Installation & Operation Manual

RAVEN-EYE 2®

Open Channel Non-Contact RADAR Flow Meter

V1.4, December 2019

FLOW-TRONIC nv

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1 Specifications

Specifications are subject to change without notice

Materials & Dimensions	
Dimensions (W x L x D)	140 x 422 x 183 mm, without cable and mounting hardware
Weight	3,65 kg, without cable and mounting hardware
Enclosure	Polyurethane (PU)
Protection	IP68 waterproof rating
Interconnecting cable (disconnect at both sensor and logger ends)	Polyurethane, 8 mm diameter
	IP68 < 1bar
	Standard length: 10 m ; maximum length: 300 m
Environmental Conditions	
Operating temperature	-30°C (-4°F) to +70°C (+122°F)
Storage temperature	-30°C (-22°F) to +80°C (+140°F)
Velocity Measurement	
Method	Radar
Type	Pulsed Wave Doppler
Range	±0,08 m/s to ±15 m/s (bi-directional)
Frequency	24.075 to 24.175 GHz, <100 mW (EIRP) max.
Accuracy	±0.5% ±0.02 m/s (based on sensed surface velocity)
Beam angle	10°
Installation angle	35°
Power Requirements	
Power supply	Supplied by RTQ-Logger Series, IFQ MONITOR, IFQ LOGGER or any 4.8 to 24 VDC power supply
Power consumption	0,42 W (12V - Average 5min)
Level Measurement	
Level measurement	Separate standard range ultrasonic level sensor (range: 1,75 m | 5.74 ft) attached to the sensor using a mounting hardware Accuracy: 0,3% FS Temperature error: max. 0,04%/K
	Separate long range ultrasonic level sensor (range: 5,75 m | 18.86 ft) attached to the sensor using a mounting hardware Accuracy: 0,2% FS Temperature error: max. 0,04%/K
	Separate radar level sensor (range: 8 m | 26.25 ft) attached separately using a mounting hardware Accuracy: ±5 mm (±0.2 in)
	External 4-20 mA loop powered level sensor with correct electrical parameters to be connected to the IFQ MONITOR or IFQ LOGGER

Communication & Outputs	
Communication	RS-485 with proprietary protocol for use with RTQ-Logger Series, IFQ MONITOR or IFQ LOGGER
	RS-485 with serial MODBUS ASCII slave open protocol for use with PLCs
Output	1 passive analog 4-20 mA (configurable for validated surface velocity (vQP) or validated surface velocity including median filters (vQPMF)) (optional)
Certifications & Approvals	
Certification	The RAVEN-EYE® transmitter is certified to the following requirements: - Frequency: 24,125 GHz - Doppler pulse CE Directives EMC, R&TTE Use of this device is subject to the following conditions: **1** There are no used serviceable items inside this device. **2** The user must install this device in accordance with the supplied installation instructions and must not modify the device in any manner whatsoever. **3** Any service involving the transmitter must only be performed by FLOW-TRONIC S.A. or authorized trained personal. **4** The user must ensure that no one is within 20 cm of the face of the radar transmitter when operating.
Approvals	R&TTE Directive 1999/5/EC EN 300 440-1 V1.6.1 EMC / ERM 1-40 Ghz Radios : Part 1 EN 300 440-2 V1.4.1 EMC / ERM 1-40 Ghz Radios : Part 2
Flow measurement	
Method	Based on continuity equation Q = V*A
Accuracy	± 5% of reading typical where flow is in a channel with uniform flow conditions and is not surcharged, ±1% full scale max.

2 General Information

2.1 Safety information

Please read this entire manual before unpacking, setting up, or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure that the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that specified in this manual.

2.1.1 Safety Symbols And Warnings

Throughout this manual are safety warning and caution information boxes. Each warning and caution box will be identified by a large symbol indicating the type of information contained in the box. The symbols are explained below:

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

Important Note: *Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.*

Note: *Information that supplements points in the main text.*

2.1.2 Precautionary labels

	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. If on the instrument, refer to the instruction manual for operation or safety information.
	Electrical equipment marked with this symbol may not be disposed of in European public disposal systems after 12 August of 2005. In conformity with European local and national regulations (EU Directive 2002/96/EC), European electrical equipment users must now return old or end-of life equipment to the Producer for disposal at no charge to the user. ***Note:*** *For return for recycling, please contact the equipment producer or supplier for instructions on how to return end-of-life equipment, producer-supplied electrical accessories, and all auxiliary items for proper disposal.*
	This symbol, when noted on a product enclosure or barrier, indicates that a risk of electrical shock and/or electrocution exists.
	This symbol, when noted on the product, identifies the location of the connection for Protective Earth (ground).
	This symbol, when noted on the product, identifies the location of a fuse or current limiting device.
	This symbol, when noted on the product, indicated the presence of devices sensitive to Electro-static Discharge (ESD) and indicated that care must be taken to prevent damage with the equipment.

2.1.3 Confined space precautions

DANGER
Confined space entry. Training in pre-entry testing, ventilation, entry procedures, evacuation/rescue procedures and safety work practices is necessary before entering confined spaces.

Important Note: The following information is provided to guide users of RAVEN-EYE® Sensors on the dangers and risks associated with entry into confined spaces.

Definition of a confined space:

A confined space is any location or enclosure that presents or has the immediate potential to present one or more of the following conditions:

- An atmosphere with less than 19.5% or greater than 23.5% oxygen and/or more than 10 ppm Hydrogen Sulfide (H_2S).
- An atmosphere that may be flammable or explosive due to gases, vapors, mists, dusts or fibers.
- Toxic materials which upon contact or inhalation, could result in injury, impairment of health or death.

Confined spaces are not designed for human occupancy. They have restricted entry and contain known or potential hazards. Examples of confined spaces include manholes, stacks, pipes, vats, switch vaults, and other similar locations.

Standard safety procedures must always be followed prior to entry into confined spaces and/or locations where hazardous gases, vapors, mists, dusts or fibers may be present. Before entering any confined space check with your employer for procedures related to confined space entry.

DANGER
Explosion hazard. Make sure your application is NOT an ATEX rated and does NOT require ATEX certified equipment

2.1.4 R&TTE regulations

Use of this device is subject to the following conditions:

- There are no used serviceable items in this device.
- The user must install this device in accordance with the supplied installation instructions and must not modify the device in any manner whatsoever.
- Any service involving the transmitter must only be performed by FLOW-TRONIC S.A. or authorized trained personal.
- The user must ensure that no one is within 20 cm of the face of the radar transmitter when operating.

2.2 Product overview

The RAVEN-EYE® sensor measures the flow velocity in open channels using radar Doppler technology. The sensor is installed centered over the flow to be measured. The unit is designed to withstand submersion during surcharge conditions. Attached level sensors provide the system with the water level and flow is calculated from the measured flow velocity and cross-sectional area (function of channel profile and water level).

Figure 1: System overview

1	RAVEN-EYE® sensor	**4**	Mounting hardware (here: rotative handle)
2	Sensor cable	**5**	Level sensor mounting hardware
3	Level sensor		

2.2.1 Theory of operation

The RAVEN-EYE® sensor is mounted above an open channel of water and measures the surface velocity. The depth from water is measured by an optional associated level sensor. The two measurements are used to calculate the flow rate using the continuity equation. The RAVEN-EYE® converts the surface velocity to average velocity by analyzing surface velocity distribution using a self-learning technology that doesn't require theoretical modules nor site calibration. Then the water level and pipe size is converted to the fluid area. Multiplication of fluid area by average velocity to obtain the flow rate.

Surface velocity measurement

The surface velocity of the water is measured using radar technology. A radar beam is transmitted from the sensor to the water surface at the center of the channel. A portion of the signal is reflected back at a slightly different frequency. The difference in frequency, known as the Doppler frequency, is directly proportional to the speed of the flow. Proprietary Patent Pending velocity measurement algorithms are then used to calculate the average speed of the flow stream.

***Note**: The radar velocity sensor does not operate under surcharge conditions.*

Level measurement

The water level is measured using an ultrasonic pulse echo sensor. Two models are available, a standard range 1,75 m and a long range 5,75 m sensor. The sensors can be attached to the RAVEN-EYE® sensor body using specific mounting hardware. For both sensors a sound pulse is sent to the water surface and a portion of the signal is returned to the sensor. The transit time to the surface and back is used to calculate the distance from the water surface to the sensor. The pipe diameter and sensor offset are used to convert the distance to water depth.

External 4-20 mA level sensors from other manufacturers can be used to be connected to the IFQ MONITOR or any other PLC or logger.

Flow calculations

The velocity and depth measurements are used with the channel shape and its dimensions to determine the flow rate. The flow rate is calculated from the continuity equation (1):

(1) Flow rate = Average velocity × Area

where

Flow rate	=	volume of liquid that passes the sensor per unit time (e.g. 300 litres per second)
Average velocity	=	average velocity of the liquid, calculated using surface velocity measurements and patent pending measurements algorithms
Area	=	cross-sectional area of the liquid in the channel, calculated using the channel dimensions and depth measurement.

3 Installation

3.1 Unpack the instrument

Before opening the shiping boxes, check them for any visible outside damage, and report the damages immediately.

Carefully unpack the RAVEN-EYE® and its accessories from the shipping carton and inspect for any visible damage. If an item is missing or damaged, please contact the manufacturer or local agent (refer to section 7 on page- 40 -)

List of standard delivered items:

1. RAVEN-EYE® sensor
2. Cable at specified length
3. Installation & operation manual on a USB stick
4. RTQ-Log software on a USB
5. USB communication cable (optional)
6. Standard range or long range level sensor (optional)
7. Permanent or one-time entry sensor mounting hardware (optional)
8. Mounting hardware for ultrasonic standard range or long range sensor (optional)

3.2 Mechanical installation

3.2.1 Site location guidelines

For best accuracy, install the sensor where the flow is not turbulent. An ideal location is in a long, straight channel or pipe. Outfalls, vertical drops, baffles, curves or junctions cause the velocity profile to become distorted.

Where there are outfalls, vertical drops, baffles, curves or junctions, install the sensor upstream or downstream as shown in Figure 2 and Figure 3. For upstream locations, install the sensor at a distance that is at least five times the pipe diameter or maximum fluid level. For downstream locations, install the sensor at a distance that is at least ten times the pipe diameter or maximum fluid level.

If the location contains a junction and the flow in one pipe is much higher, install the sensor on the wall near the lower flow pipe.

