MantaRay

Instruction Manual

Manual Rev 3.3

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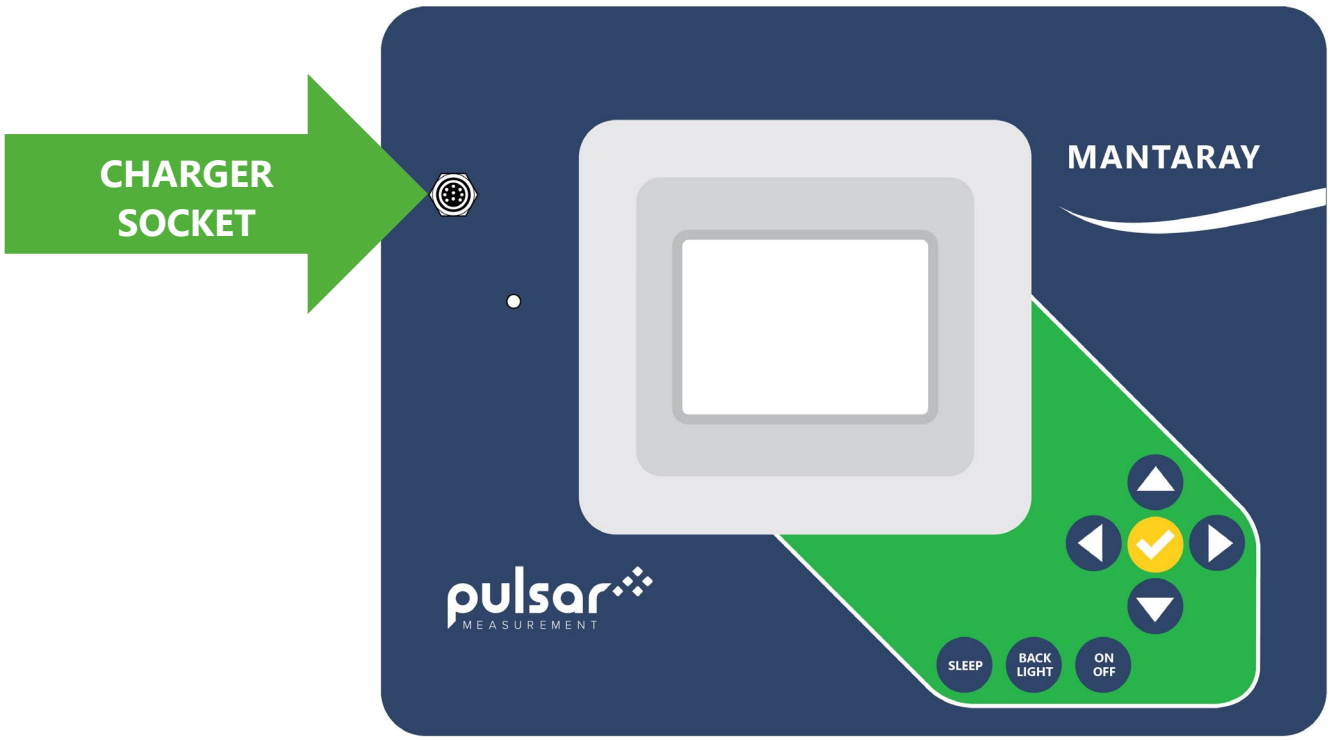
CONTENTS

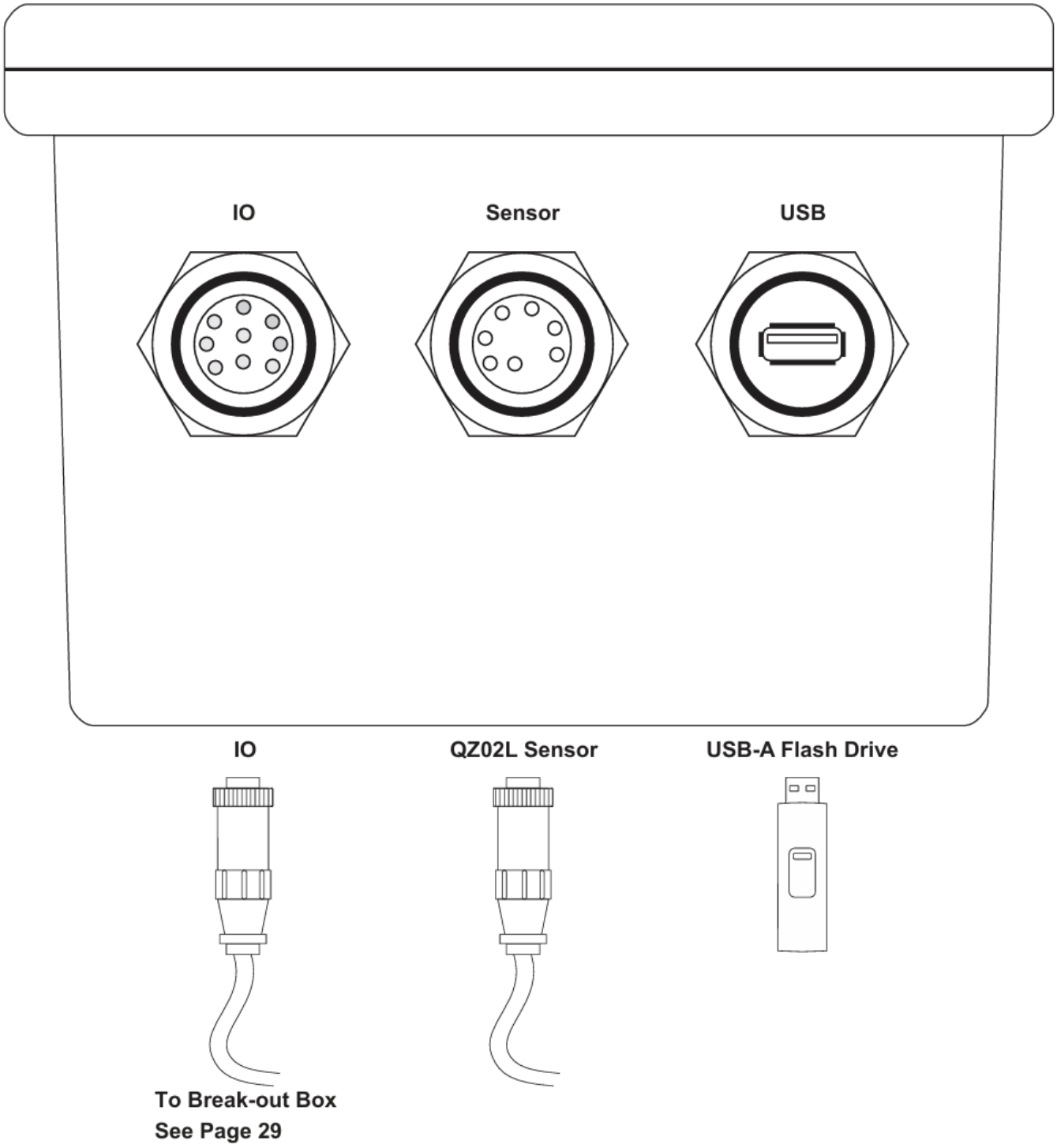
IMPORTANT NOTE: This instrument is manufactured and calibrated to meet product specifications. Please read this manual carefully before installation and operation. Any unauthorised repairs or modifications may void the warranty.

