ADS® FlowShark® Pulse Operation and Maintenance Manual

March 2009 **QR 775004 A1**

An introductory guide to the ADS® FlowShark® Pulse Meter

Valid as of **Software** Revision No. 4.10

ADS ENVIRONMENTAL SERVICES®

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CHAPTER 1

Warranty and Certifications

This chapter includes the Declaration of Conformity, the ADS® warranty, and all required certifications for the ADS FlowShark® Pulse.

Please notice that the certifications included in this chapter identify the FlowShark Pulse as the OCM Pro CF. The FlowShark Pulse is a version of the NIVUS® OCM Pro CF designed specifically for ADS. In all aspects related to certification, the FlowShark Pulse is identical to the OCM Pro CF.

Declaration of Conformity

EC Declaration of Conformity

Pursuant to

- the EC Low Voltage Directive 73/23/EEC, Annex III
- the EC EMC Directive 89/336/EEC, Annex I and II
- the EC Directive 94/9/EC: Equipment and protective systems intended for use in potentially explosive atmospheres (ATEX)

We hereby declare that the design of the

Description: Measuring device OCM Pro with active sensor

as delivered complies with the above regulations and following EC directives and DIN EN standards:

Directive/ Standard	Title
73/23/ EC	**EC Low Voltage Directive**
EN 61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements
89/336/EC	**EC EMC Directive**
EN 61000-6-2	Electromagnetic compatibility – Generic immunity standard – Industrial environment
EN 61000-6-4	Electromagnetic compatibility – Generic immunity standard – Industrial environment
94/9/EC (ATEX 100a)	**EC Directive: Equipment and protective systems intended for use in potentially explosive atmospheres**
EN 1127-1	Explosive atmospheres – Explosion prevention and protection – Part 1: Basic concepts and methodology
EN 50014	Electrical apparatus for potentially explosive atmospheres – General requirements
EN 50020	Electrical apparatus for potentially explosive atmospheres – Intrinsic safety "i"

Unauthorized changes to the device invalidate this declaration.

Eppingen, March 15th, 2007 .....

Heinz Ritz

Head of Quality Management

Product Warranty

This section includes warranty information for the ADS 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.

Ex-Approval Transmitter

Translation

(1) **EC-TYPE EXAMINATION CERTIFICATE**

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

(3) EC-Type Examination Certificate Number

TÜV 00 ATEX 1572

(4) Equipment: Measuring transducer type OCP/...

(5) Manufacturer: NIVUS GmbH

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

(7) This equipment or protective system and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

(8) The TÜV NORD CERT GmbH & Co. KG, TÜV CERT-Certification Body, notified body number N° 0032 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 N° 00 PX24000.

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

EN 50 014: 1997 **EN 50 020: 1994**

(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 [EEx ib] IIB

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

Head of the Certification Body

Hanover, 2004-02-11

TÜV NORD CERT

TÜV NORD CERT GmbH & Co. KG
legal successor of the notified body of
TÜV Hannover/Sachsen-Anhalt e.V.
German original certificate
issued on 2000-12-18

TÜV CERT A4 04.02 10.000 Lö

This certificate may only be reproduced without any change, schedule included.
Excerpts or changes shall be allowed by the TÜV NORD CERT GmbH & Co. KG

page 1/3

STOP

The approval is valid only when the corresponding indicator displays on the transmitter nameplate.

(13) **SCHEDULE**

(14) **EC-TYPE EXAMINATION CERTIFICATE N° TÜV 00 ATEX 1572**

(15) Description of equipment

The measuring transducer type OCP/... is used together with associated sensors for the measurement of flow speed and the flow level in open and closed channels via supersonic technology.

Electrical data

Supply circuit (a1 to a3) (b2, b3)	U = 90 ... 250 V AC, 25 VA or U = 18 ... 36 V DC, 25 W
Digital inputs (a12...a14, b12...b14)	U = 24 VDC, I = 12 mA
Analogues inputs (a15...a17, b15...b17)	U = 12 VDC, I = 55 mA
Analogous outputs (a18...a20, b18...b20)	Current output I = 0 ... 30 mA
Contact circuit (a4...a8, b4...b8, c4...c8)	U = 250 VAC, I = 6 A at cos φ = 0,9
Analogous sensor connection (a21, b21, c21)	in type of protection Intrinsic Safety EEx ia IIB only for the connection of certified sensors Maximum values U_o = 25.2 V, I_o = 128 mA Characteristic line: linear max. permissible outer inductance 9 mH max. permissible outer capacitance 820 nF
Sensor connections (a22...a29, b22...b29, c22...c29)	in type of protection Intrinsic Safety EEx ib IIB only for the connection of associated sensors type OCS/... according to TÜV 00 ATEX 1573 Maximum values per circuit: U_o = 10.5 V, I_o = 500 mA Characteristic line: rectangular max. permissible outer inductance 0.15 mH max. permissible outer capacitance 100 nF

page 2/3

Schedule EC-Type Examination Certificate N° TÜV 00 ATEX 1572

The intrinsically safe circuits are safely galvanically separated from all other circuits up to a peak value of the nominal voltage of 375 V.

(16) Test documents are listed in the test report No.: 00 PX 24000.

(17) Special conditions for safe use

none

(18) Essential Health and Safety Requirements

no additional ones

page 3/3

STOP

The approval is valid only when the corresponding indicator displays on the transmitter nameplate.

Translation

1. SUPPLEMENT to

EC TYPE-EXAMINATION CERTIFICATE No. TÜV 00 ATEX 1572

of the company: NIVUS GmbH
Im Täle 2
D-75031 Eppingen

The measuring transducer type OCP/... may also be manufactured according to the test documents listed in the test report.

The amendments concern the internal design and the electrical data.

Electrical data

Supply circuit (a1 to a3) (b2, b3)	U = 90 ... 250 VAC, 20 VA or U = 18 ... 36 VDC, 20 W resp. Auxiliary voltage output of the AC version 24 V / 3 W
Contact circuit (a4...a8, b4...b8, c4...c8)	U = 250 VAC, I = 6 A at cos φ = 0.9
RS232 interface (terminal a and b) (a9...a11, b9...b11)	U = ±10 V
CAN bus interface (terminal c) (c9...c11)	U = 5 V
Digital inputs (a12...a14, b12...b14)	U = 24 VDC, I = 12 mA
Analogous inputs (a15...a17, b15...b17)	U = 12 VDC, I = 55 mA
Analogous outputs (a18...a20, b18...b20)	current output I = 0 ... 30 mA

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1. Supplement to EC Type-Examination Certificate No. TÜV 00 ATEX 1572

Analogous sensor connection (a21, b21, c21)	in type of protection Intrinsic Safety EEx ia IIB only for the connection of certified sensors Maximum values: U_o = 23.1 V, I_o = 162 mA Characteristic line: linear max. permissible outer inductance 6 mH max. permissible outer capacitance 1020 nF
Sensor connections (a22...a29, b22...b29, c22...c29)	in type of protection Intrinsic Safety EEx ib IIB only for the connection of associated sensors type POA/... und OCL/...according to TÜV 03 ATEX 2262 Maximum values per ciruit: U_o = 10.5 V, I_o = 640 mA Characteristic line: rectangular max. permissible outer inductance 0.12 mH max. permissible outer capacitance 4.8 µF

The intrinsically safe circuits are safely galvanically separated from all other circuits up to a peak value of the nominal voltage of 375 V.

All other data apply unchanged for this supplement.

Test documents are listed in the test report N° 04 YEX 551173.

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Hannover, 2004-01-26

Head of the
Certification Body

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Translation

2. SUPPLEMENT to

EC-TYPE EXAMINATION CERTIFICATE No. TÜV 00 ATEX 1572

Equipment:	Measuring transducer OCM-Pro aktiv type OCP-x2xx xx x3 E xx and Measuring transducer OCM-Pro CF type OCP-x3W0 xx x3 E xx
Manufacturer:	NIVUS GmbH
Address:	Im Täle 2 75031 Eppingen

In the future, the measuring transducer type OCP/... may also be manufactured according to the test documents listed in the test report.

The changes refer to the electrical data and the protection level of the circuit „Analogous sensor connection", the execution of the OCM Pro Backplane and the type designation of the measuring transducer.
In the future, this reads: Measuring transducer OCM-Pro aktiv/CF type OCP-xxxx xx xx E xx .

The type designations according to this 2. supplement to
EC-Type Examination Certificate TÜV 00 ATEX 1572 read as follows:
„Version 2": Measuring transducer OCM-Pro aktiv type OCP-x2xx xx x3 E xx
„Version 3": Measuring transducer OCM-Pro CF type OCP-x3W0 xx x3 E xx

Electrical data

Measuring transducer OCM-Pro aktiv type OCP-x2xx xx x3 E xx and
Measuring transducer OCM-Pro CF type OCP-x3W0 xx x3 E xx

Supply circuit (Terminals a1 [L1], a2 [N], a3 [PE] resp. b2 [+], b3 [GND])	U = 90 ... 250 V a. c., 20 VA or U = 18 ... 36 V d. c., 20 W resp. auxiliary voltage output of the a. c. version 24 V / 3 W
Contact circuits (Terminals a4...a8, b4...b8, c4...c8)	U = 250 V a. c., I= 6 A at cos φ = 0.9
RS232 interface (Terminals a9...a11, b9...b11)	U = ±10 V
CAN bus interface (Terminals c9...c11)	U = 5 V
Digital inputs 1 to 4 (Terminals a12...a14, b12...b14)	U = 24 V d. c., I = 12 mA

page 1/3

2. Supplement to EC-Type Examination Certificate No. TÜV 00X ATEX 1572

TÜV NORD

Measuring transducer OCM-Pro CF type OCP-x3W0 xx x3 E xx

Auxiliary voltage output 24 V / 3 W (Terminals a14, b15)	U = 18 ... 36 V d. c., 3 W
Analogous inputs 1 to 4	U = 12 V d. c., I = 55 mA

(Measuring transducer OCM-Pro aktiv type OCP-x2xx xx x3 E xx:
Terminals a15...a17, b15...b17;
Measuring transducer OCM-Pro CF type OCP-x3W0 xx x3 E xx:
Terminals a16...a18, b16...b18)

Analogous outputs 1 to 4 — Current output 0 ... 30 mA
(Measuring transducer OCM-Pro aktiv type OCP-x2xx xx x3 E xx:
Terminals a18...a20, b18...b20;
Measuring transducer OCM-Pro CF type OCP-x3W0 xx x3 E xx:
Terminals a19...a21, b19...b21)

Measuring transducer OCM-Pro aktiv type OCP-x2xx xx x3 E xx and
Measuring transducer OCM-Pro CF type OCP-x3W0 xx x3 E xx

Analogous sensor connection .... in type of protection "Intrinsic Safety" EEx ib IIB
(OCM-Pro aktiv: Terminals a21, b21, c21; only for connection to certified sensors
OCM-Pro CF: Terminals D8, D9)
Maximum values:
U_o = 25.2 V
I_o = 90 mA
Characteristic line: linear

max. permissible external inductance	2 mH	1 mH	0.5 mH	0.2 mH
max. permissible external capacitance	380 nF	430 nF	510 nF	660 nF

Sensor connections .... in type of protection "Intrinsic Safety" EEx ib IIB
(OCM-Pro aktiv: Terminals a22...a29, b22...b29, c22...c29;
OCM-Pro CF: Terminals D1 ... D5, E1 ... E5, F1 ... F5, G1 ... G5)
only for connection to the belonging sensors type POA/... and OCL/... according to TÜV 03 ATEX 2262
Maximum values per circuit:
U_o = 10.5 V
I_o = 640 mA
Characteristic line: rectangular
max. permissible external inductance: 0.12 mH
max. permissible external capacitance: 4.8 µF

The intrinsically safe circuits are safely galvanically separated from all other circuits up to a peak value of the voltage of 375 V.

All other data apply unchanged for this 2. supplement.

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STOP

The approval is valid only when the corresponding indicator displays on the transmitter nameplate.

2. Supplement to EC-Type Examination Certificate No. TÜV 00X ATEX 1572

TÜV NORD

The equipment inclusive of these changes meets the requirements of the following standards:

EN 50 014:1997 +A1+A2 EN 50 020:2002

(16) The test documents are listed in the test report N° 05 YEX 552376.

(17) Special conditions for safe use
none

(18) Essential Health and Safety Requirements
no additional ones

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Hannover, 2005-12-01

Head of the
Certification Body

page 3/3

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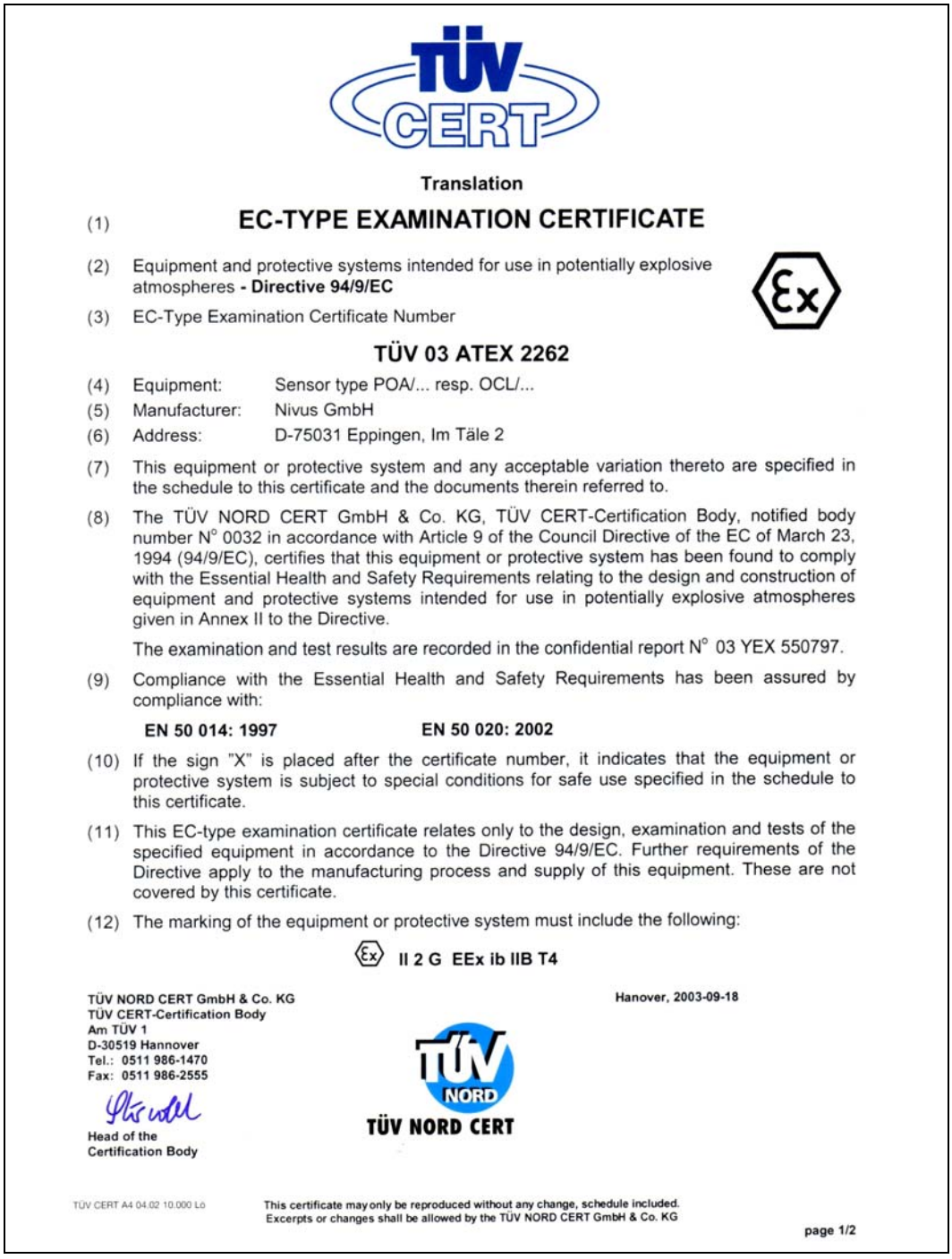
Ex-Approval Sensors



Translation

(1) **EC-TYPE EXAMINATION CERTIFICATE**

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

(3) EC-Type Examination Certificate Number

TÜV 03 ATEX 2262

(4) Equipment: Sensor type POA/... resp. OCL/...

(5) Manufacturer: Nivus GmbH

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

(7) This equipment or protective system and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

(8) The TÜV NORD CERT GmbH & Co. KG, TÜV CERT-Certification Body, notified body number N° 0032 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 N° 03 YEX 550797.

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

EN 50 014: 1997 **EN 50 020: 2002**

(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 EEx ib IIB T4

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Head of the Certification Body

Hanover, 2003-09-18

TÜV NORD CERT

TÜV CERT A4 04.02 10.000 Lo

This certificate may only be reproduced without any change, schedule included. Excerpts or changes shall be allowed by the TÜV NORD CERT GmbH & Co. KG

page 1/2

The approval is valid only when the corresponding indicator displays on the transmitter nameplate.

(13) **S C H E D U L E**

(14) **EC-TYPE EXAMINATION CERTIFICATE N° TÜV 03 ATEX 2262**

(15) Description of equipment

The sensor type POA/... resp. OCL/... is intended together with the associated measuring transformers for the measurement of the flow speed and the flow level in partly or fully filled pipes and channels via supersonic technology.

Electrical data

Signal and supply circuit (plug/prefabricated cable)	in type of protection Intrinsic Safety EEx ib IIB only for the connection to associated measuring transducer type OCP/... according to TÜV 00 ATEX 1572
	Maximum values: U_i = 10.5 V, I_i = 500 mA
or	type PCP/... according to TÜV 03 ATEX 2268 Maximum values: U_i = 9.9 V, I_i = 640 mA

The effective internal inductance and capacitance are negligibly small.

(16) Test documents are listed in the test report No.: 03 YEX 550797.

(17) Special conditions for safe use

none

(18) Essential Health and Safety Requirements

no additional ones

page 2/2

Translation

1. SUPPLEMENT to

EC TYPE-EXAMINATION CERTIFICATE No. TÜV 03 ATEX 2262

of the company: NIVUS GmbH
Im Täle 2
D-75031 Eppingen

In the future, the sensors type POA/... resp. OCL/... may also be manufactured and operated according to the test documents listed in the test report.

The amendments concern the electrical data.

Electrical data

Signal- and supply circuit (plug/prefabricated cable)	in type of protection Intrinsic Safety EEx ib IIB only for the connection to associated measuring transducer type OCP/... according to TÜV 00 ATEX 1572 Maximum values: U_i = 10,5 V, I_i = 640 mA
or	type PCP/... according to TÜV 03 ATEX 2268 Maximum values: U_i = 9,9 V, I_i = 629 mA The effective internal inductance and capacitance are negligibly small.

All other data apply unchanged for this amendment.

Test documents are listed in the test report N° 04 YEX 551201.

TÜV NORD CERT GmbH & Co. KG
TÜV CERT-Certification Body
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Hannover, 2004-01-30

Head of the Certification Body

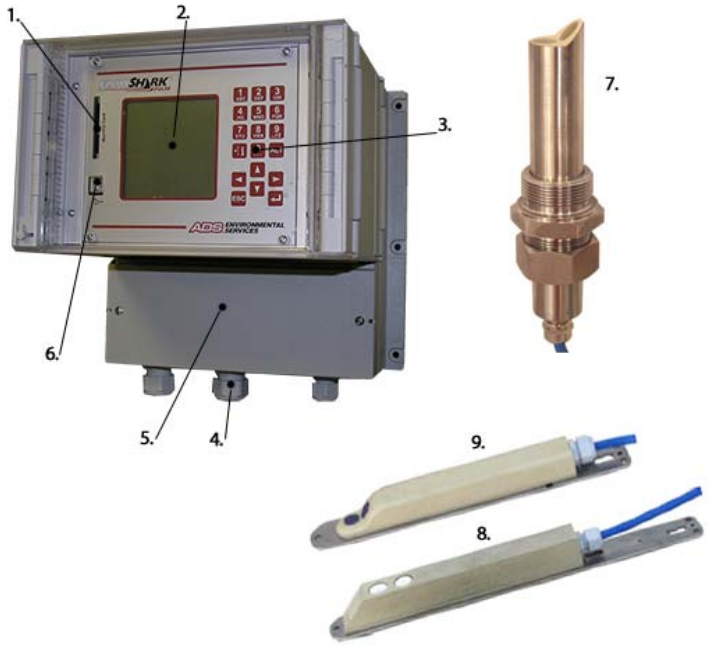
page 1/1

The approval is valid only when the corresponding indicator displays on the transmitter nameplate.

CHAPTER 2

Use and Specifications

Please read this instruction manual thoroughly. It contains all the information necessary to configure and operate the FlowShark Pulse for proper operation. This manual is written primarily for qualified technical staff that have 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.



Part	Description
1	Memory Card Slot
2	Display
3	Keypad
4	Cable Glands
5	Terminal Clamp Housing
6	USB Interface
7	Pipe Insertion Sensor
8	Air-Ultrasonic Sensor
9	Combi Sensor (Flow Velocity, Water Ultrasonic, and Pressure Depth)

Figure 2-1 Overview

Use in Accordance with the Requirements

The ADS FlowShark Pulse and corresponding sensors are designed for measuring slightly- to heavily-polluted flow in partially-filled and full pipes or other similar applications. Please adhere to the measurement specifications designated in this chapter. Monitoring flow under conditions falling outside the documented specifications of the equipments' capabilities without prior written permission of ADS occurs at the owner'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.

This equipment has an estimated lifetime of 10 years. Therefore, inspect and overhaul equipment exceeding 10 years in age.

Ex-Protection

The Ex-version of the FlowShark Pulse active sensor is designed for use in explosive environments (zone 1).

Always install the transmitter outside Ex-zones!

Approval

Sensor: ⟨Ex⟩ II 2 G EEx ib IIB T4

Transmitter: ⟨Ex⟩ II(2)G [EEx ib] IIB

Electronic Specifications

Analog sensor connections:	Ignition protection type intrinsically-safe
	EEx ia IIB
Clamps D8, D9	for connecting certified sensors only
	Max values:
	U_0 = 23.1 V
	I_0 = 162 mA
	linear characteristic

Max. outer inductivities allowed	2 mH	1 mH	0.5 mH	0.2 mH
Max. outer capacities allowed	380 nF	430 nF	510 nF	660 nF

Sensor connections — Ignition protection type intrinsically-safe EEx ia IIB

Clamps D1...D5, E1...E5 — for connection of accompanying sensors only

F1...F5, G1...G5 — Type POA/...OCL/... according to TÜV 03 ATEX 2262

Max. values per circuit:

U_0 = 10.5 V

I_0 = 640 mA

rectangular characteristic

Max. outer inductivities allowed: 0.12 mH

Max. outer capacities allowed: 4.8 µF

The intrinsically-safe circuits are isolated galvanically safe from the remaining circuits up to a peak voltage of 375 volts.

The certification is valid only when the corresponding label exists on the transmitter or sensor nameplate.

For installation and initial start-up, perform all work in accordance with the appropriate certificates of conformity and testing from the respective authorities.

Specifications

Transmitter

Power Supply	100 to 240 V AC, +10% /-15%, 47 to 63 Hz or 24 V DC ± 15%, 5% residual fluctuation
Power Consumption	Maximum 20 VA
Wall-Mount Enclosure	• Material: Polycarbonate • Weight: approximately 6.4 pounds • Protection: IP65
Ex-Approval (*optional*)	II(2)G [EEx ib] IIB
Operating Temperature	-4° to 122° F (-20° to +50° C)
Storage Temperature	-4° to 158° F (-20° to +70° C)
Maximum Humidity	80%, non-condensing
Display	Back-lit graphic display, 128- x 128-pixel
Operation	18 keys, menu-driven in English, German, French, and Italian
Inputs	• 1 x 4 – 20 mA for external depth measurement (2-wire sensor) • 1 x RxTx-Bus for ADS air-ultrasonic sensor (Type LUS) • 1 (Model 10 transmitter) *or* 4 (Model 20 transmitter) x 0/4 – 20 mA, 12-bit resolution for external depth measurement, external setpoints, and data storage setpoint • 4 digital inputs (*Model 20 only*) • 1 (Model 10) *or* 2/3 (Model 20) velocity sensors connectable
Outputs	• 1 (Model 10) or 4 (Model 20) x 0/4 – 20 mA, load 500 Ohm, 12-bit resolution, accuracy greater than 0.1% • 2 (Model 10) or 5 (Model 20) switchable relays, loadable up to 230V AC / 2 A (cos φ0.9) • RJ45 for Internet communication
Data Storage	Plug-in Compact Flash Card up to 128 MB
Data Transmission	Via Compact Flash Card; open protocol via RS 485; direct connection over a TCP/IP network, internal ISDN, or external GSM/GPRS gateway

Combi Sensor/Pipe Insertion Sensor

Measurement Principle	• Ultrasonic transit time (depth measurement) – *Combi Sensor only* • Piezoresistive pressure measurement (depth measurement) – *Combi sensor only* • Correlation with digital pattern detection (flow velocity)
Measurement Frequency	1 MHz
Protection Rating	IP 68
Ex-Approval (optional)	II 2 G EEx ib IIB T4
Operating Temperature	-4° to 122° F (-20° to +50° C) (104° F (40° C) in Ex Zone 1)
Storage Temperature	-22° to 158° F (-30° to +70° C)
Operating Pressure	Maximum 58 psi (4 bar) (combi sensor with pressure element maximum 14 psi (1 bar))
Cable Length	33/66/99/165 feet (10/20/30/50 m), extendable up to 820 feet (250 m); sensors with pressure measurement require pressure compensation element junction box
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: 0.34 ±0.01 inches (8.7 ±0.25 mm) • Sensors without pressure measurement: 0.3 ±0.01 inches (7.6 ±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 • Combi 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 (*combi sensor only*) • Combi 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 (*combi sensor only*) • Combi sensor with flow velocity sensor using cross-correlation,

	depth measurement via water-ultrasonic (and redundant pressure measurement), and temperature measurement to compensate for the effect of temperature on the velocity of sound (*combi sensor only*)
Types of Construction	• Wedge sensor for installation on pipe bottom • Insertion sensor for installation through pipe wall with nozzle and cutting ring
Medium Contacting Materials	Polyurethane, stainless steel 1.4571, PPO GF30, PA (*combi sensor only*) Option: Sensor made of PEEK, resistant against chemical substances, Hastelloy mounting plate, Titanium mounting plate, FEP coated cable
Depth Measurement – Water-Ultrasonic	
Measurement Range	0 to 6.56 feet (0 to 200 cm), lowest absolutely measurable depth 0.13 feet (4 cm)
Zero Point Drift	Absolutely stable
Measurement Error	Less than ±0.08 inches (±2 mm)
Depth Measurement – Pressure	
Measurement Range	0 to 11.5 feet (0 to 350 cm)
Zero Point Drift	Maximum 0.75% of final value (32 °F to 122 °F (0 – 50 °C))
Measurement Error	≤0.5% of final value
Depth Measurement – External Sensor	
Measurement Range	Based on device
Zero Point Drift	
Measurement Error	
Flow Velocity Measurement	
Measurement Range	-3.28 to 19.7 feet per second (-100 to +600 cm/s)
Number of Scan Layers	16 (maximum)
Zero point drift	Absolutely stable zero point
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))
Number of Sensors	1 to 3 per transmitter

Sonic Beam Angle	±5 degrees
Temperature Measurement	
Measurement Range	-4° to 140° F (-20° to +60° C)
Measurement Error	±0.5 K

Air-Ultrasonic Sensor

Measurement Principle	Ultrasonic transit time
Measurement Frequency	120 kHz
Protection Rating	IP68
Ex-Approval	II 2 G EEx ib IIB T4
Operating Temperature	-4° to 122° F (-20 to +50° C) (104° F (+40° C) in Ex Zone 1)
Storage Temperature	-22° to 158° F (-30° to +70° C)
Operating Pressure	Maximum 14 psi (1 bar)
Cable Length	33/66/99/165 feet (10/20/30/50 m), extendable up to 820 feet (250 m) maximum
Cable Type	LiYC11Y 2x1.5 + 1x2x0.34
Outside Cable Diameter	0.3 ± 0.01 inches (7.6 ±0.25 mm)
Type of Construction	Wedge sensor for installation at top of pipe
Medium Contacting Materials	Polyurethane, stainless steel 1.4571, PPO GF30, PA
Depth Measurement	
Measurement Range	0 to 6.56 feet (0 to 200 cm)
Dead Band	0.33 feet (10 cm)
Measurement Error	less than ±0.2 inches (5 mm)
Temperature Measurement	
Measurement Range	-4° to 140° F (-20° to +60° C)
Measurement Error	±0.5 K

Accessories (Option)

Pressure Compensation Element	For connection of sensors with integrated pressure measurement cell
Memory Card	SanDisk compact flash card with 128-MB maximum capacity
Read-out Adapter	Adapter for PCMCIA interfaces, primarily for data read-out via laptop
Read-out Uunit	USB interface for PC connection
Pipe Mounting System	For temporarily clamping air-ultrasonic or combi sensors in pipes DN 200 - 800 (~ID 6 – 32 inches)

CHAPTER 3

Safety and Identification

Following are the descriptions or interpretations for the general safety or danger symbols corresponding to the special notes referenced throughout this manual.

Represents cautionary information to observe

Represents special notes

Represents information regarding present dangers associated with electric voltage

Represents special warnings

To avoid accidents, observe the following information, regulations (such as Ex-regulations), and safety requirements during installation, initial start-up, and operation of the FlowShark Pulse.

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 device.

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

Device Identification

The instructions in this manual pertain only to the FlowShark Pulse. The nameplate affixed to the bottom of the unit contains the following information:

- Name and address of the manufacturer
- CE label
- Type and serial number
- Year of manufacture
- Ex-label (*applies only to Ex-version equipment*), as noted in Chapter 2

To expedite processing, please specify the article number and serial number of the respective transmitter or sensor when inquiring about products or ordering replacement parts.

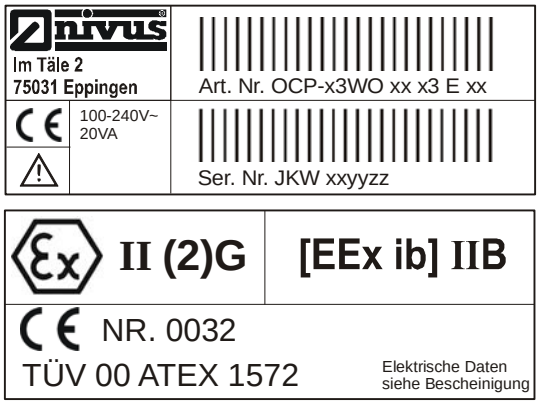


Figure 3-1: FlowShark Pulse Nameplate

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

Please follow all safety instructions contained in this manual.

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

Replacement Parts and Accessories

ADS does not certify replacement parts or accessories that are not supplied by ADS. Installing and/or using such products 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.

Emergency and Safety Procedures

In case of an emergency, terminate power in ***one*** of the following ways:

- Turn off power at the source from the which the FlowShark Pulse is receiving power.
- Set the slide switch for power on the FlowShark Pulse to the **OFF** position.

When performing maintenance, cleaning, and making repairs (authorized personnel only), disconnect the unit from its power source and take the appropriate measures to prevent it from powering up accidentally during these activities.

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 disposal (laws on wastes)
- Cleaning (cleansing agents and disposal)
- Environmental protection

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

CHAPTER 4

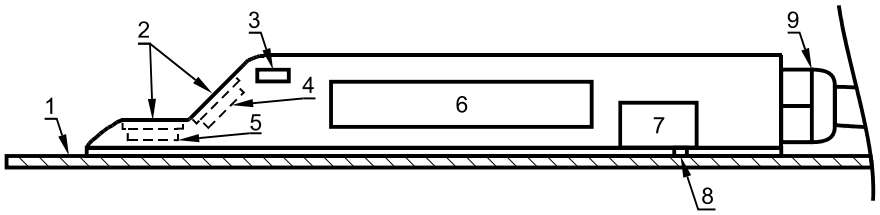
System Overview and Operation

The FlowShark Pulse is a long-term monitoring system designed for flow measurement, flow control (*Model 20 transmitters only*), data storage, and (*optional*) remote access via TCP/IP communication. This device primarily is designed for use in slightly- to heavily-polluted flow of various compositions. It can function in partially-filled and full pipes of various shapes and dimensions.

The method for measuring flow velocity 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.

Combination Sensor

The FlowShark Pulse uses a combination (combi) sensor that can simultaneously determine both flow velocity and flow depth. A combi sensor may contain up to two 2 depth measurement devices: a water-ultrasonic device and/or a hydrostatic (pressure) device.



1	Ground Plate
2	Acoustic Coupling Layer
3	Temperature Sensor
4	Flow Velocity Sensor
5	Ultrasonic Depth Sensor
6	Electronics
7	Pressure Measurement Cell
8	Pressure Measurement Duct
9	Cable Gland

Fig 4-1: Combination sensor with additional pressure measurement cell for installation at pipe bottom

Water-Ultrasonic Depth Measurement

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

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

Where,

h = Depth Level

c = Transit Time of Sound

t_1 = Time Elapsed Between the Transmitted and Received Signals

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 and the travel time of sound in the flow.

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.

Pressure Depth Measurement

The combi 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 combi 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 combi sensor has a piezo crystal 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. The size and shape of a particle determines the result of the reflected signal. Together, the returned signals produce a reflection pattern (Figure 4-2) received by the piezo crystal. This pattern is converted into electric signals that are loaded into a digital signal processor (DSP) housed in the sensor.

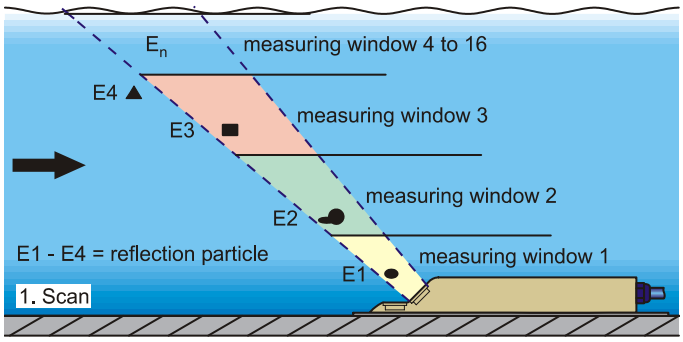


Fig. 4-2: Conditions at first signal detection

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

Flow velocities differ at varying depth levels, creating a velocity profile. Therefore, the distances (or *movement*) between reflective particles' initial and subsequent positions also vary at different depth levels, resulting in a distorted reflection pattern (Figure 4-3). 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.

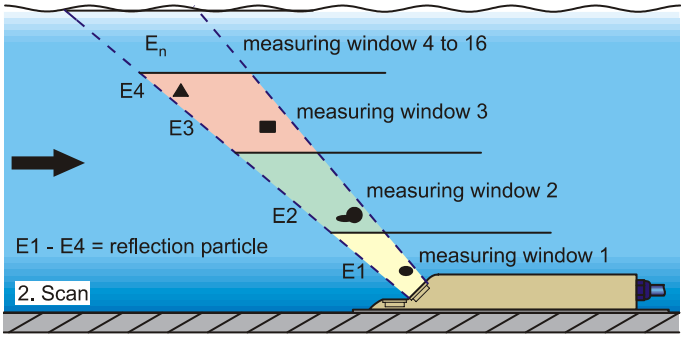


Fig. 4-3 Conditions at second signal detection

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

Based on the depth levels, both patterns are subdivided into 16 measurement windows. The DSP then examines the lag Δt (*change in time – Refer to t1, t2, and t3 in Figure 4-4*) of the signal pattern for each measurement window.

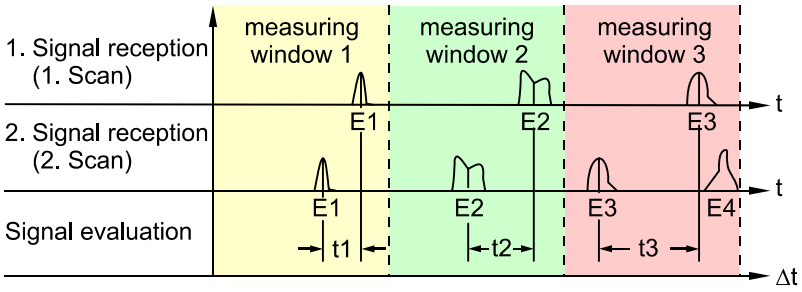


Fig. 4-4 Echo signal images and evaluation

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 profile of the acoustic path indicated on the display reflects the mathematical integration of the individual velocity measurements.

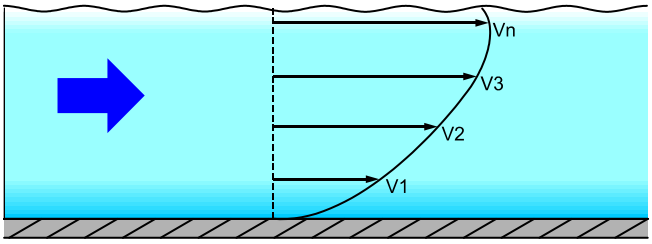


Fig. 4-5 Investigated flow profile

A 3-dimensional representation of the flow velocity distribution can be rendered from a velocity profile performed at a location with a known pipe height and geometry (Figure 4-6).

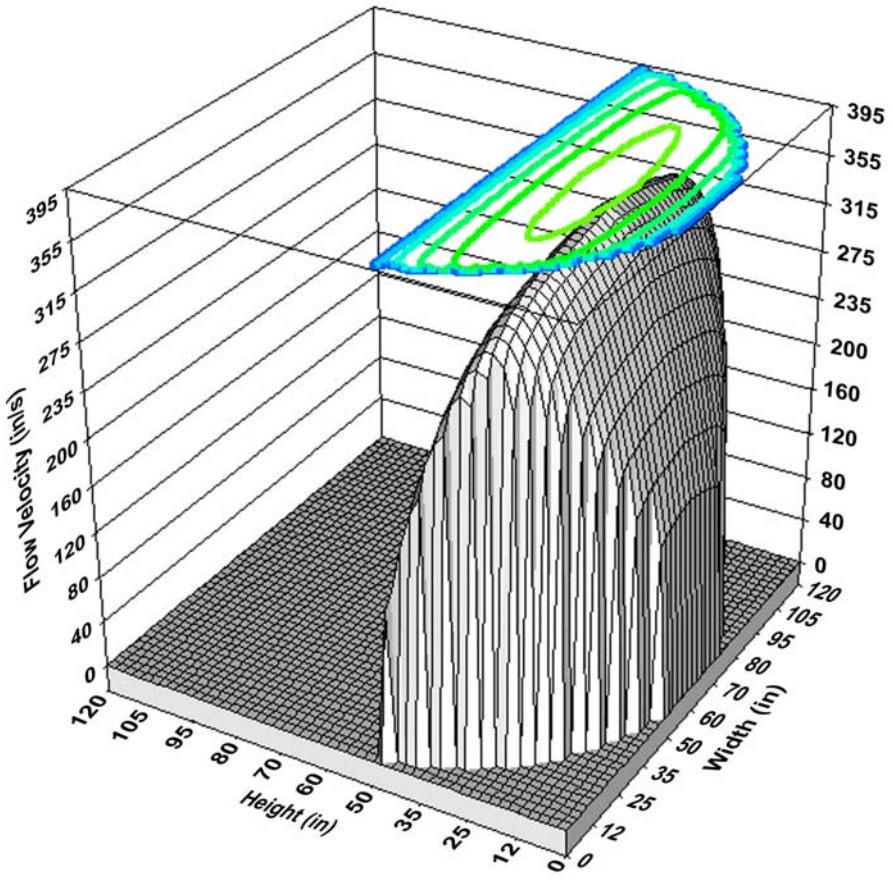


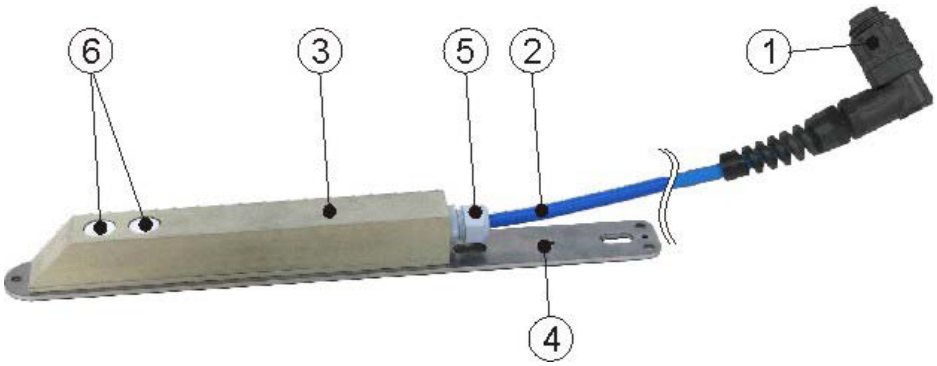
Figure 4-6 Calculated 3-dimensional flow profile

Flow rate can be calculated and displayed based on the flow velocity distribution, pipe shape and dimensions, and flow depth. It also is available for display or output to another device through either a free programmable analog signal or a pulse signal.

