Dynasonics®
Ultrasonic Flow Meters

Portable Non-Invasive Ultrasonic Flow Meter

DXN-5P

Badger Meter

HYB-UM-04661-EN-01 (June 2025)

User Manual

CONTENTS

Scope of This Manual . . . 5
Typographic Conventions . . . 5
Unpacking and Inspection . . . 5
Safety . . . 5
Terminology and Symbols . . . 5
Considerations . . . 5
Battery Care . . . 6
Introduction . . . 6
Meter Installation . . . 7
Overview . . . 7
Installation Considerations . . . 7
Equipment Required . . . 7
Installing the Transducers and RTDs . . . 8
Power Connector . . . 8
AC Power Adapter 100…240V AC ±10%, 50…60 Hz . . . 9
9…28V DC Power . . . 10
Connecting the USB Cable . . . 11
Connecting with Bluetooth . . . 11
Initial Meter Setup . . . 12
Operation . . . 13
Keypad Operation on the Home Screen . . . 13
Keypad Operation in the Menu Structure . . . 13
Selecting an Option in a Parameter Selection List . . . 14
Entering a Number . . . 14
Entering an Alphanumeric . . . 15
LEDs on Handheld . . . 15
Menu Map . . . 16
Parameter Descriptions by Menu . . . 17
Main Menu Structure . . . 17
Using Sites . . . 17
Quick Start . . . 18
Site Management . . . 18
Setup > Thermal Mode . . . 19
Setup > Units . . . 19
Setup > Meter . . . 21
Setup > Temperature RTD . . . 28
Setup > Communications . . . 28
Setup > Data Logging . . . 29

Display Menu 30
Information Menu 31
Diagnostics Menu 31
Reset Menu 32
Maintenance 33
Battery 33
Cleaning 33
Storage 33
Troubleshooting 34
Out of Specification Messages 34
Failure Messages 34
Check Function Codes 34
Warning and Alarm Message Codes 34
Symptoms 36
Replacement Procedures 38
Tools Required 38
Replacing the Batteries and Memory Card 38
North American Pipe Schedules 43
Dimensions 45
Handheld 45

SCOPE OF THIS MANUAL

This manual is intended to help you get the DXN-5P meter up and running quickly.
Read this manual carefully before attempting any installation or operation. Keep the manual accessible for future reference.

Refer to the transducer manuals for installation and location of the transducers.

Typographic Conventions

- In step-by-step instructions, **bold** text indicates items on the screen you need to select or act upon.
  Example: Click the **Setup** menu.
- Names of parameters, options, boxes, columns and fields are *italicized*.
  Example: The value displays in the *Status* field.
- Messages and special markings are shown in quotation marks.
  Example: "Error" displays in the title bar.
- In most cases, software screen text appears in the manual as it does on the screen. For example, if a word is capitalized on the screen, it is capitalized when referred to in the manual.

UNPACKING AND INSPECTION

Upon opening the shipping container, visually inspect the product and applicable accessories for any physical damage such as scratches, loose or broken parts, or any other sign of damage that may have occurred during shipment.

NOTE: If damage is found, request an inspection by the carrier's agent within 48 hours of delivery and file a claim with the carrier. A claim for equipment damage in transit is the sole responsibility of the purchaser.

SAFETY

Terminology and Symbols

⚠ DANGER	Indicates a hazardous situation, which, if not avoided, will result in death or serious personal injury.
⚠ WARNING	Indicates a hazardous situation, which, if not avoided, could result in death or serious personal injury.
⚠ CAUTION	Indicates a hazardous situation, which, if not avoided, could result in minor or moderate personal injury or damage to property.

Considerations

- The installation of the DXN-5P meter must comply with all applicable federal, state, and local rules, regulations and codes.
- Do not use sharp objects when operating the device (such as using a pen to press buttons on the keypad).
- When the DXN-5P meter is a part of a system, it is configured in a fail-safe operation so that if the handheld signal is compromised, the DXN-5P meter will not cause harm to the system.

IMPORTANT

Not following instructions properly may impair safety of equipment and/or personnel.

Battery Care

- The handheld should be turned off while charging to reduce the likelihood of overheating.
- Charge at ambient temperature 32…104° F (0…40° C).
- Lithium-ion batteries do not need to be fully charged. A partial charge is better.
- Discontinue using charger and/or battery if the battery gets excessively warm.
- Before prolonged storage, charge the battery to about 50%.
- Battery charging is disabled if the internal temperature is too high and the handheld is externally powered.

INTRODUCTION

⚠ WARNING

THIS EQUIPMENT INCLUDES SOME EXTERNAL NON-METALLIC PARTS. THE USER SHALL THEREFORE ENSURE THAT THE EQUIPMENT IS NOT INSTALLED IN A LOCATION WHERE IT MAY BE SUBJECTED TO EXTERNAL CONDITIONS (SUCH AS HIGH-PRESSURE STEAM) WHICH MIGHT CAUSE A BUILD-UP OF ELECTROSTATIC CHARGES ON NON-CONDUCTING SURFACES. ADDITIONALLY, CLEANING OF THE EQUIPMENT SHOULD BE DONE ONLY WITH A DAMP CLOTH.

The DXN-5P portable non-invasive ultrasonic flow meter measures flow using clamp-on transducers (sensors) that mount to the outside of the pipe. The kit comes with different options of transducers for different pipe sizes and conditions, clamp-on temperature sensors and wall thickness gauge.

Ultrasound can be used to measure flow in two ways: transit time for clean fluids and Doppler for fluids with particles or gas bubbles. A hybrid ultrasonic flow meter automatically switches the flow reading between transit time and Doppler based on the fluid conditions. Monitoring both the transit time signal and the Doppler signal can help with diagnosing whether air, sand or debris is in the pipe.

Transit time measures the time difference between the travel time of an ultrasound wave going *with* the fluid flow and *against* the fluid flow. The time difference is used to calculate the velocity of the fluid traveling in a closed-pipe system. The transducers used in transit time measurements operate alternately as transmitters and receivers. Meter measurements are bi-directional and are most effective for fluids that have low concentrations of suspended solids and are sonically conductive.

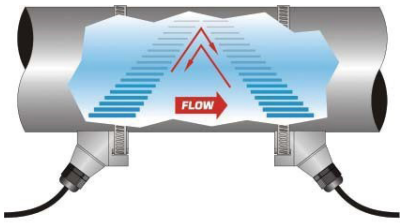


Figure 1: Transit time operation

Doppler method measures flow by reading the frequency shift reflected from particles or gas bubbles in the fluid. For example, the faster particles are moving towards the transducers, the higher the frequency of the reflected ultrasonic wave. Doppler measurements are bi-directional and are most effective for fluids that have suspended solids or gases.

