



## Malema Sensors® M-2700 Integrated Ultrasonic Flow Meter



### Operating Instructions

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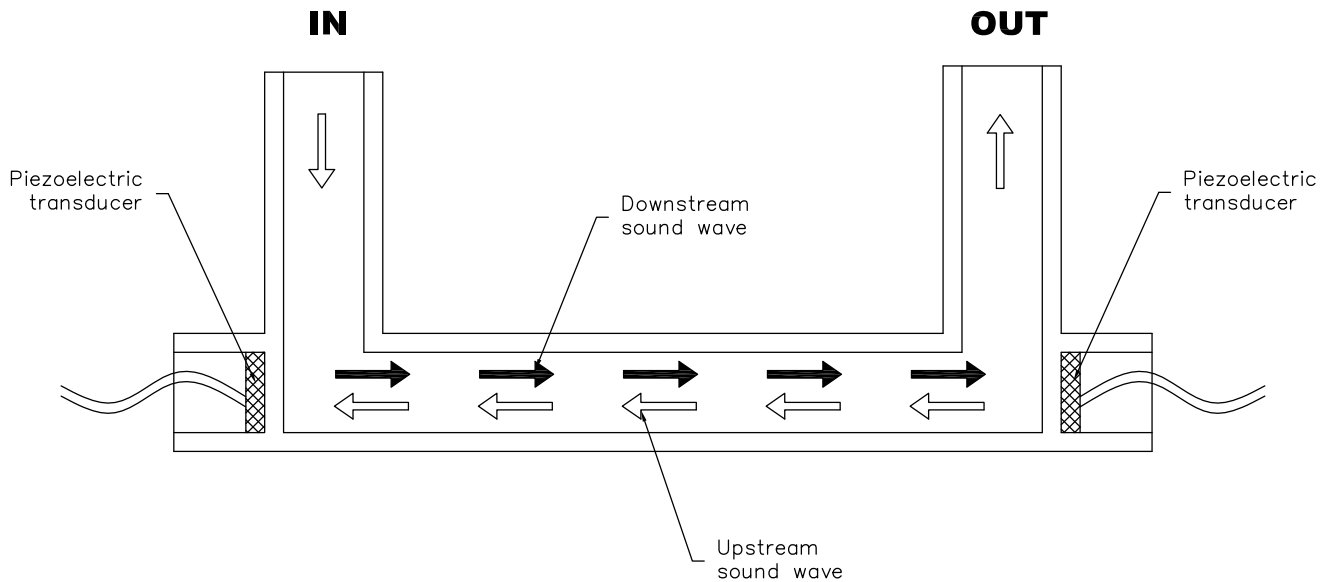
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## Introduction

The M-2700 series is an integrated flow meter in a small package. The M-2700 utilizes the latest high-speed digital signal processing (DSP) technology to provide a cost effective flow measuring solution with no compromise in performance. Malema DSP algorithms sample the entire wave form resulting in a demonstrable advantage in bubble immunity over traditional ultrasonic technologies. The flow sensor is a U- or Z-shaped PFA tube with no internal obstructions, moving parts, or mechanical seals. The M-2700 is compatible with high-temperature liquids and is an ideal choice for use where minimal footprint, high purity, corrosion resistance, low pressure drop, and easy installation are desired.

The Malema ultrasonic flow meter is designed to measure the fluid velocity of a liquid within a closed conduit (pipe). Two piezoelectric transducers spaced at a specific distance from each other function as both ultrasonic transmitters and receivers. The transducers sit outside the fluid path and are non-contacting. The flow meter operates by alternately transmitting and receiving a frequency-modulated burst of sound energy between the two transducers and measuring the time interval that it takes for the sound to travel between the two transducers. The difference in the time interval measured upstream vs. downstream is directly related to the velocity of the liquid in the pipe, and is used to derive the flow rate.