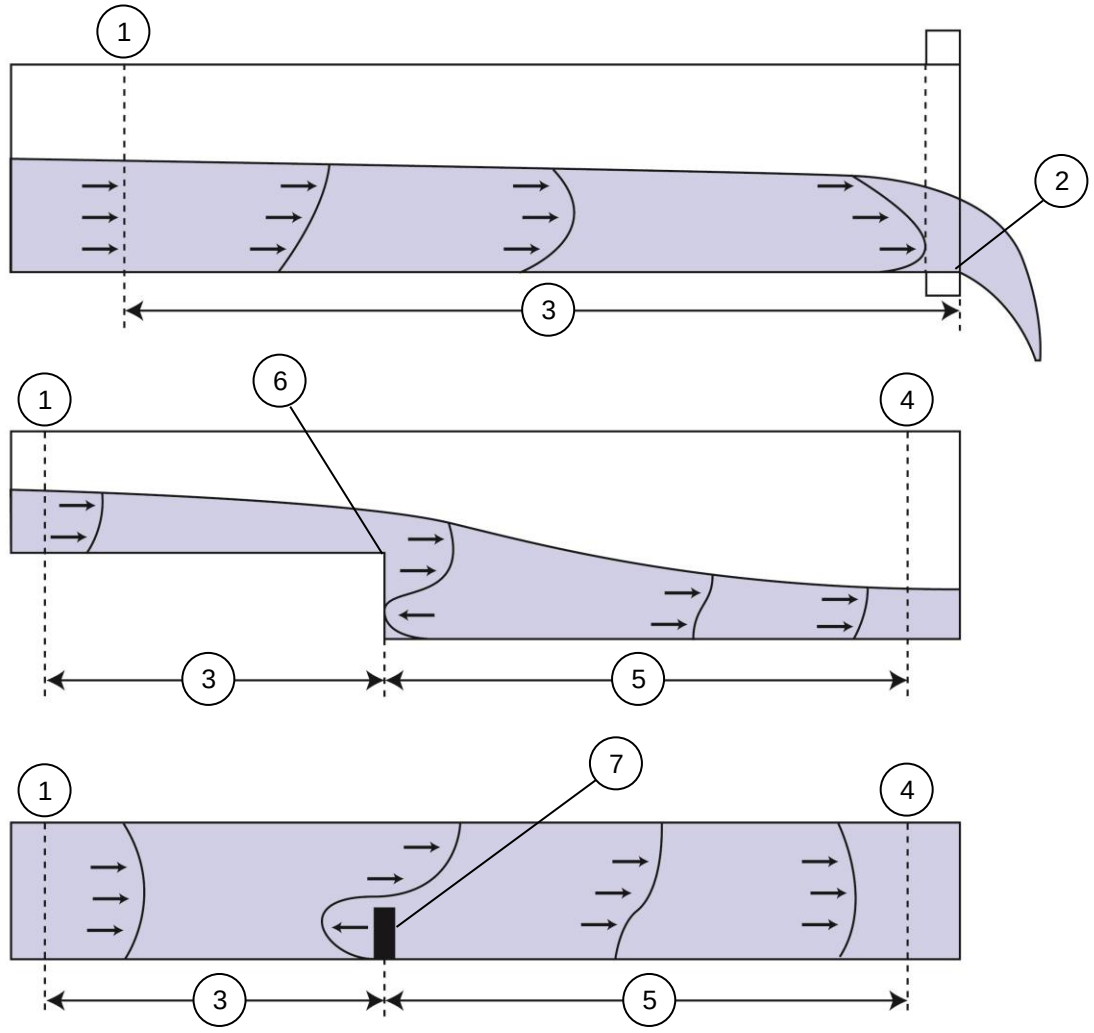


Figure 2: Sensor location near an outfall, vertical drop or baffle

1	Acceptable upstream sensor location	**5**	Distance downstream: 10 x pipe diameter
2	Outfall	**6**	Vertical drop
3	Distance upstream: 5 x maximum level	**7**	Baffle
4	Acceptable downstream sensor location		

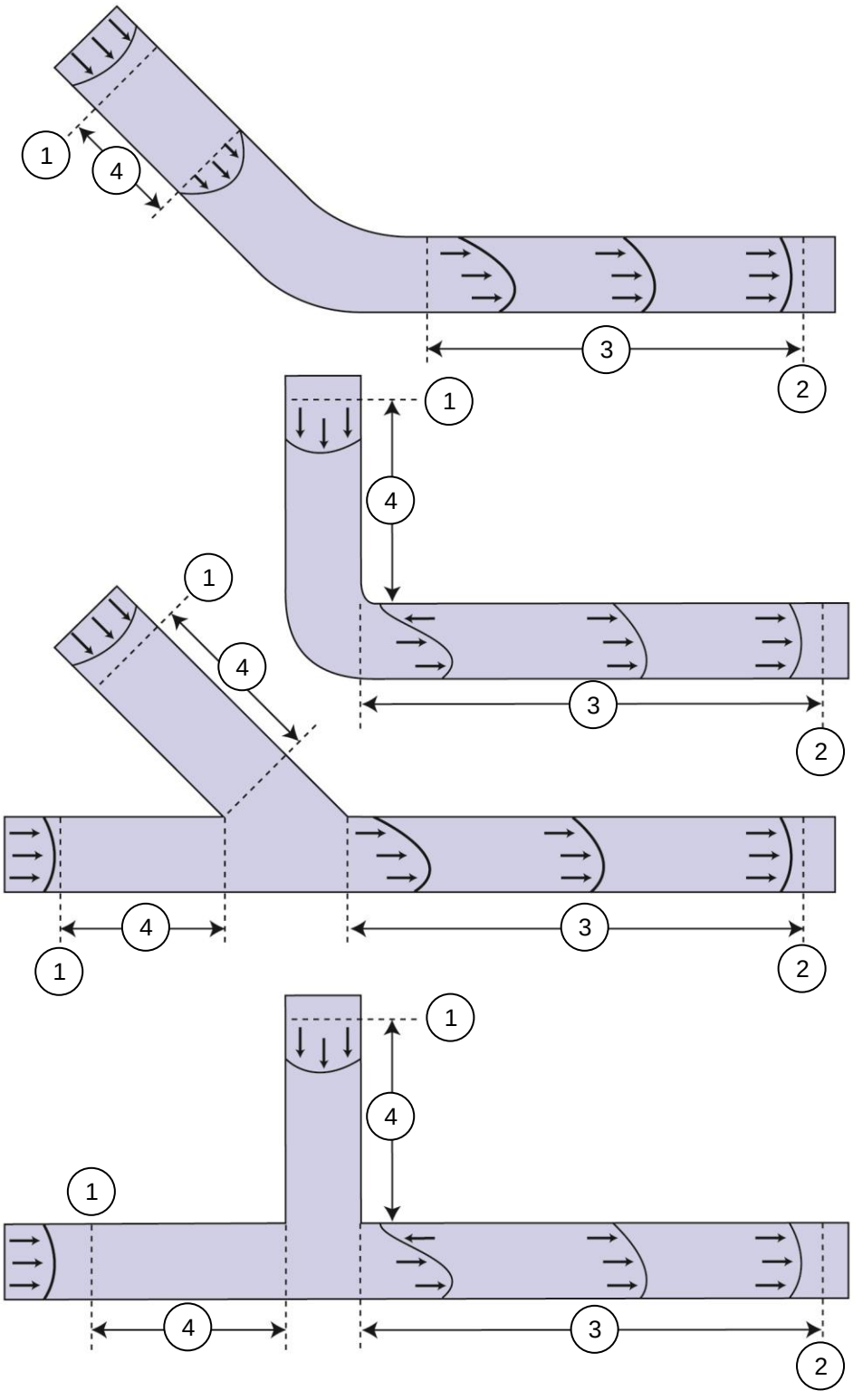


Figure 3: Sensor location near a curve, elbow or junction

1	Acceptable upstream sensor location	**3**	Distance downstream: 10 x pipe diameter
2	Acceptable downstream sensor location	**4**	Distance upstream: 5 x pipe diameter

3.2.2 Mounting hardware

The RAVEN-EYE sensor can be ordered with variuous types of mounting brackets assemblies.

Figure 4: RAV-2004

Figure 5: RAV-2005

Figure 6: Mounting spacers for RAV-2004

Figure 7: Mounting bracket for ULS-02 & ULS-06

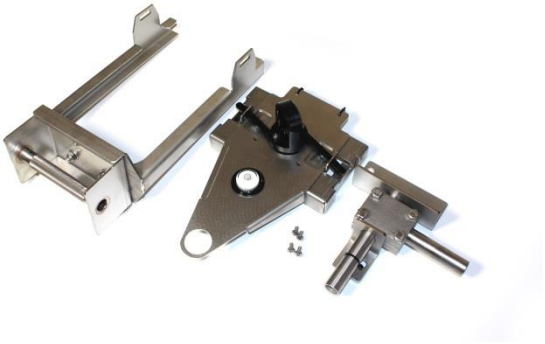


Figure 8: One-time entry sensor mount (RAV-2112)

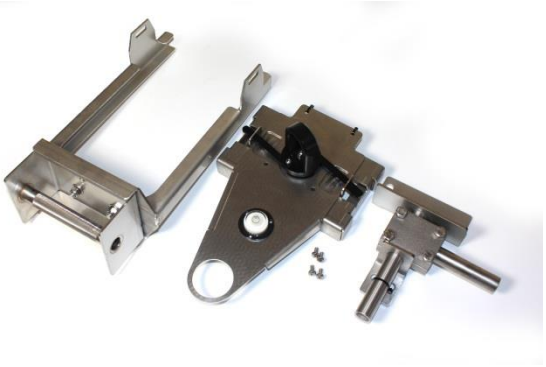


Figure 9: One-time entry sensor mount (RAV-2116)

3.2.3 Installation examples

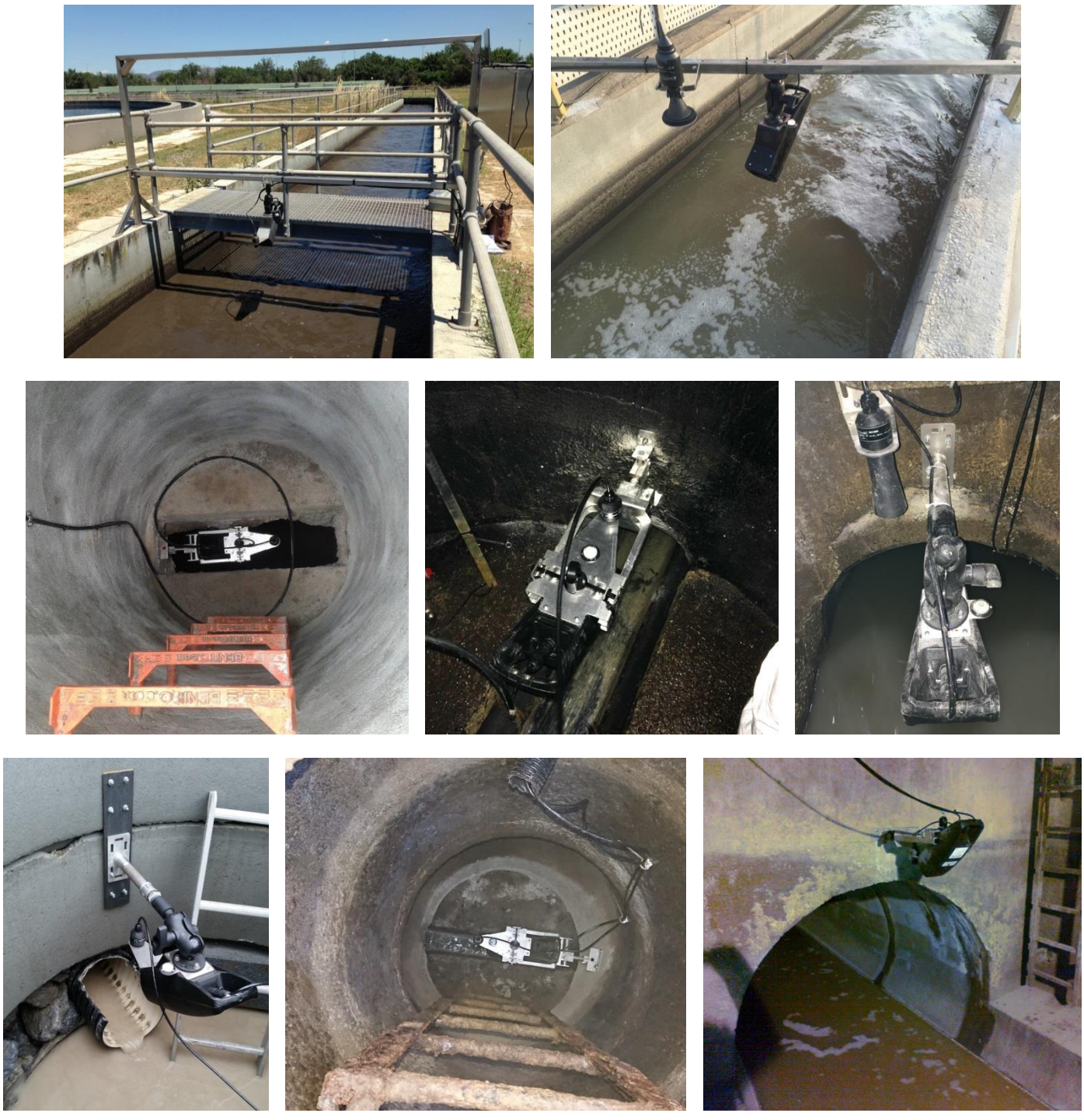


Figure 10: Installation examples

3.2.4 Sensor installation

CAUTION
Potential hearing loss risk. Hearing protection required. The level transducer emits ultrasonic sound energy when powered. Ear protection must be worn when working within 1 meter of this device. Do not point the transducer output towards ears during installation, calibration and maintenance.

Mount the RAVEN-EYE® sensor above the open channel on the wall of the manhole.

The RAVEN-EYE® sensor dimensions are shown in Figure 11 and Figure 12.