MANTARAY VERSION

IMPORTANT: This instruction manual is specific to the MantaRay equipped with a faceplate charger socket. See the reference picture below. If your MantaRay is not equipped with this faceplate charger port, please reference MantaRay User's Guide Rev 2.0 for instructions specific to your model.



CONNECTIONS

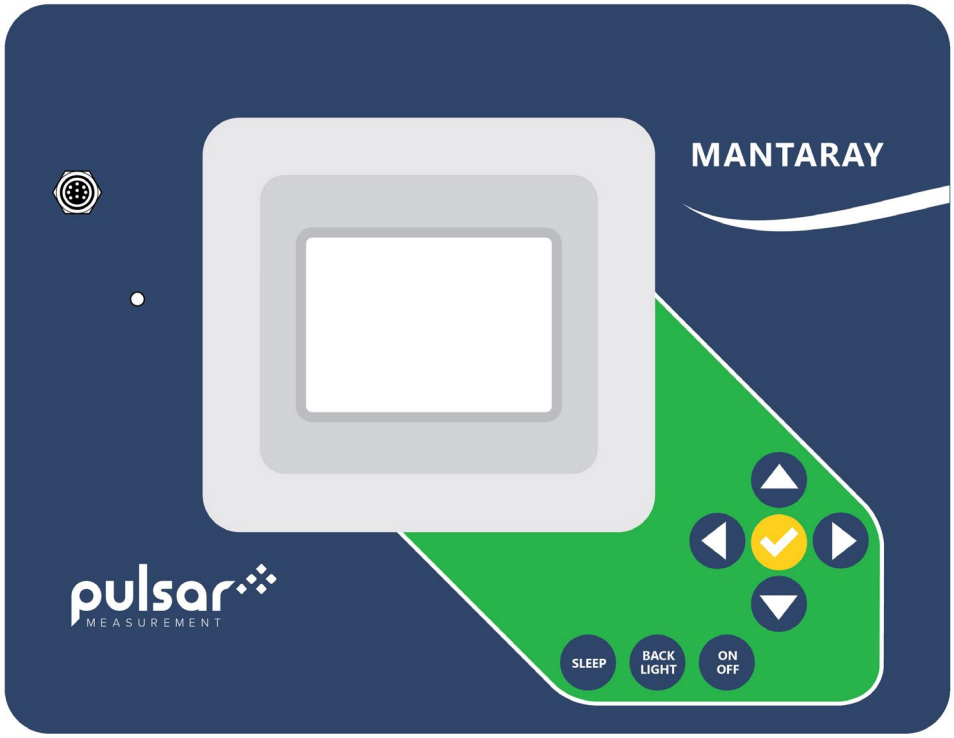


NOTE: Sockets and plugs not drawn to scale.

KEYPAD SYSTEM

The MantaRay uses a menu system for general use and configuration. Arrows show the four directions to navigate the menu. 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 ✓.



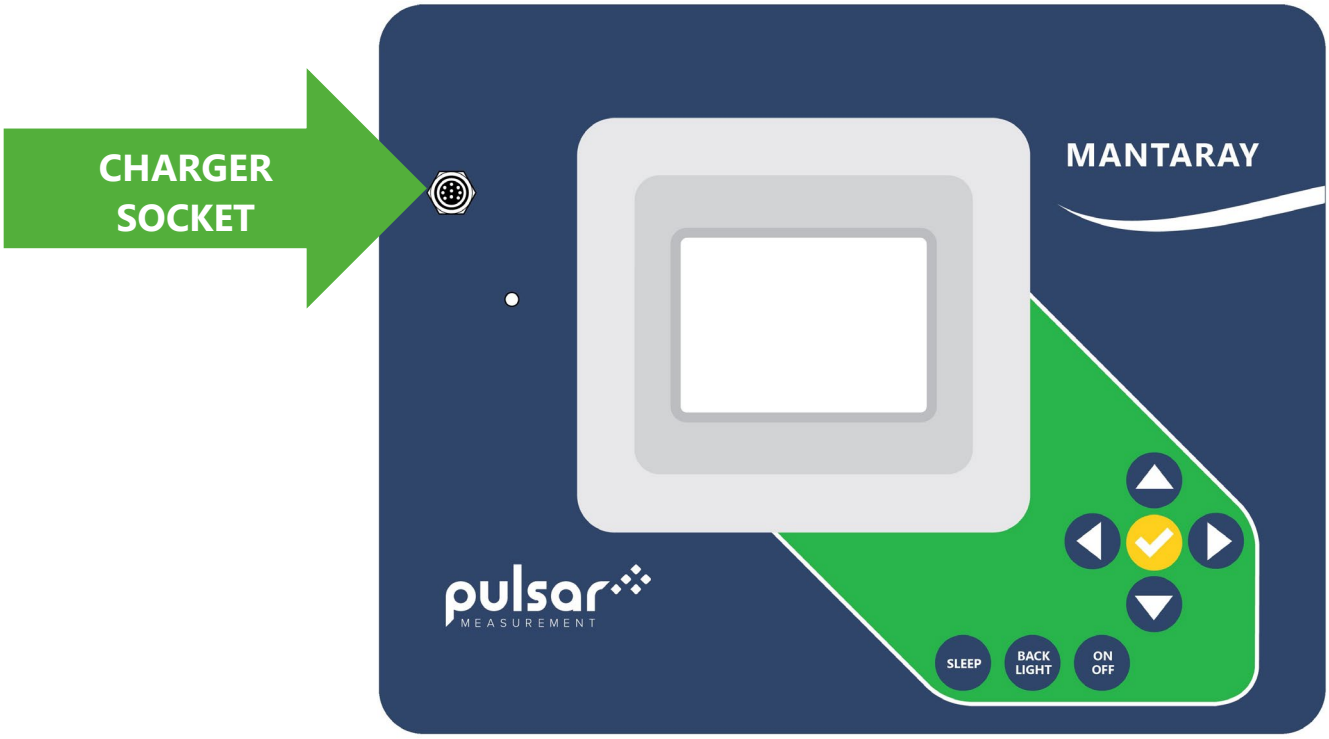
BATTERY

- 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 12 hours charging. The charge rate will be fastest between 0 and 85%, 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

