ADS® FlowShark® HV Operation and Maintenance Manual

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An introductory guide to the ADS FlowShark HV Portable Velocity Meter

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Table of Contents

Introduction

The ADS® FlowShark® HV (*hand-held velocity*) is a battery-powered, portable device designed for taking instantaneous peak flow velocity measurements in wastewater collection systems, irrigation channels, and streams. The FlowShark HV includes a control unit, sensor, and battery charger. This manual explains how to setup, operate, maintain, and troubleshoot the FlowShark HV. It also includes supplemental information detailing the technical specifications for the equipment. Please read this manual carefully to ensure proper operation.

> **Note:** When using other components in conjunction with the FlowShark HV, please consult the component's accompanying documentation to verify compatibility with the FlowShark HV.

The manual includes the following sections:

- **Warranty** This section provides comprehensive details concerning product warranty, repair, and replacement.
- **System Overview** This section offers a brief functional description of the FlowShark HV system and the operational and environmental conditions necessary for optimal use.
- **Setup and Operation** This section provides simple instructions on properly setting up and operating the FlowShark HV for velocity measurement. It includes general information on charging the battery, connecting the components, calibrating the sensor, taking velocity measurements, using the control unit display, and interpreting the results.
- **Maintenance** This section includes basic guidance and instructions for performing routine maintenance on the FlowShark HV.
- **Troubleshooting** This section provides troubleshooting techniques and possible solutions for problems that may arise when operating the FlowShark HV.
- **Technical Specifications** This section lists the technical specifications for the individual components representing the FlowShark HV. It also includes some limited certification information.

Product Warranty

This section includes warranty information for the ADS FlowShark HV.

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.

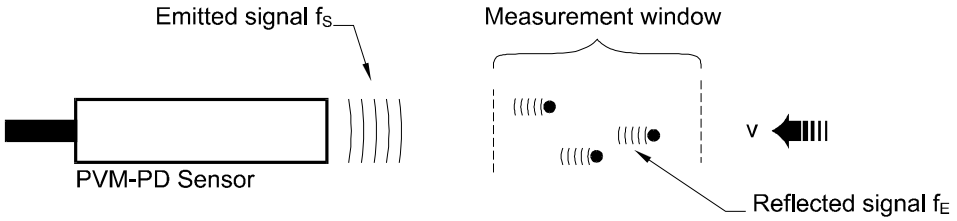
THIS IS THE ONLY WARRANTY FOR ADS PRODUCTS. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED, INCLUDING FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY. PRODUCT REPAIR OR REPLACEMENT IS THE ONLY REMEDY. IN NO EVENT WILL ADS BE RESPONSIBLE FOR ANY DIRECT, INDIRECT, CONSEQUENTIAL, OR SPECIAL DAMAGES.

System Overview

The portable, battery-powered FlowShark HV determines peak flow velocity through pulse Doppler measurement. A piezoelectric crystal on the sensor transmits ultrasonic bursts (*signals*) of a known frequency in rapid succession into the flow for reflection off existing particles. The FlowShark HV evaluates the echos returned within a defined time to determine the distances from the sensor to the particles based on the reflected signals. Analyzing and evaluating the displaced frequencies from the signals and compensating for the temperature of the flow provides a consistent peak velocity measurement.

FlowShark HV components – control unit (left) and sensor (right)

Measuring velocity using the Doppler principal requires the presence of scattered particles, such as air or solid particles, in the flow. To ensure detection, a scattered particle must be larger than 0.02 inches (0.5 mm) in diameter and occur within flow containing solids greater than 100 parts per million per volume unit.



$v = \Delta f$

$\Delta f = f_E - f_S$

Where,

Δf = Doppler frequency

f_S = frequency emitted by sensor

f_E = frequency displaced by velocity of particles in the flow

C = speed of sound in the flow

Operational and Environmental Conditions

The technical specifications of the FlowShark HV and the flow and hydraulic conditions at the measurement location determine the operational success and/or performance level of the FlowShark HV. Therefore, consider the following limitations in the hardware and conditions at the location when investigating a prospective location for performing measurement activities:

Hardware Limitations

- **Operating Temperature** Do not measure velocity at locations exhibiting temperatures outside the operating temperature range of the sensor.
- **Relative Humidity** The sensor cannot properly measure velocity levels in the context of relative humidity levels lower than 90% (absence of condensation).
- **Electromagnetic Interference** The intensity of electromagnetic interference at the site must not violate the CE guidelines.
- **Range** The sensor cannot measure velocity outside the measurement range or window designated for the sensor.
- **Durability** The control unit, sensor, and cable contain delicate mechanisms and electronics. Therefore, handle them with extreme care and avoid stepping or placing heavy objects on the cable or contacting it with a sharp object. In addition, the equipment, while durable, is subject to wear, particularly in a harsh measurement environment. Therefore, conduct routine maintenance on all components according to the instructions included in the *Maintenance* section on page 21. Contact ADS for further information concerning the durability and limitations of the equipment.

Flow/Hydraulic Limitations

- **Particulate Size and Reflectivity** Measuring velocity using the Doppler ultrasonic effect involves reflecting emitted signals off particles in the flow. Smooth, clear flow does not provide objects for reflection and, therefore, is not the appropriate environment for Doppler measurement. Particles in the flow, such as air bubbles and solid particles, must be larger than 0.02 inches (0.5 mm) in diameter and occur in a volume greater than 100 parts per million for relevant and accurate sensor measurement.
- **Turbulent/Inconsistent Flow** Abnormal or non-uniform flow conditions, such as turbulence, currents, or reverse flows, adversely affect velocity measurement. Therefore, do not measure velocity at a location in a pipe or channel that is in close proximity to these flow conditions.

- **Flow Depth** Flow levels must exist at a depth of at least 2 to 3 inches (51 to 76 mm) above the bottom center of the pipe or channel to successfully obtain velocity measurements.
- **Channel Wall/Water Surface** Do not measure velocity within 1.5 inches (38 mm) of the channel wall or flow surface.

Setup and Operation

Properly setting up and operating the FlowShark HV are critical to obtaining the most accurate and reliable velocity measurements. Developing a basic understanding of the control unit keyboard and display before taking measurements is also essential to accessing and interpreting the results correctly. These combined skills and knowledge are fundamental to performing measurement activities effectively and efficiently.

This section provides general information and instructions in the following areas of setup and operation of the FlowShark HV:

- Charging the battery
- Connecting the sensor to the control unit
- Operating the FlowShark HV
- Calibrating the sensor
- Positioning the sensor in the flow
- Taking velocity readings
- Viewing the results

Charging the Battery

Charge the battery before attempting to operate the unit by removing the protective cap from the corresponding port on the FlowShark HV and connecting the battery charger to the port. A *green* light on the charger indicates the battery is fully charged and the FlowShark HV is ready for use. A *yellow* light on the charger indicates the battery in the FlowShark HV is not fully charged, but is being recharged. When charging is complete, remove the charger and replace the protective cap on the port.

After the initial charge, ADS recommends recharging the battery only once a month under normal operating conditions. This battery type maintains a longer life and capacity when recharged less frequently. However, once every 3 months, ADS recommends draining the battery completely before recharging. The battery is considered *drained* at 10.2 volts. The unit will not function when the voltage falls below 10.

> **Warning!** Close the protective cap *manually* to avoid damaging the plastic threads.

Connecting the Sensor to the Control Unit

Connect the sensor to the control unit by removing the protective cap from the corresponding port on the unit and then inserting and screwing in the connector from the sensor cable into the port.

When measurement is complete, unscrew and remove the sensor connector from the control unit and replace the protective cap onto the port.

Operating the FlowShark HV

Turn on the FlowShark HV by pressing and holding down the **Enter** key (↵) on the control unit for at least 5 seconds. The unit temporarily will display the current firmware version installed and then the current temperature, peak velocity of the flow, average peak velocity (*when initiated manually*), and time period over which the average has been determined. This screen represents the first of three top-level screens accessible through the control unit.

The second screen displays the battery voltage of the battery in the control unit and indicates whether the sensor is connected to the control unit. The third screen displays the signal quality of the measurment, the Doppler frequency, the main peak velocity, the designated number of neighborhood peaks, and a histogram representing the measurements taken. Navigate backward and forward among these top level screens using the horizontal arrow keys (◄,►).

