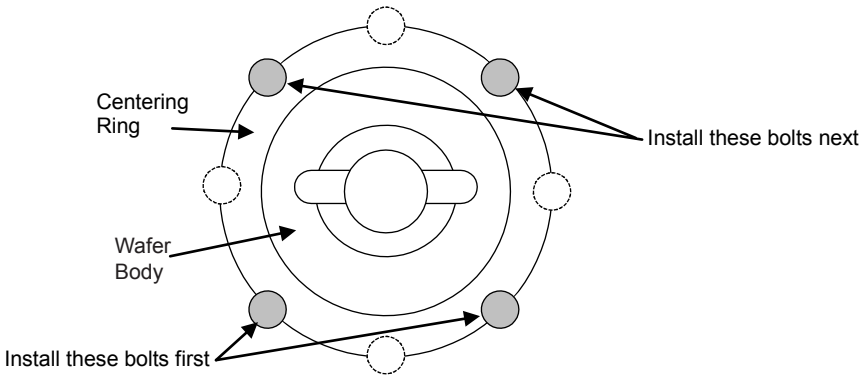
Step 1	The centering rings have notches along the outside edge that correspond to bolt locations in the flanges. Install two lower flange mounting bolts through the flanges to line up with the two lower notches in the centering rings. The centering rings will support the meter body and assist in proper alignment of the body to the mating flanges.
Step 2	**Meters without reducing adapters:** Insert and screw the cone into the meter body (see *CONE INSTALLATION*, previous page) and slide the centering rings over each end of the meter body being careful not to get too close to the pressure taps.
	Meters with reducing adapters: Insert and screw the cone into the meter body (see *CONE INSTALLATION*, previous page). Insert the reducing adapter O-rings into each adapter and push the adapters onto the ends of the body. Slide the centering rings over each adapter.
Step 3	Set the meter body (or meter body with adapters) and centering rings onto the two lower bolts *(Figure 12)*. The centering rings will support the meter body until all components are installed and secured by the flange bolts. Rotate the meter body to orient the pressure taps as needed *(Figure 5)*. Slide each flange gasket into place - the two lower bolts will keep them from falling.

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5.4 METER BODY INSTALLATION (continued)

Figure: 12



Step 4	Install bolts into two of the upper bolt holes in the same pattern as the lower two. Snug the bolts in an alternating pattern while checking alignment of the meter and gaskets. When all components are secured in place, install the balance of the bolts as required and tighten using the appropriate tightening sequence. Examples of installed meter assemblies are shown below *(Figure: 13)*.

Assembly without Reducing Adapters **Assembly with Reducing Adapters**

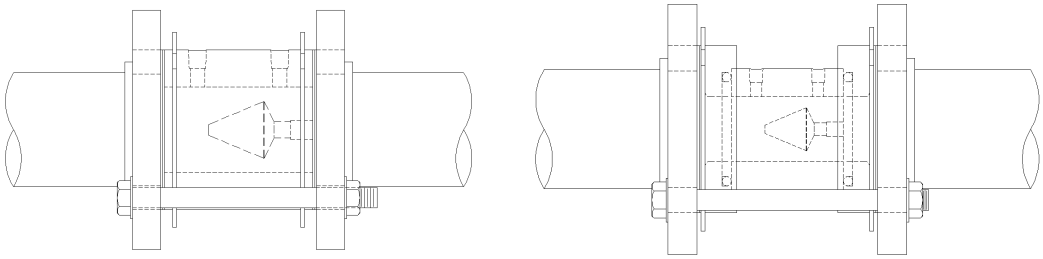


Figure: 13 (Bolts removed for clarity)

