Malema Clamp-On Ultrasonic Meter M-3100 Series (Transmitter model M-3100T and Sensor model M-3100S)

User Manual

Copyright

Subject to Technical Changes

Owing to our policy of continuous product development, the illustrations and technical data contained in this document may differ slightly from the current version of the device.

Legal Manufacturer

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Certifications/Compliances

CE Compliance via the following testing:
1. EN61000-4-2: Electrostatic Discharge
2. EN61000-4-3: Radiated Immunity (and Radiated Emissions)
3. EN61000-4-4: Electrical Fast Transients
4. EN61000-4-5: Surge - Power Line
5. EN61000-4-6: Conducted Immunity

Support Email Address

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1.00 Introduction

1.01 Safety Precautions

- Read this user manual carefully before installing and starting up the device!
- The user (i.e. the person who integrates the Malema Ultrasonic Transmitter into a control cabinet) is responsible for any risks resulting from an incorrect or incomplete integration of the Malema Ultrasonic Transmitter.
- The customer must ensure that the persons involved in the integration of the Malema Ultrasonic Transmitter are adequately qualified in regard to the integration of industrial and process measurement transmitters.
- In addition, the information in this user manual must be followed.
- Before the first use after the Malema Ultrasonic Transmitter was transported or taken from storage, ensure that the system has enough time to adapt to the ambient temperature in order to ensure an accurate measurement.
- Due to possible failures of the Malema Ultrasonic Transmitter or the system it is part of, we strongly advise against the use of the flow values provided by the Malema Ultrasonic Transmitter to directly control the closed loop system unless the risk was fully analyzed and additional risk control measures have been established.
- If the used Malema Ultrasonic Flow Sensor is switched to another flow channel, if another Malema Ultrasonic Flow Sensor is used, or if the Malema Ultrasonic Flow Sensor is unplugged and reconnected, it must be reconfigured prior to the measurement (e.g. zero flow adjustment).
- The Malema Ultrasonic Transmitter, the Malema Ultrasonic Flow Sensor(s), and sensor lines are part of a sensitive sensor system. Electromagnetic fields can lead to interferences affecting the measurements or the accurate function of the system.
- The Malema Ultrasonic Transmitter consists of components sensitive to electrostatic discharge. Handle only in EMV-protected areas according to IEC 61326-1.

Although the flow measurement system consisting of the Malema Ultrasonic Transmitter and the Malema Ultrasonic Flow Sensor represents a state-of-the-art technology, the user may be put at risk if the device is operated incorrectly. You should therefore read the user manual carefully before use. Inspect your equipment for completeness and damage after unpacking.

This user manual contains important information on the safe handling of the flow measurement system and its accessories and should be kept it in an easily accessible location. Familiarize yourself with, and observe all warning and safety information.

It is the responsibility of the operator (i.e. the person carrying out the flow measurement and/or the person operating the system the Malema Ultrasonic Transmitter is part of) of the device to ensure it is used, inspected and maintained in accordance with the user manual. Subsequent revisions or instructions from the manufacturer must also be taken into account in this regard.

The manufacturer reserves the right to modify technical data without prior notice. Your local distributor will supply you with current information and updates to this user manual.

If the Malema Ultrasonic Transmitter is integrated into an industrial system, the user and operator have to observe the following:

- The measured values supplied by the Malema Ultrasonic Transmitter report the volumetric flow rate via analog interface.
- If the unit is used to control the liquid volume flow, the user must analyze the risk of the application and, if necessary, take actions independent of the Malema Ultrasonic Transmitter to minimize the risk.
  More information regarding the suggested action to solve the respective error/warning can be found in Section 8.00 Troubleshooting.

1.00 Introduction

1.01 Safety Precautions

Symbols used in this User Manual

Symbol	Meaning
	Warning! This safety symbol precedes critical information that must be strictly observed in order to prevent injuries and fatal hazards. This warning symbol is the most important safety symbol.
	Caution! Important information regarding correct handling. Must be strictly observed! If this information is not observed, faults or damage to the product or its surroundings may occur.

1.02 Intended Purpose

The Malema flow measurement system in general and the Malema Ultrasonic Transmitter is designed for the measurement of volumetric flow of liquids in tubing circuits. The measurement is based on the ultrasonic transit time method. It is usually used in semiconductor manufacturing, laboratory, and industrial processes. The device is intended to be mounted and used in a control cabinets only. The device must be used with compatible Malema Ultrasonic Flow Sensors.

1.03 Usage Restrictions and Limitations

The Malema Ultrasonic Transmitter was developed and is sold for the above-mentioned intended purpose and use only. The Malema Ultrasonic Transmitter and the Malema Ultrasonic Flow Sensors are not intended to be used for the following purposes/under the following circumstances:

- Medical device
- Measuring gaseous media or explosive and/or flammable liquids
- Measurements in explosive areas
- Home or consumer use
- Outdoor use
- Legal metrology
- When any part of the system is damaged

Due to the single-channel structure of each individual channel, the Malema Ultrasonic Transmitter is not a fail-safe system.

- If applied in safety-critical systems, the user has to consider a partial or complete system failure and is responsible for the introduction of additional risk measures in their system.

For more information concerning compatible Malema Ultrasonic Flow Sensors, please contact Malema.

1.04 Liabilities and Responsibilities

The user is responsible to use, check and maintain the Malema Ultrasonic Transmitter and the Malema Ultrasonic Flow Sensor in accordance with the user manual. Dover, PSG and their subsidiary companies are neither liable nor responsible for any consequences arising from the use of the Malema Ultrasonic Transmitter and/or the Malema Ultrasonic Flow Sensor that does not comply with the operating and safety instructions or the specifications in this user manual.

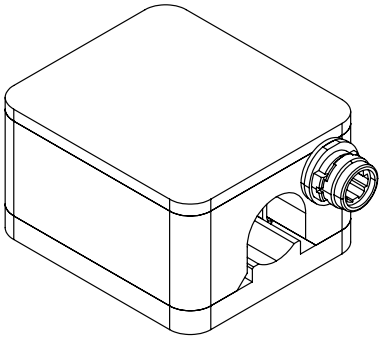
1.00 Introduction

1.05 Package Contents

The Malema Ultrasonic Transmitter is shipped with the following components:

Malema Ultrasonic Transmitter (Single Channel Platform with analog interface) supporting one flow channel included:

- One 12-pin connector for DC power, analog output, and digital input/output



The Malema Ultrasonic Flow Sensor is shipped with the following components:

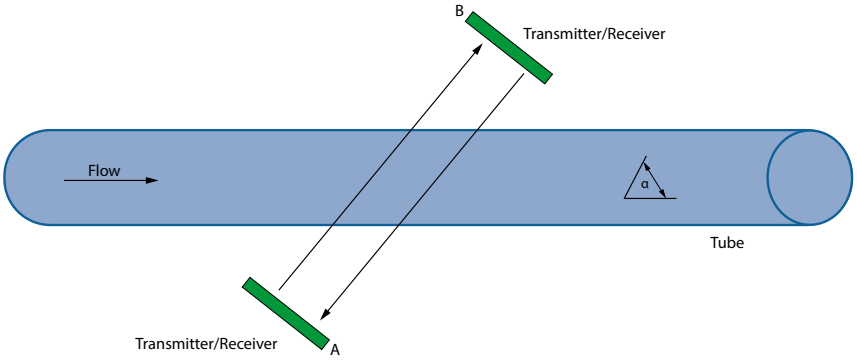
Malema Ultrasonic Flow Sensor (non-invasive flow sensor) includes,

- 5 m cable (Accessories)
- 6-pin round receptacle (attached to cable)
- 2 x M5x8 cross-head screws (part of sensor)

Note: The Malema Ultrasonic Transmitter and Sensor are ordered separately, but are paired and should not be separated from each other or mixed with other transmitter sensor pairs.

2.00 Operating Principle

The function of the flow measurement system consisting of the Malema Ultrasonic Transmitter and the Malema Ultrasonic Flow Sensor is based on an acoustic measurement principle and utilizes the transit time method to determine the flow. For this, the system utilizes two ultrasonic piezo ceramics that each function as both transmitter and receiver for the burst of sound energy that is sent between them. For each transmission, the difference in transit time that it takes for the pulse to travel between the ceramics is measured. As the difference in transit time is directly related to the velocity of the liquid, it can be used as the basis to determine the volumetric flow rate.