Air-Ultrasonic Depth Sensor

An air-ultrasonic depth sensor 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 and the sensor offset from the pipe height. The sensor offset represents the distance from the top of the pipe to the sensor crystal position.

The air-ultrasonic 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, IP68 (only for PCM)
2	Sensor cable
3	Sensor body
4	Ground plate
5	Cable gland
6	Sensors (*crystals*) for depth measurement using air-ultrasonic

Figure 4-7 Air ultrasonic sensor

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 combi sensor. Therefore, refer to the *Flow Velocity Measurement* on page 4-3 for more information on the method employed by this sensor for velocity measurement.

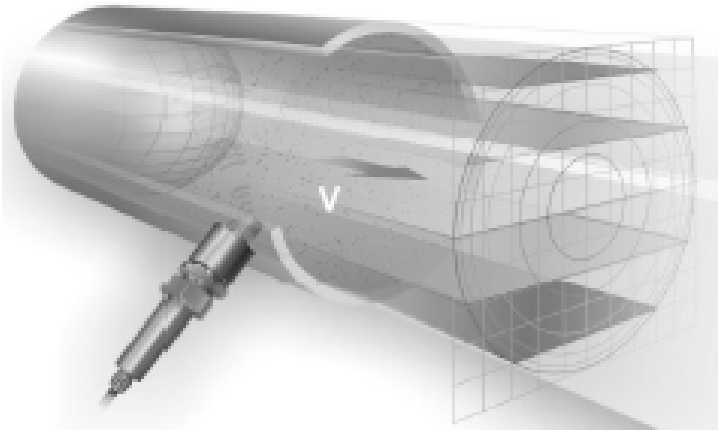


Figure 4-8 Pipe insertion sensor

Device Versions

The FlowShark Pulse transmitter and the supporting combi, pipe insertion, and air-ultrasonic sensors are available in different versions. The tables below provide a brief overview of the various options.

Transmitter

Transmitters vary primarily based on the power supply, Ex-protection, and enclosure construction. The article number posted on a label on the bottom of the enclosure identifies the device type. Refer to the following table for device type specifications.

FlowShark Pulse	**Flow measurement transmitter in wall mount enclosure (IP65) for open channels and partially-filled and full pipes. Spatial allocation of flow velocities by ultrasound. Signal evaluation using cross-correlation. Depth measurement based on sensor type via air-ultrasonic, water-ultrasonic, pressure measurement cell, or mA input for external depth measurement. Membrane keypad; 128- by 128-pixel graphic display. Compact flash card slot for data storage. Internet access via HTML protocol and TCP/IP via Intranet.**				
5000-PULSE METER-	**Model**				
	10	Standard version with 2 relays, 2 mA outputs (galvanically-isolated), and 1 mA input (galvanically-isolated with 2-wire sensor supply) for external depth measurement			
	20	Multi-functional version with 5 relays, 4 mA outputs (galvanically-isolated), 4 digital inputs, 5 analog inputs (1 galvanically-isolated with 2-wire sensor supply), integrated 3-point step controller with flush function, and connection options for up to 3 sensors			
		Data Transmission (B, C, and D currently are not available*)**			
		A	Internet communication via Ethernet or LAN		
		B	Internet communication via internal analog modem*		
		C	Internet communication via internal ISDN modem*		
		D	Internet communication via GPRS and T-D1*		
			Power Supply		
			1	100-240 V AC/47-63 Hz	
			2	24 V DC regulated	
				Approvals	
					None
				E	Intrinsically-safe sensor supply in Ex zone 1

Fig. 4-9 Type key for FlowShark Pulse transmitters

Sensors

Several sensor models support the FlowShark Pulse. Individual models may vary based on Ex-protection, cable length, and unique construction. The item number identifying the sensor model is printed on the sensor where the cable enters the sensor body and on a nameplate at the end of the cable. A transparent tube on the end of the cable provides protection for the nameplate against weather conditions and abrasion.

Combi and Pipe Insertion Sensors	**Active ultrasonic combi and pipe insertion sensors for flow velocity and depth measurement. Connect to the FlowShark Pulse. These sensors provide spatial allocation of flow velocities over a maximum of 16 scan layers.**				
5000-PULSE-SENS-W	**Sensors**				
	1	**Without Depth Measurement**			
		K	Combi sensor made of PPO with PEEK sensor face; ground plate 1.4571		
		R	Pipe insertion sensor made of PPO with PEEK sensor face; pipe body 1.4571		
	2	**With Water-Ultrasonic**			
		K	Combi sensor made of PPO with PEEK sensor face; ground plate 1.4571		
		R	Pipe insertion sensor made of PPO with PEEK sensor face; pipe body 1.4571		
	3	**With Pressure Measurement Cell (*pressure compensation element required*)**			
		K	Combi sensor made of PPO with PEEK sensor face; ground plate 1.4571		
	4	**With Pressure Measurement Cell and Water-Ultrasonic (*pressure compensation element required*)**			
		K	Combi sensor made of PPO with PEEK sensor face; ground plate 1.4571		
			Approvals		
				None	
			E	Ex zone 1	
				Cable Lengths	
				10	10 meters (33 ft)
				15	15 meters (49 ft)
				20	20 meters (66 ft)
				30	30 meters (98 ft)
				50	50 meters (164 ft)
				99	100 meters (328 ft)

					Sensor Connection		
					K	Cable end pre-configured for connection to 1K/1R and 2K/2R FlowShark Pulse units	
					L	Cable end pre-configured for connection to 3K and 4K FlowShark Pulse units (*pressure compensation element required*)	
						Pipe Length	
						0	(*applies only to combi sensor*)
						2	20 centimeters (8 in) – standard
						3	30 centimeters (12 in)– minimum length for stop valve)
						4	40 centimeters (16 in)
						G	20 centimeters (8 in) with threaded extension

Fig. 4-10 Type key for combi sensors

Air-Ultrasonic Sensor	**Air-ultrasonic sensors measure flow depth without contacting the flow. Connects to the FlowShark Pulse**			
500-PULSE-SENS-AIR-	**Approvals**			
		None		
	E	Ex zone 1		
		Cable Lengths		
		10	10 meters (33 ft)	
		15	15 meters (49 ft)	
		20	20 meters (66 ft)	
		30	30 meters (98 ft)	
		50	50 meters (164 ft)	
		99	100 meters (328 ft)	
			Sensor Connection	
			K	Cable end pre-configured for connection to Pulse

Fig. 4-11 Type key for air-ultrasonic sensors

*OCS (old model range) passive sensors **do not** support Model 10/20 transmitters.*

CHAPTER 5

Delivery, Maintenance, and Handling

This chapter contains information regarding shipping, maintaining, handling, storage, and disposal of the FlowShark Pulse transmitter and sensors.

Delivery and Receipt

Delivery of a typical FlowShark Pulse measurement system includes the following:

- Instruction manual including all the necessary steps to correctly install and operate the measurement system and the certificate of conformity
- FlowShark Pulse Model 10 or 20 transmitter
- Ultrasonic sensor: combi sensor or pipe insertion sensor with threaded cutting ring (consisting of spigot nut, cutting ring, and pipe double nipple)

Additional accessories, such as a pressure compensation element (when using combi sensors with an integrated pressure measurement cell), memory cards, card readers, pipe mounting systems, or separate depth measurement devices (such as an air-ultrasonic sensor), also may be included in the order.

Upon receipt, please inspect the hardware and verify all standard equipment and accessories according to the invoice to ensure the order is complete and intact. 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!

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 FlowShark Pulse is extremely durable, is virtually maintenance-free, and does not require calibration. The only item in the system that requires maintenance is the combi sensor with the integrated pressure measurement cell.

If necessary, clean the transmitter enclosure with a dry, lint-free cloth. For heavy soiling, ADS recommends using a mild detergent. *Do not use abrasive cleansers!*

To clean the enclosure surface with a damp cloth, first disconnect the unit from the main power supply.

In flow that contains a significant amount of debris and/or pipes that experience a substantial amount of silt, it may be necessary to clean the sensor regularly using a plastic bristle brush, broom, or similar tool.

Do not use hard objects, such as wire brushes or scrapers, to clean the sensor. A water hose with a maximum pressure of up to 50 psi (4 bars) can be used to clean most sensors. However, do not use a water hose to clean a flow velocity sensor with a pressure measurement cell (Types 3K and 4K).

Do not use a high pressure device for cleaning. This could damage the equipment, producing measurement failure.

Due to the physical design of sensors with pressure measurement cells, these sensors experience long-term drift in depth measurements (see *Chapter 2, Overview and Specifications*). Therefore, ADS recommends calibrating sensors with integrated pressure measurement cells twice a year relative to the respective zero point. The best results are produced when the depth level is as low as possible or the sensor is independent from the measurement medium. Refer to *Chapter 8* for the calibration procedure.

To ensure reliable, accurate, and trouble-free operation of the flow measurement system, contact ADS to perform an inspection of the equipment at least once a year.

To identify the zero point for the pressure measurement cell, consider measuring the current depth level with a yardstick, ruler, or similar tool without removing the sensor from the flow. However, keep in mind that this method can produce errors. Inserting the ruler (or yardstick) into the flow creates a surge that could lead to measurement errors based on the current flow velocity. When this a concern, another method for determining flow depth involves measuring the distance from the top of the pipe to the flow surface (commonly referred to as "range") and subtracting this distance from the pipe diameter.

Remove combi sensors with the pressure measurement cell (Type 3K and 4K) if the pressure depth measurement component fails. Rinse this sensor with clean water for a sufficient amount of time and then carefully rinse the pressure duct or clean it with a soft brush.

Do not use high pressure water to flush the duct. This could damage or destroy the built-in pressure sensor.

In addition, never remove the ground plate. This could increase the potential for leakage or permanent damage to the sensor.

Handling

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

Storage

Strictly adhere to the following conditions regarding equipment storage:

Transmitter:	Maximum temperature:	158°F (70°C)
	Minimum temperature:	-22°F (- 30°C)
	Maximum humidity:	80 %, non-condensing
Sensor:	Maximum temperature:	158°F (70°C)
	Minimum temperature:	-22°F (- 30°C)
	Maximum humidity:	100 %

Protect the devices 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.

Disposal

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

CHAPTER 6

Installation

Reading and following the installation instructions before initial start-up will help ensure success in flow measurement and device configuration. Do not initiate start-up until installation is complete and verified. If any problems occur during installation, connection, or configuration, please contact an ADS representative.

Installation 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.

Protect the FlowShark Pulse power supply separately using a 6-amp slow-blow fuse and isolate it from other facility parts through a separate turn-off. For example, consider using an automatic cut-off.

Successfully complete transmitter and sensor installation before providing the rated voltage.

All outer circuits, wires, and lines connected to the device must have a minimum isolation resistance of 250 volts. Voltages exceeding 42 volts DC require an isolation resistance of at least 500 kOhm.

The cross-sectional dimension of the power supply wires must be 0.03 square inches (0.75 mm^2) and in accordance to IEC 227 or IEC 245. The device protection rating is IP 65.

The maximum allowable switching voltage on the relay contacts must not exceed 250 volts. According to Ex protection, this voltage must be verified if the device's power supply will be integrated into the facility's emergency shutdown procedures.

Transmitter Installation and Connection

General

When selecting a mounting location for the transmitter, avoid locations exhibiting or near the following conditions:

- Direct sunlight (use weatherproof cover, if necessary)
- Heat-emitting objects (maximum ambient temperature of 104°F (40°C))
- Objects generating strong electromagnetic fields (such as frequency converters or electric motors that consume significant power)
- Corrosive chemicals or gas
- Mechanical shock
- Walkways or heavy traffic areas
- Vibration
- Radioactive emissions

To fasten the wall mount enclosure, use one of the following fastener configurations based on the composition of the mounting structure:

- Four M5 machine screws of suitable length with corresponding nuts and shims. These screws must penetrate the wall at least 1.575 inches (40 mm).
- Four wood screws with a minimum diameter of 0.177 inches (4.5 mm). These screws must penetrate the appropriate dowels at least 1.97 inches (50 mm).

The clear door on the measurement transmitter has a protective film to prevent potential damage during transport and scratches during assembly. Remove this film immediately after assembly.

Exposing the film to direct solar radiation for a long period will make it more difficult to remove the film.

Clean the door with mineral spirits or car polish, when necessary. If these cleansers are not effective, order a new front door from ADS.

The FlowShark Pulse Model 10/20 transmitter does not support passive OCS sensors (older models).

Enclosure Dimensions

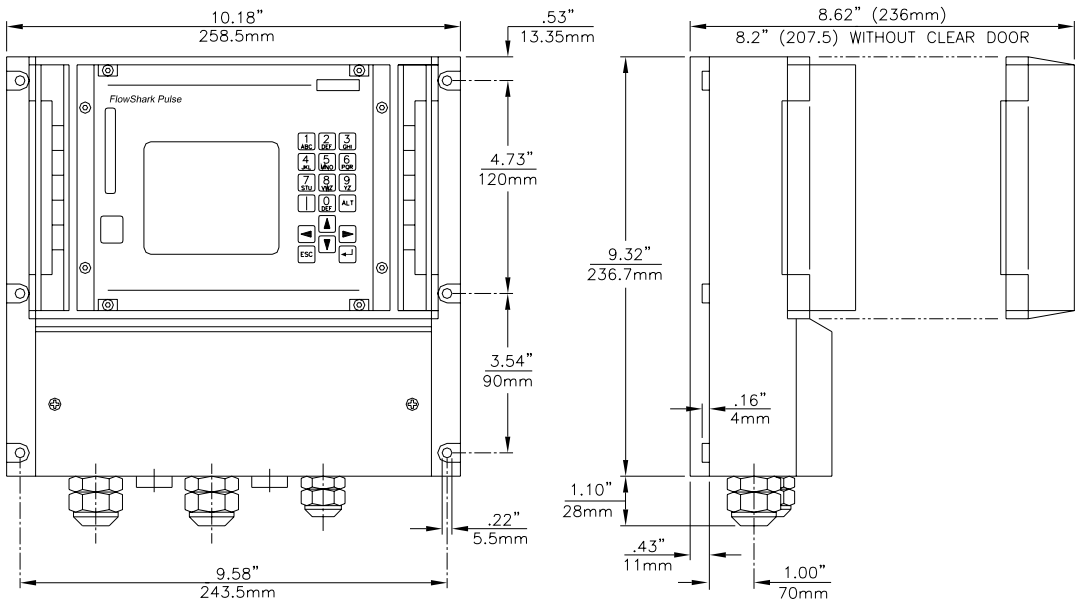


Fig 6-1 Wall mount enclosure

Transmitter Connection

General

The FlowShark Pulse transmitter is available in 2 different versions:

- Model 10 standard version
- Model 20 with supplemental connections for up to 3 flow velocity sensors, digital inputs, and additional analog inputs/outputs plus controller function

Both models have the same clamp terminal marking. However, the Model 20 transmitter includes additional connections.

The wall mount enclosure has cable glands and dummy plugs. Some are screw-type and some are enclosed for spare or additional parts. The transmitter model determines the number and size of cable glands and dummy plugs.

Model 10 Transmitter:

- 2 glands M20 x 1.5
- 1 gland M16 x 1.5
- 2 plugs M20 x 1.5
- 2 plugs M16 x 1.5

Model 20 Transmitter:

- 2 glands M20 x 1.5
- 3 glands M16 x 1.5
- 2 plugs M20 x 1.5
- 2 plugs M16 x 1.5

Use the glands supplied to connect the following outer cable cross-sections:

- M16 x 1.5: 3.5 mm – 10.5 mm (0.138 – 0.413 in)
- M20 x 1.5: 6.0 mm – 14.0 mm (0.236 – 0.591 in)

To use a cable with a diameter outside of the specified tolerance, use a gland that ensures IP 65 minimum protection.

Protect unused wire access openings with an appropriate dummy plug before initial start-up.

The transmitter has terminal clamps that accommodate power supplies and digital/analog outputs/inputs with single and multi-wired cables with cross-sectional areas of 0.007 – 0.098 inches² (0.18-2.5 mm²).

The combi, air-ultrasonic, and 2-wire level sensors have connection plugs for handling purposes. The cable ends of the FlowShark Pulse sensors or single and multi-wired cables with cross-sectional areas of 0.007-0.098 inches² (0.18-2.5 mm²) can receive these plugs.

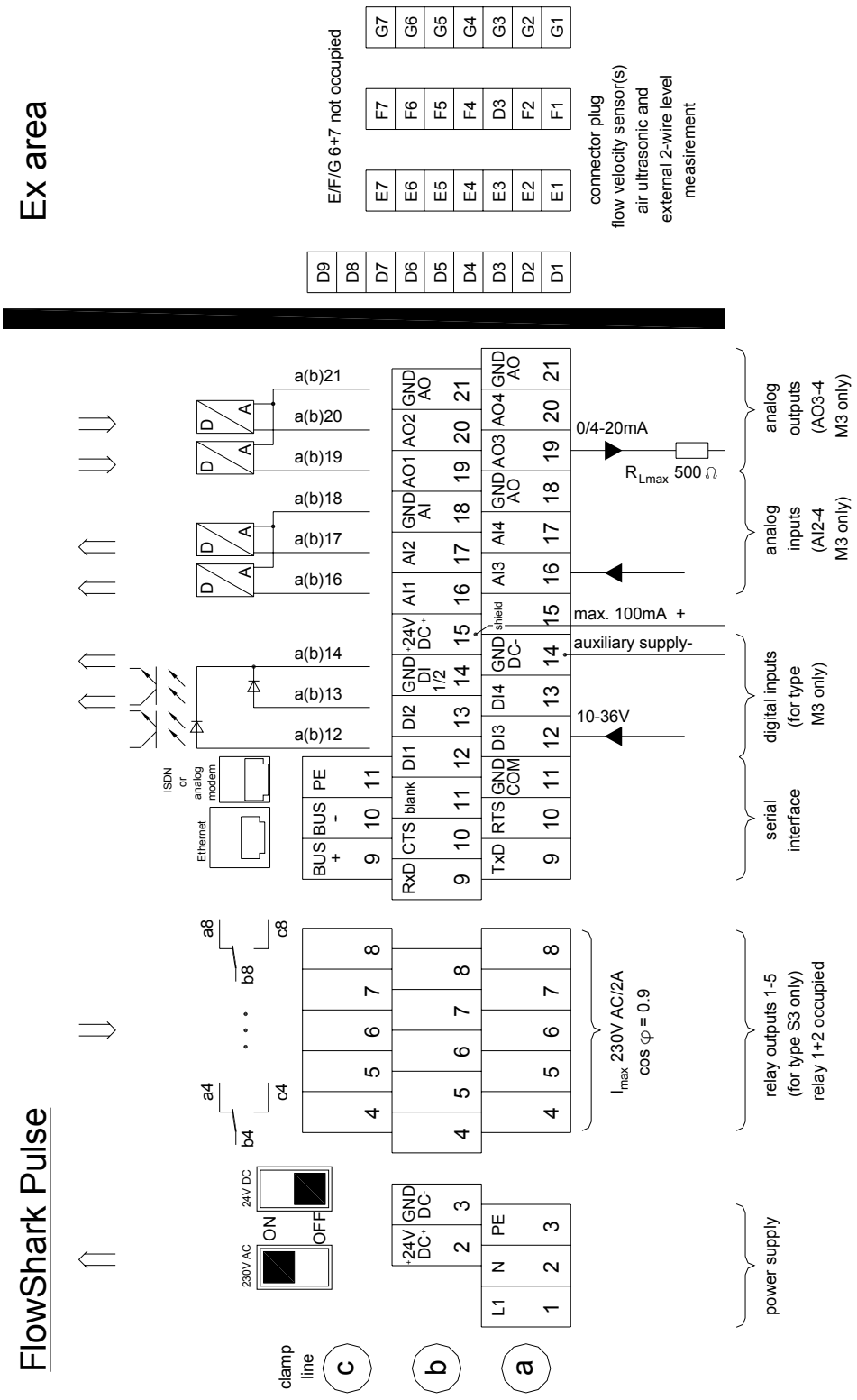
The 7-pole plug-and-socket connections of the flow velocity sensors are interchangeable. However, the hardware configuration does not support switching between 7-pole and 9-pole plug rails (9 poles = level sensors).

Connecting terminal clamps requires a slotted screwdriver with a 0.118- or 0.138-inch (3.0-mm or 3.5-mm) blade. Connect the sensors to the plugs using a slotted screwdriver with a 0.079- to 0.098-inch (2.0-mm to 2.5-mm) blade.

While the terminal clamps typically arrive unscrewed upon delivery, please verify they are unscrewed before connecting the power supply or the signal wires.

Before making the first connection, apply slight pressure to the screw on the clamping connection to ensure safety in opening and a proper connection.

Water or dirt must not leak into the terminal housing. Therefore, please seal the housing with the lid and two screws supplied. Position lid with the beveled side up (it is not reversible). An improper or faulty seal will not provide adequate protection.



GND potentials isolated from each other: DE1/2, DC-, AE1 ... 4, AA1 ... 4

Internal wiring: b2 + b15; b3 + a14

Figure 6-2 Wiring diagram for FlowShark Pulse wall mount enclosure

Sensor Installation and Connection

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 draw-downs, steps, curves, obstructions, pipe joints, profile changes, or immediately upstream or downstream of inlet or lateral connections.
- Choose a location where sedimentation (sand, grit, sludge, etc.) 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 buildup 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 slopes.
- In general, make sure the distance of the upstream approach to the sensor is 5 times the approximate diameter of the pipe and the distance downstream from the sensor is 2 times the approximate diameter of the pipe. However, consider longer straight approaches when turbulent hydraulic conditions generate distorted flow profiles.

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

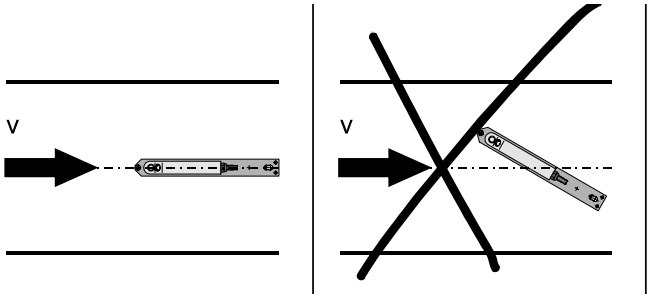
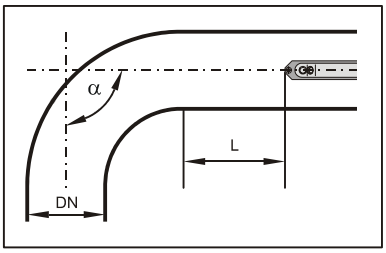
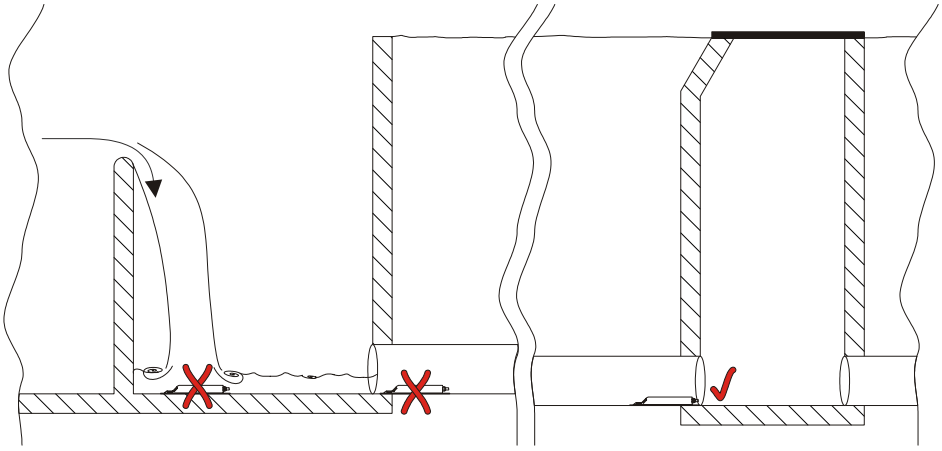


Figure 6-3 Sensor Adjustment: (left) proper installation in center that should yield reliable measurements; (right) faulty installation that will yield erroneous measurements



Angle of the Curve in the Pipe	v ≤ 1m/s	v > 1m/s
α ≤15°	L ≥ min. 3x DN	L ≥ min. 5x DN
α ≤45°	L ≥ min. 5x DN	L ≥ min. 10x DN
α ≤90°	L ≥ min. 10x DN	L ≥ min. 15-20x DN
DN represents the nominal diameter		

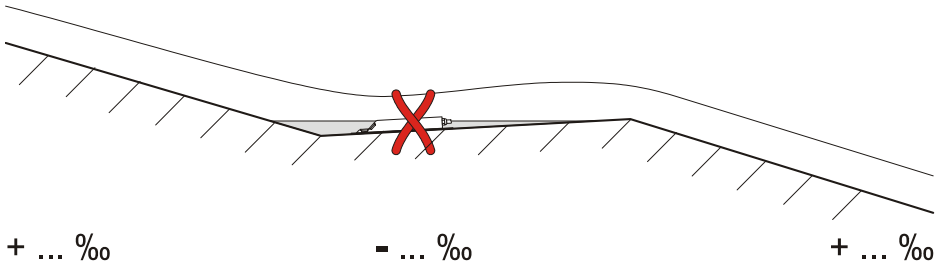
Figure 6-4 Sensor position behind curves or elbows



✕ = Error! Undesirable flow conditions

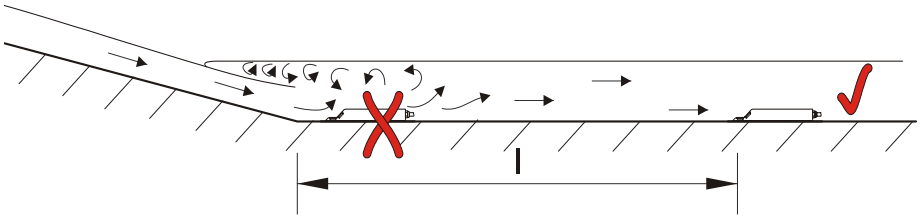
✔ = Sufficient distance to obtain steady flow (10 … 50 x diameter, depending on the application)

Figure 6-5 Overflow pipes or fall error caused by unstable flow conditions



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

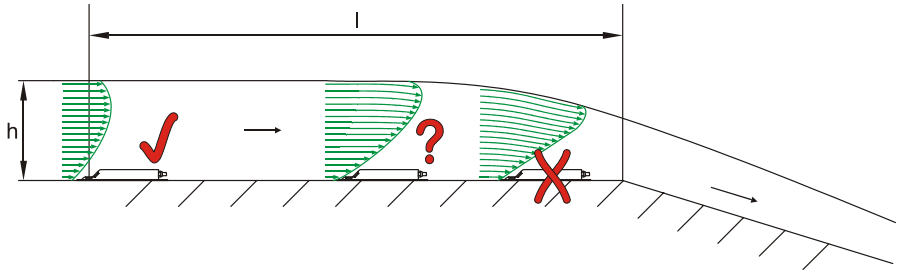
Figure 6-6 Negative slope – risk of silt accumulation



✕ = Error! Changes in slope = changes in flow profile

✔ = Distance depending on slope and flow velocity reading
l = min. 20 x diameter

Figure 6-7 Error caused by changes in slope

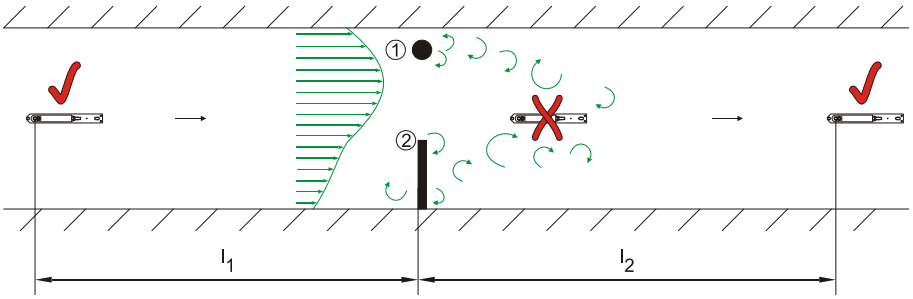


✕ = Error! Installed in draw-down
Depth measurement may fail + velocity and depth measurement may be erroneous

? = Critical measurement point, not recommended! Flow begins to fall (*or sink*)

✔ = Distance l = min. 5 x h_{max} at place of installation

Figure 6-8 Error caused by changes in flow profile in front of slope fluctuation or fall

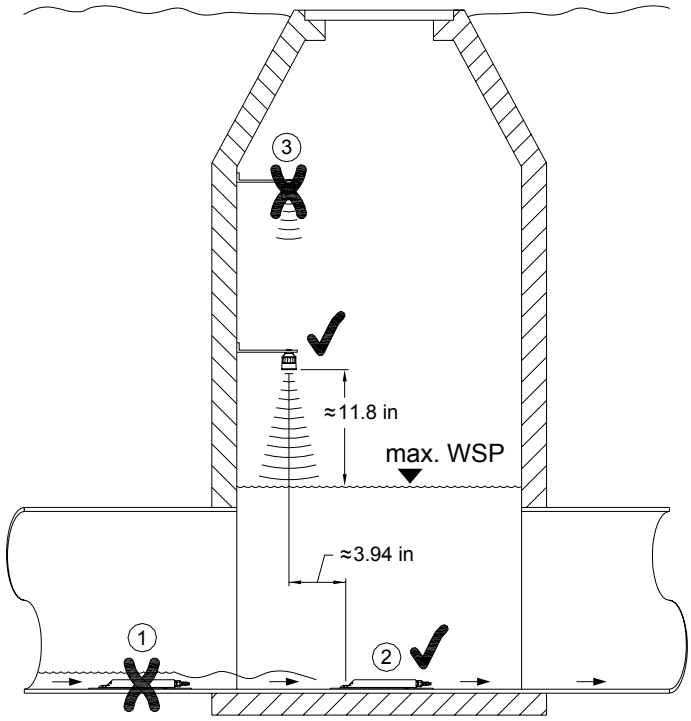


(1) = Fixtures such as samplers or similar
(2) = Obstruction

✕ = Error! Caused by vorticity, tangential, and/or asymmetric flow

✔ = Distance l_1 (upstream of obstruction) = minimum 5 x h_{max}
Distance l_2 (downstream of obstruction) = minimum 10 x h_{max} in case of flow velocities >1 m/s

Figure 6-9 Errors caused by equipment or obstructions

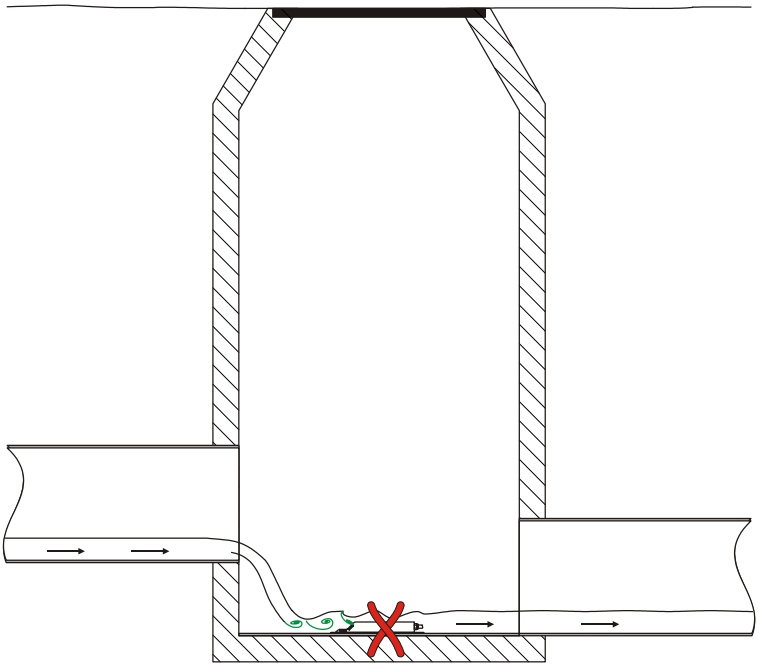


(1) = Wave formation on water surface behind the sensor → error message from following air-ultrasonic sensor (2)

(2) = Good (might have to be installed 0.39 inches (10 mm) lower in low flow depth conditions)

(3) = Distance too large from edge of sensor bottom to maximum water level

Figure 6-10 Installation with separate depth measurement devices in the manhole



✕ = Error! Caused by vorticity and wave formation behind fall
→ Choose another location or redesign manhole

Figure 6-11 Error caused by fall or changing slope

Sensor Installation

When installing the sensors, use only non-corrosive fastening materials and fasten the sensors both securely and tightly.

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

Combi Sensor

Fasten the sensor through the four holes on the front and reverse sides of the ground plate (Figure 6-12, detail Y). Use the slotted holes (Figure 6-12, detail X) to snap the sensor onto a special base plate (Type BST) for use in conjunction with the pipe mounting system. Never use the slotted holes to install the sensor with screws or similar fasteners.

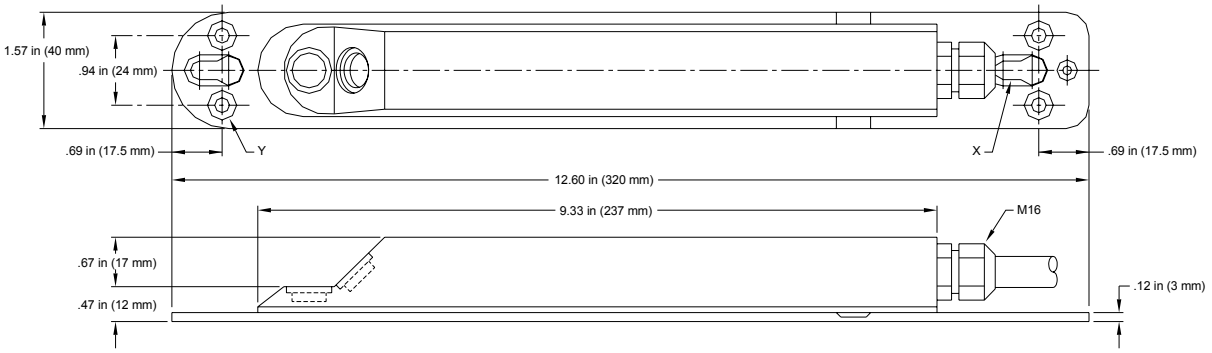


Figure 6-12 Combi sensor dimensions (X represents slotted holes for fastening on the pipe mounting system; Y represents 4 x countersunk holes M6 for direct fastening)

To install the combi sensor on the pipe bottom, use 4 stainless steel screws of sufficient length (*between 1.18 and 2.76 inches (30 and 70 mm)*) with the accompanying dowels. ADS does not recommend using studs or similar bolts. Determine the length of the screws based on the consistency and integrity of the structure to which the sensor will be secured. Choose an adequate length to ensure the sensor can be safely and securely fastened and the installation will remain durable under any operational conditions.

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 they are as flush as possible with the plate.

Install the sensor at the bottom the center of the pipe (*unless instructed otherwise by ADS*) with the beveled side facing upstream toward the oncoming flow.

When using a combi sensor with simultaneous water-ultrasonic depth detection, install the sensor parallel with the flow surface and no more than ±2 ° from the

bottom center of the pipe. Higher depth levels and/or flow velocities may produce erroneous measurements if the sensor is not installed properly.

When using a combi sensor with water-ultrasonic and pressure measurement capability, environmental conditions, such as the *Bernoulli effect*, may produce erroneous measurements in the presence of high flow velocities and low depth levels. Under these conditions, ADS recommends taking ultrasonic measurements using the air-ultrasonic sensor from the top of the pipe and pressure depth measurements from the bottom in the flow simultaneously until flow depth levels reach an adequate depth to implement water-ultrasonic depth measurement using the combi sensor.

Although the design of the sensor significantly limits build-up from debris in the flow, the sensor mounting plate is more susceptible to build-up. Therefore, make sure that no gap exists between the sensor mounting plate and pipe bottom. Seal any gap or seam that may exist around the tip of the sensor following installation with silicone or a similar material.

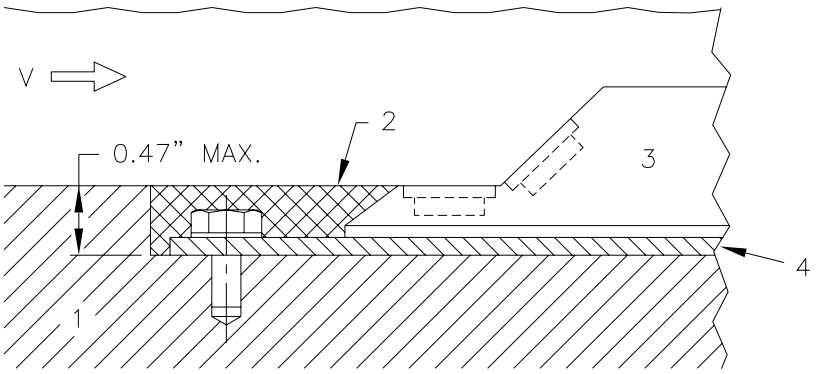
The bottom of the pipe must be completely flat (plane surface) for sensor installation. Otherwise, the sensor could experience damage or leakage, resulting in potentially irreparable damage to the electronic components.

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** integrated pressure elements, consider installing the sensor in a depression at the pipe bottom up to 0.47 inches (12 mm) deep. This will minimize the lowest measurable depth level and the susceptibility of the sensor to the build-up of debris. Once installation is complete, fill up the remaining gaps and seams with a permanently elastic material, such as silicone.

Never countersink combi 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.

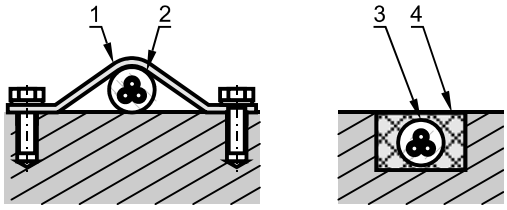


1	Pipe Bottom
2	Silicone or Similar
3	Sensor
4	Mounting Plate

Figure 6-13 Suggestion for installing countersunk combi sensors

Make sure the combi sensor is not covered with or deposited in filling material. This could result in signal attenuation or erroneous measurements.