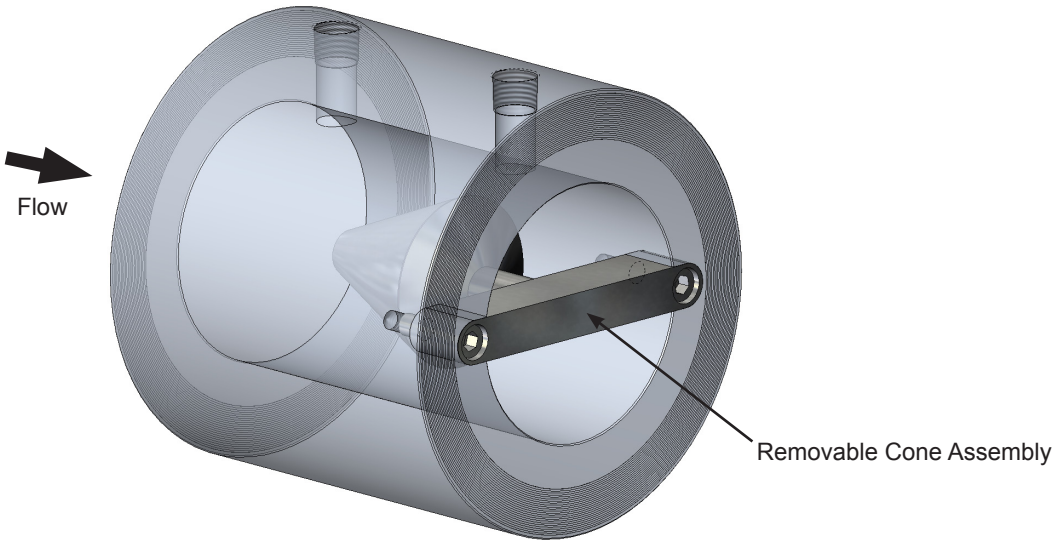


Figure: 14 Wafer-Cone up to 6 inches in diameter.

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SECTION 6 - MANIFOLD and DP TRANSMITTER INSTALLATION

Gauge lines (High and Low pressure lines) with appropriate fittings can now be installed. A suitable means of support should be provided for the manifold. The support should be capable of supporting both the weight of the manifold and the DP Transmitter. The support can be in the form of a bracket as part of the meter assembly or a post separate from the pipeline. A remote mounted manifold (and DP Transmitter) should have gauge lines with enough flex to accommodate movement in the pipeline. **Do not rely upon the gauge lines to support the weight of the manifold and DP Transmitter**.

6.1 INSTALLING WAFER-CONE WITH REMOTE MOUNT MANIFOLD AND TRANSMITTER

6.1.1 INSTALLING THE GAUGE LINES AND REMOTE SUPPORT

Install the high and low pressure gauge lines as needed (*See Figure: 15, arrow* 1). Liquid, Gas and Steam applications have different requirements for routing the gauge lines. The V-Cone Installation Manual (Literature # 24509-15) discusses several methods of installing gauge lines, and can be downloaded from www.mccrometer.com/library.

Pressure tap thread dimensions are shown in the Dimension Table (*Section 4.6*) for each meter body size. The thread size for the manifold is typically 1/2" FNPT. All gauge line materials, adapters and seals should be appropriate for the intended application. Follow all applicable codes and regulations.

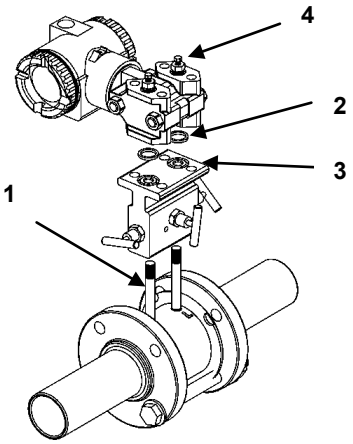


Figure: 15

6.1.2 INSTALLING THE MANIFOLD

Close all valves on the manifold. Connect the manifold to the gauge lines and secure the manifold to the support. Two methods for supporting the manifold are shown below *(Figure 16 and Figure 17)*.

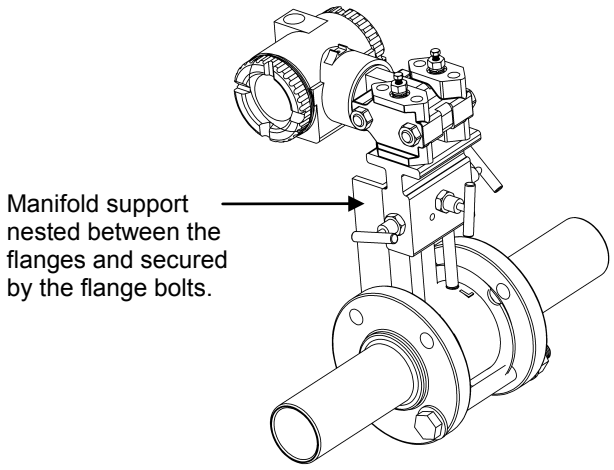


Figure: 16
Flanged bolts omitted for clarity)