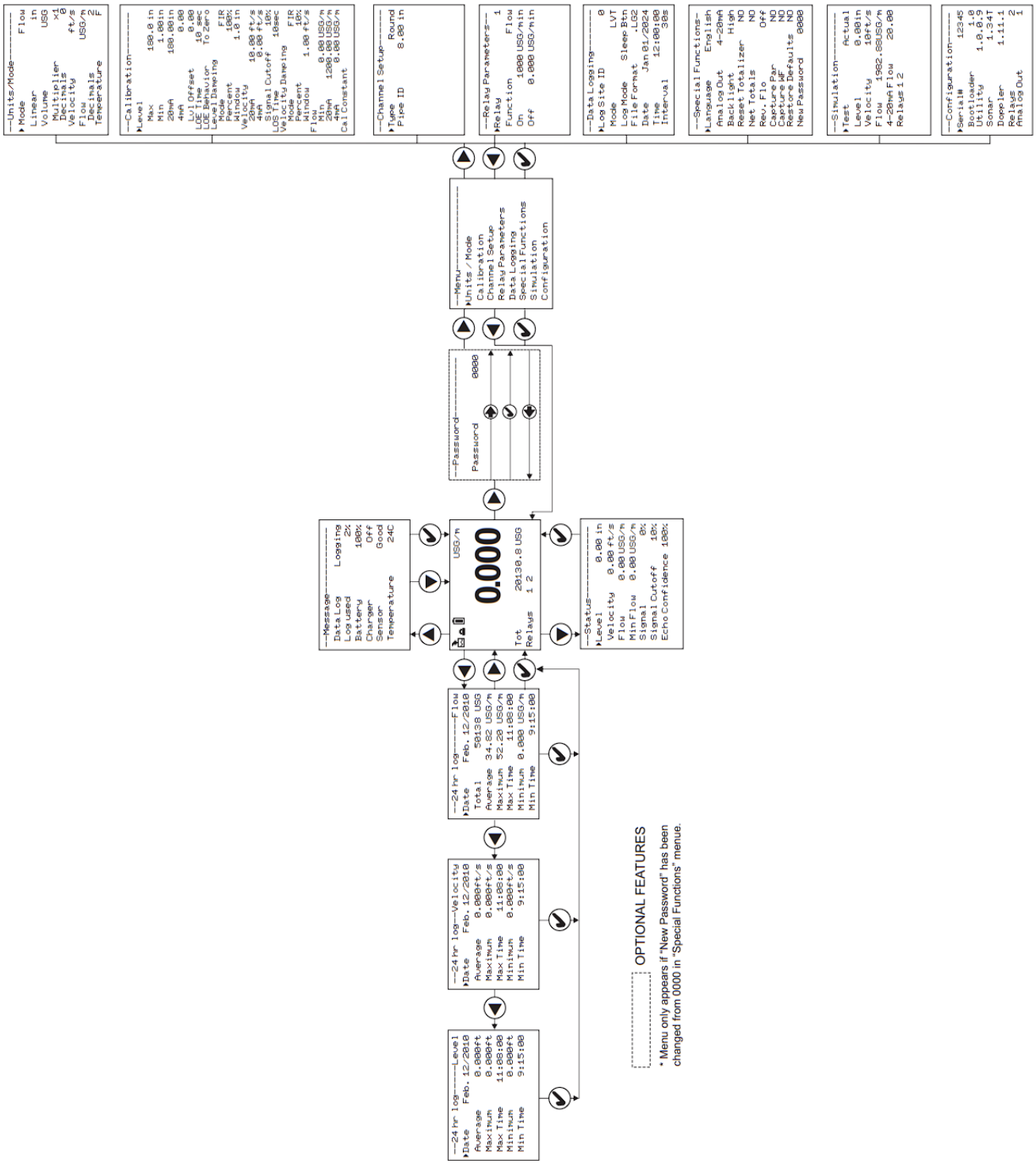
A 15V AC-DC power module is supplied for battery charging and continuous use. The charger connects to the faceplate of the MantaRay. Full charge requires approximately 12 hours when fully drained. The charge rate is at its fastest between 0 to 85%, it will slow down as it approaches 100%. Solid battery icon indicates when battery is very close to fully charged (≥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 an OFF state.



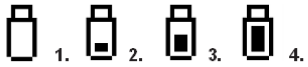
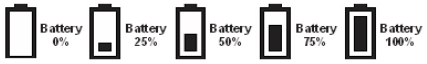
NOTE: Depending on the manufacturing date of your MantaRay, the charger may not connect to the faceplate as shown above. Please reference MantaRay User's Guide Rev 2.0 for instructions specific to that version MantaRay.

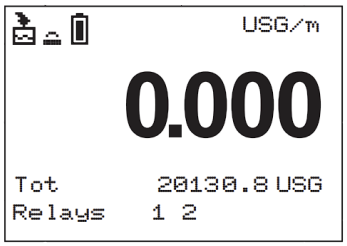
PROGRAMMING MENU



ICONS

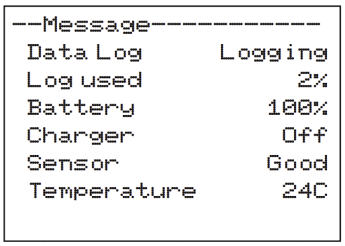
On the Main Screen, the following icons may present themselves:

	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.



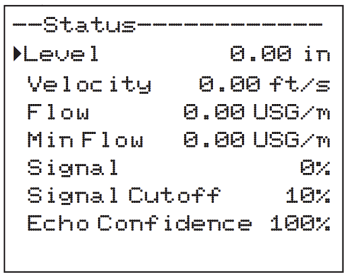
MAIN DISPLAY

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

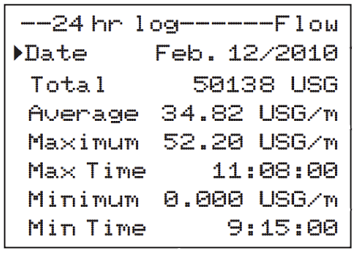
Press ▲ from the main display to view Data Log state and percent used, Battery fuel gauge, Charger connection state, Sensor Status (Good, Short, Open, Dry, Echo Loss), and measured Temperature of the sensor. Press ✓ or ▼ to return to the Main Display.



STATUS

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

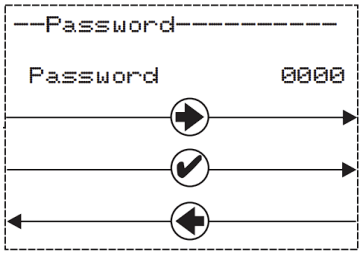
Level	The current level measurement displayed in units selected in the Units/Mode menu.
Velocity	The current velocity measurement displayed in units selected in the Units/Mode menu.
Flow	The current flow rate measurement displayed in units selected in the Units/Mode menu.
Min Flow	Read-only value of 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 when the Echo Confidence is above 0%.



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

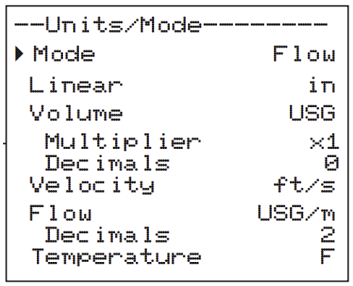
The optional Password (a number from 0000 to 9999) prevents unauthorised access to the main programming menus.

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

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^3, L, bbl (1 bbl = 42 USG), and ft^3.

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:

Abbreviation	Description	Abbreviation	Description
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^3/d	cubic feet per day	m^3/d	cubic meters per day
ft^3/h	cubic feet per hour	m^3/h	cubic meters per hour
ft^3/m	cubic feet per minute	m^3/m	cubic meters per minute
ft^3/s	cubic feet per second	m^3/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              1.00in
  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

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.