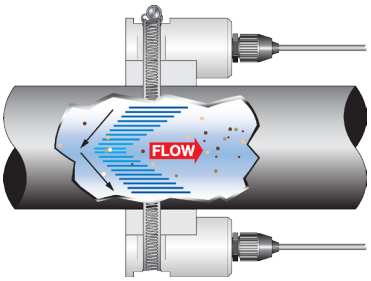


Figure 2: Doppler operation

Both transit time and Doppler methods calculate the flow rate from the velocity and inner diameter of the pipe.

An ultrasonic energy meter equipped with heat flow capabilities measures the rate and quantity of heat delivered or removed from devices such as heat exchangers. By measuring the volumetric flow rate of the heat exchanger liquid, the temperature at the inlet pipe and the temperature at the outlet pipe, the energy usage can be calculated.

By applying a scaling factor, this heat flow measurement can be expressed in various units (Btu, Watts, Joules, Kilowatts and others).

An ultrasonic mass meter calculates mass flow rate from the fluid temperature and the flow rate.

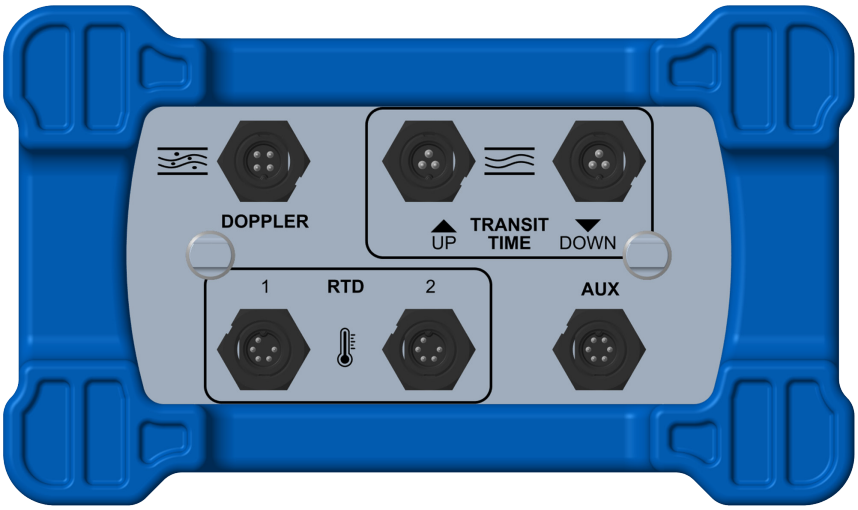


Figure 3: Handheld accessory options

METER INSTALLATION

Overview

Each of the installation steps that follow is explained in detail on *page 7* through *page 11* . The actual installation procedures differ slightly, depending on whether the transducers are *fixed* or *adjustable*.

1. Charge battery in the handheld to at least 50% before using the handheld.
2. Turn on the handheld.
3. Set up the meter by selecting the site or by selecting the transmission path, fluid and pipe properties.
4. Install the transducers on the pipe. Use the *SPACING* value to determine the distance between the transducers.
5. Connect the transducers cables to the handheld.
6. Program any other parameters, such as units or data logging settings.

Installation Considerations

Place the handheld in a location

- where little vibration exists.
- that is protected from corrosive fluids.
- that is within the handheld's ambient temperature limits:
  –4…131° F (–20…55° C); relative humidity 0…85%, non-condensing; altitude 2000 m max.
- that is out of direct sunlight. Direct sunlight may increase handheld temperature above the maximum limit.

Equipment Required

- User manual for transducers
- The kit includes cables, couplant and straps for the transducers. Replacements are available.

Installing the Transducers and RTDs

Choose whether to use transit time transducers for clean liquids, Doppler for liquids with large particles or bubbles, or both for the meter to automatically detect which transducers have a better signal (hybrid mode). In the *QUICK START* menu on the handheld or the *Start* menu in SoloCUE, enter all the parameters listed. For transit time transducers, view *SPACING* for the distance between the two transducers. See *SETUP > METER* for more descriptions of the parameters. See the user manual for your specific transducers or RTDs for installation instructions.

After installing the transducers on the pipe, connect the transducers to the handheld using the matching cables provided. Transducers and cables are marked with either Transit Time or Doppler.

