ADS® Portable FlowShark® Pulse Installation, Operation, and Maintenance Manual

February 2013 **QR 775006 A2**

An introductory guide to the ADS® Portable FlowShark® Pulse Meter

Valid as of **Firmware** Revision No. 4.00

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CHAPTER 1

Introduction

This manual is primarily designed for instructing the user on installing, programming, operating, maintaining, and troubleshooting the ADS® Portable FlowShark® Pulse and the corresponding sensors and devices. It also includes detailed information concerning system overview, function, specifications, and certifications.

Please notice that the declaration included in this chapter identifies the Portable FlowShark Pulse as the PCM 4. The Portable FlowShark Pulse is a version of the NIVUS® PCM 4 designed specifically for ADS. In all aspects related to certification, the Portable FlowShark Pulse is identical to the PCM 4.

Please read this instruction manual thoroughly. It contains all the information necessary for properly setting up and using the ADS Portable FlowShark Pulse. This manual is written primarily for qualified technical personnel that have an adequate knowledge of measurement technology, automation technology, information technology, and wastewater hydraulics. Reading and following the instructions in this manual before initial start-up will help ensure success in device configuration. Do not initiate start-up until installation is verified and complete.

This chapter includes introductory information concerning product certification, identification, safety, and use. It also includes the warranty for the ADS Portable FlowShark Pulse and user responsibilities.

Declaration of Conformity

NIVUS GmbH
Im Täle 2
75031 Eppingen

Telefon: 07262 9191-0
Telefax: 07262 9191-999
E-mail: info@nivus.com
Internet: www.nivus.de

EG-Konformitätserklärung
EC Declaration of Conformity
Déclaration de conformité CE
Świadectwo Zgodności UE

Für das folgend bezeichnete Erzeugnis:
We hereby declare that the design of the:
Le produit désigné ci-dessous:
Dla niżej opisanego produktu:

Bezeichnung: *Description / Désignation / Opis:*	**Portabler Durchflussmessumformer PCM 4** *Portable flow measurement transmitter / Convertisseur de mesure de débit portable / Przeplywomierz przenośny*
Typ */ Type / Type / Typ:*	**PC4-...**

wird bestätigt, dass es mit den folgenden Richtlinien übereinstimmt:
as delivered complies with the following EC directives:
Est certifié, conforme aux directives CE suivantes:
stwierdza się, iż odpowiada on wymaganiom następujących dyrektyw:

- 2004/108/EG

Die Geräte stehen im Einklang mit den folgenden harmonisierten Normen oder Dokumenten:
The devices furthermore comply with the following harmonised standards or documents:
En outre, ces appareils satisfont aux normes et documents harmonisés désignés ci-après:
Urządzenie odpowiada wymogom następujących norm sharmonizowanych lub dokumentów:

- EN 61000-6-2
- EN 61000-6-4

Diese Erklärung wird verantwortlich für den Hersteller / Importeur:
This declaration is submitted on behalf of the manufacturer / importer:
Le fabricant / importateur assume la responsabilité de cette déclaration:
Za niniejsze świadectwo odpowiada producent / importer

NIVUS GmbH
Im Taele 2
75031 Eppingen, Germany

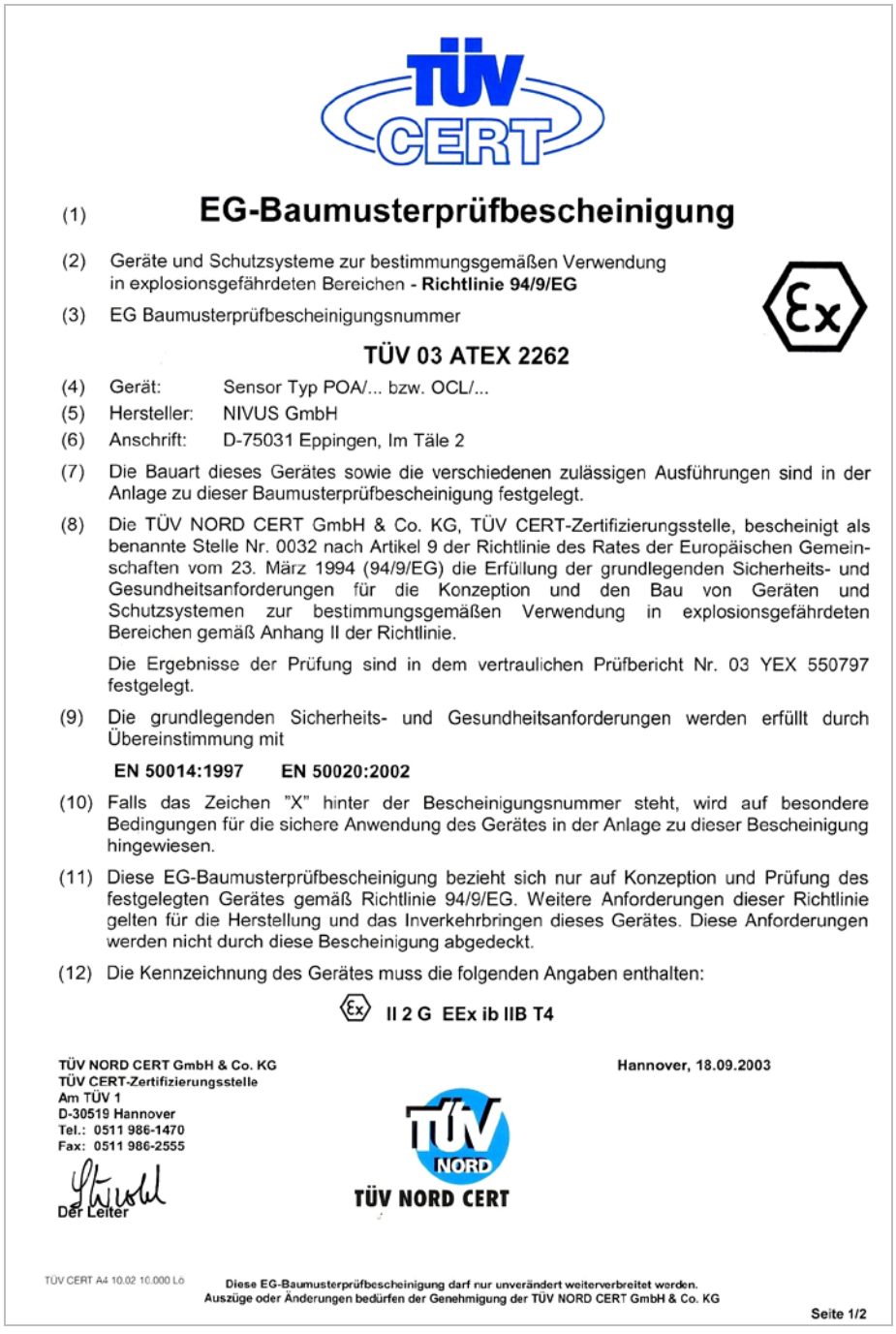
abgegeben durch */ represented by / faite par / wydane przez:*
Ingrid Steppe (Geschäftsführerin */ Managing Director / Gérante / Dyrektor)*

Eppingen, den 12.11.2010 Zg.d Steppe

(Rechtsgültige Unterschrift */ Legally valid sign / Signature authentique / prawnie wiążący podpis)*

E:\ CE \ CE PC4_01.jpg

Ex Approvals



(1) **EG-Baumusterprüfbescheinigung**

(2) Geräte und Schutzsysteme zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen - **Richtlinie 94/9/EG**

(3) EG Baumusterprüfbescheinigungsnummer

TÜV 03 ATEX 2262

(4) Gerät: Sensor Typ POA/... bzw. OCL/...

(5) Hersteller: NIVUS GmbH

(6) Anschrift: D-75031 Eppingen, Im Täle 2

(7) Die Bauart dieses Gerätes sowie die verschiedenen zulässigen Ausführungen sind in der Anlage zu dieser Baumusterprüfbescheinigung festgelegt.

(8) Die TÜV NORD CERT GmbH & Co. KG, TÜV CERT-Zertifizierungsstelle, bescheinigt als benannte Stelle Nr. 0032 nach Artikel 9 der Richtlinie des Rates der Europäischen Gemeinschaften vom 23. März 1994 (94/9/EG) die Erfüllung der grundlegenden Sicherheits- und Gesundheitsanforderungen für die Konzeption und den Bau von Geräten und Schutzsystemen zur bestimmungsgemäßen Verwendung in explosionsgefährdeten Bereichen gemäß Anhang II der Richtlinie.

Die Ergebnisse der Prüfung sind in dem vertraulichen Prüfbericht Nr. 03 YEX 550797 festgelegt.

(9) Die grundlegenden Sicherheits- und Gesundheitsanforderungen werden erfüllt durch Übereinstimmung mit

EN 50014:1997 EN 50020:2002

(10) Falls das Zeichen "X" hinter der Bescheinigungsnummer steht, wird auf besondere Bedingungen für die sichere Anwendung des Gerätes in der Anlage zu dieser Bescheinigung hingewiesen.

(11) Diese EG-Baumusterprüfbescheinigung bezieht sich nur auf Konzeption und Prüfung des festgelegten Gerätes gemäß Richtlinie 94/9/EG. Weitere Anforderungen dieser Richtlinie gelten für die Herstellung und das Inverkehrbringen dieses Gerätes. Diese Anforderungen werden nicht durch diese Bescheinigung abgedeckt.

(12) Die Kennzeichnung des Gerätes muss die folgenden Angaben enthalten:

II 2 G EEx ib IIB T4

TÜV NORD CERT GmbH & Co. KG
TÜV CERT-Zertifizierungsstelle
Am TÜV 1
D-30519 Hannover
Tel.: 0511 986-1470
Fax: 0511 986-2555

Der Leiter

Hannover, 18.09.2003

TÜV NORD CERT

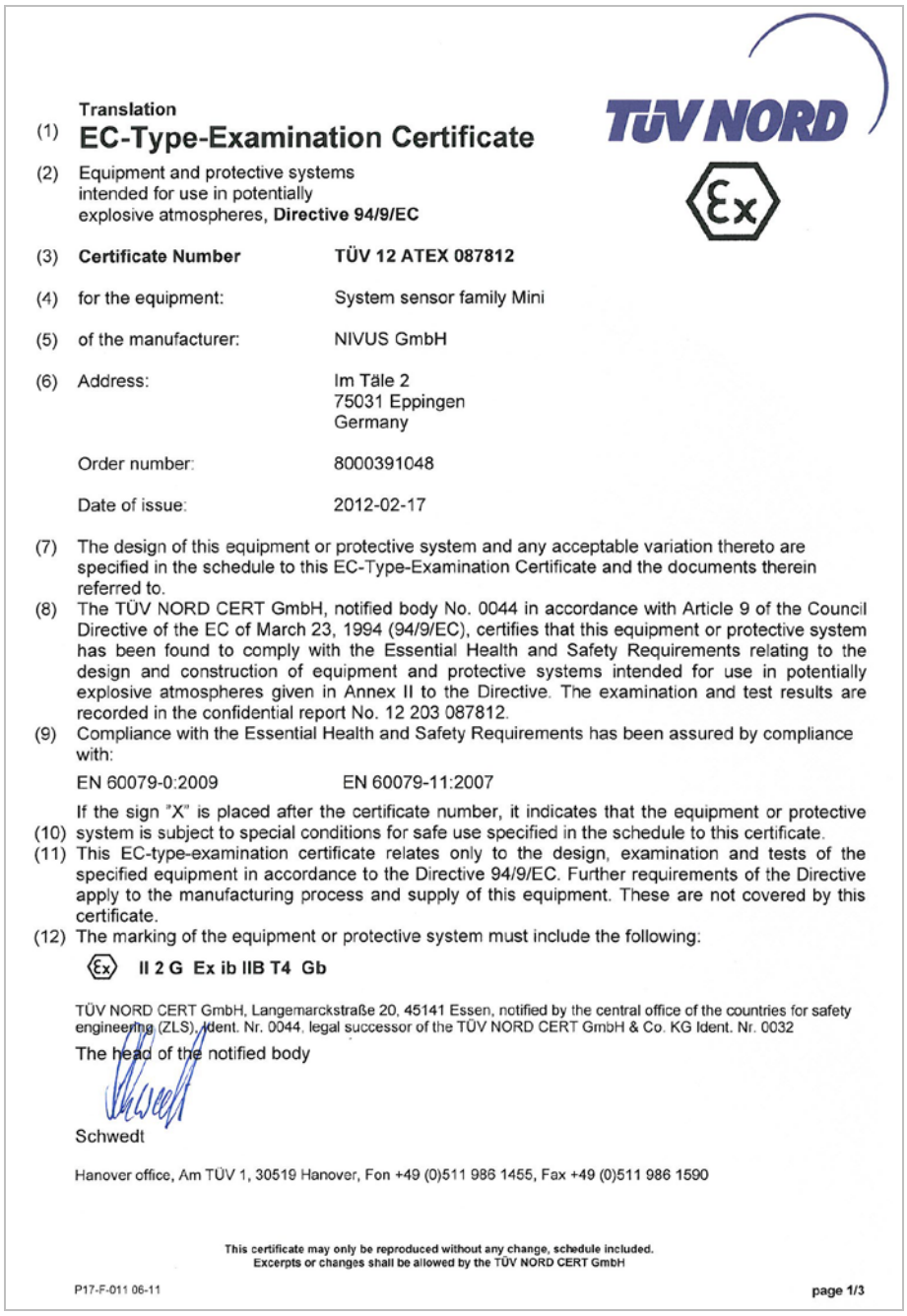
TÜV CERT A4 10.02 10.000 Lö

Diese EG-Baumusterprüfbescheinigung darf nur unverändert weiterverbreitet werden.
Auszüge oder Änderungen bedürfen der Genehmigung der TÜV NORD CERT GmbH & Co. KG

Seite 1/2

This approval is valid only in connection with the respective markings on the sensor nameplate.

The complete EC-type examination certificate (including supplemental) is available through ADS.



Translation

(1) **EC-Type-Examination Certificate**

(2) Equipment and protective systems intended for use in potentially explosive atmospheres, **Directive 94/9/EC**

(3)	**Certificate Number**	**TÜV 12 ATEX 087812**
(4)	for the equipment:	System sensor family Mini
(5)	of the manufacturer:	NIVUS GmbH
(6)	Address:	Im Täle 2 75031 Eppingen Germany
	Order number:	8000391048
	Date of issue:	2012-02-17

(7) The design of this equipment or protective system and any acceptable variation thereto are specified in the schedule to this EC-Type-Examination Certificate and the documents therein referred to.

(8) The TÜV NORD CERT GmbH, notified body No. 0044 in accordance with Article 9 of the Council Directive of the EC of March 23, 1994 (94/9/EC), certifies that this equipment or protective system has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres given in Annex II to the Directive. The examination and test results are recorded in the confidential report No. 12 203 087812.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 60079-0:2009 EN 60079-11:2007

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment or protective system is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-type-examination certificate relates only to the design, examination and tests of the specified equipment in accordance to the Directive 94/9/EC. Further requirements of the Directive apply to the manufacturing process and supply of this equipment. These are not covered by this certificate.

(12) The marking of the equipment or protective system must include the following:

II 2 G Ex ib IIB T4 Gb

TÜV NORD CERT GmbH, Langemarckstraße 20, 45141 Essen, notified by the central office of the countries for safety engineering (ZLS), Ident. Nr. 0044, legal successor of the TÜV NORD CERT GmbH & Co. KG Ident. Nr. 0032

The head of the notified body

Schwedt

Hanover office, Am TÜV 1, 30519 Hanover, Fon +49 (0)511 986 1455, Fax +49 (0)511 986 1590

The mini sensor family for the system consists of the following components:

- Electronic Box for mini sensors
- Mini water-ultrasonic velocity sensor
- Mini air-ultrasonic depth sensor

This approval is valid only in connection with the respective markings on the sensor nameplate.

The complete EC-type examination certificate is available through ADS.

Device Identification

The instructions in this manual pertain only to the Portable FlowShark Pulse and the specific sensors supporting the unit. The article number (i.e., part number) on the sensor displays at the location at which the sensor cable enters the sensor body and on a nameplate at the end of the cable. A special transparent hose protects the nameplate against the elements and abrasion. The article number on the Portable FlowShark Pulse displays on a nameplate affixed to the bottom of the unit. The nameplate contains the following information:

- Name and address of the manufacturer
- CE label
- Type and serial number
- Year of manufacture
- (*applicable only to Ex-version devices*) Ex label

To ensure accurate and expeditious processing, please specify the type of equipment, year of manufacture, and serial number of the respective transmitter or sensor when inquiring about products or ordering replacement parts. Following are some sample nameplates for system components:

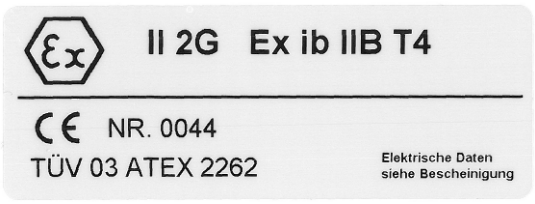
Sample of Portable FlowShark Pulse nameplate

Sample of Water-Ultrasonic Velocity/Combination Sensor

Sample of Mini Water-Ultrasonic Velocity Sensor nameplate

Sample of Mini Air-Ultrasonic Depth Sensor nameplate

Sample of Electronic Box (EBM) nameplates



Sample of Ex label for sensors

This instruction manual is an essential component of the Portable FlowShark Pulse system; therefore, ADS recommends keeping this manual accessible at all times.

Follow all safety instructions contained in this manual.

ADS strictly prohibits disabling or altering the function of the safety devices in any way.

Use in Accordance with the Requirements

The Portable FlowShark Pulse and corresponding sensors are designed for temporary use in measuring slightly- to heavily-polluted flow in partially-filled and full pipes or other similar applications. The portable unit also detects and records external data and supports external peripheral equipment.

While the Portable FlowShark Pulse is primarily designed to receive power from a rechargeable battery pack, it also can receive power from an independent power source through the combination power pack/battery charger. The unit stores flow measurement and other data on a removable memory card.

Please adhere to the measurement specifications designated in this manual. Monitoring flow under conditions falling outside the documented specifications of the equipments' capabilities without prior written permission of ADS occurs at the user's risk.

Modifying or using this equipment for purposes other than the intended use (described above) without the prior written consent of the manufacturer will be considered outside the specifications of the equipment. Therefore, any resulting damages that may occur will be at the user's risk or expense.

Sensors

Water-Ultrasonic Velocity/Combination Sensor

This sensor is designed to measure flow velocity in slightly- to heavily- polluted media in partially-filled and full sewers, pipes, and other channels. Some versions of this sensor can also perform level (i.e., depth) measurement.

Air-Ultrasonic Depth Sensor

This sensor is designed for measuring flow depth from the top of the pipe using ultrasonic technology.

Mini Water-Ultrasonic Velocity Sensor

This sensor is designed for measuring flow velocity in slightly- to heavily-polluted media in partially-filled or full pipes and channels exhibiting low depth levels. It connects to the Portable FlowShark Pulse through the Electronic Box (EBM). However, it requires an additional level (i.e., depth) measurement.

Mini Air-Ultrasonic Depth Sensor

This sensor is designed for measuring flow level (i.e., depth) from the top of smaller pipes using ultrasonic technology. This sensor connects to the Portable FlowShark Pulse through the Electronic Box (EBM).

EBM Electronic Box

The Electronic Box (EBM) is designed for connecting the Mini Water-Ultrasonic Velocity and Mini Air-Ultrasonic Depth Sensors to the Portable FlowShark Pulse using independent electronic sensor components.

Please note the maximum permissible limit values specified in Appendix A. The owner assumes all risk and responsibility for any applications that fall outside these specifications without the written consent of ADS.

The sensors and the Electronic Box are intended to be used exclusively for the purposes as described above. Modifying or using the sensors or Electronic Box for any other purpose without the prior written consent of the manufacturer will not be considered as use in accordance with the requirements. Therefore, any damages resulting from this use will be incurred at the user's risk.

The sensors are designed for a lifetime of approximately 10 years. After 10 years, the sensors must undergo an inspection and a general overhaul.

Ex-Approval

The Ex-version of the sensors is designed for use in areas with explosive atmospheres (zone 1).

Approval ⟨Ex⟩ II 2 G Ex ib IIB T4 Gb

This approval is valid only in connection with the respective markings on the sensors' nameplates.

The Ex-version sensors coincide with the Portable FlowShark Pulse regarding the assessment of intrinsically safe electrical systems according to EN 60079-25.

When using other manufacturer's transmitters, the operator must assess the system based on EN 60079-25.

Obtain the required specifications for Ex-version sensors from the EC-type examination certificate TÜV 03 ATEX 2262 or TÜV12ATEX087812.

User's Responsibilities

Obtain all local **operating permits** required and observe the provisions contained within the permits. In addition, observe all local laws and regulations concerning the following:

- Personnel safety (accident prevention regulations)
- Work material and tool safety (safety equipment and maintenance)
- Product and material disposal (laws on wastes)
- Cleaning (cleansing agents and disposal)
- Environmental protection

Before operating this equipment, all personnel involved in installation and/or initial start-up activities must consider and acknowledge all local regulations, such as those pertaining to performing operations in sanitary sewer environments.

Safety and Identification

Following are the descriptions or interpretations for the general notification, safety, and danger symbols corresponding to the special comments referenced throughout this manual.

Represents cautionary information to observe

Represents special notes

Represents information regarding present dangers associated with electrical voltage

Represents special warnings

To avoid accidents, observe the following information, regulations, and safety requirements during installation, connection, initial start-up, and operation of the Portable FlowShark Pulse, the sensors, and/or the Electronic Box.

To ensure safety and maintain the product warranty, ADS must perform all operations that extend beyond the installation, connection, or configuration procedures designated in this manual for this equipment.

Due to the wastewater environment in which the transmitter, sensors, and cables are installed and operate, this equipment may become coated with potentially dangerous diseases and germs. Therefore, please take precautionary measures to protect human health.

For installation in explosive areas, appropriate protection measures must be taken (e.g., gas warning device, sufficient ventilation, and anti-spark tools).

Markings

For risk prevention, the safety recommendations are included on the pipe sensor upon delivery and, therefore, must not be removed!

!!! Important Information - Please note !!!	
1	Pipe line under pressure! Relieve from pressure prior to sensor replacement
2	Do not operate the pipe sensor without retaining element
3	Do not damage outer cable sheathing
4	Avoid kinks or sharp bends on sensor cables
5	Please refer to instruction manual prior to installation

Emergency and Safety Procedures

Before performing maintenance, cleaning, and making repairs (by authorized personnel only), disconnect the battery pack from the unit or the unit from its power source.

For portable units receiving power from an external source, terminate power by turning off the power at the source from which the unit is receiving power.

Delivery and Receipt

Delivery of a Portable FlowShark Pulse measurement system typically includes the following components. Each item includes the part number for both the standard unit and the Ex version of the unit, when applicable.

- Portable FlowShark Pulse transmitter (ADS p/n 5000-PPORT METER-4 for the standard unit; 5000-PPORT METER-10 for the Ex version)
- Rechargeable battery (ADS p/n 5000-PPORT-BATTERY-4 for the standard unit; 5000-PPORT-BATTERY-01 for the Ex version)
- Compact flash card (ADS p/n 5000-PULSE-CF-128)
- Water-Ultrasonic Velocity/Combination Sensor – *includes flow velocity, ultrasonic depth, and pressure depth measurement capabilities* (ADS p/n 5000-PPORT-SENS-W4K-10F0 for the standard unit; 5000-PPORT-SENS-W4K-E10F0 for the Ex version)
- Air-Ultrasonic Depth (Level) Sensor (ADS p/n 5000-PPORT-SENS-AIR-10S for the standard unit; 5000-PPORT-SENS-AIR-E10S for the Ex version)
- Power pack/battery charger (ADS p/n 5000-PPORT-CHARGER-4 for the standard unit; 5000-PPORT-CHARGER-01 for the Ex version)
- RMS2 Pipe Mounting System (ADS p/n 5000-PPORT-PIPE-MNT-RMS2)

Additional accessories, such as other pipe mounting system and sensor options, are also available. Manuals are available through ADS Client Services.

Upon receipt, please inspect the hardware and verify all standard equipment and accessories are present according to the invoice to ensure the order is intact and complete. Confirm the equipment is in working order and free from damage. If damage has occurred in transit, immediately report the damage to the carrier and send a written report to ADS.

Please provide a written report of any missing items to an ADS representative within two weeks.

Resolve all problems immediately!

Product Warranty

This section includes warranty information for the ADS Portable FlowShark Pulse.

New Product Warranty

All new products manufactured by ADS will be free from defects in material and workmanship for up to two (2) years following the date of shipment from ADS. During this warranty period, upon satisfactory proof of a defect, the product may be returned for repair or replacement, at ADS's sole option. No returns will be accepted unless the Owner has prepaid shipping and has received a prior authorization return number from ADS. Please contact ADS to obtain an authorization return number. Warranty repairs and replacements will be performed only by ADS. Any unauthorized repair or replacement will void this product warranty. Any repair or replacement will be covered by this new product warranty for ninety (90) days from the date that such repaired or replaced product is shipped from ADS. This warranty is available only if the product has been setup and operated in accordance with the procedures outlined in the ADS Operations and Maintenance Manual. This warranty does not apply to damage by catastrophes of nature, fire, explosion, acts of God (including, but not limited to, lightning damage and power surges), accidents, improper use or service, damage during transportation, or other similar causes beyond ADS's control.

Out of Warranty Product Repairs

After the new product warranty expires, a product may be returned, at the owner's prepaid expense, to ADS for repair. The owner will pay for all parts and labor associated with the repair. Any repair part will be covered by the new product warranty for 90 days from the date of shipment from ADS.

Troubleshooting Fee

ADS will charge a troubleshooting fee if the reported product defect cannot be found and/or the reported defect is not due to a defect in materials or workmanship.

Shipping

All repaired products will be returned via surface transportation prepaid by ADS. Import duties, fees, taxes, and other related charges are the responsibility of the owner.

THIS IS THE ONLY WARRANTY FOR ADS PRODUCTS. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY. PRODUCT REPAIR OR REPLACEMENT IS THE ONLY REMEDY. IN NO EVENT WILL ADS BE RESPONSIBLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL, OR SPECIAL DAMAGES.

Replacement Parts and Accessories

ADS does not certify replacement parts or accessories that are not supplied by ADS. Installing and/or using parts or accessories supplied by other vendors could adversely affect the operation of the equipment. Therefore, users are responsible for all damages incurred as a result of using parts or accessories supplied by any manufacturer other than ADS.

Using replacement parts that are subject to wear, such as rechargeable batteries or filters, that have not been approved by ADS will invalidate any warranty claims.

CHAPTER 2

System Overview and Operation

The Portable FlowShark Pulse is a portable monitoring system and data storage device designed for temporary flow measurement in slightly- to heavily-polluted flow of various compositions in partially-filled to full pipes of various shapes and dimensions. The system measures flow velocity by spatial allocation using ultrasonic pulses. Signal evaluation occurs through cross-correlation using a digital signal processor. Depth measurement occurs through various sensors via ultrasonic (transit-time) technology directed from the top (air) or bottom (water) of the pipe, pressure measurement cell, or mA input (for external depth measurement).

The method for measurement is based on the ultrasonic reflection principle. Therefore, to ensure the system operates properly, it is essential that particles, such as dirt, gas bubbles, or similar objects, are present in the flow for reflecting the ultrasonic signal sent by the sensor.

Portable FlowShark Pulse

ADS primarily offers two versions of the Portable FlowShark Pulse:

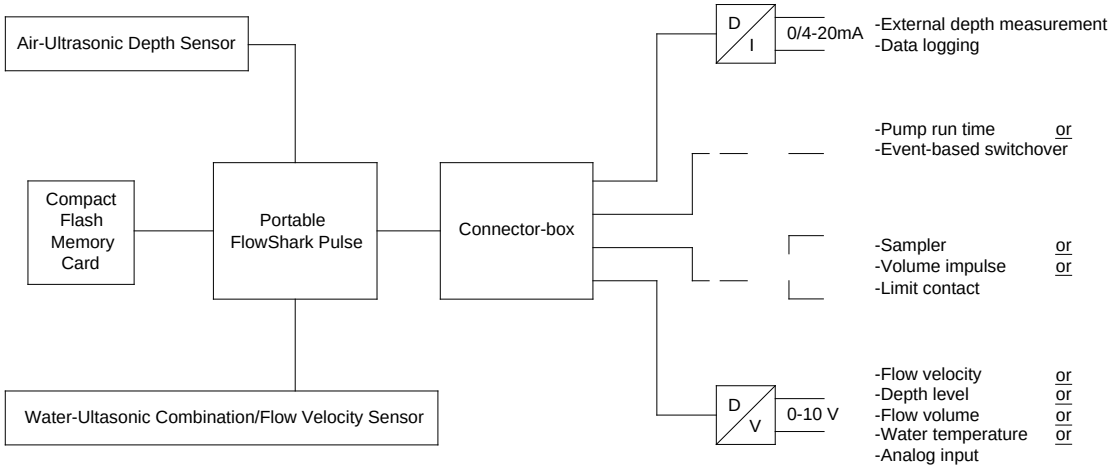
- Portable unit powered by rechargeable battery pack (ADS p/n 5000-PPORT METER-4)
- Portable unit powered by rechargeable battery pack – *Ex-certified* (ADS p/n 5000-PPORT METER-10)

The part number posted on a weatherproof label on the bottom of the enclosure identifies the version of the device.

The battery-powered portable transmitter includes an alphanumeric keypad and 128-by 128-pixel full graphic display. A compact flash card (*not included in standard delivery*) inserts into a slot on the front of the transmitter for data storage. The unit includes various ports for sensors, digital and analog inputs and outputs, and power features.

Part	Description
1	Display
2	Keypad
3	Communications port (*not applicable*)
4	Combined mains adapter / battery charger port
5	Air-ultrasonic depth sensor port or external depth measurement 4-20 mA
6	Water-ultrasonic velocity / combination sensor or electronic box port
7	Multi-function port for connecting connection-box, active digital input, 0/4-20 mA input signal, or 0- to 10-volt voltage output and relay output
8	Battery compartment
9	Compact flash card slot with cover

Portable FlowShark Pulse

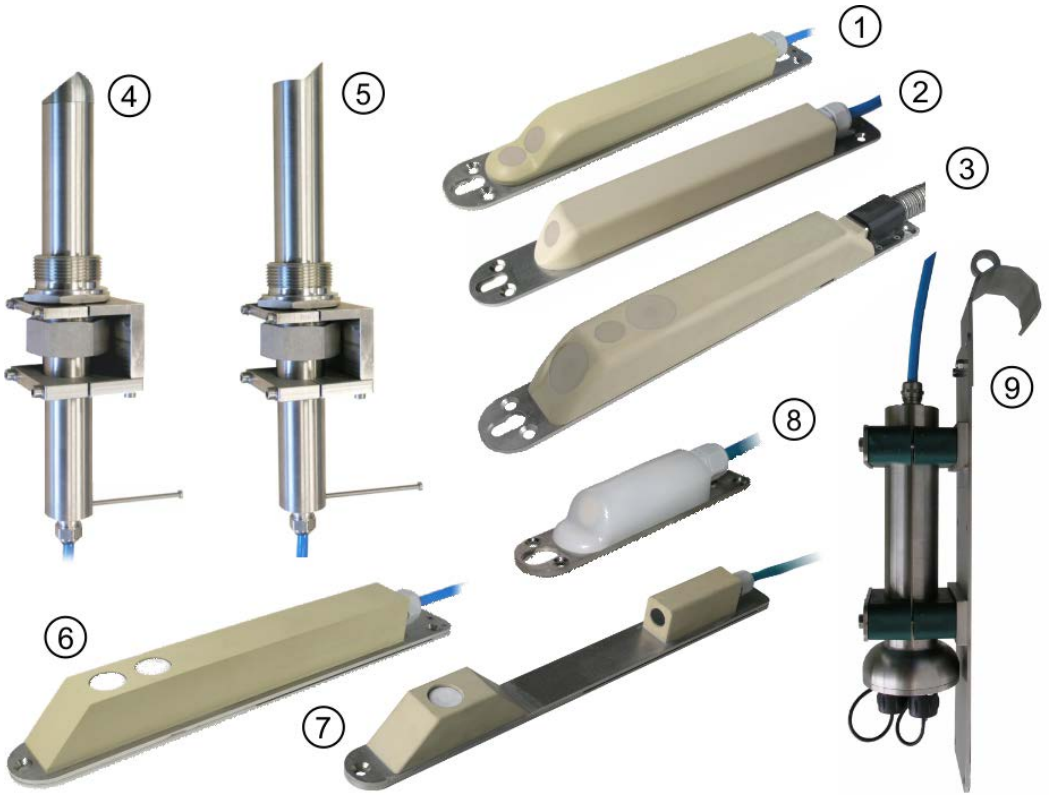


Possible combinations

Use the connector-box only when connecting more than one input or output to the multi-functional port at the same time.

Sensors

The Portable FlowShark Pulse supports several sensor models, including water-ultrasonic velocity/combination, pipe insertion, and air-ultrasonic sensors, that are available in different versions. Individual models may vary based on measurement capabilities, cable length, and unique construction. The part number identifying the sensor model is printed at both ends of the cable and on the bottom of the ground plate.



1	Water-Ultrasonic Combination Sensor
2	Water-Ultrasonic Velocity/Combination (with pressure measurement cell) Sensor
3	Water-Ultrasonic Velocity/Combination Sensor – *not supported by the Portable FlowShark Pulse*
4	Pipe Insertion Sensor with sensor screw connection and retaining element – *not supported by the Portable FlowShark Pulse*
5	Pipe Insertion Sensor with sensor screw connection and retaining element
6	Air-Ultrasonic Depth Sensor
7	Mini Air-Ultrasonic Depth Sensor for connection to external Electronic Box (EBM)
8	Mini Water-Ultrasonic Velocity Sensor for connection to external Electronic Box (EBM)
9	Electronic Box (EBM)

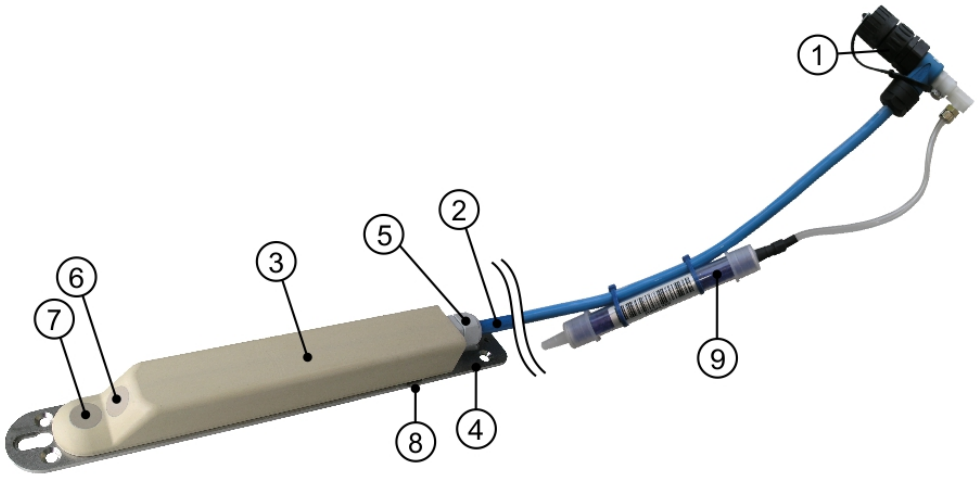
Sensors and Electronic Box

The following sections describe the design and function of the available sensors.

Water-Ultrasonic Velocity/Combination (*Wedge*) Sensors

The Portable FlowShark Pulse uses a combination sensor that can simultaneously determine both flow velocity and flow depth or a standalone velocity sensor. A combination sensor may contain up to two 2 depth measurement devices: a water-ultrasonic device and a hydrostatic (pressure) device. Two independent piezo crystals function as transmitter or receiver for taking ultrasonic measurements to determine flow depth and velocity.

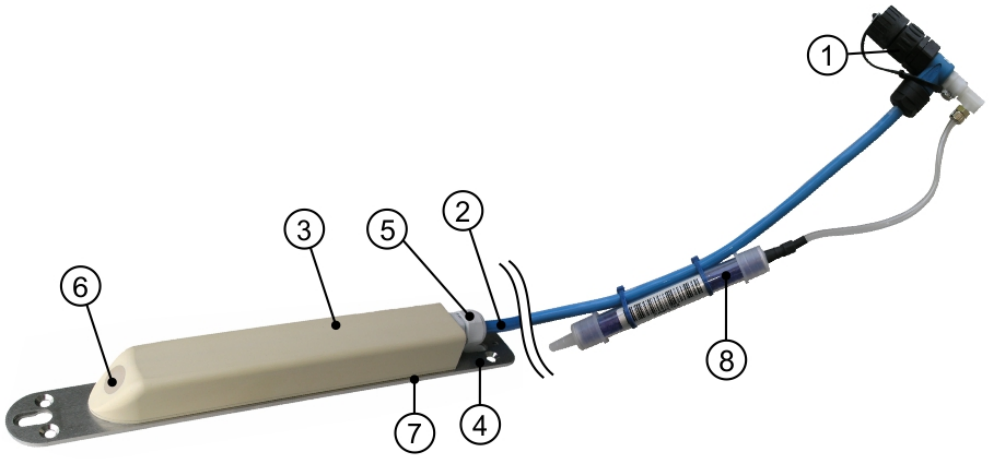
Water-Ultrasonic Combination Sensor



1	Connector with Spigot Nut (*optional*)
2	Sensor Cable
3	Sensor Body
4	Ground Plate
5	Cable Gland
6	Sensor for Flow Velocity Measurement
7	Sensor for Depth Measurement using Water-Ultrasonic (*optional*)
8	Sensor for Depth Measurement using Pressure (*optional*)
9	Air Filter (*optionally equipped with connector*)

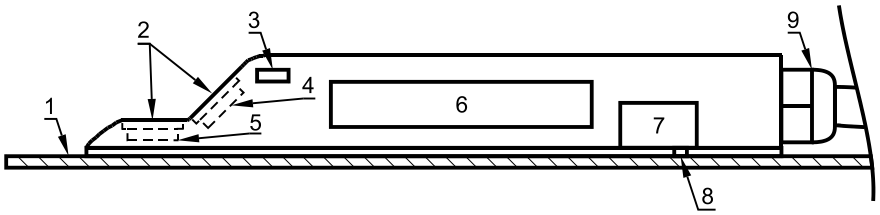
Water-Ultrasonic Combination Sensor with water-ultrasonic depth option

Water-Ultrasonic Velocity/Combination Sensor



1	Connector with Spigot Nut (*optional*)
2	Sensor Cable
3	Sensor Body
4	Ground Plate
5	Cable Gland
6	Sensor for Flow Velocity Measurement
7	Sensor for Depth Measurement using Pressure Measurement Cell (*optional*)
8	Air Filter (*optionally equipped with connector*)

Water-Ultrasonic Velocity/Combination Sensor with pressure depth option



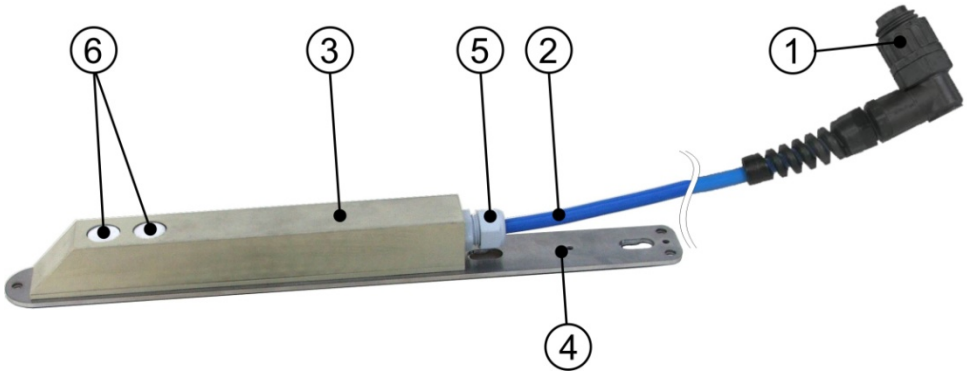
1	Ground Plate
2	Acoustic Coupling Layer
3	Temperature Sensor
4	Flow Velocity Sensor
5	Level (Depth)/Height Sensor (*optional*)
6	Electronics
7	Pressure Sensor (*optional*)
8	Pressure Measurement Duct (*optional*)
9	Cable Gland

Water-Ultrasonic Combination Sensor with additional pressure measurement cell for installation at pipe bottom

Air-Ultrasonic Depth Sensor

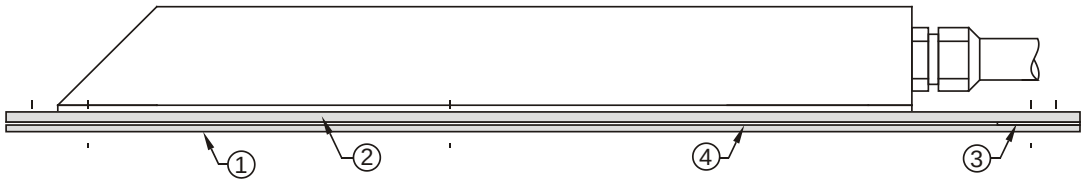
ADS offers an air-ultrasonic depth sensor for the Portable FlowShark Pulse that uses horizontal sensor crystals to determine the distance (*range*) from the sensor to the flow surface based on the time difference between transmitting and receiving a pulse reflected off the flow surface (*the transit-time method*). The flow depth is calculated by subtracting the range from the pipe height, while compensating for the sensor offset.

The air-ultrasonic depth sensor is not effective for depth measurement when the sensor becomes submerged or depths occur within 4 inches of the sensor crystal, known as the *deadband*.