Turn off the control unit by pressing and holding down the **ESC** key on the unit for at least 2 seconds. The unit will turn off automatically following 8 minutes of inactivity on the keyboard.

FlowShark HV display

Modifying the Parameter Settings

The lower level screens provide access to parameter settings that may be modified to provide additional information, compensate for flow conditions, support associated hardware, and address other relevant issues involved in velocity measurement activities. The default parameters are set for the FlowShark HV at the factory. Under normal conditions, it should not be necessary to access or modify the parameter settings on the control unit.

> **Warning!** Making changes to the parameter settings requires a comprehensive understanding of the equipment and settings because it can have a significant impact on the outcome and accuracy of the velocity measurements. Therefore, please contact a regional ADS representative for assistance before setting or modifying any parameters on the FlowShark HV.

Understanding the Keys on the Control Unit

The following table provides general functional descriptions for the keys on the control unit. Each key serves multiple functions. The current function of a key depends on the current content displayed on the control unit screen.

Key	Functional Description
ESC	Turns off the control unit when held down for more than 2 seconds Returns the menu to the previous level
↵	Turns on the control unit when held down for at least 5 seconds Displays the parameter settings from the top level Displays subsettings of parameter settings (when applicable) Displays current value/option setting corresponding to parameter setting selected Activates editing mode for bracketed text/values ([xxx]) Deactivates editing mode for bracketed text/values (<xxx>) and saves text/values for parameter
►	Scrolls forward through top level screens Scrolls forward through available parameter settings and subsettings Moves cursor forward through individual characters in editable field
◄	Scrolls backward through available parameter settings and subsettings Moves cursor backward through individual characters in editable field
▲	Scrolls forward through individual characters or options in editable field Scrolls forward through available options for selection in an editable field representing a particular parameter setting
▼	Scrolls backward through individual characters or options in editable field Scrolls backward through available options for selection in an editable field representing a particular parameter setting

Calibrating the Sensor

Before taking velocity measurements, immerse the sensor into the flow to acclimate the FlowShark HV's integrated temperature sensor to the temperature of the flow. Temperature differences between the sensor and flow can produce inaccurate velocity measurements. A difference of only 1°C can lead to a measurement error of 0.24%.

Acclimation is complete when the temperature reading displayed begins to stabilize and deviates only within a very limited temperature range of a few degrees. Temperature and velocity stabilization may require 1 to 5 minutes upon initial use. It can require several minutes if a large difference exists between the temperature of the flow and the temperature at the location outside the flow.

> **Note:** If acclimation and stabilization do not occur within 5 minutes, please contact an ADS representative for further assistance.

The sensor has been calibrated for measuring velocity in water. However, if velocity measurements will be taken in another kind of medium in which the speed of sound differs from that of water (4872 feet per second (1485 mps) at 20°C (68°F)), contact ADS for assistance in modifying the calibration factor accordingly when setting the parameters.

> **Note:** Placing the sensor into the flow before turning on the unit may expedite the temperature acclimation process.

Positioning the Sensor in the Flow

Align the sensor probe parallel to the axis of the pipe/canal. Use the bubble level attached to the telescoping rod to align the probe horizontally.

Properly positioning the sensor in the flow is essential to obtaining accurate velocity measurements. Even a slight error in angle can produce errors in velocity readings. For example, an angle error of 5° will lead to a measurement error of 0.4%; a 10% angle error will result in a 1.5% measurement error.

Taking Velocity Readings

When immersed in the flow in a pipe or channel, the FlowShark HV measures and displays the localized, current peak velocity. It also can provide an average, or *mean*, of the peak velocity over a specific period of time.

The first (top) row on the control unit display shows the current peak velocity. The second row displays the current operating temperature read through the temperature sensor in the probe. Select the up arrow key (▲) to view the current raw frequency and voltage readings from which the velocity and temperature readings are calculated. The third row displays the average peak velocity, and the fourth row displays the time period over which the average peak velocity has been calculated.

Calculating Average (Mean) Peak Velocity

To view the average of the peak velocity over a defined period of time, select the down arrow key (▼) to initiate the velocity average calculations and then select the same key again after the desired time period has passed. The FlowShark HV displays and updates the average velocity following each consecutive reading based on the cumulative readings taken since the down arrow key was originally selected. The average velocity displayed represents a “running” average and continues until the down arrow key is selected again. The last average velocity reading and associated

time period over which the average was calculated will display until a new running average velocity is initiated or the control unit display is turned off or goes off automatically.