When sending ultrasonic signals through the measuring section, the transit time difference depends on the flow direction of the medium.

- The ultrasonic sound signals that are sent along the flow direction and volume flow of the medium, i.e. downstream, need less time to travel through the measurement section than the ultrasonic sound signals that are sent against the flow direction, i.e. upstream.

The calculation of the flow rate is then carried out inside the Malema Ultrasonic Transmitter.

3.00 Installation

3.01 Malema Ultrasonic Transmitter

The Malema Ultrasonic Transmitter supports DIN rail mounting for the use in cabinets of process controls (IP20) and mounted on a standard mounting channel (DIN-rail to EN 50022, TH 35/7,5 or TH 35/15).

Mounting

1. Engage the module from the top in the top-hat rail and swivel it down so that the module slides into position.
2. There is only one correct mounting position for the device. The sensor connections are on the bottom of the device.
3. Please ensure that the Malema Ultrasonic Transmitter is firmly mounted onto the rail before setting up any connections.
4. Other modules may be rowed up to the left and right of the device.
5. There must be at least 5 cm clearance for heat dissipation above and below the module to ensure sufficient cooling of the device.
6. The standard mounting channel must be connected to the equipotential bonding strip of the switch cabinet.
    - The connection wire must feature a cross-section of at least 10 mm².

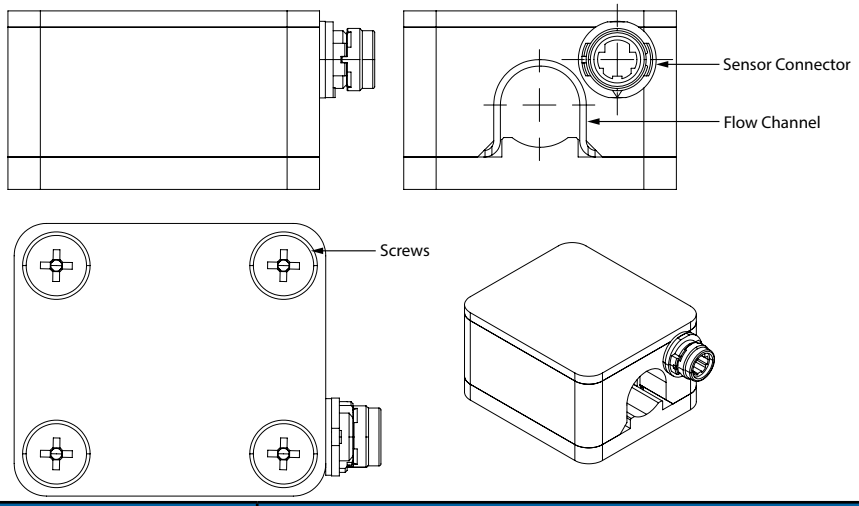
Removal

Note: Use screwdriver of 3 - 3.5mm size to remove Malema Ultrasonic Transmitter.

1. Disconnect the power supply, the sensor, and the signal lines.
2. Disconnect and remove the analog connection.
3. Pull the DIN rail fixing bracket downwards by using a screwdriver.

3.02 Connection

Malema Ultrasonic Sensor

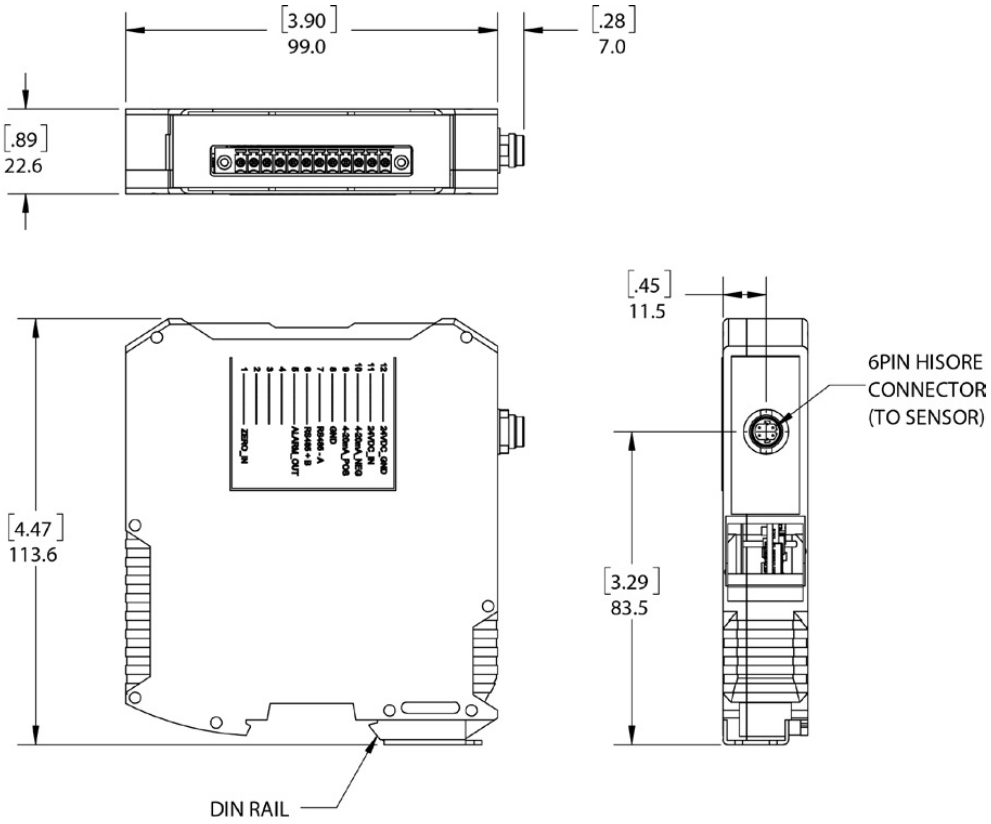


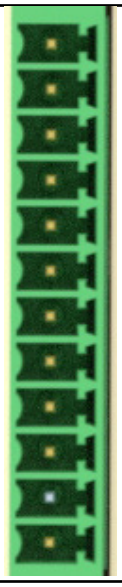
No.	Components	Description
1	Sensor Housing	For Sensor tube clamping
2	Flow Channel	Single
3	Screws	M5x8 cross-head screws; – 40 in.oz (equivalent to 2.5 in.lb or approximately 0.28 Nm)
4	Cable	Nominal length: approx. 5 m Nominal outer diameter: approx. 4.6 mm
5	Sensor connector	6-pin HR30-6R-6P(71)

3.00 Installation

3.02 Connection

Malema Ultrasonic Transmitter



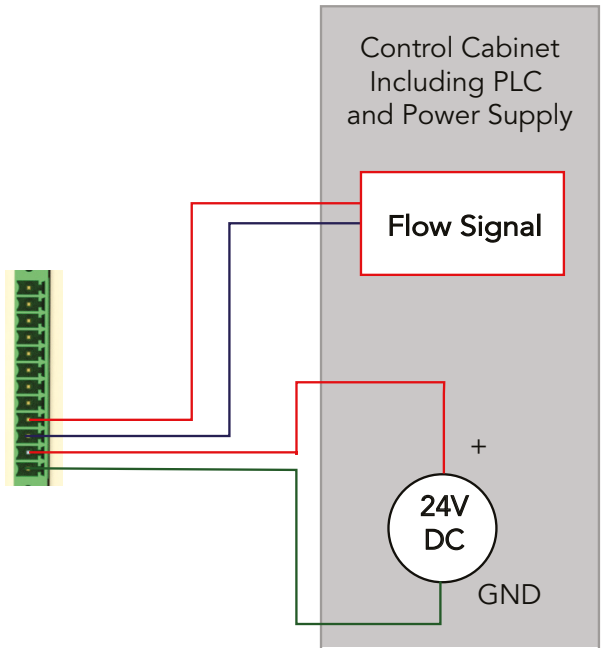
No.	Components	Description		
1	Sensor Connector	Round connector to connect the Sensor to the Transmitter		
2	Terminal Block • Analog signal • Digital signal • Alarm • 24 V DC • Communications	**Connector**	**Pin**	**Description**
			1	ZERO_IN (momentary pull-up to 24 V DC)
			2	Reset_Totalizer (momentary pull-up to 24 V DC)
			3	PULSE_OUT (Open Collector 30 V DC, 200 mA max)
			4	Earth Ground
			5	ALARM_OUT (Open Collector 30 V DC, 200 mA max.)
			6	RS485 + (B)
			7	RS485 - (A)
			8	Digital Alarm GND
			9	4-20 mA +
			10	4-20 mA -
			11	24 V DC IN
			12	24 V DC GND

⚠ The maximum resistance load on a current output must not exceed 900 Ω.