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## Storage and Handling

### Storage conditions

Store the product under packed conditions in an anti-static bag. The storage place should be free from moisture, mechanical shock and vibration. The storage temperature should be between 10°C and 35°C and the humidity between 5% and 80% R.H. without condensation.

### Unpacking and Product Inspection

Upon delivery, inspect the product for damage. Confirm that the model code on the label matches the specification in the purchase order.

Confirm that you have received the following items:

- Integrated flow meter consisting of sensor and electronics
- A physical copy of this operating manual

## Installation Instructions

### Selecting location:

The following must be considered when selecting the installation location of the Flow Meter:

1. Ambient temperature: 0°C to 46°C (32°F to 115°F) protected from direct sunshine.
2. Free from electromagnetic interference. Keep away from such heavy inductive devices as motors, pumps, power-relays and solenoid valves.
3. The location must be protected from water jets or corrosive gases.
4. The location should allow easy access for maintenance.

### Mounting of Flow Meter:

Consider the following when selecting and installing the Flow Meter for accurate measurement.

1. Flow Meter can be installed at any angle – vertical, horizontal or inclined. The best angle, however, is vertical with upward flow direction for U-shaped sensor and 45 degrees with the inlet and outlet tube sections facing up at 45 degrees for Z-shaped sensor. With this angle, air bubbles are less likely to be trapped in the flow detector, and furthermore fluid can be easily drained when maintenance work is needed.  
In the case that the flow detector is to be mounted in a horizontal pipe run, raise the downstream side slightly to prevent bubble stagnation. Please make sure that there is no deposit in the detector during operation. If there is a possibility of deposits occurring, periodically flush with a clean liquid such as water.
2. To install on a pipe that has an open end, mounting should be at the lower position of the pipeline.
3. The arrow on side plate of Flow Detector shows flow direction. Make sure the arrow matches the direction of flow.
4. Flow Detector should be mounted where pressure in the pipe is above atmospheric.

5. A flow control valve is recommended downstream of the Flow Detector to prevent formation of bubbles in the liquid. An upstream valve may form bubbles, thus attenuating the ultrasound signal and resulting in measurement noise.
6. A bypass pipe (including bypass valve and shutoff valve) is recommended for easy zero adjustment and maintenance.
7. Use two threaded holes for the mounting of Flow Meter. Take great care to avoid mechanical stress on the inlet and outlet pipes.
8. Please refer to page 6 of this Instruction Manual for the connection of the inlet and outlet pipes.

### Caution

To avoid stress on the flow tube/housing interface, follow the precautions below:

1. Tube should be held firmly while working on the tube end fittings during installation.
2. There should not be any relative displacement/movement between the tube and the housing at any point in time.

### Start Up

The M-2700 Series flow meter system requires a full pipe of liquid medium at rest before a successful startup can be completed.

#### Preliminary Checks:

1. Make all the necessary electrical connections as per the connection details on pages 7 & 8.
2. Ensure that the power supply rating is 24 V DC  $\pm$  10%, 300 mA.
3. Confirm that the Flow direction arrow on the flow meter points in the same direction as the physical flow direction.

#### Start up Process:

1. Turn on the power. The instrument will go through initialization process and start measuring flow.
2. Please allow the instrument to warm up for about 10 minutes.
3. Verify that the flow tube is full of stationary liquid without bubbles.
4. ZERO RESET through momentarily pulling up the remote zero IN wire to 24 V DC (+) or through the communication interface software, available on request.
5. The flow meter is now ready for making valid measurements.

**NOTE:** To read valid flow rates, ZERO calibration needs to be done whenever the measurement fluid properties change or the installation set-up is different than the one used for the previous ZERO Calibration.