Run the sensor cable along the pipe bottom from the back of the sensor to the pipe wall. To minimize build-up, cover the cable with a thin, stainless steel sheet *or* lay it in a small canal on the pipe bottom and then seal the canal with a permanent, elastic material. Appropriate covers are available through ADS.



1	Stainless steel sheet/cable cover (for example, Type ZMS 140)
2	Cable
3	Cable
4	Permanent, elastic material

Figure 6-14 Suggested cable layout

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

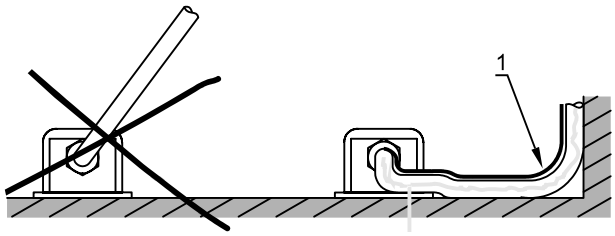


Figure 6-15 Hints on cable layout (1 represents the protective cover)

Do not bend the standard signal cable in more than a 3.94-inch (10-cm) radius. Bending it into a smaller radius could break the cable and, for certain sensors, produce kinks in the cable and create obstructions in the air compensation hose (resulting in erroneous depth measurements).

The cables of high-resistance sensors (special models) are coated with an additional transparent FEP jacket that protects the cables against organic solvents, acids, and lye. Do not damage (such as cut, penetrate, or crush) or remove this protective jacket under any circumstances.

Handle high-resistance sensors equipped with additional protective jacket (cables with FEP jacket) with care. Do not damage or crush the protective jacket in any way.

The minimum bending radius of cables with protective FEP jackets is 5.91 inches (15 cm). Bending the cables in a smaller radius may damage the protective jacket, resulting in sensor malfunction.

Combi Sensor 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 will not be able to measure flow depth accurately under these conditions.

Pipe Insertion Sensor

The pipe insertion sensor would be most suitable in applications such as closed pipes that remain full. To install the sensor, screw it tightly into the 1½-inch nozzle using a cutting ring and spigot nut. The cutting ring of the sensor will warp during installation and, therefore, cannot be used again. Therefore, to obtain new cutting rings, please contact an ADS representative..

Another installation option would involve using a ball valve to allow for sensor removal without applying pressure or a retractable fitting to allow sensor removal and replacement under operational conditions.

Make sure the horizontal part of the sensor is flush with the pipe wall once installed (Figure 6-16, far left).

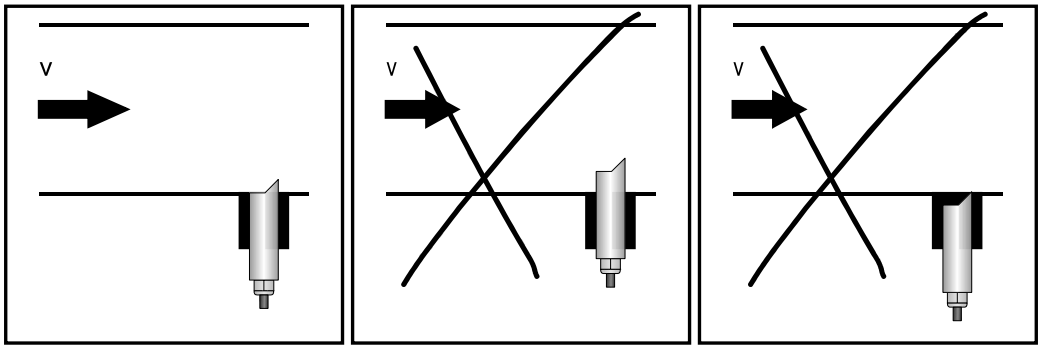


Figure 6-16 Proper pipe insertion sensor installation (left – represents a proper installation; center – represents a poor installation due to build-up; right – represents a poor installation due to faulty readings or sensor failure)

Install the sensor so that the beveled side is facing upstream. The "installation help" screw (Figure 6-17) assists in proper positioning.

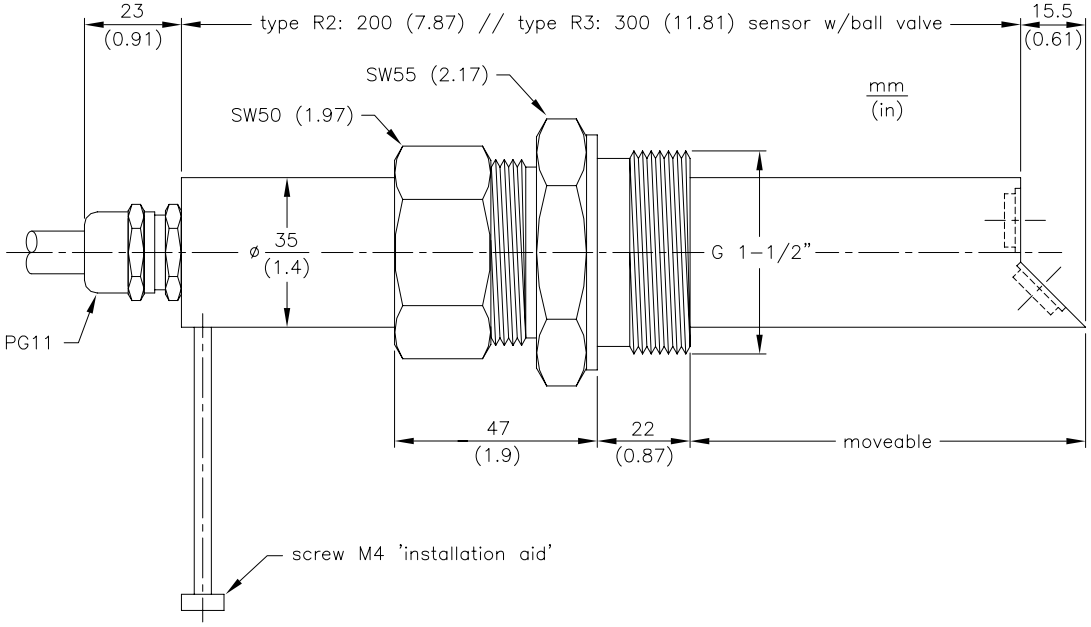


Figure 6-17 Pipe insertion sensor dimensions

When using a pipe insertion sensor with simultaneous ultrasonic depth detection from bottom up, please install the sensor perpendicular to the flow surface and no more than ±2 ° from the bottom center of the pipe. Improper installation could produce erroneous depth measurements under high depth and high flow velocity conditions.

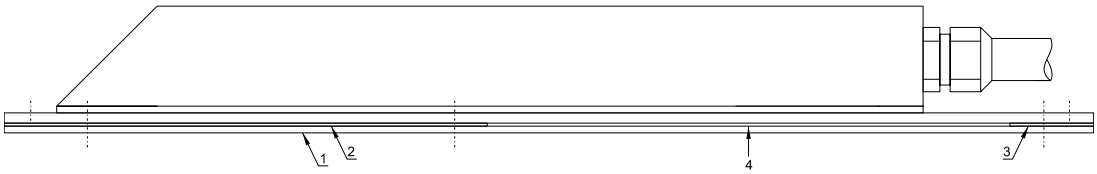
When assembling the pipe insertion sensor, use a special grease for the stainless steel couplings (DIN 2353, or equivalent). Apply a small amount of grease to the cap nut thread, threads, cone, and cutting ring during pre-assembly. The screw joints come pre-greased from the manufacturer. Purchase additional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

1	Cutting ring inside and outside
2	Thread
3	Inner cone
4	Inner thread of spigot nut

Figure 6-18 Greasing parts

Air-Ultrasonic Sensors

Install the air-ultrasonic sensor with clamping using an pipe mounting system. To install the sensor using this mounting system, run the mounting sheet located in the pipe vertex (crown) through the cut-out (Item 4 on Figure 6-19) in the air-ultrasonic sensor prior to final assembly.



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

Figure 6-19 Installing the air-ultrasonic sensor using the pipe mounting system

Before clamping the system into the pipe, adjust the sensor so that it is completely parallel to the water surface. When installing an air-ultrasonic sensor and combi sensor measuring flow velocity together, locate the air-ultrasonic sensor upstream at least 4 inches (10 cm) ahead of the combi sensor at the bottom.

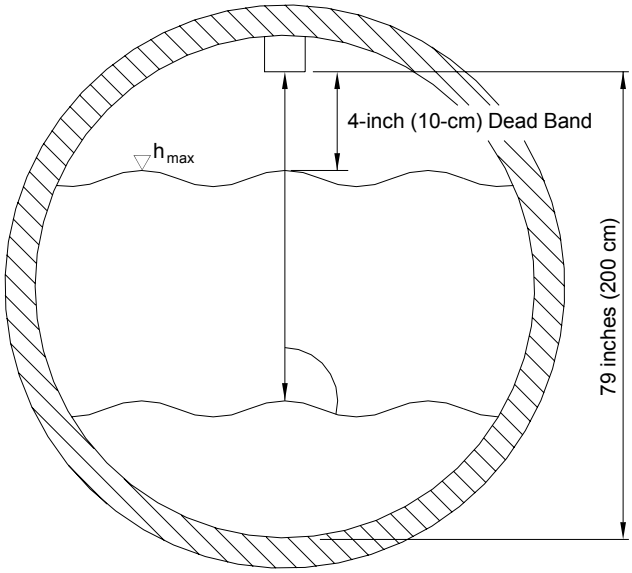


Figure 6-20 Installing the air-ultrasonic sensor

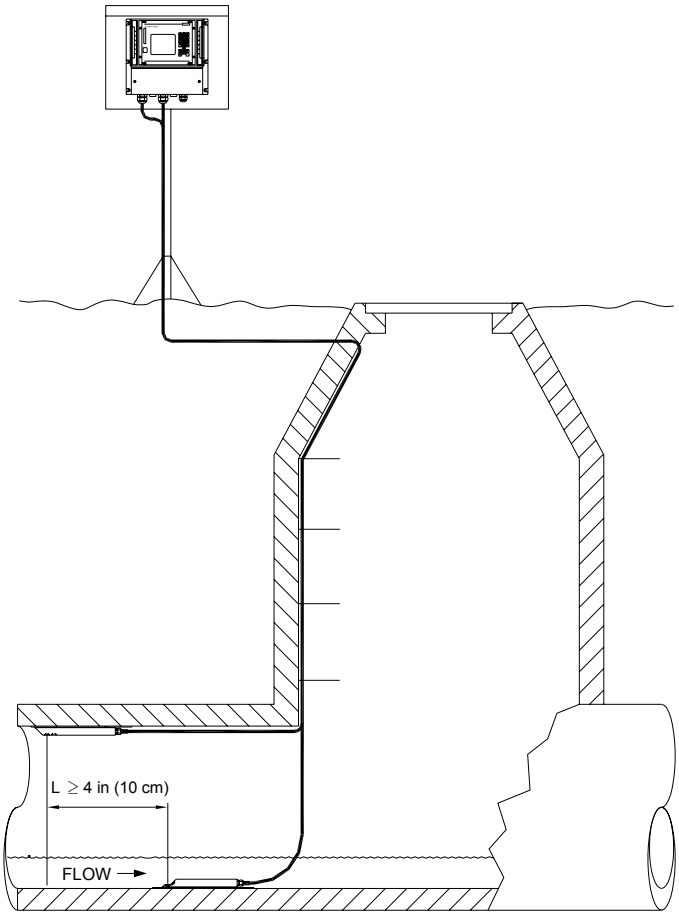


Figure 6-21 Mounting example

For a permanent installation, secure the air-ultrasonic sensor to the top of the pipe with 3 stainless steel screws (M5) and corresponding dowels (Figure 6-22).

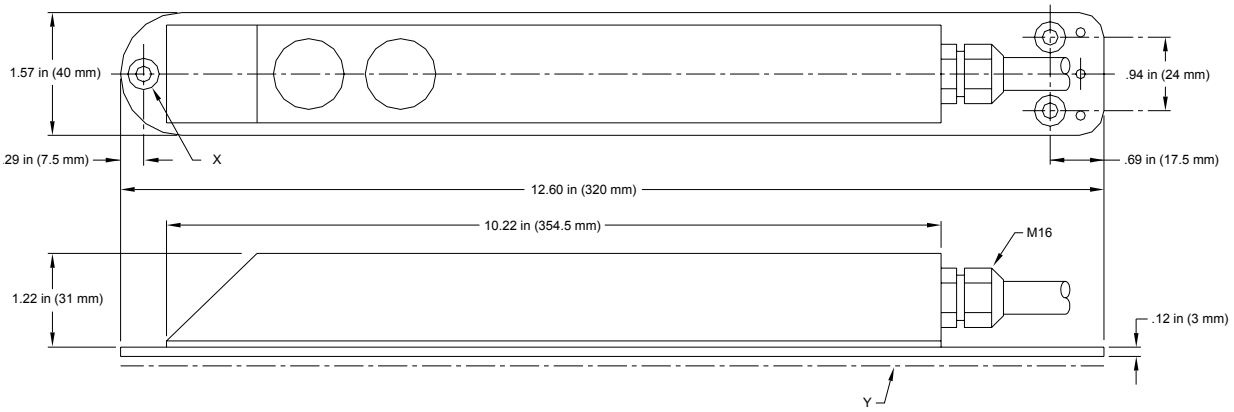


Figure 6-22 Air-ultrasonic sensor dimensions (X represents countersunk holes DIN 74 - A M5 for direct fastening; Y represents the three adapter plates required for fastening to the pipe mounting system.)

The air-ultrasonic sensor has a 4-inch (10 cm) deadband and, therefore, cannot measure depths within this range.

If depths occur within this deadband, the FlowShark Pulse will indicate a fixed distance of 4 inches (10 cm) below the air-ultrasonic sensor, producing erroneous flow quantity measurements.

If the air-ultrasonic 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 sensor. Instead, configure the equipment to obtain depth readings within this range from the pressure sensor.

Sensor Connection

A sensor with an integrated pressure cell has a Type LIY11Y 2x1.5 mm² + 1x2x0.34 mm² + PA 1.5/2.5 custom cable.

Sensors without a pressure measurement cell have Type LIY11Y 2x1.5 mm² + 1x2x0.34 mm² cables. These sensors can be extended with single-shielded signal extension cables without modification.

ADS recommends Type A2Y(L)Y 6x2x0.8 cables (*or equivalent cable types*) or a higher number of wires using 2 wires for bus communication. The remaining wires must be connected in parallel as 2 complete wires for the power supply.

The maximum fixed cable length permitted between the flow velocity sensor and the transmitter is 450 feet (150 m). A cable length of up to 750 feet (250 m) may be used if a flow velocity sensor with a 90-foot (30-m) fixed cable is used in conjunction with a connection box and a signal extension cable with a larger cross-sectional area.

The maximum cable length for an LUS air-ultrasonic sensor is 328 feet (100 m). This sensor cable may not be extended.

The signal cable attached to the sensor is not designed for underground burial for an extended period of time without protection. When burying signal cables in soil, concrete, or other comparable materials, first run the cable through conduit for protection. Consider cable removal and replacement when selecting the inner diameter, bending radius, and layout of protective pipes and hoses.

When extending the sensor cables, please note that the total resistance of the power supply lines must not exceed:

- *2.100 Ohm for sensors with 30-foot (10-m) fixed cables*
- *1.850 Ohm for sensors with 60-foot (20-m) fixed cables*
- *1.600 Ohm for sensors with 90-foot (30-m) fixed cables*

(Specification corresponds to feed + return wires!)

Longer cable lengths may be used under certain circumstances involving special cross-sectional cable areas. Please contact ADS for specific guidance.

Do not use common extensions for different installations or a common signal cable to extend separate depth and flow velocity sensors.

For sensors with a pressure measurement cell (Types 3K and 4K, the maximum uninterrupted cable length is 90 feet (30 m). For cable extensions, install a connection box with a pressure compensation element (Figure 6-23). This pressure compensation element, available through ADS, must be installed even if the cable of a sensor with an integrated pressure measurement cell is connected directly to the transmitter.

Operating sensors with an integrated pressure measurement cell for a long period without a pressure compensation element may lead to irreversible damage to the sensor electronics.

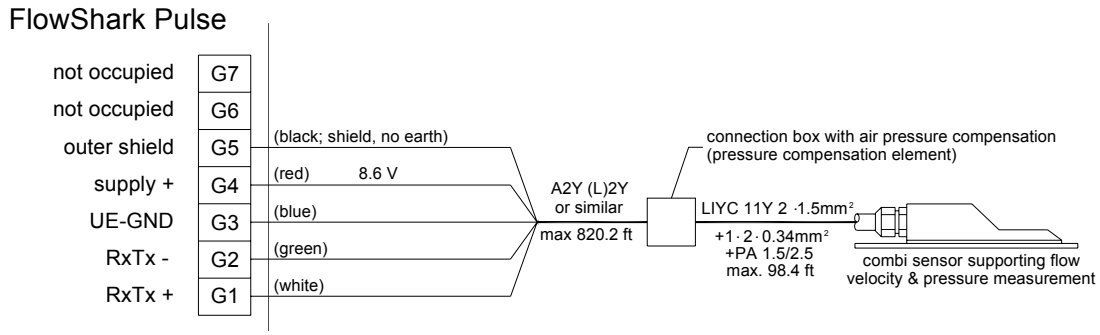
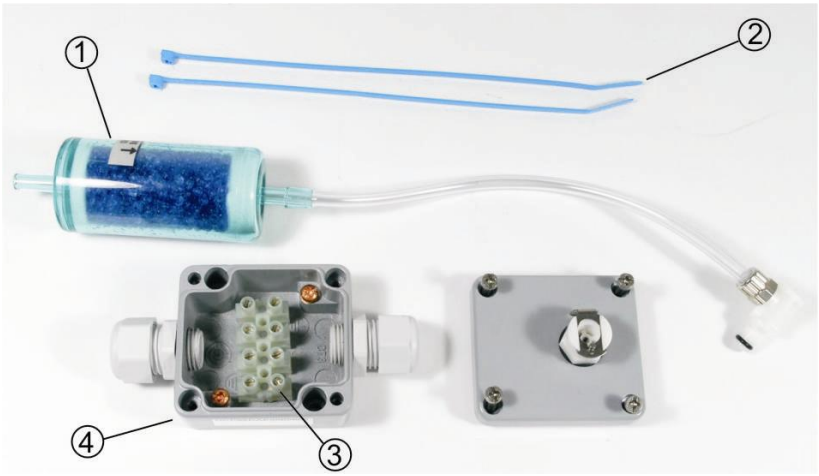


Figure 6-23 Connecting a sensor with pressure measurement cell

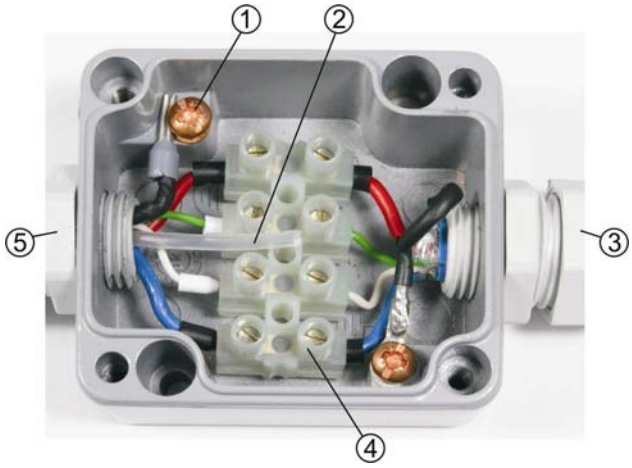
The pressure compensation element supplied by ADS consists of a filter element with an air hose and air plug, metal connection box (including terminal clamps and cable glands), connection box lid (including integrated, self-locking socket for the air hose plug), and 2 cable clips (Figure 6-24).



1	Filter element with air hose and air plug
2	Cable clips
3	Terminal clamps
4	Connection box

Figure 6-24 Components of air compensation element

Connect the 5-wire cable coming from the combi sensor to the terminal clamp strip in the connection box, with each individual wire connecting to a separate terminal clamp. For this application, connect only the power supply wires (red + blue) and the signal bus lines (white + green) to the terminal clamp strip. Connect the cable shield (black) to one of the shield connection screws in the box (Figure 6-25).



1	Shield connection screws
2	Air hose
3	Transmitter side
4	Terminal clamps
5	Flow velocity sensor side

Figure 6-25 Open connection box

Run an extension between the connection box and the transmitter using A2Y or similar appropriately shielded signal cables. After connecting the cables, secure the air filter onto one of the cables with the cable clips so that the opening of the filter element faces downward. Snap the air hose plug into the socket on the lid of the box lid, and then screw the lid onto the box.

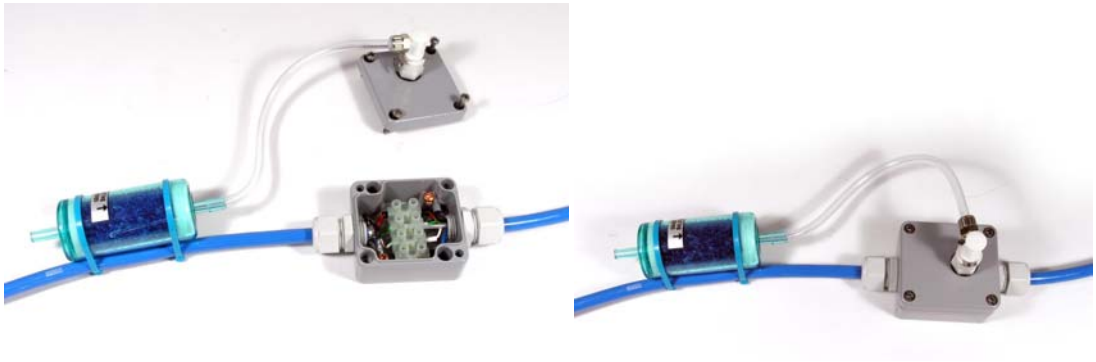


Figure 6-26 Assembled pressure compensation element

Install the connection box in an area with reliable flood protection.

Never operate the pressure compensation element with the air hose unplugged. The automatic self-locking mechanism of the integrated socket will shift the zero point for the depth measurement.

The opening of the filter element must always face downward.

Be sure to connect the feed and return cable shields to the shield connections on the metal connection box.

When necessary, extend sensors with the 30-foot (10-m) fixed cable using A2Y(L)2Y with "X" • 2 • 0,8 alternatively. X represents the number of wire pairs, depending on length of the line. Leave 15 percent of the wire for reserve.

Use a single wire to extend each signal line (RxTx).

To extend the power supply UE and earth UE-GND, use one or more parallel connected wires per line, depending on the distance.

The following table lists the minimum number of wires per connection. Two required: 1x for UE + *and* 1x for UE-GND.

Extension to	Minimum number of wires required for power supply and ground*	Total number of wires required for extension (no reserves)
98 feet (30 m)	1 UE+/1 UE-GND	4
164 feet (50 m)	1 UE+/1 UE-GND	4
230 feet (70 m)	2 UE+/2 UE-GND	6
328 feet (100 m)	2 UE+/2 UE-GND	6
492 feet (150 m)	3 UE+/3 UE-GND	8
656 feet (200 m)	4 UE+/4 UE-GND	10
820 feet (250 m)	5 UE+/5 UE-GND	12
984 feet (300 m)	6 UE+/6 UE-GND (consult ADS)	14
1312 feet (400 m)	8 UE+/8 UE-GND (consult ADS)	18
1640 feet (500 m)	10 UE+/10 UE-GND (consult ADS)	22

**Solder the parallel wires for UE + and GND together based on the supply line.*

Equivalent extension cables with other cross-sectional areas are available upon request.

Connection boxes used to extend cables must be metal. Always connect the feed and return cable shields to the shield connections on the metal connection box.

Establishing improper connections that create higher transition resistance or using other cables may lead to signal disruptions and erroneous measurements.

Connect the sensor cable to the transmitter at the termination block. Refer to the following diagram to connect a flow velocity or water-ultrasonic combi sensor:

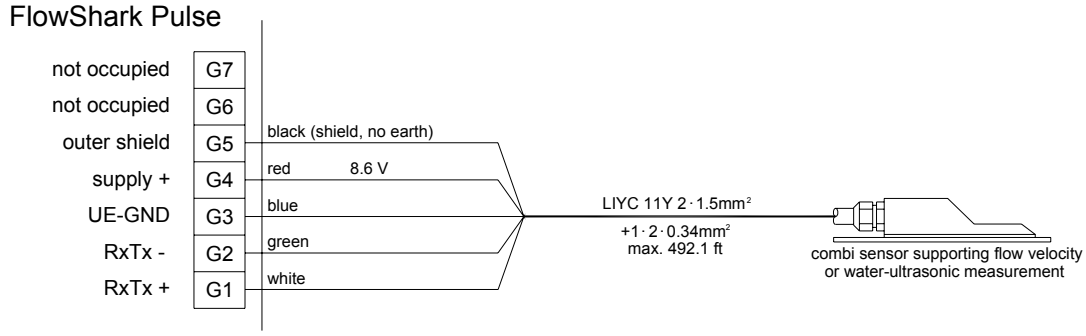


Figure 6-27 Connecting a combi sensor supporting flow velocity or water-ultrasonic

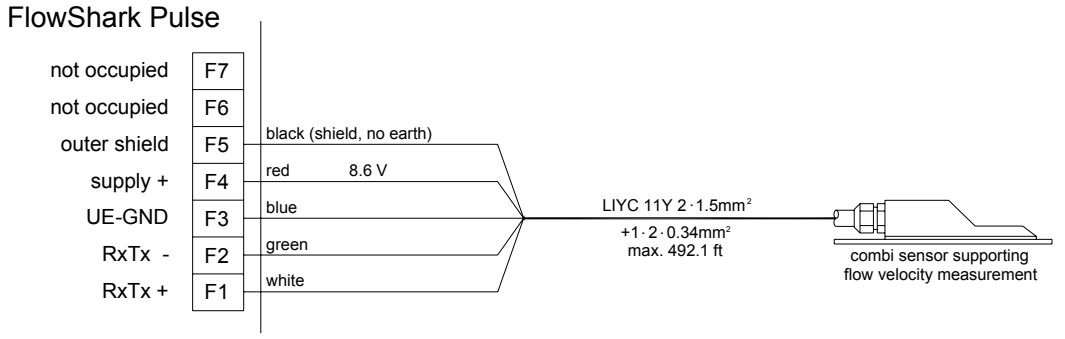


Figure 6-28 Connecting a second velocity sensor to the FlowShark Pulse Model 20

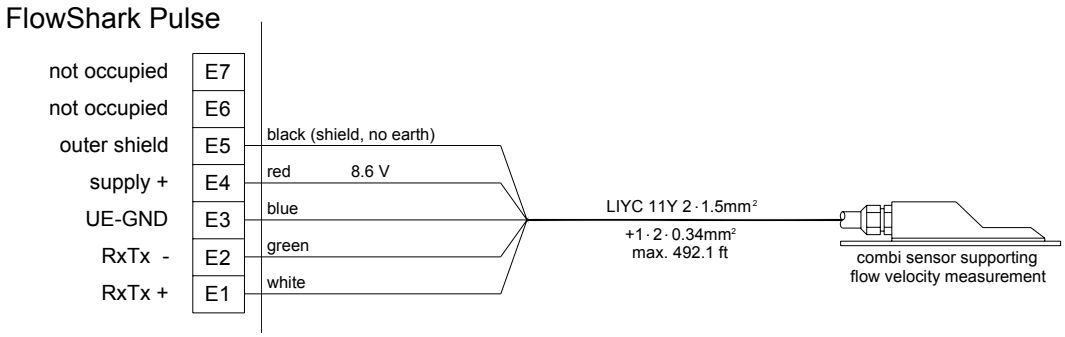


Figure 6-29 Connecting a third velocity sensor to the FlowShark Pulse Model 20

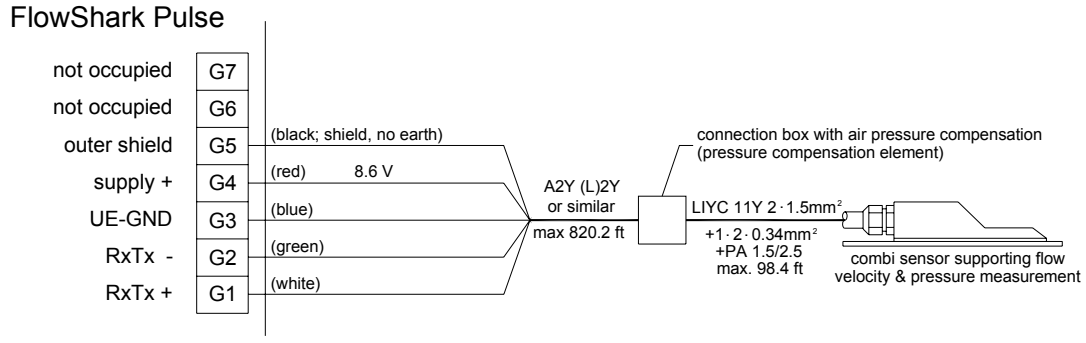


Figure 6-30 Connecting a flow velocity sensor with an integrated pressure measurement cell

The pressure compensation element also serves as a connection socket for the cable extension. Run no more than 750 feet (250 m) of cable between the sensor and transmitter to avoid exceeding the maximum permissible resistance.

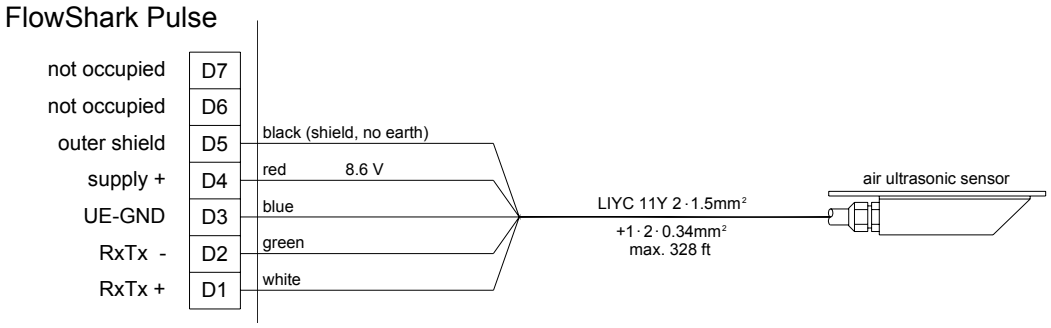


Figure 6-31 Connecting an air-ultrasonic sensor

Refer to the following wiring diagram to perform depth measurements using a 2-wire probe provided by a reputable supplier:

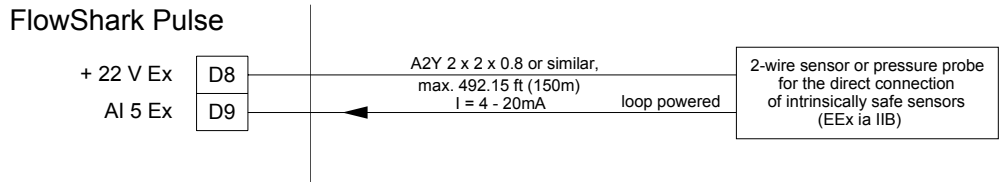


Figure 6-32 Connecting an external 2-wire sensor (Ex) for flow depth measurement

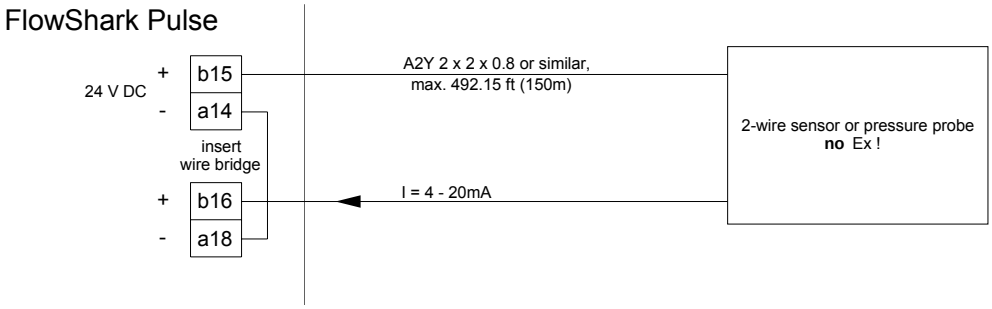


Figure 6-33 Connecting an external 2-wire sensor (non-Ex) for flow depth measurement

If an external transmitter provides the mA signal for depth measurement, connect to the clamps in the following way:

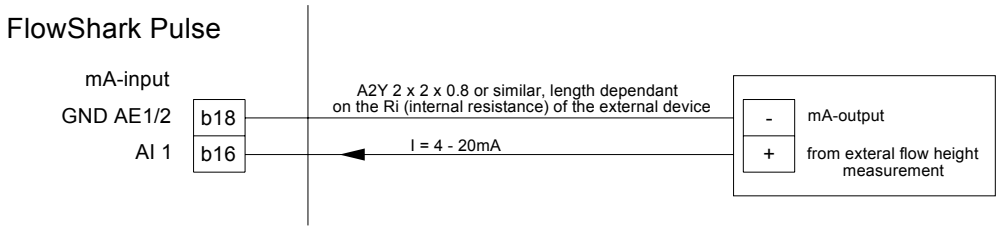


Figure 6-34 Connecting an external transmitter for flow depth measurement

When using sensors in an Ex-area, do not run the sensor cables past the mechanical shield between the termination blocks. Use only the 3 cable connections on the sensor connection block!

FlowShark Pulse Power Supply

FlowShark Pulse models are equipped to operate using either 85-260V AC (alternating current) or 24 V DC (direct current) power. Two **on/off** slide switches exist above the terminals. The **24V** switch (Figure 6-35) powers up or down the auxillary 24-volt DC output and powers down 24-volt DC input.

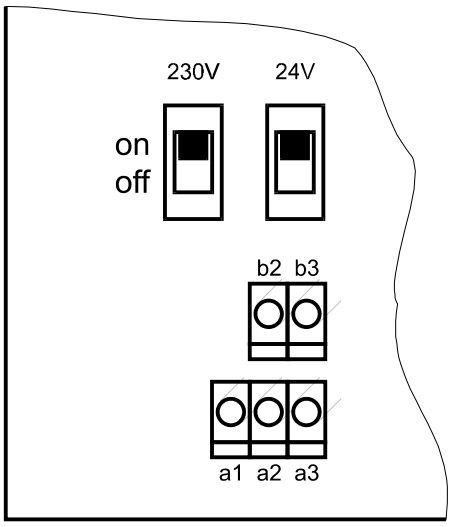


Figure 6-35 Slide switch position on the bus board

A 24 V DC transmitter cannot be operated with alternating current; a 230 V AC transmitter cannot be operated with direct current.

Before connecting a power source to the unit, move the 230V and 24V switches to the **off** position. For AC power, wire the 120 V circuit to L1, N, and PE (Figure 6-36). For 24V DC power, wire to terminals b2 (+) and b3 (–), as shown in Figure 6-37. If the unit is AC-powered, 24V DC auxillary power is available, as shown in Figure 6-36 (24V DC, 100 mA maximum).

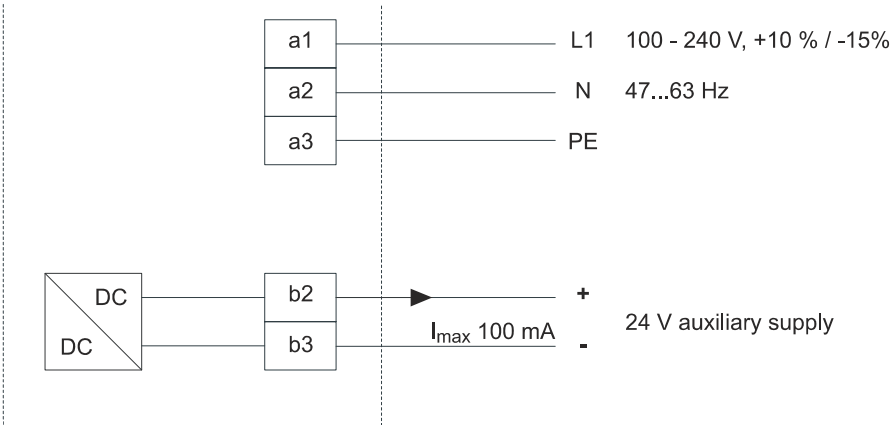


Figure 6-36 AC model power supply

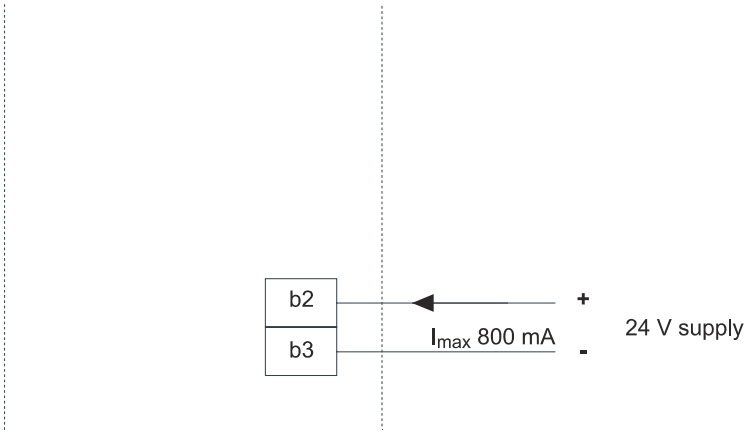


Figure 6-37 DC model power supply

Overvoltage Protection Precautions

To adequately protect the FlowShark Pulse transmitter, the power supply and mA-output must have protection. ADS recommends EnerPro 220Tr, EnerPro 24Tr surge arrestors (for 24 V DC) for the mains supply and the DataPro 2x1 24/24Tr for mA-outputs.

The flow velocity sensor and the LUS air-ultrasonic sensor have internal protection against overvoltage. Provide protection against higher voltages using the DataPro 2x1 24/24 Tr and DataPro 2x1 12/12 –0.3 Tr(N).

Using overvoltage protection elements reduces the maximum allowable cable length.

DataPro 2x1 12/12 –0.3 Tr(N) overvoltage protection will consume up to 300 mV. The line resistance is 0.3 Ohm/wire. This resistance must be taken into account with the total allowable resistance (refer to Sensor Connection on page 6-17).