1	Plug with Spigot Nut (*optional*)
2	Sensor Cable
3	Sensor Body
4	Ground Plate
5	Cable Gland
6	Sensors for Depth Measurement using Air-Ultrasonic

Air-Ultrasonic Depth Sensor



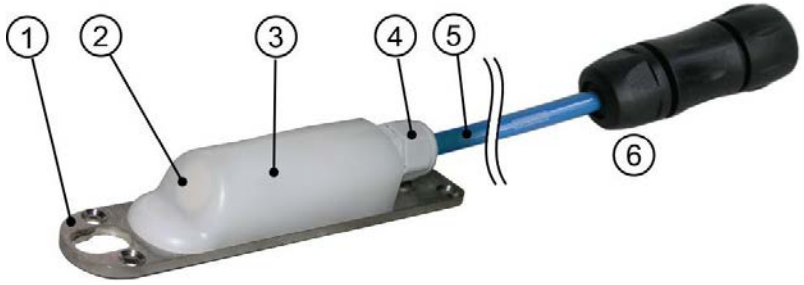
1	Ground Plate 1 (*optionally removable*)
2	Ground Plate 2 (base plate)
3	Ground Plate 3 (spacer plate)
4	Cut-out for Pipe Mounting Plate

Air-Ultrasonic Depth Sensor

Mini Sensors

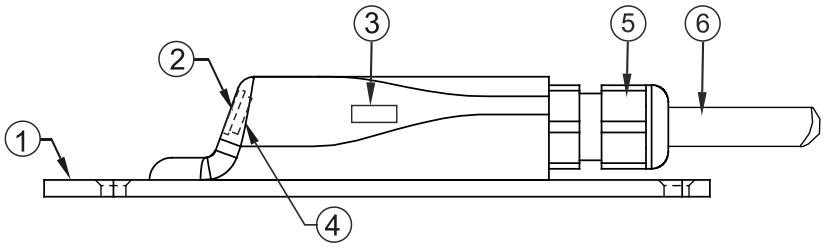
The Portable FlowShark Pulse also offers a "Mini" sensor family. This sensor family consists of the Electronic Box (EBM) (active electronics) and two passive sensors: the mini water-ultrasonic passive flow velocity sensor (below) used for measuring velocity and the mini air-ultrasonic passive depth sensor used for measuring level (i.e., depth).

Mini Water-Ultrasonic Velocity (Wedge) Sensor



1	Ground Plate
2	Sensor for Flow Velocity Measurement
3	Sensor Body
4	Cable Gland
5	Sensor Cable
6	Connector with Spigot Nut

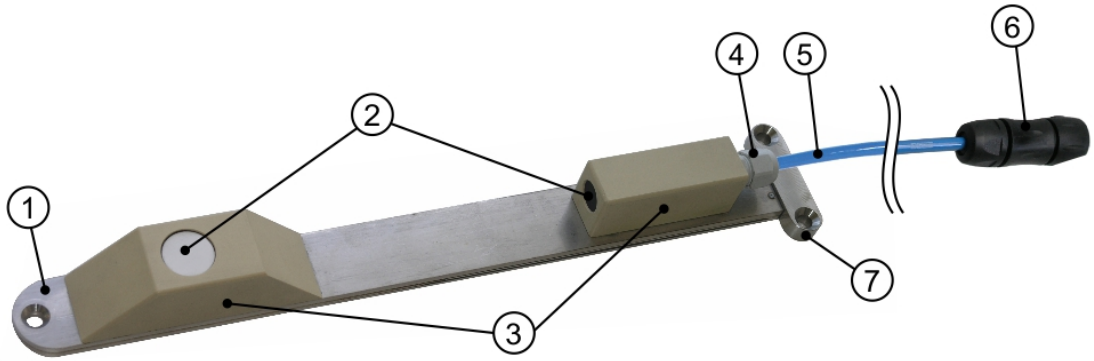
Mini Water-Ultrasonic Velocity Sensor



1	Ground Plate
2	Acoustic Coupling Layer
3	Temperature Sensor
4	Flow Velocity Sensor
5	Cable Gland
6	Sensor Cable

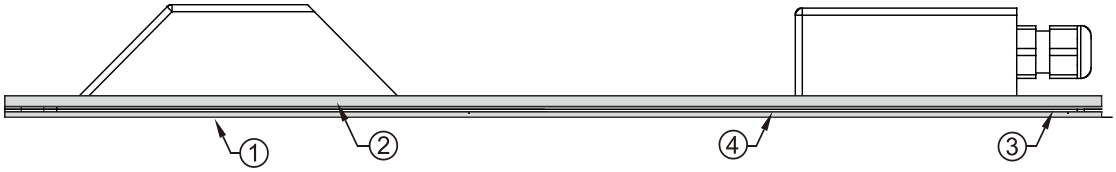
Mini Water-Ultrasonic Velocity Sensor

Mini Air-Ultrasonic Depth Sensor



1	Ground Plate
2	Sensor for Depth Measurement using Air-Ultrasonic
3	Sensor Body
4	Cable Gland
5	Sensor Cable
6	Connector with Spigot Nut
7	Fastening Clamp for Ceiling Installation

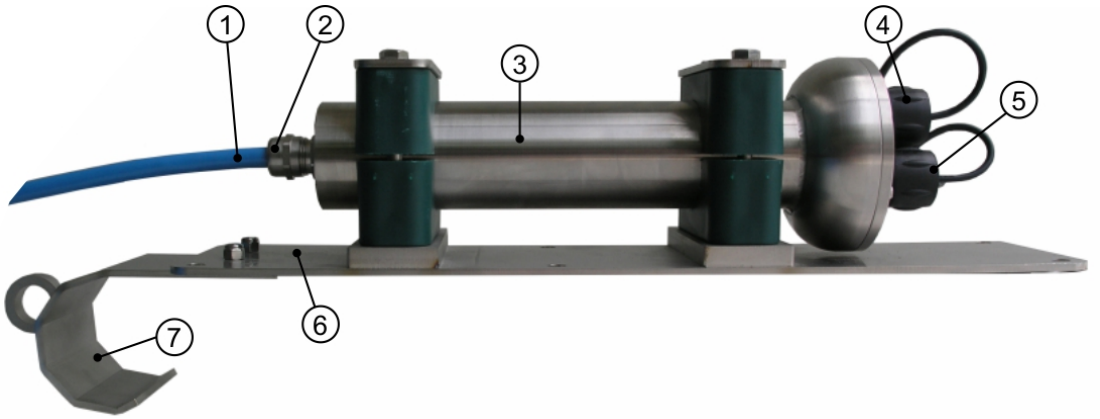
Mini Air-Ultrasonic Depth Sensor



1	Ground Plate 1
2	Ground Plate 2 (base plate)
3	Ground Plate 3 (spacer plate)
4	Cut-out for Pipe Mounting Plate

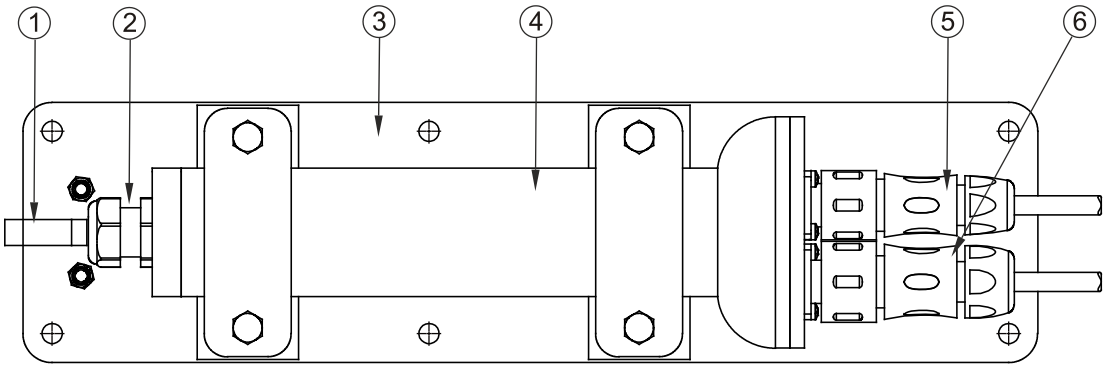
Mini Air-Ultrasonic Depth Sensor

Electronic Box



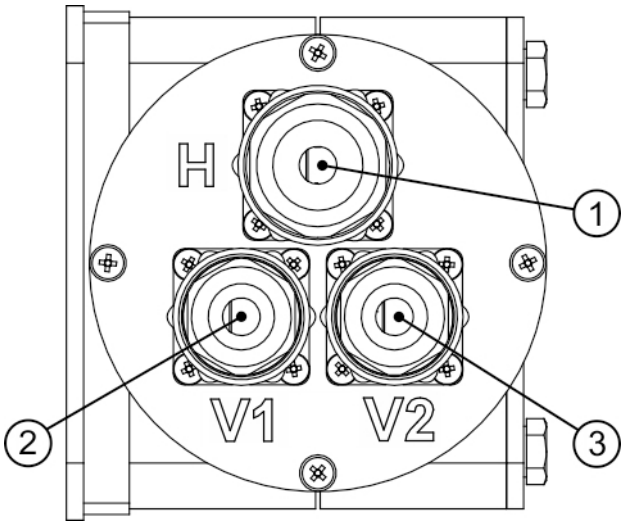
1	Cable Connection to the Portable FlowShark Pulse
2	Cable Gland
3	Electronic Box Body
4	Connector for Mini Water-Ultrasonic Velocity Sensor
5	Connector for Mini Air-Ultrasonic Depth Sensor
6	Mounting Plate
7	Suspension Bracket

Electronic Box (EBM)



1	Cable
2	Cable Gland
3	Ground Plate
4	Electronic Body
5	Port for Mini Water-Ultrasonic Velocity Sensor
6	Port for Mini Air-Ultrasonic Depth Sensor

Electronic Box (EBM)



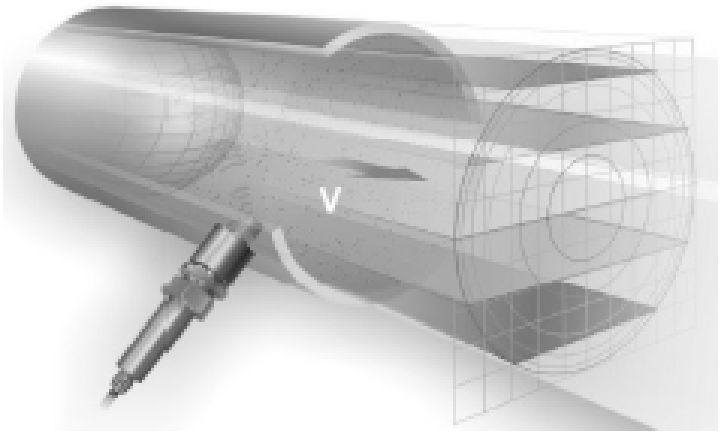
1	Port for Mini Air-Ultrasonic Depth Sensor
2	Port for Mini Water-Ultrasonic Velocity Sensor
3	*Not supported at this time*

Overview of socket wiring for Electronic Box (EBM)

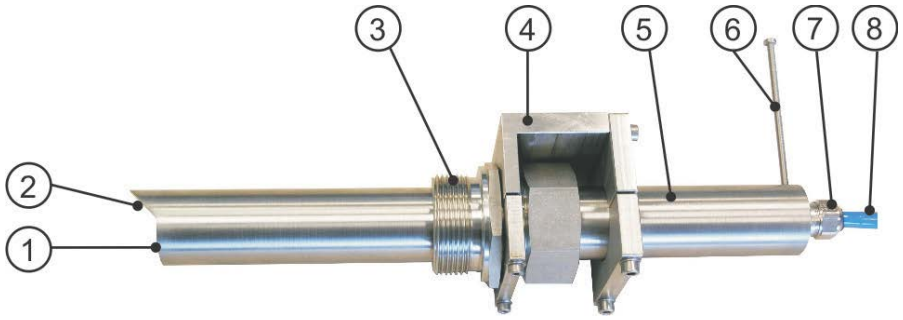
Pipe Insertion Sensor

The pipe insertion sensor primarily is used to measure flow velocity in closed pipes that remain full, eliminating the need for a depth measurement device. When installed, the sensor mounts perpendicular to the pipe and extends from the outside of the pipe, through the pipe wall, and slightly into the flow.

The pipe insertion sensor uses the same technology for measuring velocity as the velocity component of the combination sensor. Therefore, refer to *Flow Velocity Measurement* on page 2-15 for more information on the method employed by this sensor for velocity measurement.



Pipe insertion sensor



1	Sensor for Depth Measurement using Water-Ultrasonic (*optional*)
2	Sensor for Flow Velocity Measurement
3	Sensor Screw Joint (*mobile*)
4	Retaining Element
5	Sensor Body
6	Installation Help Screw M4
7	Cable Gland
8	Sensor Cable

Pipe Insertion Sensor

Flow Depth Measurement

Based on the sensor model, the water-ultrasonic velocity/combination sensor may perform up to two types of depth measurement:

- Water-ultrasonic
- Hydrostatic fill level measurement

Water-Ultrasonic

Water-ultrasonic depth measurement involves using a horizontal sensor crystal to determine flow depth based on the time difference between transmitting and receiving a signal reflected off the flow surface (*the transit-time method*).

$$h_{l} = \frac{c \bullet t_{l}}{2}$$

Where,

h = Depth (i.e., fill) Level

c = Transit Time of Sound

t_1 = Time Elapsed Between the Transmitted and Received Signal

Sound travels in water at a speed of 4856 feet per second (1480 m/s) at 68 °F (20 °C), varying at a rate of 0.13 % for each difference in degree Fahrenheit (0.23% for each

degree Centigrade). To ensure accurate depth measurements, all calculations must compensate for the flow temperature.

Adding the sensor offset to the measured depth value (h_1) determines the depth total (h). The sensor offset represents the distance from the bottom of the pipe to the sensor crystal position. The measured depth value represents the distance from the crystal to the flow surface.

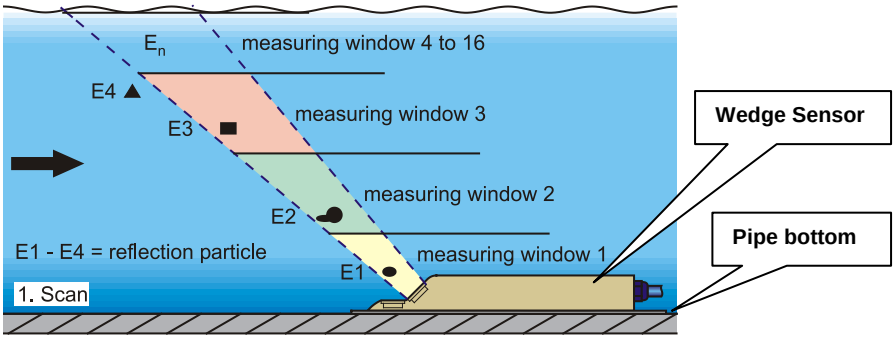
Hydrostatic Fill Level (Pressure)

Based on the type of sensor selected, the combination sensor may have an integrated hydrostatic depth measurement device. This piezoresistive pressure sensor operates according to the relative pressure principle, where the pressure of the standing water column above the sensor is directly proportional to the depth level. This device can measure depth levels even when the combination sensor is installed away from the bottom center of the pipe.

During installation, this sensor must be calibrated based on a manual depth measurement and the position of the sensor in the pipe.

Flow Velocity Measurement

The water-ultrasonic velocity/combination sensor has a piezo crystal sloped toward the flow for measuring flow velocity. This crystal sends an ultrasonic pulse at a defined angle into the oncoming flow. All air and/or dirt particles in the path of the pulse reflect a small amount of the ultrasonic signal back to the sensor. The size and shape of a particle determines the result of the reflected signal. Together, the returned signals produce a reflection pattern received by the piezo crystal. This pattern is converted into electric signals that are saved to a digital signal processor (DSP).

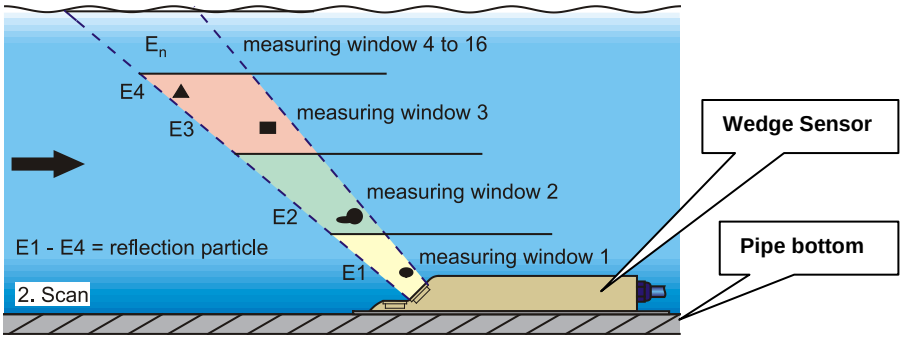


Conditions at first signal detection

After a certain period of time, the sensor sends a second ultrasonic pulse into the flow. The DSP also saves this reflected signal.

Flow velocities differ at varying depth levels, creating a velocity profile. Consequently, the distances (or *movement*) between reflective particles' initial and subsequent positions also vary at different depth levels, resulting in a distorted

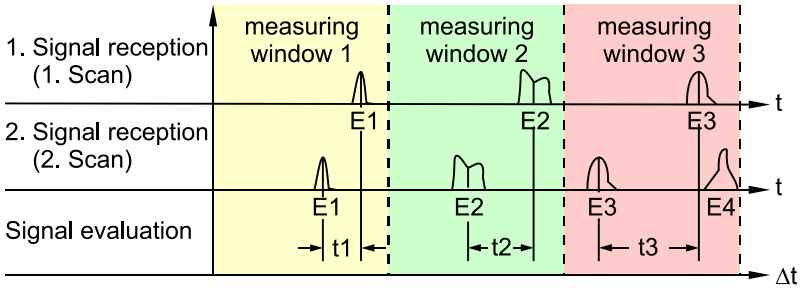
reflection pattern. Several other factors also influence particle reflection and velocity profile measurement. Rotating particles may exhibit multiple shapes for reflection; particles may exit the measurement range before a subsequent measurement can occur; and new particles may enter into the measurement range.



Conditions at second signal detection

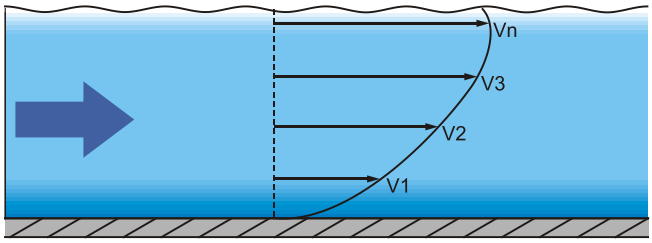
The DSP checks both of the received reflection patterns for similarities using the cross-correlation method. All unidentifiable signals are rejected so that the two similar, but temporarily offset, signal patterns remain for velocity evaluation.

The patterns are analyzed within 16 measurement windows established based on the previous depth levels. The DSP then examines the lag Δt (*change in time – Refer to t1, t2, and t3 below*) of the signal pattern within each measurement window.



Echo signal images and evaluation

The angle of the beam, the interval between the transmitted signals, and the lag Δt of the signal pattern for each measurement window determine the flow velocity. The flow profile indicated on the display reflects the mathematical integration of the individual velocity measurements. Calculating the individual flow velocities produces the velocity profile indicated on the unit display.



Investigated flow profile

Flow volume can be calculated based on the flow velocity distribution, pipe shape and dimensions, and flow depth.

CHAPTER 3

Installation

Reading and following the installation instructions before initial start-up will help ensure success in flow measurement and device configuration. Do not power up the transmitter or initiate start-up until installation is complete and verified. If any problems occur during installation, connection, or configuration, please contact ADS Client Services at adssupportcenter@idexcorp.com or (877) 237-9585.

Installations should be performed only by qualified personnel according to all statutory standards, regulations, and technical rulings. During installation, refer to all local regulations regarding electronic equipment.

Use the Portable FlowShark Pulse and sensors only in accordance with the design of the system for flow detection. Do not install the equipment in an improper or unsuitable manner or select an inappropriate or hydraulically problematic measurement location. These may result in erroneous or insufficient measurement data that is unsuitable for further processing and analysis.

A comprehensive understanding of hydraulic conditions is essential to properly analyzing the data and conducting further data processing.

Transmitter Installation

When selecting a mounting location for the transmitter, avoid locations exhibiting or influenced by the following:

- Direct sunlight (use weatherproof cover, if necessary)
- Heat-emitting objects (maximum ambient temperature of 122°F (50°C))
- Objects generating strong electromagnetic fields (e.g., frequency converters or electric motors that consume significant power)
- Corrosive chemicals or gas
- Mechanical shock
- Walkways or heavy traffic areas
- Vibration
- Radioactive emissions

The Portable FlowShark Pulse must be suspended in a shaft or manhole by the carrying handle using suitable straps, ropes, or similar resources. An optional suspension bracket also is available for special applications, such as mounting the unit to a manhole ladder.

Do not suspend the unit by a sensor cable. This could break the cable, produce leaky port connections, or cause the monitor to become disengaged or possibly lost in the flow.

Before locking the enclosure lid, make sure the seal is clean and intact. Remove any debris and/or dirt and lubricate the gasket with silicone, when necessary. The warranty does not cover damages due to leakage or defective seals.

When installing the unit in a flood shaft or channel, use suspension gear, plastic or steel rope, a chain, or similar materials to secure the transmitter to prevent it from accidentally washing away.

Connect the attached covers to the unused ports on the Portable FlowShark Pulse before installation to provide a locked, watertight seal. Damage to the unit that occurs due to exposed, unprotected ports is not covered by the warranty.

Replacement covers for covers damaged due to excessive force are available through ADS at the customer's expense.

Sensor Installation

Please observe all regulations regarding safety at work and dangers due to explosive gases prior to the beginning of installation activities. Take the appropriate security measures as required.

Choosing a Suitable Location for Sensor Installation

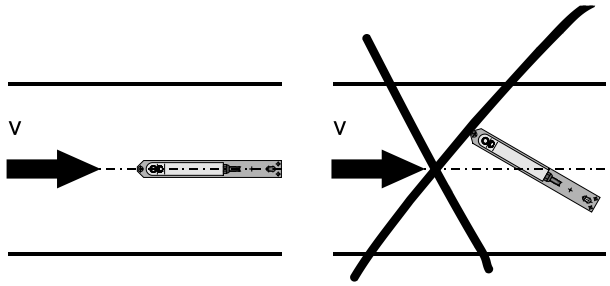
Clear and stable hydraulic conditions are essential for obtaining accurate sensor measurements. Therefore, consider the following when inspecting the physical and hydraulic conditions at all potential installation locations:

- Strictly avoid locations experiencing or near falls, draw-downs, steps, curves, obstructions, pipe joints, or changes in profile or immediately upstream or downstream of inlet or lateral connections.
- Choose a location where sedimentation (e.g., sand, grit, or sludge) does not develop under normal flow conditions. Sedimentation can accumulate due to friction in pipes at locations exhibiting minimal or negative slope or structural deficiencies that create obstructions or pockets. Typically, channels that regularly exhibit flow velocities of more than 2 feet per second will not experience a build-up of sediment.
- Avoid measuring flow depth in closed pipes that remain at least 80 percent full under normal flow conditions. These sites can fill up completely during elevated or peak flows, potentially resulting in backup or surcharge conditions.
- Avoid locations that exhibit significant changes in slope.
- In general, make sure the distance of the upstream approach to the sensor is equal to at least 5 times the approximate diameter of the pipe and the distance downstream from the sensor is equal to at least 2 times the approximate diameter of the pipe. Consider longer sections when turbulent hydraulic conditions generate irregular flow profiles.

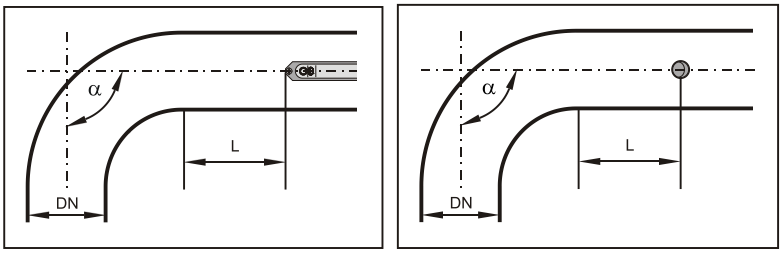
The following figures provide examples of appropriate and problematic sensor installations. Please contact your ADS representative for assistance in selecting an appropriate location or in assessing potential locations for installing sensors to ensure accurate flow measurements. Forward any applicable drawings and/or photos.

The following examples apply only to wedge and pipe insertion sensors.

Sensors in Partially-Filled Pipes

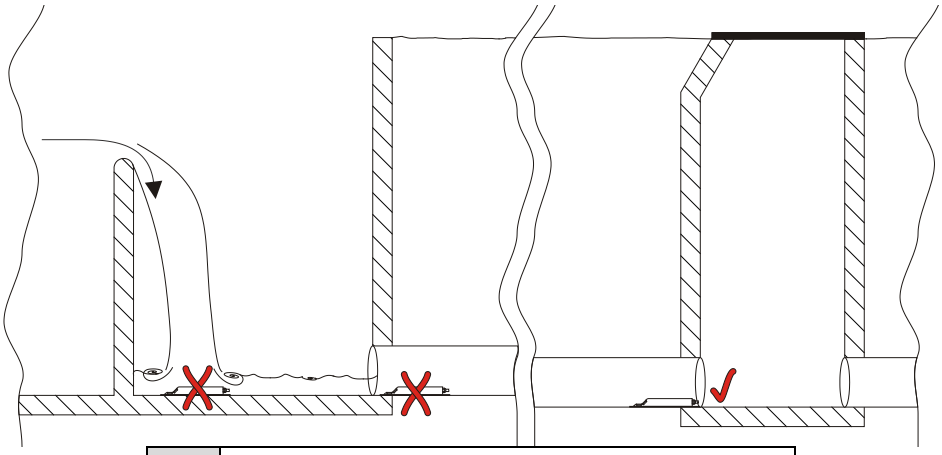


Sensor Adjustment: (left) proper installation in center that should yield reliable measurements; (right) faulty installation that will yield erroneous measurements



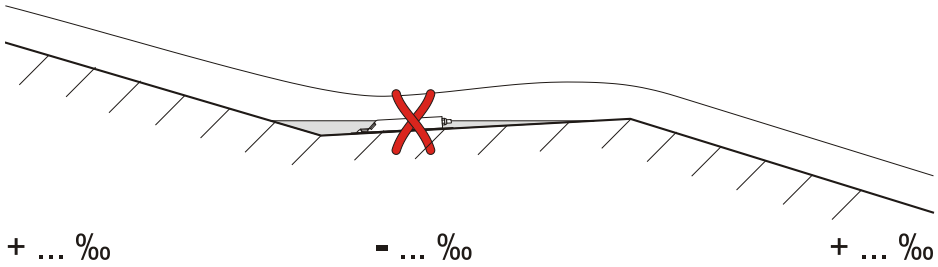
Angle of the Curve in the Pipe	v ≤ 3.3 feet per second (1 m/s)	v > 3.3 feet per second (1 m/s)
α ≤15°	L ≥ min. 3 x DN	L ≥ min. 5 x DN
α ≤45°	L ≥ min. 5 x DN	L ≥ min. 10 x DN
α ≤90°	L ≥ min. 10 x DN	L ≥ min. 15 to 20 x DN

Sensor positioned behind curves or elbows



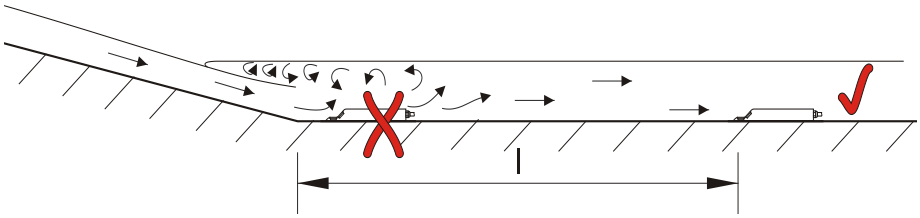
✕	Error! Undesirable flow conditions
✔	Sufficient distance to obtain steady flow (10 … 50 x diameter, depending on the application)

Overflow pipes (flows immediately downstream from a weir wall) or drops create unstable flow conditions



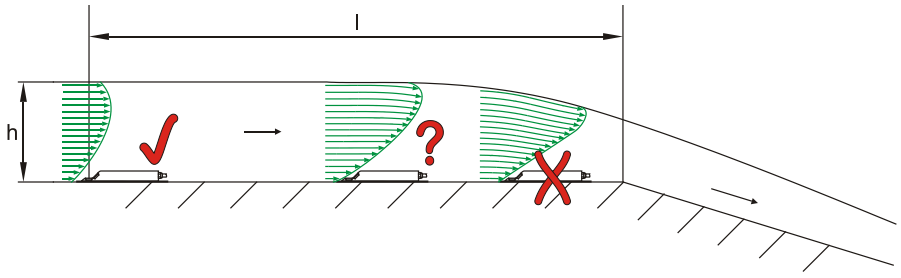
✕	Error! Risk of silt build-up / sludge accumulation caused by negative slope

Negative slope – risk of silt accumulation



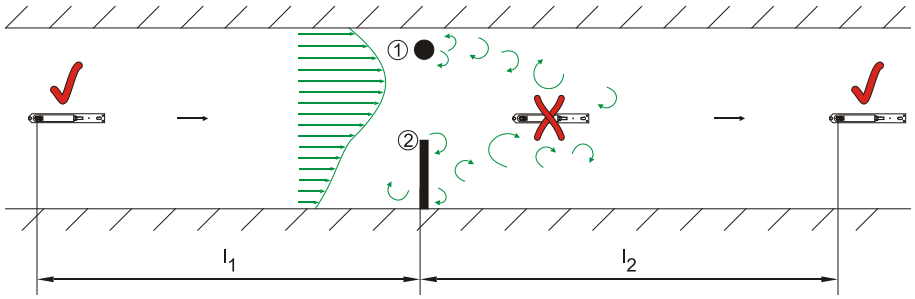
✕	Error! Changes in slope = changes in flow profile
✔	Distance depending on slope and flow velocity reading l = minimum 20 x diameter

Error caused by changes in slope



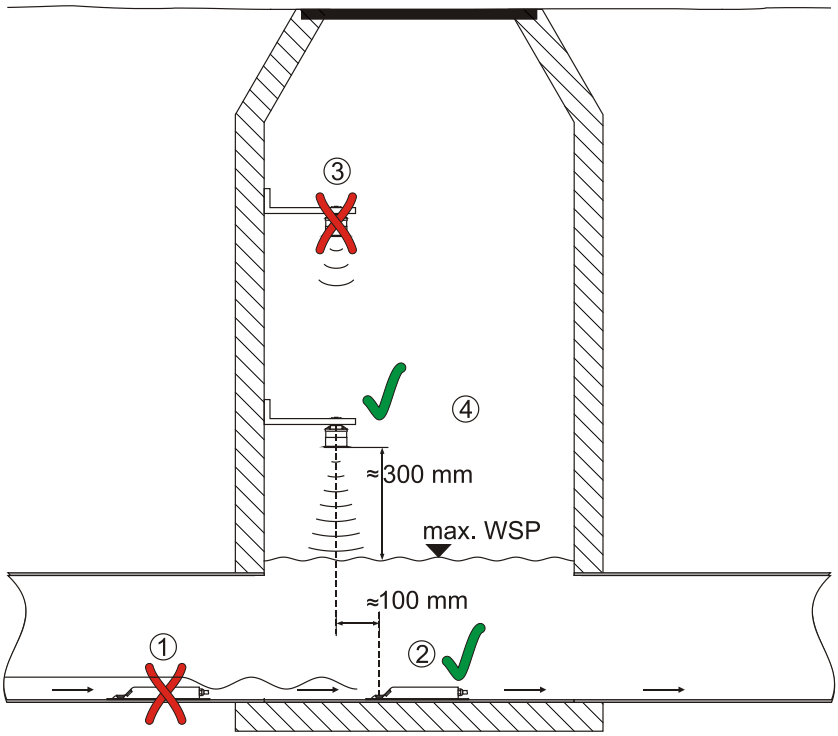
✕	Error! Installed in draw-down, transitioning from flowing to falling Depth measurement may fail and velocity and depth measurement may be erroneous
?	Critical measurement point, not recommended! Flow begins to fall (*or sink*)
✔	Distance l = min. 5 x h_{max} at location of installation

Error caused by changes in flow profile before slope fluctuation or fall



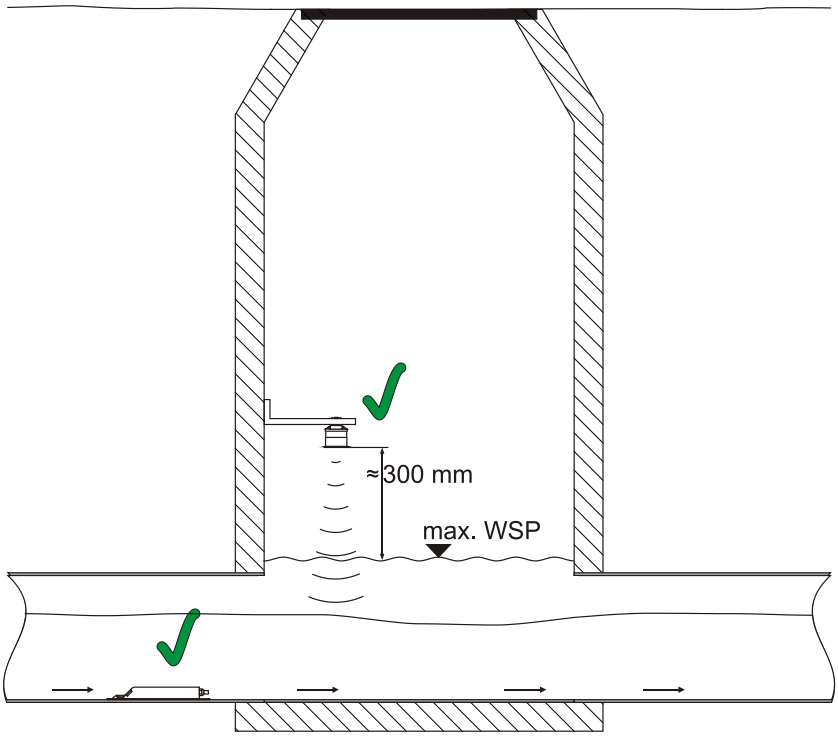
(1)	Equipment such as samplers or similar devices
(2)	Obstruction
✕	Error! Caused by vorticity, peripheral flow, and/or asymmetric flow
✔	Distance l_1 (upstream of obstruction) = min. 5 x h_{max} Distance l_2 (downstream of obstruction) = min. 10 x h_{max} in case of flow velocities >3.3 ft/s (1 m/s)

Errors caused by equipment or obstructions

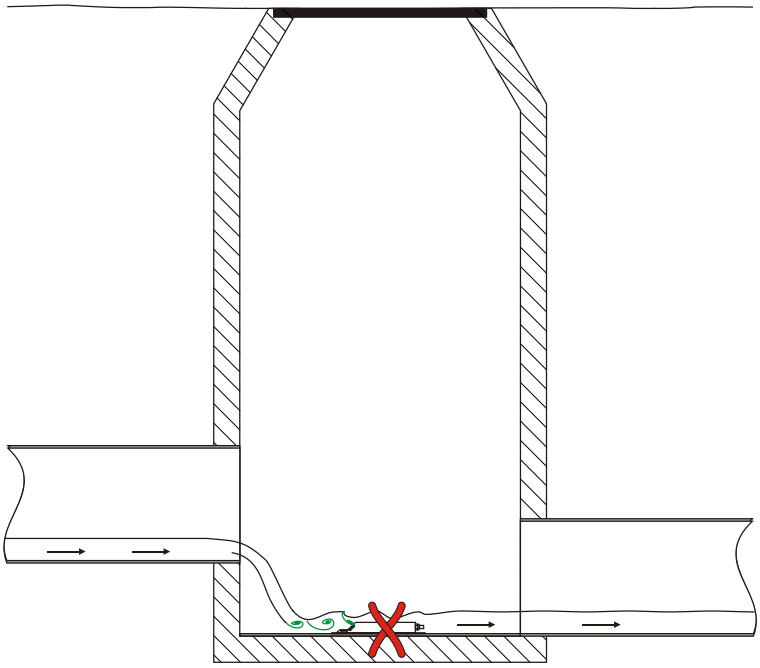


1	Waves forming on water surface behind sensor installed at bottom of pipe cause corresponding air-ultrasonic depth sensor to produce errors.
2	Good (consider installing 0.39 inches (10 mm) lower in low flow depth conditions)
3	Distance too far from edge of sensor bottom to maximum water level
4	Good. Best possible sensor position at maximum water level

Installation in manholes with depth levels ≤ 6 inches (150 mm)



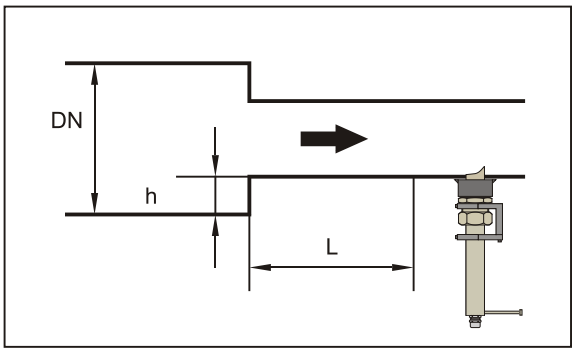
Installation in manhole with depth levels >6 inches (150 mm)



✕	Error! Caused by vorticity and waves forming behind drop → Choose another location or restore manhole

Error caused by drop or changing slope

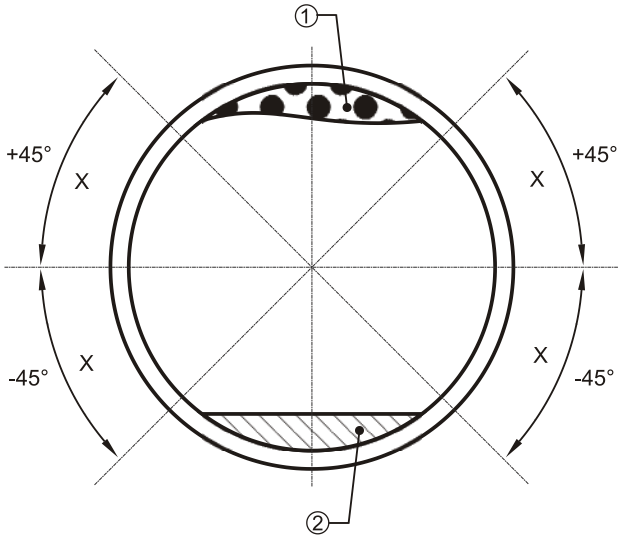
Sensors in Full Channels, Pipes, or Other Applications



h ≤ 5% of DN	L ≥ min. 3 x DN
h > 5% of DN	L ≥ min. 5 x DN
h ≥ 30% of DN	L ≥ min. 10 x DN

Sensor position after change in profile

For horizontal/level pipes, avoid mounting the sensors at the top or bottom of the pipe. Risk exists for sedimentation/silt or air bubbles resulting in measurement failure. ADS recommends mounting the sensor at a location -45° to +45° from the center horizontal axis of the pipe.

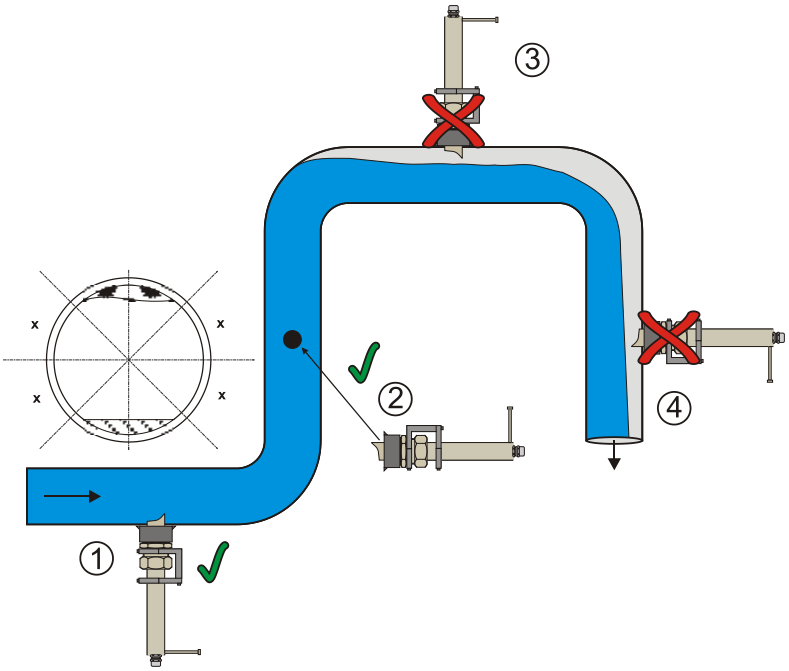


X	Recommended sensor installation positions
1	Risk of air bubbles
2	Risk of sludge deposits

Recommended installation angles

Vertically laid pipes do not carry the same risk of swamping/air; therefore, any mounting location may be selected.

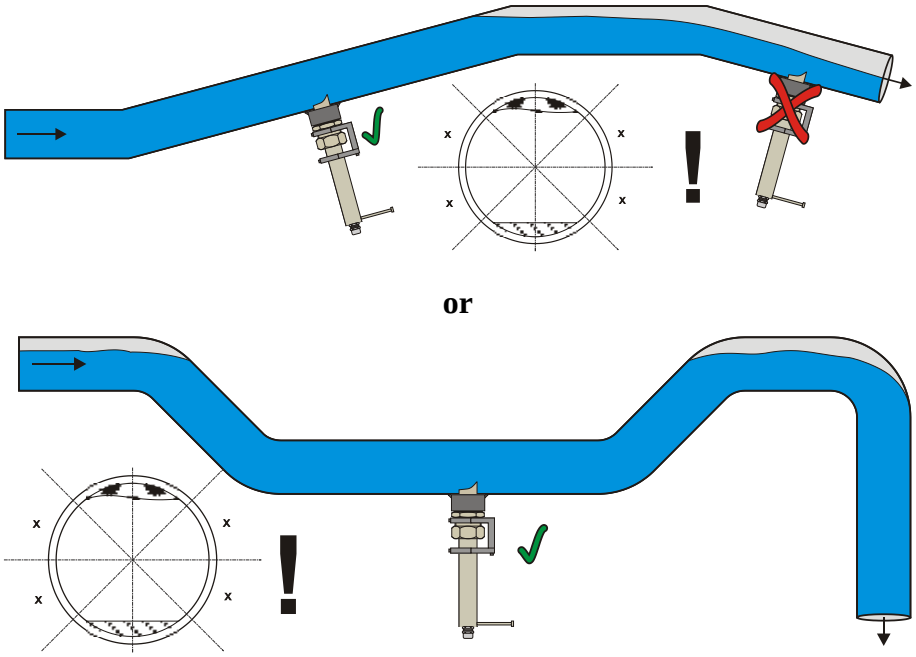
However, an accurate and reliable measurement can be performed only in full pipes. For this reason, do not install sensors in downpipes or at the highest point of the pipeline.