## Specifications

Table 1. Performance Specifications

End Connection Tube Size (Sensor Internal Diameter)	1/4" (4 mm)	3/8" (4 mm)	3/8" (6 mm)	1/2" (10 mm)
Standard Full Scale Range *	3 lpm	4 lpm	8 lpm	20 lpm
Accuracy	±1% of Flow Reading, down to 10% of Full Scale *			
Repeatability	±0.5% of Flow Reading, down to 10% of Full Scale *			

\* Custom flow ranges available upon request. Consult factory for any other special requirements

Table 2. Electrical Specifications

Output Options	Analog Output	Current Output: Active: 4 to 20 mA (Max. Load < 900 ohms) Passive: 4 to 20 mA (Max. Load < 1200 ohms @ 30 V max.) Voltage Output: 0 to 10 V DC (min. impedance > 10 K)
	Digital Output	Open Collector / Max. 30 V DC, 200 mA max. Configurable for Low flow rate, High flow rate, Totalizer greater than, Totalizer less than, Signal strength less, Positive totalizer pulse *
Digital Input	Zeroing - Momentary pull-up to 24 V DC for activation	
Power Supply	24 V DC ± 10%	
Power Consumption	100 mA (nominal)	
Digital Communication	MODBUS over RS-485	

\* Pulse frequency configurable up to 10 kHz; Pulse weight configurable from 0.01 ml

Table 3. Sensor Material Specifications

Enclosure Classification	IP64
Cable	FEP Jacketed
Non-wetted Parts	Polypropylene, PEEK, FEP
Wetted Parts	High Purity PFA

**Operating Specifications**

- Measurable Fluid: Liquids
- Fluid Temperature: 50° – 140°F (10° – 60°C) \*
- Fluid Pressure: 0 – 70 psig
- Ambient Temperature: 32° – 115°F (0° – 46°C)
- PFA Tube End or others \*
- Enclosure Classification: IP64

\* Consult Malema for any special requirements

**Table 4. Cable Specification**

CABLE	8 conductor shielded, FEP jacketed cable with free leads * 26 AWG
Wire Color	Function
White	Signal OUT (4 to 20 mA or 0-10 V DC)
Brown	Power IN (+24 V DC)
Green	Remote Zero IN **
Yellow	Alarm or Pulse OUT
Gray	RS-485 A, Data -
Pink	RS-485 B, Data +
Blue	Ground (Power and signal)
Red	Not Used

\* Bulkhead connector option available

\*\* Momentary pull-up to 24 V DC

NOTE: Consult factory for other cable and pin out options

**Maintenance Note**

Ultrasonic flow meter requires no daily maintenance since it has no moving parts that can be subject to wear and tear. However, we recommend the following checks to ensure smooth and reliable operation.

**Connection of Flow Detector**

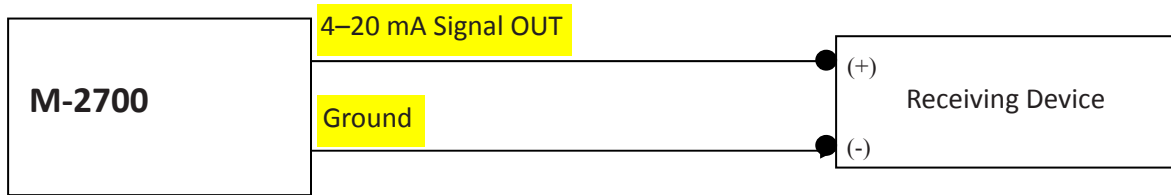
- Check for leakage around pipe connections or liquid penetration into Flow Detector tube.
- Check for any loose nuts.
- Make sure that the connection ports are leak free.
- Observe the Flow Detector visually from outside and note that there are no sediments, bubbles, or foreign materials in the measuring tube.