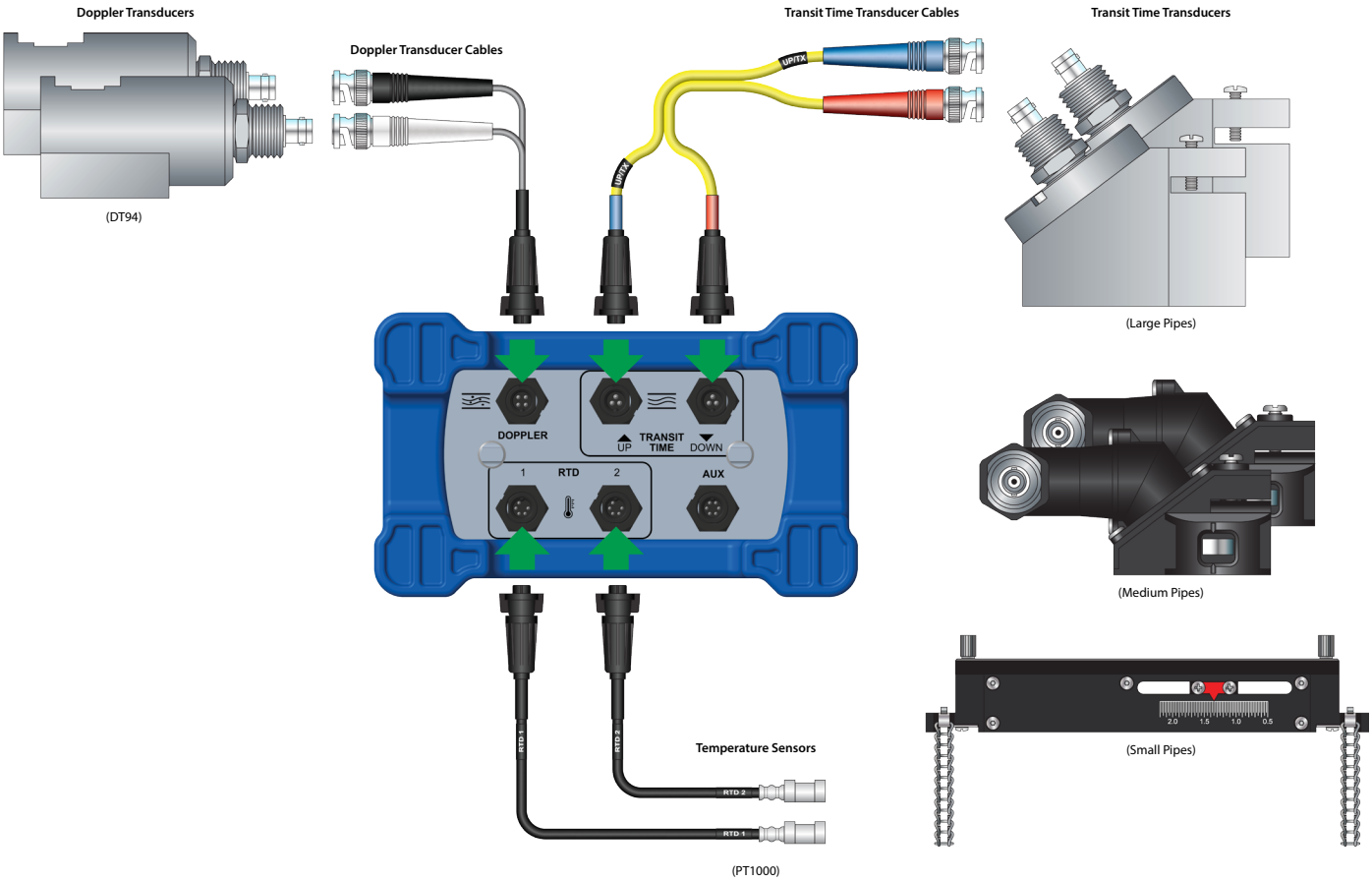


Figure 4: Handheld cable connections

Power Connector

⚠CAUTION

ANY OTHER WIRING METHOD MAY BE UNSAFE OR CAUSE IMPROPER OPERATION OF THE HANDHELD. USE ONLY AN ADEQUATELY-RATED CORD WHEN REPLACING THE DETACHABLE MAINS SUPPLY CORD.

NOTE: This handheld requires clean electrical line power. Do not operate this handheld on circuits with noisy components (such as fluorescent lights, relays, compressors, or variable frequency drives). Do not use step-down transformers from high voltage, high amperage sources. Do not to run signal wires with line power within the same wiring tray or conduit.

AC Power Adapter 100…240V AC ±10%, 50…60 Hz

⚠CAUTION

ANY OTHER WIRING METHOD MAY BE UNSAFE OR CAUSE IMPROPER OPERATION OF THE HANDHELD. USE ONLY AN ADEQUATELY-RATED CORD WHEN REPLACING THE DETACHABLE MAINS SUPPLY CORD.

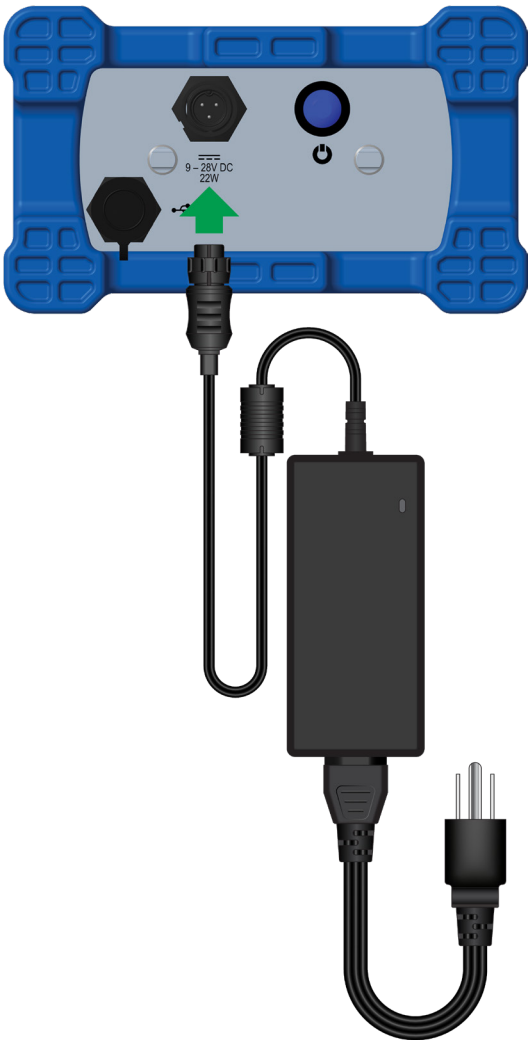


Figure 5: AC power adapter connection

⚠CAUTION

USE ONLY AN ADEQUATELY-RATED CORD WHEN REPLACING THE DETACHABLE MAINS SUPPLY CORD.

9…28V DC Power

The transmitter may be operated from a 9…28V DC source, as long as the source supplies a minimum of 22 Watts of power. Connect the DC power to 9…28V DC with 20 AWG wire.

NOTE: The handheld is protected from a major catastrophe with an internal resettable 3.7 A fuse. If the fuse keeps resetting, replace the handheld or return it to the factory for repair.

IMPORTANT

A Class II DC power supply is required.

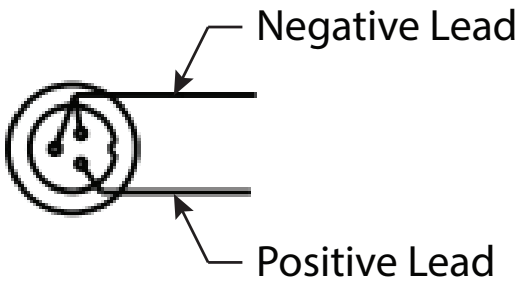


Figure 6: DC power connection

Connecting the USB Cable

Use a USB cable when connecting a computer with SoloCUE app for Windows. The USB-C port is for programming only—it is *not* for powering the handheld or charging the battery.

The handheld supports only one connection to a single device with the SoloCUE app. USB cable and Bluetooth simultaneous connection is not supported.

⚠ WARNING

DO NOT USE THE USB PORT IN A HAZARDOUS LOCATION WHERE EXPLOSIVE GAS OR DUST IS PRESENT.
DO NOT OPEN THE HANDHELD WHILE POWERED IF WATER OR SPRAY COULD CONTACT ELECTRONICS OR INTERIOR.