3.00 Installation

3.02 Connection

Wiring of the Malema Ultrasonic Transmitter



3.03 Powering of the Malema Ultrasonic Transmitter

- The terminal block requires a screwdriver with a 3.5 mm size.
- The wires used in conjunction with the terminal block should not exceed 1.31 mm^2.

The Malema Ultrasonic Transmitter works with a 24V DC power, which has to be supplied from an external power supply (please see table in Section Malema Ultrasonic Transmitter).

- The Malema Ultrasonic Transmitter needs to be connected to a limited energy circuit (24V DC with max. 1 A).
- The current needs to be limited by an overcurrent protection device of 1 A (slow).
  – The overcurrent protection device shall be a fuse or a non-adjustable non-self-resetting electromechanical device.

Connecting the Malema Ultrasonic Flow Sensor to the Malema Ultrasonic Transmitter

1. Attach the sensor cable connector to the sensor connector of the Malema Ultrasonic Transmitter.
2. Clamp flow tube to sensor housing.

- The connector of the Malema Ultrasonic Flow Sensor must be dry when plugged in.
- When connecting the plug to the receptacle, make sure the arrow on the plug lines up with the arrow on the receptacle.
- While installing the Malema Ultrasonic Flow Sensor, be sure not to impair the function of the tubing system.
- Ensure that the tube size which is used corresponds with the size of the sensor.

3.00 Installation

3.04 Line Routing, Shield and Measures to Combat Interference Voltage

Malema Ultrasonic Sensor

Inside and outside of cabinets:
In order to achieve an EMC-compliant routing of the lines, it is advisable to split the lines into the following line groups and to lay these groups separately.

1. **Group A:**
- General shielded bus and data lines (e. g. for Modbus TCP, Profibus DP, sensor extension cables, etc.)
- General shielded analog lines.
- General unshielded lines for DC voltage ≤ 60 V
- General unshielded lines for AC voltage ≤ 25 V
- Coaxial lines for monitors

2. **Group B:**
- General unshielded lines for DC voltage between 60 V and 400 V
- General unshielded lines for AC voltage between 24 V and 400 V

3. **Group C:**
- General unshielded lines for DC voltages > 400 V

The table below allows you to read off the conditions for laying the line groups on the basis of the combination of the individual groups.

	Group A	Group B	Group C
Group A	1	2	3
Group B	2	1	3
Group C	3	3	1

1. Lines may be laid in common bunches or cable ducts.
2. Lines must be laid in separate bunches or cable ducts (without minimum clearance).
3. Lines must be laid in separate bunches or cable ducts inside cabinets but on separate cable racks with at least 10 cm clearance outside of cabinets but inside buildings.

3.05 Shielding of lines

Shielding is intended to weaken (attenuate) magnetic, electrical or electromagnetic interference fields. Interference currents on cable shields are discharged to earth via the shielding bus which is connected conductively to the chassis or housing. A low-impedance connection to the PE wire is particularly important in order to prevent these interference currents from themselves becoming an interference source.

Wherever possible, use only lines with a braided shield. The coverage density of the shield should exceed 80 %. Avoid lines with foil shields since the foil can be damaged very easily as result of tensile and compressive stress on attachment. The consequence is a reduction in the shielding effect.

In general, you should always connect the shields of cables at both ends. The only way of achieving a good interference suppression in the higher frequency band is by connecting the shields at both ends. Only in exceptional cases may the shield be connected at one end only. However, this then achieves only an attenuation of the lower frequencies.

3.00 Installation

3.05 Shielding of lines

To meet CE certification, the I/O cable connected to the M-3100T needs to be shielded with its shield connected to Earth Ground at the source and the Earth ground of the cable must be connected to Pin 4 of the M-3100T I/O connector. Without earth ground, electromagnetic interference may occur."

Note: I'm in the process of setting up more CE testing. I'm going to try the latest hardware with unshielded cable to see if it will pass, if it does I will change the verbiage to something like this, "If a shielded cable is used to connect I/O and Power to the M-3100T, then to meet CE certification, the shield of said cable must be tied to Earth Ground at the source and the cable shield must be tied to pin 4 of the M-3100T I/O connector. Without earth ground, electromagnetic interference may occur.

Connecting the shield at one end may be more favorable if
- It is not possible to lay an equipotential bonding line
- Analog signals (a few mV resp. mA) are to be transmitted
- Foil shields (static shields) are used.

In the case of data lines for serial couplings, always use metallic or metallized plugs and connectors. Attach the shield of the data line to the plug or connector housing.
If there are potential differences between the earthing points, a compensating current may flow via the shield connected at both ends. In this case, you should lay an additional equipotential bonding line.

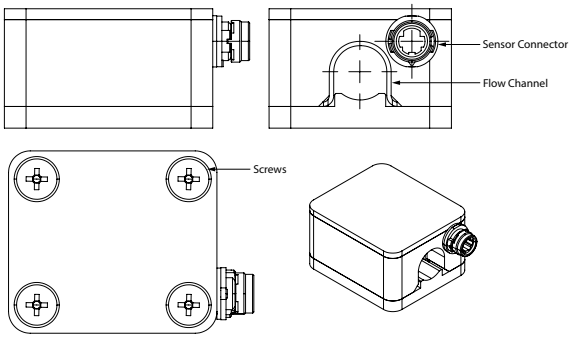
Please note the following points when shielding:
- Use metal cable clips to secure the shield braiding. The clips must surround the shield over a large area and must have adequate contact.
- Downstream of the entry point of the line into the cabinet, connect the shield to a shielding bus. Continue the shield as far as the module, but do not connect it again at this point!

Make sure that the grounding of your system complies with installation standards.

3.06 Attaching the Malema Ultrasonic Flow Sensor to the Tube

To measure the flow inside the tube, the Malema Ultrasonic Flow Sensor must be clamped onto the tube.

- Before you clamp on the sensor, make sure that the tube is not deformed, damaged, or dirty.
- Air in the tube can lead to errors in the measurement or interrupt the acoustic coupling.
- Ensure that there is no residue or dirt in the flow channel.



First, make sure that the way the sensor is clamped around the tube corresponds to the flow direction.

- The direction is indicated by the arrow on the sensor.
- Should the arrow for some reason not or no longer be there, the cable outlet should always be on the left when facing the sensor from the front as the arrow would normally point towards the cable.

To clamp on the Malema Ultrasonic Flow Sensor, follow the steps described below:

1. Remove the sensor lid by removing the four screws.
2. Insert the tube into the flow channel.
3. Close the sensor lid and secure the screws tightly.
   Note: Recommended torque for sensor lid screws is 40 in.oz (equivalent to 2.5 in.lb or approximately 0.28 Nm)

3.00 Installation

3.06 Attaching the Malema Ultrasonic Flow Sensor to the Tube

- To avoid flow turbulances and associated measurement inaccuracies, it is necessary for the tube to be straight in the area near the Malema Ultrasonic Flow Sensor.
- Do not use excessive force when closing the sensor lid; while the tube should be fixed within the channel, it must not be crammed into it as this might affect the measurement values or damage the sensor.
- Ensure the top plate is properly secured to avoid fluctuating flow values.
- Ideally, the tube should be as straight as possible for 30 mm on either side of the sensor.

3.07 Use of the Malema Ultrasonic Flow Sensor

Make sure to follow the steps described below and to heed the warnings included in them in order to ensure the highest possible accuracy of measurement values.

Before starting the flow measurement:

1. Make sure that only tubes specified for the Malema Ultrasonic Flow Sensor are used.
2. Before each measurement, the cables, connectors and pins must be checked for breaks or damages as this could result in inaccurate or compromised measurements.
3. Ensure that no air bubbles are in the tube during the zero flow adjustment. Allow sufficient time (approximately 30 minutes) for the system to adapt to ambient conditions, then zero the flow. Only then is the system ready for measurement.
4. The coupling must be checked before each measurement.
5. A zero flow adjustment must be carried out before each measurement to avoid possible offsets from the measured values.