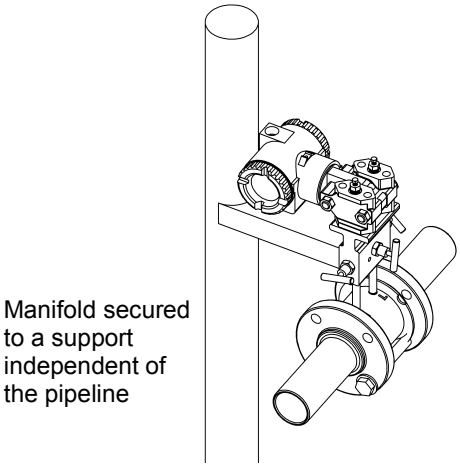


Figure: 17
Flanged bolts omitted for clarity)

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6.2 INSTALLING WAFER-CONE WITH DIRECT MOUNT MANIFOLD AND TRANSMITTER

The Wafer-Cone flowmeter with the direct mount configuration (option F) is intended to allow the manifold to be mounted to the Wafer-Cone's integral mounting block (*Figure 18, #1*) without additional support. A traditional "Flanged" process connection manifold will be required.

Note: Direct mounting is not recommended for steam or other applications where the operating temperatures exceed 200°F (93°C).

6.2.1 INSTALLING THE DIRECT MOUNT MANIFOLD

Close all valves on the manifold. Set the O-rings into the grooves in the mounting block and place the flat machined side of the manifold on top. The manifold's O-ring grooves should still be visible if installed correctly. Secure the manifold to the mounting block using four (4) 1" long bolts with a suitable diameter to match the manifold. Bolts and O-rings are usually supplied with the manifold.

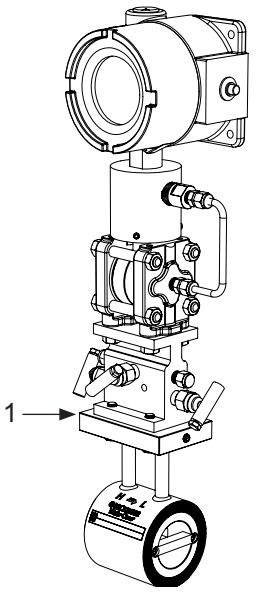


Figure: 18 Example of Direct Mount Wafer-Cone With Manifold And dP Transmitter

6.3 INSTALLING THE DP TRANSMITTER

The manifold is furnished with O-rings for proper sealing of the manifold to the DP Transmitter (*Figure 15, arrow 2*). Set the O-rings into the grooves on the manifold (*Figure 15, arrow 3*) and secure the DP Transmitter to the manifold. Hardware for securing the DP Transmitter to the manifold is usually included with both items.

NOTE: The DP Transmitter LCD display and head can be rotated for optimal viewing. Refer to the manual provided with the transmitter.

Close the transmitter bleed valves (*Figure 15, arrow 4*). The system can be now be pressurized and the installation checked for leaks. Continue to the next section for wiring and start-up.

6.4 FLOW COMPUTER

The EA403 Flow Computer is a reliable, easy to use and uniquely versatile flow measurement device. It is user configurable for flows in liquid, gas or steam applications. The multi-function flow computer is an intelligent electronic measurement device applicable to Wafer-Cones. It meets or exceeds API Chapter 21 standard.

The various hardware inputs and outputs can be "soft" assigned to meet a variety of common application needs. The isolated analog output can be chosen to follow the volume flow, corrected volume flow, mass flow, temperature, pressure, or density by means of a menu selection. For systems requiring communications, the user can assign the standard RS-232 serial port for external data logging, transaction printing, or for connection to a modem for remote meter reading.

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SECTION 7 - WIRING

Follow all national and local electrical codes. Refer to the Manual provided with the transmitter for complete wiring instructions and power requirements.