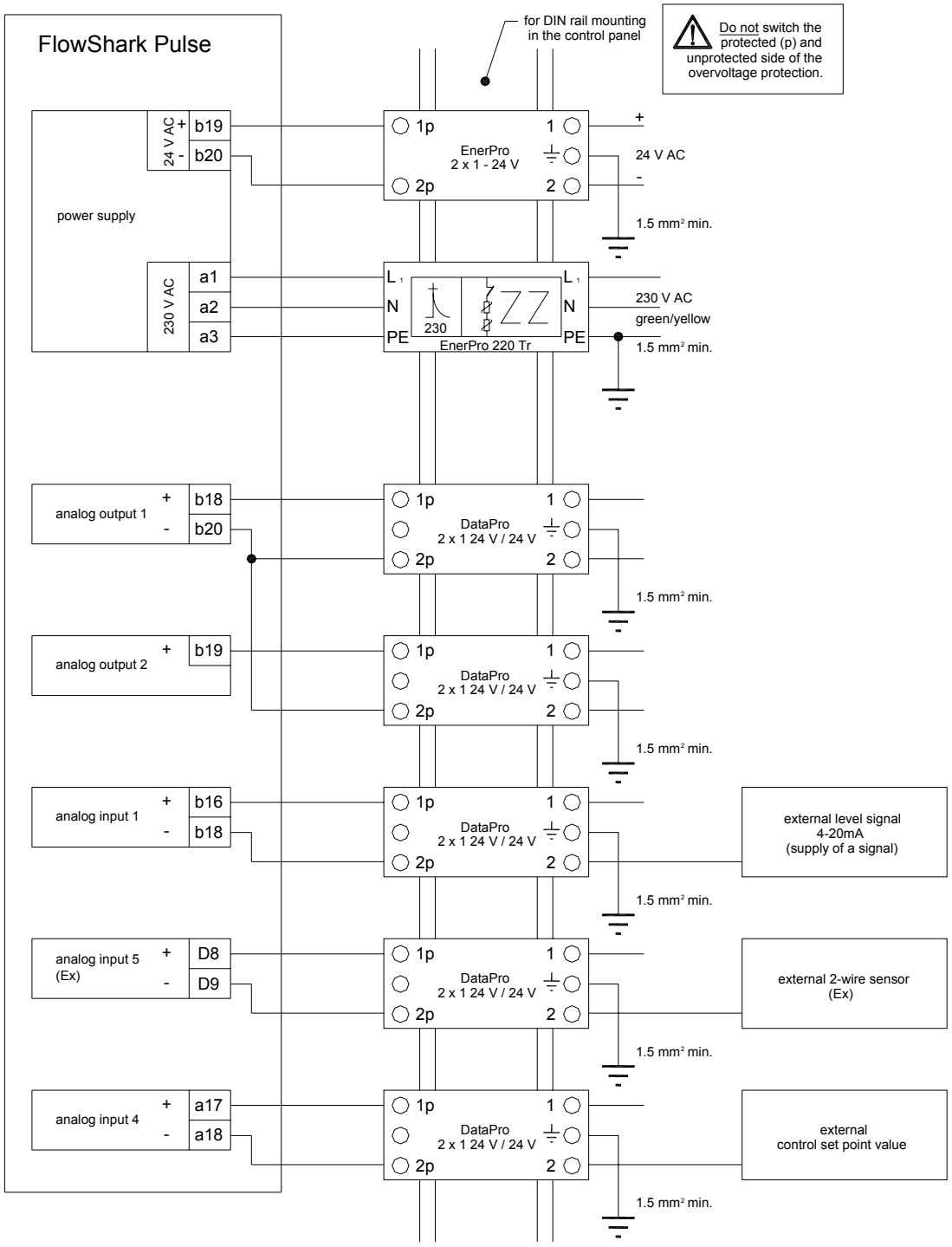


Figure 6-38 Connecting the overvoltage protection for the power supply and analog inputs and outputs

Please observe the non-reversed connection of the DataPro (p-side to transmitter) and a correct, straight wiring supply. Ground (earth) must lead to the unprotected side.

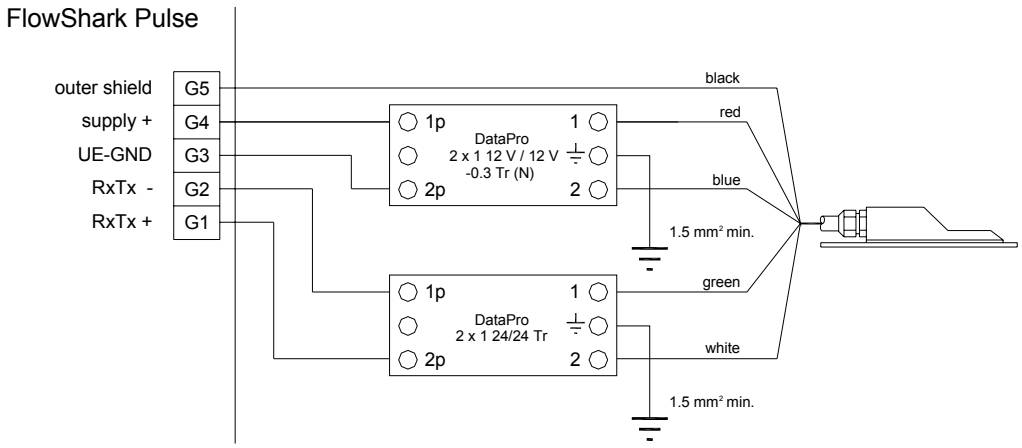


Figure 6-39 Overvoltage protection for the combi sensor supporting water-ultrasonic measurement

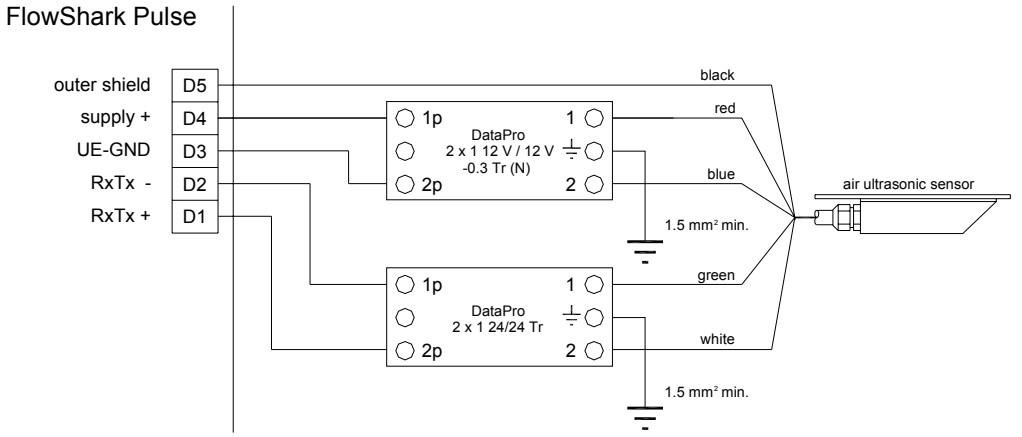


Figure 6-40 Overvoltage protection for the air-ultrasonic sensor

Please observe the non-reversed connection of the DataPro (p-side to transmitter) and a correct, straight wiring supply. Ground (earth) must lead to the unprotected side.

Please note that incorrect wiring will deactivate the overvoltage protection function.

Regulator Mode

General

A FlowShark Pulse Model 20 is required for managing flow volume, which is controlled automatically by the transmitter. The FlowShark Pulse Model 10 has neither an external setpoint input nor the two digital outputs to drive the regulator slide valve or digital inputs required for slide valve administration. Therefore, when operating a Model 10, please use an appropriate external controller and program it according to the manufacturer's specifications.

Typically, sluice gate valves, knife gate valves, or iris gate valves are used with an electrically driven three-step controller. Analog-driven slide valves cannot be used. ADS recommends selecting gate valves based on the following regulating intervals (i.e., the time elapsed between a completely open valve and completely closed valve):

</= 300 mm (11.8 in) diameter: minimum 60 seconds

</= 500 mm (19.7 in) diameter: minimum 120 seconds

</= 800 mm (31.5 in) diameter: minimum 240 seconds

</= 1000 mm (39.4 in) diameter: minimum

For proper operation and error monitoring of the slide valve, the Way-End-Switches must turn **OFF** and **ON** and the torque switches must turn **ON**. These signals must be connected to the digital inputs of the FlowShark Pulse. Please use gold-plated contacts to ensure contact reliability. Connect a signal relay between the switches and the FlowShark Pulse digital input to safely conduct the 10 mA input current.

Analog position feedback to the FlowShark Pulse is not intentional.

The FlowShark Pulse operates as a three-step controller with surge detection, quick-close control, slide valve monitoring, and automatic flush function.

Digital inputs 4 and 5 are designated, by default, to drive the regulating unit. Digital output 4 represents **slide valve closed**, and digital output 5 represents **slide valve open**.

Modifying the assignment of the digital outputs is not permitted.

The input current for the digital inputs of the FlowShark Pulse is 10 mA. Ensure contact reliability by selecting appropriate contact materials for the end switch of the controlled slide valve.

Setting up the Measurement Location

If possible, install the measurement device in front of the regulating unit. This setup may not acknowledge or consider the response time of the control system. However, it does prevent or minimize hydraulic disturbances from external vortices downstream of the regulating unit.

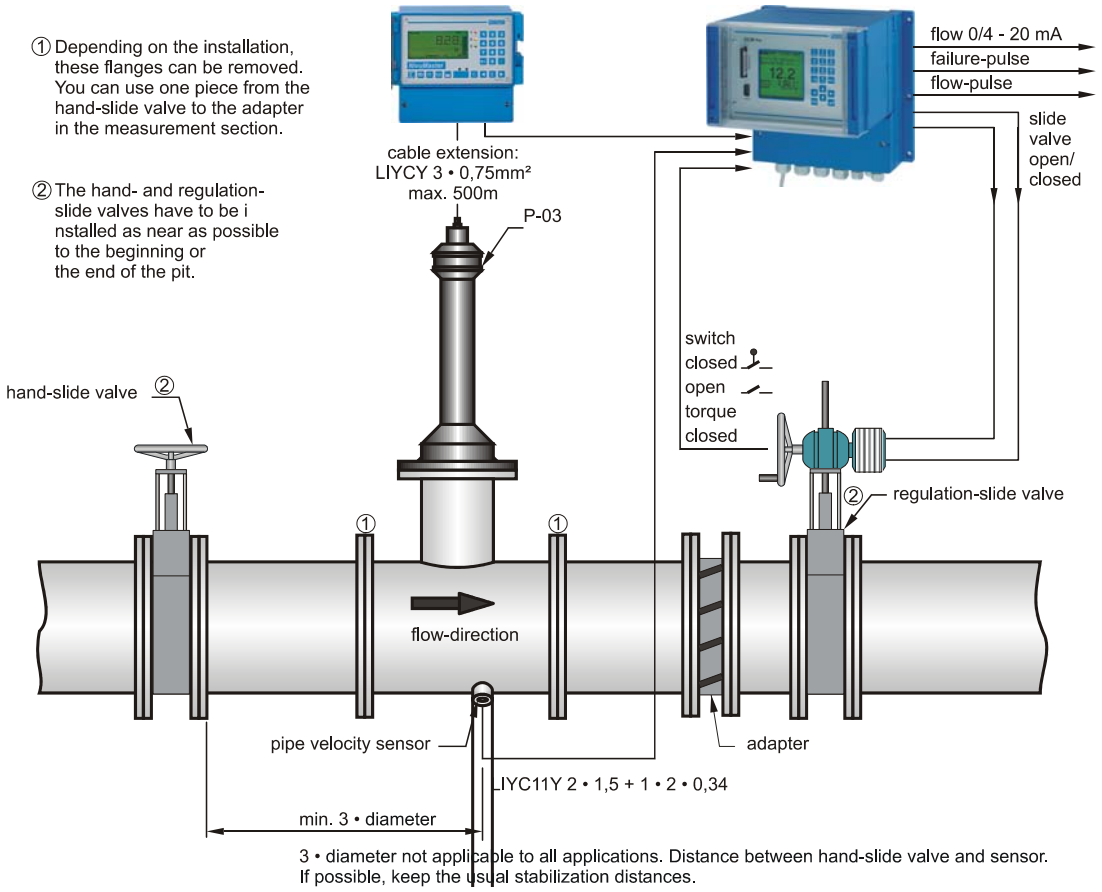


Figure 6-41 Setting up a controlled system, such as a discharge control

If this installation configuration is not possible, install the measurement device downstream of the slide valve a distance of at least 12 times the maximum pipe height (Figure 6-42). In addition, inspect the hydraulic conditions at the location before installing the equipment. To ensure suitable measurement conditions, establish an adequate distance or implement appropriate calming measures (such as deflectors or similar devices) between the gate valve and the measurement location downstream.

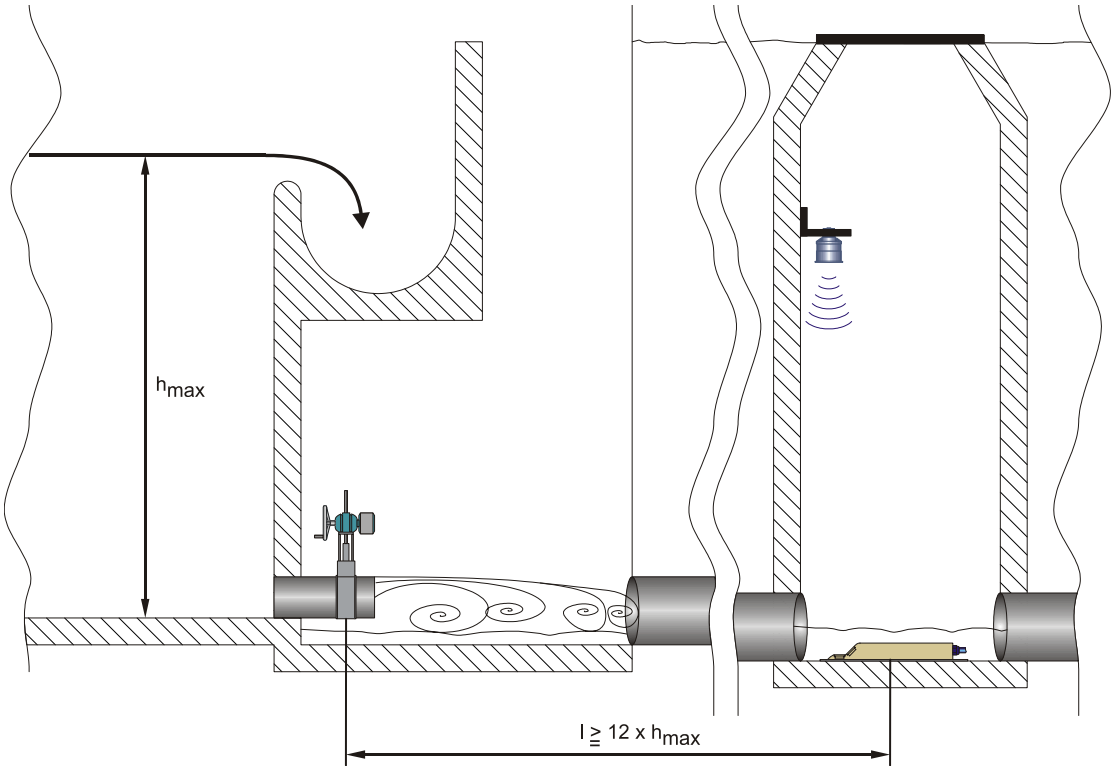


Figure 6-42 Setting up measurement to occur behind the slide valve

Please note that extended run times delay feedback from measurement and control. Therefore, program the control to respond slowly.

If maintaining a minimum distance is not possible, install flow calming elements, such as rebounding surfaces or returns. Custom design these installations according to the specific application and contact ADS for guidance.

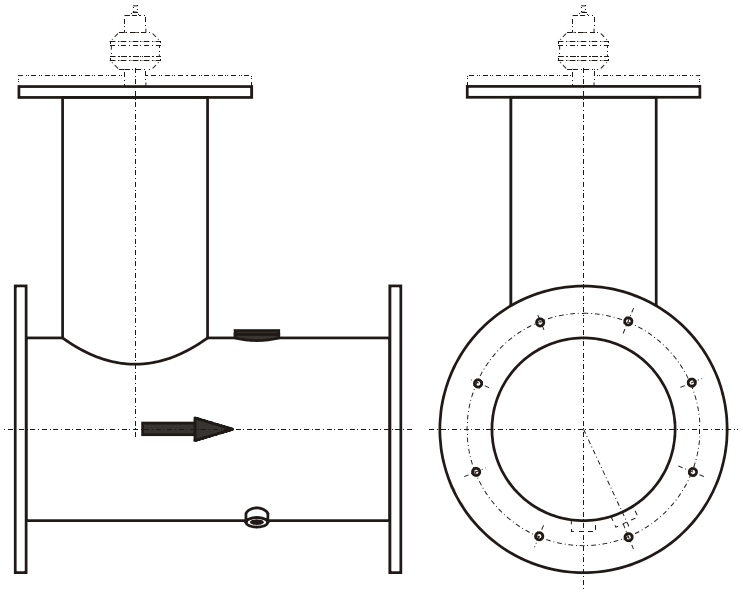


Figure 6-43 Pipe measuring section

Additional Information Concerning Control Systems

Determine the distance between the flow velocity sensor and the corresponding control slide valve based on the default flow value, nominal diameter, and preliminary pressure. This distance should be at least 3 times the internal diameter of the pipe; however, a distance of up to 5 times the internal diameter is preferable, when possible.

Flow velocities in the control distance should not fall below 0.98 feet per second (30cm/s) under typical flow conditions to ensure adequate detection.

When using an air-ultrasonic sensor, calculate the required dome height according to the maximum preliminary pressure.

Please note when using ADS air-ultrasonic sensors:

Minimum dome height [mm] =	350 mm (13.78 inches) + **x** • 40 mm (1.57 inches)
x =	maximum impound pressure in [m] upstream of control slide valve

The slide valve should have exactly the same inside diameter as the incoming and outgoing pipes. Always avoid hydraulic jumps, ledges, weld seams, rising flange densities, and other structures when choosing a measurement location.

Install pipe insertion sensors slightly off center when sludge and/or silt are present.

Measuring flow depth with the pipe insertion sensor is not possible when the sensor is not installed at the bottom center of the pipe.

Connection

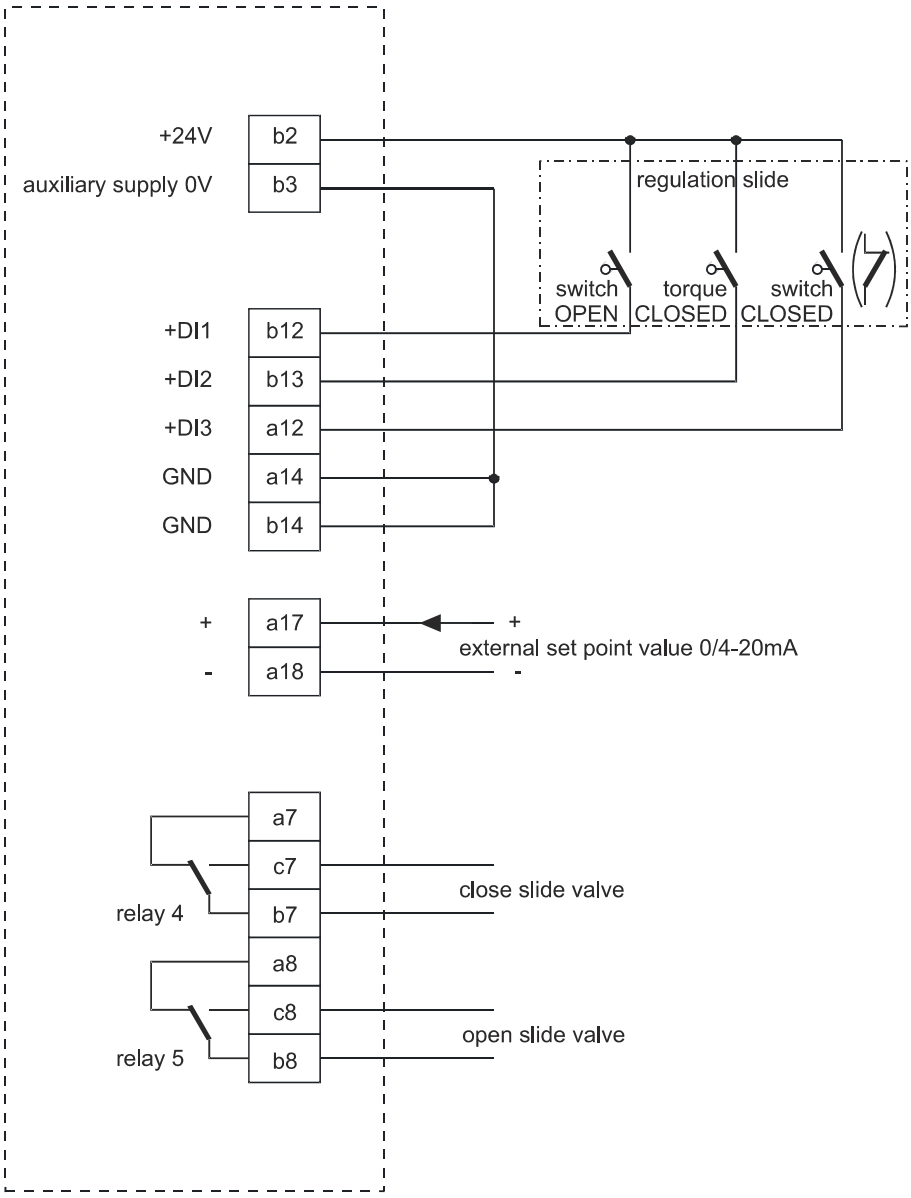


Figure 6-44 Wiring diagram for controller operation

Control Algorithm

Selecting the regulator function automatically sets relay 4 to for the **SLIDE VALVE CLOSED** function and relay 5 for the **SLIDE VALVE OPEN** function. This default assignment cannot be modified.

The digital inputs are programmable for providing position feedback. To ensure proper, reliable slide valve drive response, employ the **PATH OFF**, **PATH ON** and **TORQUE OFF** messages for the slide valve drive.

The input current per digital input is 10 mA.

*When driving the slide valves via the digital inputs, **always** use all three messages. Activating only one message may destabilize regulator operation.*

The regulator can operate with an external or internal setpoint. When using external setpoints, always route them to analog input 4.

When using a 4-20 mA signal as an external setpoint, monitor the signal for cable breaks and short circuits. If errors occur, the FlowShark Pulse will access the internal setpoint. Always set the internal setpoint when using external 4-20 mA setpoints and error monitoring.

The following equation can be used for the internal calculation for slide valve control time:

$$\text{control time} = (\text{setpoint} - \text{flow}_{\text{actual value}}) \bullet \text{P\_factor} \bullet \frac{\text{maximum slide valve runtime}}{\text{maximum flow}}$$

Communication

General

Access to the FlowShark Pulse is available, based on the following requirements:

- Corporate Intranet or TCP/IP network (i.e., Local Area Network (LAN))
- Current Internet Explorer browser (*not accessible through Firefox, Opera, or other browsers*)
- Java®

PCs and laptop computers require no special software or configuration. Once the FlowShark Pulse is configured and data transmission is set up, the unit is accessible from any location.

The FlowShark Pulse does not provide real-time access or automatic data transmission. Access to the FlowShark Pulse involves direct communication initiated by the user through a PC or laptop computer.

Data Communication

The following methods are available for data communication and setting remote parameters, depending on the model of transmitter:

- Ethernet
- External GSM/GPRS gateway

Obtaining remote access to the unit will require the user to incur certain communication costs corresponding to the equipment and usage. These costs may vary based on the Internet provider, time online, flat rate, and other contracts and agreements. ADS neither profits from nor influences these costs and/or fees.

The system administrator is responsible for anticipating and planning for immediate and ongoing communication expenses.

Communication Options

ADS offers several communications options for the FlowShark Pulse:

- Direct Ethernet connection between a PC/Laptop and the FlowShark Pulse using a cross-link cable

- Ethernet connection over a TCP/IP network connection through an Ethernet hub or switch (see Figure 6-45) using patch cables
- Network server connection via DHCP (Dynamic Host Configuration Protocol) and/or DNS (Domain Name Server) – See Figure 6-46.
- Remote communication through a GSM/GPRS communication device (gateway) – See Figure 6-47.

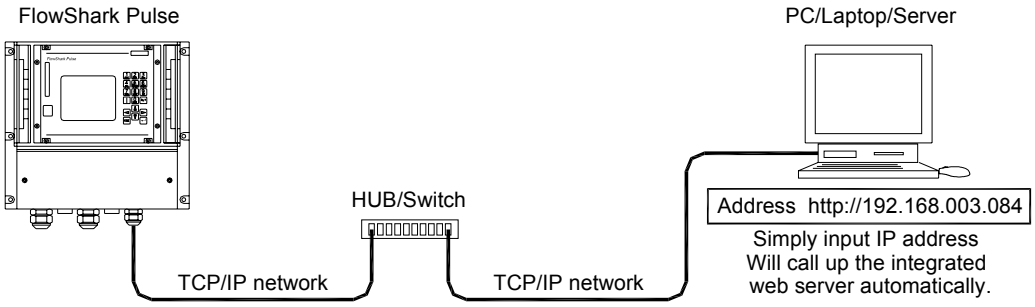


Figure 6-45 Communication without a server

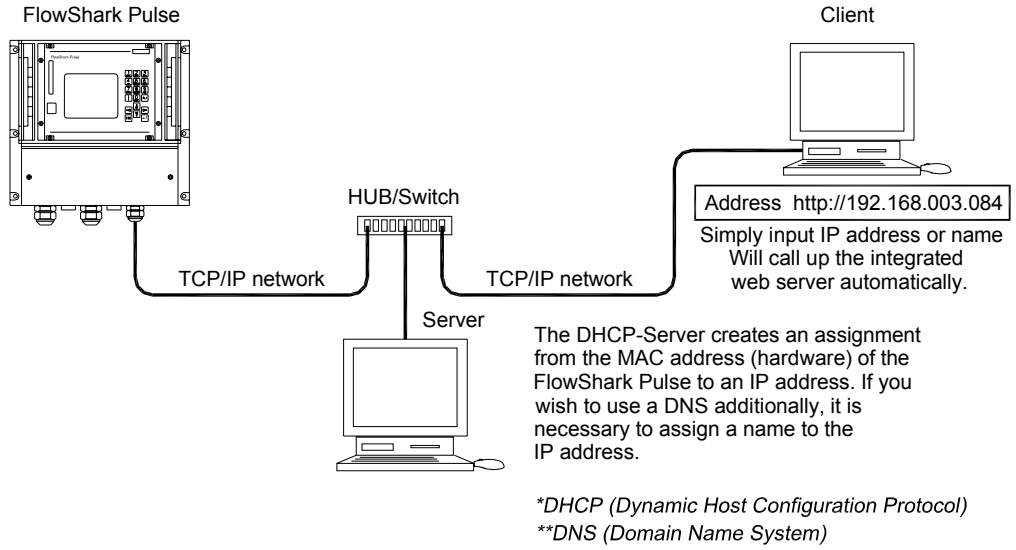


Figure 6-46 Communication with a server

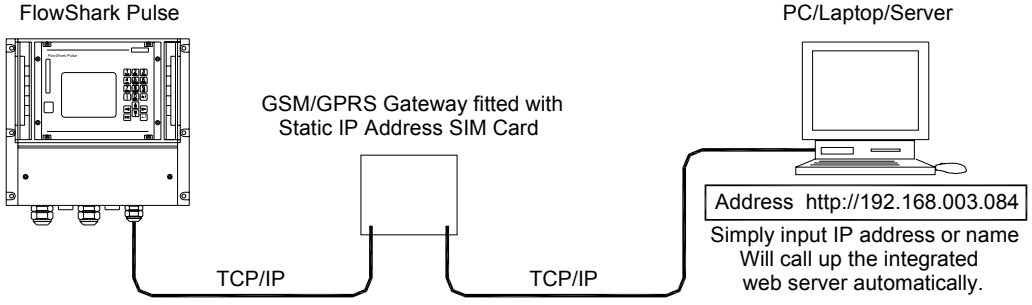


Figure 6-47 Communication through a GSM/GPRS gateway

CHAPTER 7

Initial Startup and Communication

After installing and connecting the FlowShark Pulse transmitter and sensors (refer to *Chapter 6, Installation*) and providing power to the unit, the user can communicate with the unit. The user interface on the FlowShark Pulse enables the user to easily set up basic and advanced settings on a graphic dialog to ensure reliable device operation. This interface includes a keypad on the transmitter and is also accessible through an Internet browser.

Communication with the transmitter through a browser can occur on-site or from a remote location. Direct communication requires only an Ethernet connection using a cross-link cable between the user's PC/laptop and the FlowShark Pulse. Remote access occurs over a TCP/IP network (LAN) or through an external GSM/GPRS gateway.

This chapter includes instructions on establishing communication with the FlowShark Pulse through an Internet brower, reading the display, and operating the keypad. Review this chapter carefully to become familiar with the display and keypad before configuring the device.

Establishing Communication Through a Browser

To establish communication with a FlowShark Pulse through an Internet browser, launch the browser from a PC or laptop computer and then enter the IP address for the transmitter. Once the connection has been established successfully, enter the proper username and password.

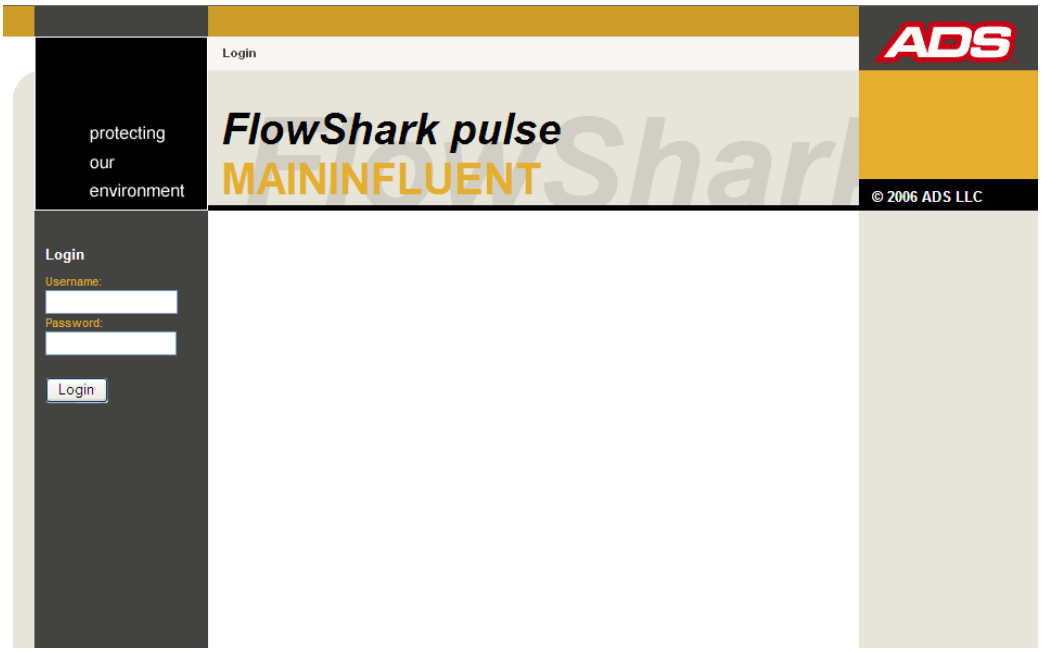


Figure 7-1 Login screen for FlowShark Pulse

Once the user is logged in, the current **Measurement Data** (flow rate, depth level, and flow velocity) displays on the right side of the screen.

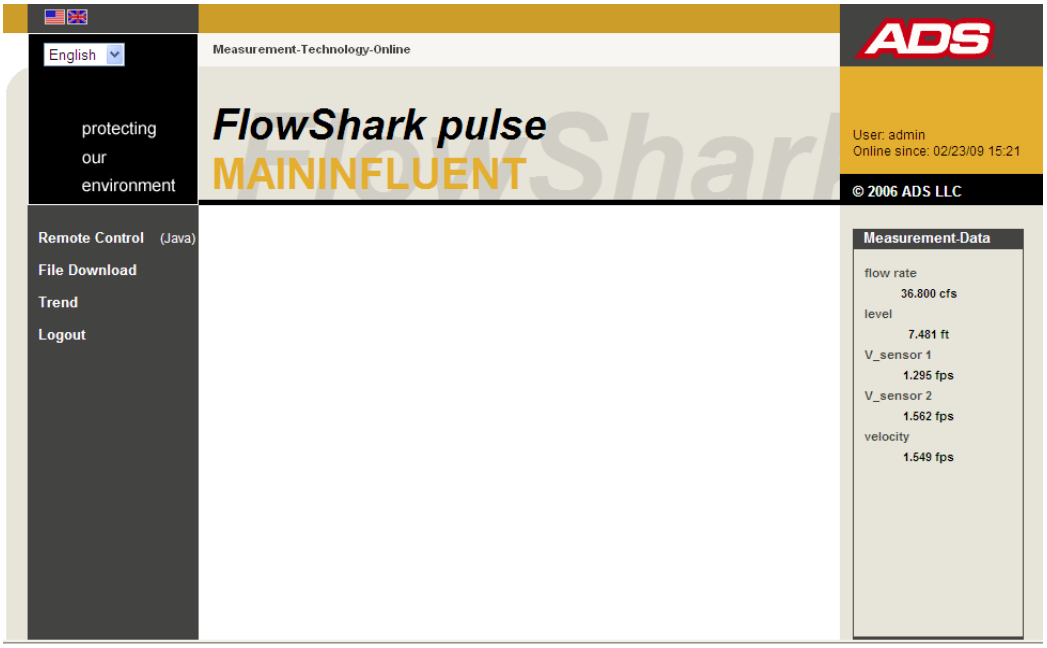


Figure 7-2 Static communication page

Setup the screen to automatically refresh these values at 2-, 5-, or 10-second intervals by selecting the desired interval from the drop-down list below the **Measurement Data** field.

Clicking the **Remote Control** button on the left side of the screen launches a Java™ applet. If the Java software is not installed on the PC, download it for free from the Java website by clicking the **Java** link (beside the **Remote Control** button).

The remote control function is not available if the free Java software is not installed on the user's PC or laptop computer.

Figure 7-3 Launching the Java® Applet

After successfully launching Java™, the FlowShark Pulse screen displays.

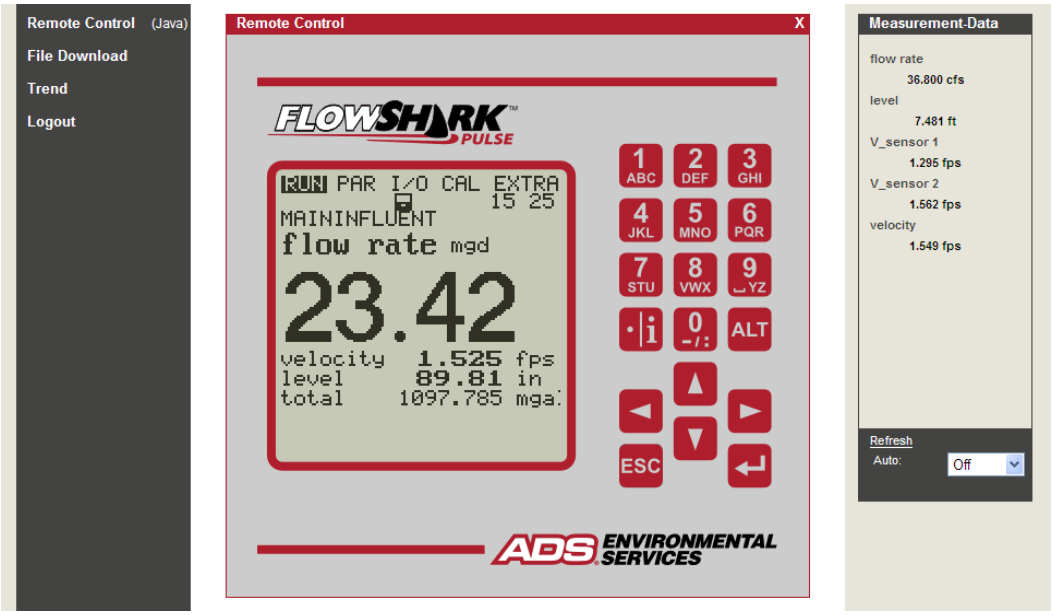


Figure 7-4 Viewing the connection online

The user can now operate the FlowShark Pulse via the PC or laptop computer keyboard (using the **left**, **right**, **up**, and **down** arrow keys and the **Enter**, **ESC** and **ALT** keys) as though the user were using the keys on the front of the unit. Another available method for operating the unit involves clicking the virtual keys on the screen using a mouse.

The user may experience delays in response due to the method of transmission. Therefore, ADS recommends avoiding quick, consecutive control entries. After

initiating a specific command, confirm visible execution and completion of the operation before proceeding to the next command.

Log off the unit by clicking on the **Logout** link on the left side of the screen.

Operator Keypad

The FlowShark Pulse has an 18-button keypad for setting parameters.

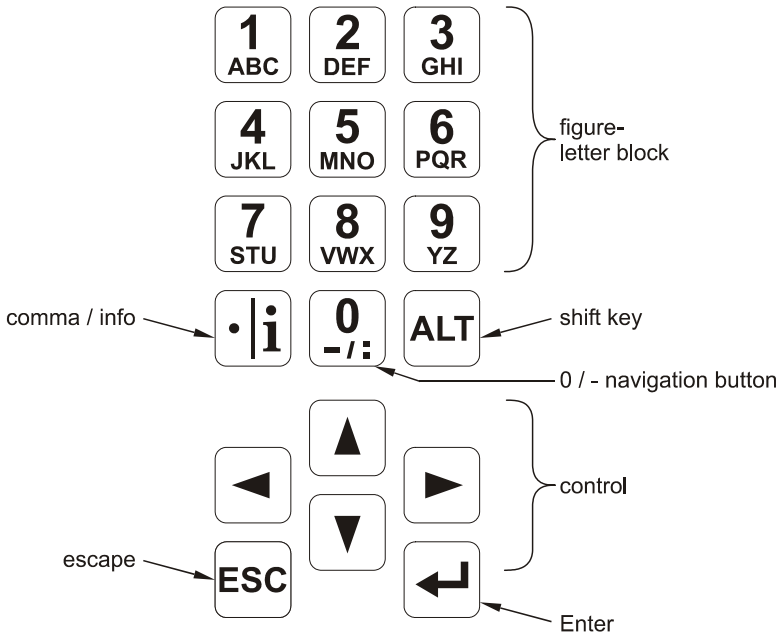


Figure 7-5 Operator panel

Display

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

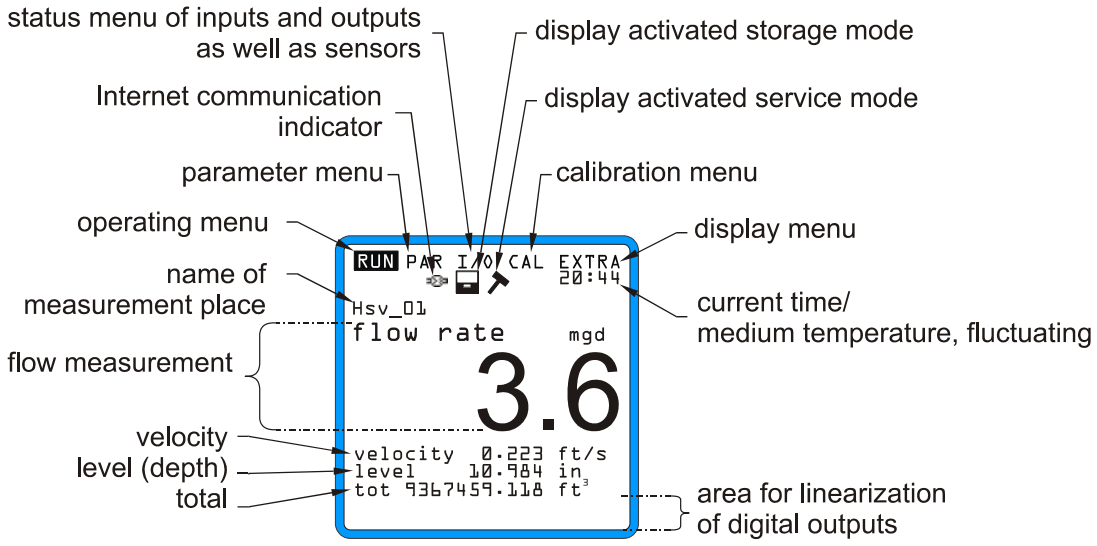


Figure 7-6 Display

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 the user 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 enabling the user to observe historical flow volume, flow depth, and average flow velocity.
- **PAR** This is the most extensive menu on the FlowShark Pulse. It exists for setting the parameters for the measurement location, sensors, analog and digital inputs and outputs, data storage and transmission, and regulator function.
- **I/O** This menu provides information concerning the internal operation of the FlowShark Pulse. It allows the user to view all current readings, including the values of analog and digital outputs and relays. It also displays sensor echoes and individual velocity readings. In addition, it enables the user to determine the memory remaining on the optional memory card as well as the time remaining on the card (based on the cycle time).
- **CAL** This menu allows the user to calibrate flow depth offsets, set additional velocity parameters, and simulate analog and digital outputs.
- **EXTRA** This sub-menu enables the user to modify the basic display settings: contrast, lighting, language, units, system times, and totalizer presets.