Zero Flow Adjustment:

1. The sensor must be clamped in the correct installation position at the location intended for it.
2. The tube must be filled with liquid and the liquid must not be moving.
   Note: zero flow adjustment is not possible with flowing liquid.
3. Allow sufficient time for the system to adapt to ambient conditions.
4. Ensure that no air bubbles are in the tube during the zero flow adjustment.
5. Begin the zero flow adjustment by momentary pull-up to 24 V DC on pin 1 of the 12-pin connector.
6. The system is ready for measurement only after the zero flow adjustment is complete.

During the flow measurement:

1. Any changes in the medium itself or its temperature can cause errors or anomalies in the measurement.
2. While it is possible to carry out measurements outside of the specified flow range, PSG cannot guarantee that resulting flow values will be within the device specified accuracy range.

3.08 Initialization and Start-Up of the Malema Ultrasonic Transmitter

The flow rate analog output channel of the M-3100T-S01 transmitter must be connected to a resistance of maximum 900 Ohm. For electrical connection and wiring example, refer to the Section “Device Description: Malema Ultrasonic Transmitter”. Alternatively, the device can be connected to an ampere meter before the power supply is attached to the device.

1. Connect a 24 V DC power supply to the power connector as described in section “Powering of the Malema Ultrasonic Transmitter”.
2. Connect the sensors as described in section “Attaching the Malema Ultrasonic Flow Sensor to the tube”.
3. Make sure to carry out a zero flow adjustment before starting the measurement. Ensure the system has been powered long enough to reach thermal equilibrium, roughly thirty minutes depending on ambient temperature.

3.00 Installation

3.08 Initialization and Start-Up of the Malema Ultrasonic Transmitter

Note: To zero the flow,
- The tube must be completely filled with liquid.
- There must be no air bubbles within the tube.
- The medium must not move within the tube.

3.09 Measurement

The Malema Ultrasonic Transmitter can be connected to a data acquisition or process control system via the analog interface. The M-3100T-S01 comes with one analog output interface that is used to transmit the flow values. The values are transmitted within the range of 4 - 20 mA. The M-3100T-S01 also comes with one digital alarm out signal over 30 V DC open collector; the alarm settings can be adjusted using the ultrasonic GUI, Refer to Appendix I.

Additionally, the M-3100T-S01 has one digital interface to perform a zero flow adjustment of the connected sensor.

- A current of 0 mA indicates a broken cable, circuit, or power leakage and must be checked before preceeding with the application.
- If the tube is too small, the sensor too large, or if there is air in the tubing, ultrasonic signal strength and measurement accuracy will be affected.
- Ensure that the tube fits the sensor you are using.
- Also follow the instructions described in Section Connecting the Malema Ultrasonic Flow Sensor to the Malema Ultrasonic Transmitter.

Flow Value

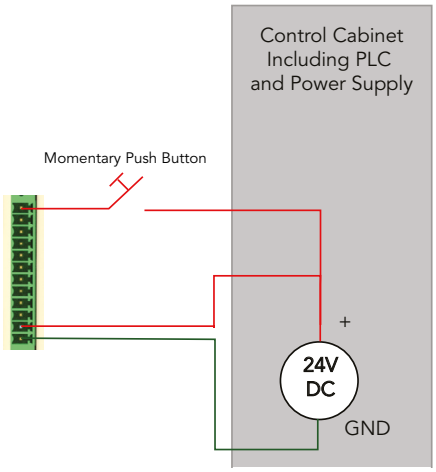
The software within the Malema Ultrasonic Transmitter maps zero flow to 4 mA and maximum flow to 20 mA.
The current output of the flow value can be read as follows:
1. 0 mA indicates a broken cable, circuit, or power leakage.
2. Between 4 mA and 20 mA, the flow is linear starting from zero flow to max flow.

Note: The default settings for "flow value at 4 mA" and "flow value at 20 mA" upon first connecting a sensor are:
- Min flow 0 L/min for "flow value at 4 mA"
- Max flow of 2.5 L/min (for part number M-3150S-02501B5-S01) for "flow value at 20 mA"

Zero Flow Adjustment

The flow sensor can be zeroed over digital input. Generally speaking, a zero flow adjustment is carried out by momentary pull-up to 24 V DC supply voltage on pin 1 of the 12-pin connector.

This can be done using a momentary push button or a toggle switch, depending on your setup and preference.



Either way, to carry out the zero flow adjustment, follow these steps:

1. Connect a voltage source to Pin 1.
2. Connect a momentary push button.
3. Switch the voltage from n/c to 24 V DC by pressing the button to zero the flow.

Note: The momentary push button must not remain pressed but go back to its original position.

4.00 Appendix I - Graphical User Interface

4.01 Introduction

The Malema ultrasonic flow meters are advanced Transit-Time Ultrasonic flow measurement systems. They are also the most flexible, finding applications from sewage plants to semiconductor fab clean rooms, and everywhere in between. With this flexibility, there are some unavoidable measures of complexity.

Malema has minimized this complexity by developing an easy-to-use application for Windows PC. This document will guide the new user through the configuration and setup of the Malema Sensors® Ultrasonic flow meter (UFM).

4.02 Getting Started

Install the Malema UFM interface program using the provided installer file.

The flow meter features RS-485 communication capabilities. Connect a RS-485 serial to USB adapter to the terminal; refer to startup guide or label on the flow meter transmitter.

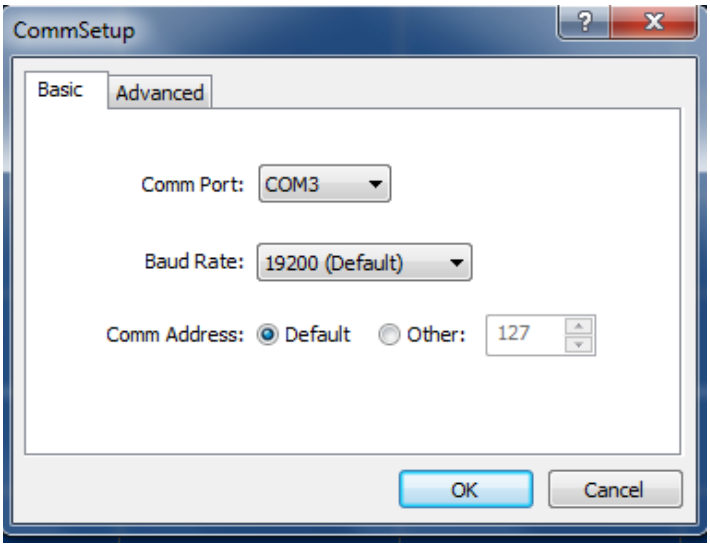
Apply power to the flow meter and start the program by double clicking the Malema UFM icon on the Desktop or start menu.

"If the communication status ("COMM") reads "OK" (green) at the bottom-right of the screen, the Malema UFM interface program is communicating properly with the Malema device. If not, ensure that the Malema device is powered on, and that the RS-485 cable is properly connected. If there are multiple serial ports on the computer, then make sure that Malema UFM Interface program is configured to use the proper serial port.

Serial port configuration can be accessed through "Comm" > "Setup" from the main menu.

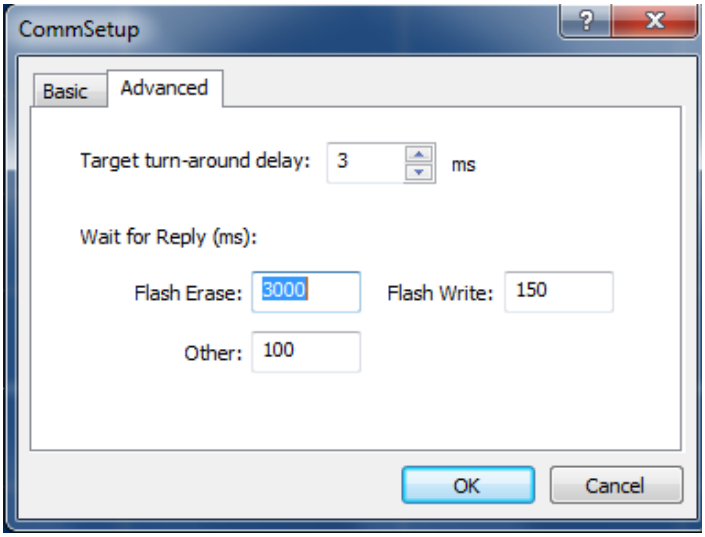
4.00 Appendix I - Graphical User Interface

4.02 Getting Started



A serial port, baud rate, and address may be selected in this screen. Default values are normally sufficient for Baud Rate and Address Basic Settings: by default, the RS-485 Comm Address is "2", the RS-232 Comm Address is "Default", and the Baud Rate is "19200".

