



# MantaRay

## Instruction Manual

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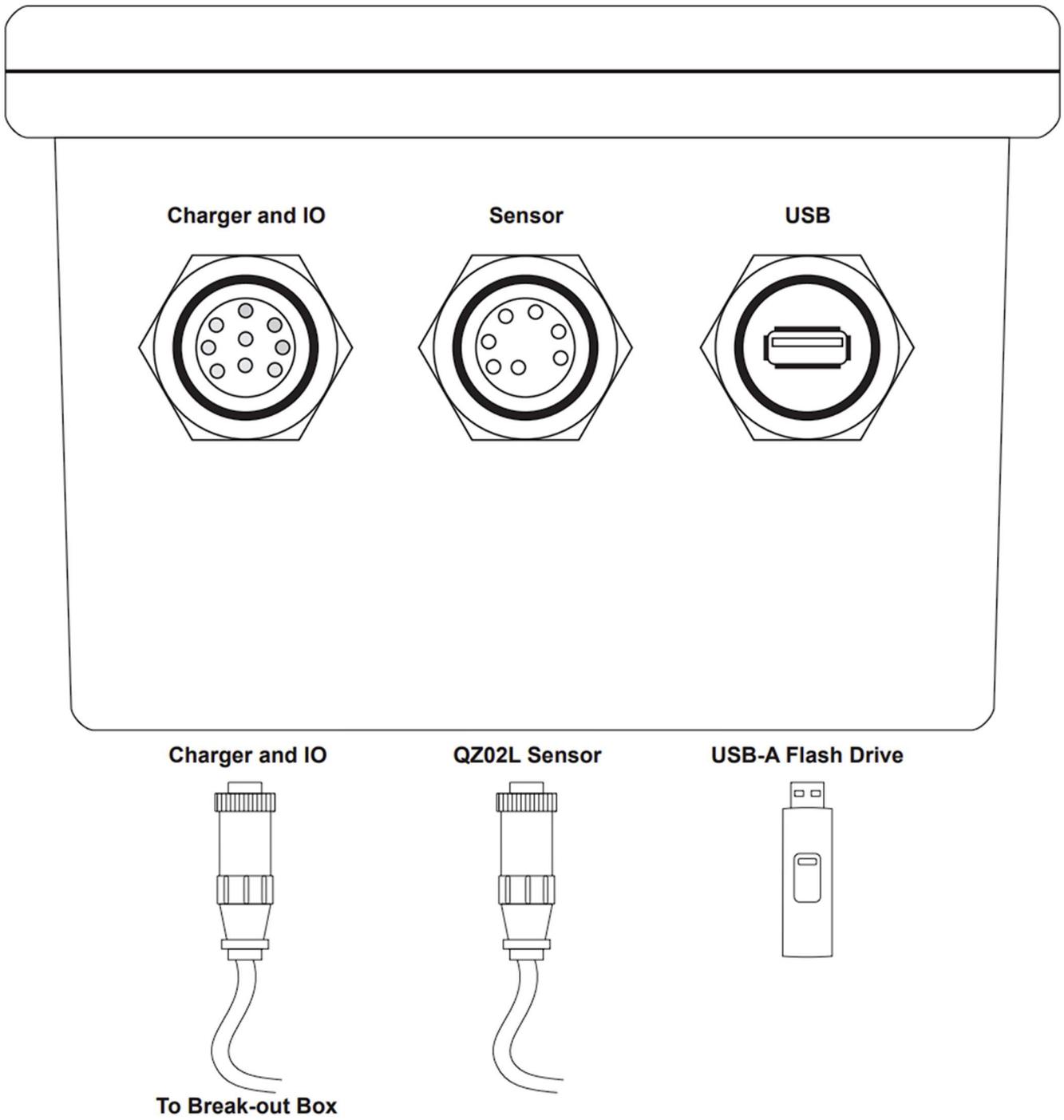
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*IMPORTANT NOTE: This instrument is manufactured and calibrated to meet product specifications. Please read this manual carefully before installation and operation. Any unauthorized repairs or modifications may result in a suspension of the warranty.*

*Available in Adobe Acrobat pdf format*

**CONNECTIONS**



**NOTE:** Sockets and plugs not drawn to scale.

## KEYPAD SYSTEM

The MantaRay uses a menu system for general use and configuration. Arrows show the four directions to navigate the menus. Pressing a corresponding keypad arrow will move to the next item in the direction shown. Move the cursor (underline) under numerals and increase or decrease numerals with the ▲ and ▼ keys.

To store calibration values permanently (even through power interruptions), press ✓.



## BATTERY

- A built-in rechargeable NiMH battery supplies power for approximately 40 hours continuous operation when fully charged. Your battery life may vary depending on factors like temperature, battery age, and backlight level.
- Display brightness is adjustable to conserve power. Press the "Back-Light" button to disable the backlight completely.
- The MantaRay will switch off automatically when the battery is fully discharged.
- Full charge requires approximately 6 to 9 hours charging. The charge rate will be fastest between 0 and 90%, and then it will slow down as it approaches 100% so that it is not over-charged.
- Sleep mode extends battery life for long-term data logging (30 days for 5 minute logging).

## CHARGING BATTERY

A 16.5V AC-DC power module is supplied for battery charging and continuous use. The charger connects to the faceplate of the MantaRay or to the exterior of the break-out box. Charge requires 6-9 hours when fully drained. Solid battery icon indicates when battery is very close to fully charged ( $\geq 90\%$ ), and a power cable icon indicates the battery is fully charged.

**IMPORTANT:** When the MantaRay is OFF and the charger is connected, the MantaRay will turn on and display a charging animation. Pressing the power button or disconnecting the charger will place the meter in the normal ON Main Screen. You must disconnect the charger and press the power button to return to and OFF state.



## ICONS

On the Main Screen, the following icons may present themselves:



A message is waiting. Press ▲ to view.



Data Logger is Stopped.



Data Logger is Running.



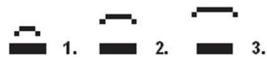
Data Log is transferring to USB drive.



Data Log transfer to USB drive complete.



Data Log transfer to USB failed.



Level ECHO OK.



Level sensor DRY. No ECHO, but sensor OK.



Level ECHO loss/no signal.



Battery fuel gauge levels, and minimum charge for each icon.



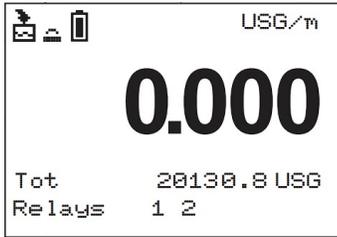
Meter is operating on external battery via break-out box.



Internal battery is fully charged.

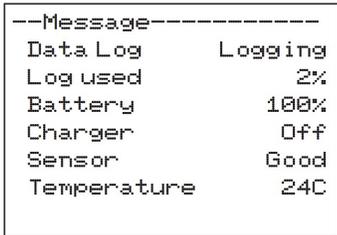


Sleep Logging is enabled. Press the Sleep button to deploy into the low-power sleep logging state. Press the Sleep button once in this state to wake back up.



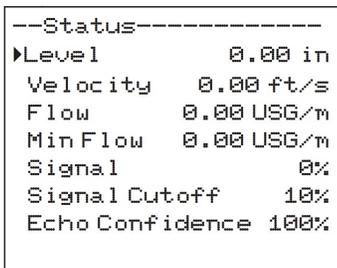
**MAIN DISPLAY**

The main display shows the units selected from the Units/Mode menu, Flow or Velocity rate being measured, TOTALIZER and RELAY states. The MantaRay will start-up with this display.



**MESSAGE ICON**

Press ▲ from the main display to view Data Log state and percent used, Battery fuel gauge, Charger connection state, Sensor Status (Good, Short, Open, Dry, Echo Loss), and measured Temperature of the sensor. Press ✓ or ▼ to return to the Main Display.



**STATUS**

Press ▼ from the Main Display to view instrument status. Press ✓ or ▲ to return to the Main Display.

**Level** The current level measurement displayed in units selected in the Units/Mode menu.

**Velocity** The current velocity measurement displayed in units selected in the Units/Mode menu.

**Flow** The current flow rate measurement displayed in units selected in the Units/Mode menu.

**Min Flow** Read-only value of the currently programmed Min Flow in the Calibration menu. Any measured flow less-than Min Flow will result in the Flow reporting 0.

**Signal** The current signal strength for the Doppler velocity measurement, 0-100%. Size of the Signal Strength depends on velocity and quality of the Doppler reflectors entrained in the flowing fluid. Signal of 100% is typical, but Signal all the way down to just above the default Signal Cutoff (10%) is also acceptable for very slow moving fluids.

**Signal Cutoff** Read-only value of the currently programmed Signal Cutoff in the Calibration menu. Any Signal less-than the Signal Cutoff will result in the velocity stagnating or going to zero depending on Calibration menu configuration.

**Echo Confidence** The current echo-confidence for the level measurement. Echo confidence is the percent ratio of the number of good echoes received compared to the number of pulses sent to the water surface. E.g. if 8 pulses are sent and 8 received, echo confidence is 100%. A level measurement is considered good as long as Echo Confidence is above 0%.

```

--24 hr log-----Flow
▶Date      Feb. 12/2010
Total      50138 USG
Average    34.82 USG/m
Maximum    52.20 USG/m
Max Time   11:08:00
Minimum    0.000 USG/m
Min Time   9:15:00

```

### 24 HR LOG

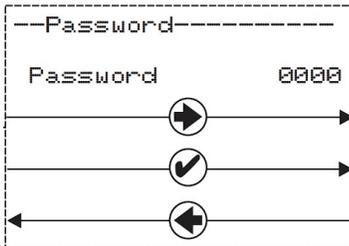
Press ◀ from the MAIN display to view a formatted flow report from instruments with a built-in data logger. Press ◀ to pan through Flow, Velocity, and Level summaries. Press ▼ to scroll down one day or repeatedly to scroll to a specific date. Up to 365 days can be stored. The newest date will overwrite the oldest. Press ✓ to return to the main display.