ADS also recommends an ISO standard that includes several other methods for calculating average velocity using the individual velocity measurements obtained through the FlowShark HV:

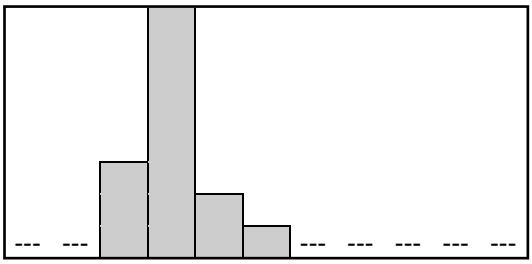
ISO 748:2007, Hydrometry – Measurement of Liquid Flow in Open Channels Using Current-Meters or Floats.

Viewing the Results

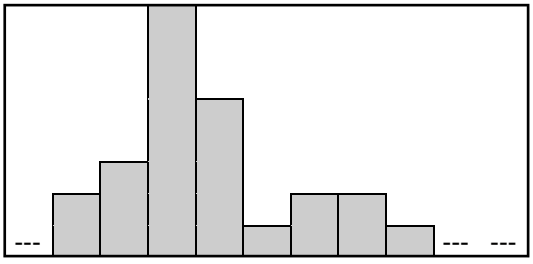
A *velocity frequency histogram* shows the distribution of the Doppler frequencies emitted. Each bar (peak) represents a frequency group, and up to 11 frequency groups can display at one time. The frequency range is automatically adjusted to fit the range of the velocities. The distribution and formation of frequency groups in the histogram indicate the quality of the velocity readings.

The quality of a measurement (ranging from 0 to 100%) represents the correlation between the evaluated Doppler frequency and the complete spectrum of the measured frequencies. Typically, higher quality ratings reflect more reliable velocity measurements. However, occasionally, a velocity measurement with a relatively high quality can be unreliable. When a measurement is questionable, examine the form of the frequency distribution. Velocity measurements with a quality of less than 15% will be rejected. Consider the following sample histograms for reference in assessing histograms:

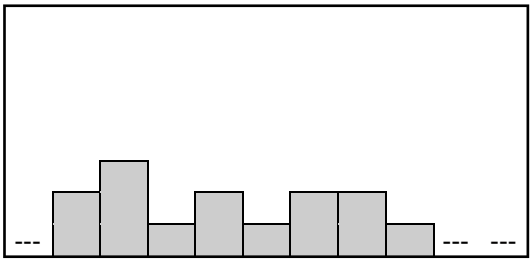
- **Optimum** The following histogram diplays a narrow frequency range with a stable, very high peak.



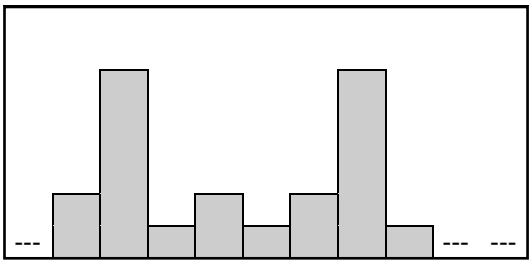
- **Normal** The following histogram reflects a wide frequency range with a stable, high peak. It has a quality rating greater than 40%.



- **Poor Reflection Quality in Flow** The following histogram displays a very wide range of frequencies with no stable peak, producing a quality rating of less than 30%. The velocity readings displayed are essentially too low, and the histogram suggests that the low quality rating may be the result of a low concentration of reflective particles that are too small for detection. Scattering or air-injecting reflective particles, such as sand, into the flow for a short time could improve the histogram and produce more reliable velocity readings. Refer to the technical specifications for the sensor for specific information on the minimum particulate size and concentration required for adequate signal reflection.



- **Disturbing Influences** The following histogram reveals a wide range of frequences with a random (*jumpy*) peak that appears in several frequency groups. The calculated Doppler frequency (F) jumps significantly. Although the quality is greater than 40%, the velocity readings are erroneous or unstable and inconsistent. This histogram could reflect the formation of a whirlpool, standing waves, a turbulent flow surface, or a very shallow flow depth. Therefore, a site exhibiting these conditions would not be a suitable location for obtaining reliable velocity measurements.