The DP Transmitter is fitted with NPT threaded openings for attaching conduit or compression fittings for securing the power input/signal output cable. Make the wiring connections after the system has been tested for leaks. Refer to the flow computer's IOM manual for complete wiring instructions of the flow computer.

SECTION 8 - PARTS

BODY – Provide the body size and serial number if the body is being replaced – Wafer-Cone bodies can be of many different materials, inside diameters and end configurations (e.g. smooth, serrated, O-ring grooved, etc.). Standard bodies are S316 stainless steel.

Body Sizes
1"
1 ½"
2"
2 ½"
3"
4"
6"

CONE – Replacement cones should match the original meter size and beta ratio, unless the process conditions have changed – Wafer-Cones can be of many different materials and different beta ratios for a variety of flows. Standard cones are S316 stainless steel.

CENTERING RINGS – Provide the meter size or reducing adapter outside diameter, and the type of flange bolt pattern. The Centering Rings are notched with the same bolt circle and number of bolts as the mating flanges (two required per meter).

REDUCING ADAPTERS – Reducing Adapters are provided with an O-ring seal to the meter body, and mating surfaces appropriate for mating to the flanges (e.g. smooth, serrated, O-ring grooved, etc.). The Reducing Adapters and O-rings are made of materials appropriate for the application (two required per meter).

Always provide the meter serial number when ordering replacement parts. Advise the factory of any process changes since the original meter was installed. Changes to the meter cone and body size could be required.

SECTION 9 - TROUBLESHOOTING

9.1 WRONG OR NO DIFFERENTIAL PRESSURE

The meter could be the wrong size for the application or the BETA Ratio is incorrect.

Each Wafer-Cone is "sized" for each individual application and has a unique flow coefficient. The application sizing will indicate the meter size, BETA Ratio and the process conditions for which the meter was designed. The serial number etched on the meter body can be matched to an application sizing.

- Verify that the BETA Ratio etched on the cone cross-support matches the application sizing.
- Compare the application sizing data to the actual process conditions.
- Check that the cone was not left out of the meter body during installation.
- Check the pipeline and meter for debris.

9.2 ERRATIC PERFORMANCE

Components could be misaligned or loose.

Centering rings are provided to assist in aligning all of the meter components with the center of the pipeline.

- Verify that the components have not slipped out of position during installation.
- Check to see that the meter body is in line with the pipeline.
- Check that the retaining bolts are parallel with each other and the meter body.
- Verify that the flange gaskets have an inside diameter is small enough to contact the cone cross-support.
- Check the pipeline and meter for debris.

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9.3 LEAKS

Components could be misaligned, loose or missing.

- Check for the placement of O-rings if reducing adapters are used.
- Verify that the proper gaskets were used between the meter and mating flanges.
- Check component alignment – tighten fastening bolts in the proper sequence.
- Check all fittings, valves and bleed screws.

9.4 GENERAL TROUBLESHOOTING

SYMPTOM	AREA	POSSIBLE PROBLEM / SOLUTION
No signal (0 mA)	Transmitter	No power to transmitter
Negative signal (<0mA)	Transmitter	Transmitter not wired correctly. Perform continuity check on wiring.
Low signal (<4mA)	Transmitter	Transmitter wires are reversed.
	Meter	Meter installed backwards, with gauge lines attached as marked. In this case, the high pressure tap would be sensing a lower pressure than the low pressure tap. This negative DP would force the signal below 4 mA.
	Gauge lines	Gauge lines are reversed. Transmitter sees more pressure on the low side than the high side. Check “H” and “L” marks on meter body and transmitter.
Zero signal (4 mA)	Transmitter	Transmitter is malfunctioning. Some transmitters will send a specified mA signal when a malfunction occurs. This can be set to low values, such as 3.8 mA, or high values, such as 20.1 mA.
	Meter	Meter has been damaged. Remove meter and visually inspect.
	Meter	No flow in pipeline. Check other system locations to verify flow through the meter.
	Manifold	Manifold/gauge lines closed or blocked. Ensure valves and lines are open. If fluid is safe, open vent valves on transmitter to verify pressure in the gauge lines.
Wrong signal - high or low	Transmitter	Transmitter is in check mode. Some transmitters allow for system checks by forcing the signal to 4 or 20 mA. Vent low side of transmitter to ensure the signal responds to pressure changes.
	Meter	Process conditions do not match actual conditions. Contact McCrometer or your sales representative to recalculate using the correct process conditions.
	Meter	Wrong meter. Verify serial numbers on meters to ensure correct specifications. Sometimes two meters are interchanged. Each Wafer-Cone has a unique flow coefficient.
	Gauge lines	Foreign material trapped in gauge lines. Dirt and sediment can settle in the gauge lines. If the fluid is safe, vent the gauge lines and inspect for spurts of solids, gasses, or liquids (whichever should no be there). In a horizontal, liquid application, install the meter with the taps on the sides of the pipe (3 or 9 o’clock).
	Flow computer	Flow calculations are in error. Use loop calibrator and apply 4, 12, and 20 mA to computer/ system. Each of these points should correlate with the Wafer-Cone sizing information.
	Flow computer	mA signal is read incorrectly. Apply a known current to the loop and read the raw signal in the computer. Most computers allow the user to see the mA signal directly.