**Connecting pipe**

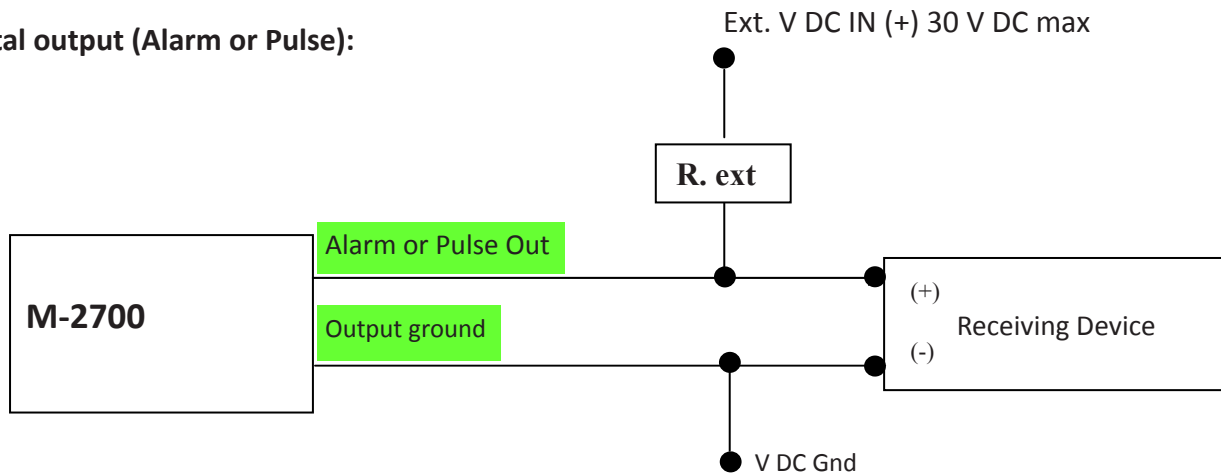
- Check for mechanical stress to Flow Detector caused by possible warping of connecting pipes or loose connections caused by heavy pipe vibration.

Wiring Examples

4-20 mA active current output:



Digital output (Alarm or Pulse):



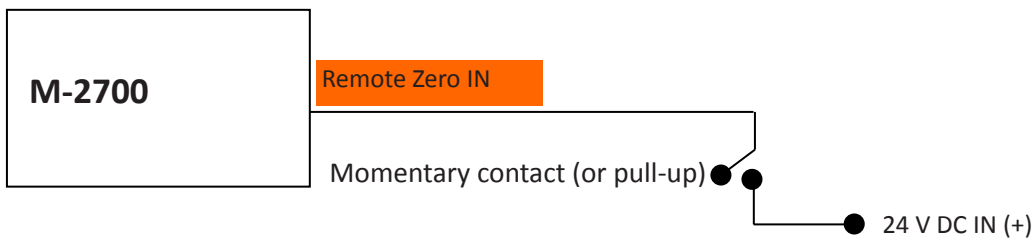
R. ext is an external resistor.

Choose R. ext so that the maximum current through the terminal does not exceed 200 mA.