**NOTE:** Inserting a USB flash drive into the USB port of the MantaRay while on this screen will cause the meter to download the 24 hr log data as a .CSV file to the USB drive.

```

--Password-----
Password          0000

```



### PASSWORD

The optional Password (a number from 0000 to 9999) prevents unauthorized access to the main programming menus.

When a Password other than 0000 is set in the Special Functions menu, this menu will appear and will require you to enter the password before you can access the Main Menu. If the Password in the Special Functions menu is 0000, this screen will not appear.

From the Main display press ▶ to get to Password or bypass this screen.

If a password is required, press ▶ to place the cursor under the first digit and ▼ or ▲ to set the number, then ▶ to the second digit, etc. Press ▶ or ✓ to proceed to the Main Menu.

A new password can be set by going the Special Functions menu and adjusting the Password parameter.

--Units/Mode-----	
▶ Mode	Flow
Linear	in
Volume	USG
Multiplier	x1
Decimals	0
Velocity	ft/s
Flow	USG/m
Decimals	2
Temperature	F

### UNITS/MODE

From the Main Menu, press the ▶ button while the cursor is on Units/Mode to access this menu. The configuration parameters available in the Units/Mode menu are described below. Use the ▲ or ▼ button to move the cursor up or down, and the ▶ button to edit the selected parameter.

All parameter options in Units/Mode are list types. When changing a parameter, use the ▲ or ▼ button to choose between the available selections. Press ✓ to save your selection, or ◀ to cancel. Default values (US) are shown in the image to the left.

**Mode** selects the measurement mode for the MantaRay. Choose between Flow, Velocity, and Level.

**Linear** selects the engineering units for measuring level, or configuring pipe/channel dimensions. Choose between in (inches), mm, m, and ft.

**Volume** selects the engineering units for measuring volume accumulation. Choose between USG (US Gal), USMG (US Million Gal), IG (Imperial Gal), IMG (Imperial Million Gal), m<sup>3</sup>, L, bbl (1 bbl = 42 USG), and ft<sup>3</sup>.

**Volume Multiplier** selects the multiplier to use for displaying accumulated volume. E.g. an accumulated 1,000 USG with the Volume units configured for USG and Multiplier of 1k would display as 1 USG x 1k. Choose between 1, 10, 100, 1k, 10k, 100k, and 1M.

**Volume Decimals** selects the number of decimals to display for accumulated volume. E.g. an accumulated 1,000 USG with the Volume units configured for USG, Multiplier of 1k, and Decimals of 2 would display as 1.00 USG x 1k. Choose between 0, 1, 2, and 3.

**Velocity** selects the engineering units for velocity. Choose between ft/s, and m/s.

**Flow** selects the engineering units for flow rate. Choose between the options listed in the table on the next page.

**Flow Decimals** selects the number of decimals to display for flow rate. E.g. a flow rate of 1,000 USG/m with the Flow units configured for USG/m, and Decimals of 2 would display as 1,000.00 USG/m. Choose between 0, 1, 2, and 3.

**Temperature** selects the engineering units for temperature measurement. Choose between Deg F, and Deg C.

**UNITS/MODE (CONT.)**

Available Flow Rate Engineering Units:

<b>Abbreviation</b>	<b>Description</b>	<b>Abbreviation</b>	<b>Description</b>
USG/d	US gallons per day	L/d	liters per day
USG/h	US gallons per hour	L/h	liters per hour
USG/m	US gallons per minute	L/m	liters per minute
USG/s	US gallons per second	L/s	liters per second
ft <sup>3</sup> /d	cubic feet per day	m <sup>3</sup> /d	cubic meters per day
ft <sup>3</sup> /h	cubic feet per hour	m <sup>3</sup> /h	cubic meters per hour
ft <sup>3</sup> /m	cubic feet per minute	m <sup>3</sup> /m	cubic meters per minute
ft <sup>3</sup> /s	cubic feet per second	m <sup>3</sup> /s	cubic meters per second
bbl/d	barrels per day (1 bbl = 42 USG)	IG/d	Imperial gallons per day
bbl/h	barrels per hour (1 bbl = 42 USG)	IG/d	Imperial gallons per day
bbl/m	barrels per minute (1 bbl = 42 USG)	IG/d	Imperial gallons per day
bbl/d	barrels per second (1 bbl = 42 USG)	IG/d	Imperial gallons per day
USMG/d	US million gallons per day	IMG/d	Imperial million gallons per day
USMG/h	US million gallons per hour	IMG/h	Imperial million gallons per hour
USMG/m	US million gallons per minute	IMG/m	Imperial million gallons per minute
USMG/s	US million gallons per second	IMG/s	Imperial million gallons per second

Note: the volume selection "bbl" denotes U.S. barrels.

```

--Calibration-----
▶Level
  Max          180.0 in
  Min          1.00 in
  20mA        180.00 in
  4mA         0.00
  Lvl Offset   0.00
  LOE Time    10 sec
  LOE Behavior To Zero
  Level Damping
    Mode       FIR
    Percent    100%
    Window     1.0 in
  Velocity
    20mA       10.00 ft/s
    4mA        0.00 ft/s
    Signal Cutoff 10%
  LOS Time    10sec
  Velocity Damping
    Mode       FIR
    Percent    10%
    Window     1.00 ft/s
  Flow
    Min        0.00 USG/m
    20mA       1200.00 USG/m
    4mA        0.00 USG/m
  Cal Constant
  
```

**CALIBRATION**

From the Main Menu, press the ▶ button while the cursor is on Calibration to access this menu. The configuration parameters available in the Calibration menu are described below. Use the ▲ or ▼ button to move the cursor up or down, and the ▶ button to edit the selected parameter.

Some parameter options in Calibration are list types. When changing these parameters, use the ▲ or ▼ button to choose between the available selections. Press ✓ to save your selection, or ◀ to cancel.

Some parameter options in Calibration are numerical entry types. When editing these parameters, use the ▲ or ▼ button to increment/decrement the selected digit, and ◀ or ▶ to move the cursor position. A decimal point (.) or negative (-) may also be available for some positions. Press ✓ to save your input, or ◀ from the left-most position to cancel.

Default values are shown in the image to the left.

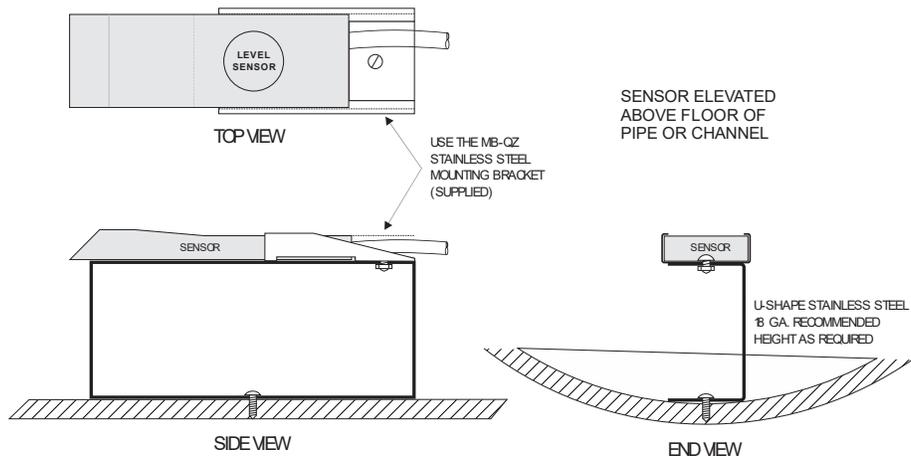
**Level Max** should be set to the maximum height the level should reach in the system in units configured in the Units/Mode menu. If a Round pipe is selected in the Channel Setup menu, then this value should be set to the same value as the inside diameter of the pipe. The default of 180 inches (15ft) is equal to the max level the QZ02L sensor can measure.

**Level Min** should be set to the minimum height the level should reach in the system, in units configured in the Units/Mode menu. Minimum level for the QZ02L sensor is 1 inch, however, this value could be set to a larger value if you want to ignore levels greater than 1 inch.

**Level 20mA** is only displayed when the Mode in the Units/Mode menu is set to Level. In this mode, the single 4-20mA output from the MantaRay will respond to changes in level measurement. This parameter configures the level equal to a 20mA output.

**Level 4mA** is only displayed when the Mode in the Units/Mode menu is set to Level. In this mode, the single 4-20mA output from the MantaRay will respond to changes in level measurement.

**Level Offset** is used when the QZ02L sensor is not mounted directly at the bottom of the channel or pipe, oftentimes when you want to prevent the sensor from being covered with mud/silt/debris.



```

--Calibration-----
▶Level
  Max          180.0 in
  Min          1.00in
  20mA        180.00in
  4mA         0.00
  Lvl Offset  0.00
  LOE Time    10 sec
  LOE Behavior To Zero
  Level Damping
  Mode        FIR
  Percent     100%
  Window      1.0 in
  Velocity
  20mA       10.00 ft/s
  4mA        0.00 ft/s
  Signal Cutoff 10%
  LOS Time   10sec
  Velocity Damping
  Mode        FIR
  Percent     10%
  Window      1.00 ft/s
  Flow
  Min         0.00 USG/m
  20mA       1200.00 USG/m
  4mA        0.00 USG/m
  Cal Constant

```

## CALIBRATION (CONT.)

**LOE Time** is used to suppress a loss in level because of air or debris in the system. The LOE Time will cause the meter to hold the last valid level reading when a loss of echo occurs until the LOE Time is expired, at which point the meter will produce a Loss of Echo alarm message, and the level reading on the meter will respond according to the LOE Behavior parameter. The default value for LOE Time is 10 seconds. If you desire that the meter respond quicker or slower to a Loss of Echo, adjust the LOE Time down or up, respectively. The MantaRay will automatically being reading level again should the condition causing the echo loss to go away, and a loss of echo will again require the LOE Time to count down.