Operation Basics

The FlowShark Pulse has a user-friendly interface and is completely menu driven. Use the control keys to navigate through the menu (refer to *Chapter 8, 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 selected submenu and open inputs and drop-down lists. This button also exists for confirming data entries.

ESC Use this button to exit submenus or cancel data entered.

1 ABC – 9 YZ Use these buttons to set parameters and to enter numbers and text (such as the name of a measurement location). Entering text on the 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. The cursor will automatically jump to the next digit if a button is not pressed within 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, sensor firmware version, and transmitter serial numbers. It also functions to resume communication between the transmitter and the flow velocity sensor or air-ultrasonic sensor.

ALT Use this button to alternate between uppercase and lowercase letters in text entry mode. It also is useful for removing and adding data. When setting parameters, this button can be used to enable or disable various functions and to SHIFT-key between various programming options.

CHAPTER 8

Parameter Settings

After installing and connecting the FlowShark Pulse transmitter and sensors (refer to *Chapter 6, Installation*), hooking up the power supply, and establishing initial communication with the transmitter, set the configuration parameters for the system. Standard applications typically require the user to input or modify only a few basic settings:

- Geometry and dimensions of the measurement location
- Sensors in use and positioning
- Display units
- Span and function of analog and digital outputs

A standard application reflects the following conditions and equipment:

- Partially-filled, standard pipe
- Combi sensor installed at the bottom of the pipe for measuring flow depth and velocity (ignoring values above or below the minimum and maximum detectable depth levels)
- Presence of silt that requires a vertical sensor offset
- 1x mA output for flow rate and 1x impulse output (e.g., to a sampler)

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 FlowShark Pulse.

Quick Start Guide for Setting Parameters

Set the following parameters for a standard installation using the FlowShark Pulse menu:

1. **EXTRA > Units** Select the units of measure for flow rate (mgd), velocity (ft/s), depth/height (ft), and total (ft^3) (units in brackets reflect the default settings).
2. **PAR > Measurement place > Channel profile** Select the profile of the pipe or channel.
3. **PAR > Measurement place > Channel dimensions** Enter the dimensions of the channel or pipe.
4. **EXTRA > Display** Adjust the brightness and contrast for the display, if necessary.
5. **EXTRA > System time** Adjust the time, if necessary.

Additional Settings

6. **PAR > Measurement place > Name** Enter the name of the measurement location.
7. **PAR > analog outputs > Function** Enable analog output 1 (flow).
8. **PAR > analog outputs > output span** Select the output range (e.g., 4 – 20 mA).
9. **PAR > analog outputs > measurement span** Select the specific entity measurement range (e.g., 0 – 20 mgd).
10. **PAR > analog outputs > error mode** Designate the default depth value the analog output should report when a sensor error occurs.
11. **PAR > Relay outputs > Function** Enable relay 1 (select pos-total impulse).
12. **PAR > Relay outputs > Pulse parameter** Set the impulse value (e.g., volume of flow after which an impulse is triggered) and duration.

When finished setting the parameters, exit the parameter settings and save the settings by entering the following code number: **2718**.

Basics for Setting Parameters

The transmitter operates automatically using the existing settings until the user enters and accepts new input parameters. Once the user finishes entering all the new settings, the system will prompt the user whether to accept the new values.

Following confirmation, the user must enter the following code number.

2718 Type in 2718 if prompted.

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

If the user enters the wrong code three times, the system will abort the parameter mode and initiate operation based on the existing parameters. If the correct code is entered, the system will accept the modified parameters and reset. The reset will take approximately 20 to 30 seconds.

In addition to saving modified parameters or rejecting modifications (by clicking **No** at the end of the parameter setting procedure), the user also can return to the previous menu level using the **Back** function. This enables the user to modify settings that may have been overlooked without saving the settings modified previously.

Figure 8-1 Screen displayed once parameters are set

If the user verifies each parameter without modifying any of the parameters, the system will not prompt the user at the end.

Because the language, units, contrast, and display brightness parameters only affect presentation, and not measurement or output, the user is not required to enter the code after modifying these settings.

This instruction manual describes all the configuration and programming options for the FlowShark Pulse. The transmitter type will determine the inputs and outputs available. While the inputs/outputs may be programmable, they may not be available for

use or connection. Refer to Chapter 4, System Overview and Operation.

The FlowShark Pulse Model 10 transmitter represents this kind of scenario because it has only 2 analog outputs, 2 relay outputs, and 1 analog input. This device does not have a digital input and cannot be operated as a controller. It can be operated only with 2 analog outputs and 2 relay outputs. Please use the Model 20 transmitter to employ digital input and controller functions.

After mounting and installing the sensor and transmitter (refer to *Chapter 7, Installation*), activate the power supply.

The initial start-up dialog displayed is language selection:

Figure 8-2 Language Selection

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

Please press the key only one time.

The transmitter initiates communication with the sensor and coordinates both processor programs. While this occurs, the software version number displays on the transmitter. This number is required for reference if problems occur during configuration.

Perform this procedure after each sensor change.

For safety reasons, please reset the system when replacing a sensor by powering down the transmitter. The user can perform a full reset to the factory default settings by selecting the **load factory setup** from the **setup parameter** submenu of the **PAR** main menu.

Once the previous actions are complete, begin setting the parameters.

The unit loses custom parameters during a full reset, restoring the factory default parameters.

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:

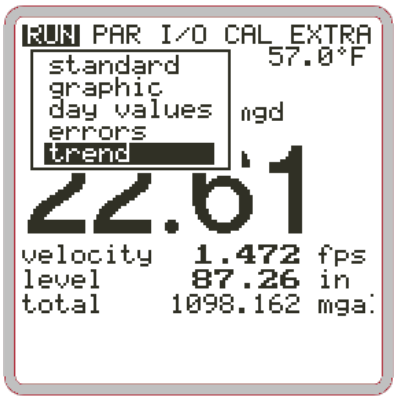


Figure 8-3 Standard operating mode

Standard

This screen displays basic information including the measurement location name, the time, and the current flow rate, velocity, flow depth (level), and flow volume (*since midnight by default*).

Graphic

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

Pressing up/down arrow keys moves the indicator line in the corresponding direction. The selected height and current velocity displays at the bottom (Figure 8-4)

This screen enables the user to view the current flow conditions at the selected measurement location. The velocity profile should be distributed evenly without excessive discontinuity (Figure 8-5).

Under poor flow conditions, change the position of the velocity sensor.

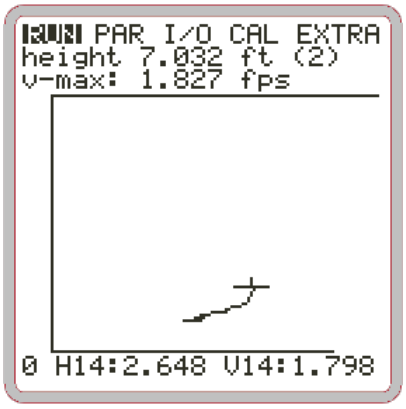


Figure 8-4 Flow velocity distribution (height = maximum depth; v-max = maximum velocity; Hx = current depth value; Vx = current velocity value; horizontal line in graph represents measurement window indicator)

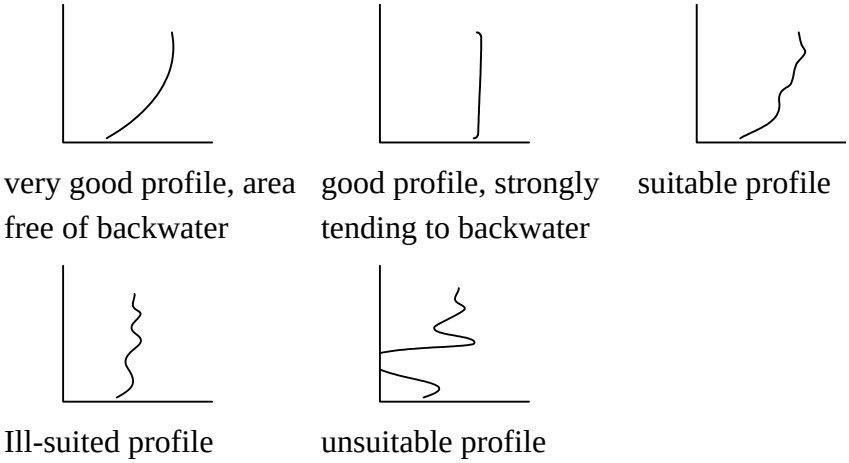


Figure 8-5 Flow velocity profiles

Day Values

Select the **INFO** submenu from the **day values** menu (Figure 8-6). This screen displays the flow totals for the past 7 days (Figure 8-7), provided the transmitter has operated without interruption for the past 7 days. If an interruption occurs, it displays the flow totals for the uninterrupted days of operation.

Flow totals typically are calculated at midnight (00:00 h). Modify the time at which this will occur, if necessary, through the **RUN > Day Values > Interval** (Figure 8-8).

The user also can obtain partial totals since the last reset. Reset the total to **0** by pressing the **ALT** key. This reset does not modify the totalizer.

Figure 8-6 Info menu

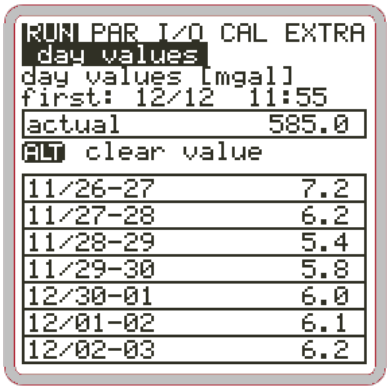


Figure 8-7 Day values

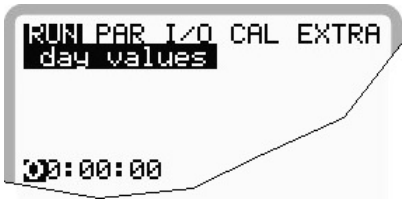


Figure 8-8 Totalizing based on the time of day

Error Messages

This screen monitors 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 before it has been addressed will prevent it from being written to memory again. However, the error will surface in the memory once it occurs again (or if the power supply is briefly interrupted).

Trend

This display functions like an electronic logger. It records average readings at a designated interval for depth, average flow velocity, and depth (level) for the past 90 days. The user can select and view individual values from a submenu.

Figure 8-9 Trend value selection

The period over which the values have been averaged displays at the bottom of the screen. New values are added as vertical lines on the right-hand side of the display at the end of each configured storage interval (Figure 8-10). As new readings display, older values move to the left and eventually move into the internal memory.

Use the left/right arrow keys to scroll through the time intervals to view older data sets. Browse through daily values using the up/down arrow keys. This enables the user to calculate and evaluate previous measurements, trends, dry weather periods, and possible measurement problems that may have occurred in recent days.

The internal memory has a 90-day capacity. Therefore, new data will overwrite older data sets in memory.

Scrolling will scale the readings displayed automatically; therefore, these values may change to represent the most accurate reading available.

The user can set the time interval for the memory in the **PAR > Storage Mode > Interva**l menu. The factory default setting is a *2-minute* interval.

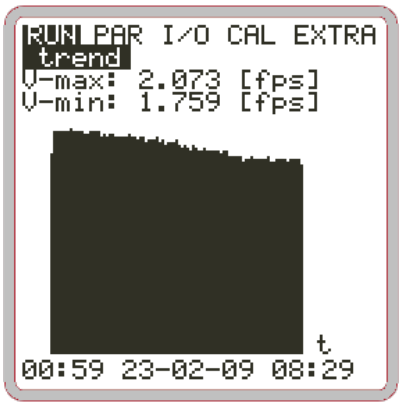


Figure 8-10 Example of trend graphic

The system will delete all graphic value trends saved previously if the user modifies the memory interval or another parameter.

Display Menu (EXTRA)

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

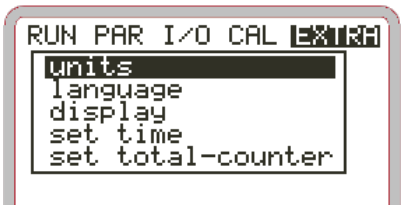


Figure 8-11 Extra submenus

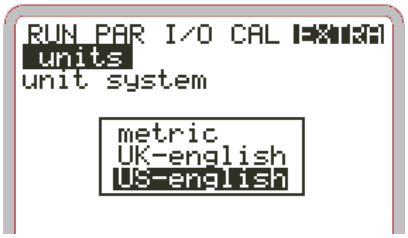


Figure 8-12 Unit system selection

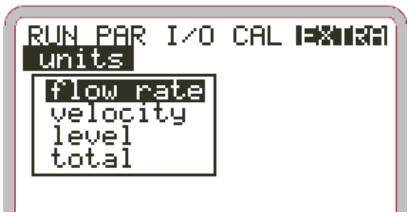


Figure 8-13 Selecting individual units

Units

This menu contains the following submenus:

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

The user can select the unit system in which each reading will display. Several unit system options are available for each kind of reading.

Unit System

This feature allows the user to select from among the metric system (liter, cubic meters, cm/s, etc.), English system (ft, in, gal/s, etc.), and American system (fps, mgd, etc.).

Language

This option enables the user to select the language (German, English, French, Czech, or Italian) in which readings will display.

Display

This feature allows the user to adjust the display settings regarding contrast and brightness. Use ▼ and ◄ to decrease settings; use ▲ and ► to increase settings. ► and ◄ modify settings at 5 percent increments; ▲ and ▼ modify settings at1 percent increments.

System Time

To perform various control and memory functions, the unit includes an internal system clock for saving dates corresponding to years, weekdays, and week numbers. The user can modify clock date and time.

First, select the **Info** menu option:

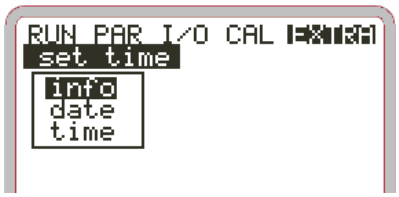


Figure 8-14 System time submenu

The unit displays the system time after confirming the settings:

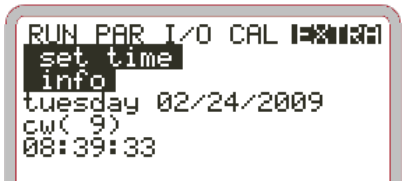


Figure 8-15 System time (date, calendar week, time)

This menu option is for display purposes only. Therefore, the user cannot adjust the system time through this option. Perform these modifications through the **Date** and **Time** menu options.

The corresponding week number will be set automatically once the date has been set.

Totalizer

This menu option allows the user to manually set the totalizer displayed on the main screen. This function typically would be performed when replacing a transmitter to ensure the same value displays following replacement.

After setting the new value, click on the **Enter** key twice consecutively to confirm and then enter the code number **2718** to accept the new value. The unit offers the user two attempts to enter the correct code.

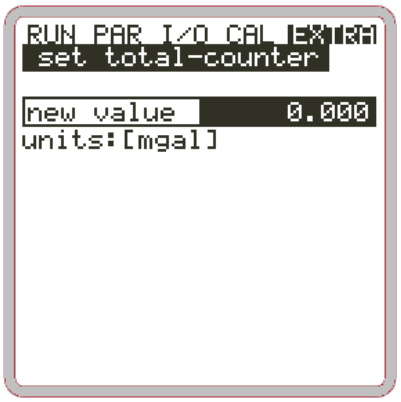


Figure 8-16 Totalizer modification

Figure 8-17 Service code request

Parameter Menu (PAR)

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

- Location name
- Pipe shape
- Pipe dimensions
- Sensor types
- Analog output (function, signal range, and measurement range)
- Relay output (function and values)

All other functions correspond to unique circumstances or applications, such as special pipes, regulator mode, storage mode, or unusual hydraulic conditions. Contact an ADS representative for assistance in setting these parameters.

This instruction manual describes all configuration and programming options for the FlowShark Pulse. The device type determines the inputs and outputs available. While these inputs and outputs may be programmable, they may not be available for use or connection.

This applies to the FlowShark Pulse Model 10, which has only 2 analog outputs, 2 relay outputs, 1 analog input, and no digital input. The Model 10 cannot serve as a controller.

The parameter menu (PAR) includes 11 submenus described in the following sections.

Parameter Menu: Measurement Place

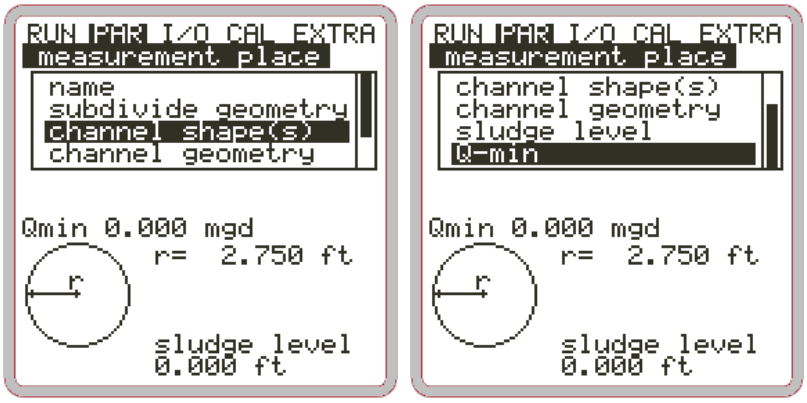


Figure 8-18 Measurement place submenu

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 bar to the right of the menu options indicates that additional options are available on the menu.

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

Name of Measurement Location

ADS recommends managing and designating names based on the names used in the associated documentation. A name may contain up to 21 characters. Entering a name on the 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. Toggle between uppercase and lowercase letters using the up and down arrow keys.

Pressing the **Alt** key will select or deselect a set of special characters (e.g., % or #). Select a specific character using the left or right arrow keys, and confirm the selection by pressing **Enter**.

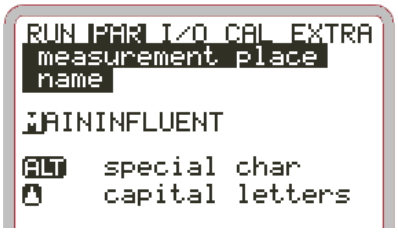


Figure 8-19 Setting the name for the measurement location

Enter the desired name using the keypad; each key represents three letters and a number (Refer to *Chapter 7, Initial Startup and Communication*). Cycle among the four characters by repeatedly pressing a key. The cursor automatically will proceed to the next character if the key has not been pressed for two seconds.

Following are descriptions of the function keys:

◄ ►	Move the cursor to the left or the right.
◄	Move the cursor to the left side to delete the character to the left of the cursor.
►	Move the cursor to the right to create a character representing a space.
▲ ▼	Toggle between uppercase and lowercase letters.
▲	Shift to uppercase letters.
▼	Shift to lowercase letters.
↵	Confirm the name entered and exit the menu.

Subdivide Channel Profile

This is a special parameter that enables the user to set parameters for large or odd-shaped pipes with rounded tops. This parameter is *not* required for most standard applications. Typically, ADS will set the parameters for applications involving unique pipe types and sizes for the customer. Following is a brief description of how to set this parameter.

The method for setting the dimensions for this pipe type involves dividing the pipe profile into 2 or 3 level or height zones.

Press the **ALT** key to move among the following 3 options:

- NO (no profile subdivision, standard setting)
- 2 (divide profile into 2 level / height zones)
- 3 (divide profile into 3 level / height zones)

Set the zones through **PAR > Measurement Place > Channel Profile(s)**.

Set the bottom zone of the profile to **Pipe (round)**, **Egg**, **Rectangle**, **U-Profile**, **Trapezoid**, or **2r Egg**. Set the height-width or height-area characteristics for the central zone, and enter the segment dimensions of the circle representing the top zone of the unique channel profile.

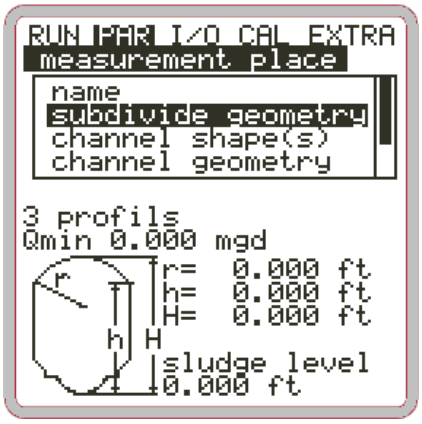


Figure 8-20 Profile divided into 3 zones

Channel Profile(s)

If the profile has not been subdivided, first select the zone (bottom, center, top) with the **ALT** key and then set the desired profile. Select one of the following standard profiles:

- Pipe (round)
- Egg (standard; height-to-width ratio = 1.5:1)
- Rectangle
- U-Profile
- Trapezoid

- 2r Egg (height-to-width ratio = 1:1)
- Q = f(h) (function of height – Lookup table)
- Ellipse

Figure 8-21 Selecting the shape of the pipe

▲ ▼ Select pipe shape using the up and down keys.

↵ Confirm selection by pressing **Enter**.

The profile created displays in the programming mode screen.

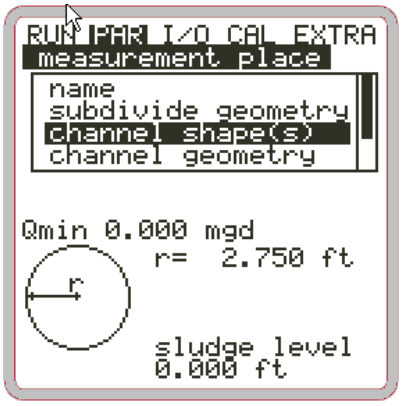


Figure 8-22 Selected profile

If the existing profile does not correspond with any of the available options from which to select, choose **Custom shape**.

↵ Confirm by pressing **Enter**.

A message displays, requesting the known dimensional relationship.

Figure 8-23 Custom shape menu

Channel Dimensions

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

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

Select **Custom shape** to display the table of 32 potential vertical segments. Enter the values relating **height-width** or **height-area** (Figure 8-24), and then enter the corresponding value pairs.

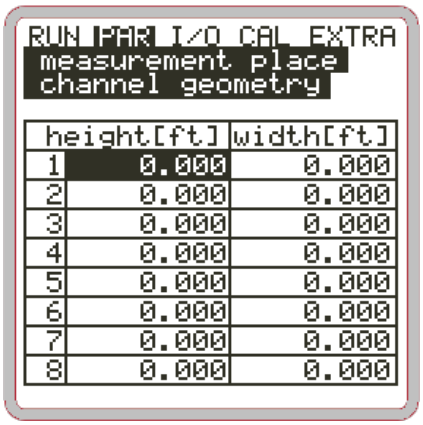


Figure 8-24 List of custom shape breakpoints

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

Distances may vary among individual segments. Decrease the distance between segments under conditions of heavy and irregular fluctuation within a specific area. It is not necessary to use all 32 segments. The FlowShark Pulse will interpolate between the missing segments.

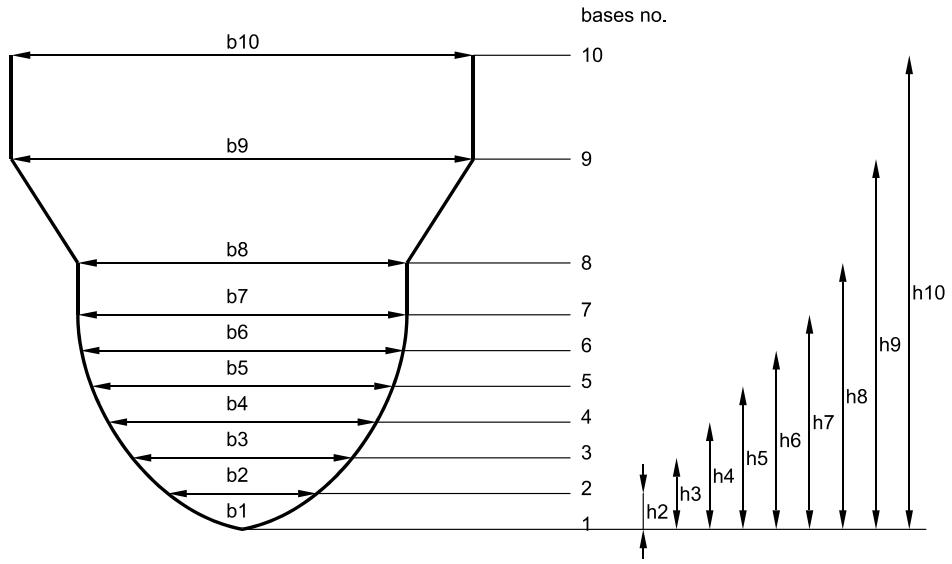


Figure 8-25 Custom profile breakpoints

For pipe profiles divided into two zones, set the following parameters:

Bottom zone:
- Pipe (round)
- Egg
- Rectangle
- U-Profile
- Trapezoid
- 2r Egg
- Q=f(h)
- Ellipse

Top zone:
- Custom profile

For pipe profiles divided into three zones, set the following parameters:

Bottom zone:
- Pipe (round)
- Egg
- Rectangle
- U-Profile
- Trapezoid
- 2r Egg
- Q=f(h)
- Ellipse

Center zone:
- Custom profile

Top zone:
- Pipe

Configuring individual pipe sections requires comprehensive knowledge and experience in operating the FlowShark Pulse. To ensure proper configuration, contact ADS for assistance in setting up these parameters.

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 FlowShark Pulse performs flow calculations.

Low-Flow Volume $Q_{min.}$

This parameter exists to minimize the impact of slow-moving flows or noticeable increases in volume. It primarily is used to measure overflow volumes in structures that remain flooded by incoming flow.

Q_{min}: readings lower than this value will be set to **0**. The user can only set positive values, and each value will be considered an absolute value (i.e., very small positive or negative flows will be set to zero).

V_{min}: low-flow volumes in applications with large profiles and depth levels can be suppressed using this parameter. Lower velocity fluctuations within longer periods of time may cause apparently large volume fluctuations which cannot be ignored using the Q_{min} value function.

Flow velocities below this value will be set to **0**, which will ensure a calculated volume of **0**.

The user only can set positive values, and each value will be considered an absolute value (i.e., very small positive or negative velocities will be set to zero).

Both low-flow suppression setting options have an OR logic relationship to each other.

Figure 8-26 Selecting low-flow volumes

*Suppressing low-flow volumes does **not** serve as an offset, but as a limitation.*

Parameter Menu: Level

Figure 8-27 Level measurement menu

This menu allows the user to define the parameters regarding depth measurement. The start screen (Figure 8-28) and parameters available for setting may vary based on the sensor type selected.

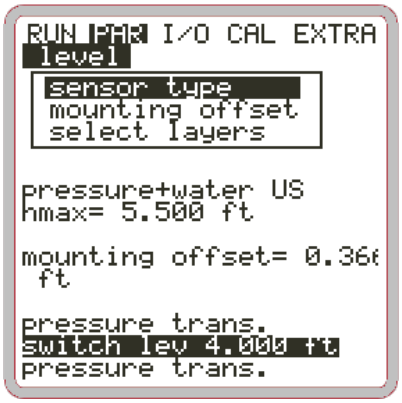


Figure 8-28 Example for selected depth sensor

Figure 8-29 Designating sensor type

Sensor	No.	
Air-Ultrasonic	01	Depth measurement using an air-ultrasonic sensor connected directly to the FlowShark Pulse. Requires an air-ultrasonic sensor.
Water-Ultrasonic	02	Standard version. Flow velocity and depth measurement using combi sensor from the bottom up. Requires a 2K combi sensor.
External Sensor	03	Second standard version. Depth measurement using an external, 2-wire sensor powered by FlowShark Pulse or by external measurement unit and depth input via mA input signal. Requires an external 4-20 mA sensor.
Fixed Value	04	Use this point to set parameters for pipes and pipes that remain full. These applications typically do not require depth measurements. Enter the consistent depth level under **Scale/Height**.
Pressure	05	Depth measurement determined by a sensor-integrated pressure measurement cell. Requires a 3K or 4K combi sensor.
Pressure + Air-Ultrasonic	06	Depth measurements performed using a sensor-integrated pressure measurement cell and an air-ultrasonic sensor connected directly to a FlowShark Pulse. Requires a 3K or 4K combi sensor and an air-ultrasonic sensor.
Pressure + Water-Ultrasonic	07	Depth measurements performed using combination of sensor-integrated pressure measurement cell and water-ultrasonic from bottom up. Requires a 3K or 4K combi sensor.
Pressure + External Sensor	08	Depth measurements performed using combination of sensor-integrated pressure measurement cell and external 2-wire sensor powered by FlowShark Pulse *or* by an external measurement unit and depth input via mA input signal. Requires a 3K or 4K combi sensor and an external 4-20 mA sensor.

Sensor	No.	
Water-Ultrasonic + Air-Ultrasonic	09	Depth measurements performed using combination of water-ultrasonic from bottom up and air-ultrasonic sensor connected directly to FlowShark Pulse. Requires a 2K or 4K combi sensor and an air-ultrasonic sensor.
Water-Ultrasonic + External Sensor	10	Depth measurement performed using combination of water-ultrasonic measurement from bottom up and external 2-wire sensor *or* external measurement unit and depth input via mA input signal. Requires 2K or 4K combi sensor and external 4-20 mA sensor.
Pressure + Water-Ultrasonic sensor + external sensor	11	One of two FlowShark Pulse maximum configurations. Three different depth sensors can determine the depth level. The sensor-integrated pressure measurement cell operates in combination with the water-ultrasonic sensor from bottom up and with an external 2-wire sensor powered by the FlowShark Pulse *or* by an external measurement unit and depth input via mA input signal. Requires a 4K combi sensor and an external 4-20 mA sensor.
Pressure + Water-Ultrasonic + Air-Ultrasonic	12	This is the second FlowShark Pulse maximum configuration. Unlike the configuration above, the third depth detection will be performed by an air-ultrasonic sensor connected directly to the FlowShark Pulse. Therefore, this sensor replaces the external transducer. Both other methods – the sensor-integrated pressure measurement cell and the water-ultrasonic sensor from bottom up – will be used in same way mentioned previously. Requires a 4K combi sensor and an air-ultrasonic sensor.

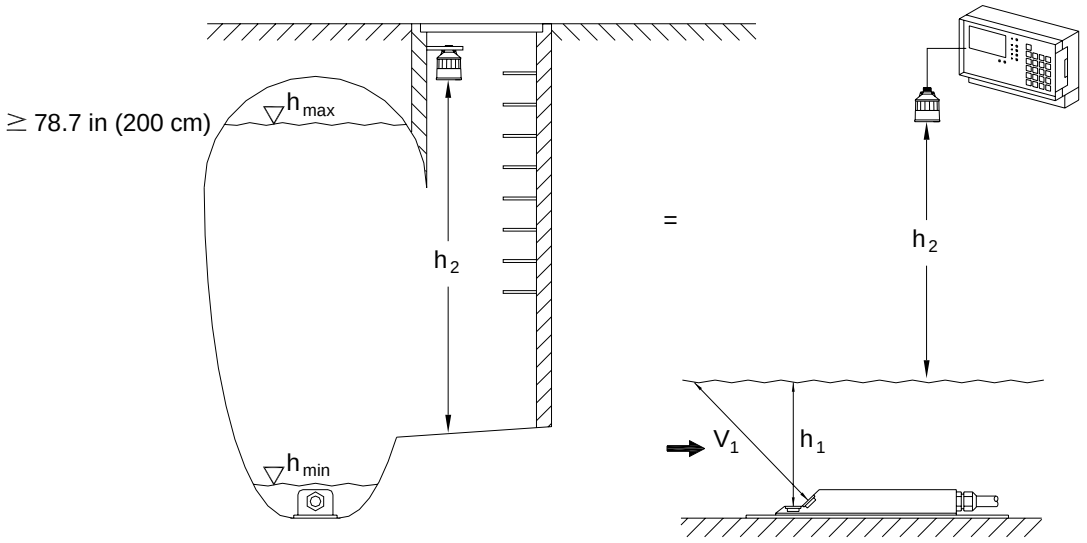


Figure 8-30 Example of an installation involving 2 depth sensors

Depth level measurement combinations 6-12 provide reliable readings under difficult measurement conditions. These involve measurement locations that require more than one sensor and experience surcharge conditions during rainfall events.

Please note that, when combined depth detection is in use among separate sensors, the system employs only one method to measure flow quantity. Select the appropriate method during configuration activities based on the flow depth. To ensure reliable depth measurements, assess the general hydraulic conditions and determine the most effective method for measurement at the location.

Enabling the memory mode and installing a memory card ensures all settings and measurements are saved, providing access to the data for verification and recalculation purposes at any time.

Determine the appropriate method for measuring depth during the preliminary stages of project planning.

When choosing the method of measurement, connect a sensor to the unit that is appropriately equipped for implementing that method.

While universal sensors have broad functionality, they may not be adequate for acquiring the measurements required.

Mounting height

This parameter represents the height of the depth sensor above the pipe bottom. The user cannot view or set the mounting height if sensor type 3 or 4 is selected.

This parameter is set to 0.394 inches (10 mm) by default. Do not modify this value unless the sensor will be installed at a *higher or lower* elevation. When installing the sensor higher (such as on a block), enter the total elevation of the 0.394 in (10 mm) default value plus the additional height. When installing the sensor lower, enter the

value resulting from subtracting the reduced height from the default value of 0.394 in (10 mm).

When using the air-ultrasonic sensor, enter the distance between the bottom edge of the sensor and the pipe bottom.

The standard mounting height for the combi sensor with the pressure cell is 0.197 in (5 mm), which represents the elevation of the sensor diaphragm above the pipe bottom. It is not necessary to modify this value unless the sensor will be installed *higher or offset sideways*. When installed higher, enter the total elevation of 0.197 in (5 mm) plus the additional height.

Scale

This parameter is available only when sensor type 3 or 4 is selected.

To configure this parameter as a fixed value, enter the persistent water level. For a full pipe, this value would be equivalent to the inside diameter of the pipe.

When using external sensors, enter the offset (to be added to the reading) and measurement range (equivalent to 20mA of the FlowShark Pulse analog input). Adjust the scale according to the measurement range or the scale of the corresponding external depth sensor's analog output.

Connection

This parameter is not available if the external depth sensor (sensor type 3, 8, or 10) is selected. The user can enable the respective terminal clamp by clicking the **ALT** key.

*Two-wire sensors must be connected to terminal clamps D8 and D9. Select **Ex-Zone** from the **Connection** menu.*

*External level signals must **always** be connected to the non-Ex area. Under this condition, select **All** from the **Connection** menu.*

To connect these sensors, refer to *Chapter 6, Installation.*

Split Sensors

This parameter is available only when the unit is set up for combined depth measurement (sensor combinations 6–12).

The user can choose up to 3 level zones: bottom, center, and top. Toggle among the zones using the **Alt** key, and set the desired method for measuring depth for each zone. The only methods available for selection are those that have been previously selected during sensor type selection.

After selecting the method for measurement, set the height at which to switch the FlowShark Pulse to the adjacent zone.

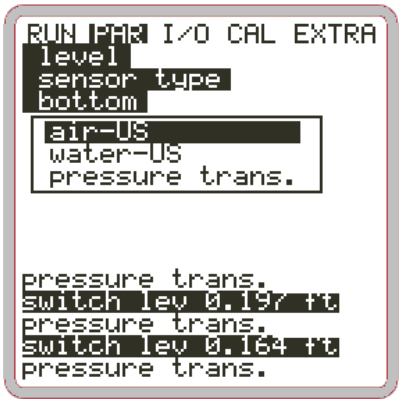


Figure 8-31 Selecting the measurement method

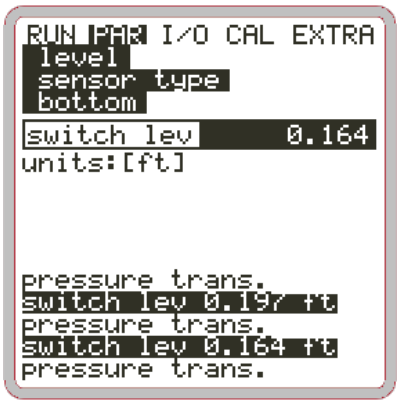


Figure 8-32 Setting the switchover depth between measurement methods

Errors are not uncommon when setting the parameters for combi sensors that perform several methods for measuring depth at multiple locations. Therefore, to confirm these settings, please contact an ADS representative for assistance in performing the initial setup procedures.

Parameter Menu: Flow Velocity

Connecting 1 sensor

The number of sensors is set to **1** by default.

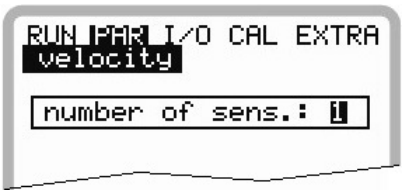


Figure 8-33 Setting the number of sensors

Configuring additional sensors requires extensive hydraulic knowledge. Therefore, ADS strongly recommends contacting an ADS representative for assistance in configuration to ensure proper setup.

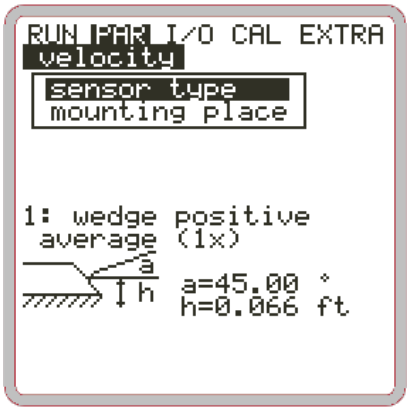


Figure 8-34 Sensor settings

Choosing the sensor type displays the following screen:

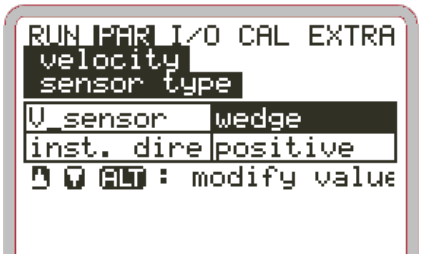


Figure 8-35 Selecting a sensor type

Sensor Type

Choose the wedge (*combi*) or pipe insertion sensor by selecting the desired option and clicking the **ALT** key.

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

Mounting Place

This parameter allows the user to modify the installation height for the flow velocity (combi) sensor. The default setting is 0.788 in (20 mm), which represents the position of the sensor when it is installed at the bottom center of the pipe. This setting does not require modification unless the sensor has been installed *higher or lower*. If the sensor has been installed higher, enter the total value of the additional mounting height plus 0.788 inches (20 mm); if the sensor has been installed lower, enter the overall height after subtracting the missing height from 0.788 inches (20 mm).

Connecting 2 or 3 sensors: Selecting 2 or 3 flow velocity sensors displays the following screen:

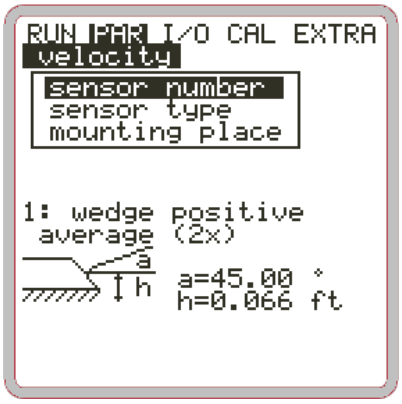


Figure 8-36 Extended sensor settings

Select the sensor corresponding to **Flow Velocity/Sensor No.** The following screen displays.