1	Recommended range in almost horizontal position (sensor can be installed on the side)
2	Recommended range in vertical pipe
3	Not recommended due to partial filling/idling
4	Measuring impossible due to idling

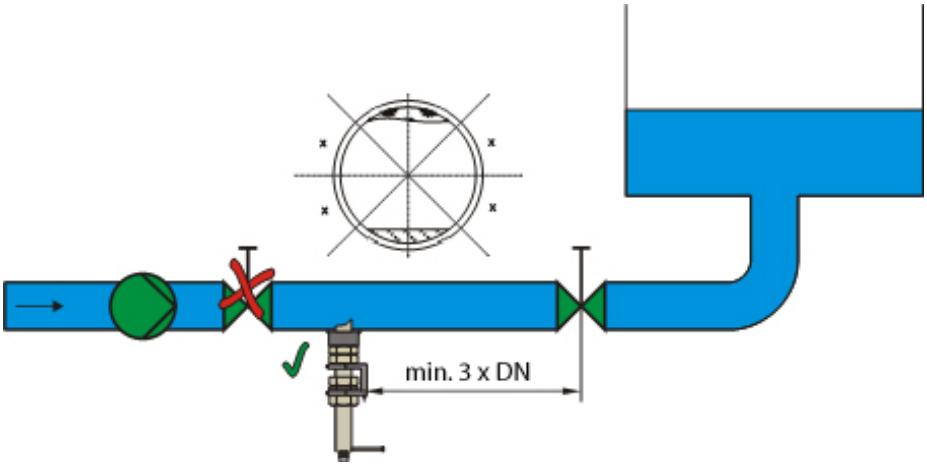
Comparison of installation locations

When measuring in horizontal pipes, ADS recommends considering a slightly inclined section or an inverted siphon.



Horizontal pipe with inverted siphon

Always install shut-off valves and control fittings downstream of flow velocity sensors.



Using shut-off valves and control fittings

Never install sensors on vibrating pipes. This may result in erroneous readings.

Sensor Installation

When installing the sensors, use only non-corrosive fastening materials and fasten the sensors both securely and tightly. Orient the velocity sensor so that the sloped side of the sensor is facing upstream against the direction of the flow.

To avoid disturbances from electrical interference, do not locate sensor cables close (or parallel) to an engine (motor) or main power lines.

Water-Ultrasonic Velocity/Combination Sensor

To install the combination sensor permanently at the bottom of the pipe, use 4 stainless steel screws of sufficient length (*M5, between 1.18 and 2.76 inches (30 and 70 mm)*) with the accompanying anchors, when necessary, *or* use an appropriate mounting plate with the sensor and properly anchor the plate. Choose screws of an adequate length to ensure the sensor can be safely and securely fastened and the installation will remain durable under any operational conditions. Determine the length of the screws based on the construction, consistency, and integrity of the structure to which the sensor will be secured. ADS does not recommend using studs or similar types of bolts directly on the sensor plate.

Screws and fasteners extending into the flow can introduce turbulence or build-up in a wastewater environment, potentially resulting in erroneous flow measurements. Therefore, use well-fitting, counter-sunk screws and screw them completely into the mounting plate so that they are as flush as possible with the plate.

Unless otherwise specified, install the sensor at the center of the pipe with the beveled edge facing the oncoming flow (*upstream*).

Although the design of the sensor significantly limits the build-up of debris from the flow, the sensor mounting plate is more susceptible to build-up. Therefore, make sure that a gap does not exist between the sensor mounting plate and the bottom of the pipe. Following installation, seal any gap or seam that may exist around the tip of the sensor with silicone or a similar material.

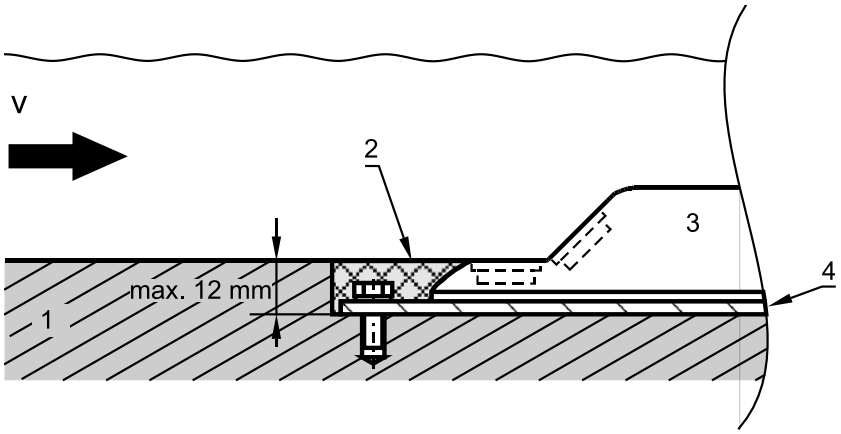
The bottom of the pipe must be completely flat (plane surface) for sensor installation. Otherwise, the sensor could experience damage or leakage, resulting in potentially irreparable damage to the electronic components.

Do not bend the ground plate during installation or removal. Use only an appropriate screwdriver for sensor removal; do not use a pry bar, chisel, hammer, lever, crowbar, hammer drill, or similar tool. In addition, do not use excessive force to remove the sensor.

Do not remove any sensor parts! Removing or loosening the ground plate and/or cable glands on the sensor will result in leakage and sensor failure.

For sensors **without** an integrated pressure element, the sensor may be installed in a depression at the bottom of the pipe up to 0.5 inches (12 mm) deep. This will allow the lowest measurable depth level and limit the susceptibility of the sensor to debris buildup. Once installation is complete, fill in the remaining gaps and seams with a permanently elastic material, such as silicone.

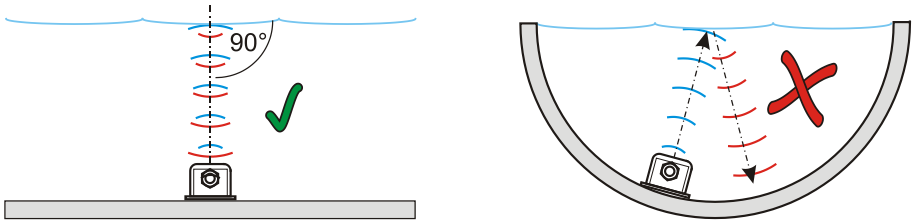
Never countersink combination sensors with integrated pressure measurement cells. The sealing material on the sides of the countersunk sensor or accumulated debris/silt could result in erroneous measurements and/or pressure measurement cell failure.



1	Pipe bottom
2	Silicone or similar
3	Water-Ultrasonic Velocity/Combination Sensor
4	Mounting plate

Suggestion for installing countersunk Water-Ultrasonic Combination Sensors

To prevent signal loss and depth measurement failure, install sensors with integrated water-ultrasonic capability so that the signal will strike the flow surface at a right angle.



Installing a sensor with the integrated water-ultrasonic measurement capability

Water-Ultrasonic Velocity/Combination Sensors with Integrated Pressure Measurement Cell

To compensate for atmospheric pressure, sensors with integrated pressure measurement cells have an air hose located inside the cable. Do not buckle or seal this air hose or clamp the hose into hermetically sealed connection sockets without air pressure compensation. The pressure cell cannot measure flow depth accurately under these conditions.

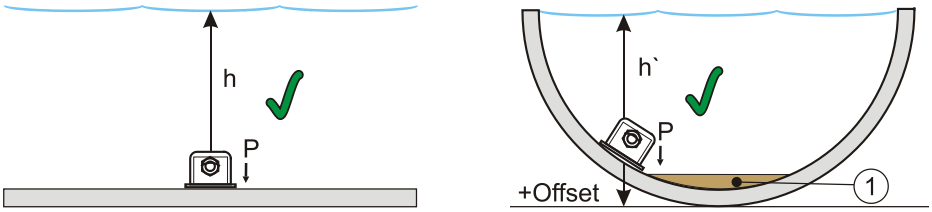
Operating sensors with an integrated pressure measurement cell with a filter element that is no longer able to absorb moisture may lead to irreversible damage to the sensor electronics.

Due to the physical design and installation of the sensor, measurement errors may occur when using a combination sensor with a pressure measurement cell under high velocity/low flow depth conditions.

Never touch the pressure element with fingers, brushes, tools, water jets, or similar items! Otherwise, the pressure element might be damaged, resulting in measurement failures.

Never remove the cover of the pressure measurement cell during installation! This cover protects the cell from damage by an external source.

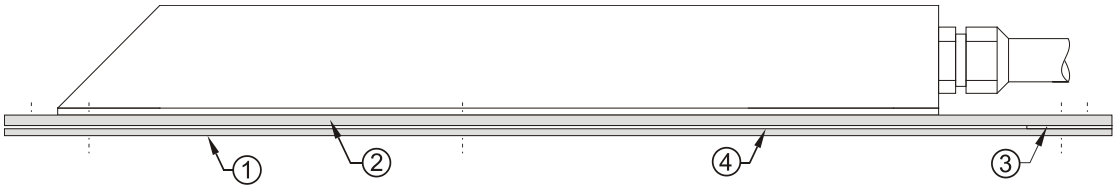
When silt or sedimentation is present, consider installing sensors with an integrated pressure measurement cell off-center. The pressure measurement cell can still detect the depth level above the sensor when installed up the side of the pipe. However, be sure to enter the resulting offset into the transmitter in the sensor installation level parameter section.



Installing sensor with integrated pressure measurement cell (1 represents sedimentation (i.e., sand or sludge))

Air-Ultrasonic Depth Sensors

Install an air-ultrasonic depth sensor using a pipe mounting system (RMS). To install the sensor using this mounting system, run the mounting sheet located in the pipe vertex (crown) through the cut-out in the air-ultrasonic depth sensor prior to final assembly.

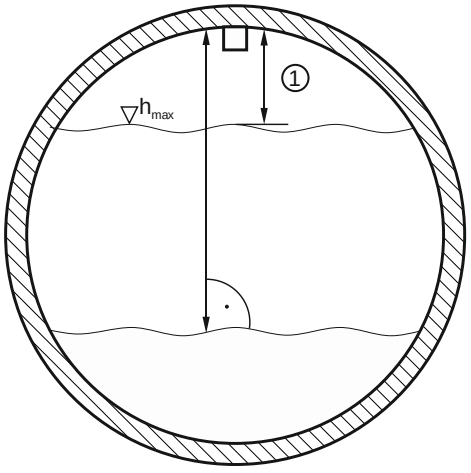


1	Ground Plate 1
2	Ground Plate 2
3	Ground Plate 3
4	Cut-out for Pipe Mounting Plate

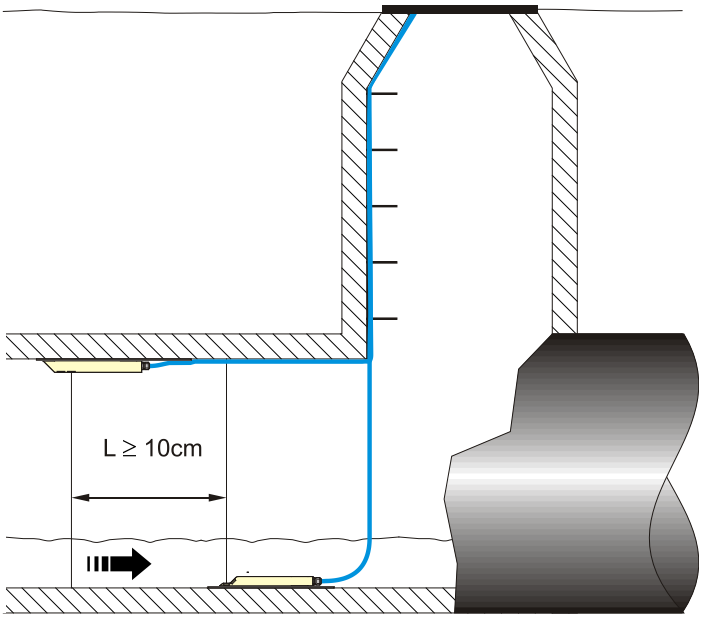
Fastening the air-ultrasonic depth sensor to the pipe mounting system

Before clamping the system into the pipe, adjust the sensor so that it is completely parallel with the flow surface.

When installing an air-ultrasonic depth sensor and a water-ultrasonic velocity sensor together, locate the air-ultrasonic depth sensor upstream at least 4 inches (10 cm) ahead of the sensor at the bottom of the pipe.



Installing the air-ultrasonic depth sensor



Arranging the sensors in the pipe

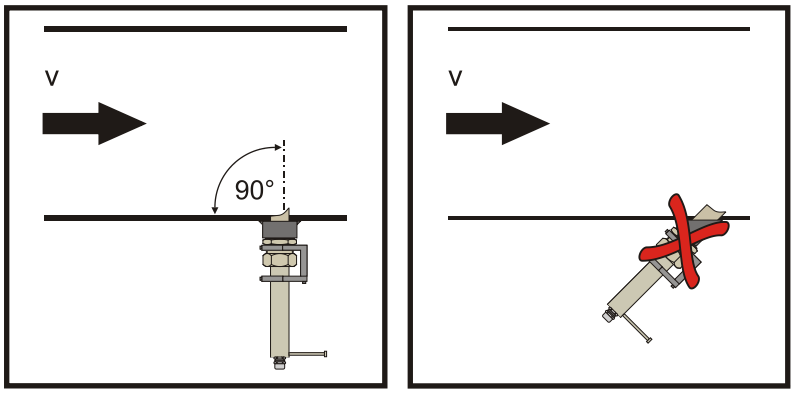
For a permanent installation, secure the air-ultrasonic depth sensor to the top of the pipe with 3 stainless steel screws (M5) or use the pipe mounting plate and attach the plate with appropriate anchors. To permanently secure the mini air-ultrasonic depth sensor, use the accompanying mounting shoe. Use screws of an appropriate length to ensure safety and durability under all operational conditions.

The air-ultrasonic depth sensor has a deadband of 4 inches (10 cm); the mini air-ultrasonic depth sensor has a 1.6-inch (4-cm) deadband. Depth levels cannot be measured within the deadband.

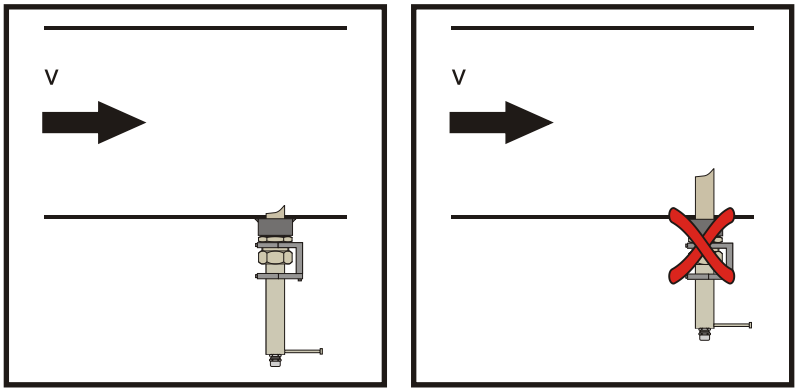
If the air-ultrasonic depth sensor becomes submerged, the sensor will send the signal directly into the flow. Since sounds travels faster in flow than in air, erroneous depth measurements are likely to occur. Therefore, do not include the deadband in the maximum depth parameter for the air-ultrasonic depth sensor.

Pipe Insertion Sensor

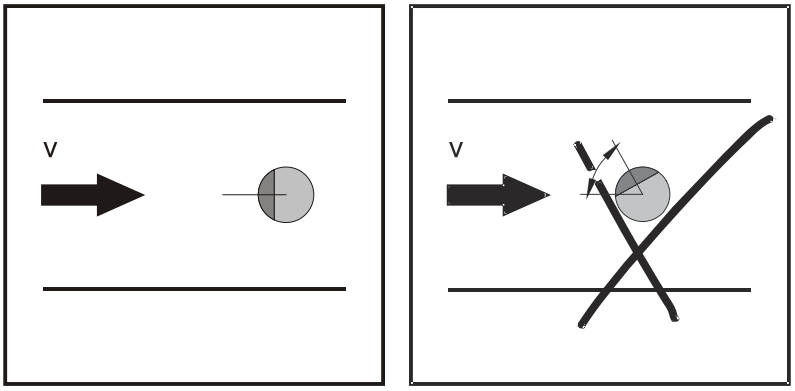
The pipe insertion sensor is most suitable for applications such as closed pipes that remain full. Once installed, the inclined side of the velocity sensor must be facing upstream and the horizontal portion of the sensor must be flush with the pipe wall. The installation aid must be facing downstream. Use only non-corrosive fastening hardware to secure the sensor securely and tightly. Screw the pipe sensor tightly into the 1.5-inch nozzle using a gasket ring and the retaining element.



Proper installation (left) and improper installation (right)



Installation susceptible to buildup of debris (left) and improper installation (right)



Sensor properly facing flow direction (left) and sensor facing the wrong direction (right)

Please note the following for installation in pipes:

- *Weld on the 1.5-inch nozzle at a 90° angle.*
- *Position the sensor so that the bevelled edge is facing upstream.*

The sensor block must be welded to steel and stainless steel 1.4571, glued to PVC, welded to HDPE, or laminated to PVC. To perform upgrades, ADS recommends using a tapping saddle. Make sure the access hole into the pipe is 1.5 inches (38 mm) in diameter and goes completely through the pipe (including any ball or gate valve) to

accommodate the sensor shaft. ADS recommends using a 1.5-inch (38-mm) diameter steel rod to test for interference to ensure the sensor shaft will fit into the pipe.

For assistance when installing the sensor taps or fittings, please contact the pipe manufacturer or a professional pipe fitter.

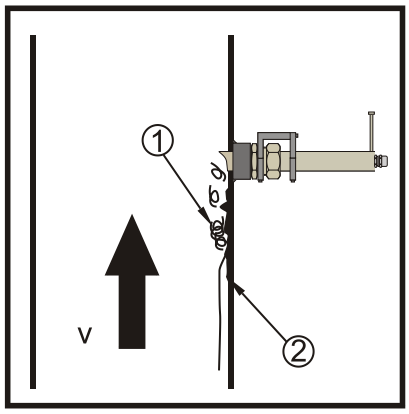
Risk of accident!

Always use a mobile safety circuit breaker when working in a wet environment and/or drilling into full pipes!

Please ensure the turnings can easily escape while drilling. Interrupt drilling as necessary to remove turnings before proceeding. Remove burrs with a file once drilling is complete to prevent measurement errors.

Never burn pipes with welding torches!

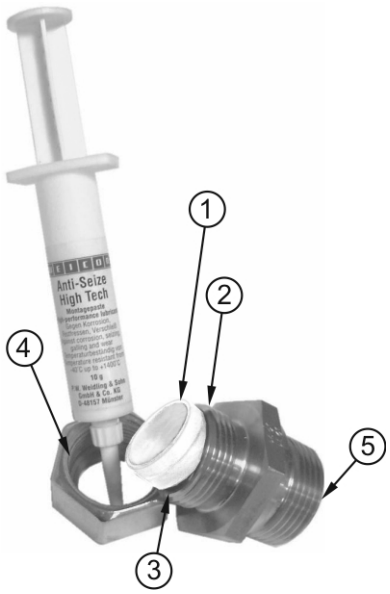
A burn in a weld seam may cause swirls and, therefore, result in measurement errors.



1	Whirls/chips
2	Weld seam burn

Disturbances and measurement errors caused by weld seam burn

When assembling the pipe insertion sensor, use a special grease for the stainless steel couplings (DIN 2353, or equivalent). Apply a small amount of grease to the cap nut thread, threads, cone, and cutting ring when pre-assembling the insertion sensor. The screw joints come pre-greased from the manufacturer. Purchase additional grease through ADS, when necessary.



1	Gasket ring
2	Thread
3	Inner cone
4	Inner thread of spigot nut
5	O-ring inside of sensor screw connections

Using grease on the cutting ring screw joint

Prior to installation, grease the screw joint at all points shown in the image above.

Install the sensor according to DIN 3859-2.

Screw the screw joint into the welding nozzle, ball valve, or the nozzle of the tapping saddle using a pipe wrench or an open-end wrench (width across flats: 2.2 inches (55 mm)).

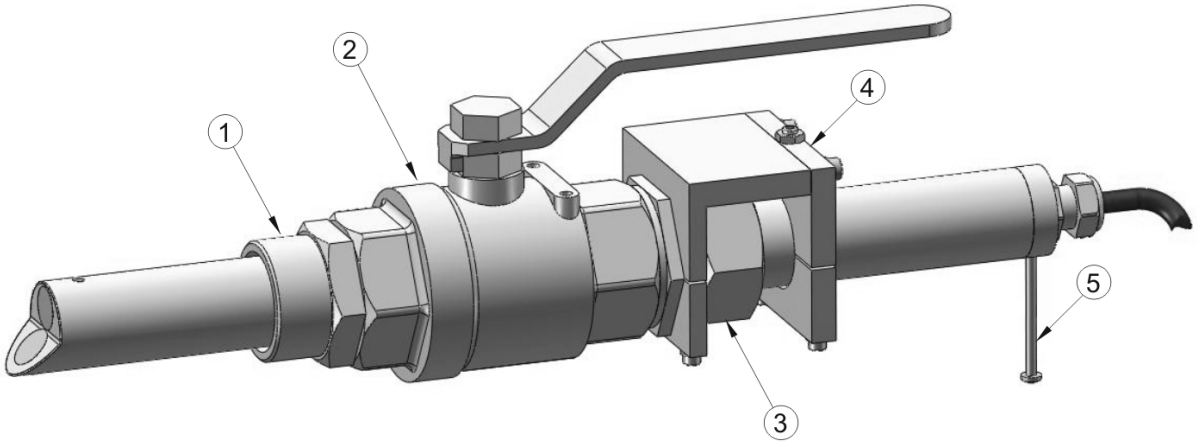
Then, pull the spigot nut and gasket ring over the flow velocity sensor and insert the sensor into the screw joint as deep as necessary (based on the application).

Next, place the gasket ring into the screw connection and tighten the spigot nut manually. Then, to control the number of remaining turns, use a marker to mark the spigot nut prior to tightening the nut an additional 0.5 turns.

The retaining element is an essential part of the pipe insertion sensors. It safely secures the sensor in position and, when installed correctly, protects the sensor from ejection.

Risk of accident!

Do not operate the sensor without the retaining element! The gasket ring exists only for sealing purposes and does not include any fastening capabilities.



1	Welding nozzle
2	Stop ball valve
3	Sensor screw connection
4	Sensor retaining element
5	Installation aid (M4 screw)

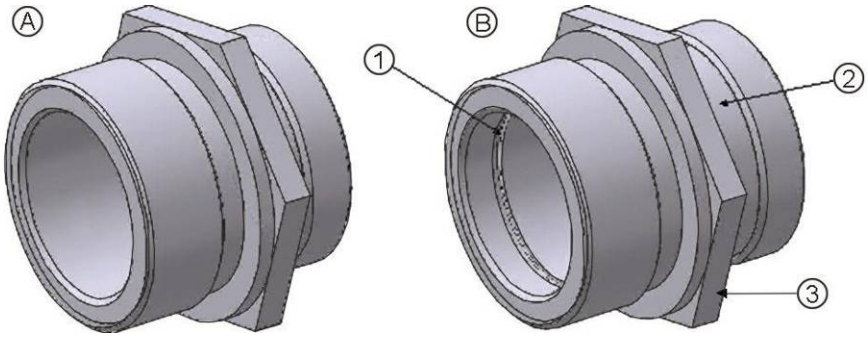
Components of pipe insertion sensor mounting

Risk of accident!

Increased pressure or pressure surges may cause unsecured flow velocity sensors to become unscrewed and, therefore, dangerous to people as well as parts of the facility!

Ejected sensors may cause the medium to flow out of the screw connection and flood the facility!

The sensor retaining elements included with the sensor must be used in conjunction with the appropriate sensor screw connections, which can be identified by the extended thread run-out as well as O-ring on the inside.



A	Sensor screw connection (old version)
B	New sensor screw connection
1	Slot for O-ring
2	Extended thread run-out
3	Hexagon length reduced from 9 mm to 6 mm

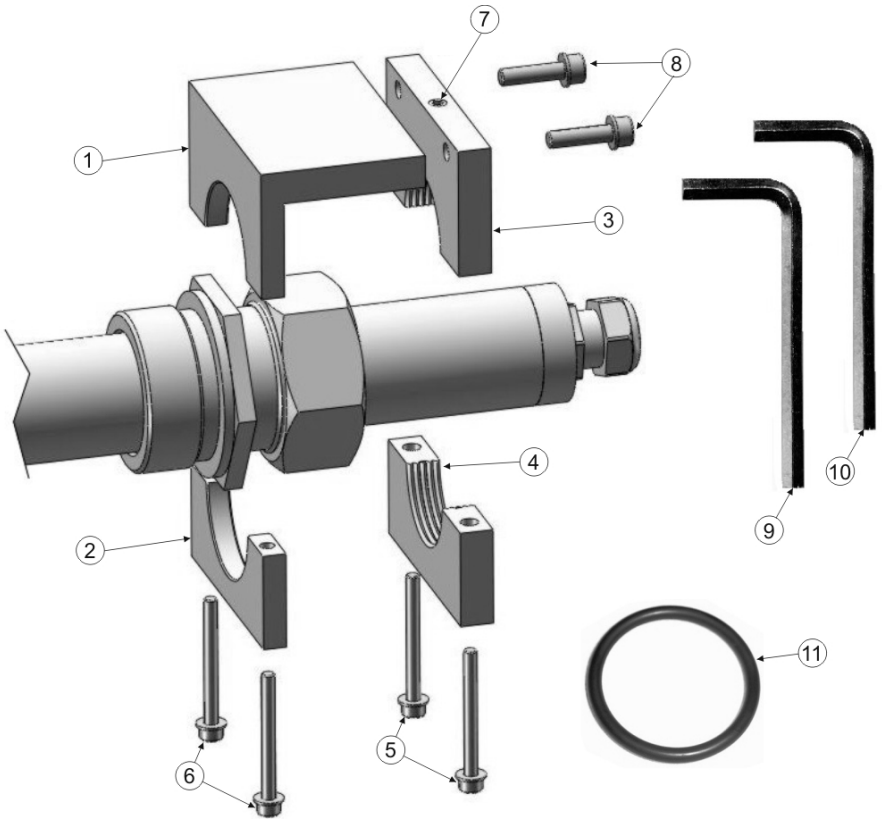
Comparison between both screw connections

ADS cannot guarantee the rear clamp element will safely sit on the screw connection if the sensor retaining element is used with an older sensor screw connection!

To ensure safe clamping, degrease the rear area of the pipe sensor as well as the clamping area (half-round milling groove) of the upper and lower rear clamp elements using an appropriate method. The sensor shaft and clamping area of the clamp elements must be dry.

Without degreasing and drying both components and the sensor shaft, an appropriate amount of static friction between the sensor and sensor retaining element will not exist to safely or reliably secure the sensor.

The retaining element included with the pipe insertion sensor from ADS has undergone testing by an independent testing laboratory using a long-term stress test applying 58 psi (4 Bars) constant load and 116 psi (8.0 Bars) impact load (30 sec.). Higher pressures cannot be applied safely!



1	Upper front clamp element (1x)
2	Lower front clamp element (1x)
3	Upper rear clamp element (1x)
4	Lower rear clamp element (1x)
5	Allen head screw M5 (2x)
6	Allen head screw M4 (2x)
7	Welded headless screw (as an additional clamp lock)
8	Allen head screw M5 (2x)
9	Allen key – 1 x 2.5 mm
10	Allen key – 1 x 3 mm
11	O-ring, spare part for sensor screw connection (refer to the previous image)

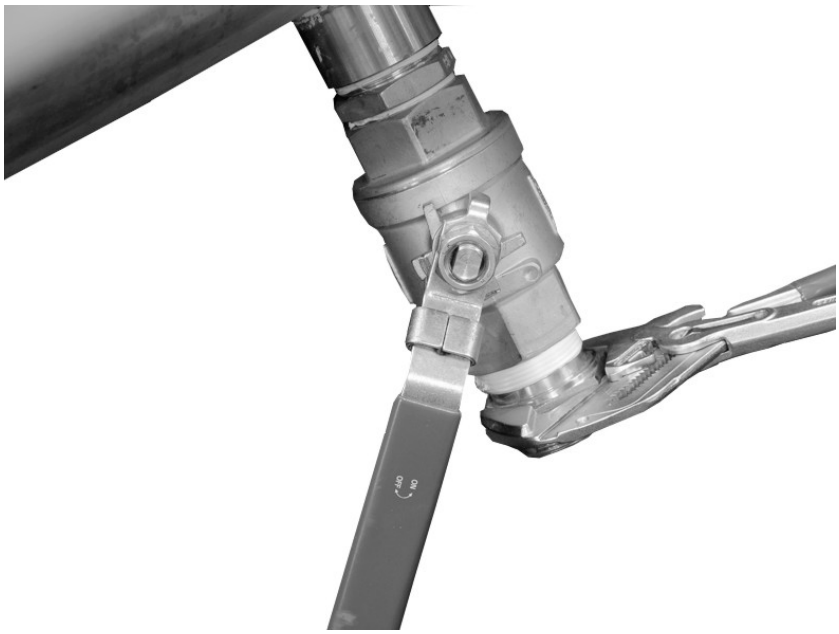
Exploded view of sensor retaining element

Proceed with the installation of the pipe insertion sensor in the following way:

1. Apply a small amount of grease to the O-ring on the inside of the sensor screw connection.

Greasing the sensor screw connection

2. Screw the sensor screw connection into the welded nozzle or the stop ball valve.



Securing the sensor screw connection to the stop ball valve

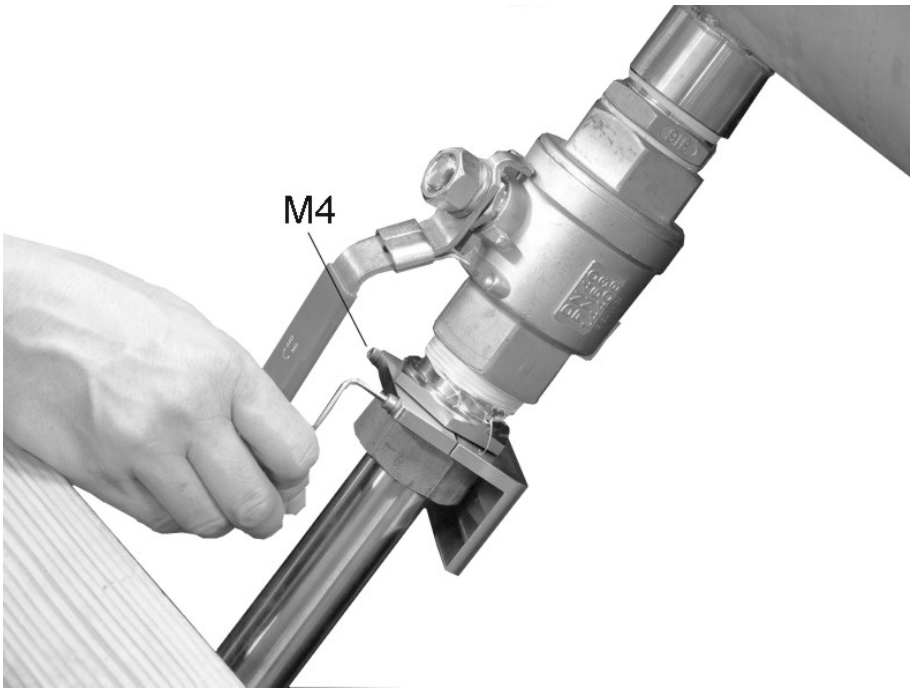
3. Place the pipe insertion sensor into the proper position.

Properly positioning the sensor

4. Fasten the sensor by gently tightening the union nut manually (plus ½ turn).

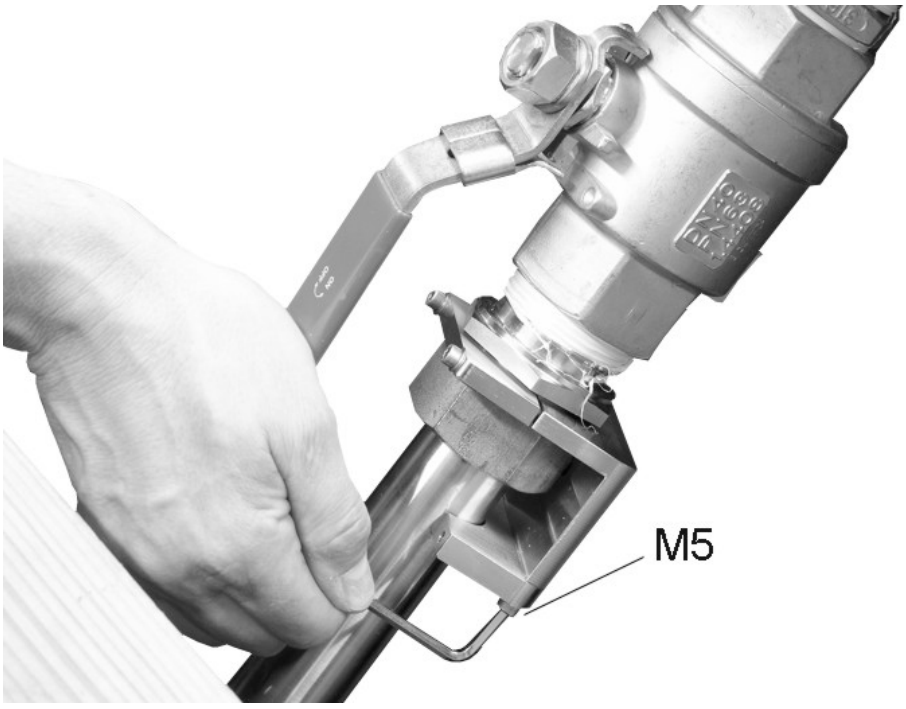
Fastening the sensor

5. Screw the upper and lower front clamp elements together behind the spigot nut of the sensor screw connection using two M4 Allen® head screws.



Attaching the lower front clamp element

6. Screw the upper rear clamp element to the upper front clamp element using both M5 Allen head screws.



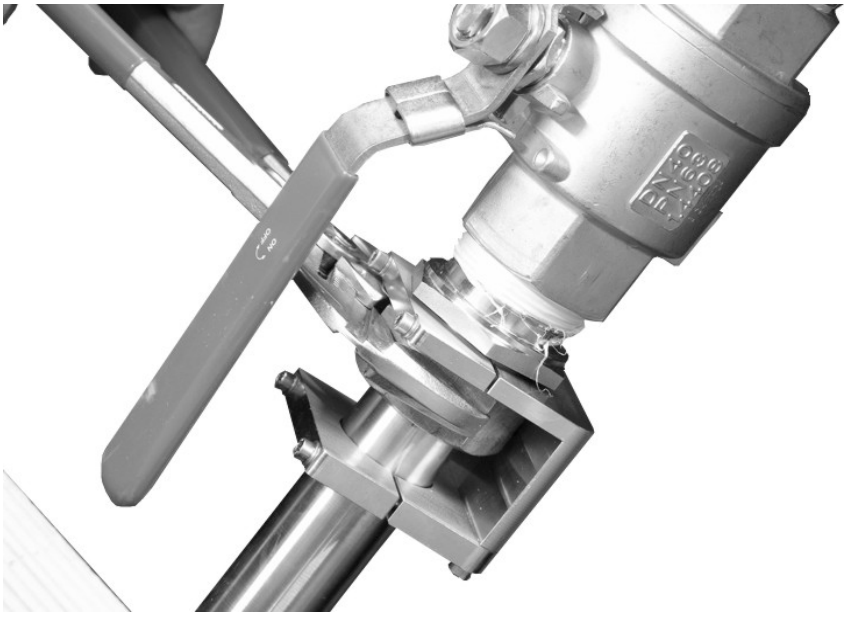
Connecting the upper rear and upper front clamp element

7. Subsequently attach the lower rear clamp element to the upper rear clamp element using the two remaining M5 Allen head screws. Apply a minimum torque of 6 Nm to tighten the screws to ensure the connection is secure.

8. Verify the tightness of the entire screw joint. If leaks develop during this process, make sure the respective screw joints are properly tightened or shut down the entire facility (if necessary) and replace the damaged gaskets, Teflon tapes, and other materials.

Attaching the final clamp element

9. The sensor retaining element allows you to reposition the sensor in the proper location following maintenance or control measures. To do this, first unscrew the spigot nut and both hexagon socket (Allen) M5 screws.



Unscrewing procedure for sensor removal

10. Then, remove the sensor. The screwed rear clamp elements will remain in their position on the pipe sensor body.

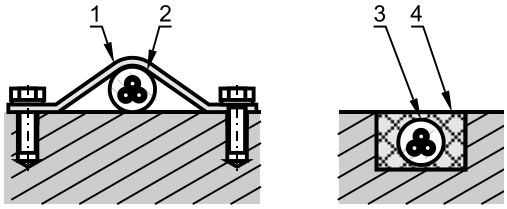
Removing the sensor (maintenance/control)

11. Clean or inspect the sensor as necessary. You can reinsert the sensor into the screw connection once again as soon as the cutting ring has been replaced. Use the rear clamp elements left on the sensor body as a detent or positioning aid.
12. Tighten the spigot nut and M5 Allen head screws again.

Locking the sensor again after reinstallation

Cable Layout

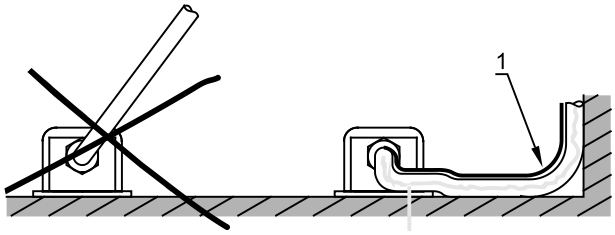
Run the sensor cable along the pipe bottom from behind the (wedge) sensor to the pipe wall. To minimize the risk of build-up, cover the cable with a thin, stainless steel sheet *or* lay it in a small canal and then seal the canal with a permanent, elastic material.



1	Stainless steel sheet/cable cover
2	Cable
3	Cable
4	Permanent, elastic material

Suggested cable layout

Do not run the cable loosely, uncovered, or across the medium. This could lead to a build-up of debris and/or cause the sensor or the cable to pull apart.



Cable layout (1 represents the protective cover)

Do not bend the standard signal cable in more than a 4-inch (10-cm) radius. Bending it into a smaller radius could break the cable.

To avoid disturbances caused by electric interference, do not lay the sensor cable close (or parallel) to motor power supply lines and power lines.

Sensor Connection

Water-Ultrasonic Velocity/Combination Sensor, Air-Ultrasonic Depth Sensor, and Electronic Box

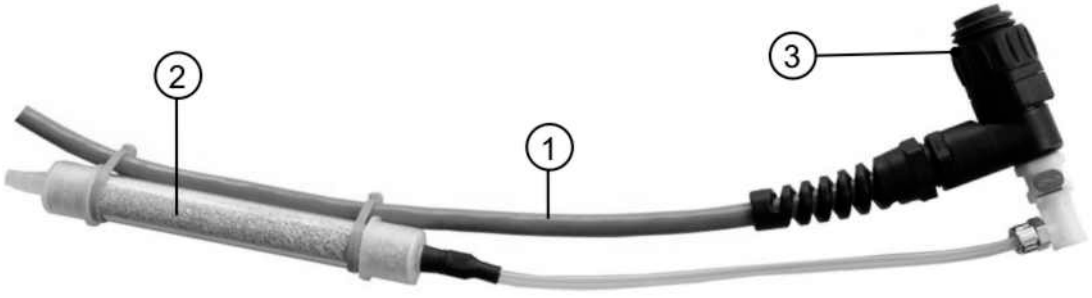
Water-ultrasonic velocity/combination sensors, air-ultrasonic depth sensors, and electronic boxes (EBM) are equipped with cable-end connectors for connection to the corresponding ports on the Portable FlowShark Pulse transmitter. To connect a sensor to the port, first unscrew the protective cover from the respective port on the transmitter, insert the sensor connector into the port, and then tighten the connector screw cap to ensure a secure connection. To prevent dirt from collecting in the protective covers, screw the remaining covers from the sensor connectors and transmitter ports together.

Protect the threads on the connectors and ports from dirt, sand, and other debris, and clean the threads with a soft, lint-free cloth prior to connection.

Sensors containing an integrated pressure measurement cell are equipped with a special air filter element containing a dehydration agent (i.e., desiccant) attached to the connector. This air filter is essential for adjusting the pressure cell based on the current air pressure. The indicator in the desiccant should be blue under normal conditions. Replace the desiccant immediately when the indicator turns clear or pink. Contact ADS for replacement desiccant or spare filter elements.

Operating sensors with an integrated pressure measurement cell with a filter element that is no longer able to absorb moisture may result in irreversible damage to the sensor electronics.

If the potential exists for the filter to become submerged at the location, properly install the air hose without any significant bends above the maximum flow depth.



1	Sensor cable
2	Filter element
3	Connector

Connector with air filter element for connecting to Portable FlowShark Pulse

When using the water-ultrasonic velocity/combination sensor with the integrated pressure cell, do not operate the transmitter without the filter installed.

Removing the filter connector from the sensor connector will automatically lock the filter connector. While a locked connector prevents water from entering the sensor, it also disrupts air pressure compensation. This inhibits the pressure cell from accurately measure depth.

Make sure the air compensation hose is not hanging in the flow, blocked, or exhibiting sharp bends. The filter must receive continuous, unhindered air flow.

2-Wire Sensors

The Portable FlowShark Pulse supports external 4 – 20 mA 2-wire sensors for measuring depth. The supply voltage for the sensor is 16 volts. Contact an ADS representative for assistance in selecting an appropriate external sensor. Pre-configured cables are available in 33-, 66-, and 98-foot (10-, 20- and 30-m) lengths.

Connect the external depth sensor to port 3 on the unit.

Sensor Cable Connection	Wire color	Function	Pin assignment on connector
Portable FlowShark Pulse -> 2-wire 4 – 20 mA sensor	brown white	16-volt (+) 4 – 20 mA	3 4

Pre-configured cables for 2-wire sensors

Peripherals

The Portable FlowShark Pulse has various analog and digital inputs and outputs that allow for the connection of a variety of sensors or actuators. Refer to *Appendix A, Specifications*, for an overview of these configurations.

Connect individual inputs/outputs directly to the multifunctional port using pre-configured cables. The following table indicates the cable types that are available. Contact an ADS representative for assistance in ordering the appropriate cable for the particular application.