**LOE Behavior** is used to select behavior for the level measurement when a loss of echo occurs (after LOE Time expires). Options are either To Zero, which means the meter will report 0 for the level measurement, or Hold, where the meter will hold the last valid level reading before the loss of echo occurred. The meter will therefore use that level for calculating flow should a velocity also be present.

**Level Damping Mode** selects the damping algorithm used for level measurement. Options are FIR, LOW PASS, and OFF.

When new measured levels are outside the Window of the damped output (value currently reported by the meter), the FIR filter will reduce the number of measurements used in the damping average so that a faster response can be made to the sudden change in level.

The LOW PASS filter will ignore new measured levels outside the Window of the damped output, while holding the damped output until there are enough consecutive measurements outside the Window to cause a sudden step-response to the new measured value.

While measured levels are within the Window of the damped output (the current level measurement), both the FIR and LOW PASS filter behave the same.

**Level Damping Percent** selects the size of the damping average. Larger values average more consecutive readings together and cause the meter to be less responsive to large changes in level measurement. Lower values reduce the damping average size and cause the meter to be more responsive to large changes in level measurement.

**Level Damping Window** sets a boundary around the damped output (currently reported level), where if the next measured value falls outside the current value  $\pm$  window, the meter will make a more rapid response to the new value (Damping Mode = FIR), or will hold the last reading until enough consecutive values are outside the window and then make a step response to the new value (Damping Mode = LOW PASS).

**Velocity 20mA** is only displayed when the Mode in the Units/Mode menu is set to Velocity. In this mode, the single 4-20mA output from the MantaRay will respond to changes in velocity measurement. This parameter configures the velocity equal to a 20mA output.

```

--Calibration-----
▶Level
  Max          180.0 in
  Min          1.00in
  20mA        180.00in
  4mA         0.00
  Lvl Offset  0.00
  LOE Time    10 sec
  LOE Behavior To Zero
  Level Damping
    Mode      FIR
    Percent   100%
    Window    1.0 in
  Velocity
    20mA      10.00 ft/s
    4mA       0.00 ft/s
    Signal Cutoff 10%
  LOS Time    10sec
  Velocity Damping
    Mode      FIR
    Percent   10%
    Window    1.00 ft/s
  Flow
    Min       0.00 USG/m
    20mA     1200.00 USG/m
    4mA      0.00 USG/m
  Cal Constant

```

## CALIBRATION (CONT.)

**Velocity 4mA** is only displayed when the Mode in the Units/Mode menu is set to Velocity. In this mode, the single 4-20mA output from the MantaRay will respond to changes in velocity measurement. This parameter configures the velocity equal to a 4mA output.

**Velocity Signal Cutoff** sets a cutoff where any measured velocity Signal Strength which is less than the Signal Cutoff will cause the meter to report 0 velocity. This value can be lowered to increase sensitivity in very low flow situations, at the risk of allowing electrical noise to be measured as actual flow. This value can be raised to decrease sensitivity, useful for when flow occurs Signal Strength is very high, yet random noise levels with no flow are above the default value of 10%. E.g. for an application where when flow is present, Signal Strength is 100%, yet with no flow the Signal Strength is 50%, setting the Signal Cutoff to 60% will suppress the unwanted noise with no flow yet not interfere with the actual velocity measurement when flow is present.

**LOS Time** is used to suppress a loss in velocity because of a disturbance which may interfere with the velocity measurement, like a sudden decrease in air/solids in the fluid or a sudden increase in turbulence which causes an inconclusive Doppler measurement. The LOS Time will cause the meter to hold the last valid velocity reading when a loss of signal occurs until the LOS Time is expired, at which point the meter will report 0 for the velocity measurement. The default value for LOS Time is 10 seconds. If you desire that the meter respond quicker or slower to a signal loss, adjust the LOS Time down or up, respectively. The MantaRay will automatically begin reading velocity again should the condition causing the signal loss to go away, and a loss of signal will again require the LOS Time to count down.

**Velocity Damping Mode** selects the damping algorithm used for velocity measurement. Options are FIR, LOW PASS, and OFF.

When new measured velocities are outside the Window of the damped output (value currently reported by the meter), the FIR filter will reduce the number of measurements used in the damping average so that a faster response can be made to the sudden change in velocity.

The LOW PASS filter will ignore new measured levels outside the Window of the damped output, while holding the damped output until there are enough consecutive measurements outside the Window to cause a sudden step-response to the new measured value.

While measured levels are within the Window of the damped output (the current level measurement), both the FIR and LOW PASS filter behave the same.

**Velocity Damping Percent** selects the size of the damping average. Larger values average more consecutive readings together and cause the meter to be less responsive to large changes in level measurement. Lower values reduce the damping average size and cause the meter to be more responsive to large changes in velocity measurement.

```

--Calibration-----
▶Level
  Max          180.0 in
  Min          1.00in
  20mA        180.00in
  4mA         0.00
  Lvl Offset   0.00
  LOE Time     10 sec
  LOE Behavior To Zero
  Level Damping
  Mode         FIR
  Percent      100%
  Window       1.0 in
  Velocity
  20mA        10.00 ft/s
  4mA         0.00 ft/s
  Signal Cutoff 10%
  LOS Time    10sec
  Velocity Damping
  Mode         FIR
  Percent      10%
  Window       1.00 ft/s
  Flow
  Min          0.00 USG/m
  20mA        1200.00 USG/m
  4mA         0.00 USG/m
  Cal Constant

```

## CALIBRATION (CONT.)

**Velocity Damping Window** sets a boundary around the damped output (currently reported velocity), where if the next measured value falls outside the current value  $\pm$  window, the meter will make a more rapid response to the new value (Damping Mode = FIR), or will hold the last reading until enough consecutive values are outside the window and then make a step response to the new value (Damping Mode = LOW PASS).

**Flow Min** sets a cutoff where if measured flow is less than the Min Flow, the reading on the LCD display and output signals will report 0.

**Flow 20mA** is only displayed when the Mode in the Units/Mode menu is set to Flow. In this mode, the single 4-20mA output from the MantaRay will respond to changes in flow measurement. This parameter configures the flow equal to a 20mA output.

**Flow 4mA** is only displayed when the Mode in the Units/Mode menu is set to Flow. In this mode, the single 4-20mA output from the MantaRay will respond to changes in flow measurement. This parameter configures the flow equal to a 4mA output.

```

--Channel Setup-----
▶Type          Round
  Pipe ID      8.00 in

```

## CHANNEL SETUP

From the Main Menu, press the ▶ button while the cursor is on Channel Setup to access this menu. The configuration parameters available in the Channel Setup menu are described below. Use the ▲ or ▼ button to move the cursor up or down, and the ▶ button to edit the selected parameter.

Some parameter options in Channel Setup are list types. When changing these parameters, use the ▲ or ▼ button to choose between the available selections. Press ✓ to save your selection, or ◀ to cancel.

Some parameter options in Channel Setup are numerical entry types. When editing these parameters, use the ▲ or ▼ button to increment/decrement the selected digit, and ◀ or ▶ to move the cursor position. A decimal point (.) may also be available for some positions. Press ✓ to save your input, or ◀ from the left-most position to cancel.

Default values are shown in the image to the left.

**Type** is used to select the shape of the channel or pipe. Based on this selection, additional parameter options not shown in the image to the left may appear. Select from the following:

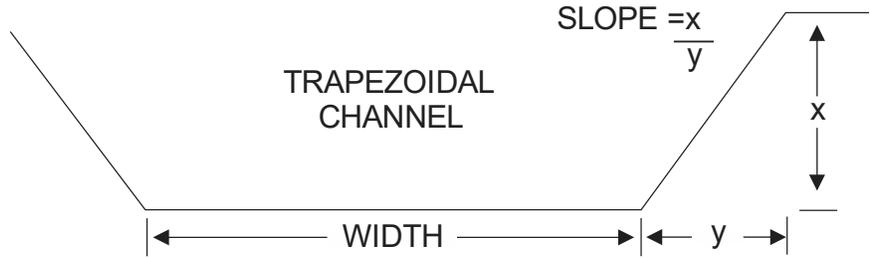
- Round**      Select Round for open pipes. Set Pipe ID to the inner diameter of the pipe.
- Rectangle**    Select Rectangle for rectangular channels. Enter the channel width.
- Trapezoid**    Select Trapezoid for trapezoidal shaped channels. Specify the Width and Slope of the channel as shown in the following illustration.

```

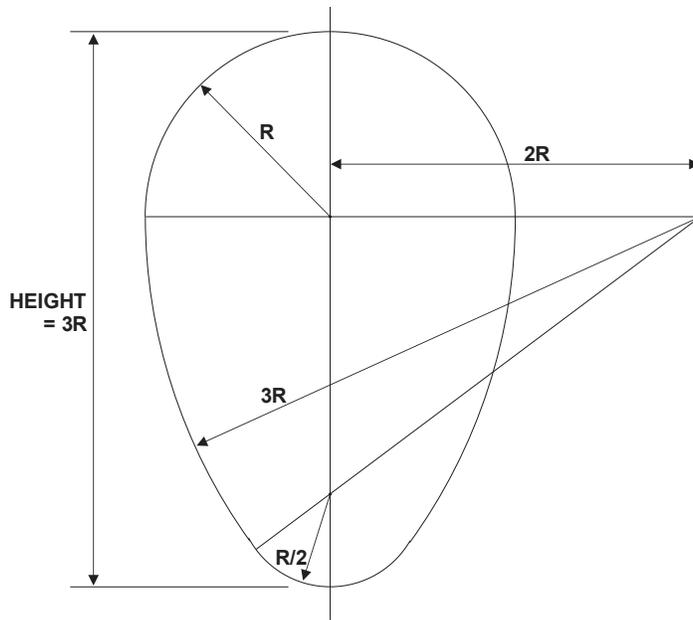
--Channel Setup-----
▶Type           Round
Pipe ID        8.00 in
    
```