1. Remove the cover for the USB-C port.
2. Connect the USB cable to the USB-C port.
3. Start SoloCUE app to program the handheld.
4. In SoloCUE for Windows, click the **+** icon in the Device List to connect to the handheld.
5. Remove the USB cable and secure the cover over the USB port.

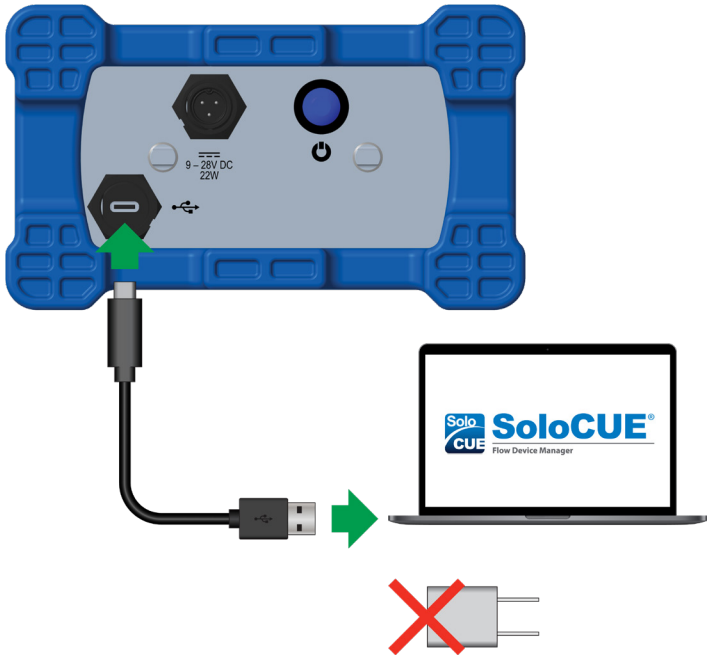


Figure 7: Connecting the USB cable

Connecting with Bluetooth

1. Check if Bluetooth icon is active on the handheld *Home Screen*. If the Bluetooth icon is not visible, enable Bluetooth in the *SETUP* > *COMMUNICATIONS* > *BLUETOOTH* menu on the handheld.
2. Open SoloCUE mobile app. Go to new device tab and select the handheld to pair and connect.

INITIAL METER SETUP

You can set up the meter using the DXN-5P keypad or the SoloCUE Flow Device Manager app. This document addresses procedures using the DXN-5P keypad. To use SoloCUE, see the *SoloCUE® Flow Device Manager Installation Guide* or download the app from the App Store or Google Play.

For in-depth parameter programming, see *"Parameter Descriptions by Menu" on page 17*.

1. If this is a new kit or new transducers have been added, check the calibration.
   a. In the *SETUP* > *METER* > *CALIBRATION* menu, select **Field** for the *Factor Mode* if firmware version is prior to 02.02.480.
   b. Enter the calibration and sensor factors from the transducers into the scale factor and sensor factor value.
2. Program the meter settings.
   a. When using the keypad to set up the DXN-5P meter to measure flow, press **MENU/BACK** to enter the *Main* menu.
   b. In the *QUICK START* menu:
      - Select if transit time (clean fluids), Doppler (fluids with particles or gas bubbles) or both for the meter to automatically select.
      - Select if one or more RTD temperature sensors is used.
      - Install transducer. See the transducer user manual for instructions.
3. Zero the meter.

   NOTE: Due to different pipe characteristics, the meter must be zeroed in order to maintain accuracy. The recommended method is to stop flow and make sure there is no flow before zeroing the meter. In situations where that is not feasible, you may zero the meter while the flow is steady or enter the zero manually. Based on *ZERO MODE*, the *SET ZERO* option is selectable.

   a. If *ZERO MODE* is set to *NO FLOW*:
      - Check that the pipe is full of liquid and not flowing. Flow must be absolutely zero.
      - Securely close any valves and allow time for settling to occur.
      - Select **SET ZERO-NO FLOW** and click **OK** to set the new zero.
   b. If *ZERO MODE* is set to *STEADY FLOW*:
      - Check that the pipe is full of liquid and flowing at a steady rate.
      - Select **SET ZERO-FLOW** and click **OK** to set the new zero.
4. Select units.
   a. In the *SETUP* > *UNITS* menu, select the units and format of flow rate, total and velocity.
   a. In the *SETUP* > *UNITS* menu, select the energy rate, energy total and temperature for energy meters.
5. Select flow direction, low flow cutoff, and minimum and maximum flow.

OPERATION

The meter can be set up and monitor with SoloCUE Flow Device Manager app for Windows, Android, iPhone and iPad, or by using the keypad on the handheld.

Keypad Operation on the Home Screen

Figure 8: Home screen

The *MENU/BACK* key enters menu structure.

The *UP ARROW* and *DOWN ARROW* keys toggle between flow rate, flow total, velocity and flow rate with flow total.

The *LEFT ARROW and RIGHT ARROW* keys have no function.

The *ENTER* key has no function.

Keypad Operation in the Menu Structure

Figure 9: Menu structure

The cursor bar highlights the submenu or parameter to be viewed or edited. The scroll bar on the right indicates the relative position the cursor bar is at on the list when there are more than 4 items.

- *MENU/BACK* returns to parent menu (up a level). If at the *Main* (top level) menu, returns to the *Home Screen*.
- *DOWN ARROW* scrolls the list.
- *RIGHT ARROW* and *ENTER* have the same function in the menu structure and advance to the submenu or to read/edit a parameter.

Selecting an Option in a Parameter Selection List

Figure 10: Parameter selection list

The active option in the parameter list has a filled-in box on the left side. The scroll bar on the right indicates the relative position the cursor bar is at on the list when there are more than 4 items.

- *UP ARROW* and *DOWN ARROW* scrolls the list.
- *ENTER* selects the option and the box on the left side fills in to show the item is selected.
- *MENU/BACK* exits parameter editing and returns to the parent menu (up a level).
- *LEFT ARROW* and *RIGHT ARROW* have no function.

Entering a Number

Figure 11: Entering a number

The parameter name and current value is displayed in top portion of screen. Edit the number on the bottom right of screen.

- When the cursor highlights the whole number:
  - ◊ *NUMERIC KEYS* add numbers to the rightmost digit when the whole number is highlighted.
  - ◊ *DELETE* clears the numbers and sets the number to zero.
- When the cursor highlights only one digit:
  - ◊ *NUMERIC KEY* replaces the number.
  - ◊ *DELETE* switches the cursor to highlight the whole number.
- *MENU/BACK* exits parameter editing and returns to parent menu (up a level). The parameter remains at the value displayed in the top portion of the screen.