Input/Output Application	Cable Description
Analog Input	32.8-foot (10-m) connection cable, Portable FlowShark Pulse – analog input (one end with connector for multifunctional port, other end with open cable end)
Analog Output	32.8-foot (10-m) connection cable, Portable FlowShark Pulse – analog output (one end with connector for multifunctional port, other end with open cable end)
Digital Input	32.8-foot (10-m) connection cable, Portable FlowShark Pulse – digital input (one end with connector for multifunctional port, other end with open cable end)
Relay Output	32.8-foot (10-m) connection cable, Portable FlowShark Pulse – relay output (one end with connector for multifunctional port, other end with open cable end)

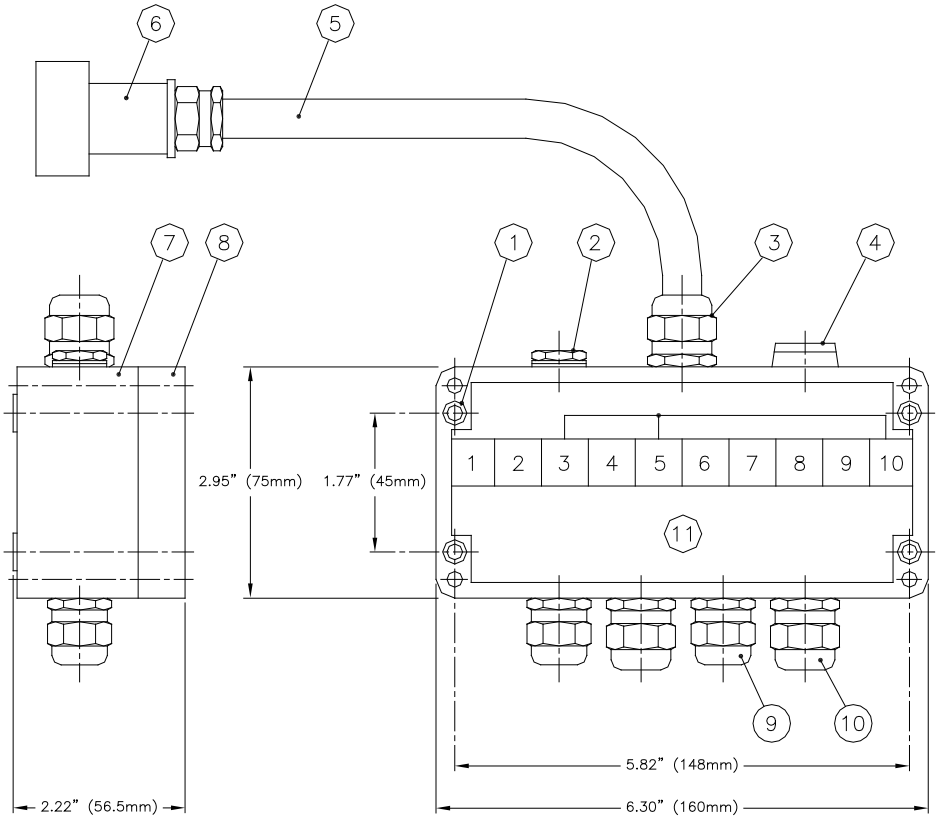
Cable types for connecting peripherals to the Portable FlowShark Pulse

Cable Connection	Wire Color	Function	PIN Assignment on Connector
Portable FlowShark Pulse -> analog input	gray brown	0/4 – 20 mA AGND	3 2
Portable FlowShark Pulse -> analog output	pink brown	0 – 10 volts GND	4 5
Portable FlowShark Pulse -> digital input	white brown	DE active 3.3 volts GND	6 5
Portable FlowShark Pulse -> relay output	green brown gray	Root contact (COM) normally closed (NC) normally open (NO)	8 7 1

Wiring pre-configured cables

Connector Box

A connection box (ADS part number 5000-PULSE-CONN-BOX) is available through ADS for connecting several devices to the Portable FlowShark Pulse simultaneously.



1	Pre-drilled holes for M4 screws for fastening enclosure		
2	Pressure compensation element DAE		
3	M20 x 1.5 cable gland		
4	M16 x 1.5 dummy plug		
5	3.3-foot (1-m) connection cable		
6	Multifunctional connector with 9 pins for connection to Portable FlowShark Pulse		
7	Enclosure bottom		
8	Enclosure lid		
9	2x M16 x 1.5 cable glands for cable ø4-8 mm / peripheral side		
10	2x M20 x 1.5 cable glands for cable ø6-12 mm / peripheral side		
11	Terminal clamp compartment/ wiring	1	Analog output (0 – 20 mA) passive
		2	Analog ground (AGND)
		3	GND
		4	Analog output (0 – 10 volts)
		5	GND
		6	Digital input
		7	Relay output (NC)
		8	Relay output (COM)
		9	Relay output (NO)
		10	Shield

Overview of connection box

Electronic Box (EBM)

Seal unused connection sockets on the Type EBM Electronic Box watertight by fastening the screw cover on each socket prior to installation. Otherwise, ADS cannot guarantee the protection of the entire unit. The ADS warranty does not cover damages resulting from uncovered connection ports.

ADS offers, at an additional cost, covers to replace those damaged or lost due to the use of force.

Accessories and Installation Aids

Pipe Mounting System

The pipe mounting system is an installation resource for water-ultrasonic velocity/combination sensors, mini water-ultrasonic velocity sensors, air-ultrasonic depth sensors, and mini air-ultrasonic depth sensors primarily used for portable applications.

Three different pipe mounting systems are available:

- **RMS 2** pipe mounting system for pipes with inner diameters between 8 and 31 inches (200 and 800 mm)
- **RMS 3** pipe mounting system for pipes with inner diameters between 6 and 12 inches (160 and 300 mm)
- **RMS 4** (*combination of RMS 2 and RMS 3*) pipe mounting system for pipes with inner diameters between 6 and 31 inches (160 and 800 mm)

The pipe mounting system consists of the following components:

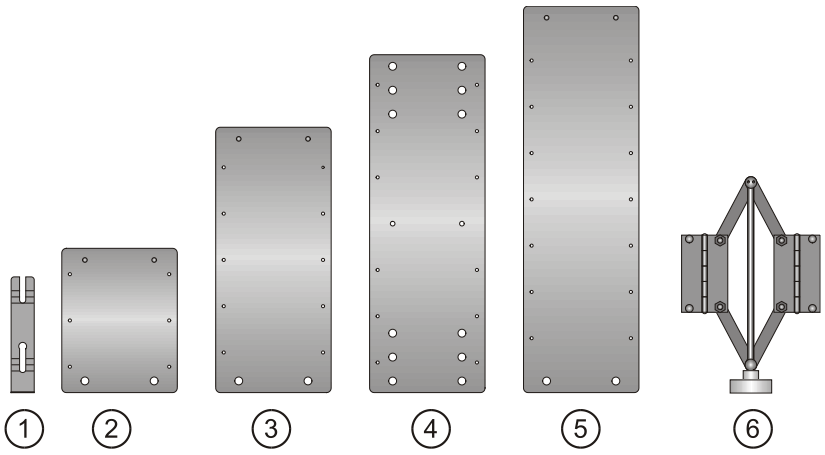
- Scissors jack
- Base plate
- Fastening clips
- Extension sheets (*optional*)

All the parts comprising the different mounting systems are compatible with one other.

RMS 2

Pipe Mounting System RMS 2

Determine the appropriate parts required based on the figure below, the following chart, *and* the existing pipe diameter.



1	Fastening clip
2	Extension sheet V5
3	Extension sheet V10
4	Base plate
5	Extension sheet V15
6	Scissors jack with clamp handle

Components included in the RSM2 pipe mounting system

I.D. (Inside Diameter)	BST base plate	SPV scissors jack	V5 extension plate	V5 extension plate	V10 extension plate	V10 extension plate	V15 extension plate	V15 extension plate
8 inches (200 mm)	x inner hole	x						
10 inches (250 mm)	x inner hole	x	x	x				
12 inches (300 mm)	x outer hole	x	x	x				
14 inches (350 mm)	x inner hole	x			x	x		
16 inches (400 mm)	x outer hole	x			x	x		
18 inches (450 mm)	x inner hole	x	x	x	x	x		
20 inches (500 mm)	x outer hole	x	x	x	x	x		
24 inches (600 mm)	x outer hole	x	x	x			x	x
28 inches (700 mm)	x outer hole	x			x	x	x	x
32 inches (800 mm)	x outer hole	x	x	x	x	x	x	x

Table of mounting sheets for different pipe diameters

During assembly, always locate the scissors jack at the top of the pipe and the base plate at the bottom of the pipe. When using air-ultrasonic and water-ultrasonic sensors at the same time, the air-ultrasonic sensor must be installed at the pipe crown with the scissors jack in immediate proximity.

When it is necessary to use extension sheets, locate them on the right and left sides between the scissors jack and the base plate.

The fastening clips allow for quick installation. Install them flush on the mounting plate, and position them against the flow.

The light-gauge metal sheets have sharp edges. Therefore, please wear protective gloves when installing or disassembling the pipe mounting system.

Left	Assemble the base plate and extension sheet
Center	Insert the pins through the holes
Right	Lock the pins using the fastening clip (clip must sit flush against the mounting plate and against the direction of the flow)

Using fastening clips in installation

Snap the water-ultrasonic sensor onto the base plate with the slotted holes located toward the rear of the sensor.

Left	Place the sensor with the cutouts (slotted holes) onto the base plate.
Center	Slide back the sensor until completely in place.
Right	Make sure the sensor locks securely and flush with the base plate.

Connecting the sensor to the base plate

Rotate the clamp handle of the scissors jack clockwise until the scissors are closed. Then, place the entire system into the pipe and adjust and secure the system against the pipe by rotating the clamp handle counter-clockwise.

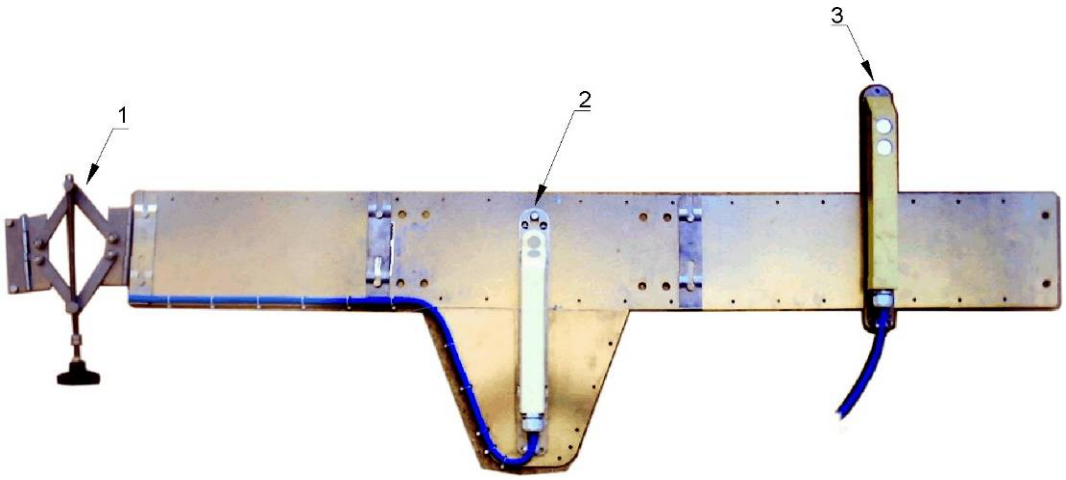
Left	Connect the scissors jack to both sides of the final plate using the fastening clip.
Right	Close the scissors completely by rotating the clamp handle before installing in the pipe.

Preparing the mounting system for installation into the pipe

Consider the following when installing the pipe mounting system temporarily into the pipe:

- Provide adequate contact pressure against the pipe wall to prevent the mounting system from becoming loose. This is particularly critical in large diameter pipes and in pipes with high flow depths. For added security, install additional stainless steel screws into the pipe wall.
- Mount the system completely flush against the wall to prevent the potential for the build-up of debris. Make sure that no gap exists between the mounting plate and sensor or pipe bottom.
- Secure the sensor cable to the downstream edge of the plate using cable ties.
- Lay and secure the cable along the channel wall with clamps as necessary.
- Refer to the Table of Mounting Sheets for the appropriate parts to assemble the mounting system.

- When using the air-ultrasonic depth and water-ultrasonic sensors simultaneously, use the support plate (ADS part number 5000-PPORT-PIPE-INST-RMS2). In this configuration, the water-ultrasonic sensor mounts to the base plate with the slotted holes at the front of the sensor. The support plate ensures proper cable layout and placement of the water-ultrasonic sensor behind (*downstream from*) the air-ultrasonic sensor.
- Use the double-mounting plate to secure the air-ultrasonic sensor to the extension plates. Install the sensor completely parallel to the flow surface.

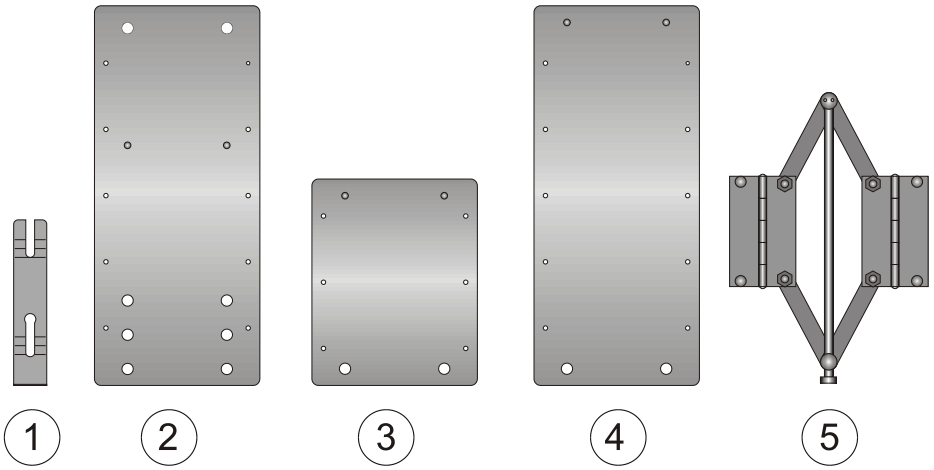


1	Scissors jack
2	Water-Ultrasonic Velocity/Combination Sensor or Mini Water-Ultrasonic Velocity Sensor
3	Air-Ultrasonic Depth Sensor or Mini Air-Ultrasonic Depth Sensor

Fastening the sensors to the pipe mounting system

Pipe mounting system with support plate for combined installation of a water-ultrasonic sensor and air-ultrasonic sensor

RMS 3



1	Fastening clip
2	Base plate BST
3	Extension sheet V5
4	Extension sheet V10
5	Scissors jack

Components included in the pipe mounting system 3

Inside Diameter	BST Base Plate	SPV Scissors Jack	V5 Extension Plate	V10 Extension Plate
160 mm	X inner hole	X	X	
200 mm (8 inches)	X inner hole	X		X
250 mm (10 inches)	X inner hole	X	X	X
300 mm (12 inches)	X outer hole	X	X	X

Table of mounting sheets for different pipe diameters

During assembly, always locate the scissors jack at the crown of the pipe and the base plate at the bottom of the pipe. If air-ultrasonic and water-ultrasonic sensors are used simultaneously, install the air-ultrasonic sensor at the pipe crown with the scissors jack in immediate proximity. Use the extension sheets, when necessary, to the right-hand and left-hand sides between the scissors jack and base plate.

The fastening clips ensure quick installation. Place them flush onto the mounting plate against the direction of the flow.

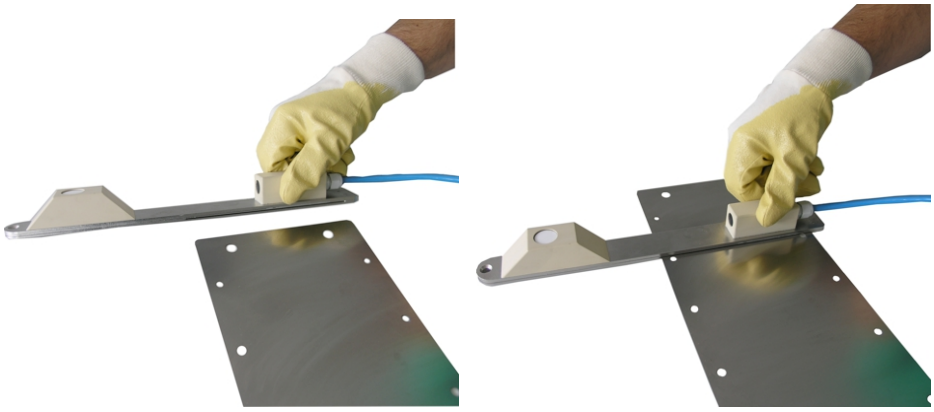
The light-gauge metal sheets have sharp edges. Therefore, please wear protective gloves when installing or disassembling the pipe mounting system.

Left	Assemble the base plate and extension sheet
Center	Insert the pins into the holes
Right	Lock the pins using the fastening clip (clip must sit flush against the mounting plate facing the oncoming flow)

Assembling the mounting plate

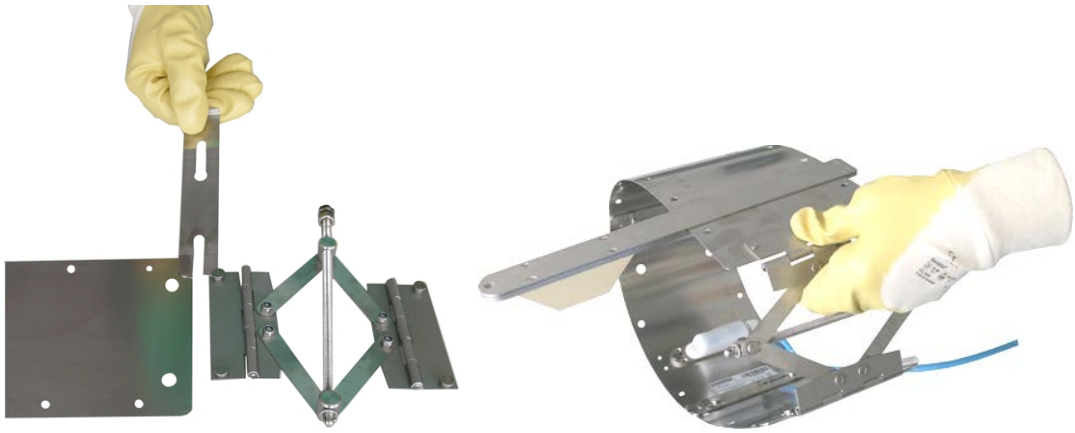
Left	Place the sensor with the cutouts (slotted holes) onto the base plate.
Center	Slide back the sensor until it is completely in place.
Right	Make sure the sensor locks securely and flush with the base plate.

Installing the mini water-ultrasonic velocity sensor



Left	Install the mini air-ultrasonic depth sensor using the double mounting plate.
Right	Place the extension sheet into the cut-out between mounting plates 1 and 2.

Installing the mini air-ultrasonic depth sensor



Left	Connect the scissors jack to both sides of the final plate using the fastening clip.
Right	Turn the scissors jack clockwise all the way until it is closed before installing the mounting system into the pipe.

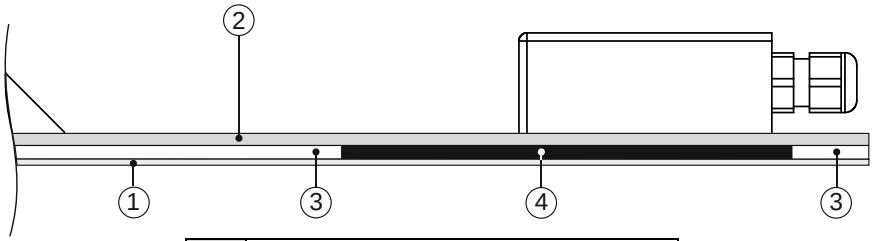
Assembling the RMS 3 pipe mounting system with the scissors jack

Rotate the clamp handle of the scissors jack clockwise all the way until the scissors are closed. Then, insert the entire system into the pipe, align it, and tighten the clamps by rotating the clamp handle counter-clockwise

Consider the following when installing the pipe mounting system temporarily into the pipe:

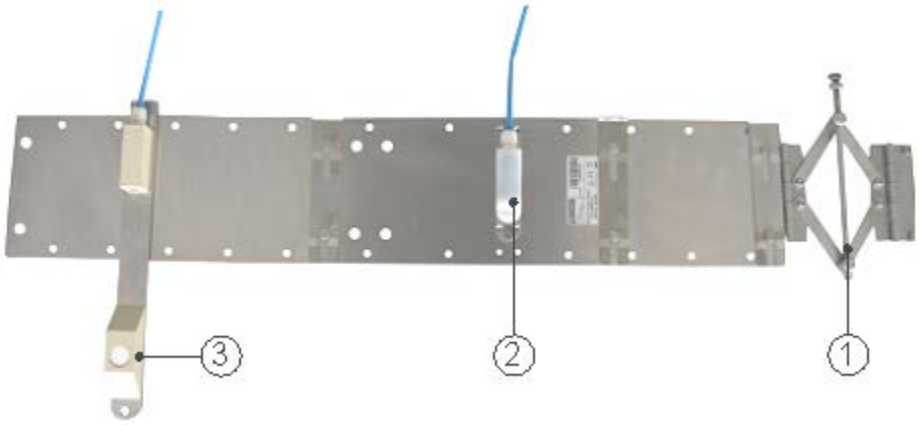
- Make sure the pipe mounting system is tightly and securely seated against the pipe wall in order to prevent the system from getting loose.
- Mount the system flush against the pipe wall to minimize the risk of debris build-up. Make sure no gap exists between the mounting plate and sensor or pipe bottom.
- Secure the sensor cable along the downstream edge of the mounting system using cable ties.
- Please refer to the list of mounting sheets on page 3-39.

Place the air-ultrasonic sensor onto the extension plate using the double mounting plate, and make sure the sensor is installed completely parallel to the flow surface.



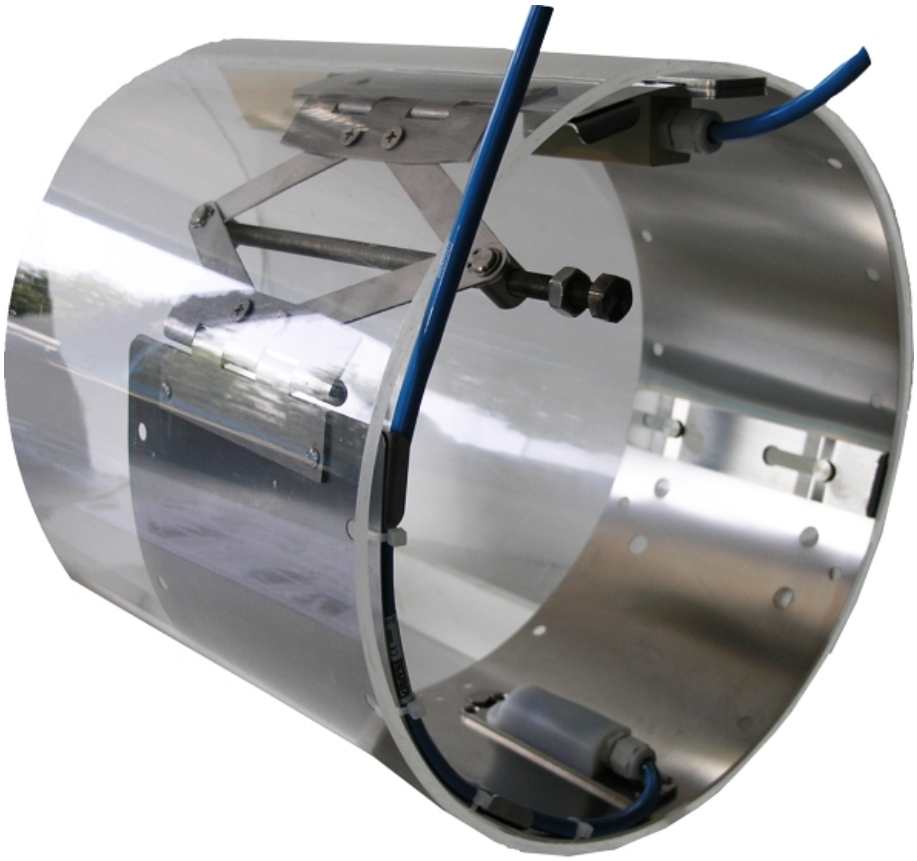
1	Mounting plate 1
2	Mounting plate 2 (base plate)
3	Mounting plate 3 (spacer plates)
4	Insertion area for the pipe mounting sheet

Constructing the mini air-ultrasonic sensor mounting plates



1	Scissors jack
2	Mini water-ultrasonic velocity sensor
3	Mini air-ultrasonic depth sensor

Fastening the sensor on the pipe mounting system RMS 3



RMS 3 installed with mini water-ultrasonic velocity sensor and mini air-ultrasonic depth sensor

Sensor Cover

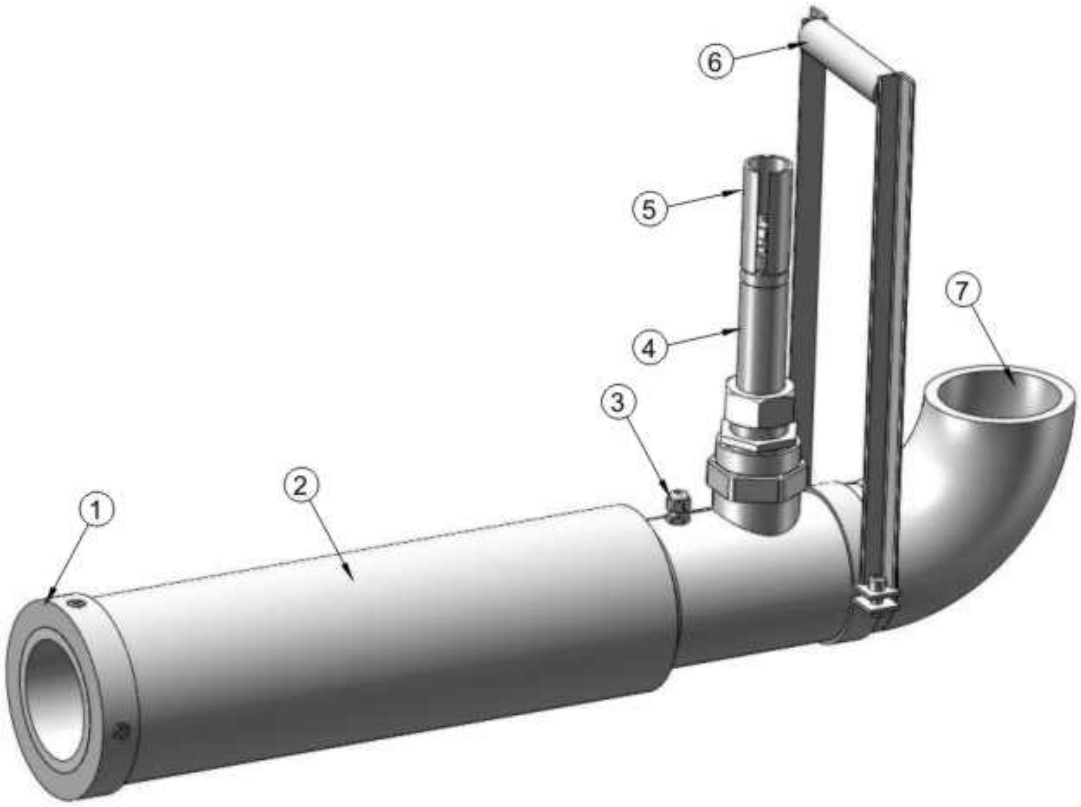
High velocity flow with a substantial amount of grit or stone poses a significant risk of damage to the sensor body. Therefore, ADS offers a sensor cover (ADS p/n 5000-PULSE-PROTECT-SENS) to protect the sensor against the impact of large objects and to limit mechanical stress to the sensor body.

However, if the cover is used in slower flows, a higher potential for build-up exists. Therefore, it may require more frequent cleaning.

Sensor cover

Pipe Profiler

The *Pipe Profiler* is a pipe measuring section that serves as an extension of the Portable FlowShark Pulse measurement system. This flexible measurement system ensures accurate flow measurement even under difficult conditions such as low discharge volumes or poor hydraulic conditions.



1	Clamp ring
2	Balloon
3	Ventilation
4	Pipe sensor
5	Cable protection jacket
6	Handhold
7	Pressure pipe

Pipe profiler

ADS permits inflating the balloon of the pipe profiler to a maximum pressure of 21.8 psi (1.5 bars) only when using a safety filling valve!

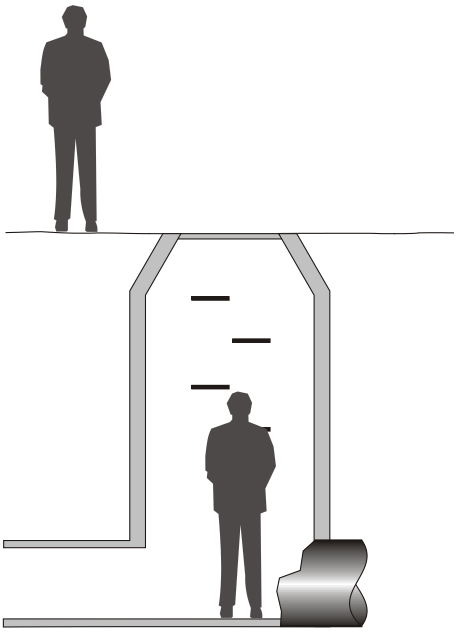
Safety filling valve

As with other field activities, mounting and installation of a Pipe Profiler requires two field crew members.

The following images corresponding to pipe profiler installation are for illustration purposes only. Please observe all applicable safety procedures regarding confined space entry to protect human health and prevent injuries.

Consider the following before initiating installation activities:

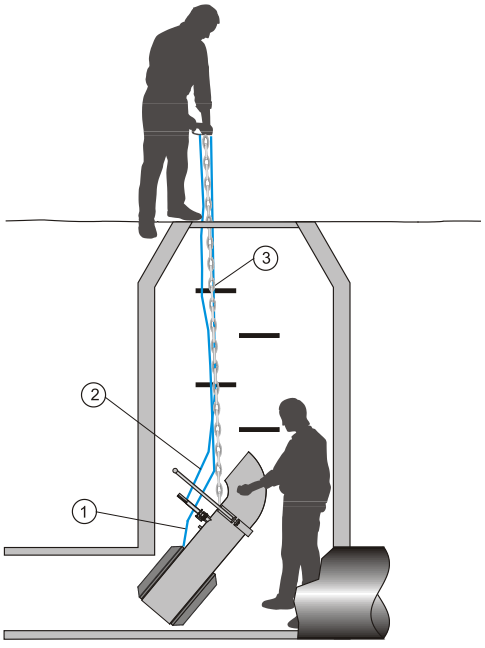
- Inspect the measurement location
- Examine the pipe conditions, such as for the presence of debris or sludge, broken pieces of glass, and faulty connections



Installation requires a 2-person crew

Install the pipe profiler in the following way:

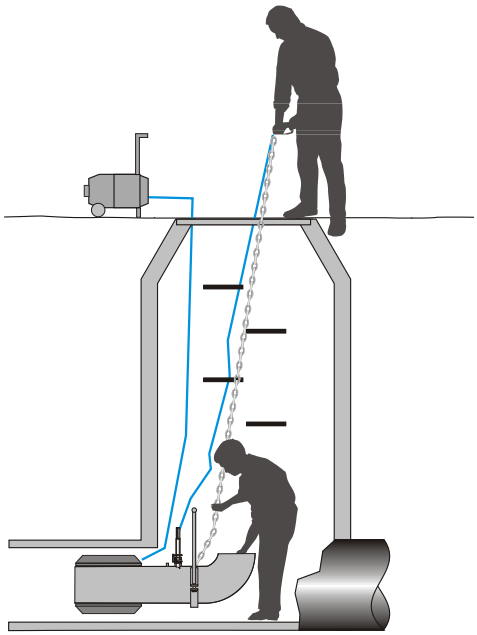
1. Lower the pipe profiler into the manhole on a chain.
2. Be careful to avoid straining the cable or air hose.



Lowering the pipe profiler into the manhole by a chain

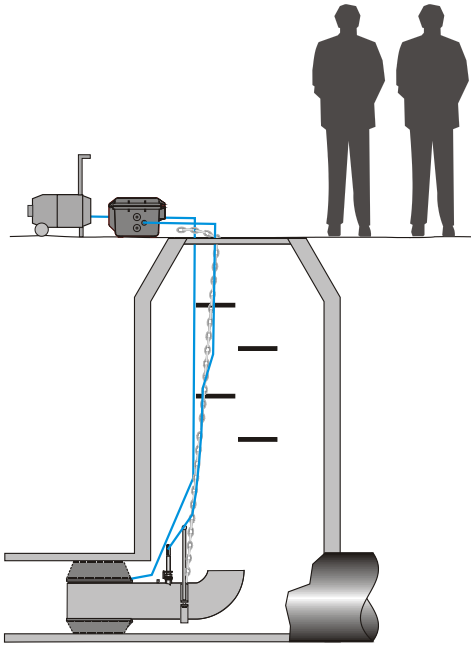
3. Insert and adjust the pipe profiler in the pipe so that the opening of the pressure pipe faces upwards.

4. Add a little pressure into the balloon using the safety valve. Widen the balloon wide enough to seat the pipe profiler against the pipe walls first. Adjust the profiler in a vertical position.



Inserting and adjusting the pipe profiler

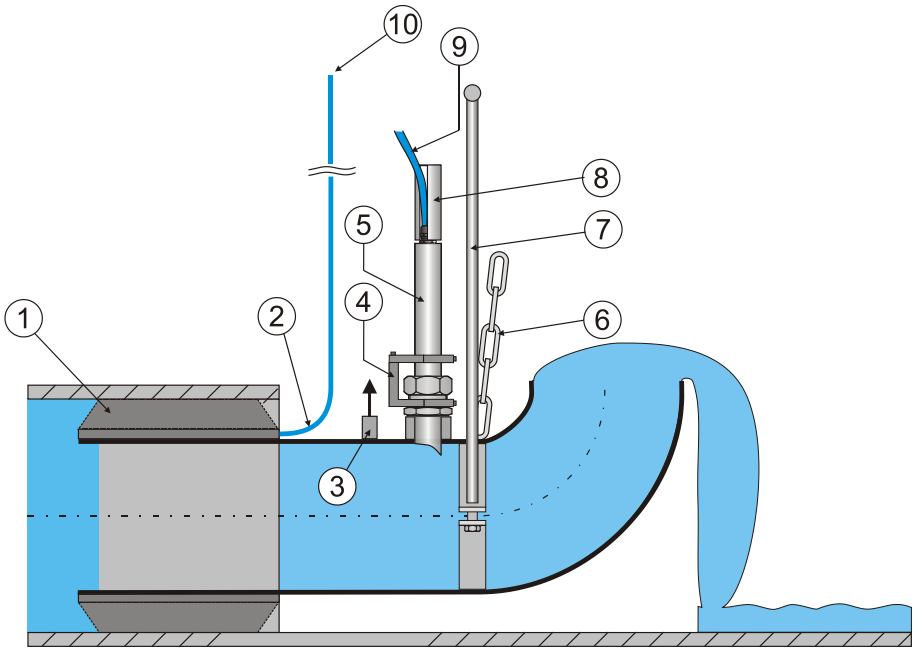
5. Exit the manhole before completely inflating the balloon!
6. Fill up the balloon completely to a pressure of 21.8 psi (1.5 bars).



Filling the balloon to 21.8 psi

Do not allow anyone into the manhole during balloon inflation to 21.8 psi (1.5 bars)!

Injury can occur from flying parts or the blast wave resulting from an exploding balloon (e.g., caused by over pressurizing the balloon)!



1	Balloon expansion
2	Air hose for pumping up balloon
3	Ventilation
4	Sensor retaining element
5	Pipe sensor
6	Chain
7	Hand hold
8	Cable protection jacket
9	Sensor cable
10	Air vent plug

Construction of pipe profiler

Air vent plug for pipe profiler

An air vent plug is attached to the air hose on the end connected to the compressor.

This plug is required for dismantling the profiler. Dismantle the profiler in the following way:

- Prior to dismantling the profiler, prevent it from floating away using the chain. For example, consider tying the unit to a manhole rung.
- Stand safely at the rim of the manhole and anticipate the high tractive forces that might occur from the strong water pressure pushing the unit out once the air pressure is released.
- Deflate the balloon by carefully pressing the air vent plug into the connection valve at the end of the air hose.

Air will escape from the balloon slowly and the water dammed upstream will force the pipe profiler out of the pipe.

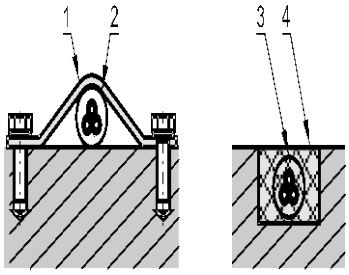
Air will escape with a pressure of up to 21.8 psi (1.5 Bar).

Strong water pressure may result from certain factors, such as high dam pressure or the blockage created from the pipe profiler. Under these circumstances, take sufficient measures to secure the chain (e.g., using a tripod and karabiner or similar device) prior to deflation.

Pull up the pipe profiler using the chain. When elevating the profiler, take into consideration the weight of the unit based on the diameter. Therefore, ADS strongly recommends employing equipment such as pulleys or other lifting devices.

Cable Cover

To prevent debris buildup around the cable and/or to safely fasten sensor cables on horizontal surfaces, cover the cable with a thin, stainless steel sheet 1.4571 (V4A). Covers of 3.3 feet (1 m) in length are available from ADS.



1	Stainless steel/cable cover
2	Cable

Cable layout with cable cover

CHAPTER 4

Power

The Portable FlowShark Pulse comes standard with a rechargeable, lead gel battery pack for power. This battery pack offers an extensive battery life for taking measurements long-term.

The unit also can receive power directly from a mains (100-240 V AC) power source.

Rechargeable Battery Pack

The rechargeable lead gel battery pack resides in a padded battery compartment in the Portable FlowShark Pulse. This compartment is accessible from the inside of the unit through a cover/lid located to the right of the display that is secured with four screws. Upon delivery, the battery pack will arrive fully charged. However, ADS does not ship the unit with the battery pack installed in the battery compartment, so the battery pack must be installed in the unit prior to operation.

To initially install, charge, or replace the battery pack, unscrew the four screws on the lid of the battery compartment by hand and remove the cover. When replacing an existing battery pack, unplug the connection between the unit and the battery pack and remove the battery pack.

The battery charger must meet the appropriate specifications. Therefore, use only the ADS power adapter and battery charger to charge the battery. Using an unauthorized charger could lead to damage to the battery pack, such as leakage or explosion.

Charge the battery pack only in a dry environment.

Using replacement parts, such as rechargeable battery packs, that are not supplied or authorized by ADS will invalidate the warranty.

1	Battery charger
2	LED indicator
3	Rechargeable lead gel battery
4	Adapter cable
5	Connection cable

Battery charger with rechargeable battery pack

Always disconnect the battery charger/power adapter from the mains power source prior to connecting it to or disconnecting it from the battery pack.

The battery charger/power adapter has a built-in LED to indicate the charging status.

Color of LED	Status
Yellow	Battery charging
Green	Battery trickle charging
LED off	Reversed polarity, short circuit, or no mains connection

Battery status table

Insert the new battery pack into the battery compartment, and insert the plug from the unit into the connector on the battery pack cable. Replace the lid and secure the lid to the unit with the screws.

Connecting the unit to the rechargeable battery pack

The maximum capacity of the rechargeable battery will decrease over time, also reducing the overall battery life. The integrated lifetime calculation function built into the Portable FlowShark Pulse does not compensate for this reduction.

High and low temperatures and long-term use also lower voltage capacity.

Since rechargeable batteries decrease in capacity over time, replace the battery pack in the Portable FlowShark Pulse no less than once every two years. Consider a shorter replacement period under heavy use.

Recharge the battery pack before each use of the Portable FlowShark Pulse.

Remove battery packs from units that are not in use, and store them in a dry, frost-free location. Recharge them every two months (when not in use) to maintain capacity.

Make sure the battery compartment remains locked firmly during system operation.

Discard used rechargeable battery packs according to state and local regulations regarding battery disposal.

Never remove any screws other than the safety screws on the battery cover from the unit enclosure!

Mains Power

To power the Portable FlowShark Pulse from a mains (100 – 240 V AC) power source, attach the connector from the mains adapter/battery charger cable to the corresponding port on the unit. Do not remove the rechargeable lead gel battery pack from the unit during mains operation. Battery charging occurs simultaneously with mains operation. This ensures the battery pack remains charged so that it is available to serve as a backup power source in case of a mains power failure and sustains unit operation during the charging process.

Battery charger connected directly to the Portable FlowShark Pulse

Charge the rechargeable battery pack only in a dry and frost-free environment.

CHAPTER 5

Initial Startup

After installing and connecting the Portable FlowShark Pulse transmitter and sensors and charging the battery pack/providing mains power to the unit, you can initiate system startup and begin setting the system parameters through the transmitter's user interface. ADS strongly recommends using this manual to understand how to properly program the Portable FlowShark Pulse via the display and keyboard. The user-friendly design enables even new users to designate basic settings quickly and easily to ensure reliable device operation.

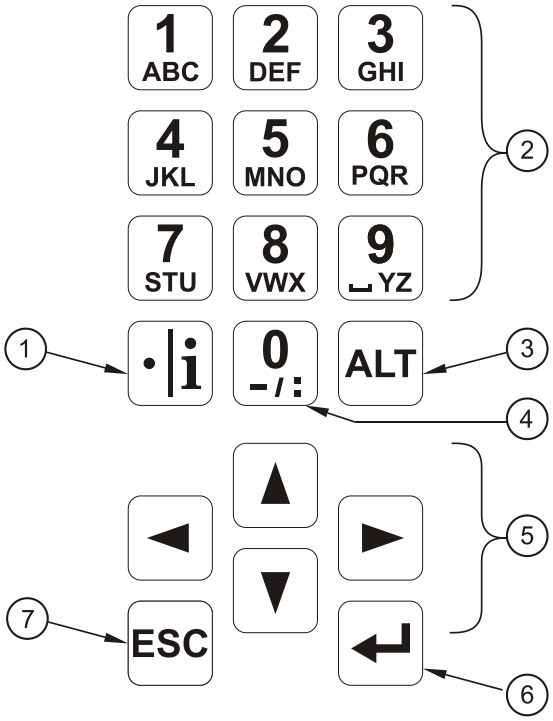
If any issues arise regarding installation, connection, or programming, please contact ADS Client Services at adssupportcenter@idexcorp.com or (877) 237-9585.

Communication with the unit occurs solely through the transmitter's keypad and display. ADS currently does not offer a remote communication option with the Portable FlowShark Pulse.

This chapter includes instructions on operating the keypad and control buttons to navigate through the main menus and other screens, interpreting the information and layout on the main screen, and implementing the memory mode. Review this chapter carefully to become familiar with the display and keypad before configuring the device.