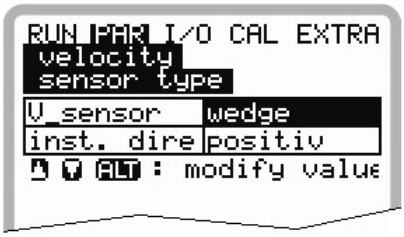


Figure 8-37 Selecting sensor type and mounting position

Sensor Type

Selecting and choosing the parameters for several flow velocity sensor types involves the same procedure used for only one velocity sensor.

Mounting Place

Enter the mounting height for each sensor on this screen. Use the lowest sensor (**must be sensor 1**) as the point of reference for determining the height of the other sensors. (refer to Figure 8-38).

Installed at the lowest point in the channel or pipe, sensor 1 serves as the guide for the height settings for the other flow velocity sensors.

If several flow velocity sensors are in use and one of them functions in conjunction with ultrasonic depth measurement from the bottom up (water-ultrasonic) or with the pressure measurement cell, designate this sensor as sensor 1 within the sequence and install it at the lowest point of the installation.

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

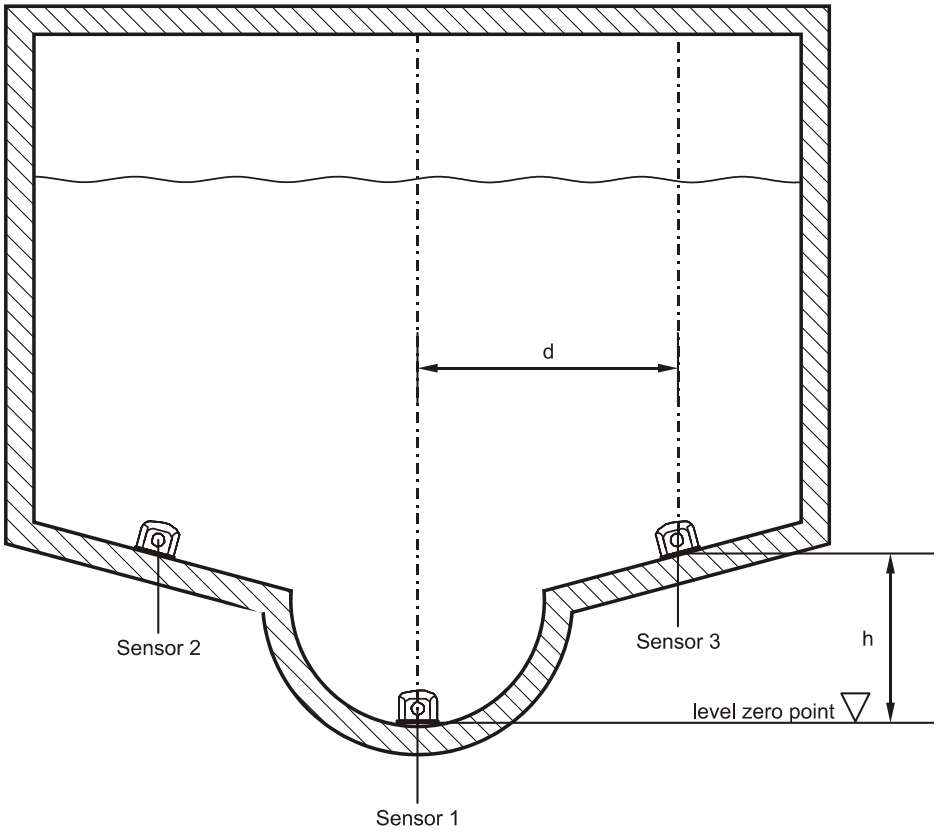


Figure 8-38 Sensor assignment

*If sensors 2 and 3 are installed at a higher elevation than sensor 1, enter the height difference for **height h** under the **mounting place** menu option. Velocities occurring below this level will refer to only sensor 1.*

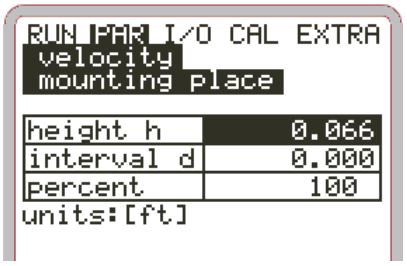


Figure 8-39 Assigning individual values for flow velocity sensors

Distance d represents the distance to the vertical profile center line. *This parameter currently is not applicable.*

The **percent** setting defines the relative weighting of each sensor in relation to the velocity profile.

The weighting of individual sensor velocities depends primarily upon the geometry of the channel and sensor placement. Contact ADS for assistance in assigning weighting for each sensor.

Parameter Menu: Analog Inputs

Figure 8-40 Analog inputs – submenu

Based on the transmitter type, several analog inputs may be available. For example, the Model 10 transmitter includes the following inputs:

- 1 analog input (galvanically isolated) for two-wire sensors
- 1 additional analog input for external depth sensor connection

Model 20 transmitters include the following inputs:

- 1 analog input (galvanically isolated) for two-wire sensors
- 4 additional analog inputs for external depth sensor connection and external setpoints or analog data storage.

The user can choose and select settings for any analog input, regardless of the transmitter in use (for example, Model 10 transmitters have only 2 analog inputs).

*If an external depth sensor (connection: AI1) has been enabled for a Model 10 transmitter in the **Level** menu in the past, an analog input parameter will no longer be available in the settings.*

Function, measurement range, control signal span, and other parameters may be set for each analog input. It also is possible to linearize each input stage independently.

Channel Number

Select the appropriate analog input, from inputs 1–4, for which to set the following parameters.

Name

(*optional*) Enter a name to which to save the analog input to the memory card. This card is the only location in which this name will be saved.

To enter the name, follow the same procedure used in **PAR > Measurement Place > Name**.

Function

Assign functions to the analog input selected under the **Channel Number**. Select from among the following functions by pressing the **ALT** key:

- Analog input disabled – disabling the analog input
- Log value – saving/logging the analog input value (data logging function of transmitter)
- Setpoint – enabling the analog input as the external setpoint when the unit is in regulator mode
- Setpoint + Log – enabling and saving the analog input as the external setpoint when the unit is in regulator mode

Measurement Span

Select the appropriate signal measurement span: 0-20 mA *or* 4-20 mA. Using an optional 0-5 V or 0-10 V voltage input requires a corresponding modification to the unit hardware. This modification should be performed only by ADS personnel.

Units

Select the appropriate unit of measure from the units table.

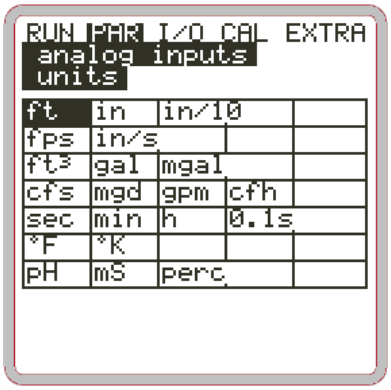


Figure 8-41 Units of measurement table

Linearization

Define the range for the analog input, and modify the weighting of the analog input using a 16-digit (maximum) breakpoint table. When used properly, this point can provide some helpful insight into setting FlowShark Pulse parameters. For example, the user can convert a depth/height signal into a volume-proportional signal, which can be saved, or route the signal to one of the analog outputs for further processing or display.

Simply enter the number of breakpoints, and then confirm the entry by pressing ↵. This displays a table with the respective units.

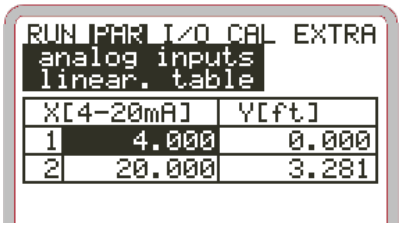


Figure 8-42 Table of values for analog input range

Enter the mA value in the X-column and the other value in the Y-column (The user previously selected the appropriate unit of measure through the **Units** menu option).

For standard (linear) applications, such as setpoint input, or to save a reading, enter **2** as the breakpoint value. Then, define the analog input range (i.e., enter the respective values for 4 mA and 20 mA).

Offset

In addition to the input current, add a fixed positive or negative offset to the analog value using the units previously chosen.

Parameter Menu: Digital Inputs

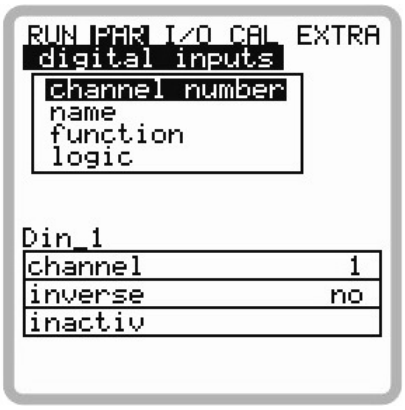


Figure 8-43 Digital inputs – submenu

This section enables the user to set and assign the digital input signals **Control OPEN**, **Control CLOSED**, and **Torque CLOSED**. The FlowShark Pulse Model 20 requires these input classifications for regulator operation.

The **Lock v-measurement** function is available *only* for digital input 1.

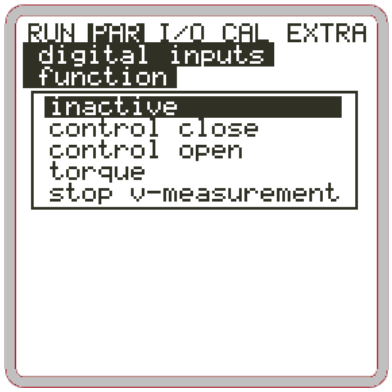


Figure 8-44 Digital input functions

Locking measurements may be useful for challenging applications, such as locations that characteristically reflect backwater conditions. The unit either releases or locks the velocity measurement based on a limit value contact, such as a discrete echo sounder, float switch, or conductive transducer, using the overflow height as the switching threshold. Locking refers to setting the flow velocity readings to **0**. Since the unit will calculate volume as V=0, no analog or digital values corresponding to flow will be available.

However, selecting the option to save individual gates will ensure individual velocity readings are saved.

Channel number

Select the appropriate digital input, from inputs 1–4, for which to set the following parameters.

Name

(*optional*) Enter the name to which to save the digital input to the memory card. This card is the only location in which this name will be saved.

To enter the name, follow the same procedure used in **PAR > Measurement Place > Name**.

Function

Assign regulator setting functions to the digital input selected under the **Channel Number**. Select from among the following functions by pressing the **ALT** key:

- **Disabled**
- **Control CLOSED** Routes the slide end switch for closed condition to the selected digital input

- **Control OPEN** Wires the slide end switch for open condition to the selected digital input
- **Torque** Connects the torque switch for closed condition to the selected digital input
- **Lock V-measurement** Configures DI 1 to lock the measurement exclusively. The display will read **Measurement locked**. No output from AO + DO.

  This function is designed particularly for locations that characteristically experience turbulent backwater conditions. To effectively use this function, the flow velocity reading must be either locked or released at a specific threshold value corresponding to the peak overflow. For example, detection could occur using a separate echo sounder, float switch, or conductive sensor. A locked measurement means that flow velocity reading will be set to **0**. Therefore, the volume will be calculated based on a velocity reading of 0, eliminating analog or digital flow output. Enabling the option for saving single velocity gates will ensure the unit saves individual velocity readings without using them in calculations.

Digital inputs are passive and, therefore, are supplied by an external 2- V DC power supply. The signal current is 10 mA. To ensure reliable conductivity, use relay or end switch contacts made of a high-quality material.

Logic

Toggle between inverse and non-inverse input by pressing **ALT**. For example, this can allow a user to configure the unit to view closed slide valve signals under normal conditions. Therefore, a constant signal level would be equivalent to a disengaged end switch, allowing the unit to detect cable breaks easily.

Parameter Menu: Analog Outputs

Figure 8-45 Analog outputs – submenu

Use this option to define the function and measurement range of each analog output.

The user typically can select and set 4 analog outputs; however, Model 10 transmitters have only 2 analog outputs.

Channel number

Select the analog output, from outputs 1-4, for which to set the following parameters.

Name

This parameter is not required. Set this parameter only when saving the analog output to the memory card. This name will be saved only to the card.

Follow the same procedure described in **PAR/Measurement Place/Name**.

Function

Assign the following functions based on the analog output channel selected through the **Channel Number** parameter. Select the desired output function from the list:

- **Disabled** No analog output signal is available.
- **Output flow** Analog signal output represents calculated flow volume.
- **Output level** Analog signal output represents the depth level reading.
- **Velocity** Analog signal output represents the mean (*or average*) flow velocity based on the individual velocity readings.
- **Water temperature** Analog signal output represents the water temperature reading.
- **Air temperature** Analog signal output represents the air temperature measured by the LUS air-ultrasonic sensor (output is available only when the LUS sensor is connected).
- **Analog input 1** Analog output signal represents the analog input 1output value assigned by the user.
- **Analog input 2** Analog output signal represents the analog input 2output value assigned by the user.
- **Analog input 3** Analog output signal represents the analog input 3 output value assigned by the user.
- **Analog input 4** Analog output signal represents the analog input 4output value assigned by the user.

The following functions also are available when using more than one velocity sensor:

Function

- **Velocity v1** Analog signal output represents average velocity from sensor 1.

- **Velocity v2** Analog signal output represents average velocity from sensor 2.
- **Velocity v3** Analog signal output represents average velocity from sensor 3.

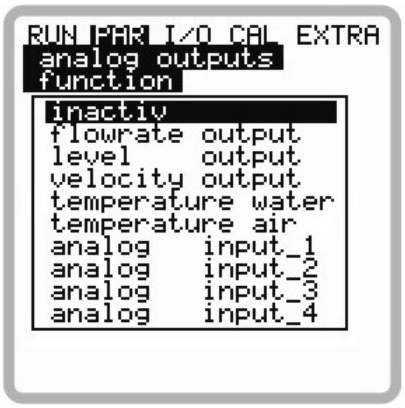


Figure 8-46 Selecting analog output functions

The hardware configuration of the Model 20 transmitter allows the user to route the analog input to the analog output. While the user can configure the Model 10 transmitter for this setup, the wiring in the Model 10 does not support this hardware implementation.

Output span

Select one of the following output spans: 0-20 mA or 4-20 mA.

Measurement span or range

Define the range for the analog output signal. **Negative values** may be included.

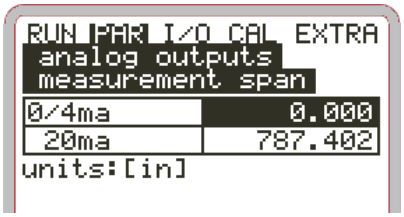


Figure 8-47 Measurement span

Example:

The measurement location tends to experience backwater conditions. Therefore, the unit will record negative values. However, the system has only one analog input available. When this occurs, set the analog output signal for "floating" conditions.

Configure the measurement span so that the zero (0) reading for flow exists in the middle of the measurement span, such as the following:

4 mA = -1.00 mgd

20 mA = 1.00 mgd

For this example, the signal output for a zero (0) reading for flow would be 12 mA. Backwater would decrease the analog signal; positive flow would increase the signal.

Error mode

Define the desired analog output condition for errors, such as cable breaks or a CPU failure.

ALT

Pressing this key offers the following options for selection:

- 0 mA
- Hold (This option retains the latest valid signal value until the error has been removed or no longer exists.)
- 4 mA
- 20.5 mA

Parameter Menu: Digital Outputs

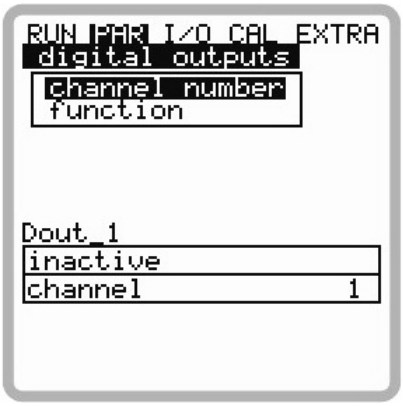


Figure 8-48 Digital outputs – submenu

This menu allows the user to define both functions and accompanying parameters, such as limit values and pulse duration, for individual relay outputs.

Typically, the user can choose and set 5 relays; however, Model 10 transmitters have only 2 relays.

Relays 4 and 5 in Model 20 transmitters are dedicated for regulator functions only when the regulator has been enabled.

Channel number

Select the relay, from relays 1–5, for which to set the following parameters.

Name

This menu is available only when a function has been enabled. Entering a name is not required; the name is used only for internal unit functions. However, when entering a name, select a name corresponding to the name of the relay output previously selected.

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

Function

Assign functions to the selected relay by entering the **Channel Number**. Use the **ALT** key to select from the following functions:

- **Disabled** This function is not in use.
- **Flow limit contact** The relay will close if the flow exceeds a designated threshold and open if the flow falls below a second designated threshold.
- **Velocity limit contact** The relay will close if velocity exceeds a designated threshold and open if velocity falls below a second designated threshold.
- **Level limit contact** The relay will close if the depth level exceeds a designated threshold and open if the depth level falls below a second designated threshold.

The following functions need to be set only one time:

Total positive impulses – the relay will output volume-proportional impulses if the flow occurs in a positive direction. Weighting and impulse duration are programmable.

Total negative impulses – the relay will output volume-proportional impulses if the flow occurs in a negative direction (backwater]. Weighting and impulse duration are programmable.

Error messages – the relay will close when error messages occur, such as sensor errors, cable breaks, power failures, or processor failures.

Figure 8-49 Defining the relay function

Logic

Pressing the **ALT** key enables the user to select between **normally open** and **normally closed**. Selecting **normally open** ensures the relay closes once the designated threshold is met. Selecting **normally close** ensures the relay closes immediately after setting the parameter and opens once the designated threshold is met.

Trigger Levels

This menu displays only when the **trigger level** function is selected.

Figure 8-50 Setting the trigger levels

The start and stop point settings determine whether the corresponding trigger serves as a switching threshold (**ON > OFF**) or as an in-range alarm (**ON < OFF**).

Impulse Parameter

This menu displays only when the **Impulses** function is selected.

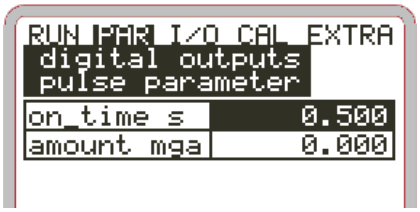


Figure 8-51 Setting impulse parameters

Select from the following options:

- **Duration** Select an impulse duration between 0.01 and 2.0 seconds. The ratio between impulse and break is 1:1. It is useful to increase the impulse duration beyond the 0.5-second default setting for slow PLC inputs or when mechanical counters are in use.
- **Amount** This parameter defines when the impulse occurs. The measured amount (e.g., gallons flowing) will be integrated internally until the selected value has been reached. An impulse signal of the duration programmed previously will be emitted, afterwhich the integrated internal value will be set to 0 again. This process will recur indefinitely.

Parameter Menu: Flow Controller

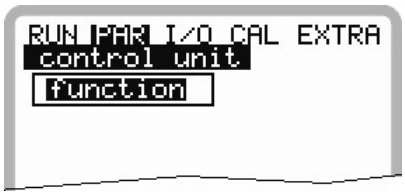


Figure 8-52 Basic settings for the flow controller

This menu enables the user to adjust the transmitter for almost any wastewater conditions to achieve optimum performance. It also allows slide valve execution, torque monitoring, and quick-close control or automatic flush functions.

Refer to the *Regulator* section in *Chapter 6, Installation*, for more comprehensive information on the principles for setup and operation.

The flow controller function may be used only in conjunction with Model 20 transmitters. While the Model 10 allows the setting of these parameters, it has neither the outputs nor respective connections for regulator operation.

Function

The function must be enabled (by pressing the **ALT** key) to display additional submenus. In addition, the regulator setting options will not display if the regulator has not been enabled.

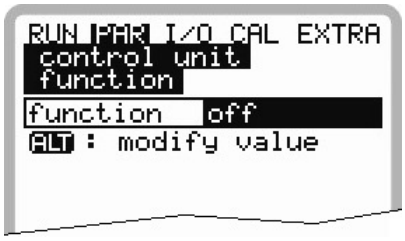


Figure 8-53 Enabling the flow controller

Setpoint

Choose the type of setpoint. Selecting *internal* allows for defining setpoints through the FlowShark Pulse; selecting *external* provides setpoints that have been preset through the dedicated analog input 4.

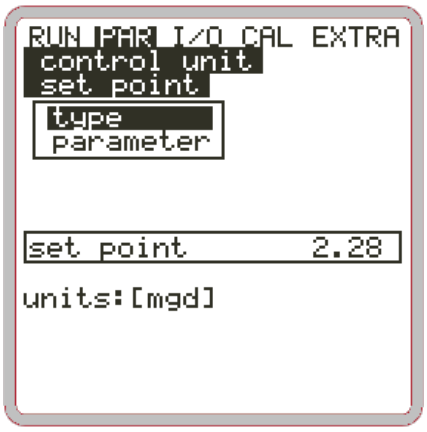


Figure 8-54 Setting the setpoint type

Analog input 4 is the dedicated hardware input for analog setpoint signals. Therefore, this assignment cannot be changed.

Parameters:

Internal setpoint:

- Define the internal setpoint for the selected unit.

External setpoint:

- Enter the name. This parameter is not required; it is for internal use only.
- Select the range of measurement range for the external setpoint: 0/4-20mA or 0-5/10V.
- Set the setpoint input linearization. Under normal conditions, enter 2 for the number of breakpoints. Set the starting setpoint start (= 0) to 0/4-20mA and the stopping setpoint to 20mA.

Offset:

- Enter the offset to be added to the external setpoint. Negative values are acceptable.

Setting a 4-20 mA range for the external setpoint initiates monitoring for cable breaks. The unit switches over to an internal setpoint when a cable break is detected (default setting = 100 l/s).

Relays

Use this menu to modify the logic functions for both output relays.

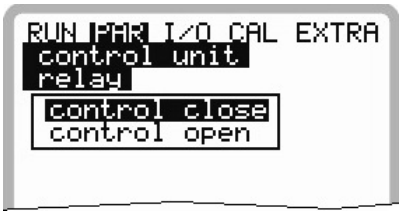


Figure 8-55 Assigning relay functions

Slide valve CLOSED: Enter the internal name (*not required*) and select the logic function for relay 4 (*normally closed* or *normally open*) by pressing **ALT**.

Slide valve OPEN: Enter the internal name (*not required*) and select the logic function for relay 5 (*normally closed* or *normally open*) by pressing **ALT**.

*Relay 4 is defined as **slide valve CLOSED** and relay 5 is defined as **slide valve OPEN** by the hardware configuration. The unit does not permit modification of this assignment.*

*If **normally open** has been selected, the relay will energise for the designated period of time once the corresponding setpoint has been reached. If **normally closed** has been selected, the relay will energise immediately after setting the parameters and will open for the designated period of time once the corresponding setpoint has been reached.*

End switch

This menu allows the user to assign functions and the associated parameters to the corresponding digital inputs.

The channel number is equivalent to the number of the digital input. For example, channel no. 1 would represent digital input 1, and channel no. 2 would represent digital input 2.

Selecting channel number and function enables the user to determine the specific end switch to which an individual signal input is connected.

Entering the name is for internal use only and, therefore, is not required.

Modifying the logic (inverse / non-inverse) allows the user to detect cable breaks at end switch connections.

Figure 8-56 End switch assignment

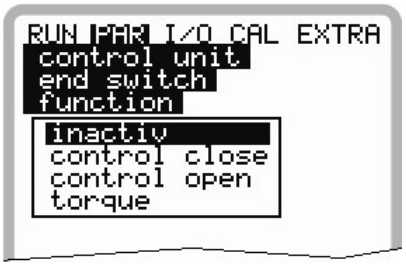


Figure 8-57 Possible functions

P-Factor

The P (proportionality) factor indicates the degree to which the regulating time will be affected when a deviation Δw from setpoint **w** occurs. The higher the proportionality factor, the longer the regulating time of the slide valve at the same control deviation.

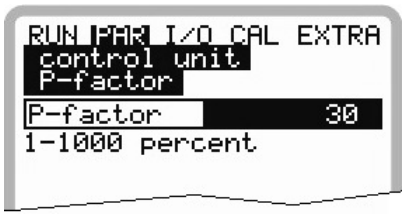


Figure 8-58 P-Factor setting

Interval/cycle time

Set the processing interval for the controller.

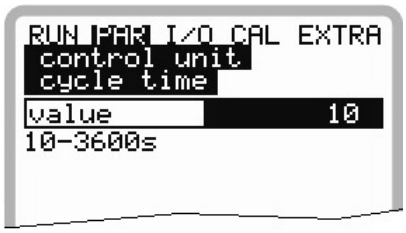


Figure 8-59 Setting the interval

Shorter intervals will accelerate the control behavior; however, they will cause the control circuit to oscillate when longer run times exist between the regulating unit and measurement.

A longer interval will decrease the tendency for the controller to oscillate; however, it will increase the inertia of the regulating system.

Guideline:

$$\text{Interval} = \frac{\text{average flow velocity}}{\text{distance between regulating unit and measurement}} \bullet 1.3$$

Control deviation

This parameter defines the amount of deviation that can occur from the setpoint of the control system without executing a regulating event. This setting reduces the tendency for the system to oscillate. Hydraulic conditions cause volume measurements to fluctuate. If there is no tolerance defined for setpoint deviation, the system will repeatedly attempt to adjust the actual value according to the setpoint. This may cause the regulating unit to run continuously, potentially resulting in mechanical defects or deterioration.

Both values have an *AND* logic relationship to each other. Under this condition, it typically is sufficient to define a percentage value.

Consider entering an absolute value for external setpoint control (channel network management) and large controlling ranges. Otherwise, for low setpoints, the permissible control deviation percentage may be very low. Inputting an absolute value as well will help avoid control oscillations under these conditions.

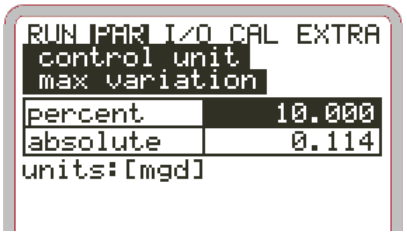


Figure 8-60 Setting permissible control deviations

Minimum duration of control impulse

This parameter is similar to the I-component of PID controllers. It defines the minimum regulating time for a regulating unit to ensure that very short calculated control impulses mechanically affect the regulating unit. Therefore, specify a longer duration for the minimum control impulse than required for the combined motor start-up time, gear clearance, and slide valve clearance.

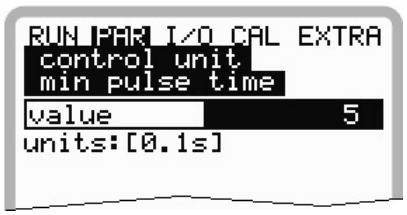


Figure 8-61 Setting the minimum duration for the control impulse

Slide valve run time/shifter time

Use this parameter to monitor spindle breaks, slide valve gate breaks, gear defects, and power failures involving the regulating unit or other system malfunctions that may indicate that the regulating unit is not moving, even when the unit is generating control signals.

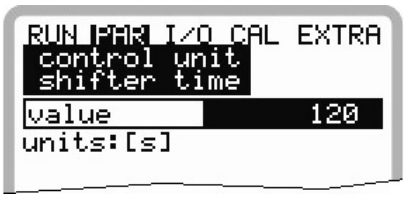


Figure 8-62 Setting the slide valve run time

The control unit will generate an error message if it does not reach the end switch CLOSED position after the slide run time has expired.

Guideline:

Slide run time = time elapsed between open and closed condition of slide valve during permanent operation • 1.2 .....2.0. (The longer the slide run time, the lower the factor.)

The slide run time produces an effect similar to the P-factor and must be set.

Quick-close function

Use the quick-close function when certain conditions, such as large diameters, long slide valve run times, and long dead times, exist at the measurement location. During sudden rainfall events, this function will partially close the open slide valve independent of the calculated regulating time. During normal operations, this function will be executed without any interruption to runtime.

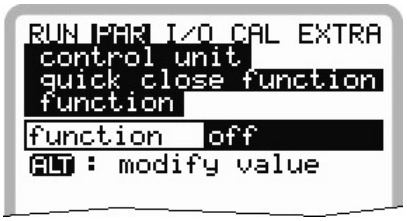


Figure 8-63 Enabling quick-close function

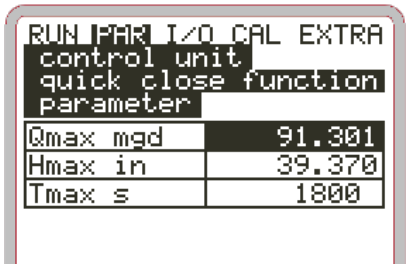


Figure 8-64 Quick-close parameters

Q_{max} and h_{max} serve as OR logic parameters. Based on the application, set these parameters 10 to 50 percent higher than the parameters set for conditions when the system switches to regulator mode during dry weather operation.

T_{max} is the amount of time the control unit requires to move from the open position to the standard position during control operation mode.

Automatic flush function

This function provides the capability to frequently flush the measurement section during dry weather operation using regulator mode. To dam up the flow and generate a flush surge, set the **Days** and **Time** parameters. The control unit will open again after the **Impounding Duration** (to be set) has expired and will remain in the open condition for the designated **Duration of Flush**. This sequence will occur repetitively.

Set the number of **flush events**: from 1 to 9.

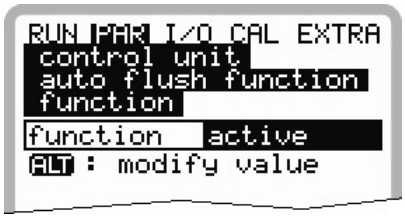


Figure 8-65 Enabling flush function

The flush function is not available during active control operation.

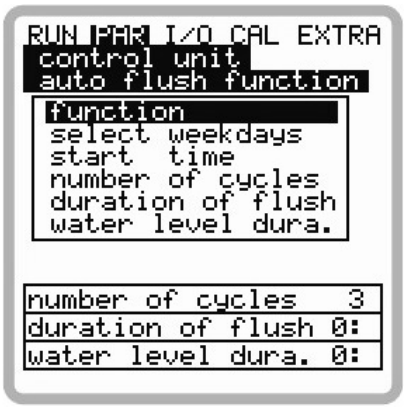


Figure 8-66 Flush function parameters

Start days represents the days to execute the flush function

Use the **ALT** key to select the days individually.

Figure 8-67 Setting individual flush days

Start time designates the time at which the flush will begin. Each selected day may have a different start time.

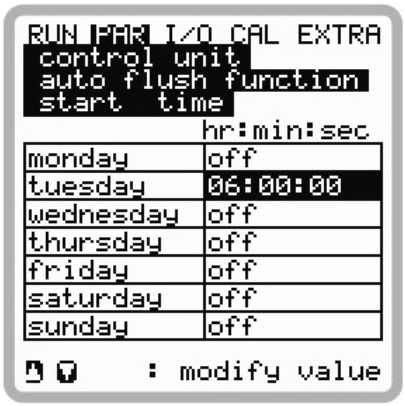


Figure 8-68 Setting the flush start time

Number of flush events designates the number of times to execute the flush event. A complete flush event involves the impounding duration and the duration of the flush.

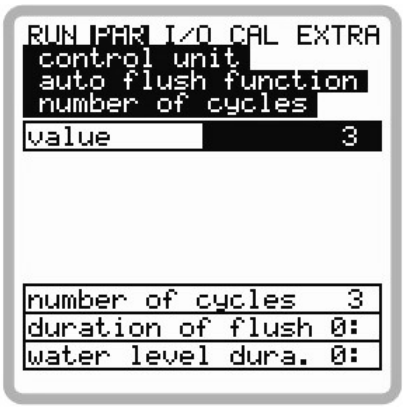


Figure 8-69 Setting the number of flush events

Duration of flush defines the length of time the regulating unit will remain open, independent of the current value.

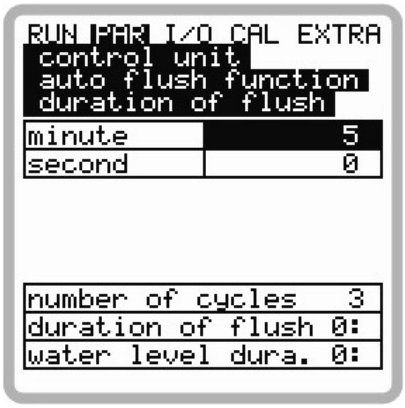


Figure 8-70 Setting the duration of the flush

Impounding duration defines the length of time the regulating unit will remain closed, independent of the current value, to allow the flow to dam up for flushing purposes.

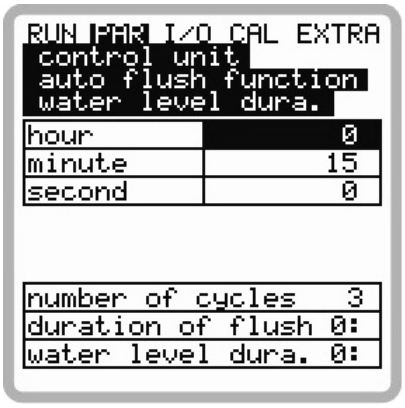
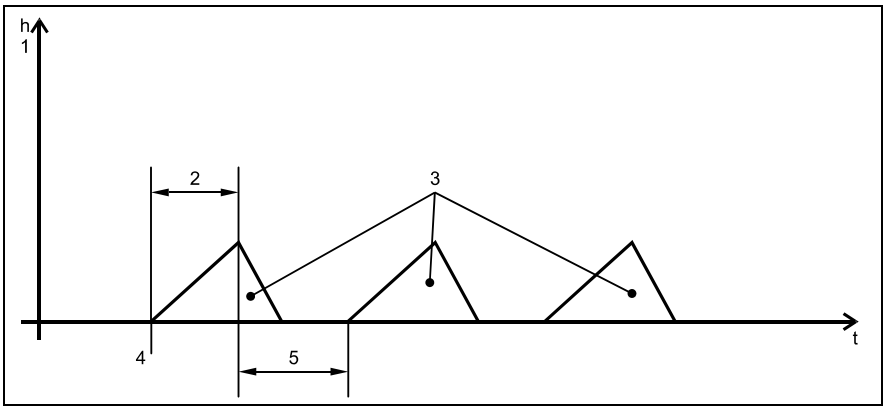


Figure 8-71 Setting the duration of impounding



1	Backwater
2	Impounding duration
3	Number of flush events
4	Start day, start time
5	Duration of flush

Figure 8-72 Example of a flush event

Parameter Menu: Settings

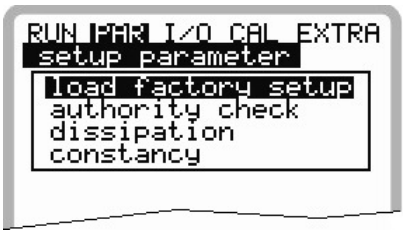


Figure 8-73 Settings – submenu

This menu allows the user to either modify or reset the following basic settings of the system.

Load factory setup

This option enables the user to reset the measurement transmitter. Selecting this option displays the following screen:

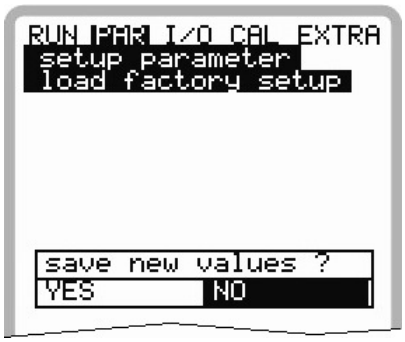


Figure 8-74 Executing a general reset

*Selecting **YES** will reset the system to the basic parameter settings. The default settings will be restored and all customer modifications will be eliminated (system general reset).*

Service code

Entering a special code provides additional system settings options. These options may include capabilities, such as modifying the beam angle or medium sound of the velocity sensor, transmit voltages, or special adjustments regarding the transmitter's crystal drive. These settings may be modified only by ADS personnel during start-up activities because they require comprehensive knowledge of the equipment and should not require adjustment during standard use.

Damping

This menu enables the user to adjust the display and analog output damping between 20 and 600 seconds. A 0 to 100 percent increase in the calculated volume requires the designated time to pass on either the display or the output.

Based on the damping setting, the FlowShark Pulse reading will fall to 0 if this period expires without an accurate depth/height measurement.

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.

Constancy

The constancy parameter represents the period during which the FlowShark Pulse will retain and output (via Analog Output) the last valid reading before registering zero (e.g., due to a temporary sensor obstruction).

Parameter Menu: Memory Mode

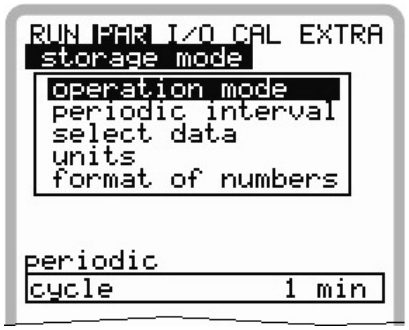


Figure 8-75 Memory mode – submenu

Before accessing this menu, insert an ADS 16 to 128 (maximum) MB compact flash card. When necessary, obtain this card through your ADS representative.

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

Insert the card into the **Memory Card** slot on the unit's faceplate. Orient the card so that the side with the small holes is plugged into the unit. The card can plug into the unit in only one way. Therefore, if it does not insert easily, please do not apply force. Instead, rotate the card into the correct position and then attempt to re-insert it into the unit. Make sure the card is seated securely.

Figure 8-76 **Memory Card** slot

After a new memory card has been installed and storage has been enabled in the programming menu, the FlowShark Pulse will prompt the user to **Format card**.

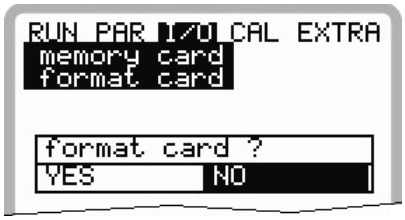


Figure 8-77 Request to format the card

Execute card formatting through the **I/O > Memory Card > Format card** menu.

Due to the card's storage cycle restrictions (approximately 100,000 writing events), the FlowShark Pulse only saves incoming data on the card on an hourly basis. This interval is pre-set through the internal system time. Two exceptions include very high data density and a cumulative data volume of approximately 3000 – 4000 bytes.

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

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

The unit will save data as mean values averaged over the designated interval set in memory, not as current individual values.

Operation Mode

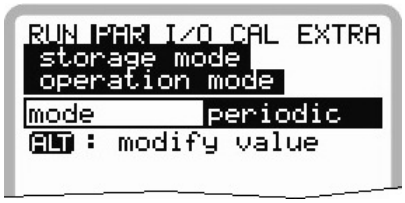


Figure 8-78 Enabling the operation mode

Mode

ALT Pressing this key allows toggling among the following options:

- Disabled – this option prevents data from being saved
- Periodic – this option provides cyclical storage of depth level, flow velocity, and flow rate data
- Event – this option offers two different memory cycles (cycle interval and event interval) with user-defined storage times

Periodic interval

Select the periodic storage interval from 1 minute to 1 hour. The available intervals include 1; 2; 3; 4; 5; 6; 10; 15; 20; 30, or 60 minutes. Entering a different value manually will cause the FlowShark Pulse to set the interval to the valid (available) interval that falls immediately before the value entered.

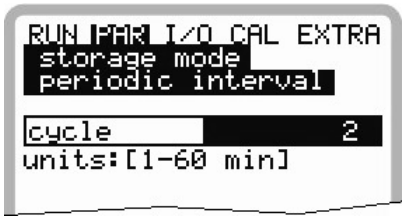


Figure 8-79 Entering the storage cycle

Select Data

Designate data sets to store in addition to the depth level, average flow velocity, volume, and medium temperature, which are stored automatically.