R. ext can be calculated as follows:

$$R. \text{ ext (k}\Omega) = \text{Ext. V DC IN} / \text{Max. current (mA)}$$

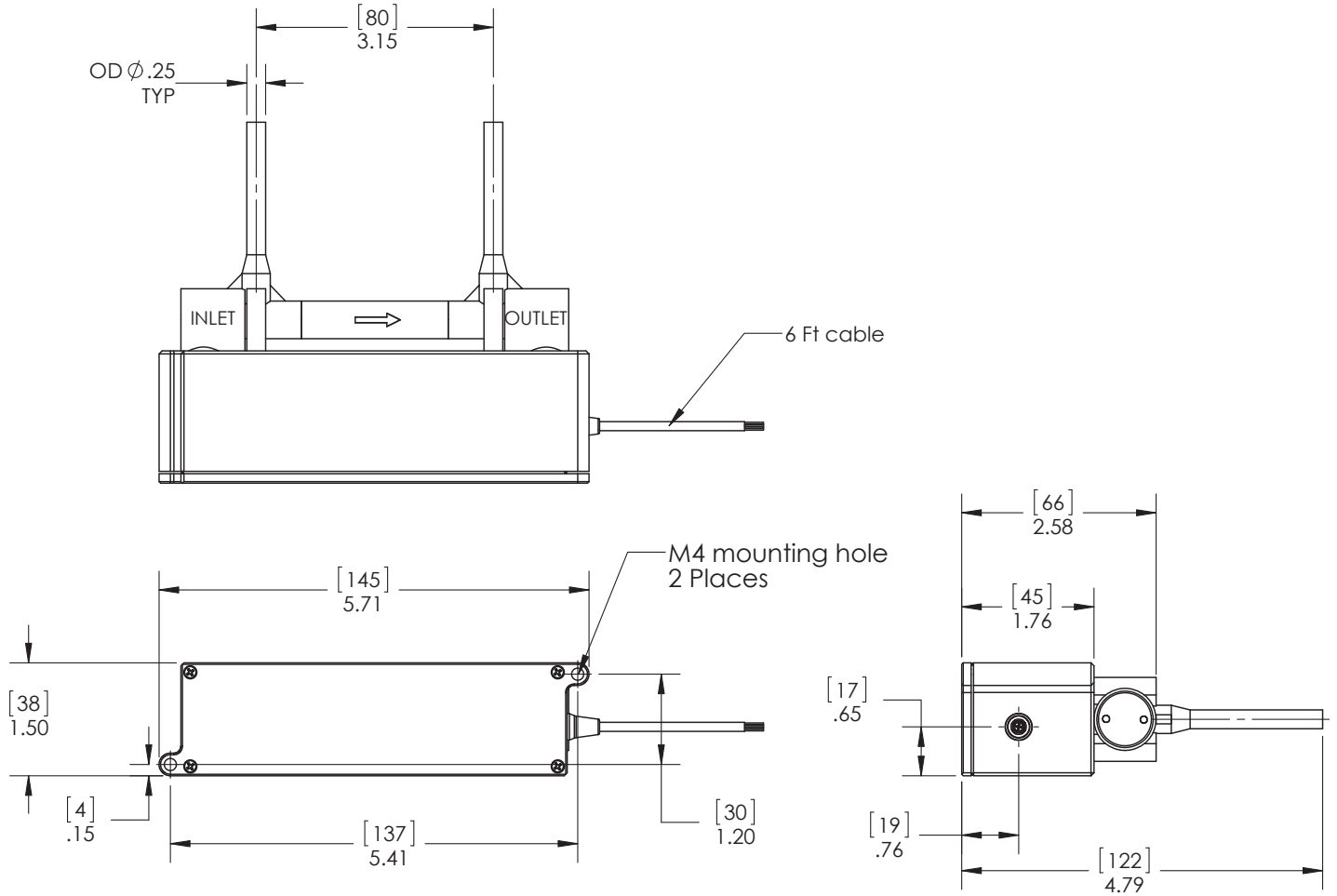
Remote Zero IN:





**Flow Meter Dimensions**

FOR REFERENCE ONLY



¼" U-shaped sensor model with standard cable connector shown. Contact Malema for other model sizes and configurations.

## Field Checklist/Troubleshooting

Problem Statement: No analog flow output even with physical flow running		
Noted Symptom	Possible Cause	Follow up checks and possible fix
<b>Flow readings on Malema GUI are zero</b>	Bubbles in the line.	Check for bubbles in the line and if needed purge the line.
	Incorrect flow direction.	Ensure physical flow direction is in accordance with arrows on the label of the flowmeter.
	Sensor signal strength compromised	Check for sensor signal strength using Malema GUI (or check alarm using open collector output). Once low signal strength is confirmed, contact Malema for replacement sensor. Please see page 13 for RMA instructions.
	Huge zero offset	Rezero must be done properly - zeroing should be done only in fluid condition as close to process fluid condition as possible without bubbles in the line. See page 12 for rezeroing procedure.
	Incorrect parameters	Ensure sensor parameters have not been accidentally changed. If needed, contact Malema for factory parameters and reset the parameters.
	Faulty Electronics	Open Malema GUI and monitor Flow readings. If readings drop to zero sporadically (intermittent readings), check and record a sequence of events how such drop occurs and how it recovers, e.g. flow rate change, pump speed change, liquid temperature change, power cycle, etc. and communicate to Malema for further guidance.
<b>Flow readings on Malema GUI shows valid and stable flow rates</b>	Analog output wiring connection is incorrect	Check analog output wiring to tool's input/output interface. Make sure wiring is connected correctly and all terminals are clean and secured. Please note - if the analog output is wired incorrectly, permanent damage can be caused to the Malema sensor circuit board.
	Load resistance or impedance of input/output terminal not within specification	Confirm if load resistance or impedance of external input/output terminal is within specification. Max. Load < 900 ohms in case of current output and min. impedance > 10 K Ohm in case voltage output.
	Analog output of the flowmeter is bad	Check analog signal directly on analog output wires of the meter (with the wires not connected to tool's input/output interface). Please consult factory if the analog output is bad or incorrect.