Maintenance

Perform routine maintenance on the FlowShark HV to maintain optimal performance and maximize the life of the components. The maintenance interval and scope may vary based on operational and environmental conditions and practical experience obtained over time.

However, the following are some general maintenance procedures ADS recommends implementing for the FlowShark HV:

- Clean the control unit and sensor after every measurement.
  - ❑ Wash the *sensor* with warm water and mild dishwashing soap, and then cleanse it using an appropriate disinfectant (when necessary).
  - ❑ Clean the *control unit* with a damp cloth.
- Always store the control unit and probe/sensor in a safe location away from direct heat or cold and, preferably, in a protective case when they not in use.
- Recharge the battery every 3 months when the FlowShark HV is not use. The battery life will diminish in capacity over an extended amount of time in storage.

Troubleshooting

The following tables contain general techniques for troubleshooting and resolving problems that may occur with the FlowShark HV.

Problem	FlowShark HV will not turn on.
Possible Causes	Battery voltage is too low. Surrounding temperature is outside the specified operating temperature.
Possible Solutions	Recharge battery. Warm or cool equipment.

Problem	Measurement value will not display or is fluctuating.
Possible Causes	Sensor is not properly placed in flow or sensor cable is not correctly connected into control unit.
Possible Solutions	Check connections. Reposition sensor in the flow.

Problem	Measurement value is too low and fluctuating heavily.
Possible Causes	Reflective particles do not exist in an adequate concentration in the flow.
Possible Solutions	Choose another location for measurements.

Problem	Measurement value is too low/high and fluctuating heavily.
Possible Causes	Significant turbulence exists in water. Surrounding temperature is outside the specified operating temperature.
Possible Solutions	Recharge the battery. Choose another location for measurements.

Technical Specifications

The following tables include the technical specifications for the components comprising the FlowShark HV and the CE guidelines. When applicable, certain specifications may reflect using the equipment under optimal operational and environmental conditions. Individual specifications also may include details concerning possible external influences or conditions that may affect the velocity data obtained.

Control Unit

The following table contains the specifications for the control unit.

Enclosure	Lacquered aluminum casing with shoulder strap
Dimensions	4.45 inches (113 mm) high x 6.81 inches (173 mm) wide x 8.66 inches (220 mm) deep
Protection Rating	IP65 (NEMA 4)
Weight	8.27 pounds
Display	LCD; 4 rows x 20 characters
Operation	6-key
Range	0 to 9.8 feet per second (0 to 3 meters per second)
Accuracy	1% of the actual velocity measured *or* ±0.03 feet per second (±0.01 mps), whichever is greater
Operating Temperature	32° to 122° F (0° to 50° C)
Storage Temperature	23° to 140° F (-5° to 60° C)
Power Supply	12-volt/ 2 Ah rechargeable lead battery
Battery Life	4 to 6 hours of cumulative use
Battery Charger	Primary: 115/230 V AC Secondary: 12 V/ 500 mA
Connectors	• Sensor • Charger

Sensor

The following table contains the specifications for the sensor probe for velocity measurement.

Material	Stainless steel and polyurethane
Rating	IP68 (NEMA 6)
Removable Rod	Material: Aluminum (telescopic) with bubble level Length: 28 to 63 inches (0.7 to 1.6 meters)
Emitting Frequency	750 kHz
Measurement Window	Position: 2.36 inches (6 cm) along the horizontal axis in front of the sensor Length: 1.18 inches (3 cm) Diameter: 0.63 inches (1.6 cm)
Minimum Particle Size for Signal Reflection	0.02 inches (0.5 mm) in diameter; 100 parts per million
Operating Temperature	32° to 140° F (0° to 60° C)
Cable	33-, 49-, 66-, and 98-foot (10-, 15-, 20, and 30-meter) lengths with connector *Custom cable lengths also are available.*

CE Guidelines

Interference transmission	EN 50011		
Interference resistance	EN 50082-2	Intensity grade 3	IEC 801.2
			IEC 801.3
			IEC 801.4