**CHANNEL SETUP (CONT.)**

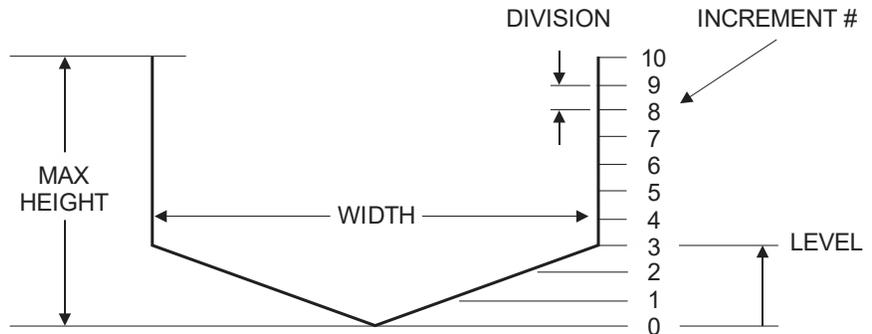
**Trapezoid (Cont.)**



**Egg** Select Egg for egg shaped channels. Enter the Max Height of the channel.



**Custom** Define Max Height of the channel, and number of Divisions for defining Width at each Increment. Level displays the level of the channel for each Increment and Width entry. Use Reset Data to clear the custom channel if you made a mistake or using a new custom channel.



```

--Relay Parameters--
▶Relay                1
Function              Flow
On                   1000 USG/min
Off                   0.000 USG/min

```

## RELAY PARAMETERS

From the Main Menu, press the ▶ button while the cursor is on Relay Parameters to access this menu. The configuration parameters available in the Relay Parameters menu are described below. Use the ▲ or ▼ button to move the cursor up or down, and the ▶ button to edit the selected parameter.

Some parameter options in Relay Parameters are list types. When changing these parameters, use the ▲ or ▼ button to choose between the available selections. Press ✓ to save your selection, or ◀ to cancel.

Some parameter options in Relay Parameters are numerical entry types. When editing these parameters, use the ▲ or ▼ button to increment/decrement the selected digit, and ◀ or ▶ to move the cursor position. A decimal point ( . ) may also be available for some positions. Press ✓ to save your input, or ◀ from the left-most position to cancel.

**Relay** is used to select which of the two relay outputs you wish to reconfigure. After choosing either 1 or 2, use the Function parameter to select how you wish to use that relay.

**Function** is used to set the behavior of the relay selected at the Relay parameter. Choose between the following functions. Depending on function, additional options will appear/disappear.

- On** Will set the associated Relay ON.
- Level** Will provide an **ON** and **OFF** setpoint for level alarm. When ON>OFF, the level alarm functions like a high level alarm. When measured level is greater than ON setpoint, the relay will turn on, and the relay will turn off when measured level goes below OFF setpoint. When ON<OFF, the level alarm will function like a low level alarm instead with reverse logic as described above. **LOE mode** is used to choose how the relay will behave when a loss of echo occurs. Note: the LOE mode behavior will override any behavior which would occur due to the LOE Behavior in the Calibration menu. E.g. if the meter is set to HOLD for LOE Behavior, and ON for LOE mode, this relay will turn on regardless if the held level would have the relay off.
- Velocity** Like Level, will provide an **ON** and **OFF** setpoint for velocity alarm. When ON>OFF, the velocity alarm functions like a high velocity alarm. When measured velocity is greater than ON setpoint, the relay will turn on, and the relay will turn off when measured velocity goes below OFF setpoint. When ON<OFF, the velocity alarm will function like a low velocity alarm instead with reverse logic as described above.

```

--Relay Parameters--
▶Relay              1
Function            Flow
On                 1000 USG/min
Off                0.000 USG/min
    
```

**RELAY PARAMETERS (CONT.)**

**Flow** Like Level and Velocity, will provide an **ON** and **OFF** setpoint for flow alarm. When ON>OFF, the flow alarm functions like a high flow alarm. When measured flow is greater than ON setpoint, the relay will turn on, and the relay will turn off when measured flow goes below OFF setpoint. When ON<OFF, the flow alarm will function like a low flow alarm instead with reverse logic as described above.

**Direction** Used to set the relay to latch ON or OFF depending on measured flow direction. A requirement for this to work is to have Rev Flow in the Special Functions menu set to ON or INVERT. When flow is negative on the main screen, the relay will turn ON. When flow is positive, the relay will turn OFF. There is a couple second delay built-in to the relay changing state, so that there is no chatter near 0 flow conditions.

**Pulse** Sets the amount of volume which needs to accumulate for a relay pulse to occur, in units configured in the Units/Mode menu. A relay pulse is a 350ms in duration. Minimum time between pulses is 2.25 seconds. Use this output to accurately measure volume without having to integrate the 4-20mA output over time.

Note: The volume accumulation starts from when the new Pulse value is accepted with the ✓ button. E.g. if the totalizer was 525 gallons when the Pulse was set to 100 gallons, the next pulse output would occur at 625 gallons.

**Off** Turns the selected relay OFF.

```

--Data Logging-----
▶Log Site ID      0
Mode              LVT
Log Mode          Sleep Btn
File Format        .LG2
Date              Jan 01/2024
Time              12:00:00
Interval          30s

```

## DATA LOGGING

From the Main Menu, press the ► button while the cursor is on Data Logging to access this menu. The configuration parameters available in the Data Logging menu are described below. Use the ▲ or ▼ button to move the cursor up or down, and the ► button to edit the selected parameter.

Some parameter options in Data Logging are list types. When changing these parameters, use the ▲ or ▼ button to choose between the available selections. Press ✓ to save your selection, or ◀ to cancel.

Some parameter options in Data Logging are numerical entry types. When editing these parameters, use the ▲ or ▼ button to increment/decrement the selected digit, and ◀ or ► to move the cursor position. A decimal point (.) may also be available for some positions. Press ✓ to save your input, or ◀ from the left-most position to cancel.

**Log Site ID** is used to enter a number from 00 to 99. The site ID will become part of the downloaded file name to help distinguish downloads from different instruments.

**Mode** is used to select between LVT, Flow, Velocity, and Level mode. Default is LVT. LVT logs flow rate, level, velocity, and temperature simultaneously. Flow, Velocity, and Level modes only log the parameter described. It is suggested to use LVT since it is useful to see the behavior of level and velocity independently in order to understand flow meter performance. The Mode cannot be changed when the meter is Logging, you must Stop or Delete the log first.

**Log Mode** is used to select the sleep mode behavior of the MantaRay. When Sleep Btn is selected, the SLEEP button on the front of the meter is used to put the MantaRay in a low power state, where it will periodically “wake-up” based on the Interval, and log data before going back to the low power state. This is used to greatly increase battery life for longer term studies. When Log Mode is set to Sleep Btn, you will also see the “Zz” animation on the main display. When set to Telemetry, pressing the SLEEP button on the meter will put the meter into a low-power state, but instead of automatically “waking up” at the proper interval, the MantaRay will wait for a signal from an external telemetry device, like a SignalFire RANGER, then go back to a low-power state after being signaled. When in Telemetry mode, there is no “Zz” on the main display.

**File Format** allows you to choose .LG2 to download data in .lg2 format for viewing on Greyline Logger software. Choose .CSV to download data in .csv format for import directly to Excel. This menu option can be changed at any time without adversely affecting existing data.

**Date** allows you to set the date in MMM DD, YYYY format. It is suggested that you Delete and Start the log over again after changing the date.

**Time** allows you set the time in HH:MM:SS format, from 00:00:00 to 23:59:59. It is suggested that you Delete and Start the log over again after changing the time.

```

----Data Logging-----
▶Log Site ID      0
Mode              LVT
Log Mode          Sleep Btn
File Format        .LG2
Date              Jan 01/2024
Time              12:00:00
Interval          30s
    
```

**DATA LOGGING (CONT.)**

**Interval** is used to set the length of time between data log entries. Choose between 10s, 30s, 1min, 2min, 5min, 10min, 15min, 30min, and 60min.

**IMPORTANT:** Using the SLEEP button when Log Mode is Sleep Btn or Telemetry will only work when the Interval is 30s or greater. This is because the amount of time the meter will “wake up” to make a measurement in the low-power state is longer than the shortest interval – 10s.

**Data Log** is used to Stop, Start or Delete the log file.

**Important Note:** You MUST Delete an old log and Start a new log AFTER having made changes to Log Site ID, Mode, Date, Time and/or Interval for those changes to be applied.

**Important Note:** Changing any of the parameters in the Units/Mode menu will start a new log. It is recommended that you Delete and start a new log after changing any Units/Mode settings.

**RETRIEVING LOG FILE**

Plug a USB Flash Drive (one is included with the AVFM 6.1) into the USB output port on the side of the meter. The main display will show the data download icon until the log file is transferred to the memory card, at which point it will show a completed (check mark) icon. The USB flash drive may be removed when the icon for a successful download appears.

Download filenames will appear in this format: MRAY\_0A.LG2, where the “0” will automatically change to match the Log Site ID from the Data Logging menu, “A” will increment to “B” and so-on, for each subsequent download of the data log from one specific meter, and “.LG2” is for File Format LG2 or “.CSV” for File Format CSV.