<b>Flow readings on Malema GUI shows an unstable flow rate</b>	Bubbles in the line.	Check for bubbles in the line and if needed purge the line.
	Actual flow is unstable	Check flow and pressure stability and take necessary actions to fix it
	Wrong parameters-filter setting	Change filter settings if needed. Consult with the factory for additional guidance and support.
	Electrical noise in tool analog input/output board	Check signal with oscilloscope; if noisy, find source of noise and repair
	Issues with Power supply	Make sure power supply is able to supply required current; 24 V DC supplied is stable and clean; if required repair or replace power supply

**Problem Statement: Accuracy is off - unacceptable difference between flow readings and observed flow rate**

<b>Noted Symptom</b>	<b>Possible Cause</b>	<b>Follow up checks and possible fix</b>
<b>Flow readings on GUI are different from what's transmitted to tool software interface</b>	Analog output wiring connection is incorrect	Check analog output wiring to tool's input/output interface. Make sure wiring is connected correctly and all terminals are clean and secured. Please note - if the analog output is wired incorrectly, permanent damage can be caused to the Malema sensor circuit board.
	Load resistance or impedance of input/output terminal not within specification	Confirm if load resistance or impedance of external input/output terminal is within specification. Max. Load < 900 ohms in case of current output and min. impedance > 10 K Ohm in case voltage output.
	Analog output of the flowmeter is bad	Check analog signal directly on analog output wires of the meter (with the wires not connected to tool's input/output interface). Please consult factory if the analog output is bad or incorrect.
	Wrong parameter settings	Check parameter settings of the meter such as full scale and flow unit, flow meter analog output specification (e.g. voltage vs. current outputs), scaling setting on tool's software, etc.

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<b>Flow readings on GUI are identical to what's transmitted to tool software interface</b>	Bubbles in line	Check for bubbles in the line and if needed purge the line
	Huge Zero offset	Rezero must be done properly - zeroing should be done only in fluid condition as close to process fluid condition as possible without bubbles in the line. See page 12 for rezeroing procedure
	Application fluid significantly different from DI Water	Check if liquid property is different from DI water's and decide if calibration (linearization) is required or a known calibration factor for a specific liquid should be entered (either into flow meter or external look-up table on tool software). Please consult the factory.
	Wrong parameter settings - Liquid property settings	Check if liquid property has changed unintentionally under flowmeter parameter settings. Consult factory for additional support
<b>Malema Sensor Alarm (Low Signal Strength Alarm)</b>	Bubbles in line	Check for bubbles in the line and if needed purge the line
	Sensor signal strength compromised	Check for sensor signal strength using Malema GUI (or check alarm using open collector output). Once low signal strength is confirmed, contact Malema for replacement sensor. Please see page 13 for RMA instructions.
	Wrong parameters	Ensure sensor parameters have not been accidentally changed. If needed, contact Malema for factory parameters and reset. Check the signal strength alarm threshold and hysteresis settings on the Malema GUI in case they are set too aggressively for a given liquid

## Rezeroing

1. Run liquid at process flow rate or higher to purge out any bubbles. In general, zeroing after longer run (30 sec. or longer) at higher flow rate/pressure is preferred.
2. Stop the flow, wait approx. 5 sec. for the flow rate to stabilize, ensure no physical flow, and execute zeroing.