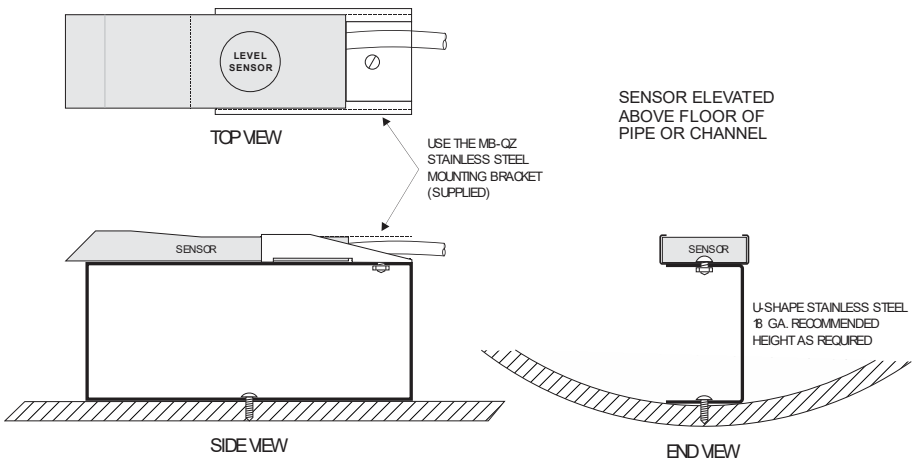
Level Max should be set to the maximum height the level should reach in the system in units configured in the Units/Mode menu. If a Round pipe is selected in the Channel Setup menu, then this value should be set to the same value as the inside diameter of the pipe. The default of 180 inches (15ft) is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

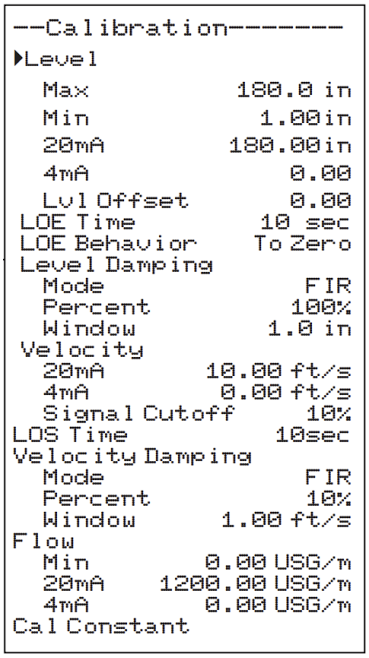
Level Min should be set to the minimum height the level should reach in the system, in units configured in the Units/Mode menu. Minimum level for the QZ02L sensor is 1 inch, however, this value could be set to a larger value if you want to ignore levels greater than 1 inch.

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 (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 behaviour 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 behaviour is used to select behaviour 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.

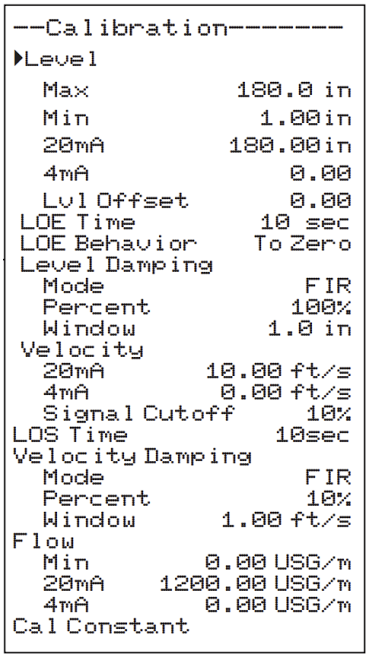
The LOW PASS filter will ignore new measured levels outside the Window of the damped output, while holding the damped output until there are enough consecutive measurements outside the Window to cause a sudden step-response to the new measured value.

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 ± 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 (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.

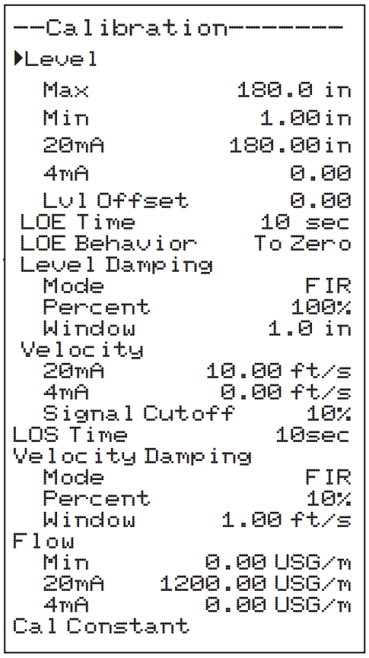
Velocity Damping Mode selects the damping algorithm used for velocity measurement. Options are FIR, LOW PASS, and OFF.

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.



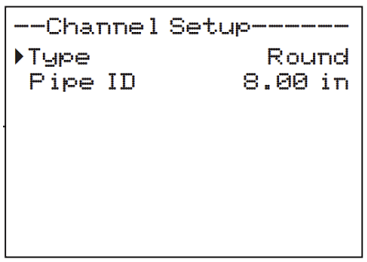
CALIBRATION (CONT.)

Velocity Damping Window sets a boundary around the damped output (currently reported velocity), where if the next measured value falls outside the current value ± 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

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.

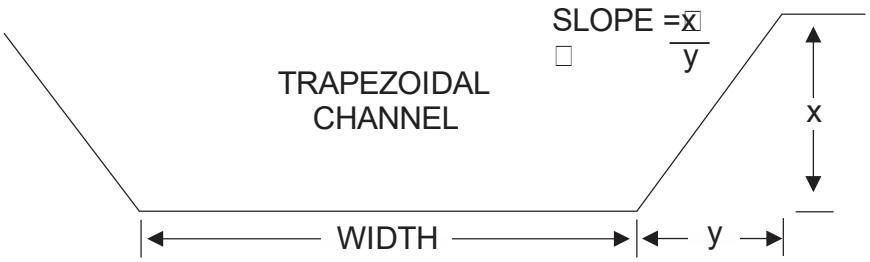
Type is used to select the shape of the channel or pipe. Based on this selection, additional parameter options not shown in the image to the left may appear. Select from the following:

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.

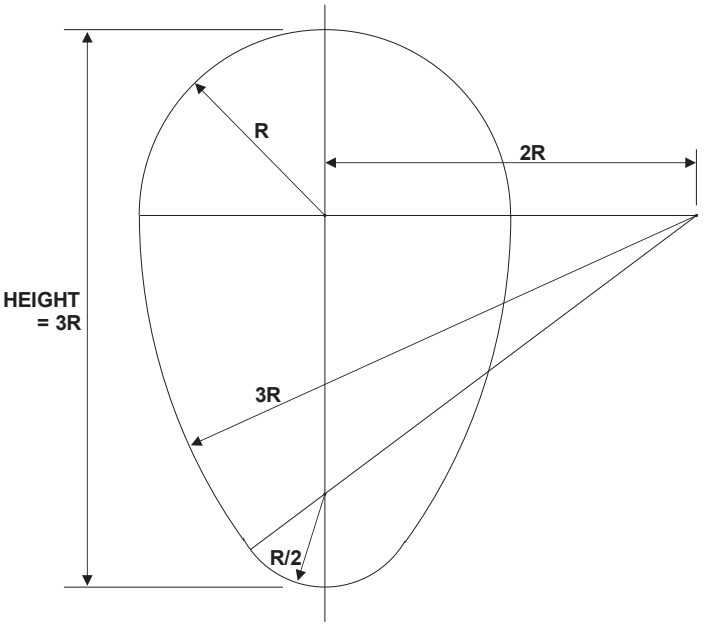
```
--Channel Setup------
▸Type              Round
 Pipe ID       8.00 in
```

CHANNEL SETUP (CONT.)

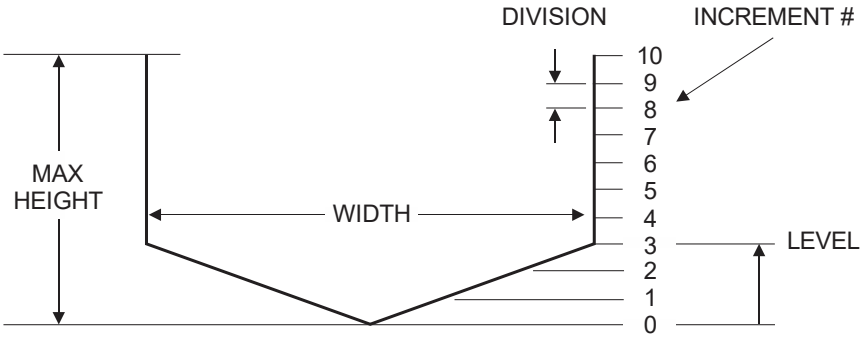
Trapezoid (Cont.)