**Note:** Downloading files in .lg2 format will take approximately 35 seconds per 1% of internal log memory used.

Downloading files in .csv format will take approximately 8 minutes per 1% of internal log memory used.

**Note:** Opening .LG2 files: Install Greyline Logger (available for free at [pulsarmeasurement.com](http://pulsarmeasurement.com)) on your PC or laptop. Select File/Open/Instrument Log (.log) to open the log file from your USB flash drive. Data can also be converted to .CSV via Greyline Logger software.

**Note:** Opening .CSV files: Use a datasheet program such as Microsoft Excel® to import data in a comma delimited format. Use Excel to manipulate or graph data.

```

--Special Functions--
▶Language      English
Analog Out     4-20mA
Backlight      High
Reset Totalizer NO
Net Totals     NO
Rev. Flo       Off
Capture Par    NO
Capture WF     NO
Restore Defaults NO
New Password   0000

```

## SPECIAL FUNCTIONS

From the Main Menu, press the ► button while the cursor is on Special Functions to access this menu. The configuration parameters available in the Special Functions menu are described below. Use the ▲ or ▼ button to move the cursor up or down, and the ► button to edit the selected parameter.

Some parameter options in Special Functions are list types. When changing these parameters, use the ▲ or ▼ button to choose between the available selections. Press ✓ to save your selection, or ◀ to cancel.

Some parameter options in Special Functions are numerical entry types. When editing these parameters, use the ▲ or ▼ button to increment/decrement the selected digit, and ◀ or ► to move the cursor position. A decimal point (.) may also be available for some positions. Press ✓ to save your input, or ◀ from the left-most position to cancel.

**Language** is used to change the language for text on the MantaRay. Choose between English, Spanish (Español), and French (Français).

**Analog Out** is used to select between 4-20mA and 0-5V for the type of signal sent out from the analog output on the MantaRay, available in the breakout I/O box. Both the 4-20mA and 0-5V are internally powered by the MantaRay.

**Backlight** is used to change the backlight level for the LCD display, for different environmental lighting levels or to conserve battery via a lower backlight level.

**Reset Totalizer** is used to reset the volume totalizer on the main display to 0. Choose YES to perform the reset, or NO or ◀ to cancel.

**Net Totals** is used to make the main volume totalizer on the meter a net totalizer, meaning positive flows will make the volume go up, while negative totals will make the totals go down. This parameter should only be used when Rev Flow is ON or INVERT.

**Rev. Flo** is used to enable reverse flow measurement on the MantaRay (ON), or to reverse the orientation of positive and negative flow on the MantaRay (INVERT).

**Capture Par** can be enabled in order to prepare the configuration parameters in a .CSV file so that it can be emailed. After selecting YES, wait for Insr USB to appear, then insert your USB flash drive into the plug on the MantaRay, at which point the meter will flash SAVING on the screen a couple times then return to NO. When this happens, you are OK to remove the flash drive. The parameter file will have a filename format of MANT\_POA.CSV.

**Capture WF** can be enabled in order to prepare a digital copy of the level waveform, plus a copy of the configuration parameters, to a .CSV file so that it can be emailed. After selecting YES, the meter will flash WORKING. Wait for Insr USB to appear, then insert your USB flash drive into the plug on the MantaRay, at which point the meter will flash SAVING on the screen a couple times then return to NO. When this happens, you are OK to remove the flash drive. The parameter file will have a filename format of MANT\_W0A.CSV.

```

--Special Functions--
▶Language      English
Analog Out     4-20mA
Backlight      High
Reset Totalizer NO
Net Totals     NO
Rev. Flo       Off
Capture Par    NO
Capture WF     NO
Restore Defaults NO
New Password   0000
    
```

**SPECIAL FUNCTIONS (CONT.)**

**Restore Defaults** can be used to return all programming parameters, except limited parameters like Cal Constant, to their default values. Choose the US option to restore parameters to Imperial units, or Metr to restore values to metric/SI units.

**New Password** is used to configure a password to protect against unauthorized access to the Main Menu for programming. Any time the value is set to something other than 0000, the user will be prompted to enter the password when going from the Main Display to the Main Menu using the ▶ button from the Main Display.

```

--Simulation-----
▶Test      Actual
Level      0.00in
Velocity   10ft/s
Flow       1982.88USG/m
4-20mA Flow 20.00
Relays 1 2
    
```

**SIMULATION**

From the Main Menu, press the ▶ button while the cursor is on Simulation to access this menu. The configuration parameters available in the Simulation menu are described below. Use the ▲ or ▼ button to move the cursor up or down, and the ▶ button to edit the selected parameter.

Some parameter options in Simulation are list types. When changing these parameters, use the ▲ or ▼ button to choose between the available selections. Press ✓ to save your selection, or ◀ to cancel.

Some parameter options in Simulation are numerical entry types. When editing these parameters, use the ▲ or ▼ button to increment/decrement the selected digit, and ◀ or ▶ to move the cursor position. A decimal point (.) may also be available for some positions. Press ✓ to save your input, or ◀ from the left-most position to cancel.

**Test** is used to choose how to exercise the 4-20mA/0-5V analog output as well as Relays 1 and 2. Actual will populate the Level, Velocity, and Flow with values from the actual measurement before entering the Simulation menu. Change to Minimum to set the Level, Velocity, and Flow to their Min levels (4mA/0V). Change to Maximum to set the Level, Velocity, and Flow to their Max levels (20mA/5V). While Test = Actual, you can also enter the Level, Velocity, and Flow parameters and manually change their values.

**4-20mA/0-5V** is a read-only view of the analog output for Level/Velocity/Flow, depending on Units/Mode configuration. The analog output will respond to simulated values so that it can be tested independently of the actual measurement. Exiting the simulation menu will cause the analog output to respond according to the actual measurement.

**Relays 1 2** is a read-only view of the relay state (a black numeral with white background is OFF, and a white numeral with black background is ON). Relays will respond to simulated values so that their logic can be tested independently of the actual measurement. Exiting the simulation menu will cause the relays to respond according to the actual measurement.

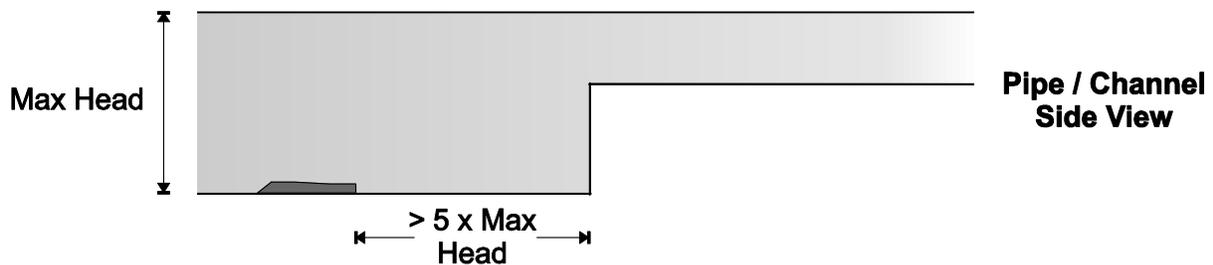
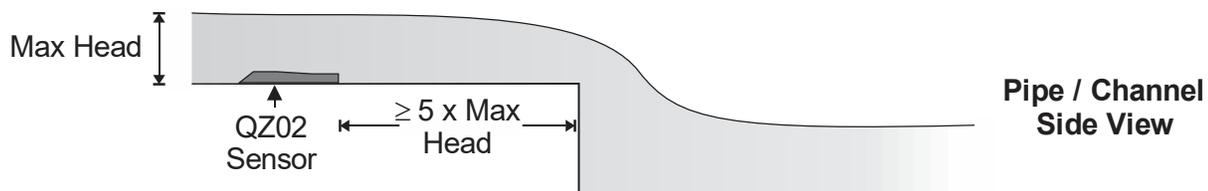
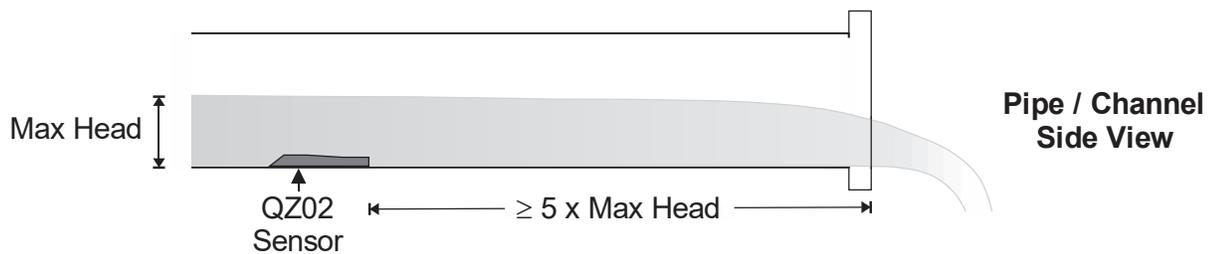
## INSTALLATION – SENSOR LOCATION

For the most accurate flow measurement possible, careful consideration should be made to the placement of the sensor in relation to flow disturbances. In general, the best accuracy will occur where flow is evenly distributed across the channel/pipe and free of turbulence.

Specific installation considerations are listed and discussed in more detail below.