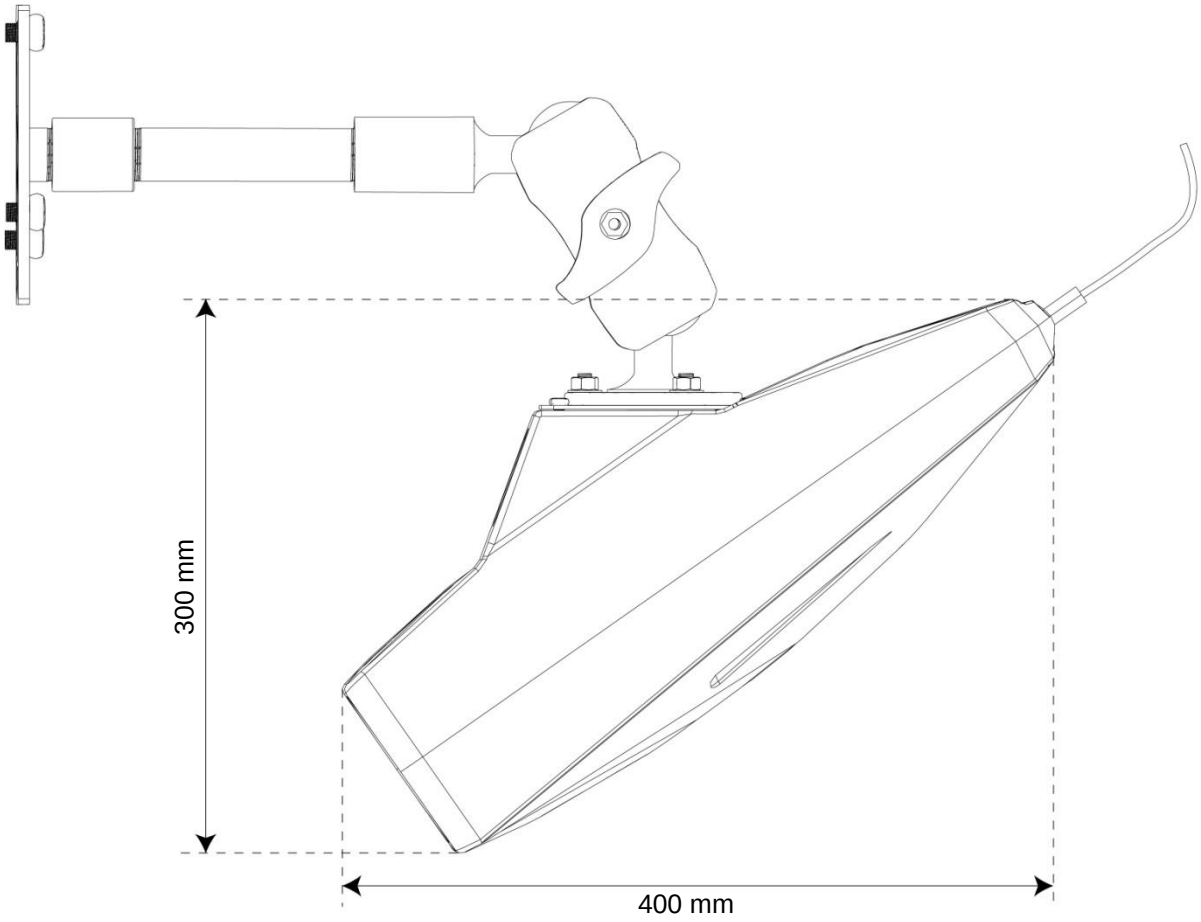


Figure 11: RAVEN-EYE® sensor dimensions side view as installed

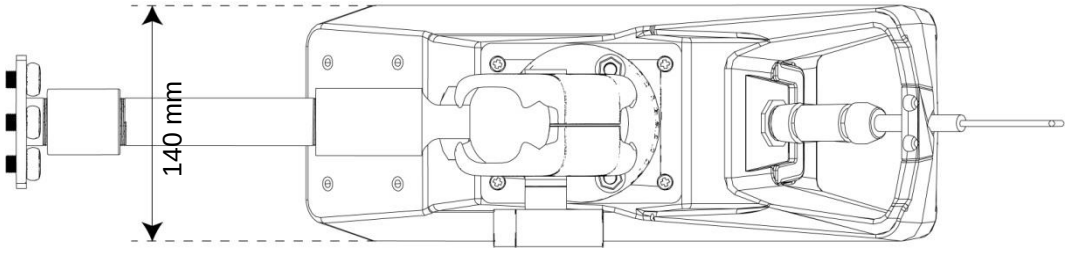


Figure 12: RAVEN-EYE® sensor dimensions top view as installed

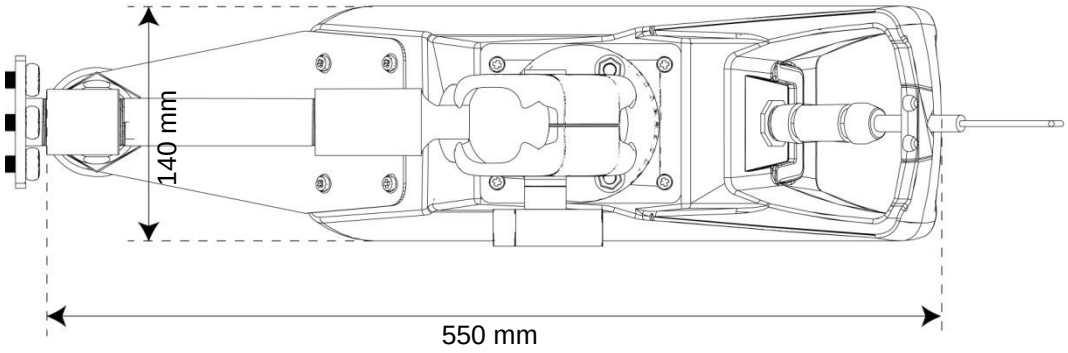


Figure 13: RAVEN-EYE® sensor dimensions top view with level sensor as installed

3.2.4.1 Install the mounting hardware on the wall

Sensor location guidelines

Review the following guidelines to find the best location for the sensor.

- Examine the upstream and downstream flow characteristics. Use a mirror if necessary. Install the sensor above the water where the flow is steady. Do not install the sensor where there are standing waves, pools or objects or materials that can disrupt the flow profile.
- If the upstream flow characteristics are acceptable, install the sensor on the upstream wall of the manhole with the sensor pointing upstream. This location will make sure that the measured flow is the same as the flow in the pipe and that the sensor cable points away from the wall.
- Install the sensor away from the sides of the pipe and in the very center of the flow where the fluid is at the maximum depth.
- Install the sensor in a location that is accessible for maintenance.

Prerequisites

- Permanent or one-time entry mounting hardware
- Material needed: Fixings, washers and screws from the correct size
- Tools needed: mirror, ruler or tape measure, marker, battery operated power drill, wrench.

Procedure

Complete the steps to install the mounting hardware on the wall of the manhole above the flow. Be sure to follow all codes and/or directives that are relevant to the location (refer to section 3.2.1 on page - 10 -).

1. Make a mark on the wall 400 mm above the crown of the pipe. The wall bracket will be installed centered on this mark.
2. Make sure that when the sensor is in position, the radar beam will not be blocked by the wall or channel. Refer to Figure 16 or Figure 18.
3. Position the wall mount bracket centered around this mark.
4. Attach the brackets to the wall using anchors and screws.
5. Connect the rest of the mounting hardware to the wall bracket.

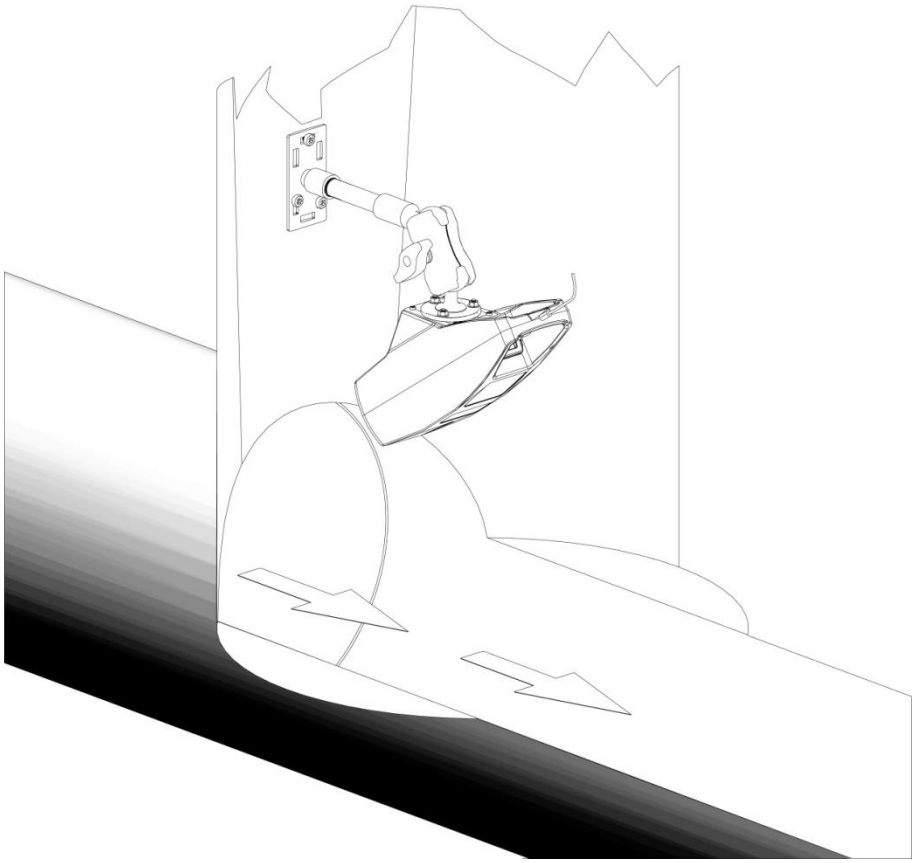


Figure 14: Wall installation

1	Distance from crown of pipe to wall bracket	

3.2.4.2 Attach the sensor to the mounting hardware

The sensor is equipped with 4 threads (M5) to be attached to the mounting hardware. Attach the rotative handle or the ball mount to the sensor. The sensor can be removed from the frame and installed without entering the manhole when installed with the one-time entry mounting hardware.

Procedure

1. Make sure that the cable is tightly connected to the sensor.
2. Locate the 4 threads on the sensor forseen to attach the ball mount or the rotative handle.
3. Attach the ball mount or the rotative handle to the sensor using a screwdriver and the 4 M5 screws delivered with the hardware.
4. Loosen the wing nut from the ball mount of the mounting hardware.
5. Insert the ball mount from the sensor and thighten the wing nut so that the sensor stays attached to the mounting hardware.