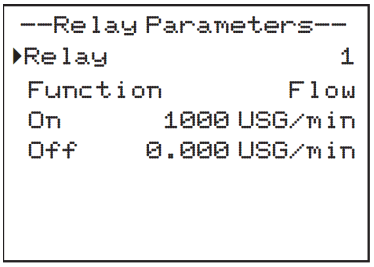


Egg Select Egg for egg shaped channels. Enter the Max Height of the channel.



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

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.

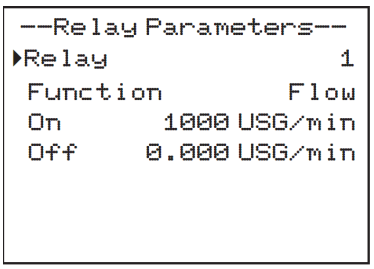
Relay is used to select which of the two relay outputs you wish to reconfigure. After choosing either 1 or 2, use the Function parameter to select how you wish to use that relay.

Function is used to set the behaviour 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 behaviour will override any behaviour which would occur due to the LOE behaviour in the Calibration menu. E.g. if the meter is set to HOLD for LOE behaviour, 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 (CONT.)

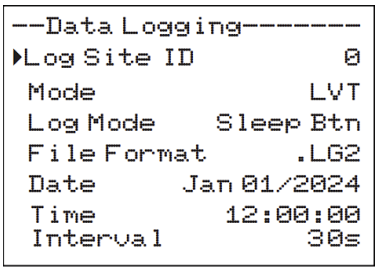
Flow Like Level and Velocity, will provide an **ON** and **OFF** setpoint for flow alarm. When ON>OFF, the flow alarm functions like a high flow alarm. When measured flow is greater than ON setpoint, the relay will turn on, and the relay will turn off when measured flow goes below OFF setpoint. When 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

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 t or u to move the cursor position. A decimal point (**.**) may also be available for some positions. Press **ü** to save your input, or t 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.

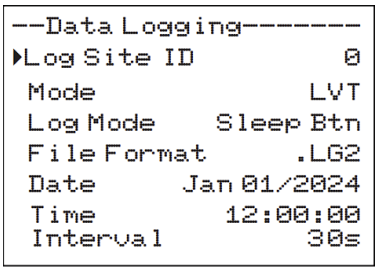
Mode is used to select between LVT, Flow, Velocity, and Level mode. Default is LVT. LVT logs flow rate, level, velocity, and temperature simultaneously. Flow, Velocity, and Level modes only log the parameter described. It is suggested to use LVT since it is useful to see the behaviour of level and velocity independently 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 behaviour 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_z" 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 signalled. When in Telemetry mode, there is no "Zz_z" on the main display.

File Format allows you to choose .LG2 to download data in .lg2 format for viewing on Pulsar 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 (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.

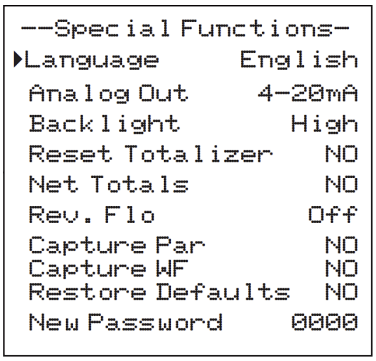
Download filenames will appear in this format: MRAY__0A.LG2, where the "0" will automatically change to match the Log Site ID from the Data Logging menu, "A" will increment to "B" and so-on, for each subsequent download of the data log from one specific meter, and ".LG2" is for File Format LG2 or ".CSV" 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 Pulsar Logger (available for free at 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 Pulsar 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

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 t or u to move the cursor position. A decimal point (**.**) may also be available for some positions. Press **ü** to save your input, or t 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 analogue 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.

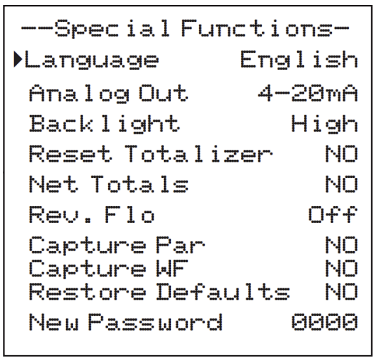
Reset Totalizer is used to reset the volume totalizer on the main display to 0. Choose YES to perform the reset, or NO or t to cancel.

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 to prepare the configuration parameters in a .CSV file so that it can be emailed. After selecting YES, wait for Insrt 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_P0A.CSV.

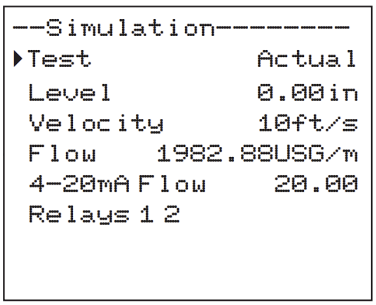
Capture WF can be enabled to prepare a digital copy of the level waveform, plus a copy of the configuration parameters, to a .CSV file so that it can be emailed. After selecting YES, the meter will flash WORKING. Wait for Insrt USB to appear, then insert your USB flash drive into the plug on the MantaRay, 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 (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

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 t or u to move the cursor position. A decimal point (**.**) may also be available for some positions. Press ü to save your input, or t 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 analogue output for Level/Velocity/Flow, depending on Units/Mode configuration. The analogue output will respond to simulated values so that it can be tested independently of the actual measurement. Exiting the simulation menu will cause the analogue 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.

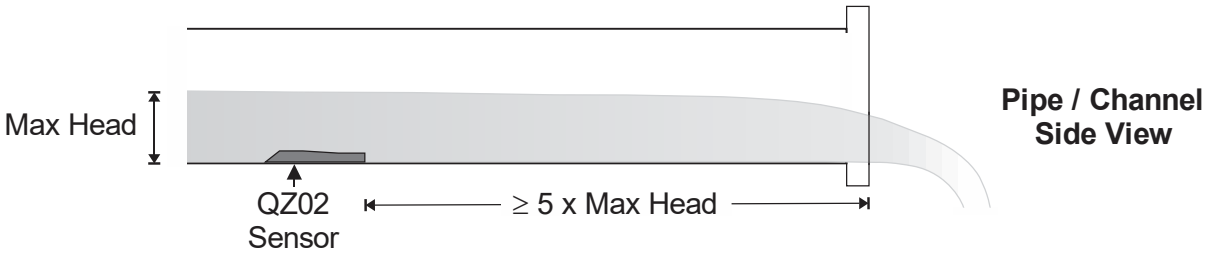
INSTALLATION – SENSOR LOCATION

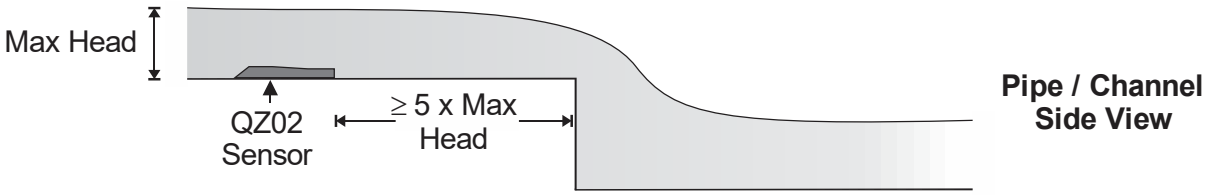
For the most accurate flow measurement possible, careful consideration should be made to the placement of the sensor in relation to flow disturbances. In general, the best accuracy will occur where flow is evenly distributed across the channel/pipe and free of turbulence.