- *UP ARROW* and *DOWN ARROW* cycle through the numbers and other options.
- *RIGHT ARROW* moves the cursor to the right. Once it reaches the rightmost digit or a space, the cursor moves to the leftmost digit.
- *LEFT ARROW* moves the cursor to the left. Once it reaches the leftmost digit or a space, the cursor moves to the rightmost digit.
- *ENTER* accepts the value.

Entering an Alphanumeric

Figure 12: Entering an alphanumeric

The text field is displayed at the top of the screen.

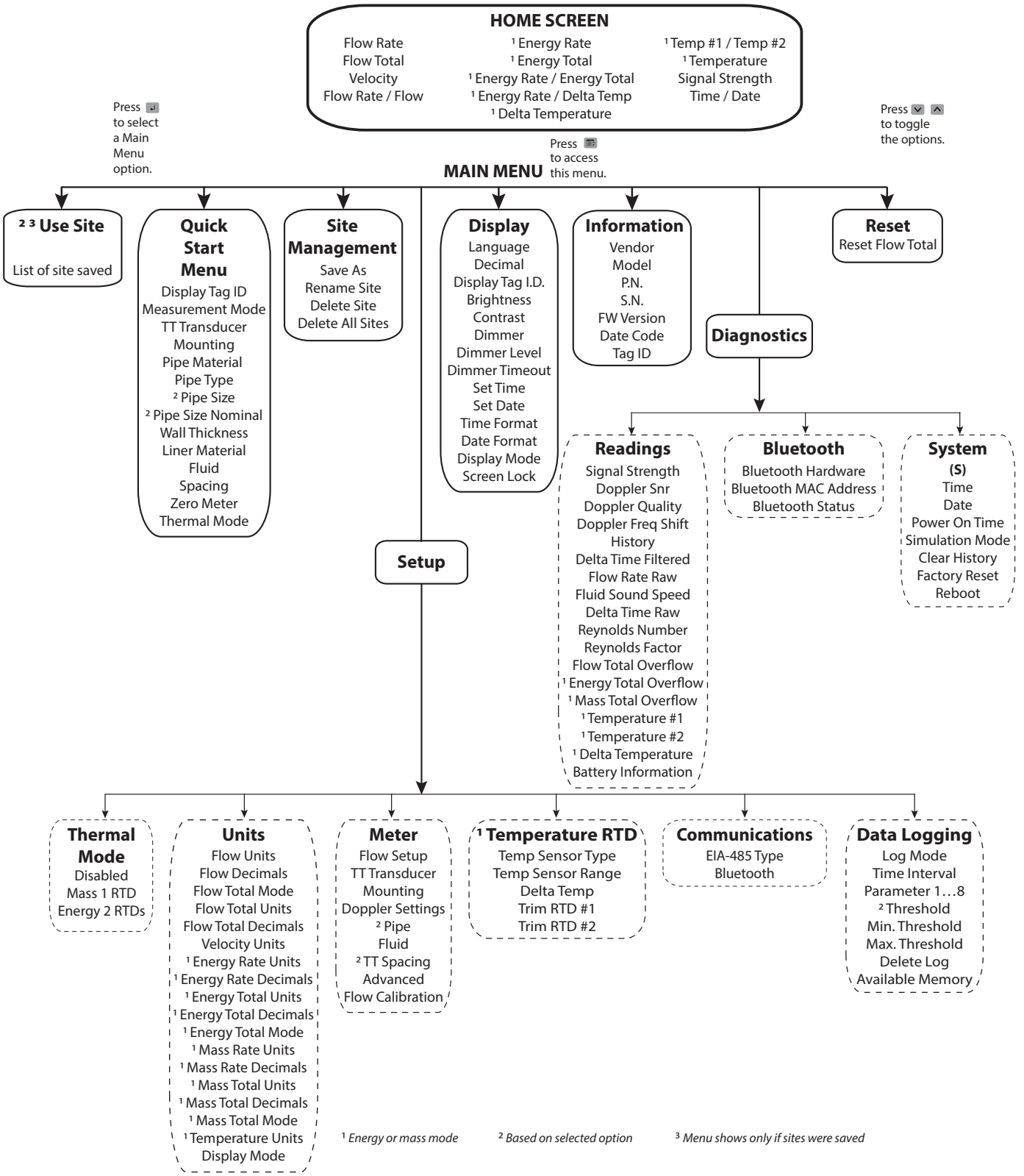
- *MENU/BACK* exits parameter editing and returns to parent menu (up a level).
- *UP ARROW*, *DOWN ARROW*, *LEFT ARROW* and *RIGHT ARROW* move the cursor around. More letters can be selected by pressing the DOWN ARROW. The space, capitalizing up arrow and checkmark remain fixed in lower right corner of screen.
- *DELETE* removes the rightmost letter.
- *ENTER* accepts the value.
- Pressing a numeric key adds the number to the text string.
- Moving the cursor to the *Checkmark* and pressing *ENTER* accepts the text string.

LEDs on Handheld

- Plug symbol (located on front of handheld) indicates external power supplied to handheld.
- Battery symbol (located on front of handheld) indicates the battery is charging.