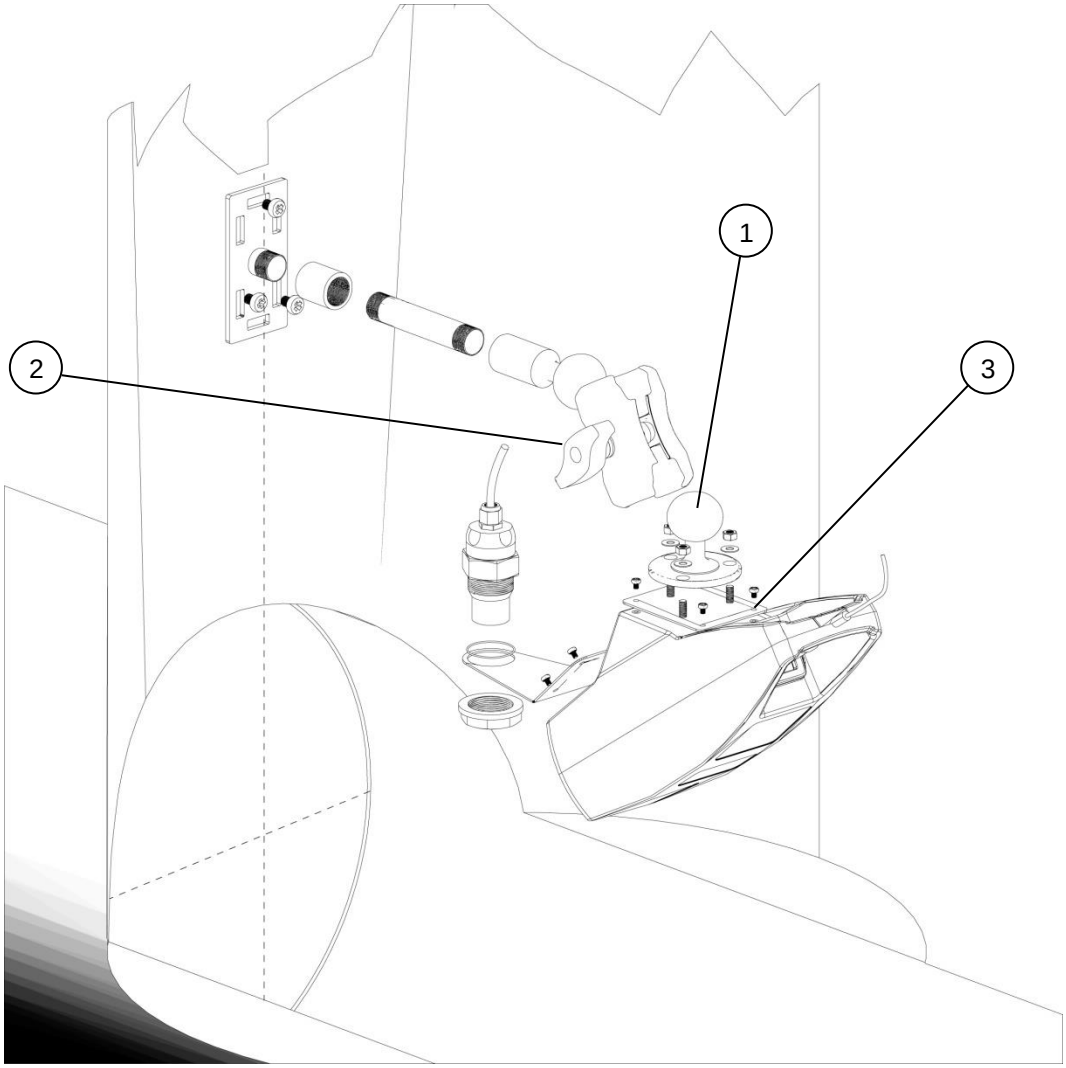


Figure 15: Assembling the mounting hardware

1	Ball mount	**3**	Threads for mounting hardware attachment
2	Wing nut		

3.2.4.3 Align the sensor vertically – RAVEN-EYE® without attached level sensor

The sensor must be aligned vertically to make sure that the sensor is above the flow and that the radar beam will not be blocked by the wall or pipe (Figure 16).

Procedure

1. Make an estimate of where a line that extends from the top of the radar lens perpendicular to where the lens will point (Figure 16).
2. Loosen the wing nut on the ball mount hardware and position the frame so that the radar beam will point below the crown of the pipe by at least 25 mm (Figure 16). It may be necessary to install the 200 mm or the 300 mm (optional) spacer to position the RAVEN-EYE® farther from the wall.
3. Tighten the wing nut and make sure that the radar beam is not blocked by the wall or pipe. If the beam is blocked, move the frame further away from the wall using the 200 mm or the 300 mm (optional) spacer or lower the frame.

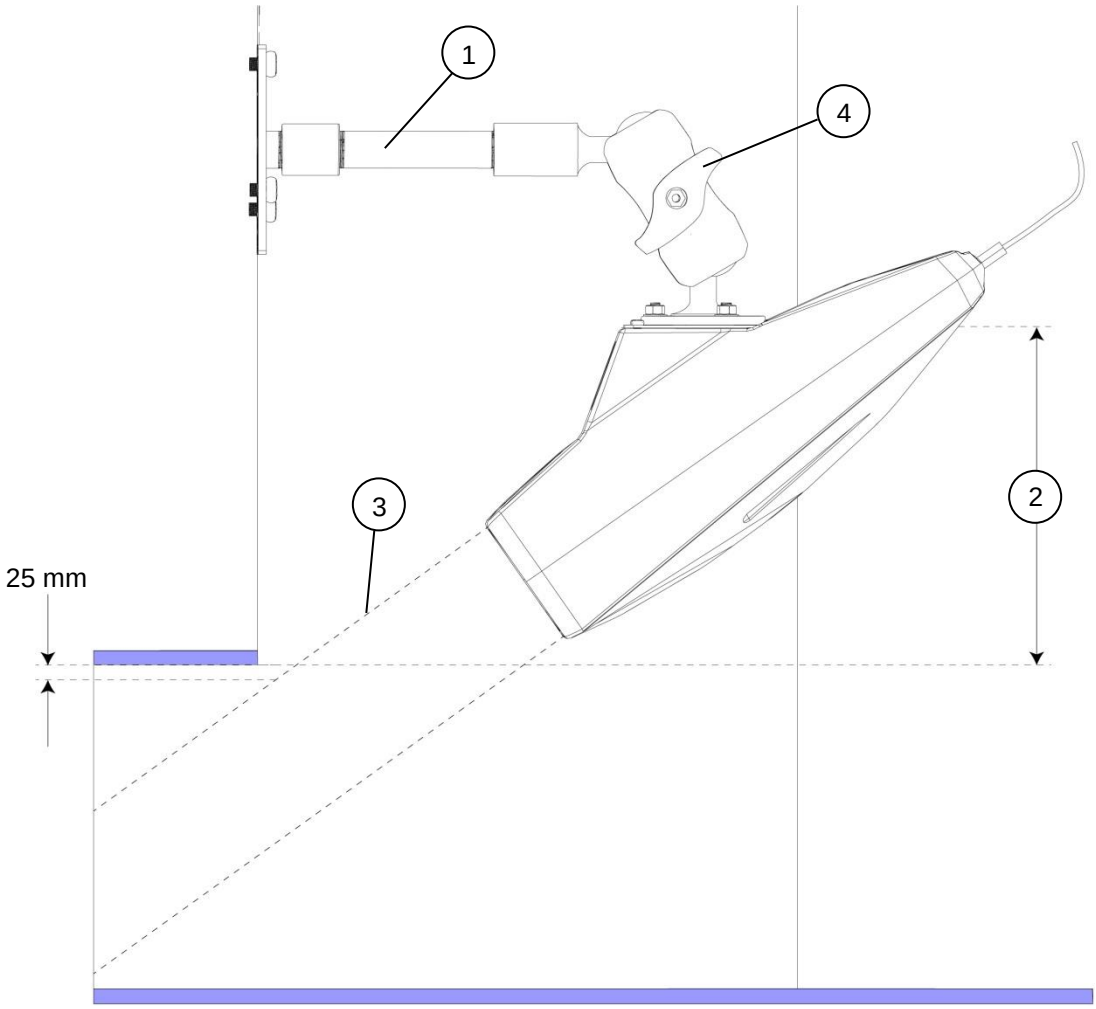


Figure 16: Vertical alignment of the RAVEN-EYE® sensor

1	Spacer	**3**	Line that extends from the top of the radar lens perpendicular to where the lens will point
2	Distance from crown of pipe to ball mount	**4**	Wing nut

3.2.4.4 Attach the level sensor

Procedure

1. Locate the 4 threads to attach the level sensor.
2. Locate the level sensor support and the corresponding screws to attach the hardware.
3. Attach the level sensor support using a screwdriver and the corresponding screws.
4. Attach the level sensor to the level sensor support hardware using the delivered nut.

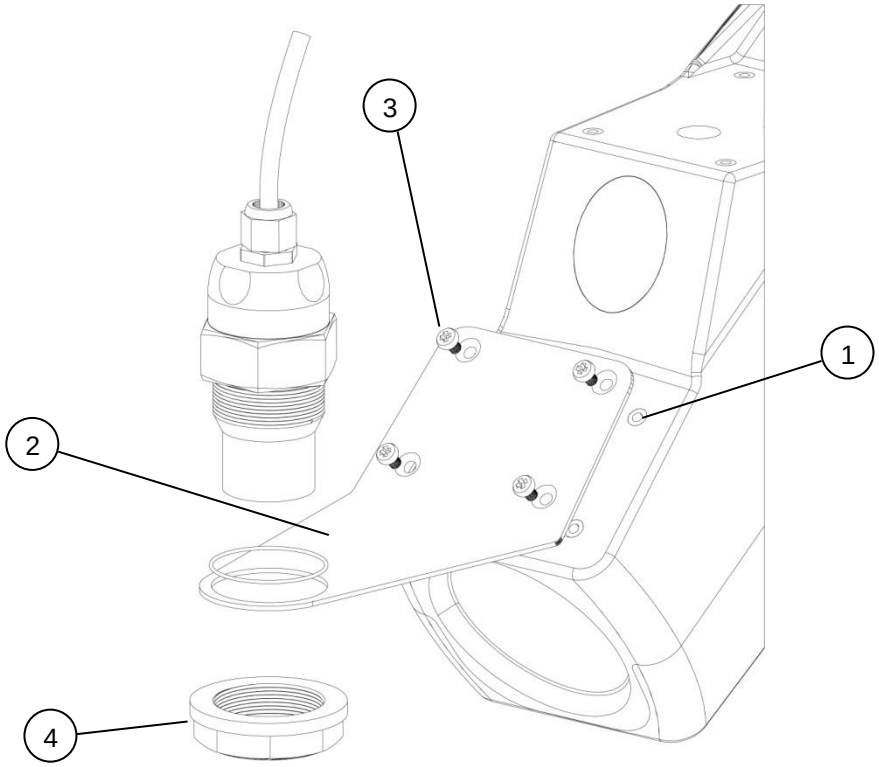


Figure 17: Level sensor attachment

1	Threads for level sensor support attachment	**3**	Screws to attach the level sensor support
2	Level sensor support	**4**	Nut for level sensor attachment

3.2.4.5 Align the sensor vertically – RAVEN-EYE® with attached level sensor

Prerequisites

- Attach the level sensor support to the RAVEN-EYE®.
- Tighten the level sensor to the level sensor support.

The sensor must be aligned vertically to make sure that the sensor is above the flow and that the radar beam will not be blocked by the wall or pipe (Figure 18).

Procedure

1. Make an estimate of where a line that extends from the top of the radar lens perpendicular to where the lens will point (Figure 18).

2. Loosen the wing nut on the ball mount hardware and position the frame so that the radar beam will point below the crown of the pipe by at least 25 mm (Figure 18). It may be necessary to install the 200 mm or the 300 mm (optional) spacer to position the RAVEN-EYE® farther from the wall.

3. Tighten the wing nut and make sure that the radar beam is not blocked by the wall or pipe. If the beam is blocked, move the frame further away from the wall using the 200 mm or the 300 mm (optional) spacer or lower the frame.