Different values may be selected for multi-drop operation (i.e connecting serveral Malema devices on a RS-485 serial bus). An option to automatically select the Comm Port is available, in which case the Malema UFM Interface program will sequentially search for a connected device in all available comm. ports — this mode simplifies connection while using a USB-to-serial device adapter.



Advanced Settings: In this screen several timeout settings are configured. Turnaround delay specifies how much time the Malema device will wait before replying to a message. The other time settings involve the maximum timeout delay under different conditions.

4.00 Appendix I - Graphical User Interface

4.02 Getting Started

A Main Menu. All commands available in the Malema UFM Interface program are accessible via the main menu.

B Main Toolbar. A subset of the most useful commands, such as access to the configuration, totalizer reset, and communication setup are available via the Main Toolbar.

C Main Screen Data. The main Malema device data are displayed.

D Historical data control and zero set. The display scale of the historical data is controlled by Scale and Zoom. The Set Zero button will make the current flow rate the zero flow of the Malema device. A display only filter may also be selected. This affects the Malema UFM Interface program data display only, and is not related to the Malema device filters covered later in this document.

E Historical data graph. The historical graph displays flow rate for the most recent data. The X and Y labels show the flow rate and the time resolution of the data.

F Electronic Serial Number (If Malema UFM interface program is currently logging, the text "Log" is displayed between F and G)

G Module status. This section should display a green Target OK message for proper operation. If any other message is displayed, the Malema device is not properly configured.

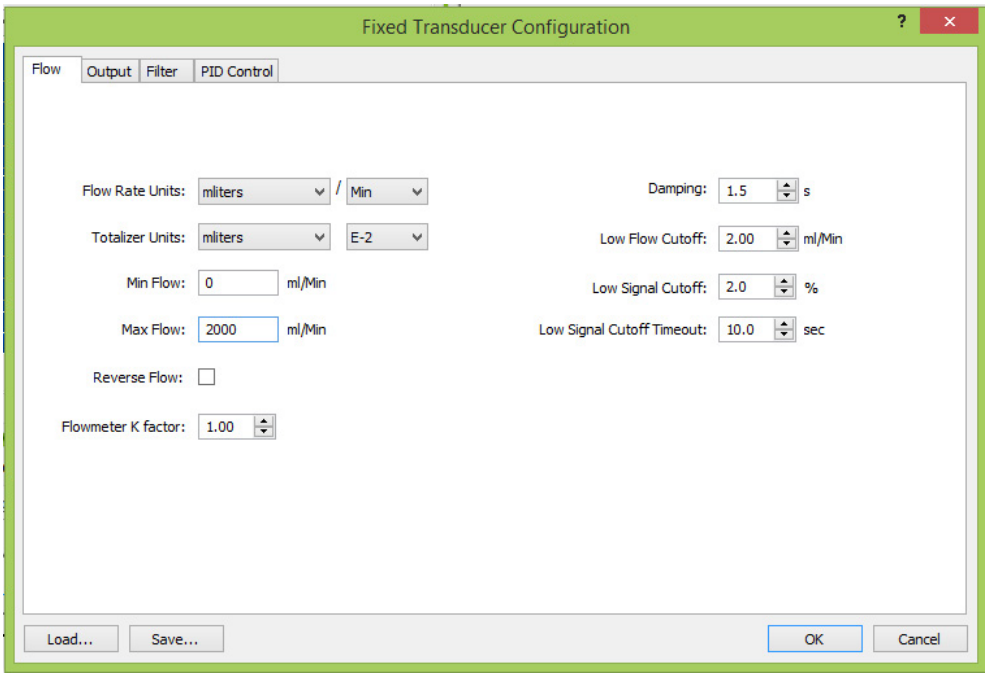
H Module Communications Status. If anything other than a green Comm OK message is displayed, Malema UFM Interface program is not communicating properly with the device.

4.00 Appendix I - Graphical User Interface

4.03 Flowmeter Configuration

The Malema device software architecture is extremely flexible and may operate in many different configurations. The main configuration is invoked by selecting "Configuration" from the >"Operations" menu (or the Config button on the main toolbar).

4.04 Flow



Flow Rate Units	Units for the volumetric flow rate. The units are used to scale the volumetric flow rate for display on the Flow Data Malema UFM Interface screen, as well as the optional LCD Malema device display. They are also are used for all parameters in this screen, such as "Min Flow", "Max Flow" and "Low Flow Cutoff"
Totalizer Units	The units are used to scale the total flow for: • Display on the Flow Data Malema UFM Interface screen. • Status output terminal (If Pos total meter option is selected)
Min Flow	The minimum flow rate expected in the particular installation. This value may be positive, negative or zero. Same as Qmin
Note: Negative minimum flow rate setting can be used for diagnostic purpose for detecting reverse flow	
Max Flow	The maximum flow rate expected in the particular installation. This value may be positive, negative or zero. Same as Qmax
Reverse Flow	Reverse flow will swap the sign of the measured flow rate (positive becomes negative and vice versa) in the event of a transducer wiring reversal or other external condition.
K-factor	Real flow rate (reading from reference flow metering) / flow reading reported by Malema flow meter. A universal calibration coefficient defined by the following equation. This can be especially useful on calibrating the meter or substitute for linearization when the process flow rate is fixed.
Damping	This is the basic filter setting. It is the same as the Filter damping in the filter configuration screen. It is duplicated here for convenience.
Low Flow Cutoff	It is the value below which the meter will declare the flow rate zero. If a nonzero value is entered and the measured flow rate is below that limit, then the Malema device will periodically recalculate and adjust the zero offset.

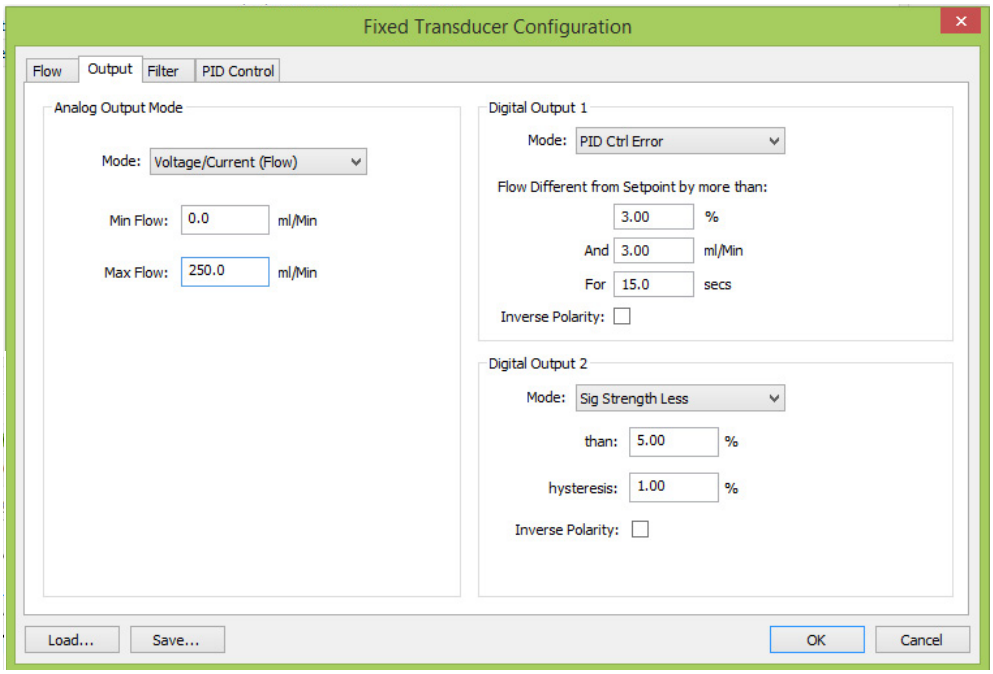
4.00 Appendix I - Graphical User Interface

4.04 Flow

Low Signal Cutoff	The signal strength below which the meter will declare loss of signal and stop measuring. Loss of signal may occur due to an empty pipe, an obstruction on the sound path, or some cable or transducer problem.
Low Signal Cutoff Time-out	The time to wait after a loss of signal is detected (low signal strength) before making the flow rate output zero.