Figure 13: LEDs on handheld

MENU MAP


HOME SCREEN
Flow Rate
Flow Total
Velocity
Flow Rate / Flow
[1] Energy Rate
[1] Energy Total
[1] Energy Rate / Energy Total
[1] Energy Rate / Delta Temp
[1] Delta Temperature
[1] Temp #1 / Temp #2
[1] Temperature
Signal Strength
Time / Date
Press to select a Main Menu option.
Press to access this menu.
Press to toggle the options.
MAIN MENU
[2] [3] Use Site
List of site saved
Quick Start Menu
Display Tag ID
Measurement Mode
TT Transducer
Mounting
Pipe Material
Pipe Type
[2] Pipe Size
[2] Pipe Size Nominal
Wall Thickness
Liner Material
Fluid
Spacing
Zero Meter
Thermal Mode
Site Management
Save As
Rename Site
Delete Site
Delete All Sites
Display
Language
Decimal
Display Tag I.D.
Brightness
Contrast
Dimmer
Dimmer Level
Dimmer Timeout
Set Time
Set Date
Time Format
Date Format
Display Mode
Screen Lock
Information
Vendor
Model
P.N.
S.N.
FW Version
Date Code
Tag ID
Reset
Reset Flow Total
Diagnostics
Readings
Signal Strength
Doppler Snr
Doppler Quality
Doppler Freq Shift
History
Delta Time Filtered
Flow Rate Raw
Fluid Sound Speed
Delta Time Raw
Reynolds Number
Reynolds Factor
Flow Total Overflow
[1] Energy Total Overflow
[1] Mass Total Overflow
[1] Temperature #1
[1] Temperature #2
[1] Delta Temperature
Battery Information
Bluetooth
Bluetooth Hardware
Bluetooth MAC Address
Bluetooth Status
System
(S)
Time
Date
Power On Time
Simulation Mode
Clear History
Factory Reset
Reboot
Setup
Thermal Mode
Disabled
Mass 1 RTD
Energy 2 RTDs
Units
Flow Units
Flow Decimals
Flow Total Mode
Flow Total Units
Flow Total Decimals
Velocity Units
[1] Energy Rate Units
[1] Energy Rate Decimals
[1] Energy Total Units
[1] Energy Total Decimals
[1] Energy Total Mode
[1] Mass Rate Units
[1] Mass Rate Decimals
[1] Mass Total Units
[1] Mass Total Decimals
[1] Mass Total Mode
[1] Temperature Units
Display Mode
Meter
Flow Setup
TT Transducer
Mounting
Doppler Settings
[2] Pipe
Fluid
[2] TT Spacing
Advanced
Flow Calibration
[1] Temperature RTD
Temp Sensor Type
Temp Sensor Range
Delta Temp
Trim RTD #1
Trim RTD #2
Communications
EIA-485 Type
Bluetooth
Data Logging
Log Mode
Time Interval
Parameter 1…8
[2] Threshold
Min. Threshold
Max. Threshold
Delete Log
Available Memory
[1] Energy or mass mode
[2] Based on selected option
[3] Menu shows only if sites were saved

PARAMETER DESCRIPTIONS BY MENU

Main Menu Structure

The handheld's firmware has a hierarchical menu structure. See *"Menu Map" on page 16* for a visual path to the parameters.

The five *Main Menus* used in the handheld firmware are as follows:

Menu	Function
USE SITE	Select a Site to use for the meter. A site is a group of parameters to configure a meter.
QUICK START	Configure all parameters for measuring flow.
SITE MANAGEMENT	Save, rename and delete sites on the handheld memory.
SETUP	Contains all of the configuration parameters for programming the handheld.
DISPLAY	Configures handheld display functions.
INFORMATION	Displays system information, such as the model number and firmware version.
DIAGNOSTICS	Displays system status and allows you to clear the history, reset to factory defaults and reboot the system.
RESET	Resets the flow total or unlatches alarms.
THERMAL MODE	Select option for temperature sensor.

The following pages define the configuration parameters located in each of the menus.

Using Sites

The meter parameters can be saved as a Site to the handheld or as a Configuration to a .sol file using the SoloCUE app. When returning to a location, the Site or Configuration can be restored to the handheld so you avoid manually entering the setup parameters.

If you plan to use the handheld without the SoloCUE app, or you do not have a dedicated laptop, mobile device or central storage location for files, then saving Sites to the handheld may be the better way to manage and access setup parameters.

If you are using the SoloCUE app and have a central storage location for files, or have a dedicated laptop or mobile device that stays with the handheld, then saving Configurations to a .sol file is recommended. A Configuration includes all the Site parameters plus diagnostics and other information. A Configuration can also be viewed offline when you are not connected to the handheld.

Quick Start

Parameter	Function
DISPLAY TAG ID	Select whether the Tag ID displays on the home screen.
THERMAL MODE	Select if any RTDs are used for calculating mass or energy.
MEASUREMENT MODE	Select **TRANSIT TIME** for clean liquids, **DOPPLER** for aerated liquids or liquids with particles or **BOTH-HYBRID** for the meter to automatically select the mode.
TT TRANSDUCER	Select transducer for transit time flow measurement.
MOUNTING	Select mounting of transit time transducer.
PIPE MATERIAL	Select pipe material when the transducers are installed.
PIPE TYPE	Select whether the pipe dimensions are entered in millimeters or inches, or select a North American pipe schedule.
PIPE SIZE	Enter the outer dimensions of the pipe. A tape measure is included in the portable kit.
PIPE SIZE NOMINAL	Select the pipe size. Parameter only shows if a North American pipe schedule is selected.
WALL THICKNESS	Enter wall thickness of the pipe. Parameter only shows if dimensions are manually entered in millimeters or inches.
LINER MATERIAL	Select liner material if this is a liner.
LINER THICKNESS	Enter the liner thickness. Parameter only shows if a liner material is selected.
FLUID	Select fluid in the pipe. Custom fluids can be set up using SoloCUE app.
SPACING	Read the recommended spacing for mounting the transit time transducers. Refer to the transducer manual for installation instructions.
ZERO METER	After installing the transducers and verifying the signal strength is good, stop the flow and set the zero.

Site Management

Menu	Function
SAVE AS	Saves parameters as a Site to the handheld. Enter the Site name by using numeric keypad and scrolling through the alpha characters. Select the checkmark to save the Site with name at the top of the screen. See *"Entering an Alphanumeric" on page 15* for more details.
RENAME SITE	Rename an existing Site. Select the Site from the list. Change the name by using the numeric keypad and scrolling through the alpha characters. Select the checkmark to save the Site with name at the top of the screen. See *"Entering an Alphanumeric" on page 15* for more details.
DELETE SITE	Deletes an existing Site. Select the Site to delete and press **ENTER**; a confirmation screen pops up. Press **ENTER** to delete or **MENU/BACK** to cancel.
DELETE ALL SITE	Deletes all Sites. Select the Site to delete and press **ENTER**; a confirmation screen pops up. Press **ENTER** to delete or **MENU/BACK** to cancel.

Setup > Thermal Mode

Menu	Function
DISABLED	Flow readings only.
MASS 1 RTD	Flow and mass readings calculated from one RTD input.
ENERGY 2 RTD	Flow and energy readings calculated from two RTD inputs.

Setup > Units

Use *SETUP > UNITS* to define the measurement standards for the handheld. Contains all of the configuration parameters for setting the units and decimals for the readings and the totalizer mode. Requires operator level passcode or higher if security is enabled.

An asterisk (*) indicates the parameter default.