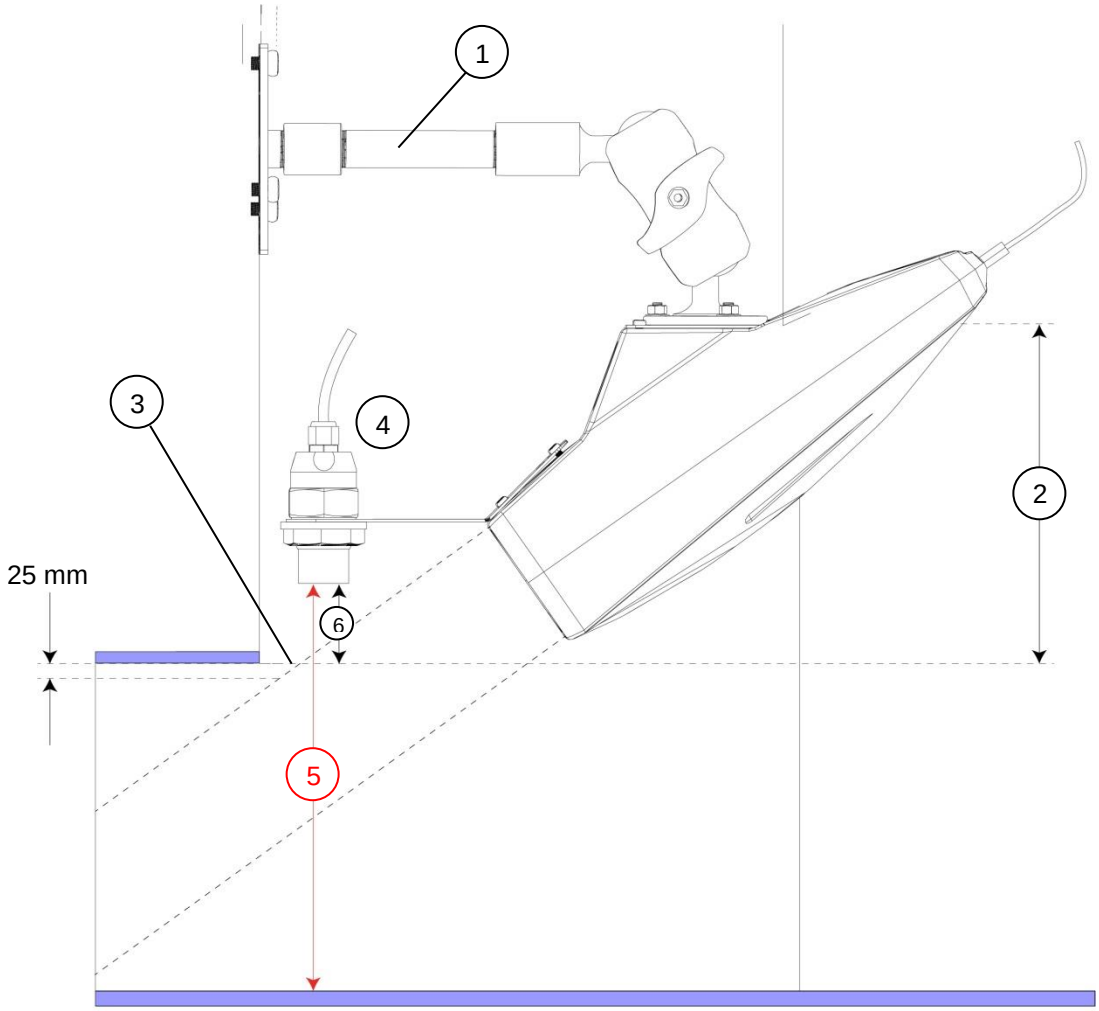


Figure 18: Vertical alignment of the RAVEN-EYE® sensor with attached level sensor

1	Spacer	**4**	Level sensor (ULS-02 or ULS-06)
2	Distance from crown of pipe to ball mount	**5**	Level sensor offset
3	Line that extends from the top of the radar lens perpendicular to where the lens will point	**6**	Distance from crown of pipe to tip of level sensor

3.2.4.6 Align the sensor horizontally

The sensor must be aligned horizontally to make sure that the sensor is centered over the flow. If the pipe is not levelled and has a slope of 2 degrees or more, align the sensor to be parallel with the surface of the water.

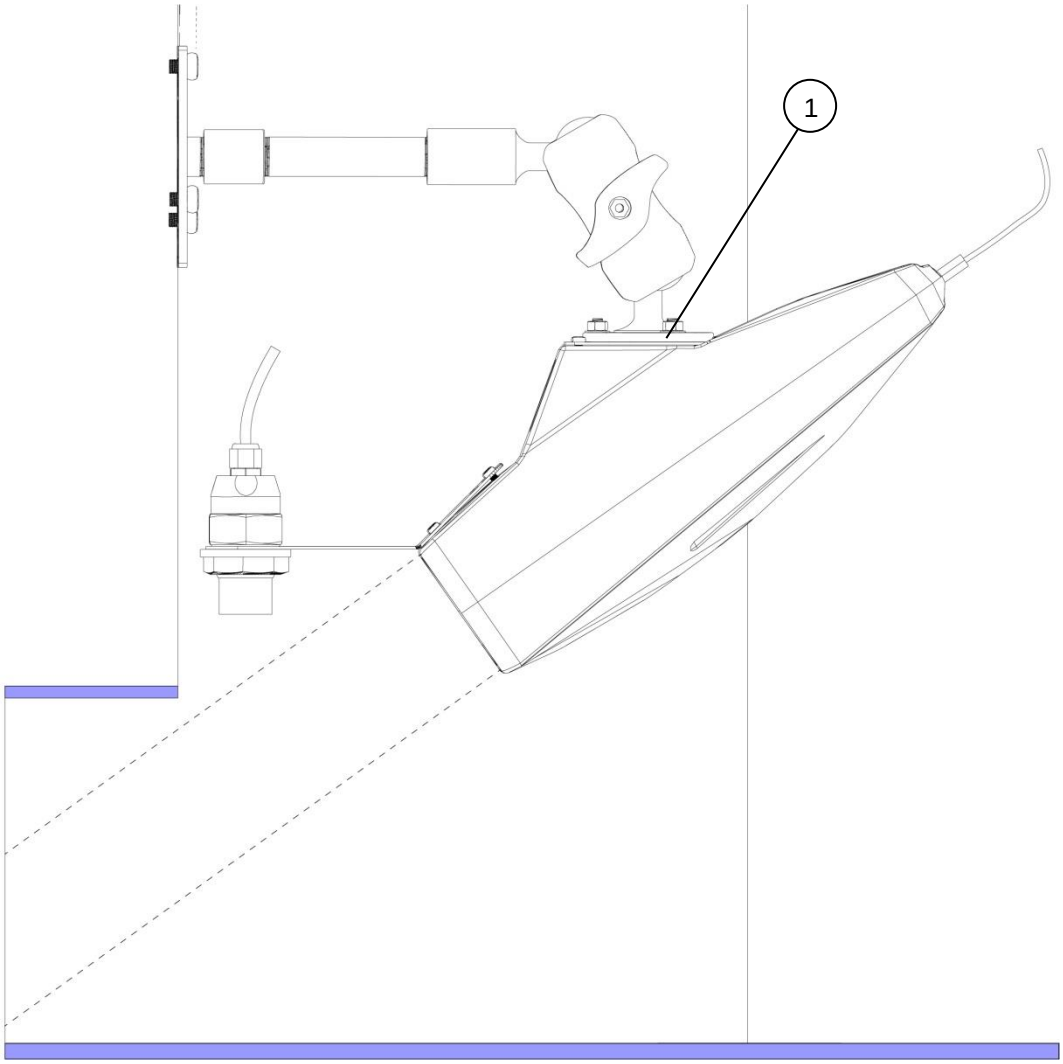


Figure 19: Horizontal alignment of the RAVEN-EYE® sensor

Procedure

1. Use a bubble level and position it on the horizontal platform of the RAVEN-EYE® (see point 1 on Figure 19).
2. Slightly loosen the wing nut and position the sensor so that the platform is positioned horizontally.
3. Tighten the wing nut and make sure the sensor is at the correct position.

3.2.4.7 Make a final alignment check

The correct vertical and horizontal alignment of the sensor is necessary for accurate measurements.

1. Check the vertical alignment (section 3.2.4.3 or section 3.2.4.5) and make adjustments if necessary.
2. Check the horizontal alignment (section 3.2.4.6) and make adjustments if necessary.
3. Repeat steps 1 and 2 until no further adjustments are necessary.

3.2.4.8 Measure the sensor offset

This section applies to ULS-02 and ULS-06 level sensors only. If you are using another type of level sensor, please refer to the instructions of the leveling device used.

The sensor offset is the distance from the tip of the level sensor to the bottom of the pipe or channel. This distance will be entered into the software and is necessary for accurate flow calculations.

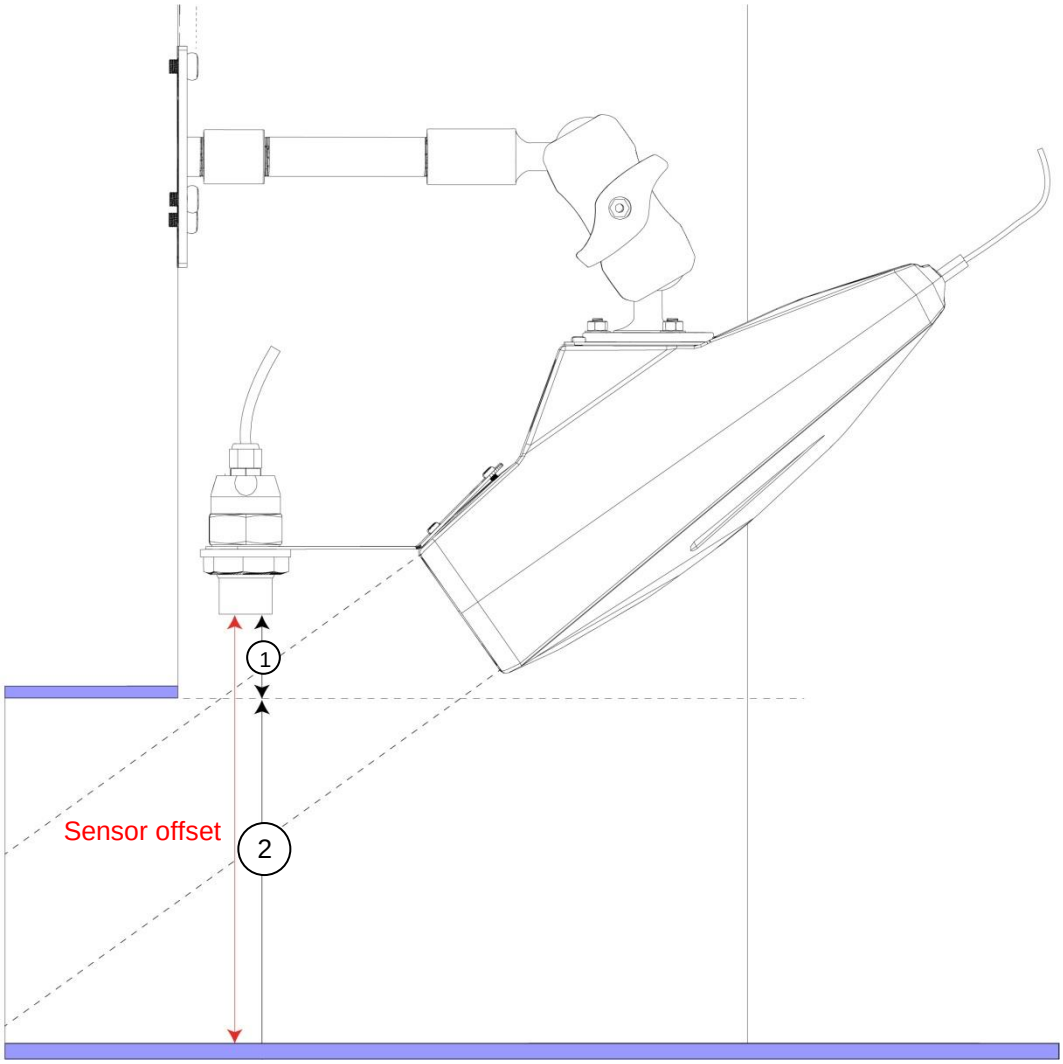


Figure 20: Sensor offset

1	Distance from crown of pipe to tip of level sensor	**2**	Pipe diameter

Prerequisites

- Rod
- Tape measure

Procedure

1. Put the rod in the bottom of the pipe or channel and align it vertically with the level sensor (Figure 20).
2. Make a mark on the rod to identify where the top of the sensor frame is.

3. Measure the distance from the bottom of the rod to the mark. This is the sensor offset.

Note: *If it is not practical to measure to the bottom of the pipe, measure the distance from the crown of the pipe to the top of the frame (Figure 20). Add this distance to the pipe diameter to get the sensor offset (sensor offset = pipe diameter + distance from crown of the pipe to top of frame).*

3.2.4.9 Sensor offset calculation

The following rules apply to the ULS-02 (P/N: RAV-0002) or ULS-06 (P/N: RAV-0006) sensors in case they are used with a PLC or controller.

The following configurations apply to the ULS-02 (standard range) and ULS-06 (long range) level sensors.

How to setup a ULS-02 sensor?

Calculation: "Range min.." 4mA : Sensor offset - 2000
"Range max." 20 mA : Sensor offset – 250

The range of the ULS-02 sensor is 1750 mm

Example: If the ULS-02 is installed at a distance of 1255 mm above the bottom of the channel, the values for the 4 mA and the 20 mA would be as follow:

"Range min." : 1255 - 2000 = -745 mm
"Range max." : 1255 - 250 = 1005 mm

How to setup a ULS-06 sensor?