4.05 Output

The built-in analog Voltage/Current output and Frequency out (Hz) and the built-in digital output may be configured in this screen.



When Voltage/Current mode is selected, the Malema device will ONLY give analog Voltage and Current output. When frequency mode is selected, the Malema device will also output a rectangular meter train with 50% duty cycle with maximum flow frequency up to 10 kHz (Frequency scaling based on Qmin/Qmax and frequency settings). The output will be a square wave with a frequency that varies continuously between the limits set in the Min Flow and Max Flow, and Min and Max Frequency windows. (Refer to the quick start guide for electrical connection details for flow meters).

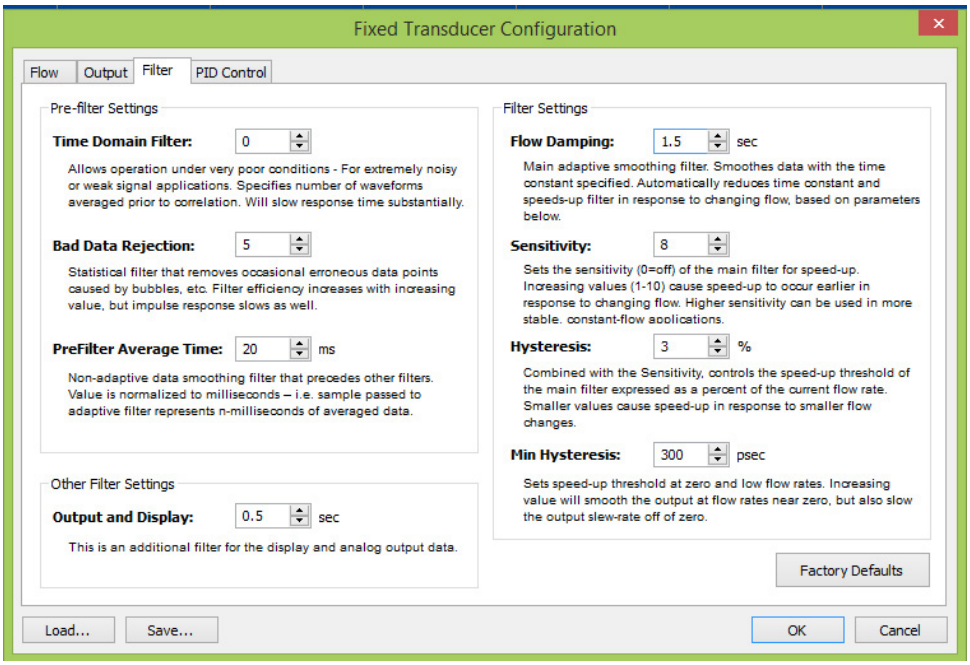
The Digital Outputs are independent ON/OFF signals that can be configured to respond to a variety of flow and signal conditions such as Signal Strength and Flow Rate. For example, if the Mode is set for Flow Less, the output will toggle high when the flow drops below the rate set in the associated input box. Hysteresis may be added to prevent jitter, and is specified as flow rate or signal strength. The signal sense may be inverted by checking the Inverse Polarity box. The outputs are completely independent, and need not be configured for the same mode. Please note: for M-3100 series, only Digital Output 1 is used.

Note: The volume meter output totalizer can be assigned to Digital Output 1 by selecting “Pos Total Puse”. The digital output can also be used as totalizer level alarm by selecting “Total Less” or “Total Greater”.

4.00 Appendix I - Graphical User Interface

4.06 Filter

The filter settings are critical for the proper operation of Meter. Several filter parameters are available and may be configured here. In addition, a simple filter simulator is displayed to demonstrate the effect of the different parameters.



Time Domain Filter	This value specifies the number of time domain measurements to average. Under conditions of poor signal to noise ratios, this will substantially improve measurement stability by improving the quieting ratio, at the expense of slower dynamic response times.
Bad Data Rejection	Occasionally an erroneous measurement may be generated due to entrained gas, solids, or other external conditions. The bad data rejection filter will evaluate each measurement with its neighbors and decide if the data is 'good' or 'bad'. This value specifies how many neighbors to look at – the higher the value the better chance of detecting and ignoring bad data. As several measurements must be evaluated in order to determine if a particular data point is valid or not, there is a slight effect on response to flow changes.
Pre-Filter Average Time	Before the data is passed to the 'main filter' the data is averaged over a period of time specified in this parameter by an FIR filter. For most installations a prefilter of 100ms is a good choice. In cases when the response time needs to be faster, the pre-filter time may be reduced to as low as 10ms or even be turned off completely by setting it to zero. The pre-filter time may also be set higher (as high as 5 seconds), which may help in some very noisy installations
Damping	This is the main setting for the filter. The filter is implemented as a standard first order IIR filter and the higher this value the smother the steady state flow rate will be and the slower the response to change. This filter is adaptive. The filter coefficient can vary depending on the flow dynamics.
Sensitivity	The adaptive nature of the filter is also tweaked by modifying this value. The higher this value, the quicker the filter will dynamically adjust the IIR coefficient in response to flow changes.
Hysteresis	The filter is adaptive in nature and changes its behavior when a fast change is detected. The amount of change required to start the 'fast change mode' is specified as a percentage of the current rate in this parameter. When a flow change is detected that exceeds the Hysteresis band specified, the IIR filter coefficient is reduced automatically. When the flow is again stable, the coefficient is automatically increased to the maximum value specified in the Flow Damping window.
Min Hysteresis	For very small flow rates the Flow Filter Hysteresis value will yield a very small threshold (sometimes below the noise level). The Min Hysteresis is used to avoid stability issues around zero flow. The value is in picoseconds DeltaT, and will affect the rate at which the measured flow rate approaches zero below that limit.

4.00 Appendix I - Graphical User Interface

4.07 PID Control and PID Diagnostic Data

These sections contain the parameters for flow control and diagnostics, which are not applicable for M-3100 series Ultrasonic Flow Meters.

4.08 Advanced Settings

For additional informaiton on advanced settings, including data logging, filter setting details, and flow linerazation, please contact malema.technicalsupport@psgdover.com to be contacted by a technical specialist who can assist you or provide the full GUI manual.

5.00 Standard Specifications

5.01 Malema Ultrasonic Transmitter

Operating principle	Ultrasonic Transit Time Flow Measurement (TTFM)
Device dimensions (HxWxD)	107 mm x 23 mm x 115 mm
Weight	±126g
Housing Material	Polyamide
DINrail mounting type	Standard TS35 DINrail according to EN 60715; 35 x 7.5 mm
Supply voltage	24 V DC (± 10 %) max. External supply. 1000 mA
Power consumption	Typically 3.3 Watt
Interfaces	
Analog Interface	4 mA - 20 mA
Digital Alarm Out	Open collector: 30 V DC 200 mA max
Digital Communication	RS-485 for Modbus RTU or Malema UFM GUI
Ambient Conditions	
Air pressure	70 kPa to 106 kPa
Operating altitude	Up to 2000 m (6600 feet)
Operating temperature range	10°C to 40°C (50°F to 104°F)
Storage temperature range	–20°C to 45° C (-4°F to 113°F)
Transport temperature range	–20°C to 55C (-4°F to 131°F)
IP Rating	IP20
Relative Air Humidity	
Operation	30% to 75% (non-condensing)
Storage and transportation	10% to 96% (non-condensing)
EMC	
The device was tested according to EN/IEC 61326-1, however, the safety of the overall system must be ensured by the customer.	