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SYMPTOM	AREA	POSSIBLE PROBLEM / SOLUTION
Signal too high	Meter	Meter is installed backwards. Look for flow direction arrow on meter body, near the pressure taps. With a meter measuring backward flow, the DP signal will be approximately 30% too high.
	Meter	Flow is going opposite direction as expected. The assumption of flow direction is sometimes wrong. Verify with other system readings. With a meter measuring backward flow, the DP signal will be approximately 30% too high.
	Meter	Partially full pipes (liquids only). A partially full pipe will cause the meter to read too high. This can happen even in pressurized systems. • On horizontal pipes: if the fluid is safe, open a pressure tap on the top of the pipe. Air release will indicate partially full pipe. • On vertical pipes: up flow will guarantee a full pipe. Down flow is difficult to diagnose if the pipe is full.
	Meter	Foreign object lodged in meter. This will increase the restriction of the meter and raise the DP. Remove the meter and visually inspect.
	Gauge lines	Leak on low pressure gauge line. Perform a leak check from the meter to the transmitter.
	Transmitter	Leak on low pressure manifold vent valve. Perform a leak check on valve.
	Transmitter	Zero point has shifted positively. This will cause errors more pronounced at the low end of the transmitter range. Verify by closing the manifold side valves and opening the center valve. The reading should go to zero (4 mA). Recalibrate if necessary.
	Transmitter	DP span is set too low. Use pressure calibrator or handheld communicator to verify span point.
	Transmitter /flow computer	Both the transmitter and flow computer are set to take the square root of the signal. The signal will only be correct at 20 mA. The positive error will increase dramatically as the signal decreases from 20 mA. Use a loop calibrator to check 12 mA point.
	Flow computer	4 mA set to minimum flow instead of zero flow. Our calculations assume that 4 mA will be equal to zero flow. Sometimes 4 mA is set to equal the minimum flow on the sizing page. This error will be zero at maximum flow and increase as the flow decreases. The amount of error will depend on the zero offset.
Signal too low	Manifold	Manifold is cross-vented. The center valve must be closed. To test, close the two side valves and watch the transmitter signal. If the signal goes to zero (4 ma), the center valve is not closed completely.
	Gauge lines	Leak on high pressure gauge line. Perform a leak check from the meter to the transmitter.
	Transmitter	Leak on high pressure vent valve. Perform a leak check on valve.
	Transmitter	Zero point has shifted negatively. This will cause errors more pronounced at the low end of the transmitter range. Verify by closing the manifold side valves and opening the center valve. The reading should go to zero (4 mA). Recalibrate if necessary.
	Transmitter	DP span is set too high. Use pressure calibrator or handheld communicator to verify span point.
	Transmitter /flow computer	Neither the transmitter nor flow computer is set to take the square root of the signal. The signal will be correct at 20 mA. The negative error will increase dramatically as the signal decreases from 20 mA. Use a loop calibrator to check 12 mA point.
Unsteady signal	Meter	Partially full pipe occurring (liquids only). Periods with a partially full pipe will cause erratic readings. See above for details.
	Transmitter	Power supply not supplying enough power to create signal. Check power specifications for transmitter.
Slow response time	Transmitter	Dampening period too long.
Sudden changes in readings	Wafer-Cone	Foreign object lodged in meter. This will increase the restriction of the meter and raise the DP. Remove the meter and visually inspect.
	Gauge lines	Leaks have started.