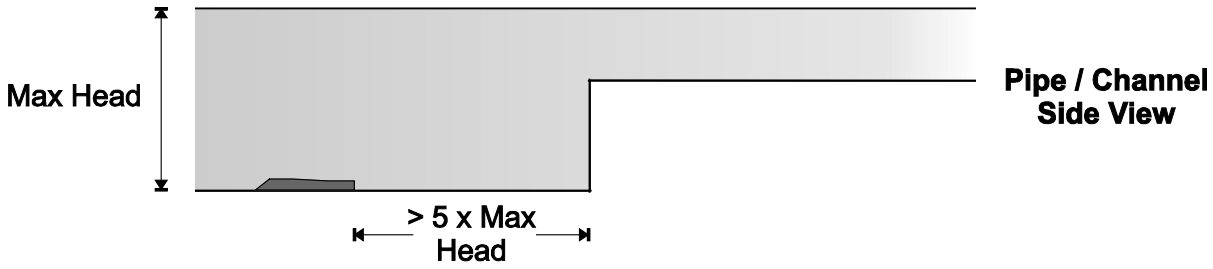
Specific installation considerations are listed and discussed in more detail below.

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:





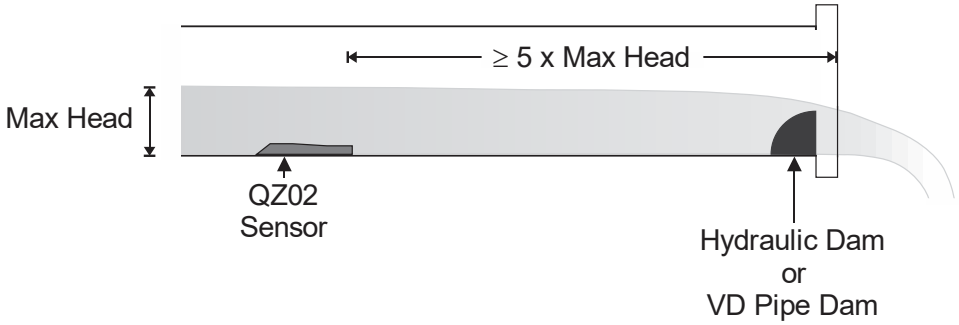


INSTALLATION – SENSOR LOCATION (CONT.)

2. Hydraulic Dams

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

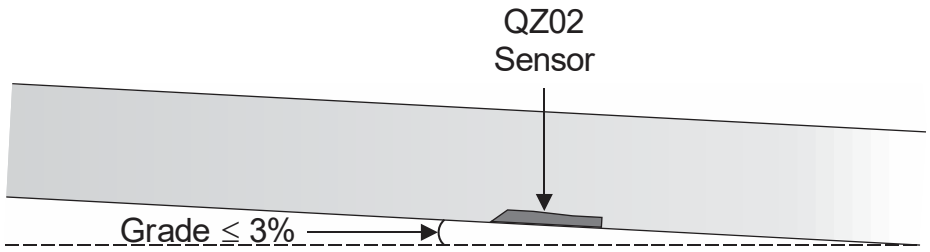
Important note: Best results when using a dam occur when the pipe/channel grade is less than 1%.



Pipe / Channel Side View

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.



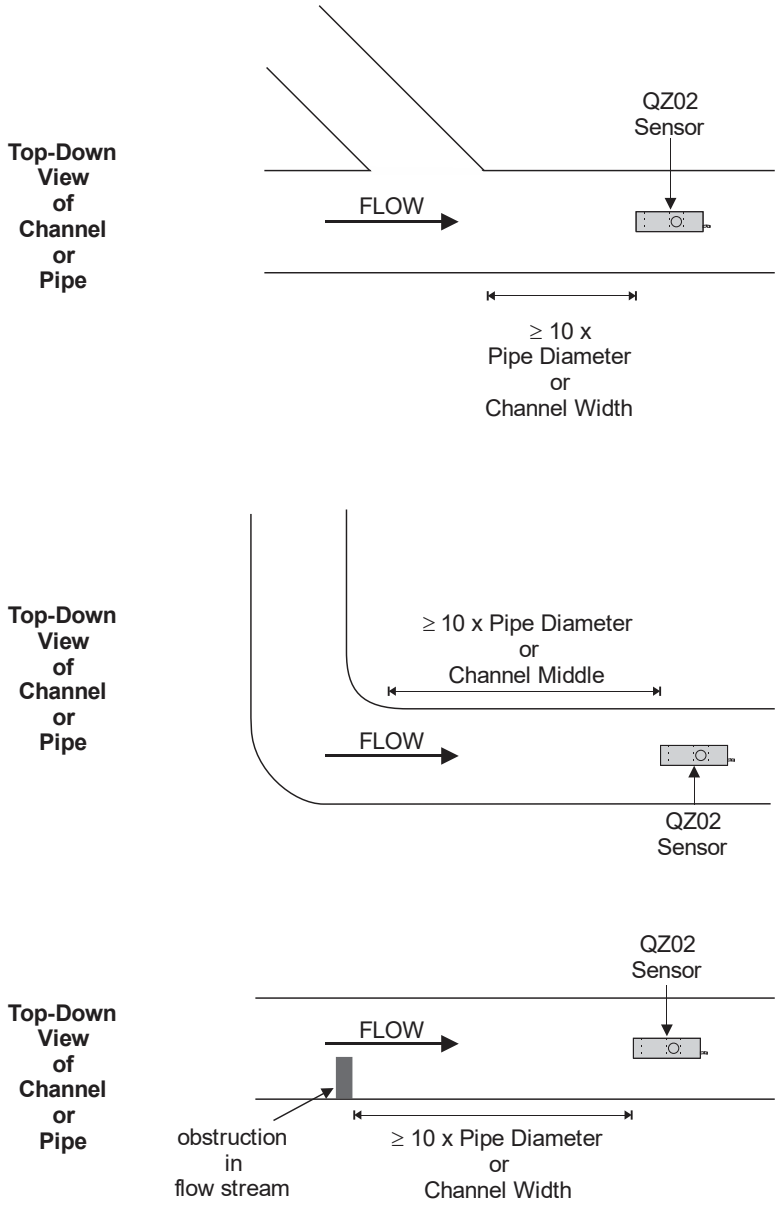
Pipe / Channel Side View

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:

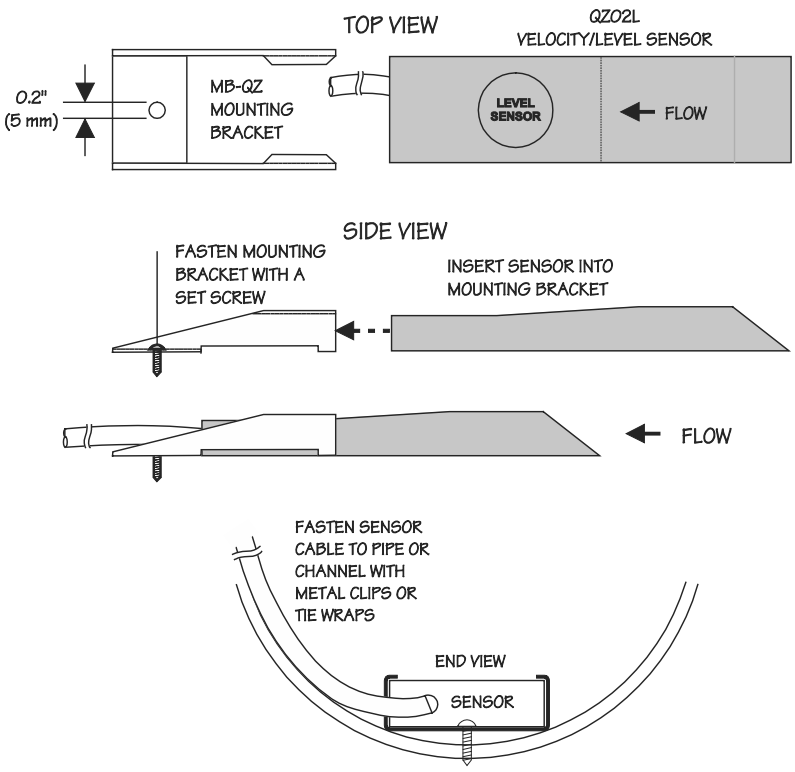


QZ02L VELOCITY-LEVEL SENSOR MOUNTING

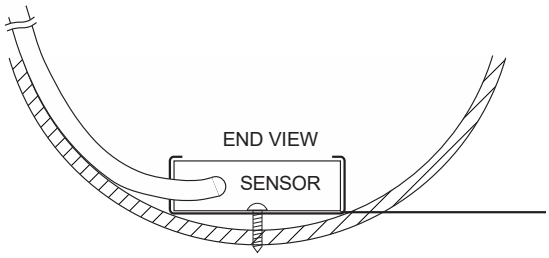
Mount the QZ02L sensor with the stainless-steel bracket and hardware supplied. Ensure that the sensor is parallel to the water surface (check with a level). Mount with the tapered end of the sensor pointing upstream and the sensor cable pointing downstream.

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

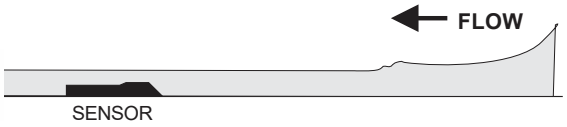
Note: The mounting bracket is designed to release the sensor if weeds or rags are caught by the sensor.

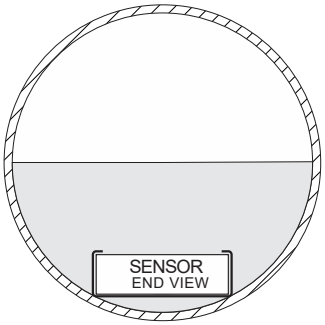


GOOD

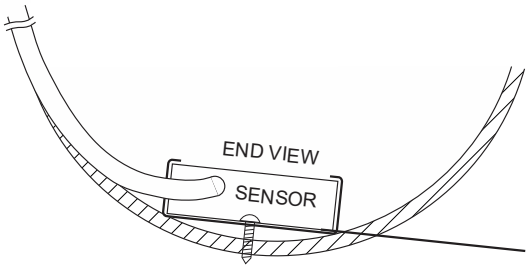

END VIEW
SENSOR

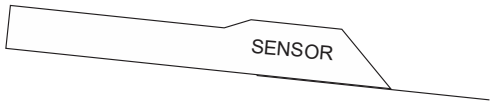

SENSOR

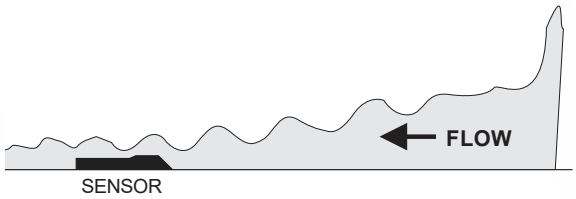

FLOW
SENSOR

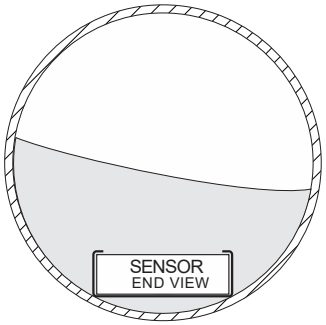

SENSOR
END VIEW

BAD

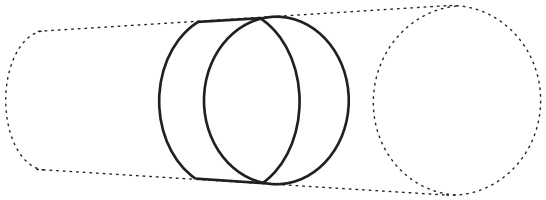

END VIEW
SENSOR


SENSOR


FLOW
SENSOR


SENSOR
END VIEW

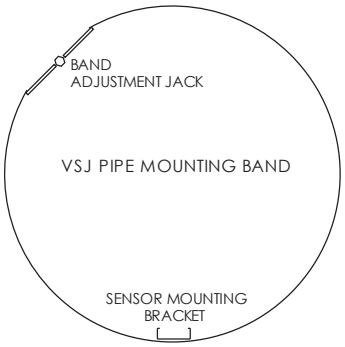
OPTIONAL VSJ PIPE BAND MOUNTING WITH QZ02L SENSOR

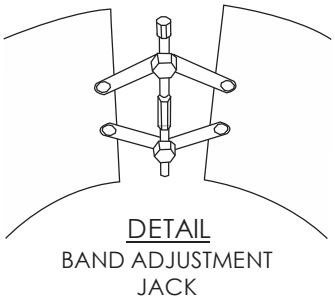


Install the stainless-steel pipe band with the sensor mounting bracket at the invert (bottom) of the pipe. Ensure that the sensor bracket is parallel to the water surface (check with a level). Mount so the tapered end of the sensor will point upstream, and the sensor cable will point downstream. (Turn the ¼" 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.