Calculation: "Range min." 4mA : Sensor offset - 6000
"Range max." 20 mA : Sensor offset - 250

The range of the ULS-06 sensor is 5750 mm

3.2.5 Measure the pipe diameter

The correct diameter of the pipe or channel is necessary for accurate flow calculations.

1. Measure the inside pipe diameter (I.D.) at three locations (Figure 21). Be sure that the measurements are accurate.
2. Calculate the average of the three measurements. Record this number for use during the software setup for the site.

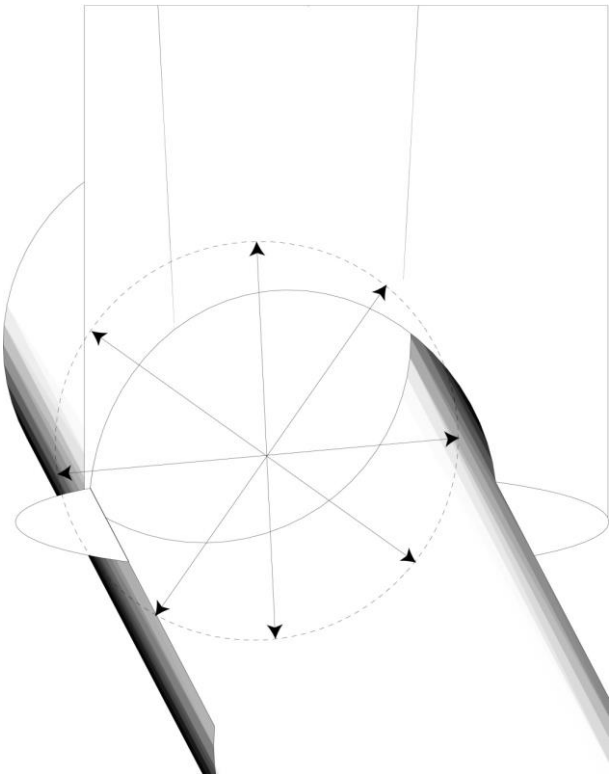


Figure 21: Pipe diameter measurement

3.3 Electrical connections

DANGER
Electrocution hazard. Always disconnect power to the instrument when making any electrical connections.

DANGER
Potential confined space hazards. If conduit is installed from the RAVEN-EYE® to the PLC or controller, the conduit must be sealed to keep sewer gases out of the electronics of the PLC or controller.

When making any wiring connections to the instrument, the following warnings and notes must be adhered to, as well as any warnings and notes found throughout the individual installation sections. For more safety information refer to section 2.1 on page - 5 -.

3.3.1 Electrostatic Discharge (ESD) considerations

Important Note: *To minimize hazards and ESD risks, maintenance procedures not requiring power to the analyzer should be performed with power disconnected.*

Delicate internal electronic components can be damaged by static electricity, resulting in degraded instrument performance or eventual failure.

The manufacturer recommends taking the following steps to prevent ESD damage to your instrument:

- Before touching any instrument electronic components (such as printed circuit cards and the components on them) discharge static electricity from your body. This can be accomplished by touching an earth-grounded metal surface such as the chassis of an instrument or a metal conduit or pipe.
- To reduce static build-up, avoid excessive movement. Transport static-sensitive components in anti-static containers or packaging.
- To discharge static electricity from your body and keep it discharged, wear a wrist strap connected by a wire to earth ground.
- Handle all static-sensitive components in a static-safe area. If possible, use anti-static floor and work bench pads.

3.3.2 Attach cable

WARNING
Always disconnect battery or power supply before making any connections.

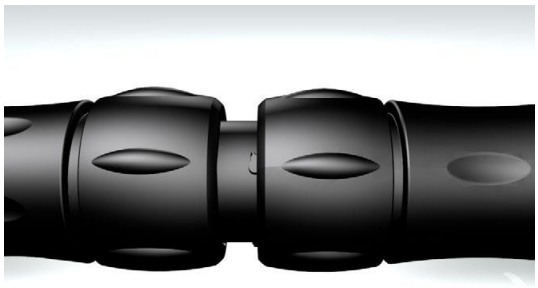
Procedure

1. Make sure there is no water inside any part of both connectors. If water is trapped inside the connectors, pins may corrode and cause damage to the instrument.
2. Attach the connector from the RAVEN-EYE®. If the sensor cable has connectors on both ends, attach the cable to the sensor first.

a. Identify the primary key of each connector

b. Align the primary keys of the connectors

c. Incorrect positioning



d. Offer the plug to the receptacle

3.3.3 Connector protection with dielectric silicon grease

It is recommended to apply dielectric silicone grease inside the connector. The use of silicon grease between the receptacle and the connector will improve the protection against humidity in hard conditions (high H2S concentration for example) and prevent any corrosion.

3.3.3.1 Product used

Silicone Grease:

- This is a water repellent, non-melting silicone grease lubricant
- Working temperature range is between -50°C to 200°C
- Non-toxic and Safe on most plastics
- High dielectric strength to prevent a short-cut between 2 PINs.

3.3.3.2 Application

Figure 22: Connector without grease

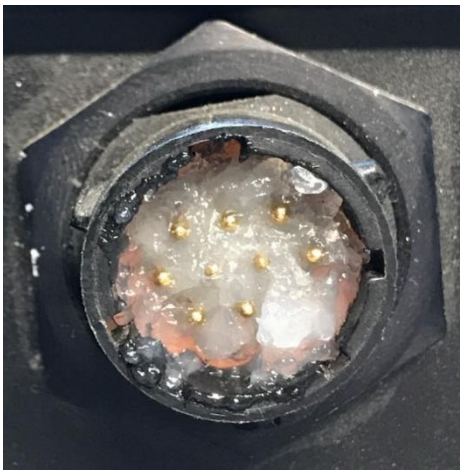


Figure 23: Connector with grease

Procedure

1. Ensure that both (the receptacle and the connector) are clean and dry.
2. Put the dielectric silicon grease directly inside the receptacle. Ensure that all PINs are covered by the grease.
3. Put both sides together (without using force).
4. Follow this procedure each time the connector is disconnected from the receptacle.

Note: *An external layer of the silicone grease on the connector can improve the protection even further.*

3.3.4 Wiring

Connect the cable from the RAVEN-EYE® sensor to the PLC or controller. The following connections are used for the RAVEN-EYE® sensor:

Colour	Properties	Description
White	A+	RS485
Black	B-	RS485
Orange	+26 VDC	4-20 mA
Violet	mA Output (-)	4-20 mA
Red	+4.1 to 26 VDC	Power supply
Green	Negative wire	Power supply
Green/Yellow	Shield	Shield

Table 1: RAVEN-EYE® connections

4 Operation

The RAVEN-EYE® sensor is meant to be operated with different logger and monitor types.

Use the RAVEN-EYE® sensor in combination with the IFQ MONITOR or IFQ MINI (S1) monitors for stationary applications and with the UNI-TRANS for stationary or hybrid applications. The RAVEN-EYE® connects directly to the monitors and the basic configuration can be made using the programming keys on the device. The whole system can additionally be configured with the RTQ-Log configuration software (for IFQ MONITOR and IFQ MINI).

Use the RAVEN-EYE® sensor in combination with one of the following loggers RTQ-500, RTQ-1000, RTQ-2000, IFQ LOGGER or IFQ MINI (S0) for portable applications or applications where no power source is present on site (battery or solar panel applications). The RAVEN-EYE® connects directly to the portable logger and the configuration of the sensor and the measuring site is made with the RTQ-Log configuration software.

The RAVEN-EYE® has also been developed for direct connection to any PLC or RTU, controller or logger equipped with a RS-485 communication port supporting the Modbus ASCII protocol. This solution is ideal for integrators and enables to read different registers in the RAVEN-EYE® such as average velocity, flow, level, quality parameters, etc. The measuring site and the RAVEN-EYE® are configured connecting the sensor to a computer using the USB configuration cable (optional) and the RTQ-Log software.

Converters are available for use with Modbus RTU, please contact our service department for more information. Contact information is available in section 7.3 on page - 40 -.

4.1 Connect the velocity sensor to the computer

***Condition**: Applicable for IFQ MONITOR **without** USB communication port or PLCs.*

Use the RAV-4001 communication cable to connect sensors equipped with open end cables to a computer. The adaptor from the RAV-4001 disposes of 4 quick connect terminals.

5. Connect the black and white cables from the sensor to the terminal of the RAV-4001.
6. Connect the red and green cables from the sensor to the terminal of the RAV-4001.
7. Connect the USB connector from the RAV-4001 to the computer and launch RTQ-Log.

***Note:** When connected via USB communication cable (RAV-4001), the sensor does not need to be connected to a separate power supply as the power coming from the computer is sufficient.*

Figure 24: RAV-4001 USB communication cable for open end cables

4.2 Connect the velocity sensor to an IFQ MONITOR or IFQ LOGGER

Pre-requisites: *Make sure RTQ-Log software (version 3.5 or above) is properly installed on the computer. Connect only one logger or sensor to the computer.*

Procedure

1. Apply power to the IFQ MONITOR or IFQ LOGGER (refer monitor or logger manual)
2. Connect the sensors to the IFQ MONITOR or IFQ LOGGER (refer to monitor or logger manual)
3. Connect the delivered USB cable to the monitor.

Figure 25: USB cable for IFQ MONITOR or IFQ LOGGER

4. Connect the other end of the USB cable to the computer.

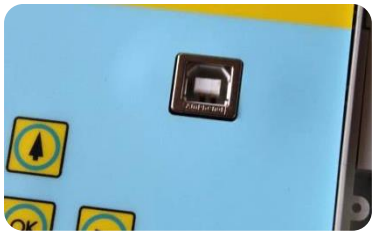


Figure 26: USB port on IFQ MONITOR

5. When a unit is attached for the first time, the driver is installing automatically. This can take several minutes as the driver installer will check the web for latest version.

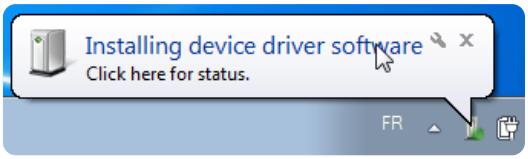


Figure 27: Device driver software installer dialog box

The “Device driver software installer” dialog box appears when you connect your device with the USB cable to your computer for the first time.

The message “Your device is ready to use” appears once the instrument is ready for connection.

IMPORTANT NOTE
Do not unplug your device while driver is installing.
Do not connect more than one device to the same computer.

4.3 Start communication with a device

Pre-requisites: *Make sure RTQ-Log software (version 3.5 or above) is properly installed on the computer.*
Make sure the unit is properly connected to the computer.

Procedure

1. Open RTQ-Log software (version 3.5 or above)
2. Click „Refresh List".
3. Select the COM Port used by the device. Usually it's the newest port showing up in the list.
4. Click „Connect" to start the connection.

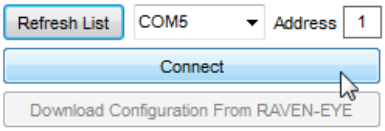


Figure 28: Connecting the logger

5. If the „RTQ-Log" is already running on the computer and changes to your active site are not saved, the following box will appear:
   - Click "Yes" to save the changes before any other action is taken into account.
   - Click "No" to continue without saving any changes.

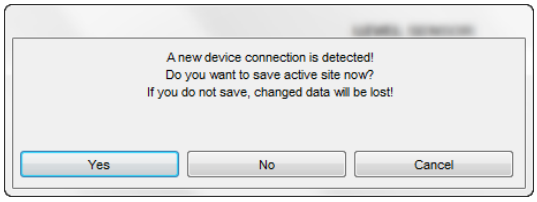


Figure 29: Dialog box

6. A dialog box appears telling to what device (ID number) the computer tries to establish a connection.
   - Click „Yes" to establish the connection with the device.
   - Click „No" to cancel the connection.

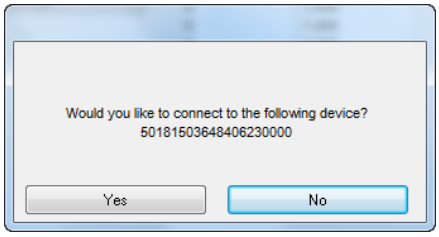


Figure 30: Connection confirmation

7. A dialog box appears asking if the configuration should be downloaded from the device or if the configuration should be taken from the latest backup located in a file on the computer's hard drive.
   - Click „Device“ to download the configuration from the device.
   - Click „File“ to get the latest configuration saved on the hard drive.