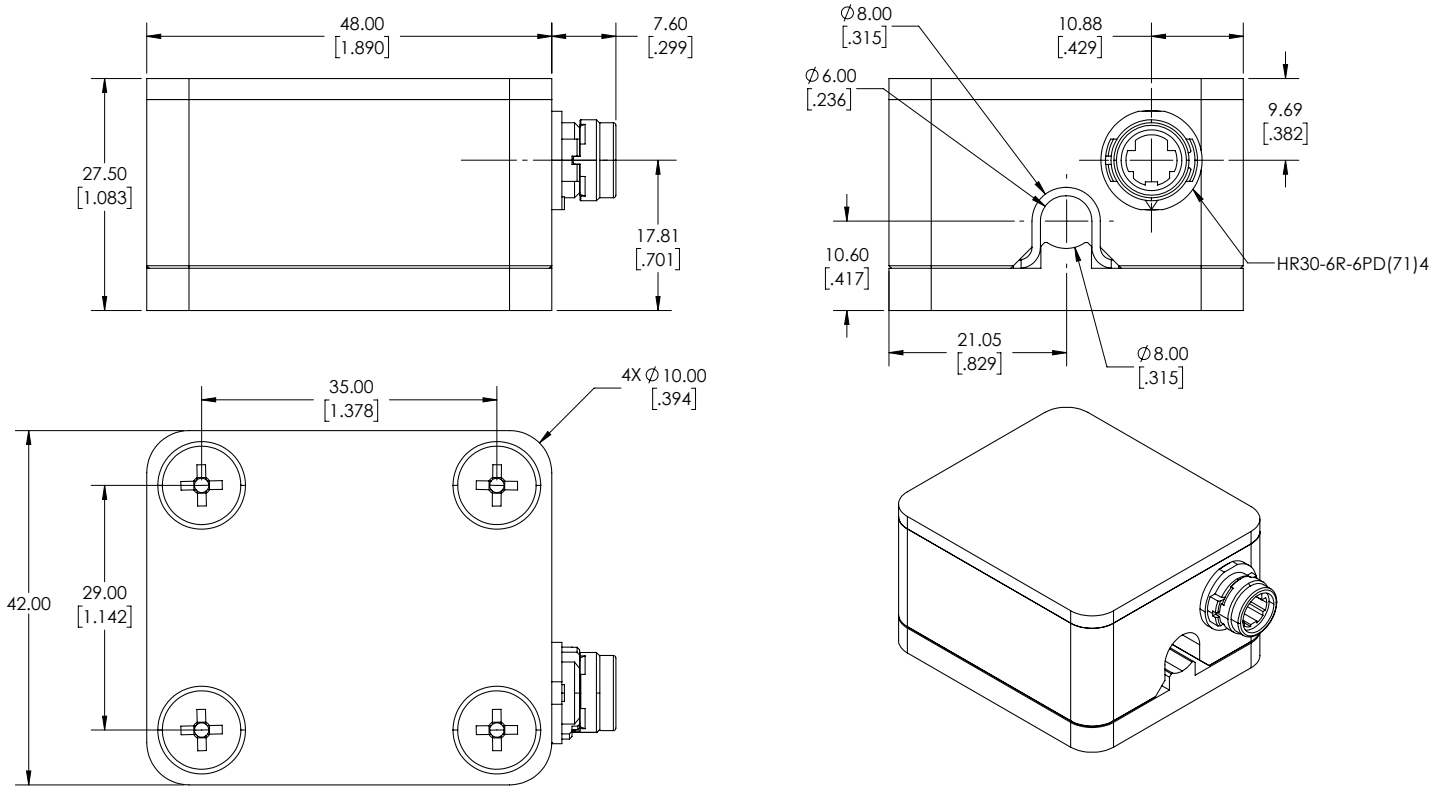
5.00 Standard Specifications

5.02 Malema Ultrasonic Flow Sensor

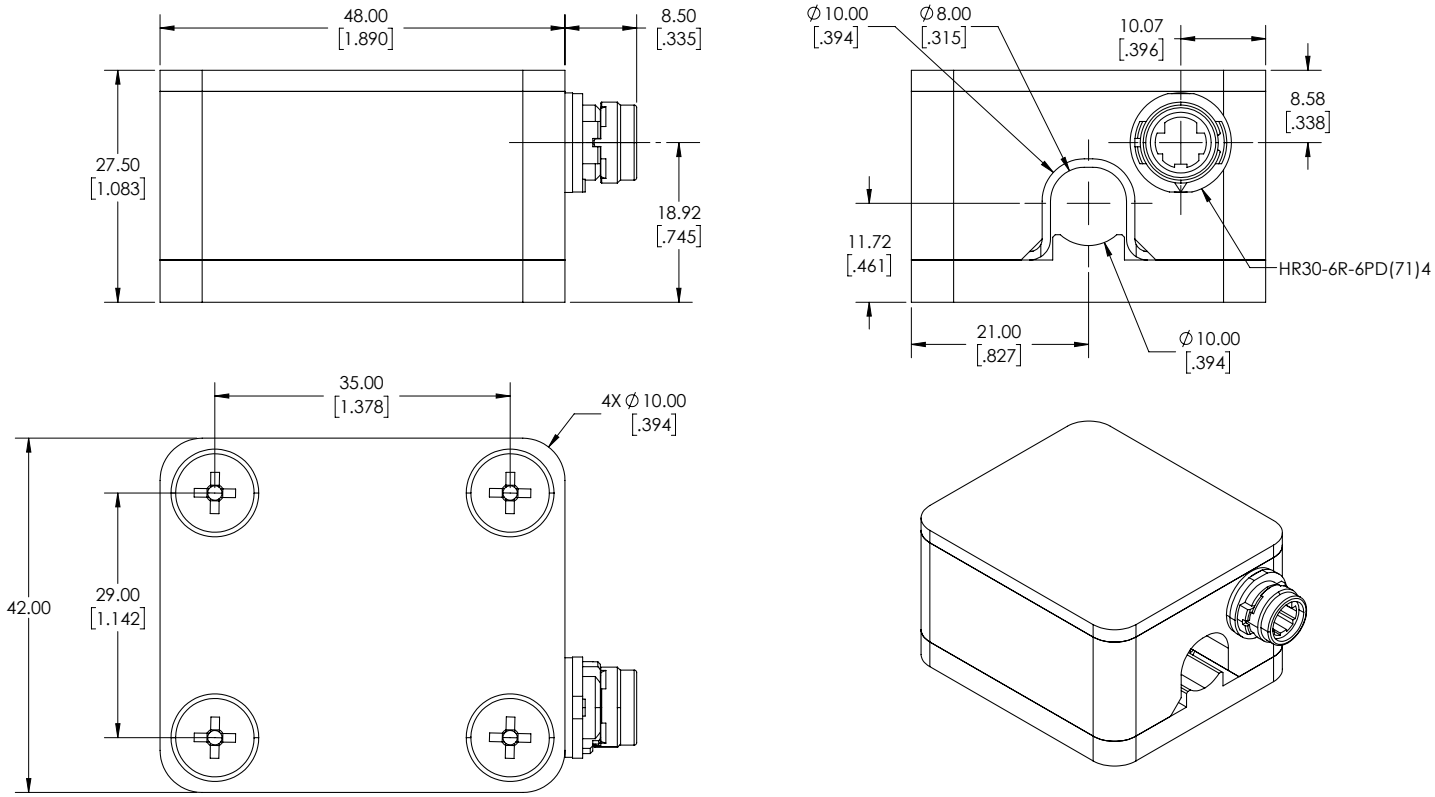
Size		0250		0375		0500	
Flow Range		0–3 LPM		0–8 LPM		0–20 LPM	
Accuracy	Flow >20% of Full Scale	±2%		±2%		±2%	
	Flow <20% of Full Scale	±10 ml/min		±30 ml/min		±100 ml/min	
Repeatability	Flow >20% of Full Scale	±1%		±1%		±1%	
	Flow <20% of Full Scale	±5 ml/min		±15 ml/min		±50 ml/min	
Operating Pressure		6.5 Bar		6.5 Bar		6.5 Bar	
Operating Temperature		10°C–60°C		10°C–60°C		10°C–60°C	
Ambient Temperature		0°C–40°C		0°C–40°C		0°C–40°C	
Tube Material		PFA		PFA		PFA	
Tube Dimensions		Inch	mm	Inch	mm	Inch	mm
ID		1/8	3.2	1/4	6.4	3/8	9.5
OD		1/4	6.4	3/8	9.5	1/2	12.7
Sensor Enclosure Rating		IP65		IP65		IP65	
Electrical Connection		Hirose		Hirose		Hirose	