Select among analog inputs 1, 2, 3, and 4 and system to designate the saving options.

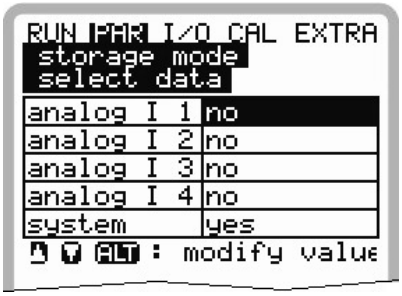


Figure 8-80 Select data table

Analog I1 to I4

This setting applies only to Model 20 transmitters because it is equipped with additional analog inputs.

ALT Use this key to toggle between the following saving options:

- No – prevents analog input from being saved
- Yes – saves selected analog input

System

ALT Use this key to toggle between the following saving options:

- No – prevents saving system parameters
- Yes – saves additional system parameters (all velocity gates and all depth data from up to 3 depth sensors), system errors, error messages, and system ON/OFF events

Unit System

Select the unit of measure in which to store data:

- Metric (litres, cubic meters, centimeters per second, etc.)
- English (feet, inches, gallons per second, etc.)
- American (feet per second, millions of gallons per day, etc.).

The display does not reflect the setting selected for this parameter.

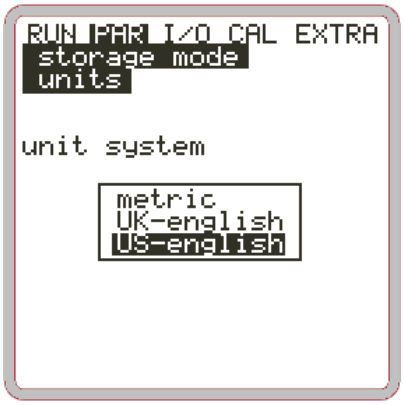


Figure 8-81 Selecting the unit system in which to save data

Units

Set the desired storage units for the 3 main memory parameters: flow, level (depth), and velocity. The options available depend on the setting selected previously for **Unit system**.

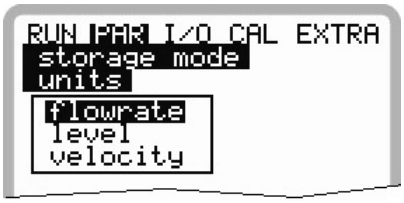


Figure 8-82 Selecting units

Format of numbers

Choose whether to save data with commas or decimal points. Commas typically are used in Europe; decimal points typically are used in other regions.

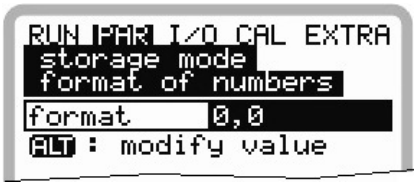


Figure 8-83 Selecting the number format

Data Structure on the Memory Card

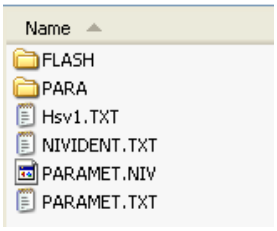
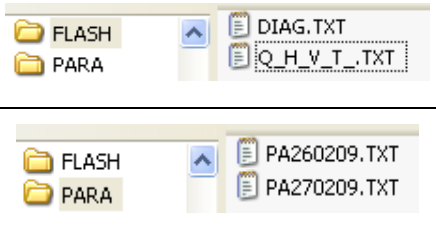
Main Directory	FLASH and PARA Subfolders
	

Figure 8-84 Data structure on memory card

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 which might have occurred during measurement activities. These may include the beginning and end of Internet communication, modem restart, or CPU restart after system reset or reprogramming.

The respective message is labelled with the date and time:

>: received error/message

<: reason for error/message cleared

Save the **DIAG** file by selecting **I/0 > Memory Card > Save backup**.

PARA

This folder includes all the parameter files with a date stamp. These files allow the user to retrace transmitter settings involving modifications to the measurement location and parameter settings. 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 interval readings are stored. It is saved under the name of the measurement location.

NIVIDENT.TXT

This text (.txt) file contains 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 FlowShark Pulse, the unit will prompt the user to format the card.

The FlowShark Pulse will create a new file for the readings with the new name, provided the card does not require formatting.

PARAMET.NIV, PARAMET.TXT

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

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 FlowShark Pulse. The FlowShark Pulse can neither use nor accept cards that have been formatted on a PC.

Parameter Menu: Communication

Modifications in this menu are required only when the user will be accessing the unit over the Internet or a local network.

The communication options available (local network or GSM/GPRS gateway) depend on the type of transmitter (see *Chapter 4, System Overview and Operation*).

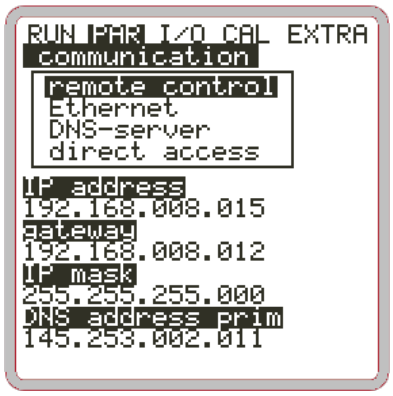


Figure 8-85 Options for Internet connection

Remote Control

Select one of the following options for remote access:

- Disabled – no remote access available
- Modem – (*For the FlowShark Pulse, this option currently is unavailable.*)

- Ethernet – communication via a local network (*Ethernet*) *or* a GSM/GPRS gateway with static IP address SIM card
- Modem → Ethernet – (*For the FlowShark Pulse, this option currently is unavailable.*)

While any variation in communication is possible, the unit must support the selected option for communication to occur. The respective configuration is available on the device ID posted on the unit (refer also to *Chapter 4, System Overview and Operation*).

Figure 8-86 Selecting remote access

Ethernet

Choosing this option allows the user to designate whether to automatically assign the IP address (required for unit access) or manually enter the address. Selecting **YES** executes assignment automatically through a DHCP routine (similar to the Internet PC setting **Get IP address automatically**). Selecting **NO** allows the user to enter the unit IP address manually. Always select this option for applications involving a GSM/GPRS gateway with static IP address SIM card. When manually entering an IP address, ADS recommends using a network address assigned by the IT administrator.

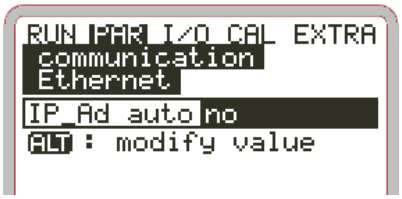


Figure 8-87 Selecting automatic or manual IP address

Observe the current network configuration.

Figure 8-88 Assigning the IP address

If the manual option (**NO**) has been selected, enter the IP address, the gateway (*optional, in case of interdigitate subnets*), and the IP mask. For the IP mask, the default setting (255.255.255.000) typically is suitable for most connections.

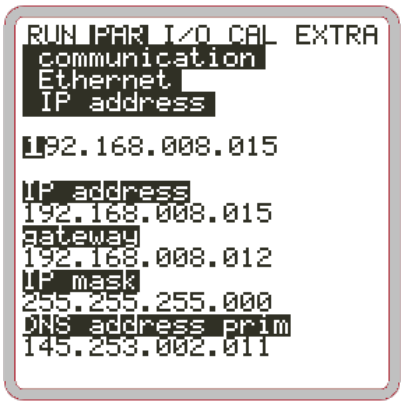


Figure 8-89 Manually setting the IP address

For assistance, please contact the system administrator or an ADS representative.

DNS Server

This parameter will display only if remote control has been enabled and **Ethernet: IP_Ad aut = yes** has been selected.

Typically, ADS recommends setting **DNS auto** to **yes**. This setting allows the provider or the local network to assign the DNS automatically. If it is set to **NO**, the user must enter a primary and secondary DNS, which are available from the service provider or system administrator of the local network.

Figure 8-90 Manual DNS entry

Direct Access

This setting is required only if the user is connecting to the FlowShark Pulse directly from a Laptop/PC through a network cable and the internal RJ45 interface. Under this configuration, designate both a username and a password for the internal connection on the PC/Laptop.

Figure 8-91 Enabling direct unit access

Signal Input/Output Menu (I/O)

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

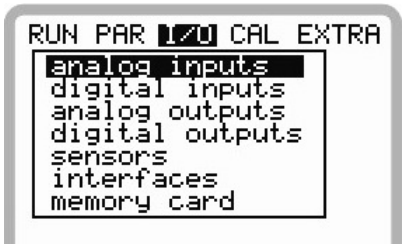


Figure 8-92 I/O submenu

This menu essentially allows the user to view any input and output, even those that may not be connected or available, such as with the Model 10 transmitter.

I/O Menu: Analog Inputs

The user can manage and view analog input values routed to the transmitter inputs from this menu. Use this menu to display values before (in [mA/V]) or after (calculated values) the analog input linearization.

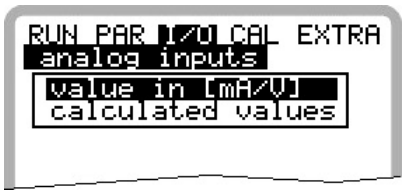


Figure 8-93 Selecting indication of values

This function primarily is useful for controlling current signals from external depth/height measurement units during initial start-up.

Typically, **Values in [mA/V]** will be set. A screen similar to the following will display:

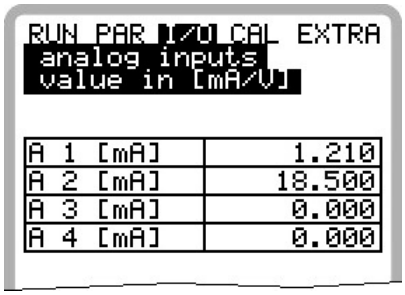


Figure 8-94 Analog value indication

Setting **Calculated values** without an available signal (>4 mA) will display the following error screen:

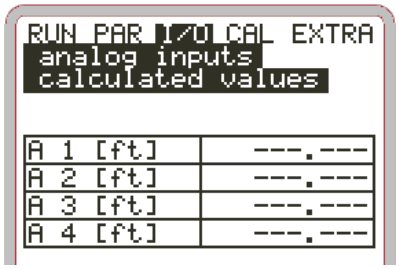


Figure 8-95 Error screen

I/O Menu: Digital Inputs

The menu enables the user to view digital input values routed to the transmitter input clamps. Displays **OFF** or **ON**.

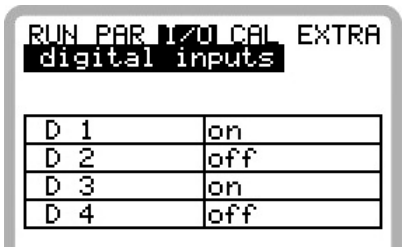


Figure 8-96 Screen digital values

I/O Menu: Analog Outputs

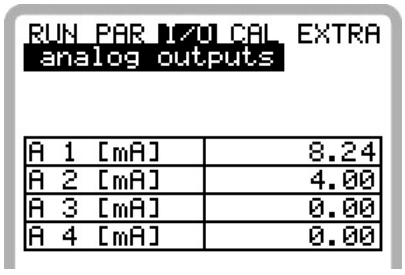


Figure 8-97 Screen analog values

This menu indicates the calculated values that must be sent to the analog converter as mA signals. While a Model 10 transmitter allows the user to set and display 4 analog outputs, only analog outputs 1 and 2 physically exist.

The actual current on the output clamps will not display. The only visible signal is the signal the analog output converter receives for output purposes.

The unit can neither detect nor indicate faulty external wiring through this menu.

I/O Menu: Relay Outputs

The user can view conditions calculated by the transmitter and later routed to the relay for output purposes from this menu. Displays **OFF** or **ON**.

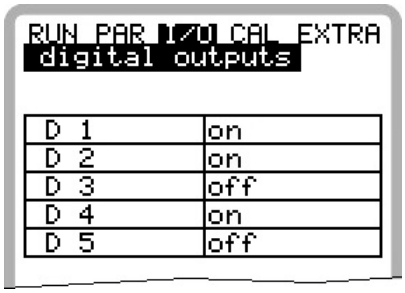


Figure 8-98 Digital values

The actual output condition of the relay contacts on the output clamps will not display. The only signal visible is the signal the relay receives for output purposes.

The unit can neither detect nor indicate faulty external wiring from this menu.

I/O Menu: Sensors

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

When using 2 or 3 flow velocity sensors, select the sensor by choosing the corresponding channel number. The menu that displays depends on the sensor configuration (depth measurement from bottom up, depth measurement from top down based on range, pressure measurement, or external sensor measurement):

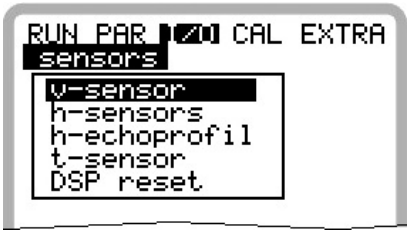


Figure 8-99 Basic selection menu

The subsequent submenu **H-Sensor(s)** may vary based on the depth sensor selected:

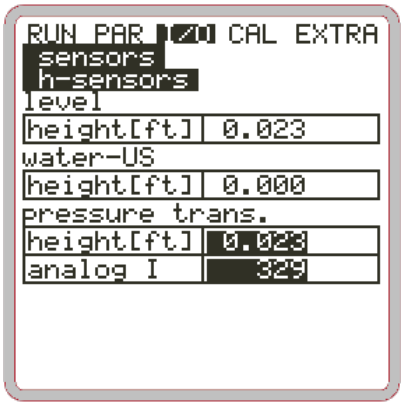


Figure 8-100 Menu with water-ultrasonic sensor from bottom up

V-Sensor

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

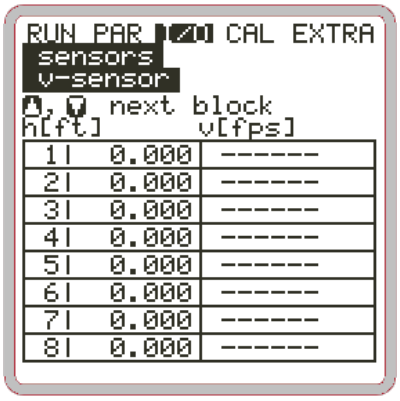


Figure 8-101 Individual velocity readings

▲ + ▼

Toggle between both pages (measurement windows or gates 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 is not available for measurement in the associated 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 13.78 inches (35 cm), where

the FlowShark Pulse automatically reduces the number of measurement windows available. The unit does not require as many measurement windows when low flow depths exist.

The failure of one or more windows does not determine measurement success. However, ADS recommends investigating the location if more than 50 percent of the measurement windows fail (except under low flow conditions). When necessary, please contact ADS for diagnostic support.

H-Sensor

When **level measurement from bottom up** has been selected, the depth level and signal quality for the returned echo will display. When external depth measurement devices are in use, only the input signal (mA) for a sensor is available.

The signal quality level should be around 90 to 100 percent. Therefore, a depth measurement with a signal quality falling below 50 percent will be rejected, producing a 0 reading.

H-Echo profile

(*enabled only when measuring depth using an air- or water-ultrasonic sensor)*

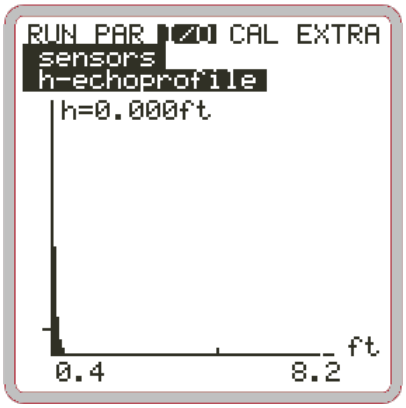


Figure 8-102 Echo profile for depth measurement

The previous graphic enables the service personnel to assess the echo signal within the acoustic range measured. Ideally, the initial peak would be very narrow, steep, and high, representing reflections from the interface between water and air. The remaining peaks would be lower and wider, representing double and multiple reflections caused by the signal echoing back and forth between the water/air and water/ground interfaces.

T-Sensor

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

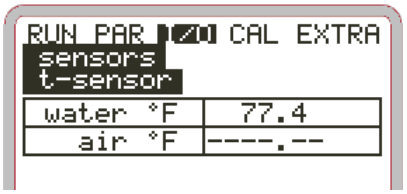


Figure 8-103 Temperature screen

I/O Menu: Interfaces

This menu displays the transmission speed of the internal interfaces. This information is available only for service purposes and is not relevant to the user.

I/O Menu: Controller

This menu is available only when the controller has been enabled through the PAR menu.

Figure 8-104 Controller information screen

Info

This menu indicates all the signals (end switch) and settings (proportionality factor, slide valve run time, control deviation, etc.) required for controller operation. It also displays the output signal times (regulating and switching times).

Use the information on this screen to detect missing end switch conditions and to monitor the current control deviation, calculated regulating time, and current controller condition. This menu also provides basic diagnostic options for addressing internal controller errors or problems.

Figure 8-105 Overview of current controller processes

Manual operation

The user can open and close the slide valve manually for testing purposes. The arrow keys, ▲ and ▼, serve as the controls for manual operation.

Figure 8-106 Menu for manual controller operation

I/O Menu: Memory Card

This menu enables the user to view general information concerning the memory card. The user also can save data and display and load the system parameters from this menu.

Figure 8-107 Memory card menu

The **Info** menu contains information concerning the remaining storage capacity and time on the card.

Figure 8-108 Card information

This information is accessible only when the memory card is installed in the unit. The card must be installed in the unit for at least one hour before the user can view the remaining storage capacity and time on the card.

*The user can replace the memory card at any time, unless the display indicates **MemoryCard active**, which occurs for approximately 1 second each full hour.*

Format the card using the following menu. Perform this procedure when using the card for the first time and following each data transfer operation. The formatting process takes 10 to 60 seconds, depending on the card capacity, and is complete when the main screen re-appears.

Do not press any keys or turn the unit off during formatting. This could cause irreversible damage to the card.

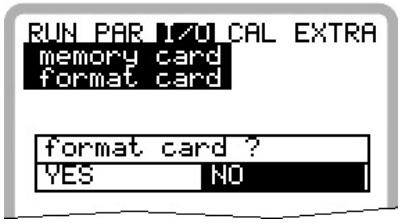


Figure 8-109 Card formatting request

All data saved to the card will be removed during the formatting process.

Save FlowShark Pulse parameter settings for backup purposes or to transfer the settings to similar measurement locations.

Select **Save parameters** to write the parameters to the memory card. This procedure takes approximately 30 seconds; a progress bar displays for tracking purposes.

Figure 8-110 Saving parameters to the memory card

The **Load parameters** menu option displays all the configuration files available on the card. Selecting this option transmits the file to the FlowShark Pulse.

The name of the required file is **PARAMET.NIV**.

save writes the parameters from the FlowShark Pulse to the memory card

load writes the parameters from the memory card to the FlowShark Pulse

The FlowShark Pulse enables the user to back up data stored in the unit within the past 14 days for protection against data loss due to a faulty data readout, defective

cards, unintentional formatting, or other issues. Use the **Store backup** option to perform this operation.

Figure 8-111 Data backup

Calibration and Calculation Menu (CAL)

CAL Menu: Level

This menu allows the user to calibrate depth sensors against actual field measurements by automatically modifying sensor mounting heights, adapt analog outputs to the corresponding systems, and emulate relay switching events and analog outputs. An option to enable and/or modify the automatic velocity calculation function (when depth falls below the minimum depth required for velocity measurement) also is available.

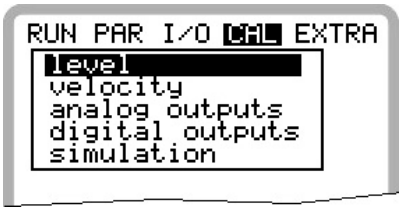


Figure 8-112 Menu selection

When using a combi sensor with the pressure measurement cell to measure depth, the pressure measurement cell, based on its design, may experience zero point drift over an extended period of time (refer to *Chapter 3, Overview and Specifications*). Therefore, calibrate the pressure sensor to the zero point on a regular basis. ADS recommends calibrating the sensor every 6 months. Analyze measurements taken with the sensor out of the flow or in as shallow flow as possible.

Manually measure the depth levels thoroughly before calibrating the sensor (i.e., adjusting mounting height) according to another reliable measurement method or device (e.g., value = 0, if the sensor has been removed from the flow).

The current depth level and range of fluctuation, including minimum and maximum values, measured by the sensor will display while this window is open. This will allow the user to determine the stability of 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 by clicking on the ↵(Enter) key.

Enter the manual (field-confirmed) value in the reference field on the next menu.

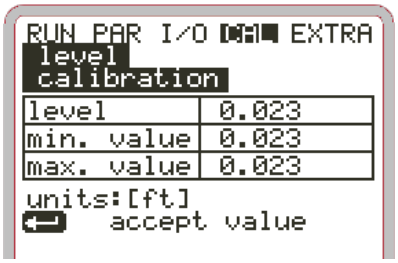


Figure 8-113 Adjusting the depth measurement

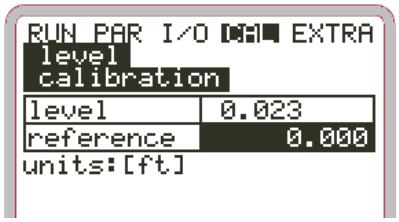


Figure 8-114 Entering the correct depth (level)

An overview menu displays, showing the new sensor depth (level) values to use. Upon pressing the **ESC** button to return to the main menu, the user receives a prompt to save these new values. The user can save these values by selecting **YES** or ignore and eliminate these new values by selecting **NO**.

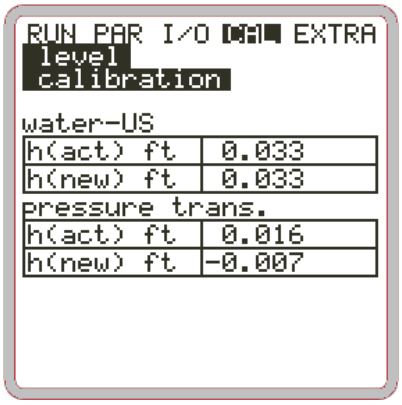


Figure 8-115 New sensor values

Figure 8-116 Prompt to save values

Determining the zero point for the pressure measurement cell often involves measuring the current depth level using a yardstick, a ruler, or another similar device without removing the sensor from the flow. This method, however, can produce errors. Inserting the ruler (or yardstick) into the flow can create a surge leading to erroneous measurements depending on the current flow velocity.

CAL Menu: Velocity

Based on the continuous profiling technology employed, velocity typically does not require calibration. However, under unusual site conditions where velocity requires constant adjustment, contact ADS for assistance in performing calibrations.

When flow falls below the minimum depth required for proper operation of the velocity sensor, (i.e., only 2.2 inches of flow exists between the water ultrasonic sensor face and the flow surface or a total depth of 2.6 inches of flow exists when the bottom plate of the sensor is at the bottom of the channel), use an automatic estimation (*auto calculation*) of velocity. Use this function for computing very low flow velocities under low depth conditions, such as unusually low minimum nightly flows. Do *not* implement this function at locations that experience backwater conditions.

Make sure that obtaining reliable depth measurements down to 0 is possible through an independent, external depth measurement device (e.g., an air-ultrasonic sensor).

With falling depth levels, at some point it may no longer be possible to measure flow velocity. When depths reach this designated minimum level, h_crit (critical level, the lowest level at which flow velocity can be measured reliably), the FlowShark Pulse will create an internal table of Q & V vs h values using the last valid flow velocity reading before dropping below this critical depth. This table of values enables flow calculations to continue, even when velocity measurements are not available, by assigning an estimated velocity to a corresponding depth level (based on the Manning-Strickler relationship). The unit automatically will compensate for the shape of the pipe in the curve.

The erroneous measurements that develop from using this method in the context of unstable hydraulic conditions may be significantly greater than the errors that arise from measuring the actual flow velocity and depth levels.

This method is suitable only for very low flow volumes that are backwater-free.

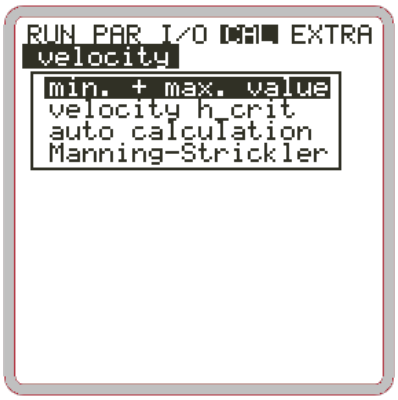


Figure 8-117 Calculation – submenu

min. + max. value

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

Set the minimum value below zero only when negative readings are expected. It is impossible to measure and to record negative velocity readings during negative flows if the minimum setting is 0.

Velocity h_crit

This table represents either the latest values obtained from depth and corresponding velocity measurements or preset values (i.e., default values of 2.6 inches for h-critical and zero for v-critical). If a reasonably reliable estimate of velocity is available at the critical depth, enter this estimate as v-critical. Otherwise, the system will apply values from the Manning-Strickler table to estimate the corresponding velocity when depth drops below h-critical while the **auto calculation** function is in use (*set to **yes***). See *Auto Calculation* on page 8-71.

Leaving the default v-critical value at zero with the **auto calculation** function disabled (*set to **no***) will drop velocity to zero when depth is below h-critical.

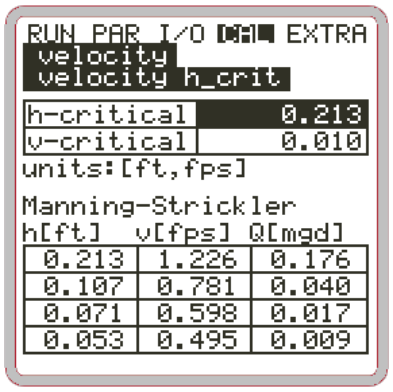


Figure 8-118 Table of values for automatic Q/h relation

Manning-Strickler

The user can change the Manning-Strickler coefficient and slope values used to populate the internal Manning-Strickler table manually or allow them to adjust automatically by setting the auto calculation function to **yes** (Refer to *Auto Calculation* on page 8-71).

Figure 8-119

Auto Calculation

Selecting **automatic YES** from the **auto calibration** menu automatically updates the Manning-Strickler table based on the last valid velocity value before depth drops below h-critical. Selecting **automatic NO** prevents set values (*including v-critical*) from changing, regardless of subsequent measurements.

Use the **ALT** button to toggle between **YES** and **NO**.

Running simulations through FlowShark Pulse outputs will impact controlled facility equipment that does not have security measures in place!

*Simulations should be executed **only** by knowledgeable personnel.*

Due to the extremely high risk of danger and unpredictable consequences that may arise from incorrect or faulty simulations, ADS is not responsible for any possible injury to persons or damage to property that may occur.

Simulating analog inputs and outputs may be performed only by trained, specialized electricians with in-depth knowledge of the facility's control system. In addition, safety personnel must be available at all times.

The following system must be set to manual operation mode. Actuators or similar devices must be disabled, if possible, or under strict control to prevent damage.

Analog Outputs

This parameter allows the user to simulate FlowShark Pulse output signals.

After selecting **analog outputs**, enter the PIN again. This will prevent unauthorized personnel from executing simulations during operation.

Figure 8-120 Selecting the analog output simulation

Channel number

Choose the analog output (from 1 through 4) to simulate by entering the respective number or using the **left** or **right** arrow keys in the simulation main menu.

Simulation

Enter the desired value in mA and confirm by pressing **Enter** to output the signal directly to the corresponding terminal.

Figure 8-121 Executing the simulation

Relay outputs

Select the desired relays to simulate by pressing the **left** or **right** arrow keys. The relay number chosen will display on the first line of the output table.

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

After selecting **Relay Outputs**, enter the PIN again. This will prevent unauthorized personnel from executing simulations during operation.

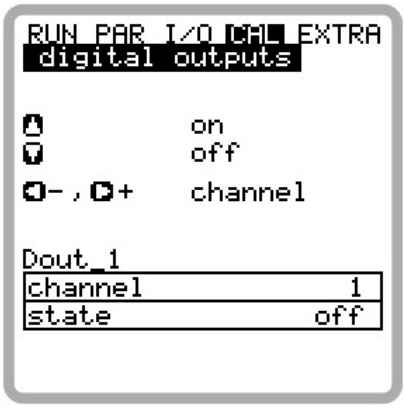


Figure 8-122 Relay simulation

CAL Menu: Simulation

This function allows the user to simulate flow conditions by entering hypothetical depth and velocity values that are not currently available. The FlowShark Pulse will calculate the current flow measurement based on the simulated values and 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.

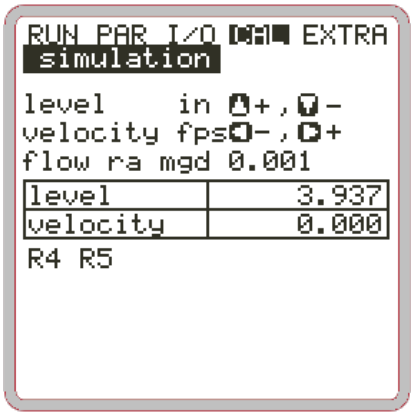


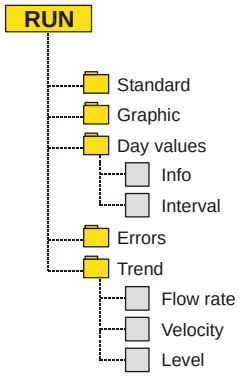
Figure 8-123 Flow measurement simulation

CHAPTER 9

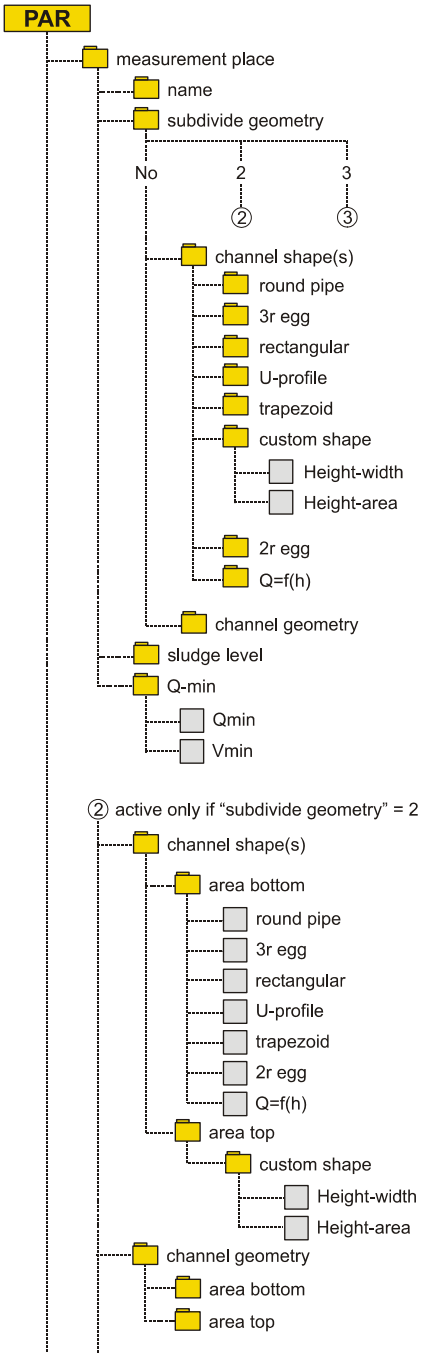
Parameter Tree

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

Operation Mode Menu (RUN)

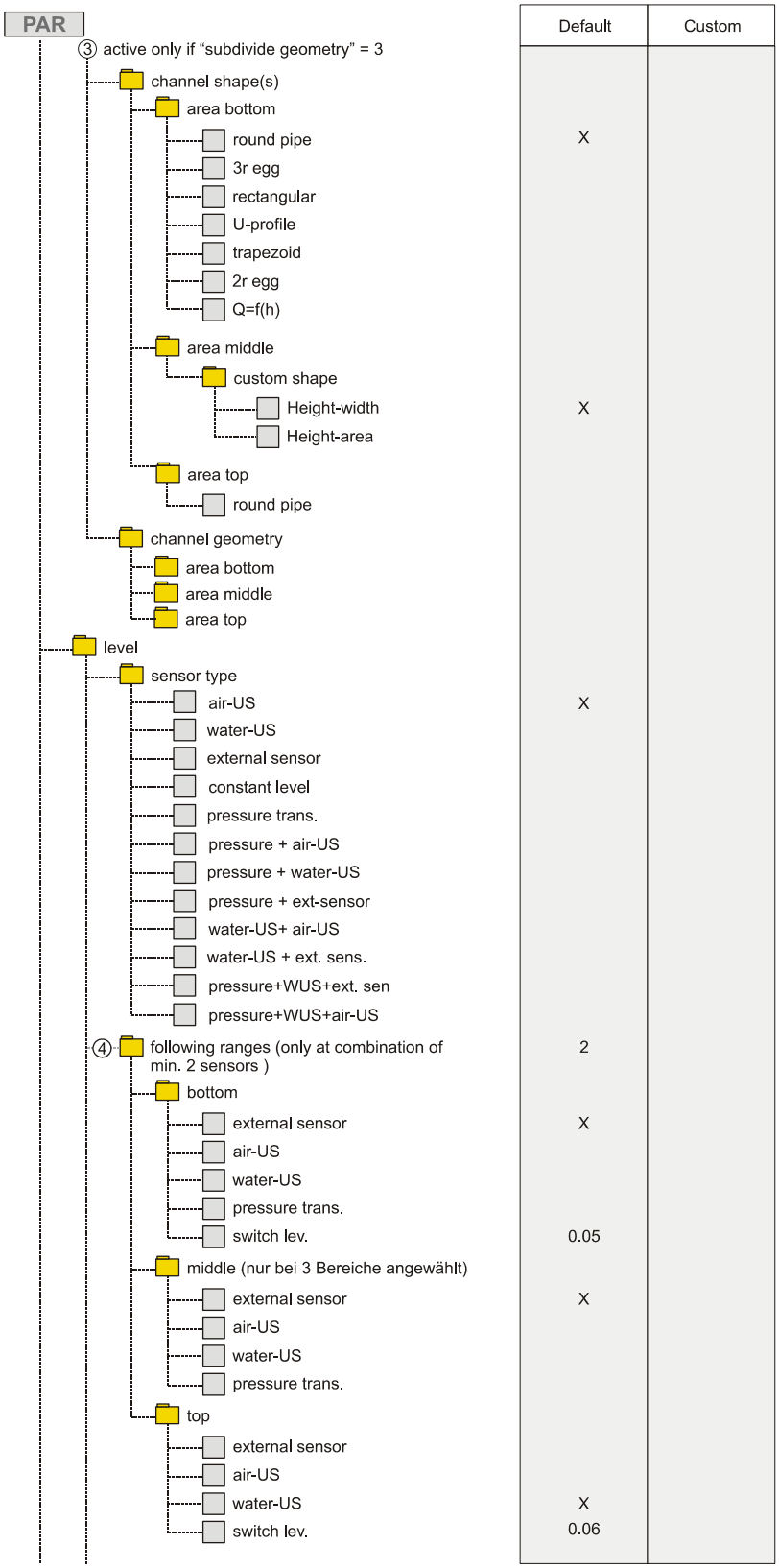


Parameter Menu (PAR) Part 1

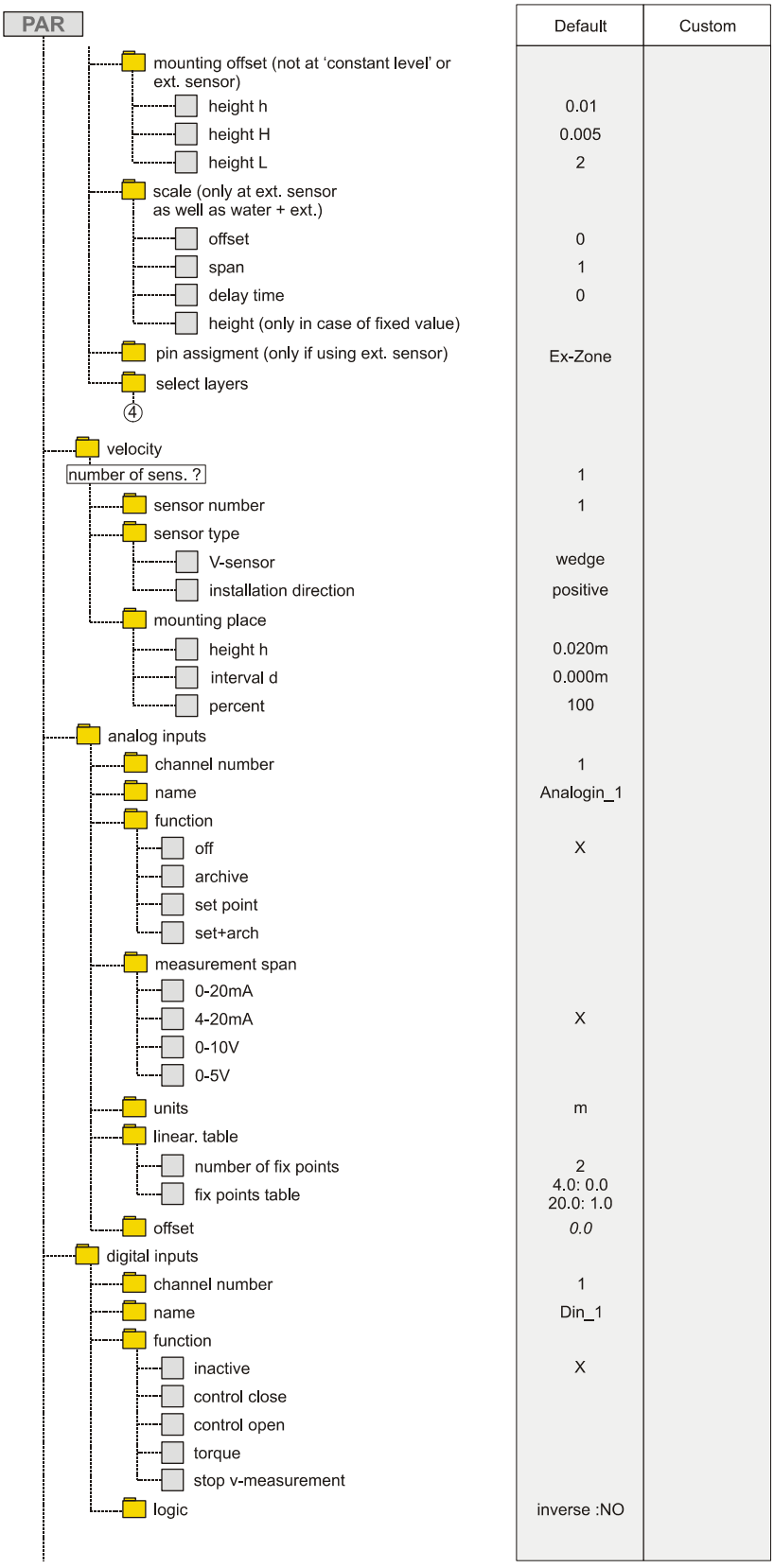


	Default	Custom
name	nivus	
subdivide geometry	No	
channel shape(s)		
round pipe	X	
channel geometry	0.5	
sludge level	0	
Q-min		
Qmin	0	
Vmin	0	
area bottom		
round pipe	X	
area top		
custom shape	X	