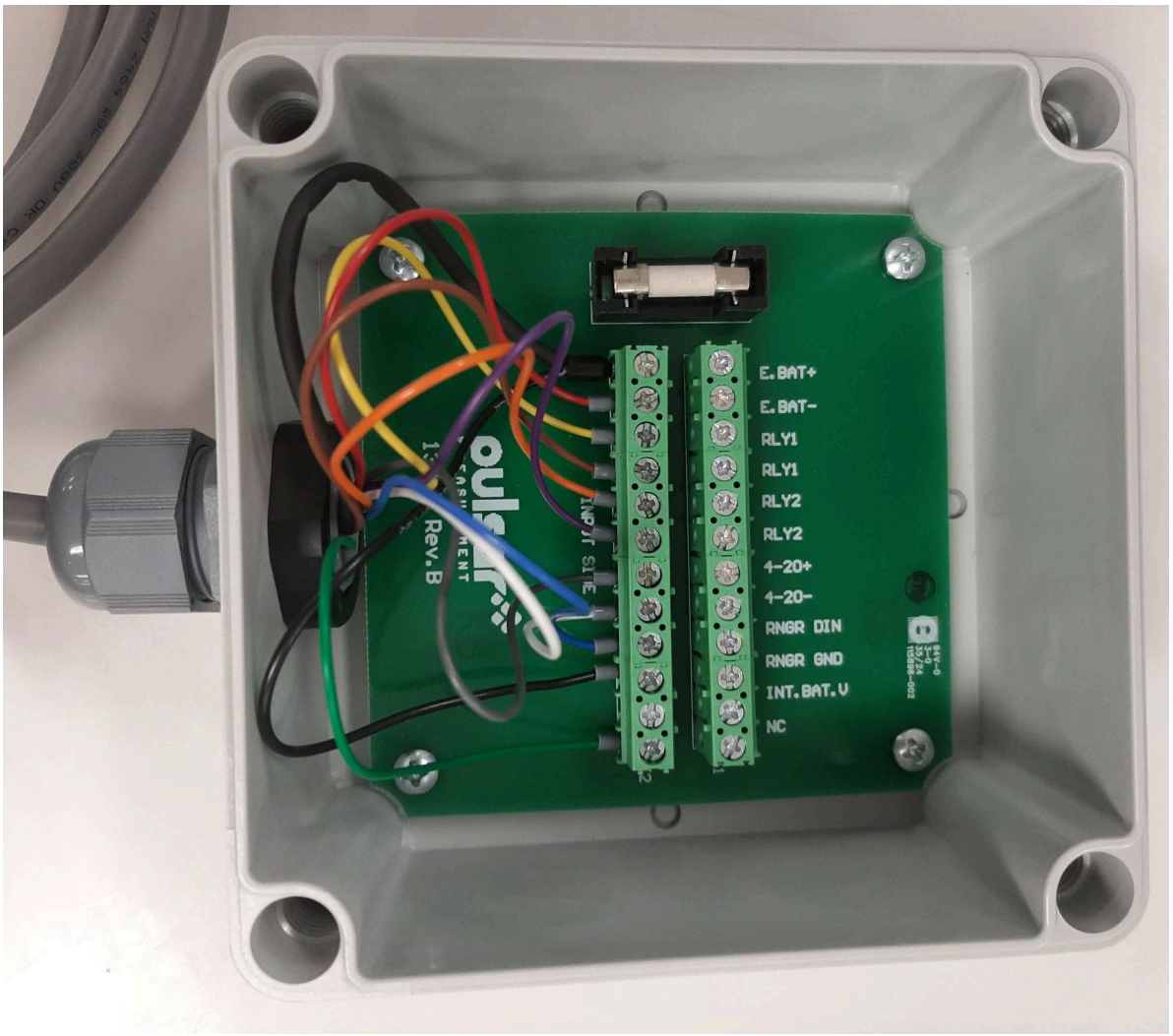
BREAK-OUT BOX

The break-out box provides a location to connect the optional external battery, two relay outputs, a single 4-20mA/0-5V output, and telemetry signal. As shown in the picture below, the left side of the terminals come factory terminated, with connection back through the cable to the MantaRay.

The break-out box cable connects to the side of the MantaRay. The break-out box has five unused M20/M25 size knockouts which can be removed for entry and exit of field wiring.

The break-out box is suitable for use outdoors by being UV resistant, waterproof, and has a IP66/NEMA4X ingress protection rating. To maintain the IP66 rating of the break-out box, be sure to use proper seal-tight connectors and strain relief for field wiring.

The break-out box also includes a replaceable fuse to protect the MantaRay against damage should the external battery circuit suddenly draw too much current. If the MantaRay is not operating as it should with the external battery connected, check the fuse to be sure it is not damaged. Specifications for replacement are: Miniature Fuse, 5x20mm, Time-Lag T, H, 250VAC, UL: 115V-300VDC.



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 analogue 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 analogue output will activate during telemetry logging to send a signal to the external telemetry device.

Wiring Instructions: 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 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:

Break-out Box Terminal Marking	**External Logger/Telemetry Connection**
RNGR DIN	DC voltage trigger positive (9-18VDC)
RNGR GND	DC voltage trigger negative
4-20mA+	4-20mA input (MantaRay 4-20mA is internally powered)
4-20mA-	4-20mA ground

TELEMETRY LOGGING (CONT.)

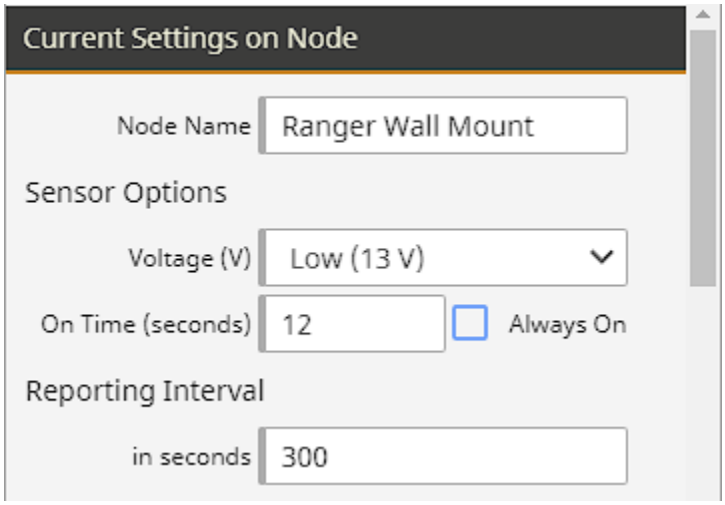
The telemetry logging feature of the MantaRay was validated to be compatible with the RANGER wireless telemetry system from SignalFire. Follow these wiring and configuration instructions for proper operation.

Wiring:

Break-out Box Terminal Marking	**SignalFire RANGER Terminal**
RNGR DIN	A_PWR
RNGR GND	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 options are available via the "Configure Node" button for the Ranger device in the SignalFire Cloud. See picture below for reference:



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

PRODUCT RETURN PROCEDURE

Instruments may be returned to Pulsar Measurement for service or warranty repair. DO NOT disassemble the unit under any circumstances, doing so will void the warranty.

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 Measurement 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 unauthorised 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

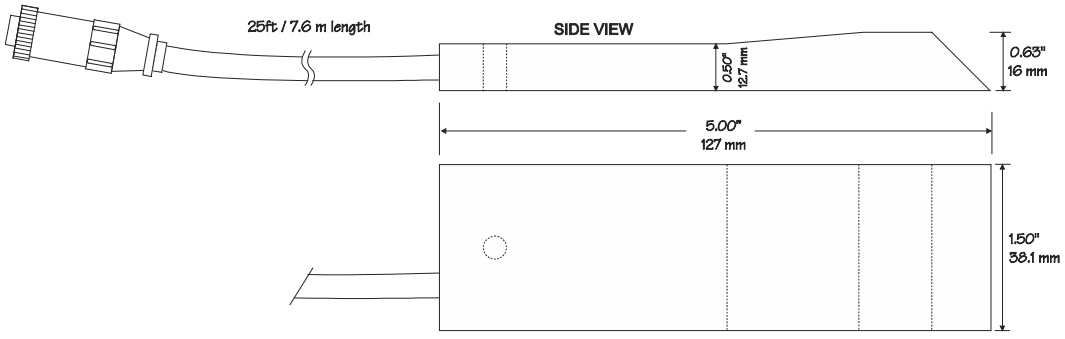
SPECIFICATIONS

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:	15V (>2.5A) (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 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:	Pulsar 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



www.pulsarmeasurement.com
service@pulsarmeasurement.com