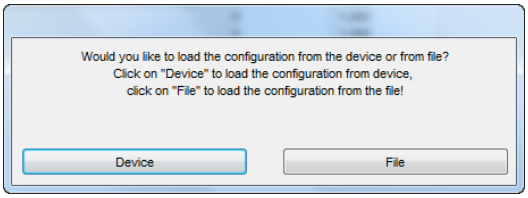


Figure 31: Configuration upload dialog box

For further details on the configuration of the system, please refer to the manual delivered with the RTQ-Log software.

4.4 MODBUS ASCII communication

4.4.1 How does it work?

In order to read the different registers using the Modbus ASCII protocol from the RAVEN-EYE® sensor, you need a PLC or controller with a RS485 communication port and a 4-20 mA input. The PLC will act as the “master” unit. Connect the level sensor (ULS-02, ULS-06 or other) to the 4-20 mA input of the PLC. The PLC will send the level information to the RAVEN-EYE® sensor and the RAVEN-EYE® will calculate the flow based on different parameters it has. The PLC can then read the different registers (refer to Table 2 on page - 33 -) from the RAVEN-EYE®.

All the parameters from the measuring site are configured using the RTQ-Log software. Refer to the RTQ-Log software installation & operation manual for instructions.

4.4.2 Address & baud rate configuration

The Modbus address is 1 as a standard. If needed, the Modbus address of the sensor can be changed when connecting the instrument to the computer.

Procedure

1. Attach the sensor to the computer (refer to section 4.1 on page - 28 -)
2. Connect the logger to the RTQ-Log software version 3.5 or above (refer to section 4.3 on page - 30 -).
3. In RTQ-Log, in the “Devices” section, click on “Change” next to Modbus Address

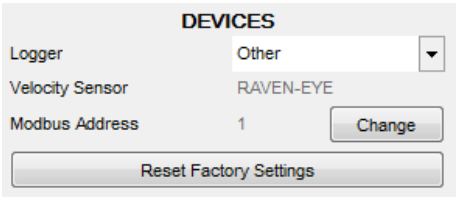


Figure 32: Change Modbus address

4. A pop-up window will appear. Introduce the new Modbus address (value from 1 to 250)

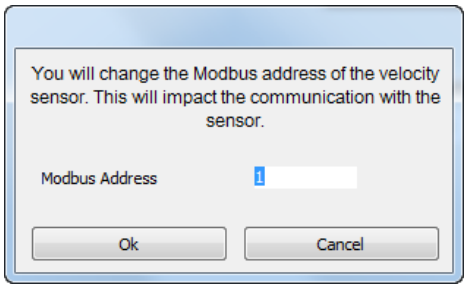


Figure 33: Introduce new Modbus address

When uploading the new configuration with the new Modbus address to the RAVEN-EYE®, the communication between the logger and the computer will get lost. To reconnect the RAVEN-EYE® to the computer, introduce the new Modbus address in the device connection box (see Figure 34)

Figure 34: Modbus address for connection

4.4.3 Modbus ASCII output parameters

The RAVEN-EYE® acts as MODBUS ASCII slave serial device. The PLC is the master device.

The serial communication has the following characteristics:

- Communication (COM PORT): RS485
- Protocol: MODBUS ASCII
- Baud rate: 19200 bauds
- Number of bits: 8
- Parity: None
- Number of stop bits: 2

The RAVEN-EYE® uses the following MODBUS functions:

- 03 “Read holding registers”
- 16 “Preset multiple registers”

Used data types:

- Signed16 16 Bit signed integer
- Unsigned16 16 Bit unsigned integer
- Float32 32 Bit Floating Point

Word Order HI-LO = Hi Byte on lower register address

4.4.4 Measurement data „read only“

Table 2: Registers to be read

Address	Mode	Length	Type	Unit	Description	Comment
1000	R	2	float32	m/s	Velocity vQP	Velocity considering the quality parameters
1002	R	2	float32	m/s	Velocity vQPMF	Velocity considering the quality parameters and the median filter
1004	R	2	float32	m/s	Velocity vAVG	Average velocity
1006	R	2	float32	m/s	Velocity vRAW	Raw surface velocity
1008	R	1	unsigned16		Sensor identification	=0x0001 (RAVEN-EYE) =0x0014 (BELUGA 20°) =0x002D (BELUGA 45°) =0x03B0 (PHOENIX)
1009	R	1	signed16		VSN	Quality parameter (Velocity Spectrum Number)
1010	R	2	float32		SNR	Quality parameter (Signal to Noise Ratio)
1012	R	1	signed16		AGC	Quality parameter (Automatic Gain Control)
1013	R	1	signed16		NOT	Quality parameter (Number Of Trials)
1014	R	2	float32	°C	Temperature	Internal temperature of the sensor
1016	R	2	float32	%	Humidity	Internal humidity of the sensor
1018	R	2	float32	Bar	Pressure	Internal pressure of the sensor
1020	R	2	float32		Standard deviation (σ)	Quality parameter
1022	R	2	float32		Amplitude (A)	Quality parameter
1024	R	2	float32	m	Level (h)	
1026	R	2	float32	l/s	Flow rate (Q)	
1028	R	1	unsigned16		Status	See section “Programming of Status” here below

4.4.5 Level input „read & write“

Table 3: Registers to be read and written

Address	Mode	Length	Type	Unit	Description	Comment
4000	RW	1	Unsigned16	mm	Level	Used for flow calculation

4.4.6 Programming of “Status” or “Alarm” register

The register 1028 is the “Status” register of the flow sensor which is also an unsigned 16 bit and has to be read as binary value.

This register will help programming alarms based on the parameters measured inside the RAVEN-EYE® enclosure such as internal temperature, internal pressure and internal humidity.

Bits 12 to 15 are linked to the internal parameters (starting with bit 0, being the LSB):

Bit 12: Internal temperature is out of limits (< -20°C (-4°F) OR > + 50°C (122°F))
Bit 13: Internal humidity is out of limits (maximum value is set to 75%)
Bit 14: Internal pressure is out of limits (>0,8 bar AND <1,2 bar)
Bit 15: Logical AND of Bit 13 & Bit 14 (internal pressure and humidity are out of limits)

Example 1:

The following status value means:

1110 0000 0000 0000 ➔ Internal humidity AND internal pressure are out of limits. For a RAVEN-EYE® with v0.24 firmware version, internal humidity is > 75% r.H. AND internal pressure is > 0,8 bar or < 1,2 bar

Example 2:

The following status value means:

0001 0000 0000 0000 ➔ Internal temperature is of limits. For a RAVEN-EYE® with v0.24 firmware version, internal temperature is < -20°C (-4°F) OR > +50°C (122°F)

***Note**: These values may be changed with future firmware versions.*

4.5 4-20 mA output (optional)

Optionally, the RAVEN-EYE® sensor can be ordered with a 4-20 mA output for surface velocity (configurable for validated surface velocity (vQP) or validated surface velocity including median filter (vQPMF)).

4.5.1 4-20 mA output wiring

Use the orange and violet wires to connect the 4-20 mA output of the RAVEN-EYE® sensor to a logger or controller. See table here below for proper wiring:

Colour	Properties	Description
White	A+	RS485
Black	B-	RS485
Orange	+26 VDC	4-20 mA
Violet	mA Output (-)	4-20 mA
Red	+4.1 to 26 VDC	Power supply
Green	Negative wire	Power supply
Green/Yellow	Shield	Shield

Table 4: RAVEN-EYE® connections

***Note**: The 4-20 mA output is passive. Power needs to be applied on the orange wire (see table above).*

***Important Note:** The maximum load is 250Ω.*

4.5.2 4-20 mA output configuration

To configure the range of the 4-20 mA output, connect the RAVEN-EYE® sensor to the computer (see section 4.1 on page - 28 -).

Procedure

1. In the “Configuration” tab and “Velocity Sensor” section, check the box close to “mA Output.
2. Select the velocity parameter vQP or vQPMF from the drop down list
3. Insert a value for 4 mA and for 20 mA

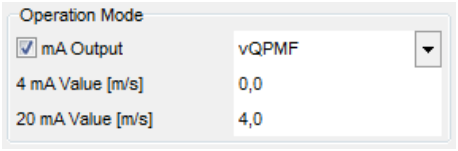


Figure 35: 4-20 mA output configuration

4. Save the configuration

When starting for the first time after power was shut off, the 4-20 mA value will be 1,8 mA until the first measured value is available. It will take 20 to 25 seconds to obtain the first measured value.

If the measured velocity is outside the configured velocity range, the 4-20 mA value will be 2,4 mA.

4.6 Configuring channel profile

For more information on profiles (round, rectangular, egg shaped or level/area table), please refer to RTQ-Log manual. The profile generator is explained here below.

4.6.1 Custom profile generator

Select “Custom Profile” to use a profile generator for rivers with non-standard shapes.

Procedure:

1. Select “Custom Profile” from the list to setup the channel shape. A popup window appears.
2. Select the units for the configuration of the profile.
3. Select a reference point for the Y axis between “Level” or Depth”. Usually “Level” is selected for wastewater or buried channels and “Depth” is selected for rivers.
4. Fill in the points coordinates to generate the profile. The profile appears on the right hand side of the window.
5. Once the profile is configured, it can be saved as a separate file (.csv) by clicking on “Export Profile”.

Example:

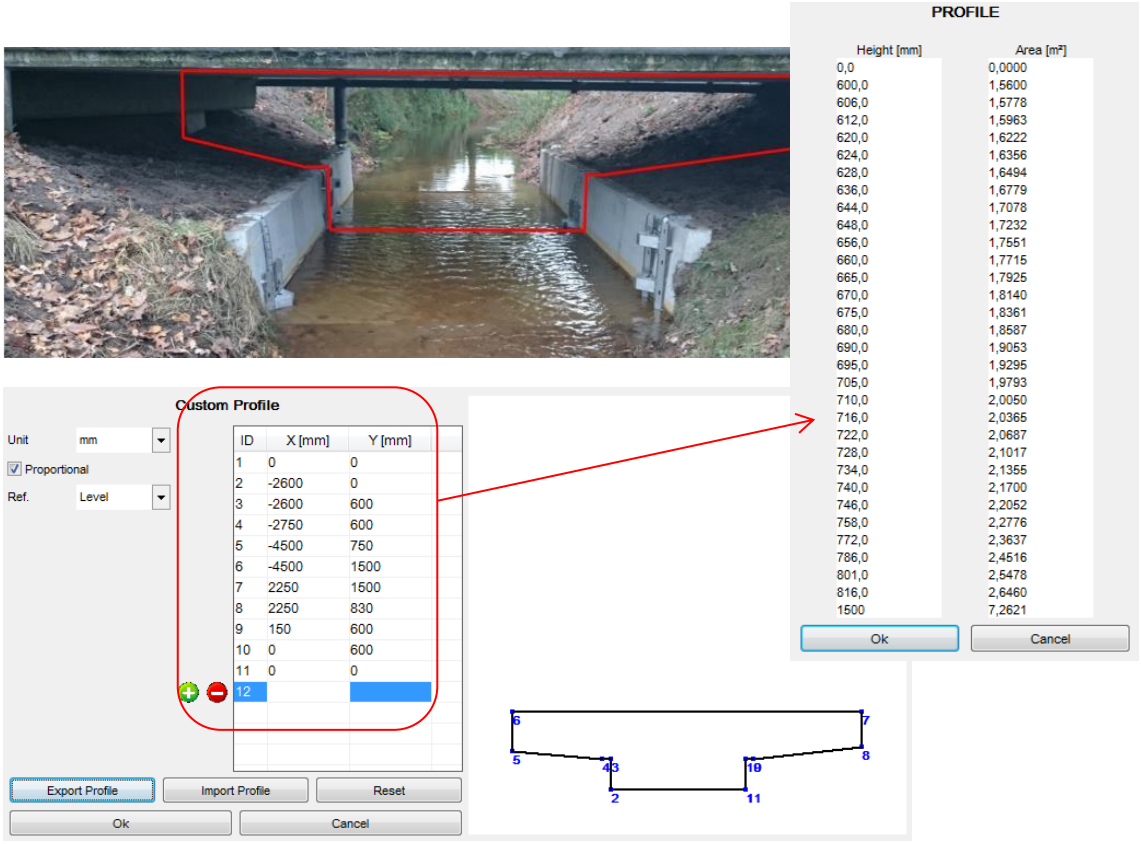


Figure 36: Custom profile

***Note**: The „Custom Profile Generator“ will automatically create the level/area table for an „Odd” profile*

4.7 Determining velocity coefficients

If the channel profile is non-standard (e.g. different than round or rectangular), the RAVEN-EYE® sensor will need to be site-calibrated. This is done by making a velocity profile of the site and compare it with the surface velocity of the flow.