<table>
<tr><th>Submenus</th><th>Options/Descriptions</th></tr>
<tr><td>FLOW UNITS</td><td>Select the flow rate units/interval displayed on the Home Screen. FLOW UNITS are automatically converted into the selected option.
<table>
<tr><th>Option</th><th>Units/Interval</th></tr>
<tr><td>Fluid BBL/D</td><td>Fluid Barrels/Day (31.5 Gal)</td></tr>
<tr><td>IBBL/D</td><td>Imperial Fluid Barrels/Day (36 IG)</td></tr>
<tr><td>L/S</td><td>Liters/Second</td></tr>
<tr><td>L/MIN</td><td>Liters/Minute</td></tr>
<tr><td>L/H</td><td>Liters/Hour</td></tr>
<tr><td>M³/S</td><td>Cubic Meters/Second</td></tr>
<tr><td>M³/MIN</td><td>Cubic Meters/Minute</td></tr>
<tr><td>M³/H</td><td>Cubic Meters/Hour</td></tr>
<tr><td>FT³/S</td><td>Cubic Feet/Minute</td></tr>
<tr><td>FT³/MIN</td><td>Cubic Feet/Minute</td></tr>
<tr><td>FT³/H</td><td>Cubic Feet/Hour</td></tr>
<tr><td>Custom</td><td>This selection in only available if Custom Units is enabled through SoloCUE Flow Device Manager. Use SoloCUE to change the Custom Units.</td></tr>
</table>
<table>
<tr><th>Option</th><th>Units/Interval</th></tr>
<tr><td>GAL/S</td><td>US Gallons/Second</td></tr>
<tr><td>GAL/MIN</td><td>US Gallons/Minute</td></tr>
<tr><td>GAL/H</td><td>US Gallons/Hour</td></tr>
<tr><td>MG/D</td><td>Million US Gallons/Day</td></tr>
<tr><td>IG/S</td><td>Imperial Gallons/Second</td></tr>
<tr><td>IG/MIN</td><td>Imperial Gallons/Minute</td></tr>
<tr><td>IG/H</td><td>Imperial Gallons/Hour</td></tr>
<tr><td>MIG/D</td><td>Million Imperial Gallons/Day</td></tr>
<tr><td>OIL BBL/D</td><td>Oil Barrels/Day (42 Gal)</td></tr>
<tr><td>AC-FT/D</td><td>Acre Feet/Day</td></tr>
</table></td></tr>
<tr><td>FLOW DECIMALS</td><td>This is a numeric entry for the number of decimal places to display. Default is 2. Options are 0…7</td></tr>
<tr><td>FLOW TOTAL MODE</td><td>*GROSS FLOW — Any flow in forward and reverse direction.
FORWARD FLOW
REVERSE FLOW
NET FLOW — Forward flow minus reverse flow. A negative total results when reverse flow is greater than forward flow.</td></tr>
<tr><td>FLOW TOTAL UNITS</td><td>Select the units for the flow total displayed on the Home Screen. FLOW TOTAL UNITS are automatically converted into the selected option:
<table>
<tr><th>Option</th><th>Units</th></tr>
<tr><td>GAL</td><td>US Gallons</td></tr>
<tr><td>MGAL</td><td>Million US Gallons</td></tr>
<tr><td>IGAL</td><td>Imperial Gallons</td></tr>
<tr><td>AC-FT</td><td>Acre Foot</td></tr>
<tr><td>MIGAL</td><td>Million Imperial Gallons</td></tr>
<tr><td>Oil BBL</td><td>Oil Barrels (42 Gal)</td></tr>
<tr><td>Custom</td><td>This selection in only available if Custom Units is enabled through SoloCUE Flow Device Manager. Use SoloCUE to change the Custom Units.</td></tr>
</table>
<table>
<tr><th>Option</th><th>Units</th></tr>
<tr><td>Fluid BBL</td><td>Fluid Barrel (31.5 Gal)</td></tr>
<tr><td>L</td><td>Liter</td></tr>
<tr><td>HL</td><td>Hectoliter</td></tr>
<tr><td>M³</td><td>Cubic Meters</td></tr>
<tr><td>FT³</td><td>Cubic Feet</td></tr>
</table></td></tr>
<tr><td>FLOW TOTAL DECIMALS</td><td>This is a numeric entry for the number of decimal places to display. Default is 0. Options are 0…7.</td></tr>
<tr><td>VELOCITY UNITS</td><td>Select the units for the velocity displayed on the Home Screen.
*FT/S Feet/Second
M/S Meters/Second</td></tr>
</table>

<table>
<tr><th>Submenus</th><th>Options/Descriptions</th></tr>
<tr><td>ENERGY RATE UNITS
(Energy Units Only)</td><td>Select the units for the energy rate displayed on the Home Screen. ENERGY RATE UNITS are automatically converted into the selected option:
<table>
<tr><th>Option</th><th>Units</th><th>Option</th><th>Units</th></tr>
<tr><td>BTU/H</td><td>Btu/hour</td><td>kJ/H</td><td>Kilojoules/hour</td></tr>
<tr><td>kBTU/H</td><td>Thousand Btu/hour</td><td>MJ/H</td><td>Mega joules/hour</td></tr>
<tr><td>MMBTU/H</td><td>Million Btu/hour</td><td>kCAL/H</td><td>Kilocalories/hour</td></tr>
<tr><td>W</td><td>Watts</td><td>MCAL/H</td><td>Mega calories/hour</td></tr>
<tr><td>*kW</td><td>Kilowatts</td><td rowspan="2">TON (RT)</td><td rowspan="2">Ton (Refrigeration)
1 Ton = 12,000 Btu/h</td></tr>
<tr><td>MW</td><td>Megawatts</td></tr>
</table></td></tr>
<tr><td>ENERGY RATE DECIMAL
(Energy Units Only)</td><td>This is a numeric entry for the number of decimal places to display. Default is 2. Options are 0…7.</td></tr>
<tr><td>ENERGY TOTAL UNITS
(Energy Units Only)</td><td>Select the units for the energy total displayed on the Home Screen. ENERGY TOTAL UNITS are automatically converted into the selected option:
<table>
<tr><th>Option</th><th>Units</th><th>Option</th><th>Units</th></tr>
<tr><td>BTU</td><td>British Thermal Unit</td><td>kWH</td><td>Kilowatt Hour</td></tr>
<tr><td>kBTU</td><td>Thousand Btu</td><td>MWh</td><td>Megawatt Hour</td></tr>
<tr><td>MMBTU</td><td>Million Btu</td><td>kJ</td><td>Kilo Joules</td></tr>
<tr><td>KCAL</td><td>Kilo Calories</td><td>MJ</td><td>Mega Joules</td></tr>
<tr><td>MCAL</td><td>Mega Calories</td><td>TON-H</td><td>Ton-hour (Refrigeration)</td></tr>
</table></td></tr>
<tr><td>ENERGY TOTAL DECIMALS
(Energy Units Only)</td><td>This is a numeric entry for the number of decimal places to display. Default is 2. Options are 0…7.</td></tr>
<tr><td>ENERGY TOTAL MODE
(Energy Units Only)</td><td>FORWARD FLOW
REVERSE FLOW
NET FLOW Forward flow minus reverse flow. A negative total results when reverse flow is greater than the forward flow.
*GROSS FLOW Any flow in forward and reverse direction.</td></tr>
<tr><td>MASS RATE UNITS
(Mass Mode Only)</td><td>LB/MIN
KG/MIN
Custom This section in only available if Custom Units is enabled through SoloCUE Flow Device Manager. UserSoloCUE to change the Custom Units.</td></tr>
<tr><td>MASS RATE DECIMAL
(Mass Mode Only)</td><td>This is a numeric entry for the number of decimal places to display. Options are 0…7.</td></tr>
<tr><td>MASS TOTAL MODE
(Mass Units Only)</td><td>FORWARD FLOW
REVERSE FLOW
NET FLOW Forward flow minus reverse flow. A negative total results when reverse flow is greater than the forward flow.
GROSS FLOW Any flow in forward and reverse direction. Total is always positive and is an absolute value of the forward and reverse direction.</td></tr>
<tr><td>MASS TOTAL UNITS
(Mass Mode Only)</td><td>LB
KG
Custom This section in only available if Custom Units is enabled through SoloCUE Flow Device Manager. Use SoloCUE to change the Custom Units.</td></tr>
<tr><td>MASS TOTAL DECIMAL
(Mass Mode Only)</td><td>This is a numeric entry for the number of decimal places to display. Options are 0…7.</td></tr>
<tr><td>TEMPERATURE UNITS
(Energy Units Only)</td><td>°F
°C
K</td></tr>
</table>