Keypad

The Portable FlowShark Pulse has an 18-button keypad for setting parameters and inputting other data.

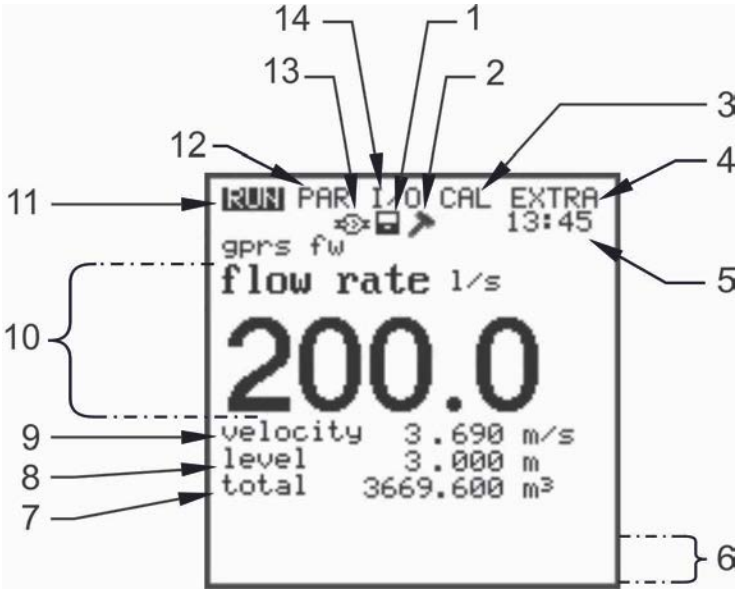


1	Comma/Information Button
2	Number/Character Buttons
3	Shift Key
4	0/- Navigation Button
5	Control Key
6	Enter Key
7	Escape Key

Keypad

Display

The Portable FlowShark Pulse has a large, backlit graphic display with a 128- x 128-pixel resolution.



1	Memory Mode Enabled
2	Service Mode Enabled
3	Calibration Menu
4	Display Menu
5	Current System Clock Time (alternately displays median temperature)
6	Digital Output Field
7	Total
8	Depth Level (Height) Reading
9	Velocity Reading
10	Flow Reading
11	Operation Menu
12	Parameter Menu
13	Bluetooth/GSM Communication (*not applicable*)
14	Input, Output, and Sensor Status Menu

Overview of display

The top of the display provides five basic menus for selection:

- **RUN** This menu represents the standard mode of operation. In addition to indicating the name of the measurement location, this menu allows you to view time, flow rate, flow depth, average flow velocity (as well as flow velocity distribution), daily totals, and error messages. It also includes a function that enables you to record flow volume, flow depth, and average flow velocity data.
- **PAR** This is the most extensive menu on the Portable FlowShark Pulse. It enables you to set the parameters for the measurement location, sensors, memory mode, communications, and other factors.
- **I/O** This menu provides information concerning the internal operation of the Portable FlowShark Pulse and allows you to view all current readings. Submenus display sensor echoes, individual velocity readings, and other data for assessing the overall hydraulic conditions at the location. In addition, it enables you to determine the remaining capacity on the optional memory card and rechargeable battery.
- **CAL** This menu allows you to calibrate flow depths and modify the settings corresponding to depth calibration and low flow velocity parameters.
- **EXTRA** This menu enables you to modify the basic display settings: contrast, lighting, language, units, system times, and totalizer presets.

The Portable FlowShark Pulse enters into energy-saving standby mode 4 minutes following the last keystroke. Therefore, the unit will activate only within the set cycles.

The display is disabled when in storage (unattended use) mode. It will remain disabled until the next keystroke.

Operation Basics

The Portable FlowShark Pulse has a user-friendly interface and is completely menu driven. Use the control keys to navigate through the menus (refer to *Chapter 6, Parameter Settings*).

◄ ► Use these buttons to move among the main menus.

▲ ▼ Use these buttons to scroll within the main menus.

↵ Use this button to enter a submenu (or the input field) selected using the right/left arrow keys. This button also exists for confirming data entries.

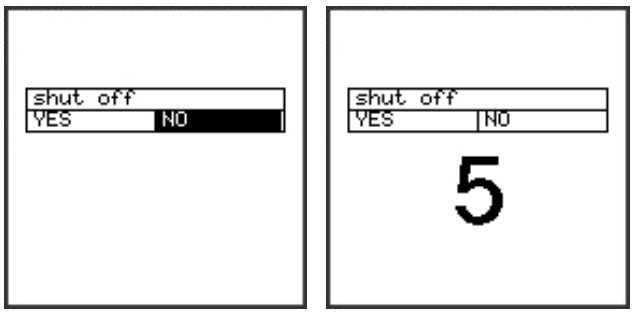
ESC Use this button to exit submenus or cancel data entered. Pressing **ESC** in the main screen for approximately 1 second will bring up a confirmation to turn the unit off. Choosing **Yes** will shut down the unit after 5 seconds, discontinuing measurements and data storage.

The unit will restart 7 seconds after pressing any key.

1 ABC – 9 YZ Use these buttons to set parameters and to enter numbers and text (such as the name of a measurement location or relay output description). Entering text on the Portable FlowShark Pulse is similar to entering text using a telephone keypad or cell phone buttons. Pressing a button multiple times quickly moves the cursor to the next letter in the series. The cursor will jump to the next digit automatically if a button is not pressed within approximately 2 seconds.

•i Use this button for entering digits and, when in RUN-Mode, recalling identification information for the device, such as the software version and electronic components in use. It also functions to initiate communication between the transmitter and sensors.

ALT Use this button to alternate between uppercase and lowercase letters in text entry mode. When setting parameters, this button can be used to enable or disable various functions and to toggle between various programming options. When used in the RUN mode, it initiates a data download to the compact memory card.



Shut-off the Portable FlowShark Pulse

Measurement and Display Functions

After the system parameters are set, the Portable FlowShark Pulse will perform a complete system reset and then begin taking measurements based on the designated interval. The time required for taking measurements within each interval is based on the flow and hydraulic conditions.

The number of storage events per hour is based on the number of intervals designated within a full hour. For example, if a user configures the system at 12:17 pm to take measurements at a 5-minute interval, the unit will store data from the first interval at 12:20 pm, the second interval at 12:25 pm, the third interval at 12:30 pm…and continue recording every 5 minutes for a total of 12 events in one hour.

Display Options in Memory Mode

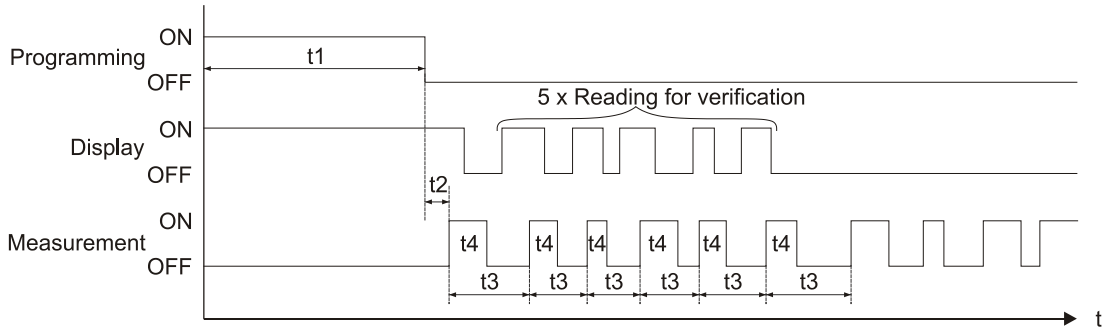
The following options are available for displaying information in memory mode:

- **Maintenance** Turning on the Portable FlowShark Pulse for maintenance purposes (such as for displaying data, checking sensors, or replacing the battery pack) without modifying the parameters displays the current readings for 4 minutes. The unit will continue to save data in the background based on the designated measurement interval, provided the unit is configured to store data at less than a 3-minute interval.

  The unit will enter standby mode and turn off the display 4 minutes after the last keystroke performed by the user. Then, the display will flash five times following the designated interval. To conserve energy, the display will remain blank while the unit continues to record data in the background at the designated interval.

- **Reprogramming or Parameter Modification** After you confirm a modification by entering the PIN code, the display will go blank for a moment and then, after the unit restarts, show the current readings for 3 minutes. The unit will save data in the background based on the designated measurement interval, provided the unit is configured to store data at less than a 3-minute interval.

  The unit will enter standby mode and turn off the display 4 minutes after the last keystroke by the user. The display will flash five times following the designated interval. To conserve energy, the display will remain blank while the unit continues to record data in the background at the designated interval.



Display Functions Outside Memory Mode

When initially setting up the Portable FlowShark Pulse system for operation in difficult applications, the memory function may not be necessary for short-term projects and scheduled verification of other monitoring systems (e.g., flumes, weirs, or magnetic-inductive systems) or throttles. However, it may be beneficial to display the current readings real-time. Therefore, the unit will continue to take and display measurements even when the memory function is disabled.

The current readings will display continually on the unit, but these readings will be saved only if the memory mode has been enabled. In addition, please note that exercising this option significantly increases power consumption.

CHAPTER 6

Parameter Settings

After installing the system (refer to *Chapter 3*, *Installation*) and activating the power supply, set the configuration parameters for the system to ensure reliable device operation. Standard applications typically require you to input or modify only a few basic settings:

- Geometry and dimensions of the measurement location
- Type of sensors for depth measurement
- Memory mode
- System time and date

For projects involving advanced configuration, complex hydraulic conditions, unique pipe shapes, limited technical staff, or specific setup procedures and error protocols, contact ADS for assistance in configuring the Portable FlowShark Pulse.

Basics for Setting Parameters

The unit's protection is guaranteed only when the enclosure lid is closed and locked securely using both locks. Therefore, always verify that the lid is locked safely using both snap locks after setting the parameters, before initiating data logging activities, and after verifying the initial readings.

During unfavorable weather conditions (such as rain) or at locations experiencing water leakage from the top of the manhole, seek a dry location in which to replace the battery pack or memory card. When a dry location is not available, protect the exposed (open) unit sufficiently from contact with moisture.

After setting the parameters, lock the unit securely using both snap locks to guarantee protection from environmental elements.

The transmitter operates automatically using the existing settings until you enter and confirm new input parameters. After finishing entering all the new settings, the system will prompt you whether to accept the new values.

Confirming the new settings (selecting **YES**) requires you to enter the following code number.

2718 Type in 2718 if prompted.

The unit will request the PIN once daily while you are setting the parameters. It also will request the pin when an interruption of power to the unit occurs.

Do not give this code number to an unauthorized individual. In addition, do not leave the code next to or write it down on the equipment. This number prevents access by unauthorized users.

If you enter the wrong code three times, the system will abort the parameter mode and continue operation based on the existing parameters. If the correct code is entered, the system will accept the modified parameters and reset (which takes approximately 20 to 30 seconds).

After mounting and installing the sensor and transmitter, activate the power supply. To activate the power supply, connect the plug in the battery compartment to the socket at the end of the wire attached to the rechargeable battery.

The initial start-up dialog displayed requires you to select the language in which the unit will display information.

Language selection

Select the desired language using the arrow keys, and then press **Enter** to confirm.

Initiate a system reset prior to each initial startup to reset the unit to the factory default settings. This helps prevent errors that can occur based on improper settings.

During a full reset, the unit loses any custom parameters and restores the factory default parameters.

After the language has been selected, the unit checks the battery status to calculate the remaining battery life. Indicate whether the battery in use has been freshly charged by selecting **YES** or **NO**. The current battery voltage displays in the top line.

Request battery full

The unit allows you to initiate the Start Assistant after checking the battery status.

Start Assistant

The *Start Assistant* displays only at initial start-up or after resetting the system, restarting a deactivated unit, or reconnecting the battery. It provides a quick start-up procedure that guides you step-by-step through setting the primary parameters. Select **ENTER** to go to the next step. This chapter offers detailed descriptions of all the parameters.

Select **NO** to continue to the display menu without using the start assistant.

Selecting **Start Assistant**

Change Set Time

Choose **YES** to modify the Portable FlowShark Pulse clock settings (date and time), if required. Confirm by selecting **ENTER**. Please notice that the clock is set to the local time.

Selecting **Set Time**

Change Date and Time

Modify the date and time within the system time menu. Select **ENTER** to proceed to the next step.

Changing date and time

Application

This menu allows you to designate the amount of pollution in the flow. Toggle between the various degrees of pollution by pressing the **ALT** key: **wastewater** (*medium* pollution), **sludge** (*high* pollution), or **natural** water (*slight* pollution).

Selecting medium pollution

Name

ADS recommends managing and defining location names based on the names referenced in the respective documentation. Location names may contain up to 21 letters. The method used for setting the name is similar to the method used for entering text in a cell phone (e.g., SMS).

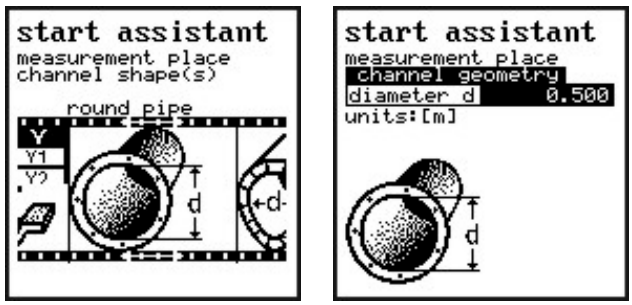
Modifying the name of the measurement location

Channel Shapes/Channel Geometry

Select the shape of the pipe/channel using the left and right arrow keys and confirm by selecting **ENTER**. Choose from the following standard profiles (according to ATV A110):

- Pipe (round or ellipse)
- Egg (standard; h:w = 1.5:1)
- Rectangle
- U-Profile
- Trapezoid A = f (h, b)
- 2r Egg (h:w = 1:1)
- NPP (Pipe Profiler)

It is also possible to subdivide the pipe into special profiles, such as Q = f (h), A = f (h), three-part profiles, and two-part profiles. Confirm by selecting **ENTER** and typing in the corresponding channel dimensions.



Selecting the channel shape and channel geometry

*When you select **NPP** as the channel profile, the unit will automatically use optimized settings for measurements in full pipes in the background.*

Sensor Type

Scroll through the sensor type(s) using the up and down arrow keys. Press the **ALT** key to select each respective sensor, and then confirm by selecting **ENTER**.

Selecting the level (depth) sensor type

Select Layers

This parameter will display only if a combination sensor has been selected.

The Portable FlowShark Pulse automatically aligns the sensors with partial layers. However, the borders for the layers must be defined manually using the **ALT** key.

Designate the threshold levels (i.e., depths) between the layers using the boxes in the **from** lines (numbers **2** and **4**).

1	Top layer sensor
2	Threshold level between the middle and top layers
3	Middle layer sensor
4	Threshold level between the middle and bottom layers
5	Bottom layer sensor

Subdividing level (depth) sensors

Mounting Offset

Selecting **Water-US int.** and **Pressure int.** sets this value to 0 mm by default. The bottom edge of the ground plate (channel bottom) serves as the reference point.

For **air-US NIVUS** sensors, the bottom edge of the ground plate also serves as the reference point; however, it is located at the crown of the pipe. The unit automatically specifies the mounting height of the air-ultrasonic depth sensor once the channel dimensions have been set.

The associated mounting heights will be adjusted based on the existing conditions and the installation circumstances once the depth level is adjusted in the **CAL** menu.

Modifying the mounting offset for level (depth)/height sensors

Storage Mode

Set the storage cycle for the compact flash card at a rate from 1 to 60 minutes.

Changing the storage cycle

Save New Values

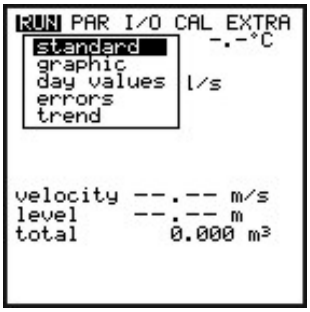
The unit will prompt you to either save all the values or ignore the selections before finishing the start assistant. Reject all values by selecting **NO** at the end of the parameter setting procedure. You can browse through all the values again in the Start Assistant by selecting the **BACK** function. This enables you to modify settings you may have overlooked without saving previously modified settings. Selecting **YES** prompts you to enter the PIN, which saves all the values and starts the unit.

Saving new values

Erasing Flash

Operation Mode (RUN)

This menu displays when the unit is in standard operating mode. The parameters contained in the following submenus are not essential for parameter setup:



Selecting the standard operating mode

RUN: Standard

This screen displays basic information including the measurement location name and the current time (*alternately displays median temperature*), flow rate, average velocity, flow depth (level), and flow volume.

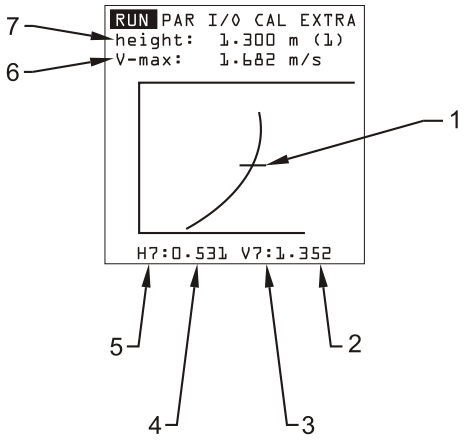
RUN: Graphic

This screen indicates the velocity distribution in a vertical measurement path.

Pressing the up or down arrow key moves the indicator line in the corresponding direction. The selected height and current velocity display at the bottom.

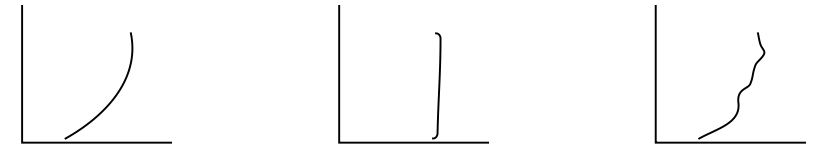
The screen enables you to view the current flow conditions at the selected measurement location. The velocity profile should be distributed evenly without excessive discontinuity.

Under extremely poor flow conditions, ADS recommends changing the position of the velocity sensor.



1	Measurement window
2	Velocity value
3	Velocity measurement window number
4	Depth (level) value
5	Depth (level) measurement window number
6	Maximum velocity
7	Maximum height

Flow velocity distribution



Very good profile, area free of backwater

Good profile, strongly tending to backwater formation or very high flow velocity

Suitable profile

Poor profile

Unsuitable profile

Flow velocity profiles

RUN: Day Values

This menu indicates the day total values and provides information concerning partial totals since the last reset (similar to the route mileage counter in a car).

View day total values for the past 90 days through the **INFO** menu. The system saves the flow totals to memory for 90 days. You can save this data to the compact flash card through the **I/O** menu.

Day total values menu

INFO

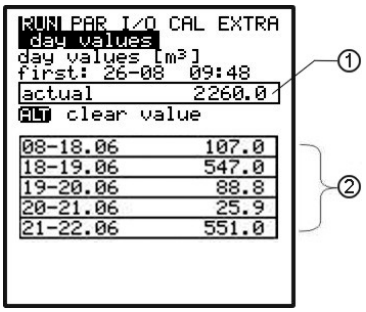
This menu contains the total flow values from the past 90 days, provided the transmitter has operated without interruption for the past 90 days. If an interruption occurs, it displays the flow totals for the uninterrupted days of operation. Reset the total to **0** by pressing the **ALT** key. This reset will not impact the totalizer.

Cycle

The Portable FlowShark Pulse typically calculates flow totals at midnight (00:00 h). However, you can modify the time at which this will occur, when necessary, through the **RUN > Day Values > Interval**. However, keep in mind that modifying the time will impact the day totals already stored in the unit's memory.

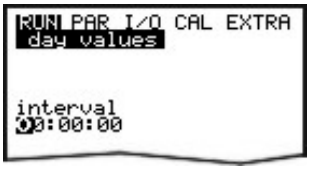
Erase memory

This option erases the internal daily totals in memory. However, the totalizer readings on the main screen will remain unaffected and continue to display.

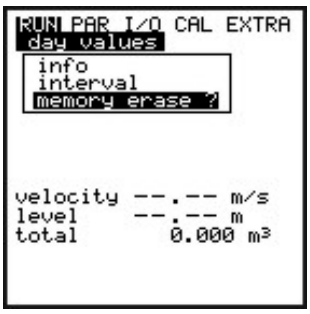


1	Range of day values
2	Day values

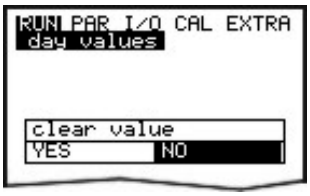
Total day values



Time of day totalizing



Erasing day values from memory



Confirming the clearing of the memory

RUN: Errors

This screen allows you to monitor any interruptions in unit function. The unit saves and organizes errors by the type of error and the date and time at which the error occurred. The **ALT** key deletes error messages one at a time, from the latest to the oldest. Deleting an error message is equivalent to confirming the error. If the error still exists at confirmation, the system will not write it into the error memory again.

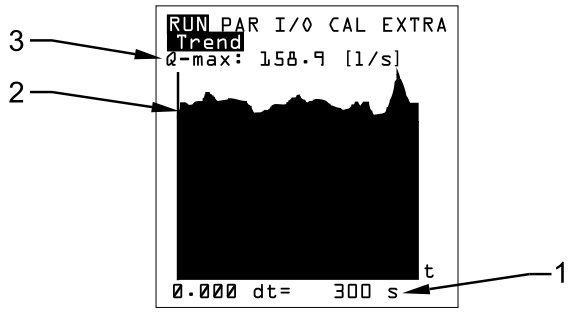
RUN: Trend

This display functions like an electronic logger, recording depth (level), average flow velocity, and height readings to memory at a designated interval. The Portable FlowShark Pulse memory can store readings for measurements taken every minute within a 14-day period.

This submenu allows you to select and view individual trends, allowing monitoring of historical conditions at a location on-site without additional resources.

Selecting trend values

The period over which the measurements have been taken displays at the bottom of the screen. Use the left/right arrow keys to select the desired period you want to view (*up to 14 days*).



1	Memory interval
2	Trend graph
3	Maximum value

Example of trend graph

Resetting the system clears the content in the internal memory and deletes all graphic value trends previously saved to memory.

Display Menu (EXTRA)

This menu allows you to modify settings, such as the standard screen, units, language, and display. The **EXTRA** menu contains the following submenus:

Figure 8-13 Extra submenus

EXTRA: Units

From this menu, you can select the unit system in which readings will display. Select from among the metric system (liter, cubic meters, cm/s, etc.), English (UK) system (ft, in, gal/s, etc.), and English (US) system (fps, mgd, etc.).

Several options are available for each kind of reading within each unit system. You can select the appropriate unit of measure to appear on the display for each of the following measured or calculated values. The next selection will display automatically after confirmation.

- Flow rate
- Velocity
- Level (*depth*)
- Total

These settings only apply to the way in which units are displayed on the screen. They do not affect the units in which measurements are stored on the memory card. To designate the units for the memory card, select ***Parameters > Memory mode > Units****.*

EXTRA: Language

This option enables you to select the language (German, English, French, Italian, Czech, Spanish, Polish, or Danish) in which text will display on the screen.

EXTRA: Display

This feature allows you to adjust the display settings regarding contrast and brightness. Use ▼ and ◄ to decrease settings; use ▲ and ► to increase settings.

The ► and ◄ buttons modify settings at 5 percent increments; the ▲ and ▼ buttons modify settings at 1 percent increments.

EXTRA: Set Time

To perform various control and memory functions, the unit includes an internal system clock for saving dates corresponding to years, weekdays, and weeks. When necessary, you can modify clock date and time. First, select the **Info** menu option.

System time submenu

The unit displays the system time after confirming the settings:

System time

This menu option is for display purposes only. You cannot adjust the system time through this option. Perform these modifications through the individual set time menus.

Setting the date

Set both the date and the time through the **Set time /Date and Time** option.

EXTRA: Set Total-Counter

This menu option represents the main totalizer setting (m^3). This will be set to zero following a system reset.

Parameter Menu (PAR)

Parameter submenu

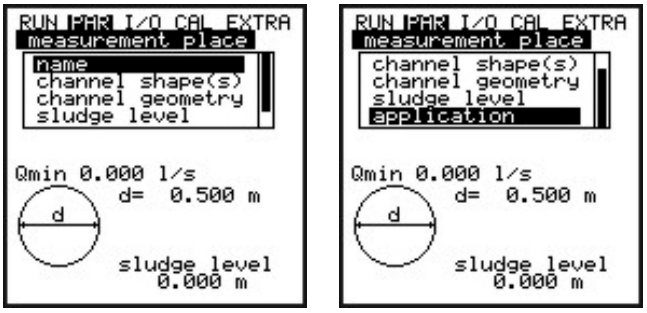
This is the most comprehensive and critical menu involved in setting Portable FlowShark Pulse parameters. While you can modify many different parameters, the system typically only requires you to set the following parameters:

- Location name
- Pipe shape
- Pipe dimensions
- Sensor types
- Storage mode

All other functions correspond to unique circumstances or applications.

The following sections describe the submenus included in the Parameter menu (PAR).

PAR: Measurement Place



Measurement place submenu

This menu is used for defining the measurement location and, therefore, serves as one of the most important menus involved in setting parameters.

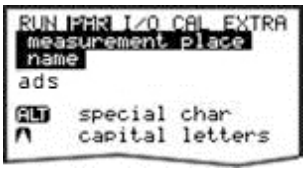
Due to the limited area for display, the entire menu cannot display on the screen. The black scroll bar to the right of the menu options indicates that additional options are available on the menu.

▲ ▼ Use the up and down arrow keys to scroll through the menu.

Measurement Place Name

ADS recommends managing and designating names based on the names used in the associated documentation. A name may contain up to 21 characters. The method used for entering a name on this screen is similar to entering text on a cellular phone:

After selecting the **Measurement Place Name** submenu from the **PAR** menu, the default setting, **ADS**, will display.



Setting the name for the measurement location

Enter the desired name using the keypad; each key represents three letters and a number (Refer to *Chapter 5, Initial Startup*). Cycle through the characters by briefly and repeatedly pressing a key. The cursor will proceed to the next character automatically if the key has not been pressed for two seconds.

Following are descriptions of the function keys:

ALT This key allows you to select special characters (e.g., % or #) that are not available on the keypad. While many characters will display, not all are available for use in location names. Symbols also may be used to indicate inputs and outputs. Select a specific character using the left or right arrow keys, and confirm the selection by pressing **Enter**.

◄ ► These keys move the cursor to the left or the right within the special character menu. Pressing the right arrow creates a character representing a space (*when in the uppercase or lowercase menu*). Pressing the left arrow deletes the previous character.

Note: You can correct mistakes in characters by moving the cursor back and overwriting the problem character.

▲ ▼ These keys toggle between uppercase and lowercase letters. The up arrow shifts to uppercase letters. The down arrow shifts to lowercase letters.

↵ Pressing this key confirms the name entered and exits the menu.

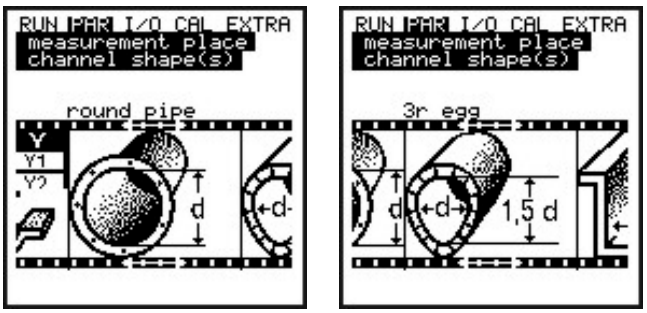
Channel Shape(s)

Select the desired profile using the left and right arrow keys and confirm by pressing **Enter**. The following standard profiles are available (according to ATV A110):

- Pipe (round or ellipse)
- Egg (standard; height-to-width ratio = 1.5:1)

- Rectangle
- U-Profile
- Trapezoid
- A = f (h, w)
- 2r Egg (height-to-width ratio = 1:1)
- NPP (*Pipe Profiler*)

Special profiles, such as Q = f (h), A= f(h), three-part profiles, and two-part profiles also are available.



Selecting the shape of the pipe

The unit saves the selected profile. The next step requires entering the channel dimensions of the profile.

NPP

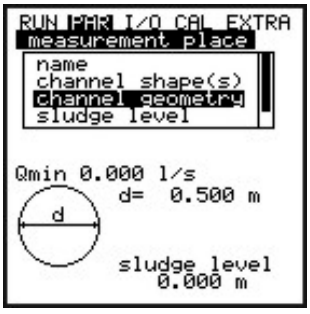
If you select **NPP** for the pipe profile, the unit will automatically use optimized settings for measurements in full pipes.

Enter the inner diameter of the NPP for the channel dimensions immediately after choosing the NPP profile .

Example of selecting NPP

Setting the channel geometry in pipe profiles

The unit subsequently displays the selected profile and channel dimensions in programming mode.



Selected profile

Channel Geometry

Enter the corresponding pipe dimensions based on the previously selected profile.

Please note the units of measure in which the values are displayed.

Entering **A = f (h, b)** (height-to-width ratio) *or* **A = f (h)** (height-to-area ratio) as the profile will display a table of 32 possible breakpoints. Use this table to set the *custom profile.*

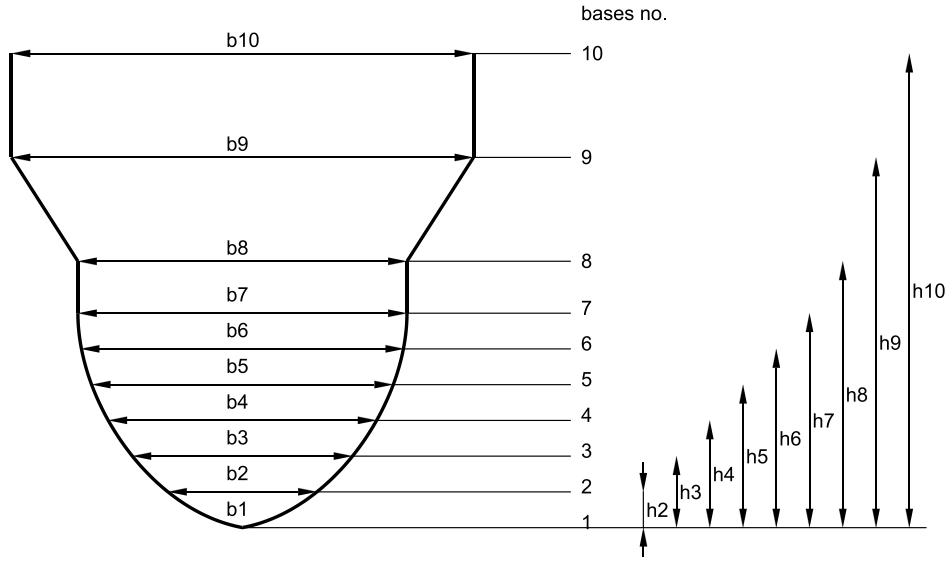
RUN PAR I/O CAL EXTRA
measurement place
channel shape(s)
channel geometry

	height[m]	width[m]
1	0.000	0.000
2	0.100	0.100
3	0.200	0.200
4	0.300	0.300
5	0.400	0.500
6	0.500	0.700
7	0.600	1.000
8	0.700	1.200

Table of custom shape breakpoints

To define the zero point for the pipe, begin by entering 0 – 0 for breakpoint 1. Enter the subsequent segments based on the height and width/area.

Distances may vary among individual depth segments. Please note that it is not necessary to use all 32 segments. The Portable FlowShark Pulse will interpolate between the missing segments. Decrease the distance between breakpoints under conditions reflecting heavy and irregular fluctuation within a specific area.



Custom profile breakpoints

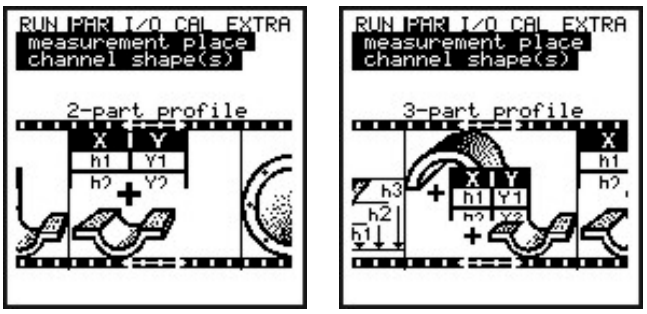
Special Profiles

ADS offers the **2-part profile** and **3-part profile** for defining special profiles.

Selecting the **2-part profile** displays the following setting options:

- Bottom Area: U-Profile
- Top Area: Custom Profile

You can custom design the top area using breakpoints.

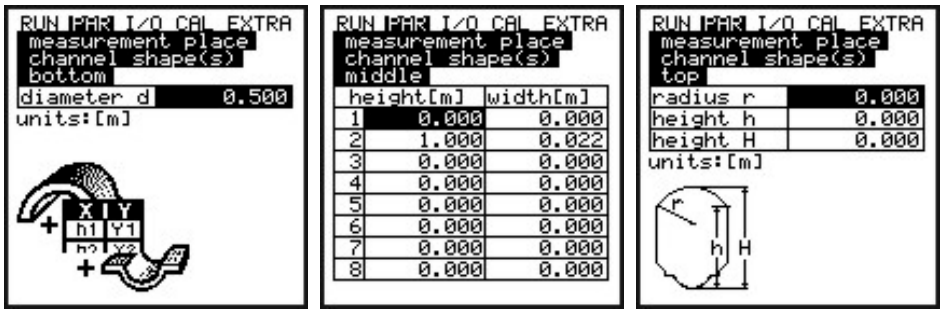


Example of setting custom profiles

Choosing the 3-part profile displays the following setting options:

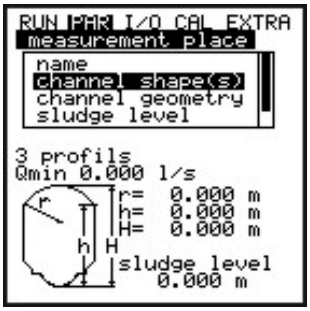
- Bottom Area: U-Profile
- Center Area: Custom Profile
- Top Area: Pipe

The center area can be custom designed.



Dividing the profile into three zones

The following screen provides an example of a special profile.



Three-part profile

Selecting the Q=f(h) option allows for the definition of only one level zone because it is impossible to divide the profile into center and top areas.

Configuring individual pipe sections is necessary only for special or very unusual profiles with convex tops and requires comprehensive knowledge and experience in operating the Portable FlowShark Pulse. To ensure proper configuration and/or to obtain assistance in setting up these parameters, please contact ADS.

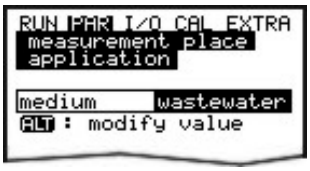
Sludge Level

This parameter represents the depth of the sludge that has accumulated at the bottom of a pipe. This factor must be subtracted from the total wetted hydraulic area before the Portable FlowShark Pulse performs flow calculations.

Application

This parameter enables you to designate the degree of debris in the flow to ensure the most accurate ultrasonic measurement. Choose the appropriate option using the **ALT** key:

- **Wastewater** Represents polluted media (e.g., untreated wastewater)
- **Sludge** Represents media with a high rate of pollution (e.g., sewage sludge), that is apparently clean, or that is only slightly polluted with a high gas rate (e.g., ventilated wastewater)
- **Normal Water** Represents pure, clean media as well as media with a lower gas or particle rate (e.g., rain water, fresh water, tap water, or treated wastewater)



Selecting the degree of pollution in the media

PAR: Level

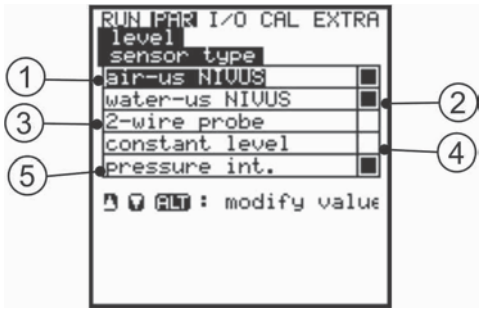
Selecting level measurement from the menu

Submenu for level measurement

Additional programming may be required depending on the sensor type selected. Selecting the wrong sensor will result in erroneous measurements.

This menu allows you to define the parameters corresponding to depth measurement. The start screen and the available parameters may vary based on the sensor type selected.

First, scroll to the sensor type using the up and down arrow keys. Select or deselect sensors using the **ALT** key. Choose from the following sensor types:



1	Air-ultrasonic depth sensor or mini air-ultrasonic depth sensor
2	Water-ultrasonic velocity/combination sensor
3	2-wire probe
4	Fixed value for full pipe applications or for testing
5	Pressure measurement cell integrated into water-ultrasonic velocity sensor

Defining the sensor type

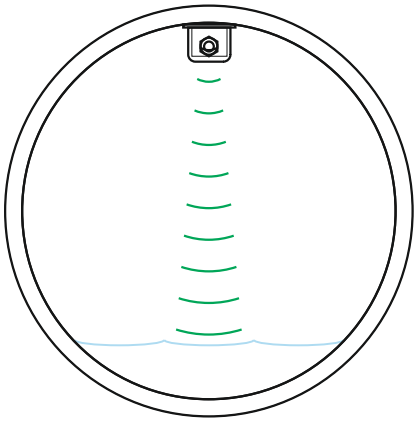
When using combination sensors featuring multiple depth measurements (e.g., water-ultrasonic and pressure measurement cell), select both depth measurements from the menu.

Option 1: Air-Ultrasonic

This option involves depth measurement using an air-ultrasonic depth sensor from the top down. However, the water-ultrasonic velocity sensor may be used in conjunction with this sensor. It requires an air-ultrasonic depth sensor or mini air-ultrasonic depth sensor.

This sensor allows you to measure low flow levels (e.g., for detecting infiltration).

It must be installed in the center of the pipe crown (+/- 2°) and parallel to the water surface.



Sensor type 1: Air-Ultrasonic

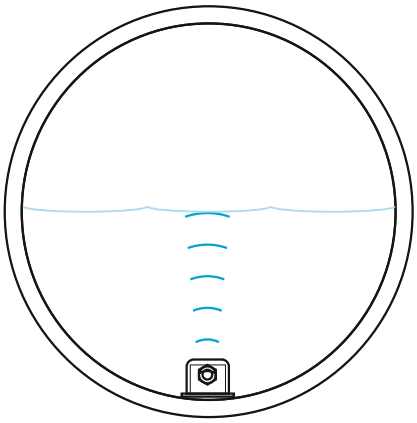
Option 2: Water-Ultrasonic

This option involves level (i.e., depth) measurement using the water-ultrasonic combination sensor and height measurement via water-ultrasonic from the bottom up.

This sensor provides discharge detection in partially-filled pipes.

It must be installed at the bottom of the pipe in the center (+/- 2°).

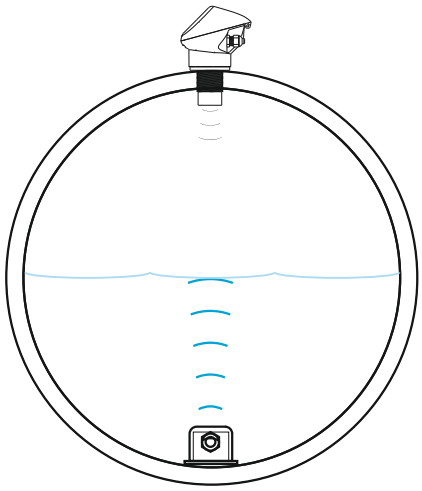
Do not use the water-ultrasonic combination sensor if the sensor cannot be installed in the center (e.g., when silt is present or a risk of sedimentation exists)! This could disrupt the signal and result in measurement failure. If this condition exists, use a different level sensor (e.g., an air-ultrasonic depth sensor from top down or pressure measurement cell).



Sensor type 2: Water-Ultrasonic

Option 3: Two-Wire Sensor

This option involves depth measurement using an external 2-wire sensor (*not supplied by ADS*). The system calculates flow rate exclusively using Q = f(h) without an additional velocity sensor. However, the velocity sensor may be used in conjunction with this sensor.



Sensor type 3: Two-Wire Sensor

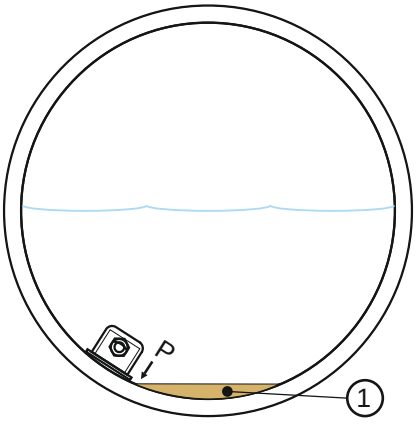
Option 4: Fixed Value

This option is recommended for applications involving pipes and channels that remain full (e.g., NPP) and, therefore, typically do not require depth measurements. Set the constant depth level **PAR > Fixed value > Scale > Height**. Use this parameter for testing or initial startups where a depth reading is not available.

Option 5: Pressure

This option involves depth measurement using a water-ultrasonic combination sensor with an integrated pressure measurement cell from the bottom up. It can be installed off-center (e.g., at locations experiencing silt and possibly heavy debris buildup).

This option also can be used for depth measurement in overflows.

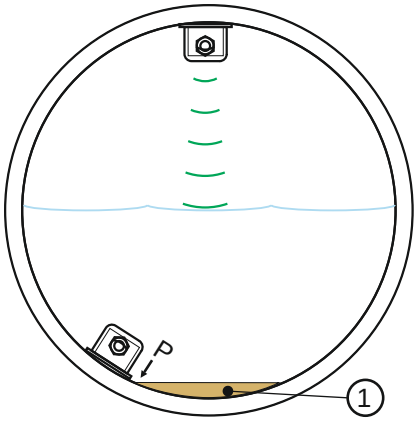


Sensor type: Pressure (1 presents sedimentation)

The remaining options involve combinations of the preceding options. These may be necessary when structural conditions prohibit a single sensor from adequately addressing the entire measurement range at a location.

Sensor Combination 1: Air-Ultrasonic and Pressure

ADS recommends this option for measuring flow at a location that can experience flows ranging from 0 inches to surcharge conditions. The air-ultrasonic depth sensor or mini air-ultrasonic depth sensor measures low depths; the pressure sensor measures full pipe. Pressure sensors may be installed off-center when heavy silt is present.