### 1. Open Discharges or Pipe/Channel Outfalls

When the QZ02 sensor is to be mounted in front (upstream) of an open discharge or pipe/channel outfall, the sensor should be placed at least 5 times the maximum head level in front of the outfall:

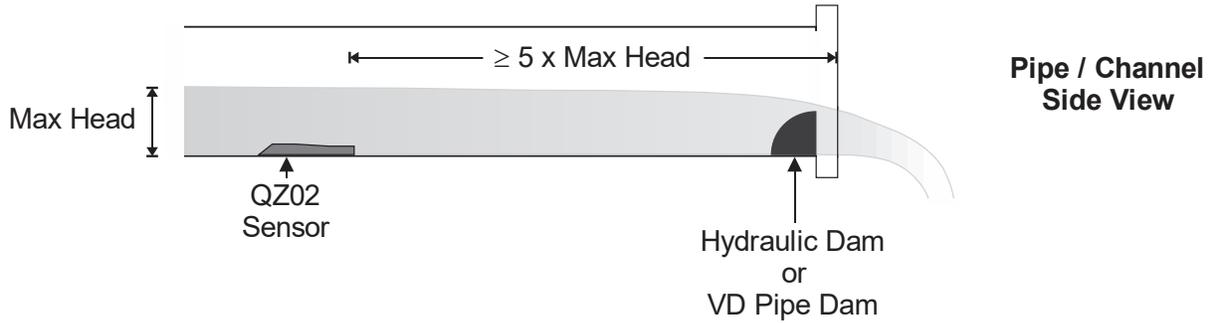


**INSTALLATION – SENSOR LOCATION (CONT.)**

**2. Hydraulic Dams**

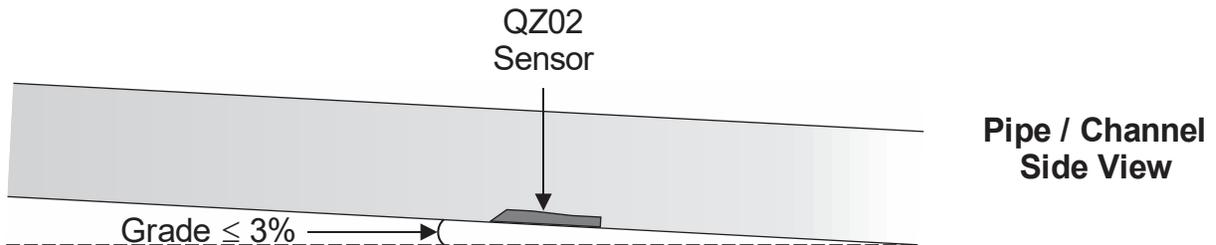
When the QZ02 sensor is to be mounted in front (upstream) of a hydraulic dam, or a Greyline VD pipe dam, the sensor should be placed at least 20 inches in front of the dam.

Important note: Best results when using a dam occur when the pipe/channel grade is less than 1%.



**3. Pipe Grade**

The pipe/channel in which the QZ02 sensor is mounted should not have a grade exceeding 3%. If a pipe/channel dam is used, slope should be less than 1% for best results.

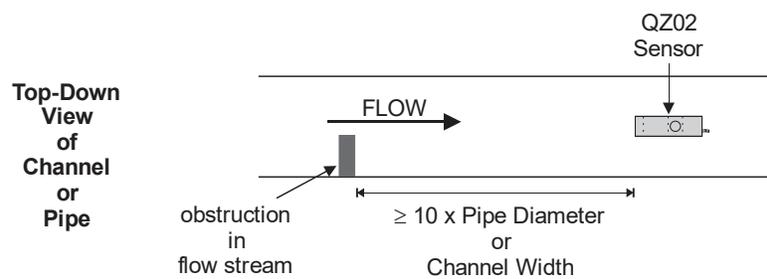
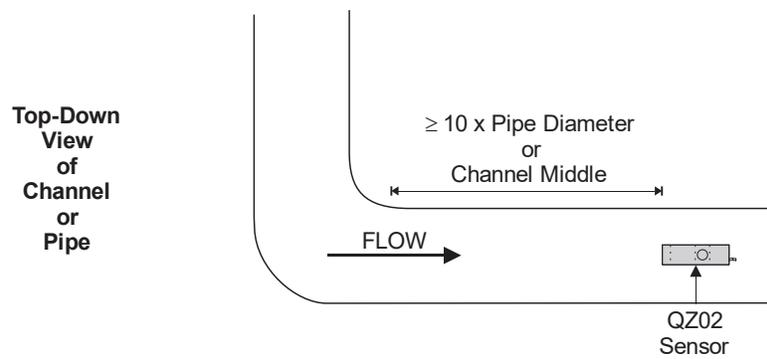
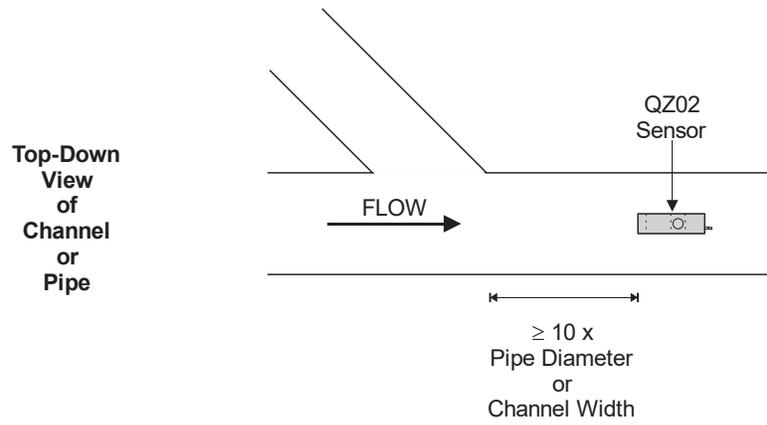


**INSTALLATION – SENSOR LOCATION (CONT.)**

**1. Flow Profile Distortion**

The pipe/channel in which the QZ02 sensor is mounted should be free of bends, tees, sudden changes in slope, and there should not be objects in the pipe/channel which disturb the flow profile in front of the sensor.

In general, the QZ02 sensor should be mounted with at least 10 pipe diameters or channel widths of straight-run upstream, and 5 pipe diameters or channel widths downstream:

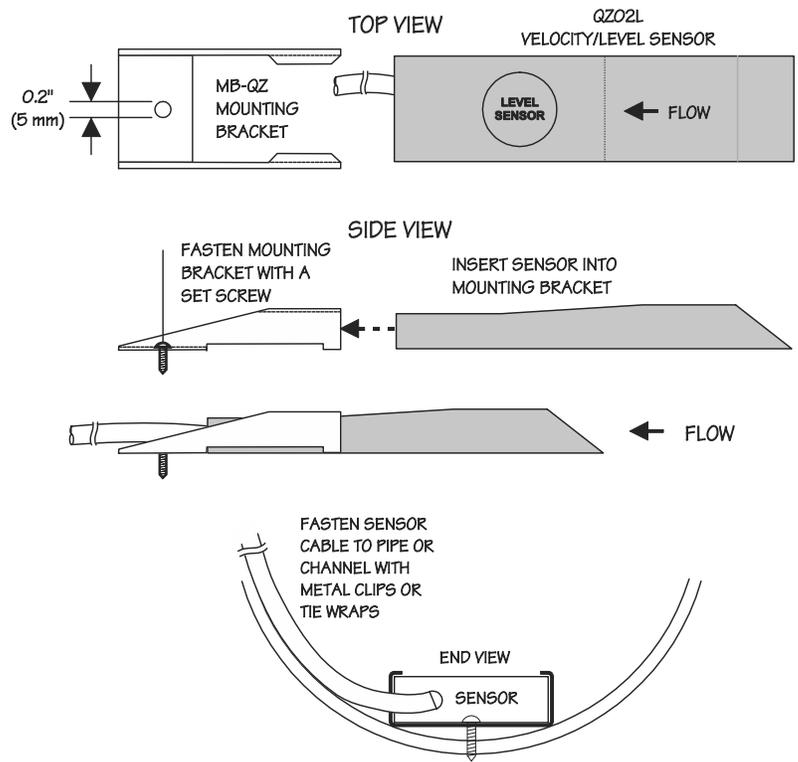


### QZ02L VELOCITY-LEVEL SENSOR MOUNTING

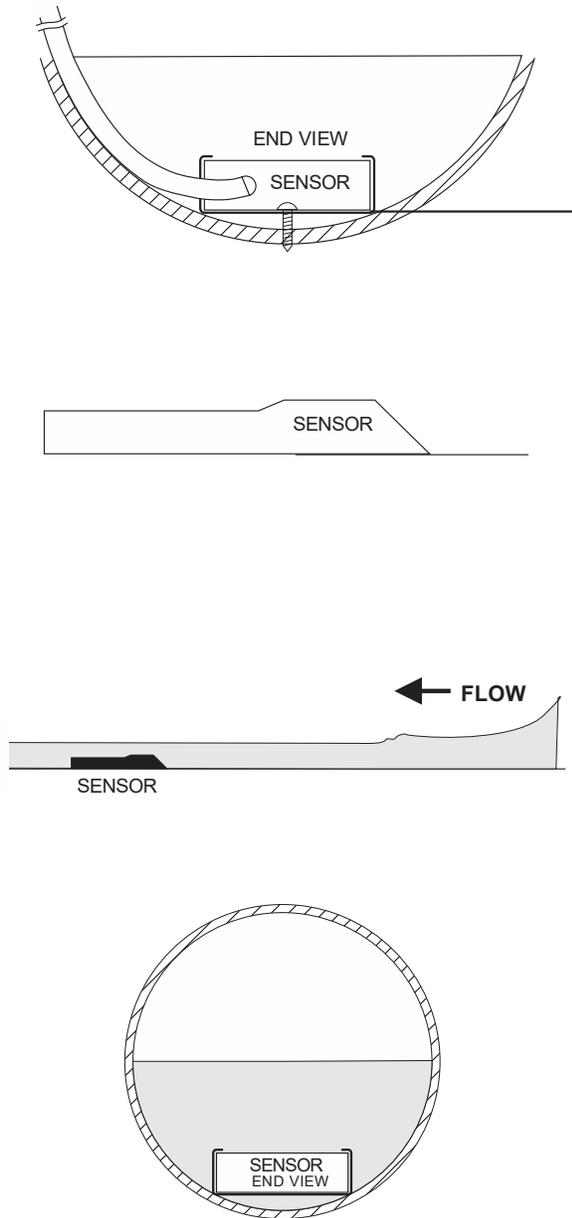
Mount the QZ02L sensor with the stainless steel bracket and hardware supplied. Ensure that the sensor is parallel to the water surface (check with a level). Mount with the tapered end of the sensor pointing upstream and the sensor cable pointing downstream.