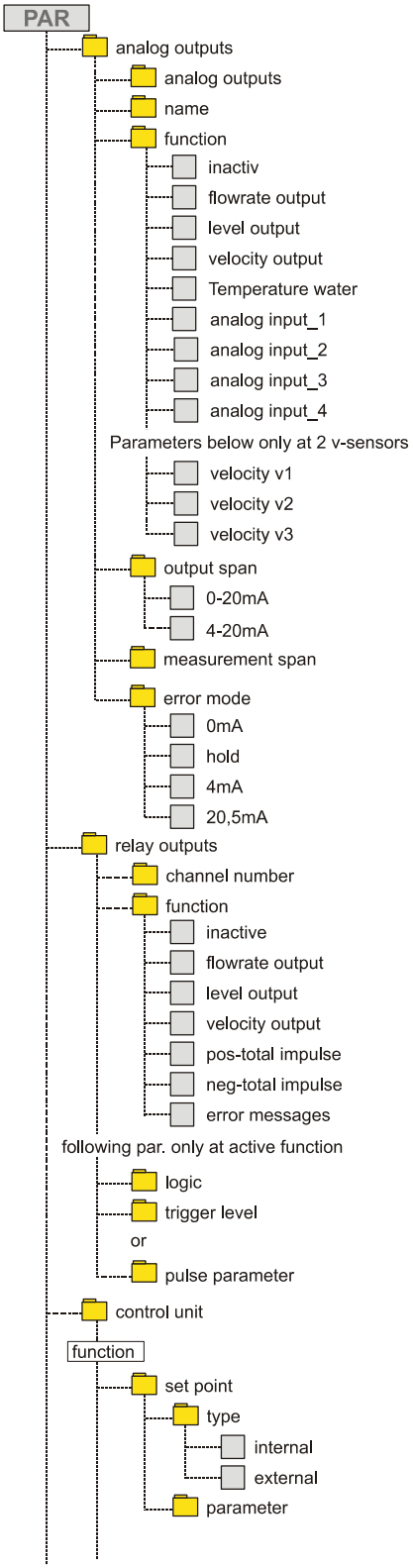
Parameter Menu (PAR) Part 2



Parameter Menu (PAR) Part 3

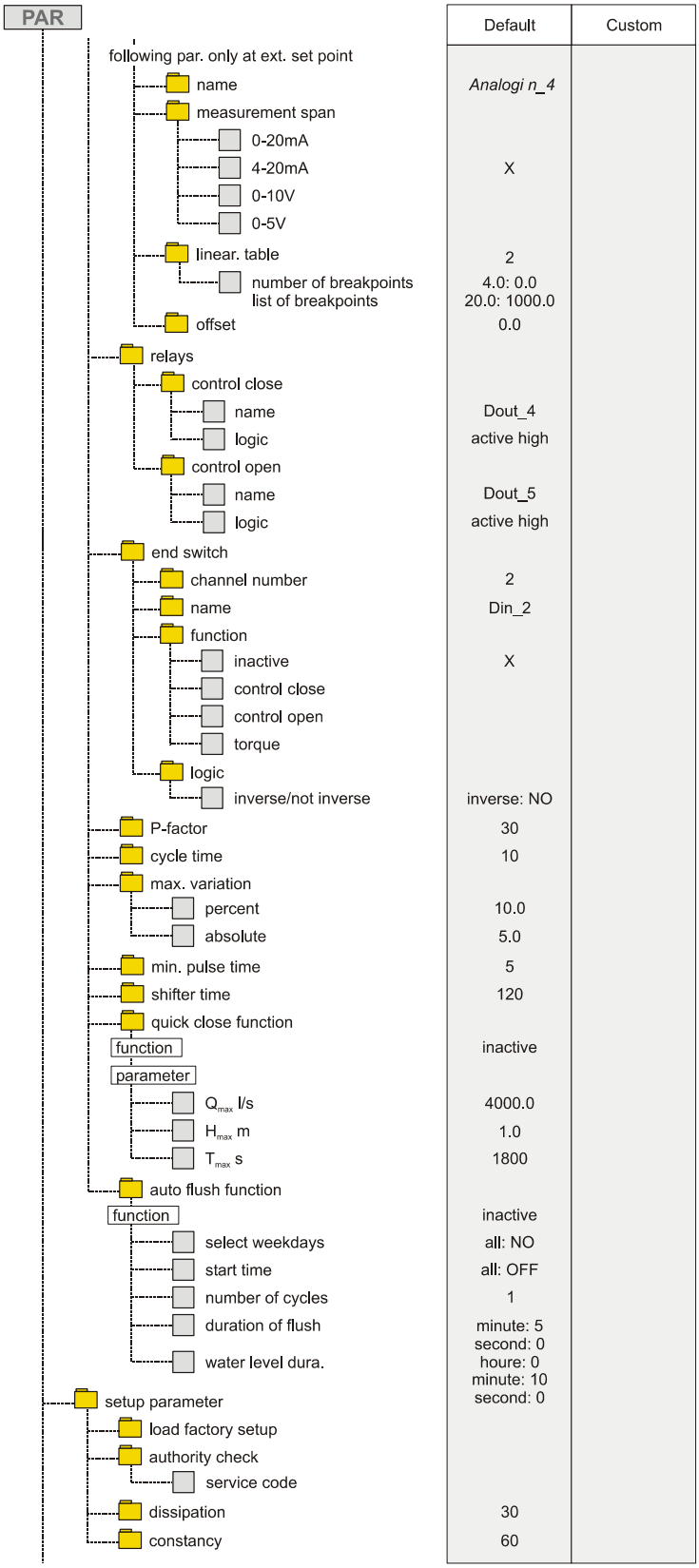


Parameter Menu (PAR) Part 4

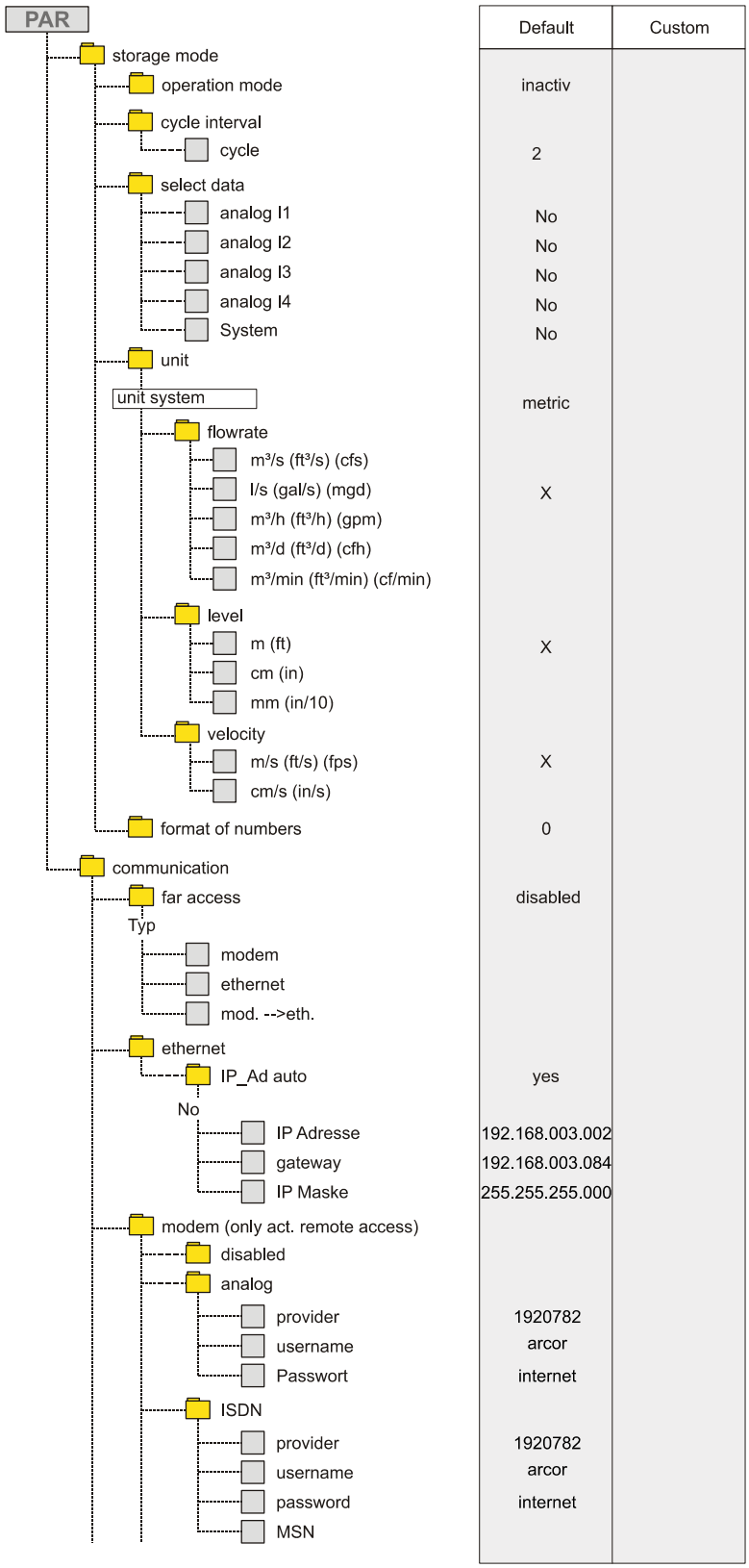


Default	Custom
1	
dac_1	
X	
X	
0/4mA: 0.0 20mA: 20.0	
X	
1	
X	
active high	
on: 0.0 off: 0.0	
duration: 0.5 quantity: 0.1	
inactive	
X	
100	

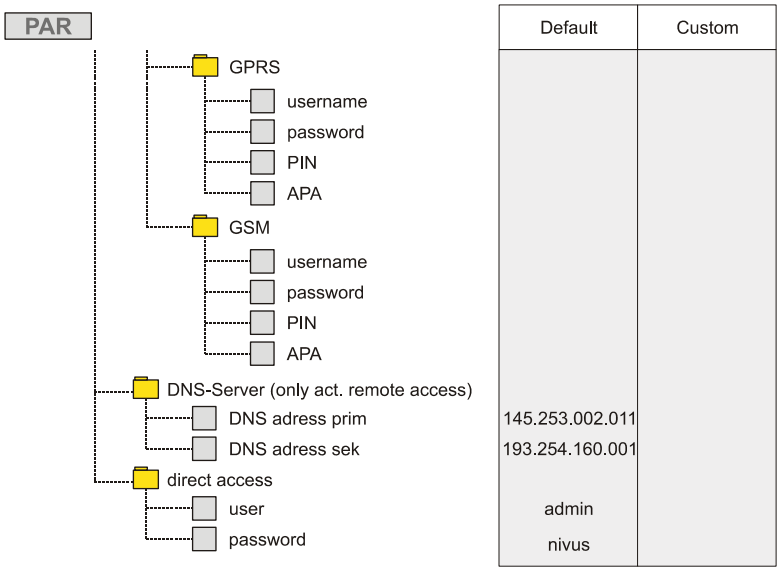
Parameter Menu (PAR) Part 5



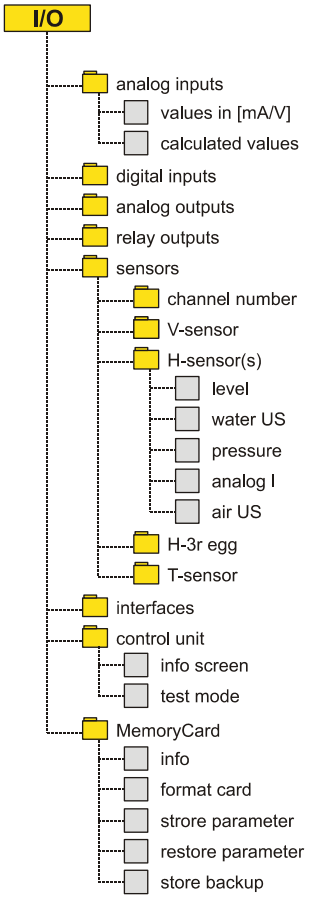
Parameter Menu (PAR) Part 6



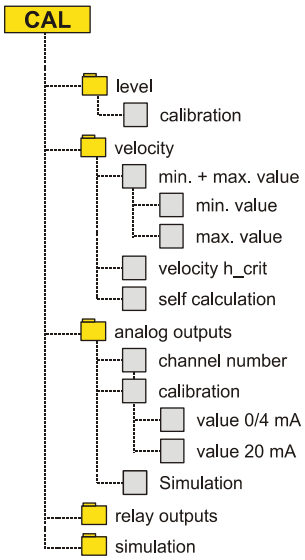
Parameter Menu (PAR) Part 7



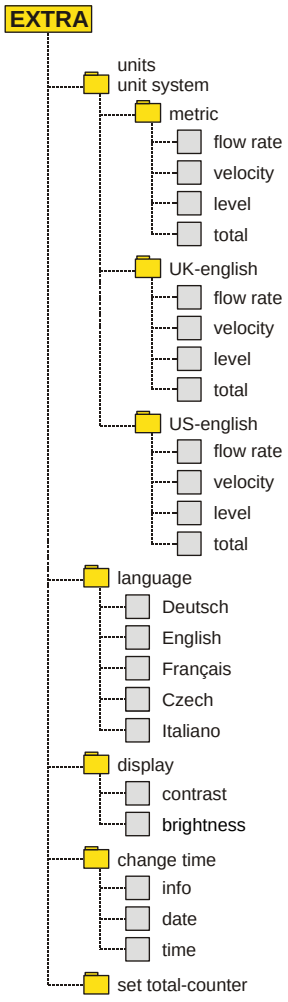
Signal Input/Output Menu (I/O)



Calibration Menu (CAL)



Display Menu (EXTRA)



CHAPTER 10

Data Collection

Once the system parameters have been set by the user, the FlowShark Pulse can begin taking the appropriate measurements and logging relevant data. Managing and collecting this data directly from the unit occurs through an Internet browser.

The FlowShark Pulse does not provide real-time access or automatic data transmission. Access to the FlowShark Pulse involves direct communication initiated by the user through a PC or laptop computer.

This chapter contains instructions for collecting the data from the memory card on the FlowShark Pulse, deleting data files, and viewing data.

Data Collection

After a connecting and logging onto the FlowShark Pulse through a browser (refer to *Chapter 7, Initial Start-up and Communication*), the screen will display the current **Measurement Data** (flow rate, depth level, and flow velocity), the transmitter display window, and several links.

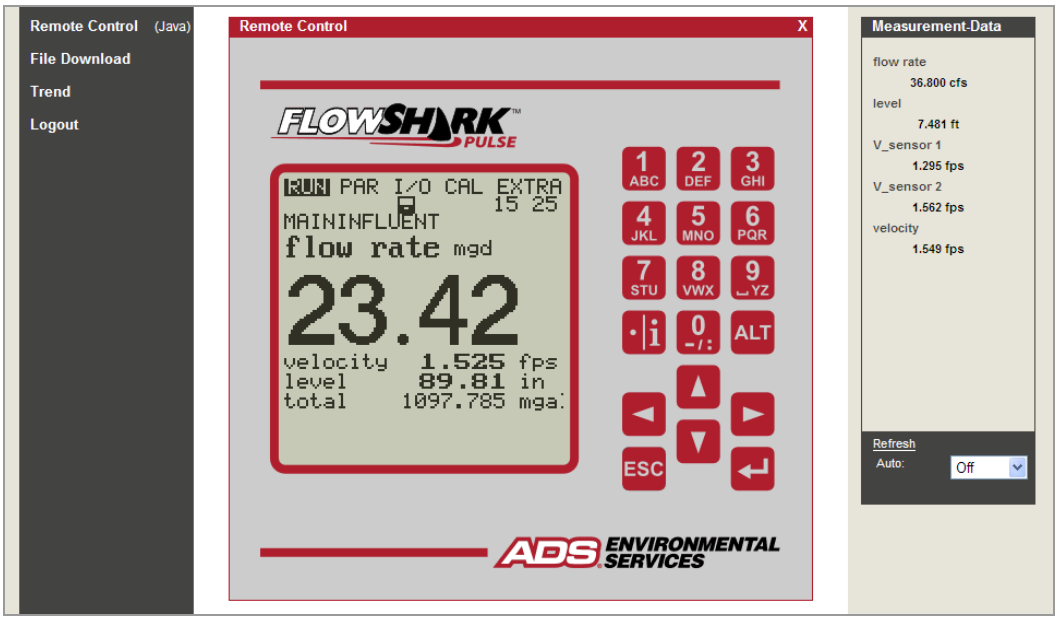


Figure 10-1 Viewing the connection online

Click the **File Download** link to download data directly from the memory card installed in the unit. Downloading this data will *not* delete the information from the card; therefore, this data will be available for downloading at a later time.

After clicking the desired file, either open the file directly or download it in the original, uncompressed format or as a compressed .zip file. Use a file utility, such as WinZip®, to extract the file from the .zip file.

Using the .zip format reduces the file size by approximately 75 percent and, therefore, ADS recommends using this format.

Refer to *Chapter 8, Parameter Settings*, for more information on the FlowShark Pulse file structure and using the individual files.

The user cannot transfer data files if the memory card is not installed and the storage capability is disabled.

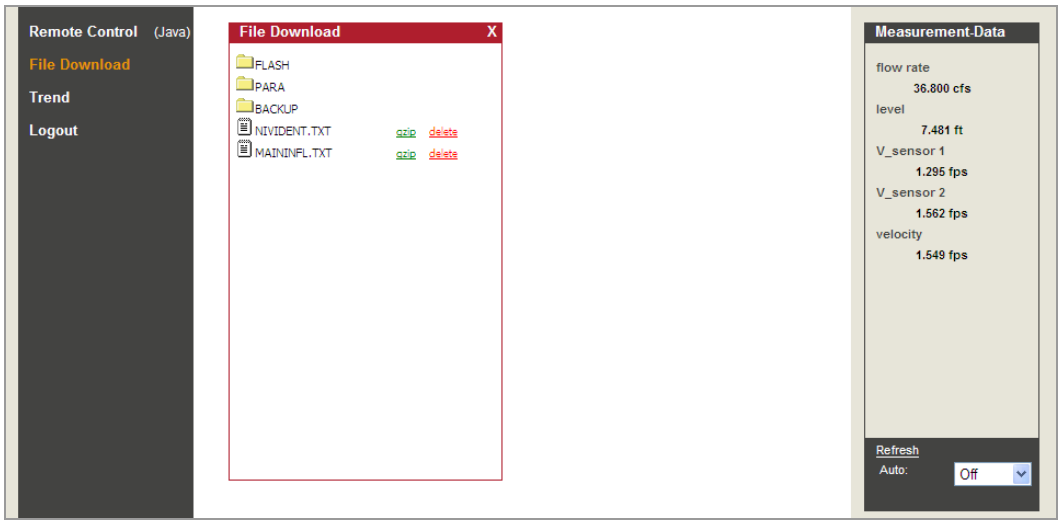


Figure 10-2 Selecting the file to transmit or delete

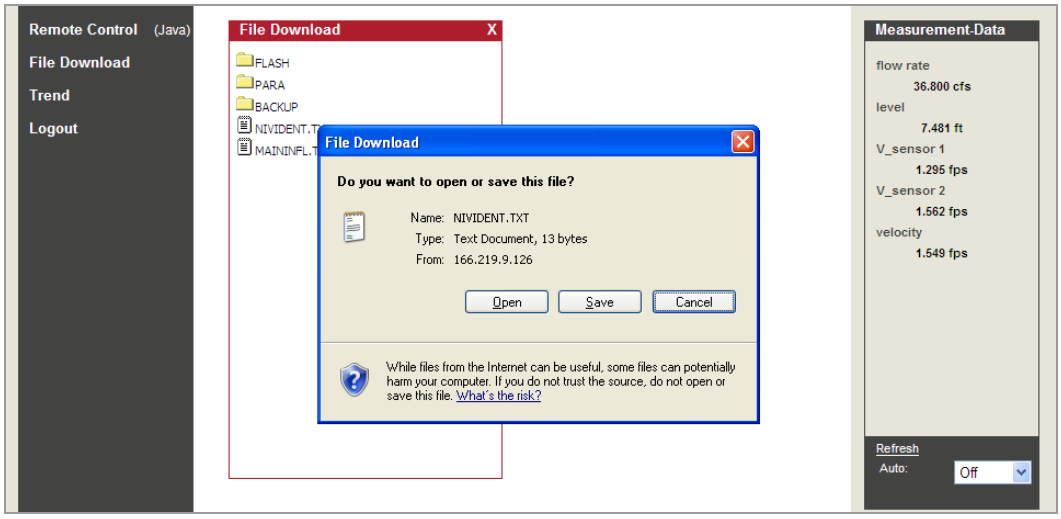


Figure 10-3 Viewing or saving transmitted files to the PC or laptop

Deleting Data Files

Delete a specific file by clicking the red **delete** link corresponding to the file (Figure 10-4). To save this file for viewing or to transmit the file at another time, the file will be moved into a backup folder. If a backup folder does not already exist, it will be created automatically. Files that have been transferred to this folder can be permanently removed from the memory card by deleting the file from the backup directory.

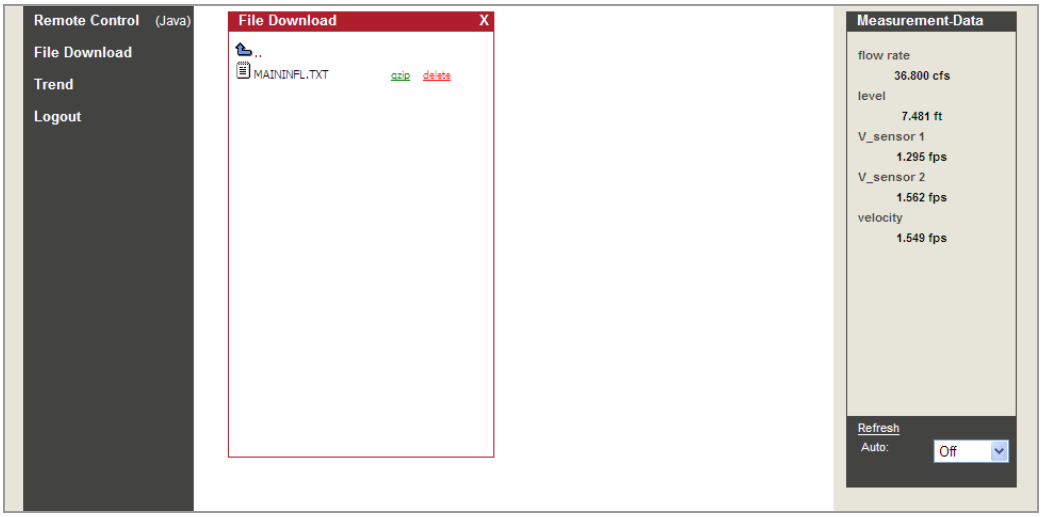


Figure 10-4 Contents of backup folder created

Data files that have not been deleted or moved to the backup folder will continue to receive all future readings. This will dramatically increase the size of the file because older, duplicate data will be transmitted and saved to the file again.

Deleting a file (moving it into the backup folder) while a file of the same name exists in the target folder will cause the older file to be overwritten without warning.

Viewing Data

Clicking the **Trend** link on the left side of the screen displays a trend graph similar to the trend screen displayed on the FlowShark Pulse. This graph displays up to 90 days of the data stored in the unit memory. The following screen (Figure 10-5) offers an example of this graph.

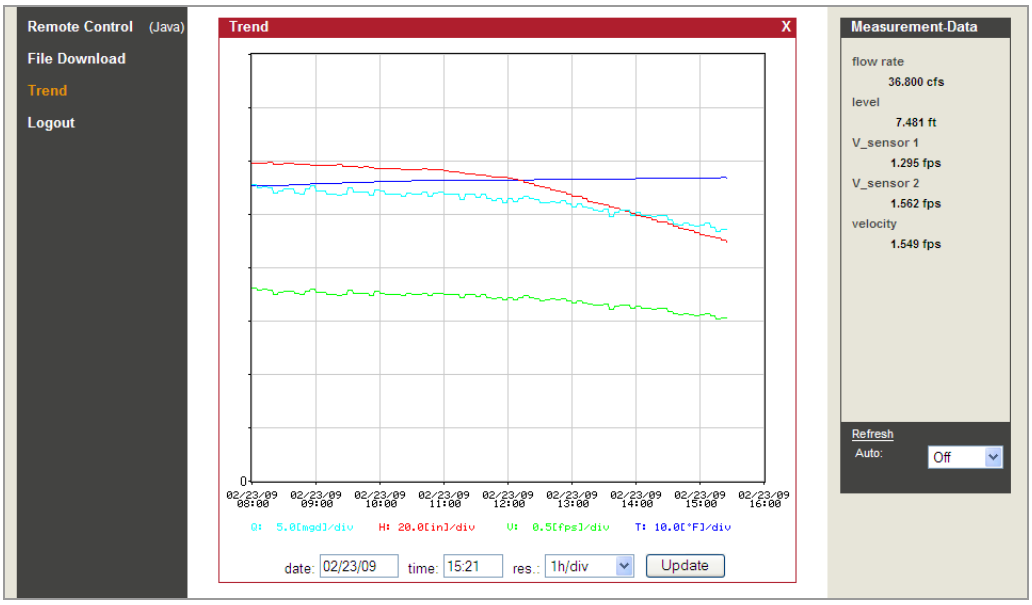


Figure 10-5 Online trend graph

Flow volume, depth level, average flow velocity, and water temperature display in color on the graph. The units on the graph reflect the units designated on the FlowShark Pulse display.

The readings on the y-axis are scaled at intervals of 0.1, 0.2, 0.5, 1, 2, 5, 10 ..... up to 10000. For this example, the selected scaling unit represents a horizontal line on the grid.

Set the starting date and time for the trend graph in the **Date** and **Time** fields and set the resolution (scale of the time axis) for the graph in the **Res** field. Choose from the following options: 10 minutes, 1 hour, 6 hours, or 24 hours per grid line.

Click on the **Update** button to refresh the graph with new measurement data as it is collected.

If the selected start date/time for the graph is the current date/time or the time axis range allows the user to view a larger range than selected for the start date/time and resolution, the graph will include data that is older than the start date/time selected.

CHAPTER 11

Troubleshooting

Error	Possible Reason	Correction
No Indication of Flow (0 *or* ----)	Connections	Check the connection between the sensor cable and terminal strip. Check the connection boxes, sensor extension cable connections, and air compensation element for proper connection or moisture.
	Sensor	Check sensor installation for proper orientation toward the flow and horizontal position.
		Check the sensor for existing soil, sedimentation, or silt, and remove obstructive debris as necessary. Check the sensor for mechanical, body, or cable damage, and replace the sensor, when necessary.
	Flow Depth Measurement	**Important:** When no flow depth exists, measuring flow velocity is not possible. **Water-ultrasonic measurement:** Check the sensor for horizontal installation. Check for sensor function in **I/O > Sensors > H-Sensor > echo profile** menu. **External level measurement:** Check the external transmitter for function and signal transmission. Inspect cables, clamp connections, short circuits, and contact resistances. **Pressure cell measurement:** Inspect the compensation tube and hardware for obstructions.
		When flow depth is greater than 2.56 inches (65 mm), the FlowShark Pulse is in Q/H measurement mode at initial start-up. Manually enter the velocity at a depth of 2.56 inches (65 mm) in the **CAL > Flow vel. > Velocity h_crit** parameter. Perform this procedure only one time.

Error	Possible Reason	Correction
		Check depth measurement parameter **Fixed value** when measuring in a full pipe without obtaining a depth measurement.
	Transmitter	Check error memory log and take corrective measures. Check cables, plug, and socket connections and sensor installation. Contact ADS if an **CPU Error** displays. Examine the moment of failure through the **RUN > Trend** menu.
	Negative Flow Direction	Check orientation of sensor installation and then reposition sensor, if necessary. For occasional reverse flows that are followed by measurement failure, set the minimum value to -3.28 feet per second (–1.0m/s) in the **CAL-Flow vel. – min. + max. value** menu.
	Configuration	Check the transmitter parameter settings thoroughly.
Blank or Flickering Screen	Connection	Check power supply connection.
	Power Supply	Check voltage of power supply.
		Check the switch position on the connection board.
		Compare the power supply (AC or DC) against the transmitter type.
	Memory card	Confirm that an ADS-supplied memory card is in use. Replace card from unauthorised manufacturer with ADS card, when necessary.
		Confirm memory card does not exceed capacity requirements. Use cards only within the maximum memory capacity allowed.
		Verify method used for formatting cards. Send cards formatted on a PC to ADS.

Error	Possible Reason	Correction
Sensor Error (X) Indicated on Display	Connection	Check cable connection. Verify wiring on terminal strip is properly connected, cables are firmly connected to plugs (retighten screws and pull at cable ends), and clamping of single wires is free of insulation. Confirm plug is firmly seated and connected in socket. **Note:** Error messages indicating sensor number 1, 2, or 3 refer to flow velocity sensor 1, 2, or 3, respectively. **Error Sensor 4** refers to the air-ultrasonic sensor.
	Communication	Check communication with the sensor by pressing the **I** key. Screen should display sensors in the third line. Check cables for interruption or loose connections and the sensor for mechanical damage.
Erratic Readings	Unsuitable Hydraulic Conditions at Measurement Location	Use the graphic flow profile display to verify the quality of the measurement location. Relocate the sensor to a more suitable location that exhibits better hydraulic conditions (extend calming section).
		Remove any existing silt or other obstructions from the front of the sensor.
		Straighten 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 and horizontal position.
		Inspect the sensor for silt or other obstructions.
Erroneous Readings	Unsuitable Hydraulic Conditions at Measurement Location	Refer to possible solutions under **Erratic Measurement Readings**.
	External Level (Depth) Signals	Check for proper connection.
		Check for damaged or crushed cables, short circuits, improper resistance loads, or current-consuming devices without galvanic isolation.
		Check measurement range and span.
		Check input signal from **I/O** menu.

Error	Possible Reason	Correction
	Sensor	Check for correct 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 from **I/O** menu.
		Verify that the sensor is installed in a vibration-free location. Check sensor installation for orientation to flow, horizontal position, and presence of silt.
	Configuration	Verify proper settings for measurement location, such as pipe shape and dimensions (and units), sensor type, and sensor installation height.
Faulty Relay Output	Connection	Check connections on terminal clamp strip.
		Check power supply for external control relays.
		Check signal output in the **I/O** menu.
		Check output control function in calibration menu.
	Transmitter	Verify transmitter type. While Model 10 transmitters have only 2 relay outputs, Model 20 transmitters have 5 relays.
	Configuration	Verify that relay outputs have been enabled.
		Verify outputs are properly assigned to their respective output channels.
		Check additional values, such as impulse parameters, limit values, and logic.
Controller is not Functioning	Connection	Check terminal clamps. Relays 4 and 5 are dedicated to controller function.
		Check the power supply for the external control relays.
		Check the input signals from the limit contacts and setpoint.
		Check the output control function manually through menu-driven controller operation.
	Transmitter	Verify the transmitter type. Only Model 20 transmitters are suitable for controller operation.
	Configuration	Check relevant settings. Verify whether the controller has been enabled and parameters

Error	Possible Reason	Correction
		have been set; analog input has been set and enabled as the setpoint; and relay outputs have been enabled.
Faulty mA Output	Connection	Check the connection clamps for the correct wiring and polarity.
		When several outputs are in use, make sure the receiving systems/indicators are not indicating a voltage. Two analog outputs share a common ground.
	Configuration	Verify that the output has been enabled.
		Verify that specific functions have been assigned to the correct output channels.
		Check the output range (0 or 4-20 mA).
		Check the output span.
		Check the offset.
		Check the output signal on the **I/O** menu
	Receiving Systems	Check cables and connections as well as input and output terminals.
		Check the input range (0 or 4-20 mA) for the system undergoing monitoring.
		Check the input span for the system undergoing monitoring.
		Check offset for the system undergoing monitoring.
Memory Card has No Data or is Missing Data	Memory Card	Verify whether the memory card is functioning correctly. Check function in 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 that the system can support the memory card capacity. Older systems can read cards up to 32 or 64 MB. Check the capacity through the CPU version by pressing the **I** key. The system currently cannot support memory cards with more than 128MB capacities.
		Verify the method used for formatting cards. Send cards formatted on a PC to ADS.
	Transmitter	Verify that the memory card is seated

Error	Possible Reason	Correction
		securely and completely in the unit.
		Make sure the memory card has been seated in unit for at least 60 minutes. This is required prior to saving data. Unit saves data to the card every hour.
	Configuration	Verify storage is enabled in **Memory Mode > Operation Mode > Mode**.

CHAPTER 12

Materials and Chemical Resistance

Sensor construction involves the following materials:

- Stainless steel V4A (ground plate or pipe sensor jacket)
- PPO GF30 (sensor body)
- PEEK (sensor crystal cover)
- Polyurethane (cable sheath and glands)

Sensors with the pressure measurement cell include the following materials:

- Hastelloy C276
- Viton (PA/PR)

The sensors are resistant to wastewater, dirt, and rainwater. 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 or sensor jacket), hydrogen sulphide (H_2S – decays copper wires and conductor paths from diffusion through cable sheath or sensor body), and various organic solvents (dissolves cable sheath or 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.

Contact ADS representative to request free sample materials for long-term testing purposes.

For special applications involving highly destructive or solvent-containing media, Hastelloy or titanium ground plates are available for sensors made of PEEK. Pipe sensors composed of highly resistant steel also are available. A special FEP coating that is resistant to organic solvents or hydrogen sulphide is available for sensor cables that will be immersed in the following highly corrosive, destructive media:

MEDIUM	FORMULA	CONCEN-TRATION	HDPE	PPO GF30	PUR	PEEK	FEP	V4A
Acetaldehyde	C_2H_4O	40 %	3/3	4	4	1	(1)	(1)
Acetic acid	$C_2H_4O_2$	10 %	1/1	2	3	1	1/1	1/1
Acetic acid methylester	$C_3H_6O_2$	tech. clean	1/0	3	0	1	1/0	1/1
Aceton	C_3H_6O	40 %	1/1	4	4	1	(1)	1/1
Allyl alcohol	C_3H_6O	96 %	1/3	2	0	1	1/1	1/1
Aluminium chloride	$AlCl_3$	10 %	1/1	2	0	1	1/1	3/4
Aluminium chloride	$(NH_4)Cl$	aqueous	1/1	1	0	1	1/1	1/2L
Ammonium hydroxide	$NH_3 + H_2O$	5 %	1/1	2	4	1	1/1	1/1
Anilin	C_6H_7N	100 %	1/2	3	4	1	1/1	1/0
Benzene	C_6H_6	100 %	3/4	3/4	2	1	1/1	1/1
Benzyl alcohol	C_7H_8O	100 %	3/4	3	2	1	1/1	1/1
Boric acid	H_3BO_3	10 %	1/1	1	1	1	1/1	1/1
Bromic acid	$HBrO_3$	konz.	0/0	0	3	1	0/0	(4)
Butanol	$C_4H_{10}O$	tech. clean	1/1	2	3	1	1/1	(1)
Calcium chloride	$CaCl_2$	spirituous	1/0	1	1	1	1/1	1/2L
Chloric gas	Cl_2		4/4	3	3	1	1/1	1/0
Chloric methane	CH_3Cl	tech. clean	3/0	4	4	1	1/0	1/1L
Chlorine water	$Cl_2 \times H_2O$		3/0	2	0	1	(1)	2/0L
Chlorobenzene	C_6H_5Cl	100 %	3/4	3	4	1	1/1	1/1
Chloroform	$CHCl_3$	100 %	3/4	4	4	1	1/1	1/1
Chromate	CrO_3	10 %	1/1	1	0	1	1/1	1/2
Diesel oil	—	100 %	1/3	2	0	1	(1)	(1)
Ethanol	C_2H_6O	96 %	1/0	1	1	1	1/1	1/1
Ethyl acetate	$C_4H_8O_2$	100 %	1/3	3	3	1	1/1	(1)
Ethylen chloride	$C_2H_4Cl_2$		3/3	4	3	1	1/1	1/1L
Ferric-(III)-chloride	$FeCl_3$	saturated	1/1	2	3	2	1/1	4/4
Formaldehyde solution	CH_2O	10 %	1/1	1	2	1	1/1	1/1
Gasoline, unleaded	C_5H_{12} - $C_{12}H_{26}$		2/3	3	2	1	1/1	1/1
Glycerol	$C_3H_8O_3$	90%	1/1	1	2	1	1/1	1/1
Heptane, n-	C_7H_{16}	90%	2/3	1	1	1	1/1	1/1
Hexane, n-	C_6H_{14}	100 %	2/3	1	2	1	1/1	1/1
Hydrofluoric acid	HF	50 %	1/1	2	3	1	1/1	4/4
Isopropanol	C_3H_8O	tech. clean	1/1	1	2	1	1/1	(1)
Magnesium chloride	$MgCl_2$	aqueous	1/1	1	2	1	1/1	1/0L
Potassium hydroxide	KHO	10 %	1/1	1	3	1	1/1	1/1
Potassium nitrate	KNO_3	aqueous	1/1	1	0	1	1/1	1/1
Methanol	CH_4O		1/1	1	2	1	1/1	1/1
Methyl benzene (toluene)	C_7H_8	100 %	3/4	3	3	1	1/1	1/1
Lactic acid	$C_3H_6O_3$	3 %	1/1	1	0	1	1/1	1/1
Mineral oil	—		1/1	1	1	1	1/1	1/1
Sodium bisulphite	$NaHSO_3$	aqueous	1/1	1	0	1	(1)	1/1
Sodium carbonate	Na_2CO_3	aqueous	1/1	1	3	1	1/1	1/1
Sodium chloride	NaCl	aqueous	1/1	1	2	1	1/1	1/2
Sodium hydroxide	NaHO	50 %	1/1	1	3	1	1/1	1/3
Sodium sulphate	Na_2SO_4	aqueous	1/1	1	0	1	1/1	1/1
Nitrobenzene	$C_6H_5NO_2$		3/4	3	4	1	1/1	1/1
Oleic acid	$C_{18}H_{34}O_2$	tech. clean	1/3	1	1	1	(1)	1/1
Oxalic acid	$C_2H_2O_4 \times 2H_2O$	aqueous	1/1	2	0	1	1/1	1/3
Ozone	O_3		3/4	2	2	1	1/1	0/0
Petroleum	—	tech. clean	1/3	3	1	1	(1)	1/1
Essential oils	—		0/0	1	1	1	(1)	1/1
Phenol	C_6H_6O	100 %	2/3	3	2	1	1/1	1/1
Phosphoric acid	H_3PO_4	85 %	1/1	1	0	1	1/1	1/3
Quicksilver-(II)-chloride	$HgCl_2$	aqueous	1/1	1	0	1	1/1	(4)
Nitric acid	HNO_3	1-10 %	1/1	1	3	1	1/1	1/1
Hydrochloric acid	HCl	1-5 %	1/1	1	3	1	1/1	4/4
Carbon disulphide	CS_2	100 %	4/4	2	0	1	1/1	1/1
Sulphuric acid	H_2SO_4	40 %	1/1	1	3	1	1/1	2/3
Ethyl alcohol	C_2H_6O	100 %	1/0	1	1	1	1/1	1/1
Carbon tetrachloride (TETRA)	CCl_4	100 %	4/4	3	4	1	1/1	1/1L
Trichloroethylene (TRI)	C_2HCl_3	100 %	3/4	4	4	1	1/1	1/1L
Citric acid	$C_6H_8O_7$	10 %	1/1	1	1	1	1/1	1/1

Chemical Resistance Legend

Resistance

Two values concerning resistiveness 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 corrosion from pitting or cracking from stress corrosion
- ( ) estimated value

Material Names

• HDPE	Polyethylene, high-density
• FEP	Tetrafluorethylene-Perfluorpropylene
• V4A	Stainless steel 1.4401 (AISI 316)
• PPO GF30	Polyphenyloxylene with 30% glass fibers
• PU	Polyurethane
• PEEK	Polyetheretherketone