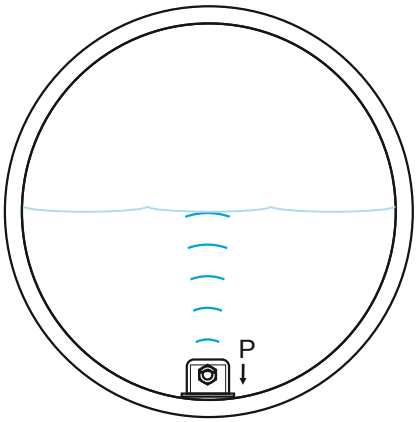
Combination: Air-Ultrasonic and Pressure (1 represents

Sensor Combination: Two-Wire Sensor and Pressure

ADS recommends this option for applications similar to the previous combination. However, the 2-wire sensor would be used in place of the air-ultrasonic depth sensor.

Sensor Combination: Water-Ultrasonic and Pressure

ADS recommends this option for measuring flow at a location that can experience flows ranging from depths of 5 mm to surcharge conditions. The pressure sensor measures the lower and highest flows; the water-ultrasonic depth sensor measures the middle range flows. The water-ultrasonic combination sensor must be installed at the bottom of the pipe in the center.

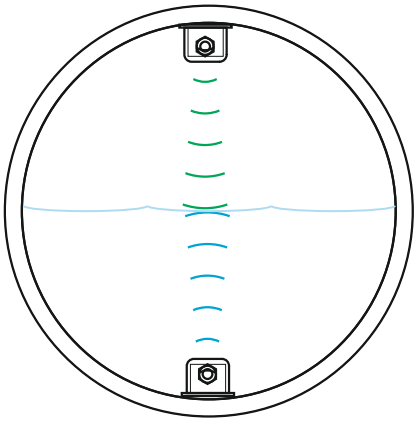


Water-Ultrasonic and Pressure

Sensor Combination: Air-Ultrasonic and Water-Ultrasonic

ADS recommends this option for measuring flow at a location that can experience flows from 0 mm up to 80 percent capacity. The water-ultrasonic depth sensor measures depths from approximately 2 inches and above; the air-ultrasonic depth sensor measures the lower depths.

The water-ultrasonic combination sensor must be installed at the bottom of the pipe in the center.



Water-Ultrasonic and Air-Ultrasonic

Sensor Combination: Water-Ultrasonic and Two-Wire Sensor

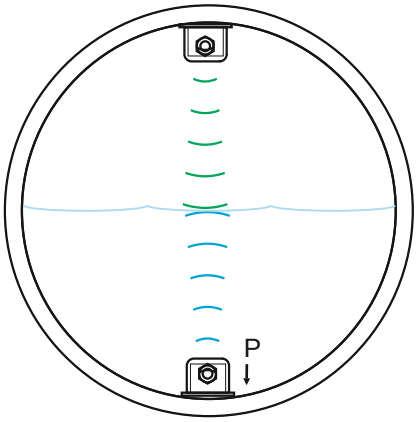
ADS recommends this combination for applications similar to the previous option. However, the external 2-wire sensor would be used in place of the air-ultrasonic depth sensor to measure low flow depths.

Sensor Combination: Air-Ultrasonic, Water-Ultrasonic, and Pressure

ADS recommends this combination for locations exhibiting flows from 0 inches up to overflow to achieve the highest level of accuracy in measurement. The pressure sensor measures the upper measurement range, the water-ultrasonic depth sensor

measures the medium range, and the air-ultrasonic depth sensor measures the low range.

The water-ultrasonic combination sensor must be installed at the bottom of the pipe in the center.



Air-Ultrasonic, Water-Ultrasonic, and Pressure

Sensor Combination: Pressure, Water-Ultrasonic, and Two-Wire Sensor

ADS recommends this option for applications exhibiting the same conditions as described with the previous air-ultrasonic, water-ultrasonic, and pressure combination. However, the external 2-wire probe would be used in place of the air-ultrasonic depth sensor to measure low depth levels.

The water-ultrasonic combination sensor must be installed at the bottom of the pipe in the center.

Mounting Offset

After selecting **Water-US int** and **Pressure int**, the unit sets the mounting offset to 0 inches by default. The bottom edge of the ground plate (i.e., the pipe bottom) serves as the reference point.

When selecting **air-US NIVUS**, the reference point is also the bottom edge of the ground plate. However, this refers to the pipe crown for this sensor.

The unit automatically specifies the mounting height of the air-ultrasonic depth sensor or mini air-ultrasonic depth sensor after you set the pipe dimensions.

The corresponding mounting heights will be adjusted based on the prevailing conditions and the installation characteristics once you set the level in the **CAL** menu.

Height h	Mounting height water-US int + pressure int
Height H	Mounting height water-US NIVUS

Mounting offset of level (depth) sensors

After modifying the mounting height of the pressure or water-ultrasonic depth sensors, you must adjust the mounting height in the ***PAR > Flow velocity*** *menu by the same value!*

Select Layers

This parameter will display only when you have selected a sensor combination. The Portable FlowShark Pulse automatically aligns the sensors to partial layers. However, you can define the borders for these layers manually using the **ALT** key. Designate the threshold levels between the layers using the boxes in the **from** lines.

1	Sensor corresponding to the top layer
2	Threshold level between middle and top layers
3	Sensor corresponding to the middle layer
4	Threshold level between middle and bottom layer
5	Sensor corresponding to the bottom layer

Selecting the layers

After selecting the sensors, they will display on the screen.

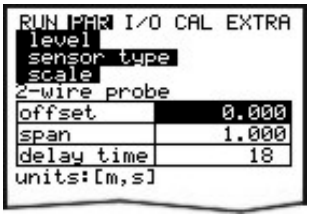
Overview of depth sensors

Scale

This option allows you to enter a measurement offset, measurement range, and time delay or the fixed depth level corresponding to the input signal, based on the selected sensor type.

Time Delay

This parameter represents the amount of time required, once the Portable FlowShark Pulse has been turned on, for the external sensors to stabilize for measurement. During this period, the sensors will receive power, but the readings will not be recorded.



Two-wire sensor settings

Screen showing 2-wire sensor

Refer to Chapter 3 for information about connecting the sensors.

PAR: Velocity

The Portable FlowShark Pulse supports a flow velocity sensor housed in a water-ultrasonic combination sensor with integrated depth measurement or as a standalone water-ultrasonic velocity sensor.

Sensor settings

Choosing **sensor type** displays the following screen:

Selecting the sensor type

Sensor Type

Choose the wedge (*combination*) or pipe insertion sensor *and* float (measurement from above) or **Pos-alpha** (positioned at any angle up to vertical) using the **ALT** key.

Installation position is set to **positive** by default. Do not modify this parameter. The **negative** setting exists only for specific applications where the flow velocity sensor is facing downstream (the sensor faces upstream toward the oncoming flow during standard applications), but is used to measure positive velocities.

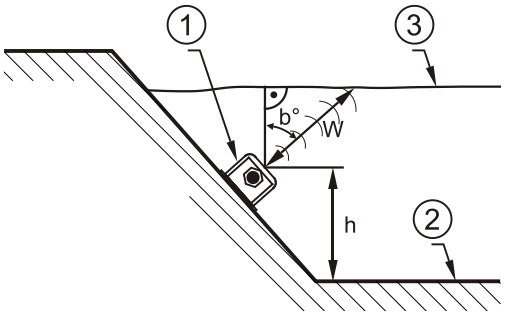
Mounting Place

This parameter allows you to modify the installation height for the flow velocity sensor. The default setting is 0 inches, which represents the bottom edge of the ground plate (pipe bottom). This setting does not require modification unless the sensor has been installed at an elevated position. If the sensor has been installed higher, add the additional mounting height to the standard mounting height of 0 inches.

When selecting **Pos-alpha**, the following mounting settings are available for input:

height h	Mounting height of the sensor body
angle b°	Sensor installation angle diverging from vertical
w	Maximum possible distance between the sensor and an obstruction (e.g., the opposite wall in a horizontal installation) This dimension must be calculated and entered by the user. The Portable FlowShark Pulse will determine this length (w) automatically once the unit measures a shorter distance to the flow surface, based on the depth level.

Parameters for off-center sensor installation



1	Sensor body
2	Pipe bottom
3	Flow surface

Measurement location settings

*Modifying the mounting location for the depth sensor requires modifying the **CAL > Velocity > Channel No. > h_crit** parameter by the same factor.*

PAR: Analog Outputs

Submenu for analog outputs

The analog output on the Portable FlowShark Pulse is a 0 – 10 voltage output. Designate the functions for the analog output through this menu.

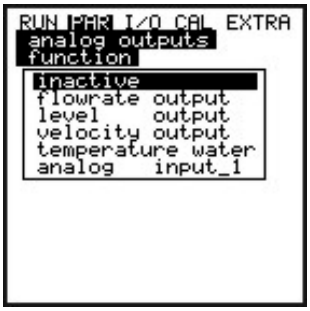
Name

(*optional – for internal use only*) To enter the name, follow the same procedure used for **PAR > Measurement Place > Name**.

Function

Assign one of the following functions to the analog output:

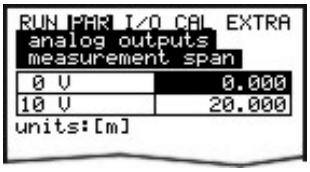
- **Inactive** No signals from analog output
- **Flowrate Output** Outputs an analog signal proportional to the calculated flow volume
- **Level Output** Outputs an analog signal proportional to the calculated depth level
- **Velocity Output** Outputs an analog signal proportional to the *average* flow velocity calculated based on the individual velocity readings
- **Temperature Water** Outputs an analog signal that represents the water temperature reading
- **Analog input 1, Socket 3** Outputs the value from analog input 1, which may have been modified based on a specific parameter



Selecting analog output functions

Measurement Span (Range)

Define the specific values for the output signal. Enter the values based on the units selected through the **Extra** menu. Negative values may be included.



Measurement span

Completed screen with correct settings

Example:

The measurement location can tend to experience backwater conditions and, therefore, negative values must be recorded. The analog output signal for this scenario must be set to **floating**.

As a result, configure the measurement span so that the unit will output a V signal for flow = 0 reading in the middle of the measurement span.

Example:

0 V = -100 l/s (-2.28 mgd)

10 V = 100 l/s (2.28 mgd)

For this example, the signal output for a zero (0) reading would be 5 volts. Backwater will cause the analog signal to decrease; positive flow will cause the analog signal to increase.

The analog output will be updated during the measurement interval. While the unit is between two consecutive measurement cycles (in sleep mode), the voltage value will be sustained based on the latest value.

PAR: Digital Outputs

Submenu for digital outputs

Function

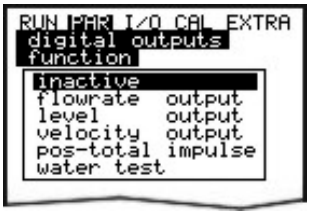
Assign one of the following functions to the relay that corresponds to a specific channel number:

- **Inactive** No signals from digital output
- **Flowrate Output** Energizes the relay if the flow exceeds a designated threshold and de-energizes it if the flow falls below a second designated threshold
- **Level Output** Energizes the relay if depth exceeds a designated threshold and de-energizes it if depth levels fall below a second designated threshold
- **Velocity Output** Energizes the relay if velocity exceeds a designated threshold and de-energizes it if velocity falls below a second designated threshold
- **Pos-total impulse**
- **Sampler**

Name

This menu is available only when a function has been enabled. Name represents the name of the relay output. Entering a name is not required; the name is for internal use only.

To enter a name, use the same procedure described for **PAR > Measurement Place > Name**.



Defining relay functions

Logic

Toggle between **normally open** and **normally closed** using the **ALT** key. Selecting **normally open** ensures the relay energizes once the designated threshold is met. Selecting **normally closed** ensures the relay energizes immediately after the parameters have been set and de-energizes once the designated threshold has been met.

Trigger Level

This menu displays only when the **Limit contact** function is enabled.

Relay trigger level settings

The switching behavior depends on whether the switch-on setting is set higher or lower than the switch-off setting: threshold behaviour (**ON > OFF**) or as an in-range alarm (**ON < OFF**).

Pos-Total Impulse

This menu displays only when the **Pos-Total Impulse** function is selected.

Setting impulse parameters

- **Duration s** Enter the duration for the impulse and adjust the value based on the selected impulse counter.
- **Volume [m^3]** Indicate the volume at which to close the contact for the designated interval.

The Portable FlowShark Pulse has been configured to process the impulses that have accumulated within the memory cycle immediately. If the measurement time is insufficient, the unit will switch over to permanent mode until all the impulses have been processed. Therefore, it is important to modify the number of impulses according to the maximum volume expected.

For example:

If the measurement cycle is 5 minutes, the duration is 0.5 seconds, the volume is 1 m^3, and the measured flow rate is 100 l/s…

5 minutes x 60 seconds x 100 liter per second / 1000 = 300 impulses x 0.5 seconds = 150 seconds

The Portable FlowShark Pulse will operate in the permanent mode for the calculated period.

Sampling

This menu displays only when the **water test** function is enabled.

Relay settings for sampling

- **Duration (seconds)** Enter the duration for the impulse. Modify this setting based on the sampler in use.
- **Volume [mgal]** Enter the volume at which to close the contact for the designated duration.
- **Level [ft]** Enter the depth beyond which to close the contact. This parameter serves to protect the sampler from drawing in air.

*The Portable FlowShark Pulse operates in continuous mode when the **water test** function is selected. The designated memory cycle will define the storage interval only for the compact flash card. This ensures that sampling begin will immediately once the flow reaches the designated volume.*

In this mode, the unit has a battery life of approximately 3 days.

PAR: Setup Parameter

This menu allows you to either modify or restore the following basic settings of the system.

Submenu for setup parameter

Load factory setup

This option enables you to execute a general reset. Selecting this option displays the following screen:

Executing a general reset

Selecting **Yes** will erase the flash memory.

Saving new values after system reset

Before exiting the menu, the unit seeks confirmation on whether to **save new values**. Selecting **Yes** will reset the Portable FlowShark Pulse to the default parameter settings.

The default settings will be restored and all customer modifications will be eliminated (general system reset).

To avoid improper programming and settings, you must execute a general system reset prior to each initial startup.

Battery / rechargeable

Enter the maximum capacity of the power source that will be used. The system will use this value when determining the remaining capacity and other information.

Damping

This menu enables you to adjust the display and analog output damping between 5 and 600 seconds.

Damping, Example 1: Damping 30 seconds, jump from 0 l/s to 100 l/s (=100 %) – unit requires 30 seconds to run from 0 l/s to 100 l/s.

Damping, Example 2: Damping 30 seconds, jump from 80 l/s to 100 l/s (=20 %) – unit requires 6 seconds to run from 80 l/s to 100 l/s.

Stability

Enter the amount of time to allow the readings to stabilize when measurement dropouts occur due to conditions such as hydraulic interference.

The damping and stability parameters are not applicable when the unit is in active memory mode. Due to the short period of measurement that occurs in this mode, the unit will use the default damping and stability periods of zero (0) seconds.

Maximum Measurement Time

The Portable FlowShark Pulse automatically controls the amount of time required for taking measurements based on several parameters. Use this parameter to modify this time period, when necessary (e.g., when the unit requires additional time to obtain a reliable measurement). However, do not adjust this parameter without requesting prior assistance from ADS.

PAR: Storage Mode

The Portable FlowShark Pulse enables you to save flow velocity, depth, temperature, and flow rate data and input and output signal readings on a compact flash memory card. When necessary, compact flash cards are available through your ADS representative with capacities ranging from 8 to 128 MB.

Use memory cards purchased only from ADS. Other manufacturer's cards may lead to irreversible loss of data, measurement failure, or permanent transmitter reset.

ADS is not responsible or liable for data lost when using a third-party memory card.

An icon in the **RUN** menu indicates when the memory mode is enabled.

The Portable FlowShark Pulse enters an energy-saving stand-by mode following four minutes of keypad inactivity. The unit will operate only during the designated interval. The unit display is disabled (i.e., remains blank) when the unit is in memory mode.

Memory card slot on transmitter (left) and memory card (right)

Due to the limited number of storage cycles on the memory card (approximately 100,000 writing events) and for its protection, the Portable FlowShark Pulse initially stores measurement data to internal memory. The unit saves this data to the card on an hourly basis, pre-set by the internal system time.

Executing data transmission from the internal memory to the card can occur manually by activating the unit directly (by pressing any key on the keypad) or by pressing the **ALT** key on an activated unit. The unit indicates data transmission is in process by displaying the message, ***Memory card busy***.

Transmit data to the memory card prior to removing or replacing the card to ensure all data is saved to the card.

Data is saved in a standard text file (ASCII) format under the following filename: **[*measurement location name*].TXT**. This file can be read and processed using **Microsoft® Excel®**.

Do not format the memory cards on a PC; always use the Portable FlowShark Pulse. The unit can neither use nor accept cards formatted on a PC.

The unit will always save data with the current date and time at the moment at which the data is saved.

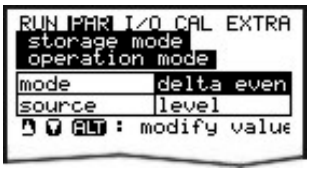
Selecting memory options

Operation Mode

ALT Use this key to toggle between the following modes:

- **Disabled** This option prevents data from being saved

- **Periodic** This option provides cyclical storage of flow data and peripheral input signals.
- **Delta Event** The Portable FlowShark Pulse can toggle between two logging options:
  - **Switchover Operation** This involves initiating the recording of readings immediately after a depth threshold is exceeded or a specific impulse from the digital input is received.
  - **Continuous operation** This involves continuously recording readings similar to using a permanent flow meter. The unit will save data based on a designated storage interval. This mode is intended for use in conditions involving very high discharge and for short-term operations.



Selecting memory options

Source

- **Level** This setting configures the pressure measurement cell to measure and retrieve depth data every 5 seconds. If the depth threshold is exceeded, the Portable FlowShark Pulse will immediately switch over to event mode.
- **Digital I1** The Portable FlowShark Pulse permanently monitors the digital input and immediately switches over to event mode when the digital input is enabled.

Storage mode screen

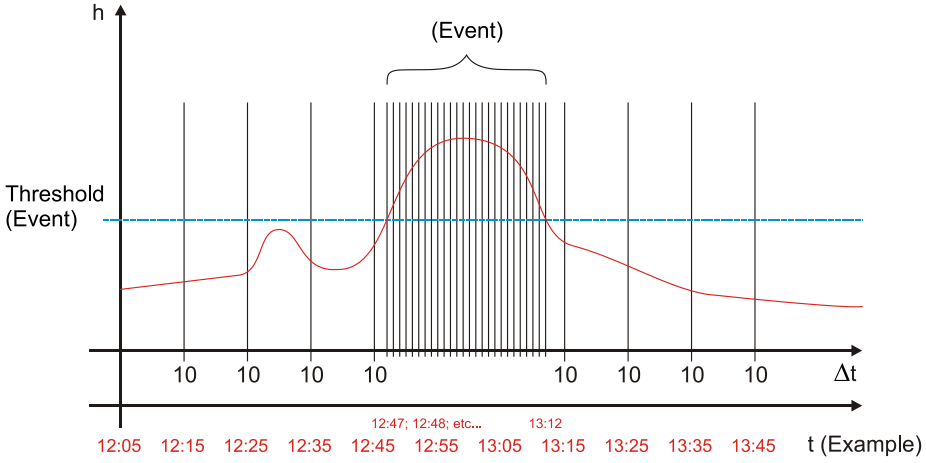
Periodic interval

This parameter exists for selecting the interval at which to save or record data. Choose a storage interval from 1 minute to 1 hour. The available intervals include 1, 2, 3, 4, 5, 6, 10, 15, 20, 30, and 60 minutes.

Event Interval

This parameter is available when the event mode is enabled and exists for defining the interval at which the unit stores data during an event. Designate the storage interval from 1 minute to 1 hour. The available intervals include 1, 2, 3, 4, 5, 6, 10, 15, 20, 30, and 60 minutes.

Setting the storage cycle



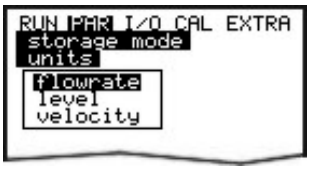
Example of setting the interval at which to save data when an event occurs

Units

Select the units of measure system in which the unit will save the flow, depth, and velocity data. Choose from the metric (e.g., liters, cubic meters, centimeters per second), English (e.g., feet, inches, gallons per second), or American.(e.g., feet per second, million gallons per day) system. After selecting the unit system, the unit will automatically display the next screen.

You also can define the units of measure in which to save the data to the memory card for each of the individual categories of measurement (i.e., measured and calculated flow, velocity, and depth). The units of measure available depend on the unit system previously selected..

Selecting the unit system for the storage mode

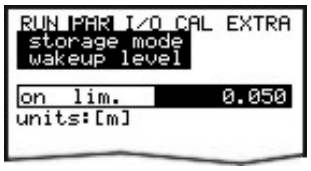


Selecting the measurement value in storage mode

Selecting the units of measure for the measurement in storage mode

Wakeup level

Define the depth level (threshold) at which to transition from storing data on a periodic interval to an event interval.

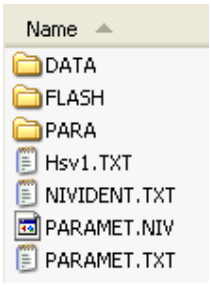
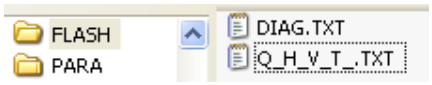
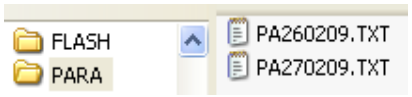


Wakeup level at which to switch to storing data at an event interval

Format of numbers

Choose whether to save data with commas or dots to represent decimal points. Dots typically are used in most regions outside Europe. Commas typically are used inside Europe. .

Data Structure on the Memory Card

Main Directory	FLASH and PARA Subfolders
	  

Data structure on the memory card

DATA

This folder represents the location in which the file containing the day totals (**TOTAL.TXT**) is stored. Save the day totals by selecting **I/O > Memory card > Day values**. .

FLASH

This folder represents the location in which the backup file is saved (To execute the backup, select **I/0 > Memory Card > Save backup**).

The name of the backup file containing the depth, velocity, flow, and temperature data written from internal memory is always **Q_H_V_T.TXT**. The **DIAG.TXT** file contains all messages, including error messages that may have occurred during measurement activities. These may include the beginning and end of communication, modem restarts, and CPU restarts following a system reset or reprogramming.

The respective message is labelled with the date and time:

>: received error/message

<: reason for error/message cleared

PARA

This folder includes all the parameter files with a date stamp. The content in these files allows you to retrace transmitter settings corresponding to the measurement location and parameter settings that may have been modified. The unit saves the latest modification made within a particular day.

The filename is **PA TT MM JJ .TXT**, where TT = day, MM = month, and JJ = year.

name of measurement place.TXT

This is the file in which all of the flow data readings are stored. It is saved under the name of the measurement location.

NIVIDENT.TXT

The name of this text (.txt) file reflects the name of the measurement location.

If the location name saved to the memory card is not consistent with the name of the measurement location saved to the Portable FlowShark Pulse, the unit will prompt you to format the card. If the card requires formatting, the Portable FlowShark Pulse will not save any data until formatting is complete.

PARAMET.NIV, PARAMET.TXT

These files are created when parameters are saved to the memory card. PARAMET.NIV is required for uploading data to the Portable FlowShark Pulse. PARAMET.TXT is the printable (text) version of PARAMET.NIV. Only parameters modified previously will be exported.

Use memory cards purchased only through ADS. Other manufacturer's cards may lead to irreversible loss of data, measurement failure, or permanent transmitter reset.

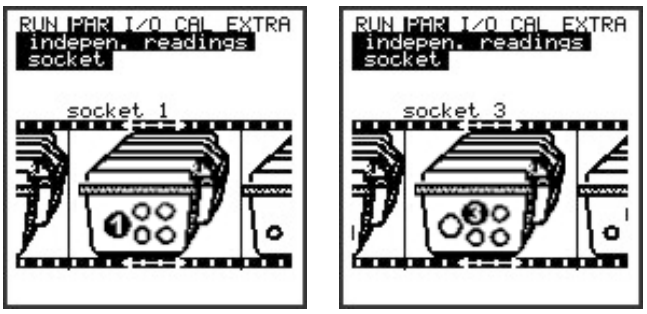
Do not format memory cards on a PC. Format cards only on the Portable FlowShark Pulse. The unit can neither use nor accept cards that have been formatted on a PC.

PAR: Independent Readings

The Portable FlowShark Pulse provides two programmable analog inputs. Select port 1 or 3 using the left and right arrow keys.

These independent analog inputs can be used for purposes such as throttle verification. A 2-wire probe installed within the throttle shaft can be connected to port 1 or 3.

This depth sensor is not used in calculating flow.



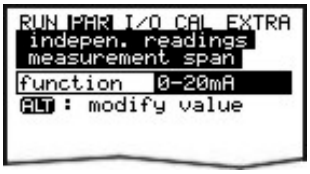
Port (socket) selection for independent readings

Port

- **Socket 1** Input via multifunctional port 1 (2-wire signal, input is passive)
- **Socket 3** Input via multifunctional port 3 (2-wire signal, powered via the Portable FlowShark Pulse)

Measurement Span

Use the **ALT** key to modify the measurement span from 1-20 mA to 4-20 mA.



Measurement span of independent readings

Set the necessary parameters after selecting the measurement span.

Overview of independent readings

Units

This parameter will be assigned to the breakpoint table under the name in which it is saved.

Units of independent readings

Linearization

Define the analog input span from this menu location. The Portable FlowShark Pulse allows you to modify the weighting of the analog input using a 16-digit (maximum) breakpoint table. When properly used, this feature can introduce some beneficial options for setting parameters.

For example, you can convert a level/height signal into a volume-proportional signal, which can be saved, or direct this signal to one of the analog outputs for further processing or display purposes.

First, simply enter the number of breakpoints and press ↵. Then, confirm the entry and press ↵ again. The screen will display a table with the respective units.

Linearization of independent readings

Enter the mA value in the X-column and the other value in the Y-column (Verify the appropriate unit has been selected before entering these values.).

For typical applications, such as saving a measurement value, simply enter **2** as the breakpoint value. Then, define the analog input span (i.e., enter the respective values for 4 mA and 20 mA).

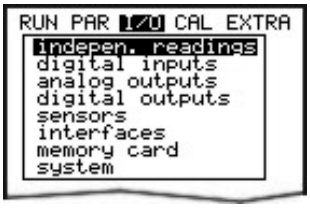
Delay Time

Echo-sounding level (i.e., depth) sensors typically require several seconds to reliably detect ultrasonic signals. Therefore, specify a time delay from 0 – 20 seconds for this parameter.

Delay time for independent readings

Signal Input/Output Menu (I/O)

This menu includes several submenus that enable you to access and to verify the sensors as well as control signal inputs and outputs. It also displays various readings and measurements, including current inputs and outputs, relay conditions, echo profiles, and individual velocities. However, it does not enable you to modify signals or settings, such as offsets, adjustments, or simulations. This menu primarily allows you to access the parameter settings and diagnose errors.

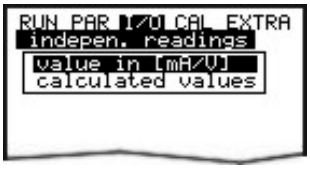


I/O submenu

I/O: Independent Readings

This menu enables you to manage and examine the analog input values received through ports 1 and 3 of the Portable FlowShark Pulse.

The display indicates the values available before (in mA/V) or after (calculated) linearization of the analog inputs occurs.

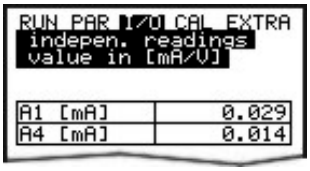


Independent readings

Value in mA/V

This function is primarily used during the startup procedures for verifying the power signals from external depth measurement units.

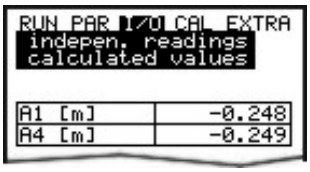
- **A 1 [mA]** Input signal from socket 3
- **A 4 [mA]** Input signal from multifunctional port 1. Indicates the input current for the mA input.



Value in mA/V

Calculated Values

This menu allows you to view the values calculated from the analog input signal selected previously in the unit.



Calculated values

I/O: Digital Inputs

This menu enables you to view digital input values routed to the transmitter input clamps. It indicates either **OFF** or **ON**.

Digital input values

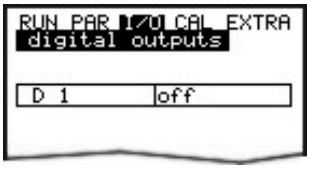
I/O: Analog Outputs

Analog input values

This menu allows you to view the calculated voltage that will be sent to the analog converter.

I/O: Digital Outputs

This menu allows you to view the conditions detected by the transmitter and routed to the relay. It indicates either **OFF** or **ON**.



Digital values

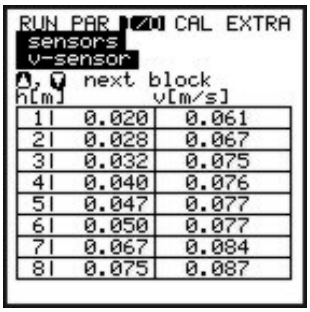
I/O: Sensors

This menu and the associated submenus allow you to view and assess the sensor status and operational conditions. It provides information on the measurement location quality, echo signal quality, and many other parameters.

I/O submenu, V-sensor

V-Sensor

Selecting this option displays a 2-page table that includes all the individual velocity readings and the heights of the corresponding measurement windows.



Individual velocity readings

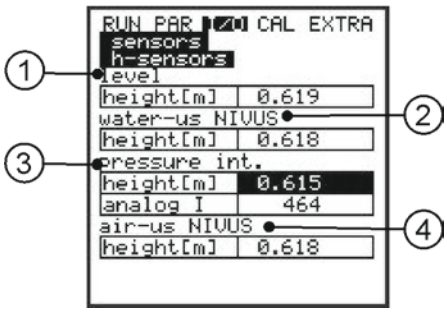
▲ + ▼

Toggle between both pages (measurement windows 1-8 and 9-16) using the up and down arrow keys.

The absence of a reading (------) in a measurement window indicates that flow velocity currently cannot be measured in the corresponding window. This may occur when the water is very clear or vorticity exists within the area. This also may occur with low flow depths, such as approximately 14 inches (35 cm), where the Portable FlowShark Pulse automatically reduces the number of measurement windows available. However, the failure of one or more windows does not determine measurement success.

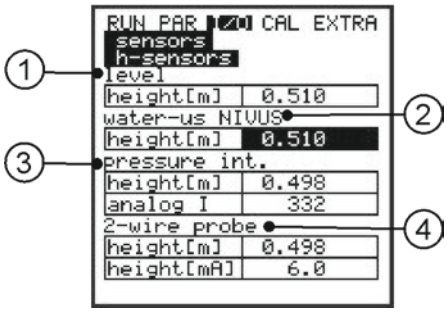
H-Sensor

H-Sensors indicate the depth levels measured. The submenus may vary based on the depth sensor selected (water-ultrasonic, pressure, air-ultrasonic, or external sensor). The following figures provide some examples:



1	Level
2	Level water-us
3	Level pressure internal
4	Level air-us

Example: Menu with water-ultrasonic, pressure, and air-ultrasonic



1	Level
2	Level water-us
3	Level pressure internal
4	Level 2-wire probe

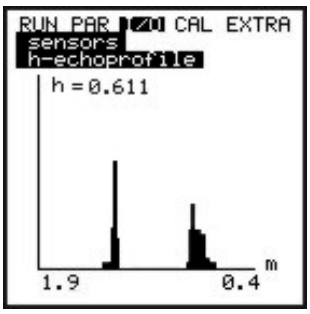
Example 2: Menu with water-ultrasonic, pressure, and 2-wire sensor

The sensor types display in this way only when 1 or 2 types have been selected.

H-Echo profile

This profile is enabled only when measuring depth using an air-ultrasonic (from top down) or a water-ultrasonic (from bottom up) sensor.

Selecting the depth measurement echo profile

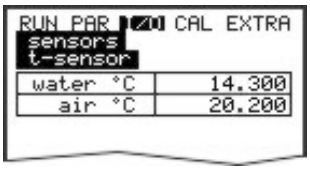


Echo profile for depth measurement

The graphic displayed above enables service personnel to assess the echo signal within the acoustical range of measurement. Ideally, the initial peak (representing echoes from flow/air interface) will be very narrow, steep, and high. The remaining peaks (representing double and multiple reflections caused by the signal echoing back and forth between the flow/air and flow/pipe interfaces) will be lower and wider.

T-Sensor

This screen allows you to view water and air temperature readings. Air temperature is available only when using an air-ultrasonic depth sensor with the Portable FlowShark Pulse. Invalid measurements may indicate cable breaks, short circuits, or improperly terminated connections.



Temperature screen

I/O: Interfaces

(*ADS currently does not support wireless communication with the Portable FlowShark Pulse*) This menu provides the signal quality and battery voltage for the GSM module and, therefore, displays only when GPRS communication is in use.

Signal quality for the GSM module

I/O: Memory Card

This menu enables you to view information on the memory card.

Memory card options

Card info menu

This information is accessible only when the memory card is installed in the unit. To view the remaining storage capacity (based on time) on the card, it must be installed in the unit for at least one hour.

You can execute the process of formatting the card through the **Memory Card** menu.

Formatting the card

Only use memory cards purchased through ADS. Other manufacturer's cards may lead to irreversible loss of data, measurement failure, or permanent transmitter reset.

Never format a memory card on a PC; always use the Portable FlowShark Pulse. The unit can neither use nor accept cards that have been formatted on a PC.

Formatting the card will erase all the data saved on the card.

Replace the memory card at any time by pressing the **ALT** key. Pressing this key transmits all the data from the internal memory to the memory card and displays the message ***Memory card busy***.

Do not attempt to replace the card while the unit is displaying the ***Memory card busy*** *message.*

The Portable FlowShark Pulse allows you to view parameter settings stored in the unit and to save settings to the unit.

Select **store parameter** to save the parameters to the memory card. This procedure takes approximately 30 seconds; a progress bar displays for tracking purposes. Once it is successful and complete, the display will provide notification and the **memory card** menu will appear.

Saving parameters to the memory card

The **load parameters** menu option displays all the program files available on the memory card. Choosing this option transmits the selected file to the Portable FlowShark Pulse. The name of the file required to program the unit from the memory card is **PARAMET.NIV**.

Loading parameters to the memory card

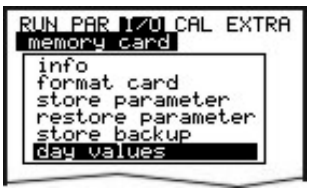
The Portable FlowShark Pulse enables you to back up the parameter data from internal memory to a memory card. This circular buffer provides storage for up to 20,000 readings and depth, velocity, flow, and temperature parameters for a 14-day period.

Data from internal memory is always used when displaying trends through the **RUN** menu.

Executing a system reset will erase all data from the internal memory.

Saving backup data

The unit also allows you to save the day totals for up to 90 days to the memory card. This data is saved to the **TOTAL.TXT** file in the **DATA** folder and includes the date, time, and total based on the difference from the previous day. The totalizing time refers to the settings designated in **RUN > day totals > cycle**. The memory functions in circular mode, where newer data begins to overwrite the oldest data once the memory becomes full. Therefore, the memory always contains the most recent 90 days of data.



Saving day totals

I/O: System

This menu enables you to retrieve current battery information. It also recalculates the capacity of the rechargeable battery following replacement.

System menu

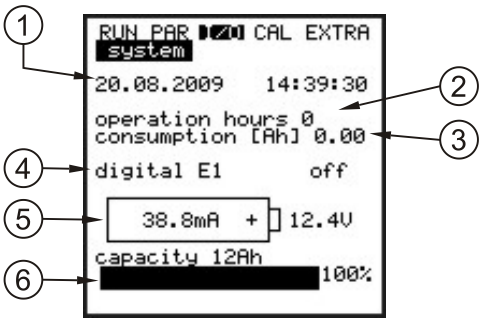
Selecting **YES** resets the capacity to 100 percent and calculates the projected battery life for the new battery.

The bar graph indicates the percentage of battery life that remains. based on the maximum capacity of the battery and the consumption of power. For the most accurate results, always begin with a fully-charged battery.

To avoid totally discharging the battery and losing data, replace the rechargeable battery when the voltage falls below 11 volts under normal operating conditions.

Selecting **NO** retains the current information for determining the remaining battery life for the existing battery.

*Always select the **YES** option after replacing the rechargeable battery.*

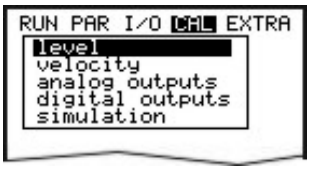


1	Current date and time
2	Number of hours of operation remaining in the unit for taking measurements. This reading does not include periods on standby.
3	Consumption of power (in ampere hours) during operation
4	Condition of digital input
5	Current power consumption and battery voltage. Do not allow the battery voltage to fall below 11.5 volts before replacing or recharging the battery. To protect the battery, the unit will discontinue providing power to the sensors if the voltage reaches 11.2 volts (*error message:* ***error sensor 1***). The Portable FlowShark Pulse will turn off automatically at 11.0 volts.
6	Maximum capacity of rechargeable battery. Enter this value in **PAR > Settings > Battery**. The percentage indicates the remaining battery life.

Viewing battery life

Calibration and Calculation Menu (CAL)

This menu enables you to adjust the depth sensors and the settings for flow velocity measurement. It also allows you to generate simulations involving relay switching events, analog outputs, and flow.



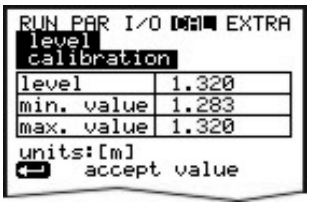
Menu selection

CAL: Level

This submenu enables you to calibrate the depth sensors for various purposes, such as adjusting the depth offset to compensate for structural conditions. Calibration involves entering a reference value obtained by performing an independent measurement, such as using a precision ruler to conduct a manual measurement.

Adjust all active depth sensors according to this reference value.

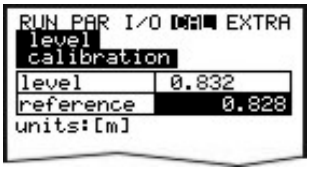
The follow screen displays after confirming a calibration:



Calibrating depth

This screen displays the current depth level and range of fluctuation, including minimum and maximum values, measured by the sensor. This data allows you to access the current flow depth conditions (e.g., surface roughness). The best results are obtained under conditions where little variation exists between the minimum and maximum values. Accept the current depth reading after reviewing it against a corresponding reference value by pressing the **Enter** (↵) key.

Enter the manual (i.e., field-confirmed) value in the **reference** field on the next menu.



Entering the depth (level) reference value

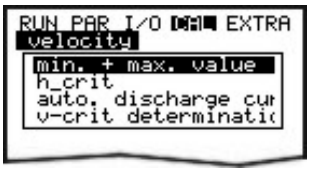
Pressing the **Enter** (↵) key after confirming the reference value displays an overview screen showing all the active depth sensors and a comparison between the previous (existing) and new offsets. The Portable FlowShark Pulse will display an error message if the difference between the offsets is too significant and, therefore, reject the new offset. If this occurs, repeat the calibration procedure and, if necessary, verify the sensor installation at the location.

Depth (level) calibration screen

Implementing an offset will modify the installation height of the individual sensors in the **PAR > Level** menu accordingly. Therefore, confirm that you would like to save the offset(s) before exiting the menu by selecting **YES**. This will ensure the unit accepts these adjustments. To ignore the new values and exit the adjustment procedure, select **NO**. Selecting **BACK** will restart the procedure without accepting the modifications.

Saving the new values

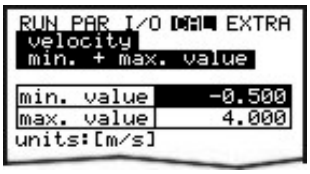
CAL: Velocity



Flow velocity screen

min. + max. value

This parameter defines the range within which the Portable FlowShark Pulse will measure flow velocity.



Measurement range for flow velocity

h_crit

A sensor cannot measure flow velocity once the depth falls below a certain threshold referred to as h_crit. The value of h_crit is determined based on the construction of the sensor and method of measurement. This information is stored in the sensor memory.

The Portable FlowShark Pulse automatically receives the stored h_crit values from the sensor following the initialization process.

The sensor memory stores the following h_crit values based on the sensor type:

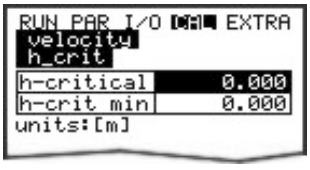
- **POA sensor** 2.6 inches (65 mm)
- **CSM sensor** 1.2 inches (30 mm)

The Portable FlowShark Pulse will now use the h_crit values from the sensor; however, these values will not be available through the **Cal > Flow velocity > h_crit** menu at this time. This menu will still indicate 0.000 for these values. However, once you manually modify the h_crit, the **Cal > Flow velocity > h_crit** menu will display the corresponding modification.

The unit will adjust the h_crit values in the background automatically if the mounting height of the velocity sensor is changed.

Following start-up, the Portable FlowShark Pulse will use the initial values from the *Manning-Strickler* table (available through **CAL > Flow velocity > v-crit determination > Manning-Strickler**) until the readings reach the stored h_crit value.

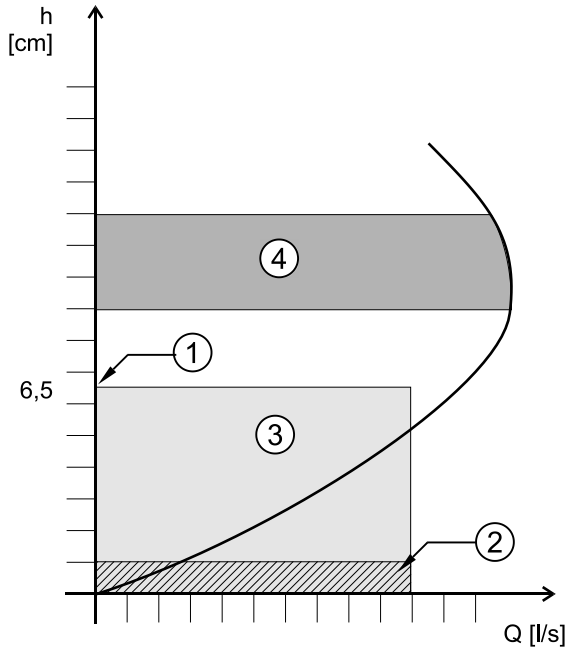
Flows ranging from 3.5 to 4.7 inches (9 to 12 cm) that exhibit a downward trend will cause the unit to recalculate the application coefficient for h_crit (automatically selects **YES**). Then, the unit will continue to estimate velocity when depth is below h_crit using the calculated application coefficient based on Manning Strickler.