Clip or tie wrap the sensor cable securely to the pipe or channel wall.

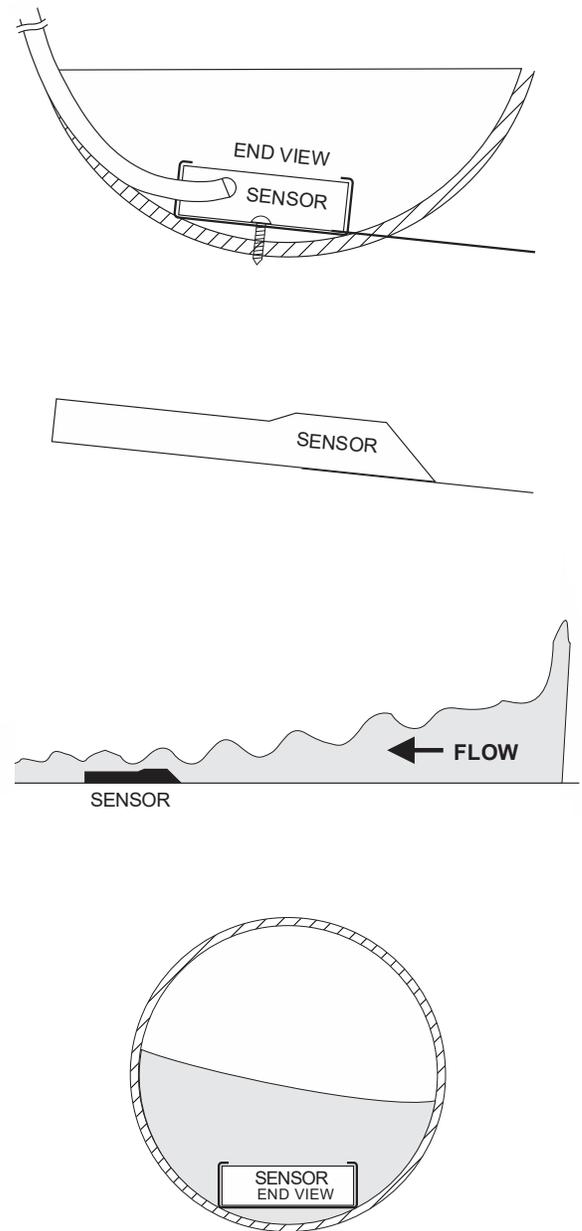
**Note:** The mounting bracket is designed to release the sensor if weeds or rags are caught by the sensor.



# GOOD

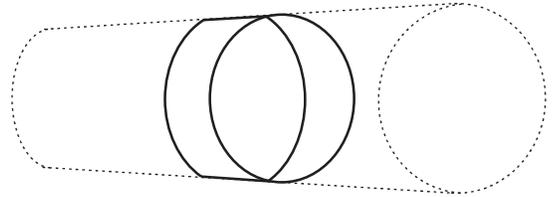


# BAD



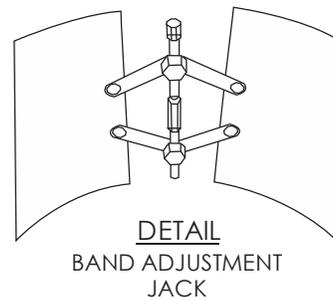
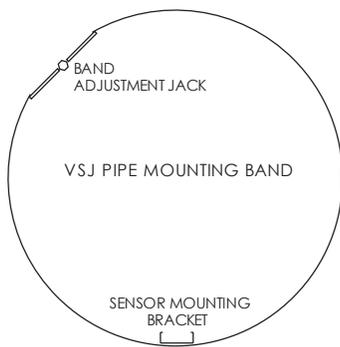
**OPTIONAL VSJ PIPE BAND MOUNTING WITH QZ02L SENSOR**

Install the stainless steel pipe band with the sensor mounting bracket at the invert (bottom) of the pipe. Ensure that the sensor bracket is parallel to the water surface (check with a level). Mount so the tapered end of the sensor will point upstream and the sensor cable will point downstream. (Turn the 1/4" adjustment nut clockwise to expand the bracket and secure to the pipe wall by friction fit.)



**Note:** VSJ6 and VSJ8 bands do not include adjustment jacks- they secure to pipe by spring tension.

Insert the sensor into the mounting bracket and tie-wrap the sensor cable securely to the pipe band using the holes provided.

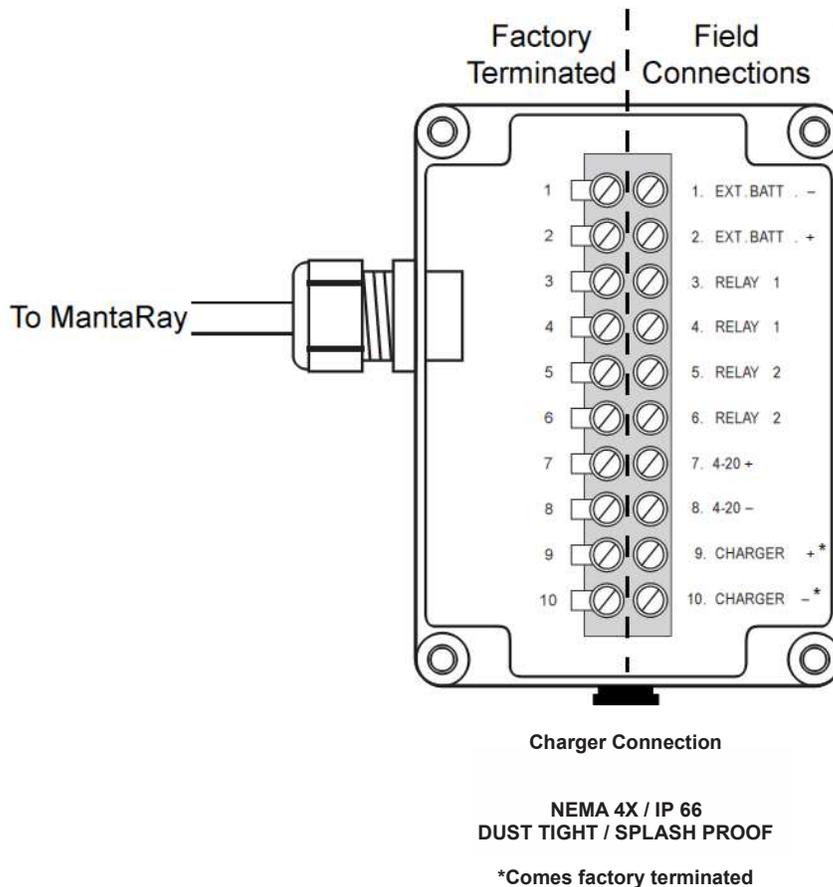


**CLEANING**

Cleaning is not required as a part of normal maintenance.

## BREAK-OUT BOX

The break-out box provides connection for optional external battery, two relay outputs, a single 4-20mA/0-5V output, and the barrel plug charger for the MantaRay. As shown in the diagram below, the left side of the terminals come factory terminated with wires already on them, with connection back through the cable to the MantaRay. The break-out box connects to the side of the MantaRay. Any user connections should be made on the right-hand side of the break-out box, except the charger which should connect to the barrel plug on the outside of the box.



### DIMENSIONS:

Width: 3.54" / 90 mm

Height: 4.72" / 120 mm

Depth: 2.42" / 61.5 mm

### CABLE:

6 ft / 1.8 m with connection plug to MantaRay

### EXTERNAL BATTERY CONNECTION:

10-30VDC; Efficiency best at 12 VDC 180 mA current draw at 12 VDC with no backlight or analog outputs connected.

**SLEEP BUTTON AND TELEMETRY LOGGING INSTRUCTIONS**

The Log Mode parameter in the Data Logging menu provides options of Sleep Btn and Telemetry. See the Data Logging menu description earlier in this manual for instructions on how to set it.

**SLEEP BUTTON**

In the Data Logging menu, when a Log Mode of Sleep Btn is selected, and the Interval is 30s or greater, pressing the “SLEEP” button on the front of the MantaRay will put the MantaRay in a low-power state by disabling the front LCD display and other non-essential electronics. Then, based on the Interval, will automatically “wake-up” essential electronics to make a measurement before going back to the low-power state. The approximate time for each sleep measurement is 12 seconds. The LCD display will not turn on while in sleep mode. The analog output will not activate during sleep button logging.

To bring the MantaRay out of sleep mode, press the “SLEEP” button on the front of the meter. If there is sufficient battery life, the LCD display will turn back on and you can return to normal operation of the meter. If the battery has completely drained, you will need to connect the external charger before using the MantaRay again.

**IMPORTANT:** Pressing the POWER button while the MantaRay is asleep will turn it off, stopping the logging. To validate that the MantaRay went into sleep mode properly, press the “SLEEP” button to wake it up, then again to put it back to sleep.

**TELEMETRY LOGGING**

In the Data Logging menu, when a Log Mode of Telemetry is selected, and the Interval is 30s or greater, pressing the “SLEEP” button on the front of the MantaRay will put the MantaRay in a low-power state by disabling the front LCD display and other non-essential electronics. Then, based on an external trigger described in more detail below, will automatically “wake-up” essential electronics to make a measurement before going back to the low-power state. The approximate time for each sleep measurement is 12 seconds. The LCD display will not turn on while in sleep mode. The analog output will activate during telemetry logging to send a signal to the external telemetry device.