Coefficients are used to calculate the average velocity over the cross-sectional flow area from the measured surface velocity.

Coefficients (k) are determined using a punctual reference measurement such as exploration of velocities over the cross-section using a current meter (suggested equipment: electromagnetic current meter) and appropriate conversion methods.

These coefficients can be introduced in the RTQ-Log software in the “Velocity/Flow Calibration Table”.

4.7.1 How to fill the flow calibration table

To determine the velocity coefficient (k), the measured surface velocity will be compared to the average flow velocity at a determined moment.

The RAVEN-EYE® must be in real-time reading mode. To obtain the average surface velocity over a determined period of time, make an average of the velocity values (vQP) over that period of time.

Measure a reference with an instrument at different points of the channel at a defined reference level (see various methods above) and generate the average velocity over the cross-sectional area over the same period of time than the RAVEN-EYE® sensor.

The velocity coefficient (k) is calculated dividing the reference measurement by the surface velocity value.

Example:

Surface velocity (vQP) = 1,13 m/s

Reference velocity : 0,96 m/s (in average)

The coefficient (k) is equal to reference divided by real-time values:

Coefficient (k) : 0,849 = $\frac{0,96}{1,13}$

Fill in the flow calibration table in RTQ-Log to adapt the flow measurement according to a reference measurement if needed.

If a different coefficient (k) needs to be entered at various levels, it can be done for up to 16 different factors. There is a linear interpolation of the factor from one level to another

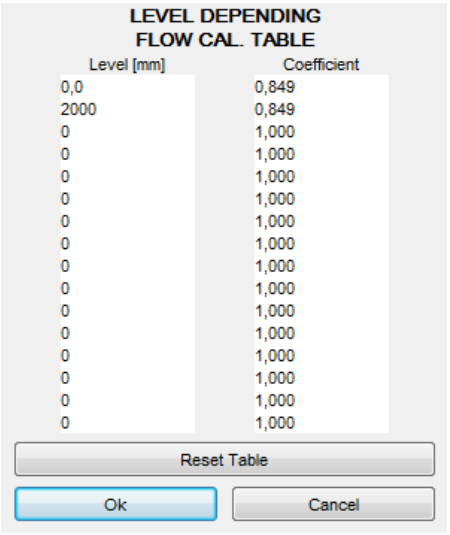


Figure 37: Calibration table

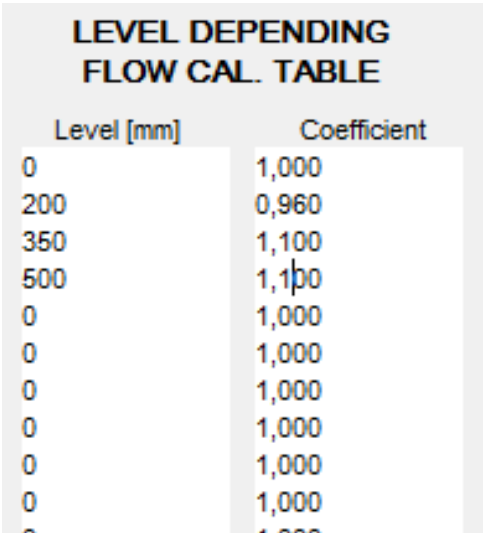


Figure 38: Flow calibration table with various coefficients

When making a site-calibration, use vQPMF as “Velocity Selector”.

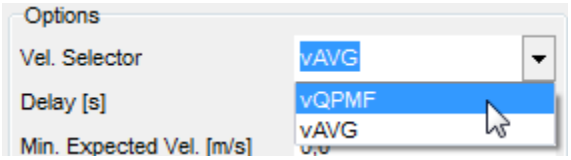


Figure 39: Velocity selector

5 Maintenance

CAUTION
Radar RF Exposure Hazard. Although the RAVEN-EYE® microwave power level is very small (~15 mW) and is well below government stated exposure limits for uncontrolled environments, users of this product should follow proper safety protocols for the handling of devices with radar frequency transmitters. Avoid placing the head and other vital organ areas within the microwave beam (within 1 meter of the microwave aperture).

IMPORTANT NOTE:
Delicate Instrumentation. Handle with care to prevent damage to the microwave transmitter. Damaged transmitters can result in higher signal power levels, which can interfere with essential terrestrial microwave links.

5.1 Preventive maintenance

Monitor the inside pressure and humidity from the RAVEN-EYE® sensor, when the internal pressure goes above 0,8 bar and the internal humidity raises above 75%, return the instrument to manufacturer for inspection and service. These parameters are controlled automatically when using an IFQ MONITOR or IFQ LOGGER. Refer to section 4.4.6 on page - 33 - for more information on how to monitor these parameters.

Examine the RAVEN-EYE® sensor on an annual basis to look for corrosion or damage. Make sure that no swelling, blistering, pitting or loss of material has occurred on the upper and lower portions of the main PU enclosure.

If the attached level sensor is used, examine the enclosure and the four M5 SS bolts. Inspect the cables and connectors for any damage or corrosion and tighten all connectors in the system.

The only parts of the RAVEN-EYE® system that can be replaced by the user is the cable and the bail or sensor mount assembly. If the sensor becomes defective, it must be replaced as a complete unit and/or returned to FLOW-TRONIC S.A (refer to section 7 on page - 40 -).

Check the electrical connections

Examine the cable connectors on an annual basis for corrosion and tightness. If corrosion is found, clean and dry the connectors to make sure that no moisture is on the connector pins. If corrosion is severe, replace the cables.

5.2 Cleaning the instrument

Regular cleaning is not necessary because the sensor does not contact the flow unless a surcharge condition occurs. Examine the sensor after a surcharge to see if cleaning is necessary.

Procedure

5. Disconnect power to the logger or controller
6. Unplug the RAVEN-EYE® sensor connector from logger or controller.
7. Remove the sensor from the manhole.
8. Remove any debris from the bottom of the sensor. Clean the external surface of the sensor with mild soap and rinse with water.
9. Lower and position the sensor back in its initial position. Make sure that the cable points toward the center of the manhole.
10. Connect the RAVEN-EYE® sensor cable to the logger or controller following the installation & operation manual.

5.3 Cable replacement Procedure

Procedure

1. Disconnect power to the logger or controller
2. Unplug the RAVEN-EYE® sensor connector from the logger or controller.
3. Remove the sensor from the manhole.
4. Remove the cable clamp by removing the two screws on the sensor handle. Remove the cable.
5. Install the new cable. Make sure that the connector is aligned properly and that no debris or water gets into the connector.
6. Replace the cable clamp.
7. Lower and position the sensor back in its initial position. Make sure that the cable points toward the center of the manhole.
8. Connect the RAVEN-EYE® sensor cable to the logger or controller following the installation & operation manual.

6 Replacement Parts and Accessories

For replacement parts and accessories, please contact your direct representative or Flow-Tronic S.A.

7 Contact Information

7.1 For Belgium and Luxembourg

Flow-Tronic S.A.
Chemin des Tilleuls 32
B-4840 Welkenraedt
Belgium

Tel : +32 (0)87 899 799
Fax : +32 (0)87 899 790
Email: site@flow-tronic.com
www.flow-tronic.com

7.2 Outside Belgium and Luxembourg

Flow-Tronic maintains a large network of representatives and distributors. To locate a representative, send an email to info@flow-tronic.com or visit www.flow-tronic.com.

7.3 Technical Support

Technical and Customer Service Department personnel are eager to answer questions about our products and their use. In Belgium and Luxembourg, call +32 (0)87 899 799. Outside the Belgium and Luxembourg, contact your direct representative or send an email to service@flow-tronic.com.

7.4 Repair Service

Authorization must be obtained from Flow-Tronic before sending any items for repair.

Steps to follow to send the device to Flow-Tronic for repair:

1. Identify the serial number of the device.
2. Record the reason for return.
3. Make sure the equipment is free from foreign debris and is clean and dry before shipping.
4. Ship the item to:

   Flow-Tronic S.A.
   Chemin des Tilleuls 32
   B-4840 Welkenraedt
   BELGIUM

5. The item that has to be repaired gets an RMA (Return Material Authorization) number.
6. The price for repair is calculated and sent to the customer.
7. Repair is made after having received the authorization from the customer.

Appendix

App. 1 Flow-Tronic Customer Service Department Registration Form

Thank you for selecting Flow-Tronic flow instrumentation for your monitoring needs. Enclosed with your instrument you should find the operation manual(s) and accessories.

So that we may better serve your needs, please take a few minutes to complete this Customer Service Registration Form. Completion of this form will enable us to provide you with application information, software upgrades or product change notices.

Please fax (+32 (0)87 899 790) or e-mail (info@flow-tronic.com) this copy to Flow-Tronic.

If you have any questions or concerns regarding technical support, parts or service, please call Customer Service at +32 (0)87 899 799 or e-mail us at service@flow-tronic.com

Chemin des Tilleuls 32 | B-4840 Welkenraedt | BELGIUM
Tel. : +32 (0)87 899 799 | Fax : +32 (0)87 899 790
E-mail : info@flow-tronic.com | www.flow-tronic.com

Customer Service Registration Form --- Customer Service Department
Flow-Tronic S.A.

Flow-Tronic Model _____ Serial Number _____

Company _____

Contact Name _____

Address _____

City _____ State _____ Zip Code _____

Phone ( ) _____ Fax ( ) _____

E-Mail _____

Application Type _____

_____

Warranty Statement

Manufacturer warrants all products of its manufacture to be free from defects in workmanship and material under normal use and service. This warranty extends for a period of twenty four (24) months after date of shipment, unless altered by mutual agreement between the purchaser and Flow-Tronic S.A. prior to the shipment of the product. If this product is believed to be defective, purchaser shall notify Flow-Tronic S.A. and will return the product to Flow-Tronic S.A., postage paid, within twenty four (24) months after date of shipment by Flow-Tronic S.A. If the purchaser believes the return of the product to be impractical, Flow-Tronic S.A. shall have the option, but will not be required, to inspect the product wherever located. In any event, if the purchaser requests Flow-Tronic S.A. visit their location, the purchaser agrees to pay the non-warranty expenses of travel, lodging and subsistence for the field service response. If the product is found by Flow-Tronic's inspection to be defective in workmanship or material, the defective part or parts will either be repaired or replaced, at Flow-Tronic's election, free of charge, and if necessary the product will be returned to purchaser, transportation prepaid to any point in Europe. If inspection by Flow-Tronic S.A. of such product does not disclose any defect of workmanship or material, Flow-Tronic's regular service repair charges will apply. Computing devices sold but not manufactured by Flow-Tronic S.A. are covered only by the original manufacturer's written warranty. Hence, this warranty statement does not apply.

The foregoing warranty is manufacturer's sole warranty, and all other warranties, express, implied or statutory, including any implied warranty of merchantability or fitness for a particular purpose, are negated and excluded. The foregoing warranty is in lieu of all other warranties, guarantees, representations, obligations or liabilities on the part of the manufacturer and Flow-Tronic S.A.

Purchaser's sole remedy and Flow-Tronic S.A.'s sole obligation for alleged product failure, whether under warranty claim or otherwise, shall be the aforestated obligation of manufacturer to repair or replace products returned within twelve months after date of original shipment. Flow-Tronic S.A. shall not be liable for, and the purchaser assumes and agrees to indemnify and save harmless Flow-Tronic S.A. in respect to, any loss or damage that may arise through the use by the purchaser of any of Flow-Tronic S.A.'s products.

FLOW-TRONIC nv

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