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SECTION 10 - MODEL NUMBER CONFIGURATION

10.1 MODEL NUMBER CONFIGURATION TABLE

Type	Size		Materials		Body Style		Bore		Fittings		Face Style	
VH		—										
	01	**1”**	**A**	**S316**	**1**	**ANSI CL 150 to 2500**	**S**	**Standard**	**N**	**NPT**	2	O-Ring Seal
	0C	1 ½”	X	Other Mat.	2	DIN 2633	X	Other	J	RC	**3**	**Serrated**
	02	2”			3	DIN 2635			X	Other	x	Other
	0D	2 ½”			4	JIS 10k			F	Direct Mount		
	03	3”			X	Other Style						
	04	4”										
	06	6”										

Example: VH01A1SN3

VH 01 1” A S316 1 ANSI CL 150 to 2500 S Standard N NPT 3 Serrated

10.2 REQUIRED INFORMATION

Each Wafer-Cone differential pressure flow meter is tailored to its specific application. Every Wafer-Cone will have a “sizing” completed according to the physical parameters of the application before it is manufactured. This computer generated sizing uses application data as a basis to predict the Wafer-Cone’s performance. Full-scale differential pressure (“DP”), working flow range, expected accuracy, and predicted pressure loss are determined by the sizing process.

The following must be provided for a sizing:

1. Fluid
2. Design pressure and temperature
3. Corrosion allowance
4. Maximum flow
5. Maximum differential pressure
6. Turndown
7. Desired accuracy
8. Pipe size
9. Pipe schedule

SECTION 11 - MAINTENANCE

The Wafer-Cone flow meter requires very little maintenance once installed. The Troubleshooting Section should be consulted before removal of the cone and body from the pipeline. First review and check those symptoms that can be corrected externally.

11.1 CLEANING

The exterior of the meter body, gauge lines, manifold and transmitter should be kept as clean as practical. The interior of the meter body and the cone normally do not require cleaning. However, the cone and the inside walls of the meter body should be inspected any time the Wafer-Cone body is removed from the pipe. Remove any deposits or sediment with a cleaner that will not harm the meter and cone materials.

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This Warranty shall apply to and be limited to the original purchaser consumer of any McCrometer product Meters or instruments defective because of faulty material or workmanship will be repaired or replaced, at the option of McCrometer, Inc., free of charge, FOB the factory in Hemet, California, within a period of one (1) year from the date of delivery. Repairs or modifications by others than McCrometer, Inc. or their authorized representatives shall render this Warranty null and void in the event that factory examination reveals that such repair or modification was detrimental to the meter or instrument. Any deviations from the factory calibration require notification in writing to McCrometer, Inc. of such recalibrations or this warranty shall be voided. In case of a claim under this Warranty, the claimant is instructed to contact McCrometer, Inc. 3255 West Stetson Ave., Hemet, California 92545, and to provide an identification or description of the meter or instrument, the date of delivery, and the nature of the problem. The Warranty provided above is the only warranty made by McCrometer, Inc. with respect to its products or any parts thereof and is made expressly in lieu of any other warranties, by course of dealing, usages of trade or otherwise, expressed or implied, including but not limited to any implied warranties of fitness for any particular purpose or of merchantability under the uniform commercial code. It is agreed this warranty is in lieu of and buyer hereby waives all other warranties, guarantees or liabilities arising by law or otherwise. Seller shall not incur any other obligations or liabilities or be liable to buyer, or any customer of buyer for any anticipated or lost profits, incidental or consequential damages, or any other losses or expenses incurred by reason of the purchase, installation, repair, use or misuse by buyer or third parties of its products (including any parts repaired or replaced); and seller does not authorize any person to assume for seller any other liability in connection with the products or parts thereof. This Warranty cannot be extended, altered or varied except by a written instruction signed by seller and buyer. This Warranty gives you specific legal rights, and you may also have other rights which vary from state to state. McCrometer, Inc. reserves the right to make improvements and repairs on product components which are beyond the warranty period at the manufacturer's option and expense, without obligation to renew the expired warranty on the components or on the entire unit. Due to the rapid advancement of meter design technology,
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