Zeroing should be done in reference to liquid condition as close to process liquid condition as possible (in steady state conditions under which flow meter will operate). Rezeroing should be done only in fluid condition as close to process fluid condition as possible without bubbles in the line. It is likely to be more difficult to ensure this steady state condition in lower flow rate operation and any impact of error may be more visible in operations requiring higher accuracy.

If fluid conditions change significantly during zero flow period, do not execute zeroing after long stagnant flow period (unless identical fluid condition can be guaranteed even after long zero flow period) but execute zeroing "immediately" after runs at process flow rate or higher (within ~5 sec. after physical flow has stopped and flow reading has stabilized). For example, supply tank keeps liquid temperature at 22°C while

ambient room temperature is at 25°C. If fluid stays stagnant inside the flow meter for extended period, its temperature will rise due to higher room temperature. If flow meter is zeroed under this condition, this is not a good zeroing for 22°C process liquid. This is just one example but can be applicable to any liquid changing its properties during zero flow period. Another example is a liquid that experiences outgassing during zero flow conditions, so zeroing while there are excessive bubbles would not result in a good zero.

In the same sense, it is not recommended that autozeroing is used if liquid properties such as temperature, bubble contents, chemical compositions, etc. change between zero flow conditions and process flow period when there is a significant gap between process flow conditions. The result will be identical to manual zeroing after long stagnant period.

#### \* Comments

It is most helpful if information can be logged using Malema's GUI while a problematic event occurs and shared with Malema technical support team.

### Service Contacts

For service support or technical assistance, please contact the Malema Engineering Corp. Technical Support Team at:

TEL: +1 (800) 637-6418

FAX: +1 (561) 995-0622

E-mail: [technicalsupport@malema.com](mailto:technicalsupport@malema.com)

### Service and Repair

To return the products, please obtain an RMA number for the product by contacting the Malema Sensors Corporate Headquarters, Boca Raton, Florida, USA, at +1 (800) 637-6418 or +1 (561) 995-0595.

Unless otherwise specified with the RMA number, all equipment must be returned to the following address:

Malema Sensors  
1060 S. Rogers Circle  
Boca Raton, FL 33487, USA

### Warranty

Malema Sensors warrants to the buyer that its products are free from defects in materials and workmanship at the time of shipment and during the WARRANTY PERIOD. Malema Sensors's obligation under this warranty is limited to the replacement of the product(s) by same product(s) manufactured by Malema Sensors or repair of the product(s) at the Malema Sensors's facility.

Malema Sensors products are sold with the understanding that the buyer has determined the applicability of the product(s) to its intended use. It is the responsibility of the buyer to verify acceptability of performance to the actual conditions of use. Performance may vary depending upon these actual conditions.

#### Warranty Period

This warranty is in effect for twelve (12) months from the date of shipment from Malema Sensors's place of business.

#### Warranty Claim

If Malema Sensors® products are found to be defective in materials or workmanship within twelve (12) months of the date of shipment, they will be repaired or replaced with same product at the discretion of Malema Sensors at its place of business at no charge to the buyer.

Ordering Information

Model Ordering Code												Description	
M-2700	-	*	**	*	**	-	*	*	-	*	-	***	
Body Material	F											PFA	
Connection Size (OD)	2R											1/4" Regular	
	3R											3/8" Regular	
	4R											1/2" Regular	
Connection Type	1											Tube Ends	
	2											Flare (Female)	
	3											Pillar (Female)	
Standard Full Scale Range	03											3 LPM	
	04											4 LPM	
	06											8 LPM	
	10											20 LPM	
-													
Converter											B	Converter without Display	
Electrical Connection											S	Standard (6' Pigtail)	
											C	Custom	
-													
Geometry											U	U-shape	
											Z	Z-shape	
-													
											XXX	Unique PN Identifier	

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