Parameter h_crit

h_crit min

Flow velocities falling below h_crit will not be calculated and, therefore, will be set to **0** (zero).

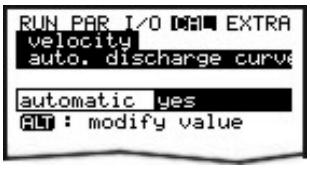


1	h_critical
2	h_crit min
3	Range of automatic Q/h relationship
4	Determination of application coefficient

Determining v_crit

Auto discharge curve

Depending on the selected setting, the unit will verify and correct (if necessary) the values entered during the next measurement interval (automatic **YES**). Another available option is for the unit to use only the values entered in the menu for Manning Strickler, manual, or Assistant (automatic **NO**).



Auto discharge curve

*Avoid backwater up to 0.5 inches (12 mm) deep when using the **Automatic YES** option.*

v-crit Determination

This menu is designed for use in depth levels less than 2.6 inches (65 mm). Three methods are available for determining flow velocity:

- Manning-Strickler (with a known slope and roughness)
- Manual (with a calculated reference value)
- Assistant (for locations that can experience blockages down to 2.6 inches (65 mm))

To achieve the most beneficial results, ADS recommends that only personnel with comprehensive knowledge and experience in this area use these parameters. Please contact ADS for assistance or training concerning these devices, when necessary.

Determining v-crit

Manning-Strickler

The unit calculates the theoretical discharge curve based on the settings for **Dimensions**, **Slope**, and **Roughness**.

This function may be used in conjunction with the automatic mode. The theoretical settings designated for the measurement location (at which the flow velocity readings are taken) will be verified using this method.

Manning-Strickler

Modify the following values to populate the Manning-Strickler table:

- **kst** Enter the Manning-Strickler coefficient.
- **Ie [%]** Enter the slope at the measurement location based on a percentage.

Please refer to the Manning-Strickler Coefficient table in Appendix C for more information.

Manual

Enter the current depth and flow velocity obtained through a manual measurement. The unit will calculate the theoretical discharge curve from these values.

This function may be used in conjunction with the automatic mode. The theoretical settings designated for the measurement location (at which the flow velocity readings are taken) will be verified using this method.

Manually setting v-crit determination

Assistant

The Portable FlowShark Pulse will guide you through a menu involving a simulated obstruction (such as a sandbag) to determine the necessary characteristics and then automatically generate a theoretical discharge curve.

This function may be used in conjunction with the automatic mode. The theoretical settings designated for the measurement location (at which the flow velocity readings are taken) will be verified using this method.

To begin this process, verify the discharge is flowing freely and then initiate depth measurement by selecting **ENTER**.

Assistant – start measuring v-crit determination

The Portable FlowShark Pulse will execute the first depth measurement under free flow conditions. This reading will take 8 seconds to complete.

Measuring countdown Assistant

Once this first measurement is complete, create an obstruction of at least 2.6 inches (65mm) (ADS recommends 4.7 inches (120 mm)) behind the sensor using a sandbag or similar object.

The unit will not initiate the second depth measurement at the obstruction until *h-actual* exhibits some stability.

Creating obstruction and initiating measurements

Once the readings are stable, the Portable FlowShark Pulse will execute a new 8-second depth measurement.

Measuring countdown for the second measurement

The unit will display the following readings after the second measurement has been completed.

- **h_actual** actual depth
- **h** depth before creating an obstruction
- **v** flow velocity reading
- **Q** investigated flow

Investigated values (*Assistant*)

Selecting **ENTER** determines and, subsequently, inserts an application coefficient (i.e., factor) for the measurement location.

CAL: Analog Outputs

This parameter allows you to simulate Portable FlowShark Pulse output signals.

Overview of analog output adjustment

Enter the analog output value

Simulation

Select this parameter and enter the desired value in volts. Confirm by pressing **Enter** to output the signal directly to the corresponding terminal.

CAL: Digital Outputs

Use the **up** or **down** arrow keys to either enable or disable the relay.

Digital output simulation

CAL: Simulation

This function allows you to simulate theoretical flow conditions by entering hypothetical depth and velocity values that currently are not available. The Portable FlowShark Pulse will calculate the current flow value using the simulated values based on the designated pipe dimensions. The results will be sent to the corresponding analog and digital outputs.

Simulate the desired flow velocity by pressing the **left** or **right** arrow keys; simulate the desired flow depth by pressing the **up** or **down** arrow keys.

Both simulated values will display in the table. The calculated flow value will display above the table.

Simulating flow measurement

Operating a Pipe Profiler

Connecting a pipe profiler to a Portable FlowShark Pulse only requires you to set the following parameters:

Selecting the NPP

1. Select **NPP** as the *profile* under **PAR > Measurement place > Channel profile(s)**.
2. Enter the exact inside diameter of the pipe profiler into the parameter **channel dimensions** and complete the parameter setting procedure.

CHAPTER 7

Maintenance and Troubleshooting

This chapter contains detailed information on performing system maintenance and troubleshooting the equipment. It also includes useful information on shipping, handling, storage, and disposal of the Portable FlowShark Pulse transmitter and sensors.

Maintenance

Because the measurement system primarily exists in a wastewater environment, it may be contaminated with hazardous germs. Therefore, please take special precautions when handling the transmitter, cables, sensors, and associated equipment.

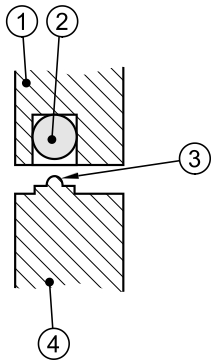
The extent and interval at which to conduct maintenance activities on the Portable FlowShark Pulse system depends on the following conditions:

- Measurement perspective or position of the depth sensor
- Wear and tear of materials
- Measurement medium and hydraulic conditions in the pipe
- General regulations for operations at the measurement location or facility
- Frequency of use
- Conditions existing in the measurement environment

To ensure reliable, accurate, and trouble-free operation of the flow measurement system, ADS recommends performing a thorough inspection of the equipment at least once a year.

Transmitter

Inspect the enclosure for leaks (IP67 protection) regularly. Check the black gasket in the rim of the lid for mechanical damage or dirt. Remove any dirt with a wet cloth, and then lightly grease the gasket with silicone or another appropriate lubricant.



1	Enclosure lid
2	Black gasket
3	Sealing lip
4	Enclosure wall

Sealing of the enclosure

The gasket on the lid of the enclosure is subject to wear and tear. Therefore, to ensure the gasket provides adequate protection for the unit against leakage, return the transmitter to ADS once a year for inspection and, if necessary, replacement of the gasket.

The warranty does not cover any damage to the unit resulting from a gasket that has not been properly maintained.

When closing the lid of the enclosure, press down firmly to lock it into place. This will ensure the sealing lip seats firmly against the unit and allow the locking clamps to latch with little effort.

Clean and dry dirty ports before reconnecting sensors. Remove dry dirt or debris carefully using pressurized air or a brush with plastic bristles (*No metal bristles!*). Use contact spray for contact maintenance, when necessary.

Tightly secure unused ports with the caps supplied to prevent corrosion to the connector contacts and to ensure proper protection.

Never remove any screws from the transmitter other than those used to secure the battery replacement cover.

When necessary, clean the transmitter enclosure with a dry, lint-free cloth.

When receiving power from an external source, first disconnect the unit from the external power supply before cleaning the enclosure surface with a damp cloth.

Battery Pack

The rechargeable battery pack may be recharged several times, but is limited in use. The lifespan of a rechargeable battery pack depends on the frequency of use and the conditions under which it is used and stored. Discard used battery packs properly according to local regulations.

Refer to Chapter 4 for instructions on recharging the battery pack.

Under normal conditions, do not use a rechargeable battery pack for more than 2 years. Replace it more frequently under heavy use.

Sensors

In flow containing a significant amount of debris and/or pipes experiencing a substantial amount of silt, it may be necessary to clean the sensors regularly using a plastic bristle brush, broom, or a comparable tool.

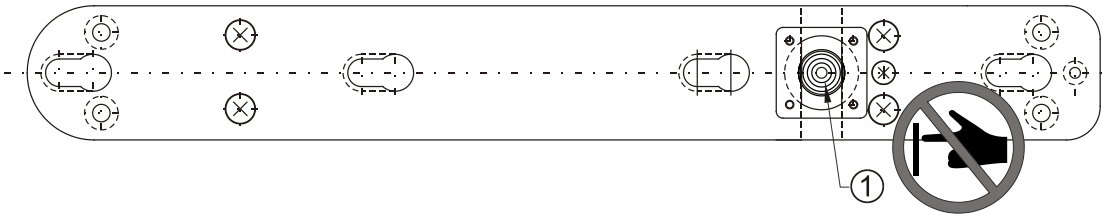
Clean and dry dirty ports before reconnecting sensors. Remove dry dirt or debris carefully using pressurized air or a brush with plastic bristles (*No metal bristles!*). Use contact spray for contact maintenance, when necessary.

Do not use hard objects, such as wire brushes, rods, or scrapers, to clean a sensor. In addition, do not use a high water pressure device for cleaning. This could damage the equipment, causing measurement failure. A water hose with a maximum pressure of up to 50 psi (4 bars) may be used to clean most sensors. However, do not use a water jet to clean a velocity sensor with a pressure measurement cell.

Water-Ultrasonic Combination Sensor with Pressure Measurement Cell

Due to the physical design of these sensors, depth measurements involving the sensors with the pressure measurement cells are subject to long-term drift. Therefore, ADS recommends calibrating sensors with integrated pressure measurement cells twice a year relative to the respective zero point. For the best results, perform calibrations when the depth level is as low as possible or the sensor is independent (i.e., removed) from the measurement medium. When necessary, contact ADS for assistance.

When the flow contains debris, such as grease, lime, or other sedimentation, this material can settle onto and/or clog the opening to the pressure element. Remove any debris, when present, to prevent measurement errors.



Bottom view of the water-ultrasonic combination sensor identifying the pressure measurement cell (1)

After uninstalling the sensor, flush the duct to the pressure measurement cell (which is milled into the ground plate) by immersing the probe into water several times. This prevents the accumulation of sedimentation. For more extensive cleaning, remove the cover of the pressure measurement cell.

Do not use high pressure water (e.g., a water jet) or a screwdriver to clean the pressure measurement cell. This could damage or destroy the pressure cell.

Do not loosen or remove the sensor from the ground plate or cable gland. This will cause leakage, resulting in measurement error and/or sensor failure.

Do not remove any part of the pressure measurement cell other than the cover. However, please be careful when cleaning an open cell. Clean the sensor by gently moving it around in a container of water. Never touch the probe with fingers, brushes, tools, water jets, or similar objects. Using these items when cleaning could damage or destroy the element and invalidate the warranty. To avoid invalidating the warranty, please contact ADS for assistance in cleaning the element, when necessary.

Contact ADS to perform maintenance on the sensor if sediment will not come off the sensor, preventing the sensor from taking accurate measurements.

The water-ultrasonic combination sensors with the pressure measurement cell are equipped with an additional air filter element containing a dehydration agent (i.e., desiccant). Time, measurement intervals, air pressure fluctuations, and environmental conditions all contribute to normal wear on the desiccant. Therefore, inspect the element regularly and before each use, following battery pack replacement, or when viewing data on the unit. The frequency at which to perform inspections depends on the typical humidity present in the air and may vary between 2 and 12 weeks based on the application. Replace the filter element or the desiccant when the desiccant begins to change color (from blue to clear/white or pink) by more than 50%.

Replacement elements and desiccant are available through ADS.

Air-Ultrasonic Depth Sensor

These sensors are designed to measure the range between the sensor and the flow surface without contacting the flow. Therefore, if the sensor becomes submerged, check for debris on the sensor face or crystals. If debris or residue exists, clean the sensor with water and a cloth or soft brush after the flow subsides to ensure the signal has free access to the flow surface.

Do not loosen or remove the sensor from the ground plate or cable gland. This will cause leakage, resulting in measurement error and/or permanent damage to the sensor.

Never remove any part from the air-ultrasonic depth sensor, other than the mounting plate on the bottom.

Handling

This section includes instructions and procedures for the Portable FlowShark Pulse and sensors concerning storage, transport, and disposal.

Storage

Strictly adhere to the following conditions regarding equipment storage:

Transmitter:	Maximum temperature:	140°F (60°C)
	Minimum temperature:	32°F (0°C)
	Maximum humidity:	90 %, non-condensing
Sensors:	Maximum temperature:	158°F (70°C)
	Minimum temperature:	-22°F (- 30°C)
	Maximum humidity:	100 %
Rechargeable Battery:	Maximum temperature:	77°F (25°C)
	Minimum temperature:	41°F (5°C)
	Maximum humidity:	60 %, non-condensing

Remove the battery pack from the transmitter and locate it in a frost-free location when storing the transmitter. Recharge the battery pack prior to re-installation.

Protect the system from corrosive or organic solvent vapors, radioactive emissions, and strong electromagnetic radiation.

Transport

The sensor and transmitter are designed for use in harsh industrial conditions. However, please avoid exposing these devices to heavy shocks or vibrations.

Always transport the equipment in the original packaging.

Carry the transmitter using the attached handle. Do not carry or suspend the unit by the sensor cables!

Disposal

When discarding the Portable FlowShark Pulse transmitter and sensors, follow all local regulations involving electronic product disposal.

Do not leave a rechargeable pack in the Portable FlowShark Pulse when it is no longer holding a charge.

Dispose all used rechargeable battery packs according to local and environmental regulations.

Troubleshooting

Error	Possible Reason	Potential Corrective Measures
No Indication of Flow (0 *or* ----)	Connections	Check the sensor cable connection to the unit.
	Sensor	Check sensor installation for proper orientation toward the flow and horizontal position.
		Check the sensor for dirt, blockage, sedimentation (covering the sensor), or damage. Replace the sensor if necessary.
	Flow Depth Measurement	**Note:** When no flow depth exists, measuring flow velocity is not possible. **Water-ultrasonic measurement:** Check the sensor for horizontal installation. **Pressure cell measurement:** Inspect the sensor for blockage. **Air-ultrasonic or external depth measurement:** Check sensor for function and signal transmission. Inspect cables, clamped connections, short circuits, and contact resistances. Check for sensor function through the **I/O > Sensors > H-Sensor > Echo profile** menu.
		Check depth measurement parameter **Fixed level** for full pipes without a depth measurement.
	Transmitter	Check error memory. Proceed based on error message (e.g., checking cables and sensor installation) or contact ADS (for a **CPU** or **DSP** error).
	Programming	Check all the parameter settings for the transmitter.

Error	Possible Reason	Potential Corrective Measures
Blank or Flickering Screen	Connection	Check power supply connection (battery connector).
	Power Supply	Check voltage of the power supply (minimum of 11.0 volts).
	Memory card	Confirm that an ADS-supplied memory card is in use. Replace card from unauthorized manufacturer with ADS card, when applicable.
		Verify method used for formatting cards. Send cards formatted on a PC to ADS.
Sensor Error Indicated on Display	Connection	Check cable connection.
	Battery Voltage	Verify that the voltage is higher than 11.0 volts, and replace the rechargeable battery pack, if necessary.
DSP Error	Communication	Check communication between CPU or sensor by pressing the **I** key. Screen should display DSP version on the third line. Erase entire error memory (through the **RUN** menu). When necessary, disconnect the unit from power for approximately 10 seconds and restart.
	Connection Problems	Contact ADS for verification.
Erratic Readings	Unsuitable Hydraulic Conditions at Measurement Location	Check the flow profile on the graph to verify the quality of the measurement location. Relocate the sensor to a more suitable location that exhibits better hydraulic conditions (e.g., extend calming section).
		Remove any existing dirt, sedimentation/silt, or other obstructions from the front of the sensor.
		Smooth the flow profile by installing appropriate baffle plates and calming elements, flow straighteners, or similar devices upstream from the measurement location.
		Increase damping.
	Sensor	Check the sensor orientation (toward the flow direction and horizontal position).
		Inspect the sensor for dirt or blockage.

Error	Possible Reason	Potential Corrective Measures
Erroneous Readings	Unsuitable Hydraulic Conditions at Measurement Location	Refer to possible solutions under the **Erratic Readings** section.
	External Depth (Level) Signals	Check for proper connection.
		Check for damaged or crushed cables, short circuits, improper resistance loads, or current customers without galvanic isolation.
		Check measurement range and span.
		Check input signal through the **I/O** menu.
	Sensor	Check for proper connection.
		Check for crushed or damaged sensor cables/extension cables, short circuits, surge arresters, or improper resistance loads.
		Check the level signal, echo profile, flow velocity signal, cable parameters, and temperature through the **I/O** menu.
		Verify that the sensor is installed at a location that is free from vibration. Check sensor installation (towards flow, horizontal orientation), and the presence of dirt or silt.
	Programming	Verify proper settings for location, such as pipe shape and dimensions (including units), sensor type, and sensor installation height.
Memory Card has No Data or is Missing Data	Memory Card	Verify whether the memory card is defective. Check card function through the **I/O > MemoryCard > Info** menu.
		Make sure the memory card is a card supplied by ADS. Replace card from another manufacturer with an ADS-supplied card.
		Verify the method used for formatting the card. Send cards formatted on a PC to ADS.
	Transmitter	Verify that the memory card is firmly seated (securely and completely) in the unit.
		Make sure the memory card has been seated in unit for adequate amount of time. Data may not have been saved before card was removed (**ALT** key stroke).
	Programming	Verify storage is enabled through the **Memory Mode > Operation Mode > Mode**.

APPENDIX A

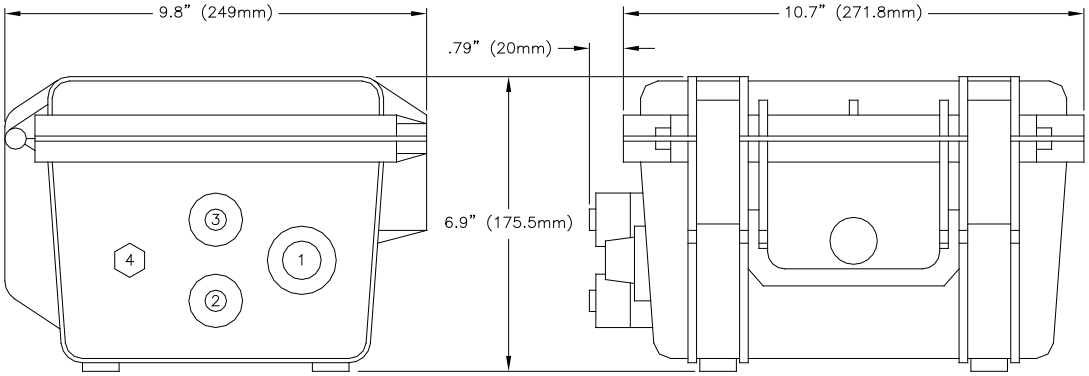
Specifications

This appendix includes the specifications for the Portable FlowShark Pulse, associated sensors, and accessories.

Transmitter

Power Supply	• 12-volt/12-ampere hour rechargeable lead gel battery • 100 to 240 V AC, 50/60-Hz power pack; 12-V DC/2.0 A output • 11.5 to 30 voltage range
Enclosure	• Material: Impact-resistant polypropylene • Weight: approximately 4.41 pounds (2 kg) (*without sensors and batteries*) • Protection: IP67 (*when cover is closed and locked*)
Operating Temperature	14° to 122° F (-10° to +50° C)
Storage Temperature	-22° to 158° F (-30° to 70° C)
Maximum Humidity	90%, non-condensing
Display	Back-lit graphic display, 128- x 128-pixel
Operation	18 keys, menu in English, German, French, Italian, Czech, Spanish, Polish, and Danish
Ports (IP68)	• Air-ultrasonic sensor for depth measurement or 4 – 20 mA for external depth measurement (2-wire sensor) • Water-ultrasonic velocity/combination sensor for flow velocity and depth measurement (sensor or electronic box (ECM)) • Multifunctional port for digital and analog inputs and outputs • Combined power pack/battery charger or alternative power supply • Bluetooth/GSM module (*not applicable*)

Inputs via Multifunctional Port	• Active digital input, supply voltage of 3.3 V DC • Analog input, 0/4 – 20 mA (*passive*)
Outputs via Multifunctional Port	• Relay (SPDT) with 250 V AC/30 V DC, 5-amp switching capacity and 5-Hz switching frequency • 0 to 10-volt output
Storage Interval	1 to 60 minutes, cyclical or event-based
Data Storage	• Up to 128 MB on plug-in compact flash card • 8 MB internal RAM
Data Transmission	Plug-in compact flash card

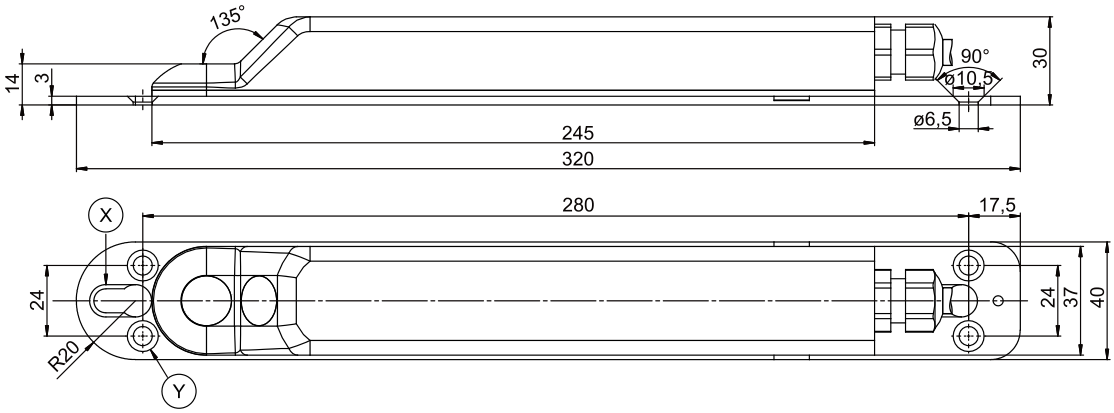


Dimensions for Portable FlowShark Pulse enclosure in millimeters

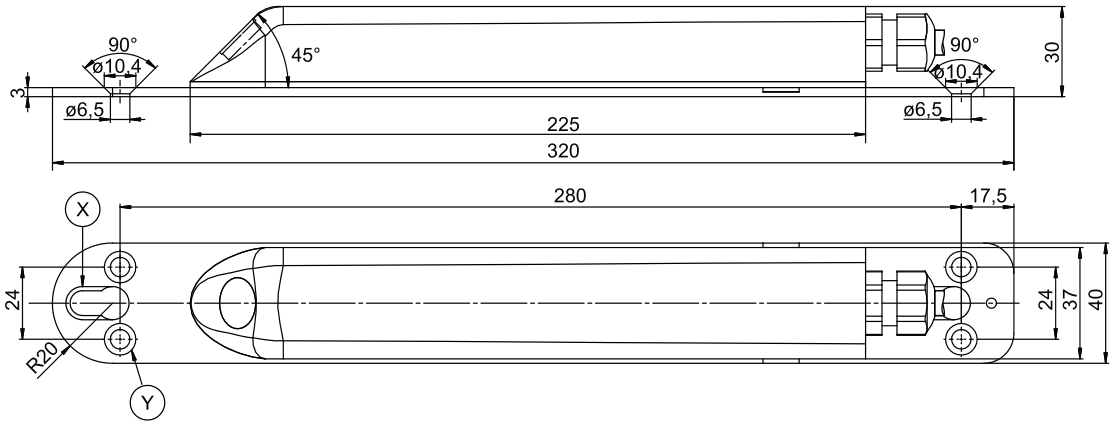
Water-Ultrasonic Velocity/Combination Sensor

Measurement Principle	• Ultrasonic transit time (depth measurement) – *Combination Sensor only* • Piezoresistive pressure measurement (depth measurement) • Correlation with digital pattern detection (flow velocity)
Measurement Frequency	1 MHz
Protection Rating	IP 68
Ex-Approval (*optional*)	II 2 G Ex ib IIB T4 Gb
Operating Temperature	-4° to 122° F (-20° to +50° C) -4° to 104° F (-20° to +40° C) for applications in Ex Zone 1
Storage Temperature	-22° to 158° F (-30° to +70° C)
Operating Pressure	Maximum 58 psi (4 bar) (combination sensor with pressure element maximum 14.5 psi (1 bar))

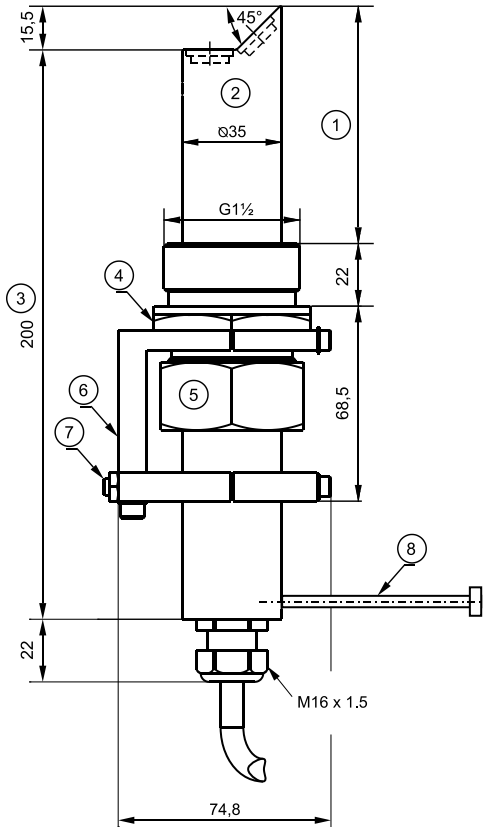
Cable Length	33/49/66/98/328 feet (10/15/20/30/50/100 m); the cables available for sensors with the integrated pressure measurement cell do not 98 feet (30 m)
Cable Types	• Sensors with pressure measurement: LiYC11Y 2x1.5 + 1x2x0.34 + PA 1.5/2.5 • Sensors without pressure measurement: LiYC11Y 2x1.5 + 1x2x0.34
Outside Cable Diameter	• Sensors with pressure measurement: 0.38 ±0.01 inches (9.75 ±0.25 mm) • Sensors without pressure measurement: 0.33 ±0.01 inches (8.4 ±0.25 mm)
Sensor Types	• Flow velocity sensor with velocity measurement using cross-correlation and temperature measurement to compensate for the effect of temperature on the velocity of sound • Combination sensor with flow velocity sensor using cross-correlation, depth measurement via water-ultrasonic, and temperature measurement to compensate for the effect of temperature on the velocity of sound • Combination sensor with flow velocity sensor using cross-correlation, depth measurement via pressure, and temperature measurement to compensate for the effect of temperature on the velocity of sound (*wedge sensor only*) • Combination sensor with flow velocity sensor using cross-correlation, depth measurement via water-ultrasonic, redundant depth measurement via pressure, and temperature measurement to compensate for the effect of temperature on the velocity of sound (*wedge sensor only*)
Types of Construction	• Wedge sensor for installation on pipe bottom • Pipe insertion sensor for installation through pipe wall with sensor screw joint and retaining element
Medium Contacting Materials	Polyurethane, stainless steel 1.4571, PPO GF30, PA (*wedge sensor only*) Option: PEEK chemical-resistant sensor; Hastelloy C-276 mounting plate; Titanium mounting plate, FEP-coated cable



Dimensions for Water-Ultrasonic Combination Sensor in millimeters
X represents the slotted holes for fastening on pipe mounting system
Y represents 4 countersunk holes (DIN 66-5); d1 = 6.5 mm, for direct fastening



Dimensions for Water-Ultrasonic Velocity Sensor in millimeters
X represents the slotted holes for fastening on pipe mounting system
Y represents 4 countersunk holes (DIN 66-5); d1 = 6.5 mm, for direct fastening

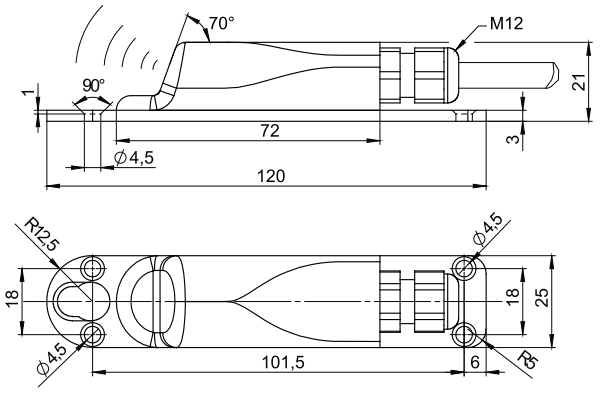


1	Movable
2	Pipe Sensor
3	300 mm (use of a ball stop valve)
4	Wrench size 55
5	Wrench size 50
6	Retaining Element
7	Set Screw
8	Screw “installation help” – 180° to flow direction

Dimensions for Pipe Insertion Sensor in millimeters

Mini Water-Ultrasonic Velocity Sensor.

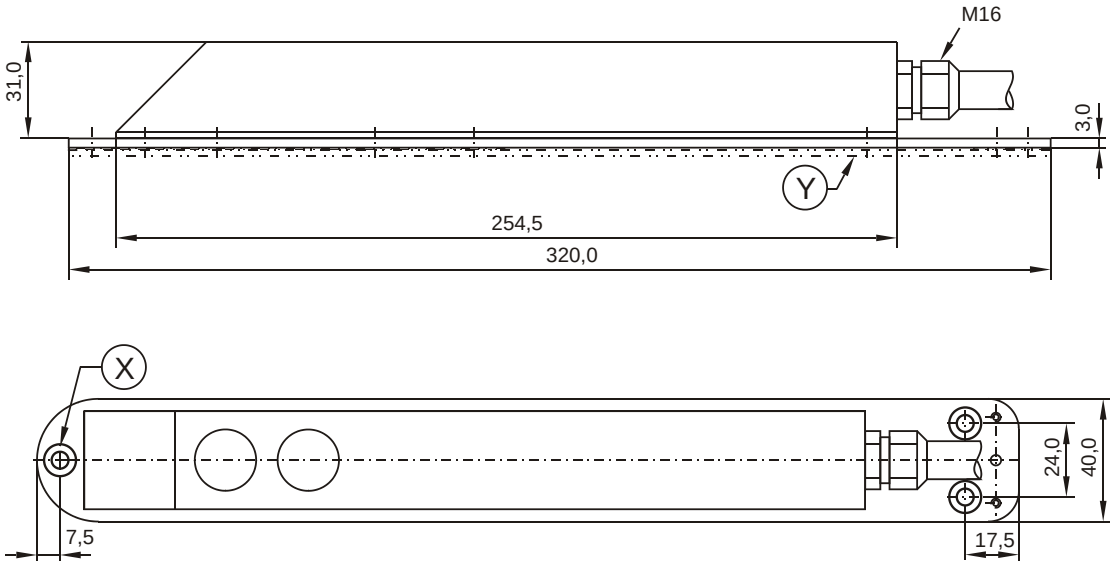
Measurement Principle	Correlation with digital pattern detection
Measurement Frequency	1 MHz
Protection Rating	IP68
Ex Approval	II 2 G Ex ib IIB T4 Gb
Operating Temperature	-4° to 122° F (-20 to +50° C) -4° to 104° F (-20 to +40° C) for applications in Ex Zone 1
Storage Temperature	-22° to 158° F (-30° to +70° C)
Operating Pressure	Maximum 58 psi (4 bar)
Cable Length	23 feet (7 m)
Cable Type	2x (2x28 AWG/7-(ST)12Y)+4x28 AWG7
Medium Contacting Materials	Polyurethane, PVDF, stainless steel 1.4571, PA
Measurement Range	-3.28 to 19.7 feet per second (-100 to +600 cm/s)
Number of Scan Layers	Maximum 16
Zero Point Drift	Absolutely zero
Error Limits (per scan layer)	≤1% of measurement value (v >3.28 feet per second (1 m/s)) ≤0.5 % of measurement value +0.2 inches per second (+5 mm/s) (v <3.28 feet per second (1 m/s))
Sonic Beam Angle	±5 degrees



Dimensions for Mini Water-Ultrasonic Velocity Sensor in millimeters

Air-Ultrasonic Depth Sensor

Measurement Principle	Ultrasonic transit time
Measurement Frequency	120 kHz
Protection Rating	IP68
Ex Approval	II 2 G Ex ib IIB T4 Gb
Operating Temperature	-4° to 122° F (-20 to +50° C) -4° to 104° F (-20 to +40° C) for applications in Ex Zone 1
Storage Temperature	-22° to 158° F (-30° to +70° C)
Operating Pressure	Maximum 14.5 psi (1 bar)
Cable Length	33/49/66/98/328 feet (10/15/20/30/50/100 m)
Cable Type	LiYC11Y 2x1.5 + 1x2x0.34
Outside Cable Diameter	0.33 ±0.01 inches (8.4 ±0.25 mm)
Type of Construction	Wedge sensor for installation at top (vertex) of pipe
Medium Contacting Materials	Polyurethane, stainless steel 1.4571, PPO GF30, PA
Depth Measurement	
Measurement Range	0 to 78.7 inches (0 to 200 cm)
Dead Band	5.5 inches (14 cm)
Measurement Error	less than ±0.2 inches (5 mm)
Temperature Measurement	
Measurement Range	-4° to 122° F (-20° to +50° C)
Measurement Error	±1° F (±0.5° K)

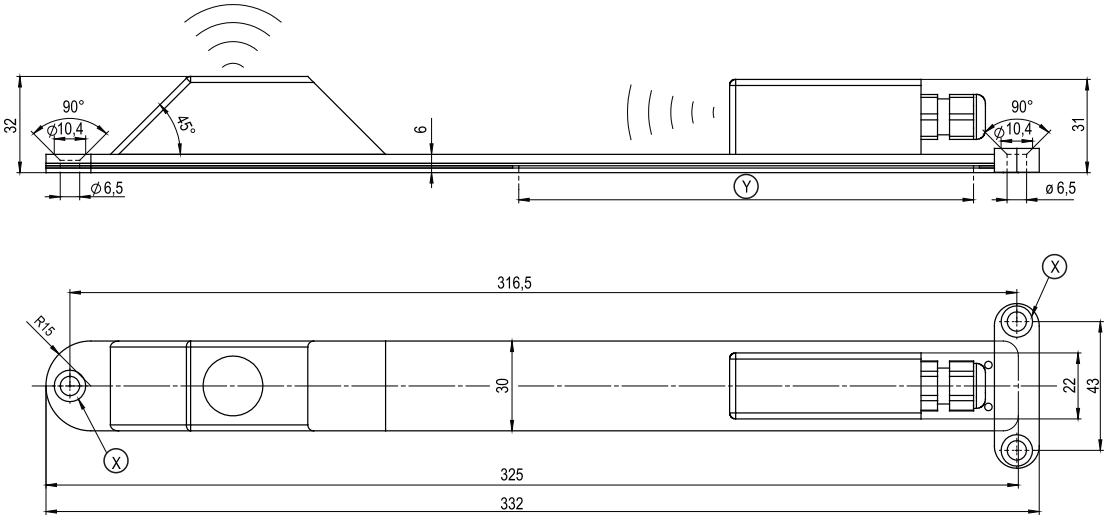


Dimensions for Air-Ultrasonic Depth Sensor in millimeters
X represents 3 countersunk holes (DIN 66-5); d1 = 6.5 mm, for direct fastening
Y represents the three adapter plates required for fastening on pipe mounting system

Mini Air-Ultrasonic Depth Sensor

Measurement Principle	Ultrasonic transit time
Measurement Frequency	125 kHz/200 kHz
Protection Rating	IP68
Ex Approval	II 2 G Ex ib IIB T4 Gb
Operating Temperature	-4° to 122° F (-20 to +50° C) -4° to 104° F (-20 to +40° C) for applications in Ex Zone 1
Storage Temperature	-22° to 158° F (-30° to +70° C)
Operating Pressure	Maximum 14.5 psi (1 bar)
Cable Length	23 feet (7 m)
Cable Type	2x (2x28 AWG/7-(ST)12Y)+4x28 AWG/7
Medium Contacting Materials	Polyurethane, stainless steel 1.4571

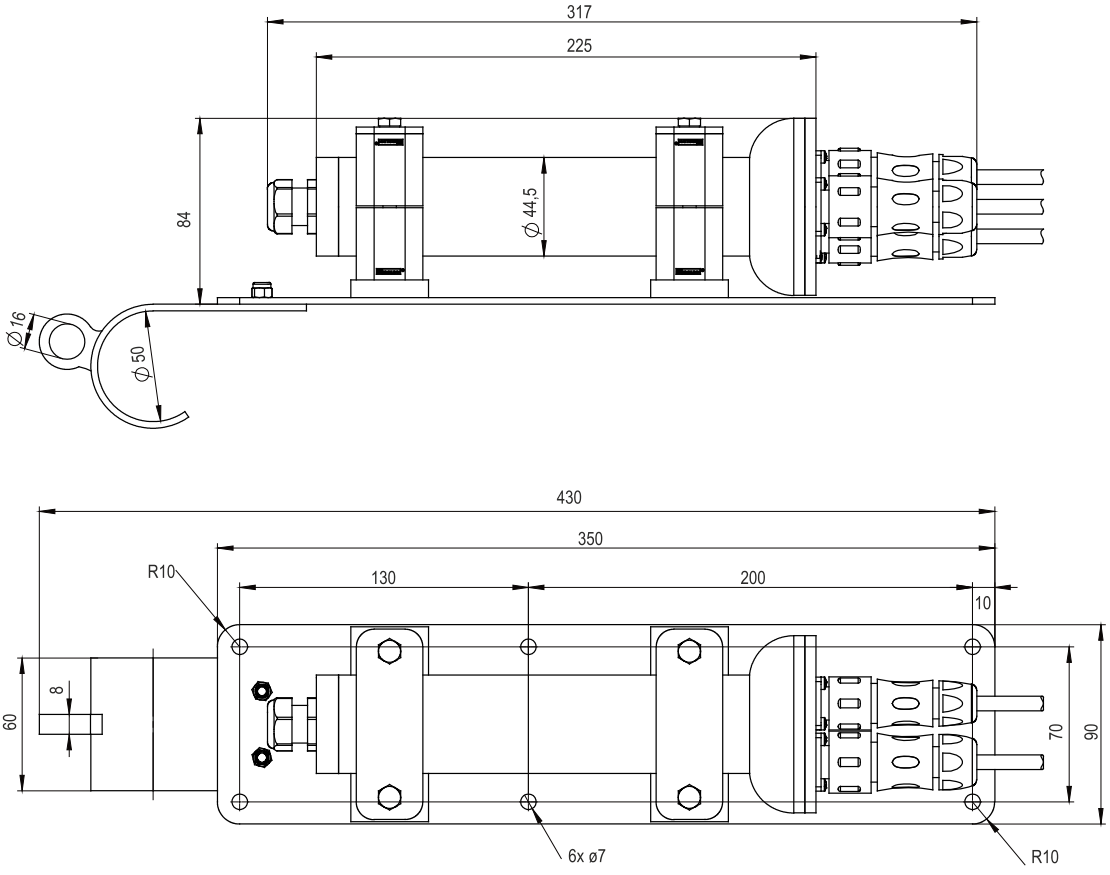
Depth Measurement	
Measurement Range	0 to 78.7 inches (0 to 200 cm)
Dead Band (from grounding plate)	1.57 inches (4 cm)
Measurement Error	less than ±0.2 inches (±5 mm)
Temperature Measurement	
Measurement Range	-4° to 122° F (-20° to +50° C)
Measurement Error	±1° F (±0.5° K)



Dimensions for Mini Air-Ultrasonic Sensor in millimeters
X represents the holder for direct fastening
Y represents the cut-out for fastening on pipe mounting system

Electronic Box (EBM)

Protection Rating	IP68 (with connection sockets locked)
Ex Approval	II 2 G Ex ib IIB T4 Gb
Operating Temperature	-4° to 122° F (-20 to +50° C) -4° to 104° F (-20 to +40° C) for applications in Ex Zone 1
Storage Temperature	-22° to 158° F (-30° to +70° C)
Operating Pressure	Maximum 14.5 psi (1 bar)
Cable Length	10/33/66/98/328 feet (3/10/20/30/50/100 m)
Cable Type	LiYC11Y 2x1.5 + 1x2x0.34
Medium Contacting Materials	Polyurethane, PVDF, stainless steel 1.4571, PP



Dimensions for Electronic Box (EBM) in millimeters

Accessories

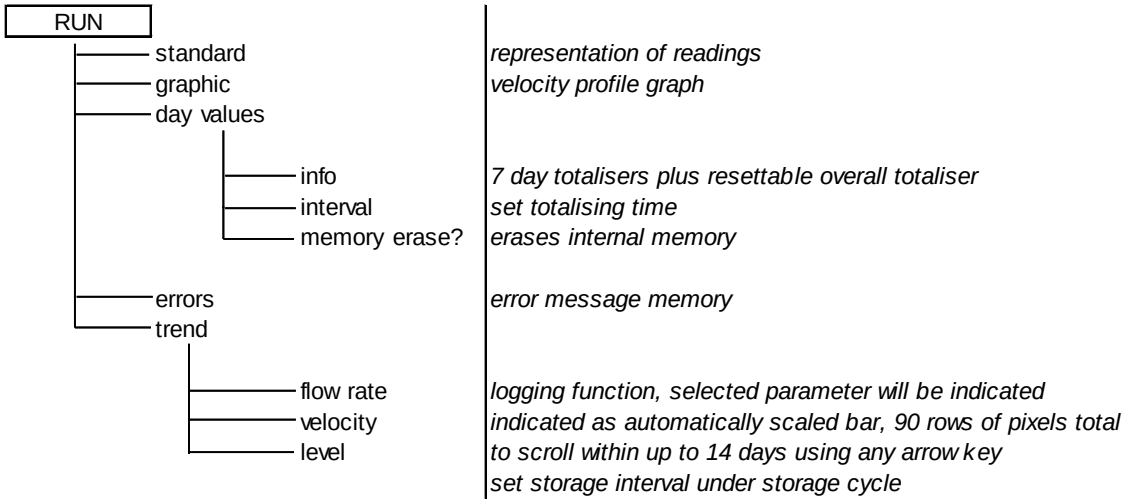
Pressure Compensation Element	For connection to sensors with integrated pressure measurement cell Material: aluminum, plastics Protection Rating: IP54
Pipe Mounting System	For temporary, non-permanent clamping installation of wedge sensors (i.e., water-ultrasonic velocity sensors, water-ultrasonic combination sensors, and air-ultrasonic sensors) in 8- to 31-inch (200- to 800-mm) diameter pipes and egg profile pipes up to 24 inches (600 mm) in height
Retractable Fitting	For manual removal of 1.5-inch pipe sensors under process conditions (not suitable for installation or fastening)
Replacement Filter	With connector and connection hose for connecting sensors with integrated pressure measurement cell to Portable FlowShark Pulse transmitters
Adaptors	Metal connection box includes clamps for adapting Portable FlowShark Pulse sensors (including connector) to other transmitters or connecting pre-configured sensor cables to other transmitters
Memory Card	128-MB compact flash card
Read-out Adapter	Adapter for PCMCIA interfaces, primarily for data read-out via laptop/notebook computer
Card Reader	Includes USB interface for PC connection
Connection Box	For connecting more than one input or output to the multi-functional port simultaneously
Power Supply Options	12-volt/12-ampere hour rechargeable lead gel battery
Suspension Bracket with Eyelet	For securing the Portable FlowShark Pulse to manhole rungs or similar structures
Power Pack/ Battery Charger	Combined battery charger for rechargeable battery pack or for direct power operation, 100-240 V AC/50-60 Hz; IP 40
Connection Cables	Pre-configured for connecting peripheral units to the Portable FlowShark Pulse

APPENDIX B

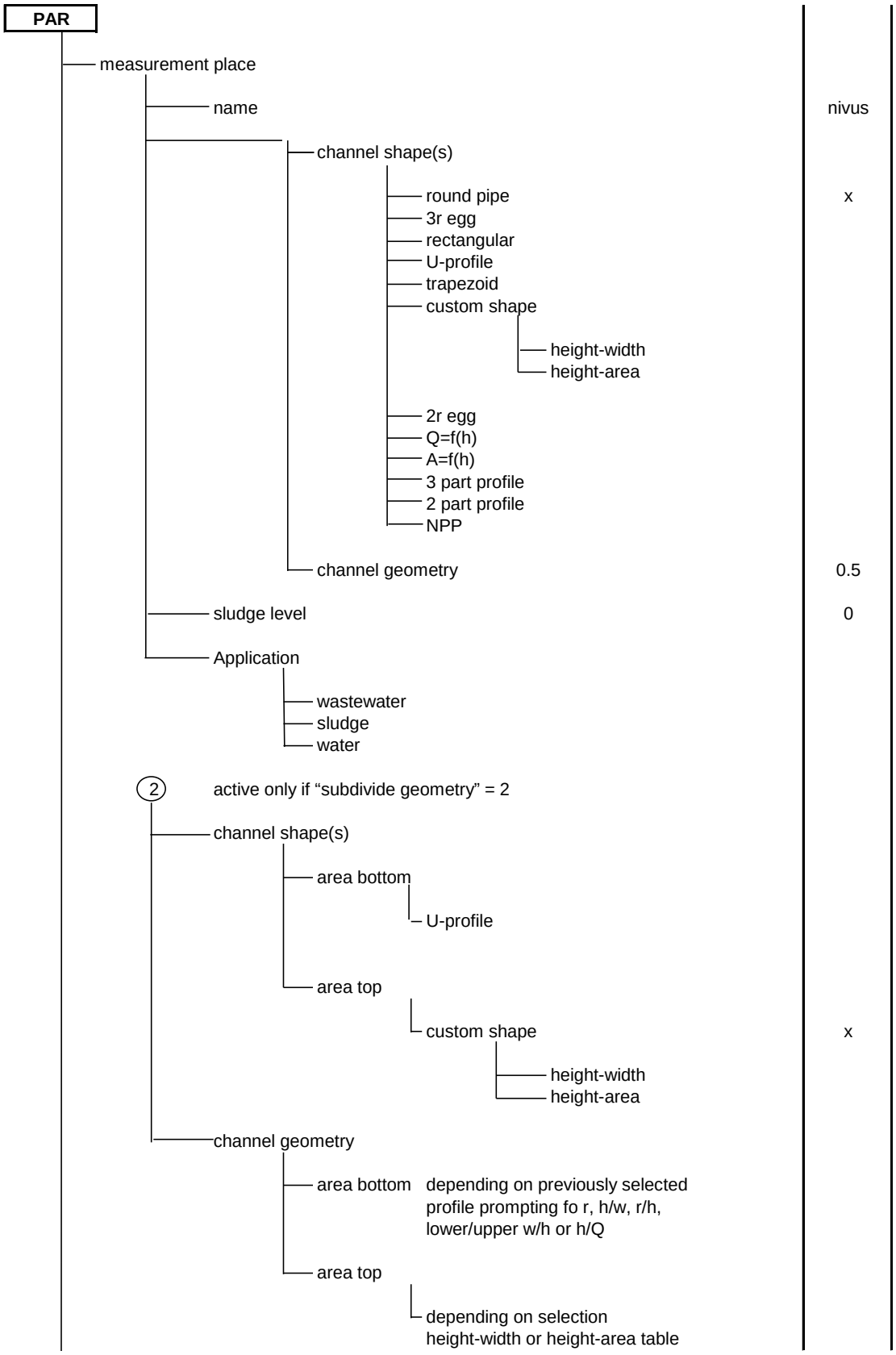
Parameter Tree

This chapter contains diagrams outlining the structure and content of each item (heading) contained in the main menu of the Portable FlowShark Pulse transmitter display. These diagrams can assist you in identifying the location for setting specific options and parameters on submenus throughout the display menu.