6.00 Dimensional Drawing

6.01 Ultrasonic Flow Sensor - 025

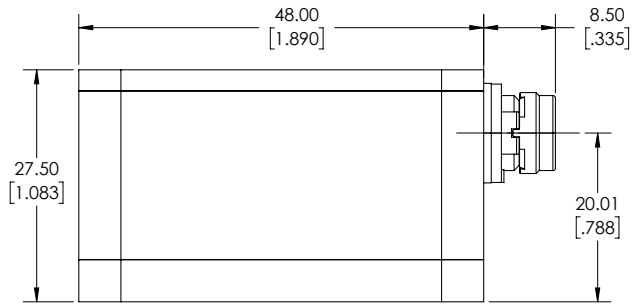


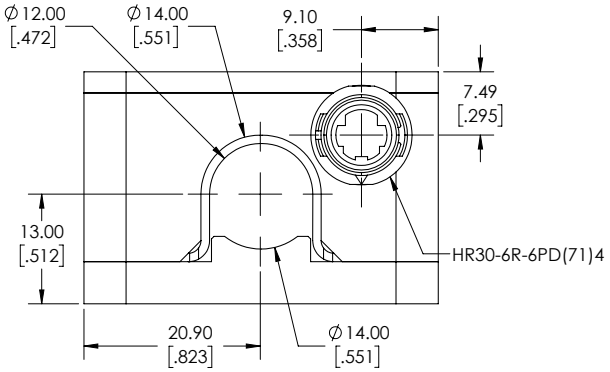
6.02 Ultrasonic Flow Sensor - 0375

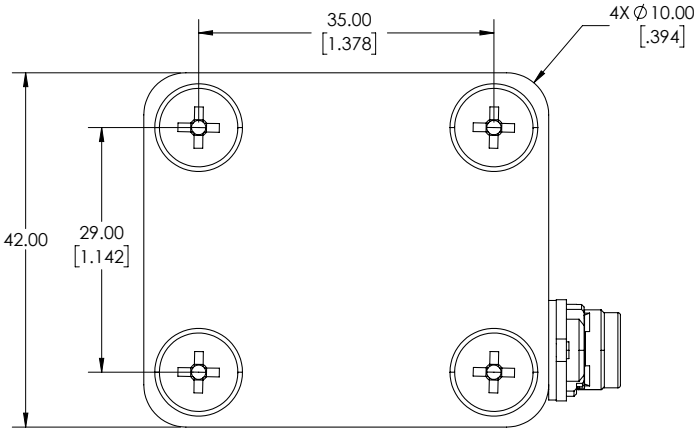


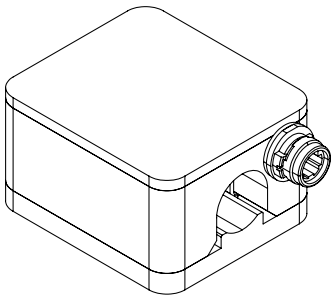
6.00 Dimensional Drawing

6.03 Ultrasonic Flow Sensor - 0500









7.00 Order Information

7.01 Sensor

Model	****	*	*	*	-***	Description
M-3100S-						Clamp-on sensor for PFA tubes
Size	0250					1/4″ OD
	0375					3/8″ OD
	0500					1/2″ OD
Wall Thickness		1				Standard
Electrical Connection			A			Connector
Cable Length				0		Reserved
Extension ID					-S01	Standard Version
					-XXX	Factory assigned Unique ID for custom versions

7.02 Transmitter

Model	-*	*	-***	Description
M-3100T				Single-Channel (for use with one M-3100S Sensor)
Analog Output	-1			1x 4-20 mA Analog output for volumetric flow rate (for M-3100T Signal Converter)
Digital Communication		M		MODBUS over TCP/IP
		X		None
Extension ID			-S01	Standard Version
			-XXX	Factory assigned Unique ID for custom versions

7.03 Accessories

Model	*	*	-***	Description
M-3100C				Extension cable
Type	A			From Sensor to bulkhead
	C			From sensor to bulkhead
Length		1		1 m*
		2		2 m *
		3		3 m **
		Z		Custom ***
Extension ID			-S01	Standard Version
			-XXX	Factory assigned Unique ID for custom versions

*Total length of cables (A+B or A+C) not to exceed 3 m.
**Only available for type C.
***Consult factory.

8.00 Troubleshooting

If any issues occur with the Malema Ultrasonic Transmitter, try the following suggestions. If the problem persists, please contact your local distributor or PSG directly.

The most common reason for an error/warning occurring is that the system has not been properly assembled. Ensure that the sensor and power supply cables have been properly attached and that there are no electromagnetic interferences influencing the system.

Notes:
- If a warning or error activates repeatedly, discontinue use and return the device for servicing.
- If a warning or error occurs that is not listed in the table below, please contact your local distributor or PSG directly.

Errors and Warnings Originating from the Flow Measurement Board
Errors and warnings originating from the flow measurement board inside the Malema Ultrasonic Transmitter can be configured to report via the alarm output pins.

9.00 Maintenance

In general, we recommend the device to be checked in regard to measuring accuracy and safety relevant aspects every two years.

The service for the Malema Ultrasonic Transmitter and the Malema Ultrasonic Flow Sensor may be carried out only by PSG-authorized technicians. If these instructions are not followed, Malema shall accept no liability for the device and the warranty will be void.

If you experience any trouble with the measurement despite following the instructions in this document, or if your Malema Ultrasonic Transmitter is damaged in any way, please contact our service department. Make a note of the serial number of the Malema Ultrasonic Transmitter and the sensor before you contact our staff.

If you need to return the Malema Ultrasonic Transmitter and/or the Malema Ultrasonic Flow Sensor for servicing, please follow these steps:
1. Contact our service department at the address refer to page 3.
2. Our service department will send you an RMA request form.
3. Fill out the form and return it to us. Will will then provide an RMA number and shipping instructions.
4. Include a copy of the form in the shipment and reference the provided RMA number on all shipping documents.

10.00 Warranty

10.01 Period of Warranty

Malema Sensors warrants its Products will meet their written specifications when used in accordance with their applicable instructions and within the limits stated in the operating manuals and/or product data sheets for a period of one year from shipment of the Products. Malema Sensors makes no other warranty, expressed or implied. Malema disclaims the warranties of merchantability or fitness for a particular purpose. The express warranty provided herein and the data, specifications and descriptions of Malema Sensors Products appearing in Malema Sensors user manuals may not be altered except by express written agreement signed by an officer of Malema Sensors. Representations, oral or written, which are inconsistent with this warranty or such publications are not authorized and if given, should not be relied upon.

Buyer shall report any claimed defect in writing to Malema Sensors immediately upon discovery and in any event, within the warranty period. If Malema Sensors on receipt of the alleged defective product determines that the defect is due to misuse or modification owing to failure to comply with instructions and/or applicable limits stated in the operating manuals and/or product data sheets or for whatever other reasons (including intentional damage), Malema Sensors shall have the right to impose such repair and other transportation charges as incurred.

10.02 Repair

Where there are manufacturers' defects, Malema Sensors shall, at its sole option, repair the products and/or equipment or furnish replacement equipment or parts thereof, at the original delivery point. Malema Sensors shall not be liable for costs of removal, reinstallation, or gaining access.

10.03 Validity of Warranty

If Buyer or other third parties repair, replace, or adjust equipment or parts without Malema Sensors' prior written approval, Malema Sensors shall be relieved of any further obligation to Buyer under this section with respect to such equipment.

No equipment furnished by Malema Sensors shall be deemed to be defective by reason of normal wear and tear, failure to resist erosive or corrosive action of any fluid or gas (unless otherwise specified in Quotations), Buyer's failure to properly store, install, operate, or maintain the equipment in accordance with good industry practices or specific recommendations of Malema Sensors or in accordance with operating manuals and/or product data sheets limits, or Buyer's failure to provide complete and accurate information to Malema Sensors concerning the operational application of the equipment.

Support Email Address

Please contact the Malema Customer Support Team at the email addresses below,

General Support:
Malema.GeneralSupport@psgdover.com

Customer Support:
Malema.CustomerSupport@psgdover.com

Order Support:
Malema.OrderSupport@psgdover.com

Quote Support:
Malema.QuoteSupport@psgdover.com

Technical Support:
Malema.TechnicalSupport@psgdover.com

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