**Wiring Instructions:** In order for the MantaRay to “wake-up”, make a measurement, and transmit the measurement to an external logger or telemetry system, it requires a DC voltage to be applied to it through the break-out box. The external DC voltage range is 10-18V. The duration the external voltage is applied should be at least 12 seconds in order for the MantaRay to stabilize for an accurate measurement and transmit the signal. The logger/telemetry system should log the 4-20mA output from the MantaRay at the end of the 12 second measurement cycle.

Wiring instructions for connecting a generic external logger/telemetry system to the break-out box is as follows:

<b>Break-out Box Terminal Marking</b>	<b>External Logger/Telemetry Connection</b>
Charger+	DC voltage trigger positive (9-18VDC)
Ext. Bat-	DC voltage trigger negative
4-20mA+	4-20mA input (MantaRay 4-20mA is internally powered)
4-20mA-	4-20mA ground

**TELEMETRY LOGGING (CONT.)**

The telemetry logging feature of the MantaRay was validated to be compatible with the RANGER wireless telemetry system from SignalFire. Follow these wiring and configuration instructions for proper operation.

Wiring:

Break-out Box Terminal Marking	SignalFire RANGER Terminal
Charger+	A_PWR
Ext. Bat-	GND (Terminal 3, between DIN2 and A_PWR)
4-20mA+	AIN
4-20mA-	GND (Terminal 6, between AIN and COM)

RANGER configuration:

Ensure the RANGER is configured to provide 13V on the A\_PWR terminal, and the "On Time" is 12 seconds. Both of these options are available via the "Configure Node" button for the Ranger device in the SignalFire Cloud. See picture below for reference:

**Current Settings on Node**

Node Name: Ranger Wall Mount

Sensor Options

Voltage (V): Low (13 V) ▼

On Time (seconds): 12  Always On

Reporting Interval

in seconds: 300

The "Reporting Interval" can be set to any duration 30 seconds or longer (minimum interval may depend on RANGER subscription service).

**ESTIMATED BATTERY LIFE**

Use this table for estimated battery life at different Intervals. The Intervals below are selected in the Data Logging menu of the MantaRay, or set via the external telemetry logging system, as shown above for the RANGER. Actual battery life may vary due to environmental factors like temperature, as well as starting state of charge and age of battery.

Interval	Est. Battery Life
Continuous	40 hours
30s	6 days
1 min	10 days
2 min	18 days
5 min	38 days
10 min	52 days
15 min	74 days
30 min	90 days
60 min	110 days

**APPLICATIONS HOTLINE**

For applications assistance, advice or information on any Pulsar Measurement Instrument contact your Sales Representative, write to Pulsar Measurement or phone the Applications Hotline below:

COUNTRY	TEL	FAX	E-MAIL	ADDRESS
<b>United States</b>	315-788-9500	315-764-0419	<a href="mailto:northamerica@pulsarmeasurement.com">northamerica@pulsarmeasurement.com</a>	11451 Belcher Road South Largo, FL 33773
<b>Canada</b>	613-938-8956	613-938-4857	<a href="mailto:northamerica@pulsarmeasurement.com">northamerica@pulsarmeasurement.com</a>	16456 Sixsmith Drive Long Sault, Ont. K0C 1P0
<b>UK</b>	+44 (0) 1684 891371	+44 (0) 1684 575985	<a href="mailto:europa@pulsarmeasurement.com">europa@pulsarmeasurement.com</a>	Cardinal Building Enigma Commercial Centre Sandy's Road, Malvern WR14 1JJ
<b>Asia</b>	N/A	N/A	<a href="mailto:asiapacific@pulsarmeasurement.com">asiapacific@pulsarmeasurement.com</a>	34-1A, Jalan 10A/KU5 Taman Aman Perdana 41050 Klang, Selangor, Malaysia
<b>Oceania</b>	+61 428 692 274	N/A	<a href="mailto:oceania@pulsarmeasurement.com">oceania@pulsarmeasurement.com</a>	N/A

**PRODUCT RETURN PROCEDURE**

Instruments may be returned to Pulsar Measurement for service or warranty repair.

**1 Obtain an RMA Number from Pulsar Measurement -**

Before shipping a product to the factory please contact Pulsar Measurement by telephone, fax or email to obtain an RMA number (Returned Merchandise Authorization). This ensures fast service and correct billing or credit.

When you contact Pulsar Measurement please have the following information available:

1. Model number / Software Version
2. Serial number
3. Date of Purchase
4. Reason for return (description of fault or modification required)
5. Your name, company name, address and phone number

**2 Clean the Sensor/Product -**

**Important: unclean products will not be serviced and will be returned to the sender at their expense.**

1. Rinse sensor and cable to remove debris.
2. If sensor has been exposed to sewage, immerse both sensor and cable in a solution of 1 part household bleach (Javex, Clorox etc.) to 20 parts water for 5 minutes. Important: do not immerse open end of sensor cable.
3. Dry with paper towels and pack sensor and cable in a sealed plastic bag.
4. Wipe the outside of the enclosure to remove dirt or deposits.
5. Return to Pulsar Measurement for service.

## LIMITED WARRANTY

---

Pulsar Measurement warrants, to the original purchaser, its products to be free from defects in material and workmanship for a period of two years from date of invoice. Pulsar Measurement will replace or repair, free of charge, any Pulsar product if it has been proven to be defective within the warranty period. This warranty does not cover any expenses incurred in the removal and re-installation of the product.

If a product manufactured by Pulsar should prove defective within the first year, return it freight prepaid to Pulsar Measurement along with a copy of your invoice.

This warranty does not cover damages due to improper installation or handling, acts of nature, or unauthorized service. Modifications to or tampering with any part shall void this warranty. This warranty does not cover any equipment used in connection with the product or consequential damages due to a defect in the product.

All implied warranties are limited to the duration of this warranty. This is the complete warranty by Pulsar Measurement and no other warranty is valid against Pulsar Measurement. Some states do not allow limitations on how long an implied warranty lasts or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Pulsar Measurement

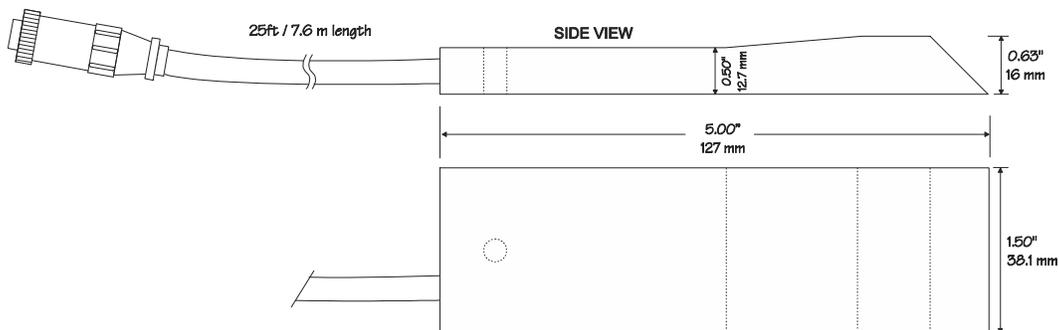
**SPECIFICATIONS**

**Electronics**

- Channel Types:** Round pipe, rectangular, trapezoid, egg or custom shapes
- Electronics Enclosure:** Polycarbonate, IP67 while plugs connected or covered
- Operating Temp. (Electronics):** -5° to 140°F (-20° to 60°C)
- Accuracy:** Level: ±0.25% of reading or ±0.08in (±2.03mm), whichever is greater  
Velocity: ±2% of reading or ±0.04ft/s (±0.012m/s), whichever is greater.  
Requires solids or bubbles minimum size of 100 microns, minimum concentration 75 ppm.  
Repeatability and Linearity 0.5%
- Display:** White, backlit matrix - displays flow rate, totalizer, relay states, operating mode and calibration menu
- Programming:** Built-in 5-button keypad with English, French or Spanish language selection
- Battery:** Internal rechargeable NiMH, 12V, 10,000 mAh
- Power Adapter:** 16.5V, 4.2A (69.3W Max), 100-240VAC 50/60Hz input, 2.0A, UL and CE listed
- Outputs/Communications:** 4-20mA or 0-5VDC (100 mA) by menu selection. 500Ω max impedance. 2 solid-state Relays, 32V AC/DC max., rated 400mA;
- Break-out Box:** Connections for charger input, external battery input, 2 relays, 4-20mA (0-5V), and external telemetry logger
- Data Logger (internal):** Programmable 26-million point capacity, time and date stamped plus formatted flow reports including Total, Average, Minimum, Maximum and times of occurrence.
- Data Logger Intervals:** Programmable 10s, 30s, 1min, 2min, 5min, 10min, 15min, 30min, 60min
- Software:** Greyline Logger for Windows. Graph and data table presentation, level/velocity to flow conversion, exports data to Excel™, exports graphs
- Approximate Shipping Weight:** 15 lbs. (6.8 kg)

**Velocity/Level Sensor QZ02L**

- Velocity Measurement Range:** 0.1 to 20 ft/sec (0.03 to 6.2 m/sec) and reverse flow to -5ft/s (-1.5 m/s)
- Level Measurement Range:** Minimum Head: 1in (25.4 mm). Maximum Head: 15ft (4.6m)
- Operating Temperature:** 5 to 175°F (-15 to 80°C)
- Exposed Materials:** 316 stainless steel, epoxy resin, polyurethane
- Sensor Cable:** 25ft (7.6 m) submersible polyurethane jacket, shielded, 3 coaxial
- Sensor Mounting:** includes MB-QZ stainless steel mounting bracket
- Temperature Compensation:** Automatic, continuous







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