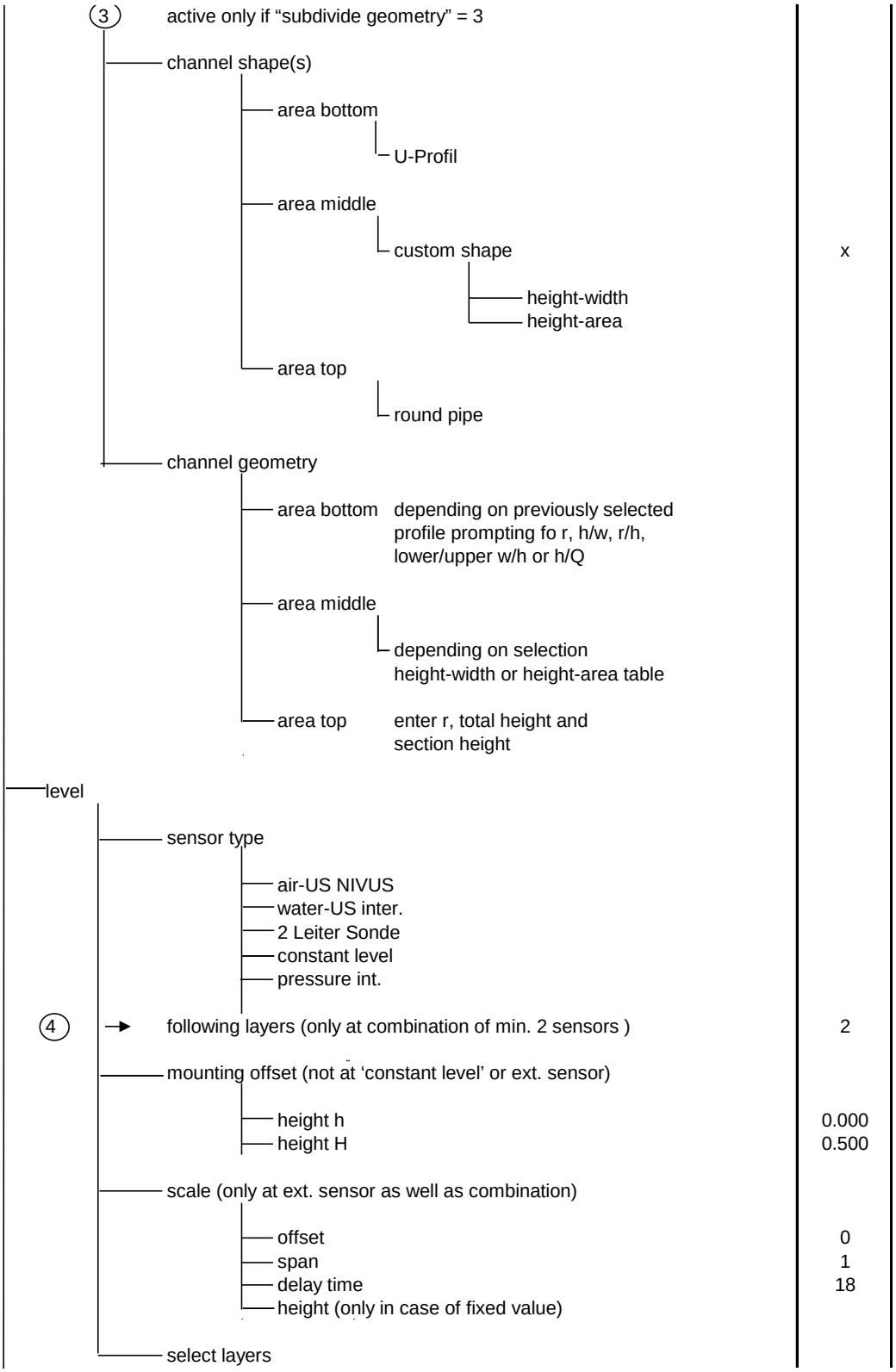
Operation Mode Menu (RUN)



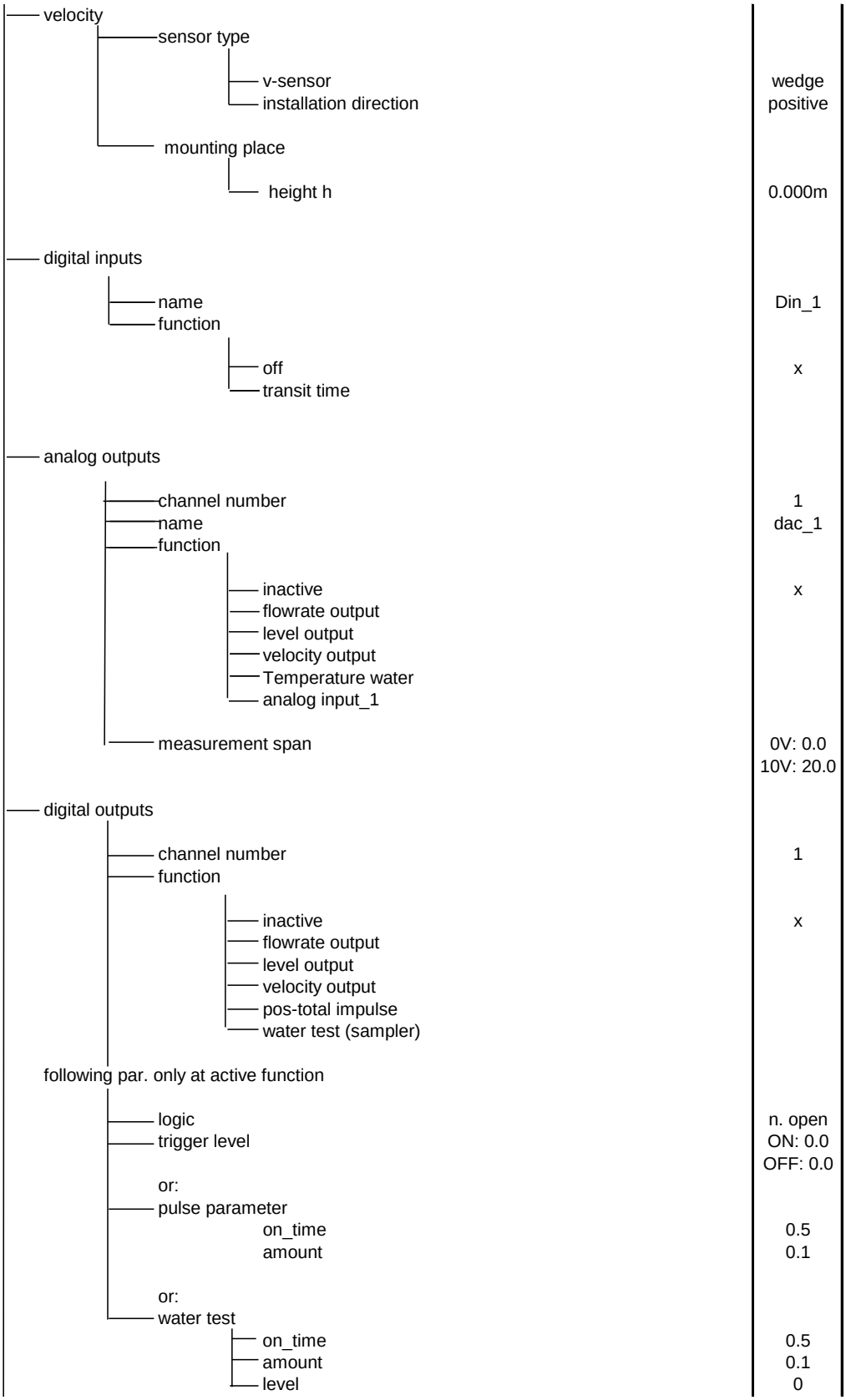
Parameter Menu (PAR) Part 1



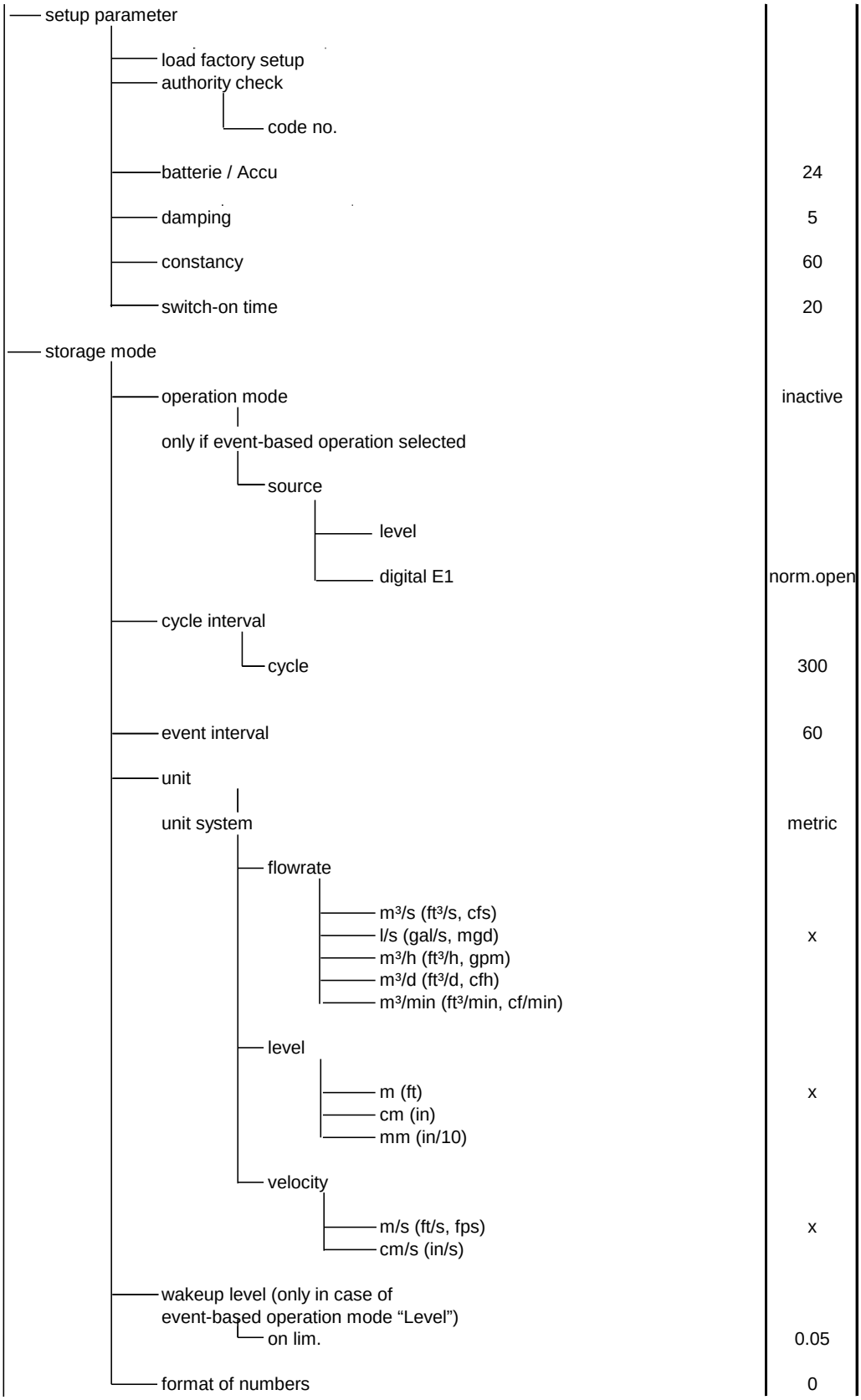
Parameter Menu (PAR) Part 2



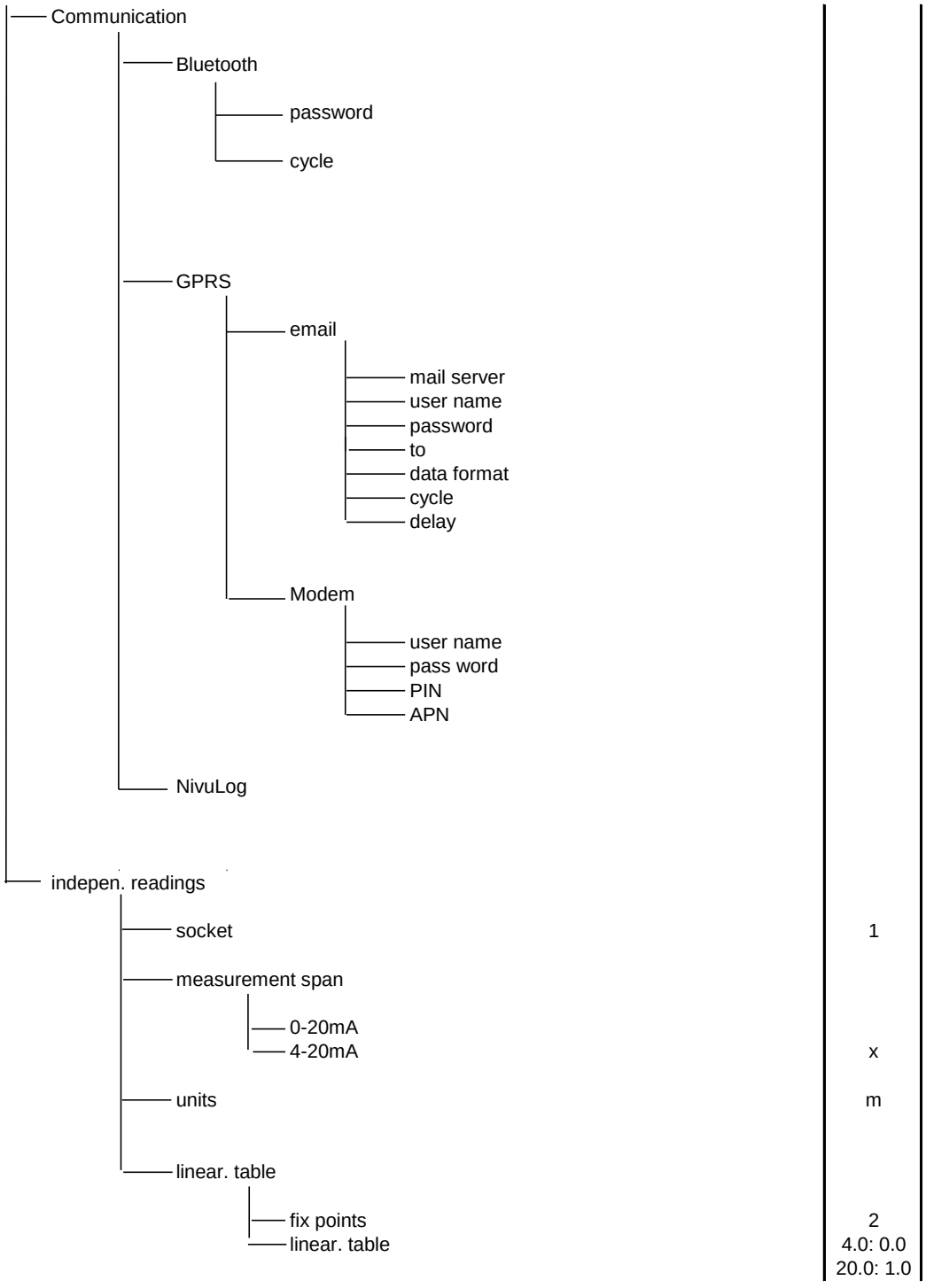
Parameter Menu (PAR) Part 3



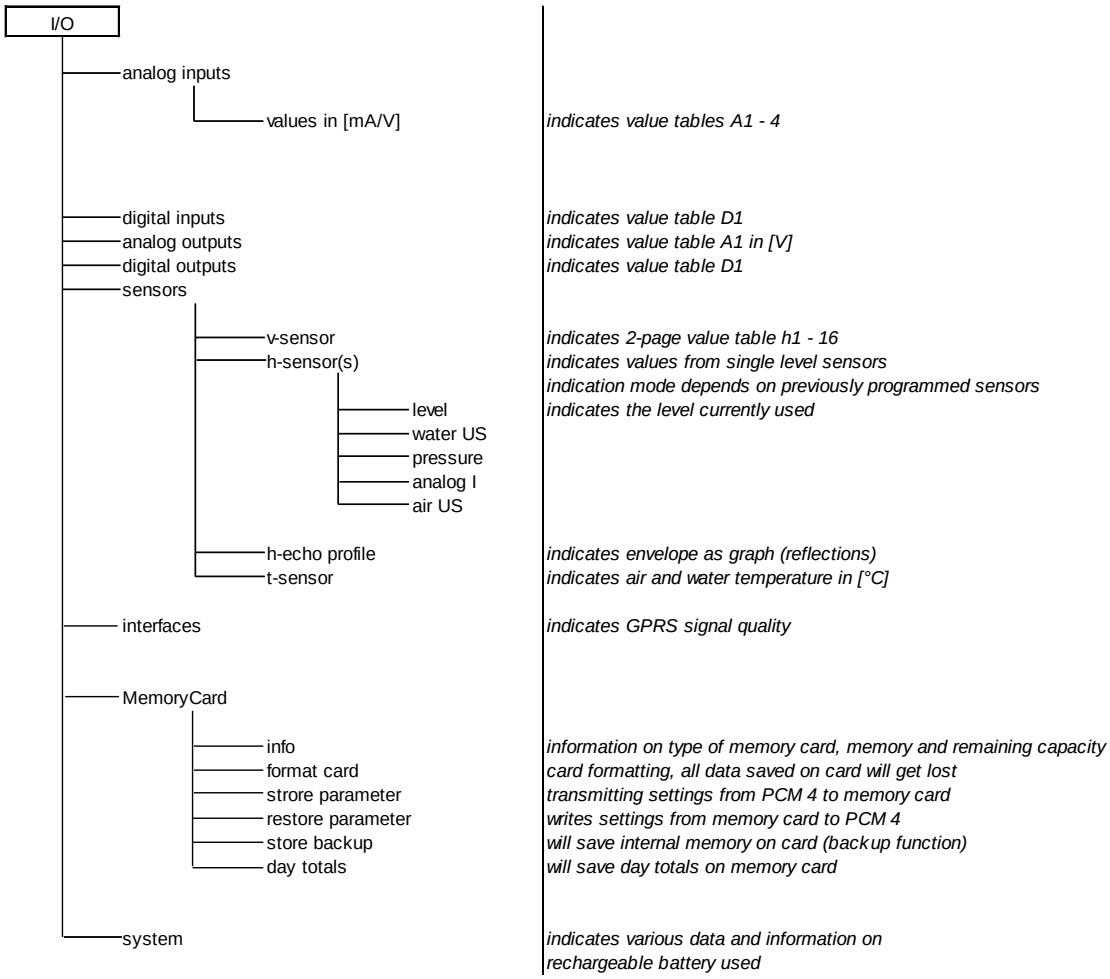
Parameter Menu (PAR) Part 4



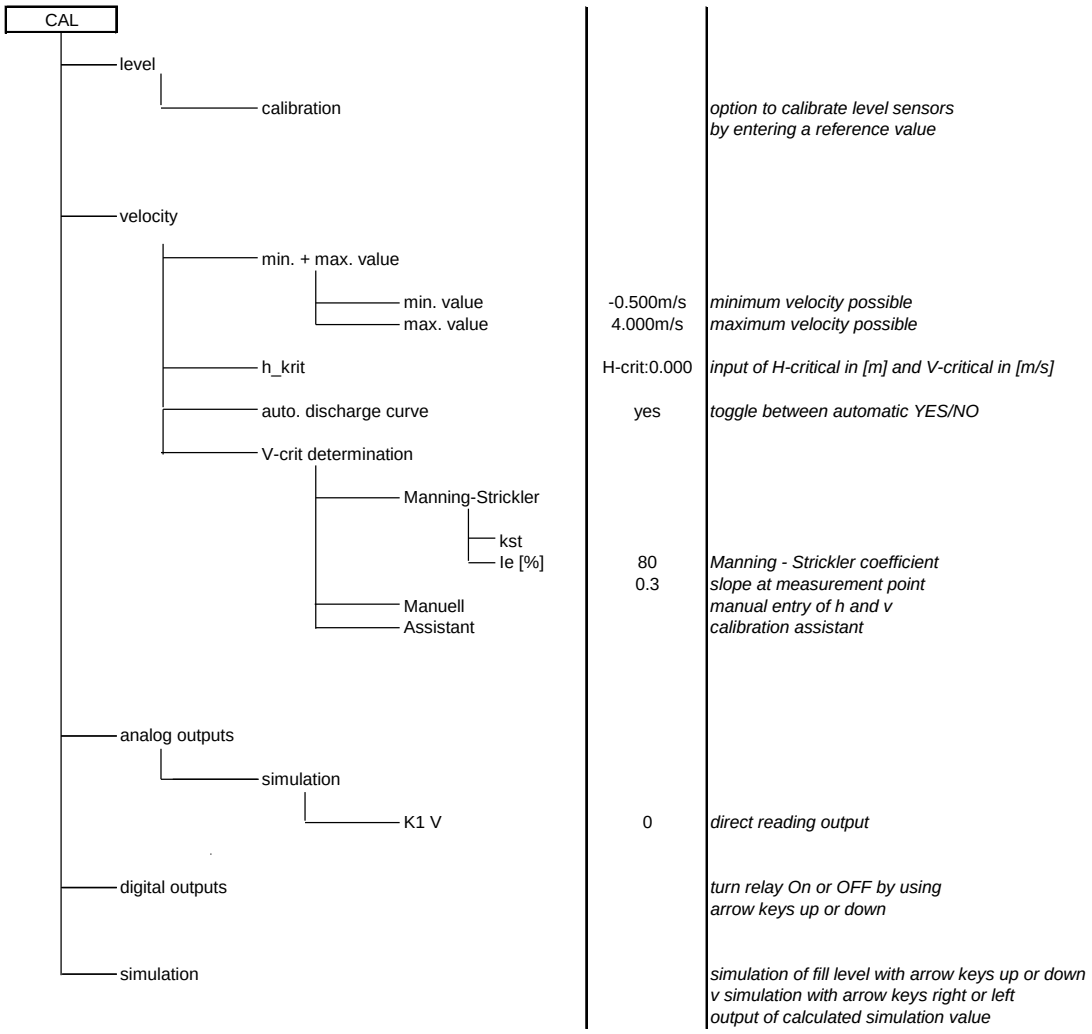
Parameter Menu (PAR) Part 5



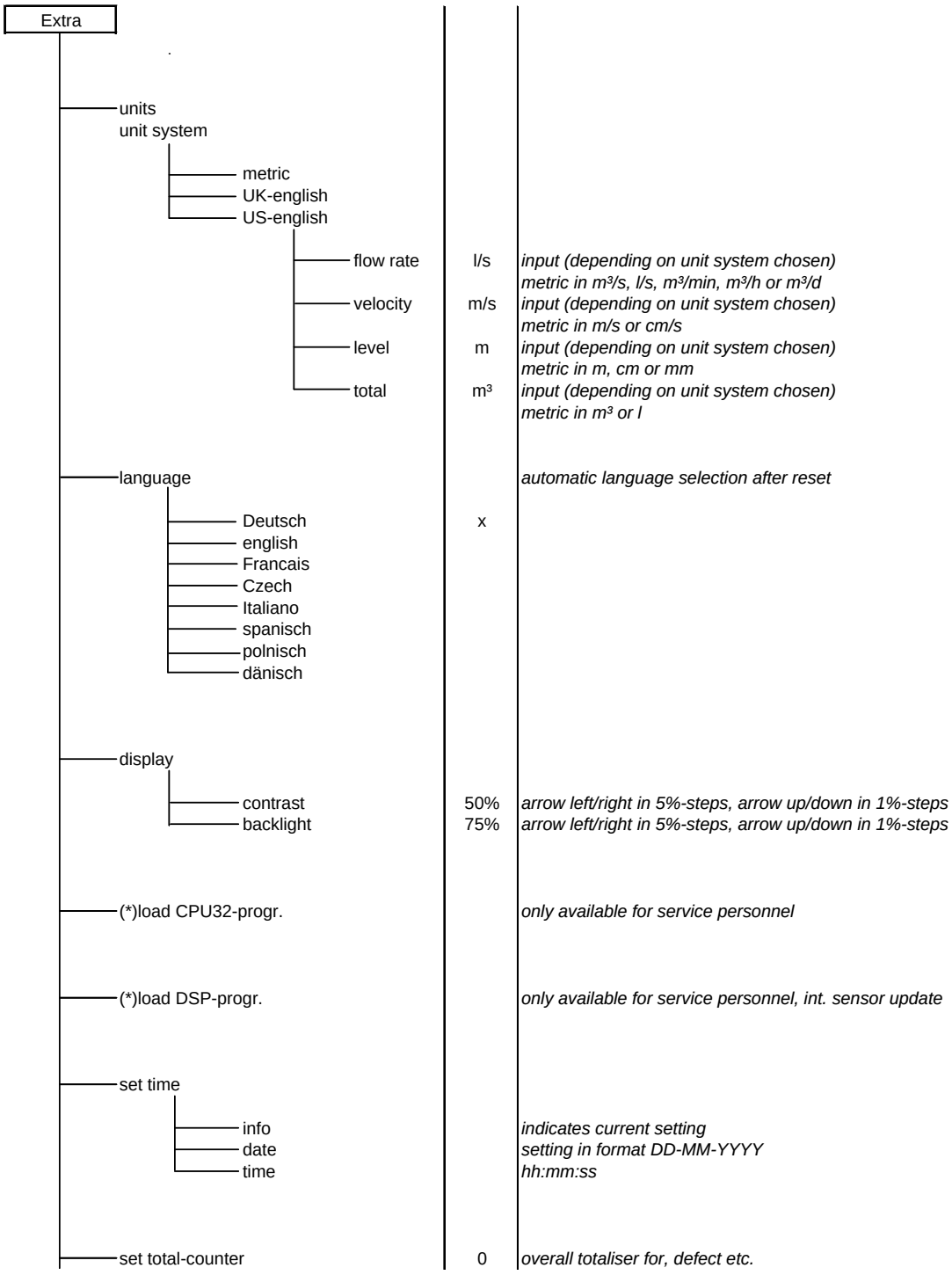
Signal Input/Output Menu (I/O)



Calibration Menu (CAL)



Display Menu (EXTRA)



A P P E N D I X C

Manning Strickler Coefficient Table

Consistency of channel wall		M in m1/3/s	k in mm
smooth	glass, PMMA, polished metal surfaces	> 100	0...0.003
	plastic (PVC, PE) new steel plate with protective coating; smoothened cement plaster	≥ 100	0.05 0.03...0.06
moderately rough	asphalt coated steel plate; concrete from steel or vacuum formwork, no joints, carefully smoothened; planed wood, joint-free, new; asbestos cement, new	90...100	0.1...0.3
	smoothened concrete, smooth finish planed wood, well-joint	85...90	0.4 0.6
	concrete, good formwork, high cement contents	80	0.8
rough	non-planed wood; concrete pipes	75	1.5
	hard-burned bricks, carefully joint; well-manufactured ashlar facing; concrete from joint-free wooden formwork	70...75	1.5...2.0
	rolling-cast asphalt finish	70	2
	well-manufactured ashlar masonry; moderately incrusted steel pipes; non-finished concrete, wooden formwork; squared stones; old and swelled wood; cement walls	65...70	3
	non-finished concrete; old wooden formwork; brickwork, no joints, finished; quarrystone walls; less accurate soil material, smooth (fine-grained)	60	6

Note: Rougher surfaces are difficult to measure under hydraulic conditions and, therefore, have not been included.

APPENDIX D

Materials and Chemical Resistance

The following materials of the sensor contact the flow:

- V4A (ground plate or pipe sensor jacket)
- PPO GF30 (sensor body)
- PEEK (sensor crystal cover)
- Polyurethane (cable sheath and glands)
- PTFE (gasket of sensor screw joint)

Sensors with the pressure measurement cell also include the following materials:

- Hastelloy® C-276
- Viton® (PA/PR)

The sensors are resistant to standard domestic wastewater, dirt, and rainwater as well as combined water from municipalities and communities. While the sensors do not experience damage from the wastewater exiting most industrial plants, the sensors are not resistant to all substances and mixtures.

In general, damage to the sensor may occur from chloride media (corrodes stainless steel ground plate and sensor jacket), hydrogen sulphide (H_2S – risk of diffusion through cable sheath or sensor that destroys copper wires and conductor paths), and various organic solvents (may dissolve cable sheath and sensor body).

Individual substances may not adversely affect a sensor. However, under certain circumstances, the combination of several of these substances could adversely affect a sensor. Due to the unlimited number of possible combinations of substances, it is impossible to determine the impact on a sensor from combining these substances.

For special applications involving highly aggressive materials or media containing solvents, ADS offers sensors made of PEEK with ground plates made of Hastelloy or Titanium and pipe sensors made of a highly resistant special type of steel. Sensor cables that will remain immersed in the flow are available with a special FEP coating for resistance to organic solvents and hydrogen sulfide.

MEDIUM	FORMULA	CONCEN-TRATION	HDPE	PPO GF30	PUR	PEEK	FEP	V4A	Hastelloy C 276	Viton (PA/PR)	PVDF
Acetaldehyde	C_2H_4O	40 %	3/3	4	4	1	(1)	(1)	0	4/4	4/4
Acetic acid	$C_2H_4O_2$	10 %	1/1	2	3	1	1/1	1/1	1	(3)	1/1
Acetic acid methyl ester	$C_3H_6O_2$	tech. clean	1/0	3	0	1	1/0	1/1	1	4/4	0/0
Acetone	C_3H_6O	40 %	1/1	4	4	1	(1)	1/1	1	4/4	3/3
Allyl alcohol	C_3H_6O	96 %	1/3	2	0	1	1/1	1/1	0	4/4	0/0
Aluminium chloride	$AlCl_3$	10 %	1/1	2	0	1	1/1	3/4	1	1/0	1/1
Aluminium chloride	$(NH_4)Cl$	aqueous	1/1	1	0	1	1/1	1/2L	1	1/1	1/1
Ammonium hydroxide	$NH_3 + H_2O$	5 %	1/1	2	4	1	1/1	1/1	1	(2)	1/1
Aniline	C_6H_7N	100 %	1/2	3	4	1	1/1	1/0	1	2/4	1/2
Benzene	C_6H_6	100 %	3/4	3/4	2	1	1/1	1/1	1	3/3	1/2
Benzyl alcohol	C_7H_8O	100 %	3/4	3	2	1	1/1	1/1	1	1/0	1/1
Boric acid	H_3BO_3	10 %	1/1	1	1	1	1/1	1/1	1	1/1	1/1
Bromic acid	$HBrO_3$	konz.	0/0	0	3	1	0/0	(4)	0	(2)	1/1
Butanol (butyl alcohol)	$C_4H_{10}O$	tech. clean	1/1	2	3	1	1/1	(1)	1	3/4	1/1
Calcium chloride	$CaCl_2$	spirituous	1/0	1	1	1	1/1	1/2L	1	1/1	1/1
Carbon disulphide	CS_2	100 %	4/4	2	0	1	1/1	1/1	1	1/0	1/0
Carbon tetrachloride (TETRA)	CCl_4	100 %	4/4	3	4	1	1/1	1/1L	1	1/1	1/1
Chloric gas	Cl_2		4/4	3	3	1	1/1	1/0	0	1/1	1/1
Chloric methane	CH_3Cl	tech. clean	3/0	4	4	1	1/0	1/1L	0	4/4	0/0
Chlorine water	$Cl_2 \times H_2O$		3/0	2	0	1	(1)	2/0L	1	1/0	0/0
Chlorobenzene	C_6H_5Cl	100 %	3/4	3	4	1	1/1	1/1	1	3/4	1/1
Chloroform	$CHCl_3$	100 %	3/4	4	4	1	1/1	1/1	1	4/4	1/1
Chromate	CrO_3	10 %	1/1	1	0	1	1/1	1/2	1	1/1	0/0
Citric acid	$C_6H_8O_7$	10 %	1/1	1	1	1	1/1	1/1	1	1/1	1/1
Diesel oil	—	100 %	1/3	2	0	1	(1)	(1)	0	1/1	1/1
Essential oils	—		0/0	1	1	1	(1)	1/1	0	1/0	0/0
Ethanol	C_2H_6O	96 %	1/0	1	1	1	1/1	1/1	1	3/0	0/0
Ethyl acetate	$C_4H_8O_2$	100 %	1/3	3	3	1	1/1	(1)	0	4/4	1/2
Ethyl alcohol	C_2H_6O	100 %	1/0	1	1	1	1/1	1/1	0	3/0	0/0
Ethylene chloride	$C_2H_4Cl_2$		3/3	4	3	1	1/1	1/1L	1	3/0	1/2
Ferric-(III)-chloride	$FeCl_3$	saturated	1/1	2	3	2	1/1	4/4	0	1/1	1/1
Formaldehyde solution	CH_2O	10 %	1/1	1	2	1	1/1	1/1	1	3/0	1/1

MEDIUM	FORMULA	CONCEN-TRATION	HDPE	PPO GF30	PUR	PEEK	FEP	V4A	Hastelloy C 276	Viton (PA/PR)	PVDF
Gasoline, unleaded	C_5H_{12} - $C_{12}H_{26}$		2/3	3	2	1	1/1	1/1	1	(1-3)	1/1
Glycerol	$C_3H_8O_3$	0,9	1/1	1	2	1	1/1	1/1	1	1/1	1/1
Heptane, n-	C_7H_{16}	0,9	2/3	1	1	1	1/1	1/1	1	1/1	1/1
Hexane, n-	C_6H_{14}	100 %	2/3	1	2	1	1/1	1/1	1	1/1	1/1
Hydrochloric acid	HCl	1-5 %	1/1	1	3	1	1/1	4/4	1	1/1	1/1
Hydrofluoric acid	HF	50 %	1/1	2	3	1	1/1	4/4	2	1/3	1/1
Isopropanol	C_3H_8O	tech. clean	1/1	1	2	1	1/1	(1)	1	1/1	0/0
Lactic acid	$C_3H_6O_3$	3 %	1/1	1	0	1	1/1	1/1	1	1/1	1/2
Magnesium chloride	$MgCl_2$	aqueous	1/1	1	2	1	1/1	1/0L	1	1/1	1/1
Methanol	CH_4O		1/1	1	2	1	1/1	1/1	1	3/4	0/0
Methyl benzene (toluene)	C_7H_8	100 %	3/4	3	3	1	1/1	1/1	0	3/3	1/1
Mineral oil	—		1/1	1	1	1	1/1	1/1	1	1/1	1/1
Nitric acid	HNO_3	1-10 %	1/1	1	3	1	1/1	1/1	1	1/1	1/1
Nitrobenzene	$C_6H_5NO_2$		3/4	3	4	1	1/1	1/1	0	4/4	1/2
Oleic acid	$C_{18}H_{34}O_2$	tech. clean	1/3	1	1	1	(1)	1/1	0	2/2	1/1
Oxalic acid	$C_2H_2O_4$ x $2H_2O$	aqueous	1/1	2	0	1	1/1	1/3	2	1/1	1/1
Ozone	O_3		3/4	2	2	1	1/1	0/0	0	1/0	1/1
Petroleum	—	tech. clean	1/3	3	1	1	(1)	1/1	0	1/0	0/0
Phenol	C_6H_6O	100 %	2/3	3	2	1	1/1	1/1	1	2/3	1/1
Phosphoric acid	H_3PO_4	85 %	1/1	1	0	1	1/1	1/3	1	1/1	1/1
Potassium hydroxide	KHO	10 %	1/1	1	3	1	1/1	1/1	1	4/4	1/1
Potassium nitrate	KNO_3	aqueous	1/1	1	0	1	1/1	1/1	1	1/1	1/1
Quicksilver-(II)-chloride	$HgCl_2$	aqueous	1/1	1	0	1	1/1	(4)	1	1/1	1/1
Sodium bisulphite	$NaHSO_3$	aqueous	1/1	1	0	1	(1)	1/1	1	1/0	1/1
Sodium carbonate	Na_2CO_3	aqueous	1/1	1	3	1	1/1	1/1	1	1/1	1/1
Sodium chloride	NaCl	aqueous	1/1	1	2	1	1/1	1/2	1	1/1	1/1
Sodium hydroxide	NaHO	50 %	1/1	1	3	1	1/1	1/3	1	3/3	0/0
Sodium sulphate	Na_2SO_4	aqueous	1/1	1	0	1	1/1	1/1	1	1/1	1/1
Sulphuric acid	H_2SO_4	40 %	1/1	1	3	1	1/1	2/3	1	1/1	1/1
Trichloroethylene (TRI)	C_2HCl_3	100 %	3/4	4	4	1	1/1	1/1L	1	1/3	1/1

Resistance Legend

Two values concerning resistance are available for each medium:

Left number = value at 68° F (20° C)/ Right number = value at 122° F (50° C).

- **0** no specifications available
- **1** very good resistance/suitable
- **2** good resistance/suitable
- **3** limited resistance
- **4** not resistant
- **K** no general specifications possible
- **L** risk of pitting or stress cracking from corrosion
- **( )** estimated value

Material Names

- **HDPE** Polyethylene, high density
- **FEP** Tetrafluorethylene-Perfluorpropylene
- **V4A** Stainless steel 1.4401 (AISI 316)
- **PPO GF30** Polyphenyl oxylene with 30% glass fibers
- **PU** Polyurethane
- **PEEK** Polyetheretherketone
- **PA GF30** Polyamide with 30% glass fiber contents
- **PVDF** Polyvinylidene fluoride

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