Setup > Meter

Contains all of the configuration parameters for setting the meter. Requires service level passcode or higher if security is enabled.

Setup > Meter > Flow Setup

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions
MEASUREMENT MODE	TRANSIT TIME DOPPLER BOTH - HYBRID
DIRECTION	*FORWARD REVERSE
BIDIRECTIONAL	*ENABLED DISABLED
LOW FLOW CUTOFF	Numeric entry. Units and decimals are based on *FLOW RATE UNITS*. Zero and positive values. *0.0
TT SIGNAL CUTOFF	*30 The low threshold when the meter stops reading flow and displays a F10 Low Signal message (see *"F10 LOW TT SIGNAL" on page 34* for causes of a low signal).
TT SIGNAL HIGH	*90% The high threshold when the meter stops reading flow and displays a F11 High Signal message (see *"F11 HIGH TT SIGNAL" on page 34* for causes of a high signal).
MINIMUM FLOW	min. –2,000,000. Number of decimals points depends on *Home Screen* settings.
MAXIMUM FLOW	max. 2,000,000

Setup > Meter > TT Transducer

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions	
TT TRANSDUCER	Select the transducer type:	
	Small 2 MHz	Universal small pipe transducers integrated in a rail
	Medium 1 MHz	Medium size pipe transducers
	Medium 1 MHz (HZ)	Can be used for a second set of medium pipe transducers, such as high temperature
	Large 0.5 MHz (LZ, YZ)	Large pipe transducers

Setup > Meter > Mounting

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions
MOUNTING	For mounting options, see the transducer user manual. Z PATH *V PATH W PATH

Setup > Meter > Doppler Settings

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions	
DOPPLER AGC GAIN	*ENABLED / DISABLED	Enables and disables automatic gain control
GAIN VALUE	Read the gain set by the automatic gain control	
MANUAL GAIN SETTING	Numeric entry in % when *DOPPLER AGC GAIN* is disabled	

Setup > Meter > Pipe

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions
PIPE MATERIAL	STAINLESS 302/303 STAINLESS 304 STAINLESS 304L *STAINLESS 316 STAINLESS 347 STAINLESS 410 STAINLESS 430 ALUMINUM BRASS NAVAL CARBON STEEL COPPER IRON - CAST IRON - DUCTILE HD POLYETHYLENE LD POLYETHYLENE PFA TEFLON PVC CPVC PVDF POLYPROPYLENE
PIPE TYPE	For the best accuracy, measure the outer diameter and wall thickness with a gauge and select *MANUAL INCHES* or *MANUAL MM*. If you do not have a gauge, you can select an ASME/ANSI or ASTM definition. Schedule, copper tubing and cast iron class are filtered based on pipe material selection. If stainless steel pipe, carbon steel, cvc, pcvc material is selected, the following pipe schedules are also available as applicable: SCHEDULE STD SCHEDULE 5 *SCHEDULE 10 SCHEDULE 20 SCHEDULE 30 SCHEDULE 40 SCHEDULE 60 SCHEDULE 80 SCHEDULE 100 SCHEDULE 120 SCHEDULE 140 SCHEDULE 160 SCHEDULE 180 SCHEDULE STG If copper material is selected, the following types are also available: TYPE K TYPE L TYPE M PIPE SIZE If cast iron pipe material is selected, the following classes are also available: CLASS A CLASS B CLASS C CLASS D CLASS E CLASS F CLASS G CLASS H If ductile iron pipe material is selected, the following classes are also available: CLASS 50 CLASS 51 CLASS 52 CLASS 53 CLASS 54 CLASS 55 CLASS 56 If aluminum or brass naval material is selected, the following is also available: PIPE SIZE (in inches)
PIPE SIZE	Available only when *PIPE TYPE* is *MANUAL*; Numeric entry; min. 0.5 in (15 mm), max. 300 in (7500 mm)
PIPE SIZE NOMINAL	*PIPE SIZE NOMINAL* is substituted for *PIPE SIZE* when a schedule/tubing/class is selected. Enumeration based on schedule; min. 0.5 in., max. 36 in. 1/2, 3/4, 1, 1-1/4, 1-1/2, 2, 2-1/2, 3, 3-1/2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 30, 32, 34, 36
WALL THICKNESS	Numeric entry; *min. 0.00, max. 5 in. (125 mm); *WALL THICKNESS* is only useful for *MANUAL METRIC* and *MANUAL INCHES*; It can be skipped for pipe schedule, tubing and classes
LINER MATERIAL	NONE ACRYLIC ASBESTOS CEMENT EBONITE MORTAR HD POLYETHYLENE LD POLYETHYLENE POLYPROPYLENE POLYSTYRENE RUBBER TAR EPOXY PFE TEFLON GLASS PYREX FIBERGLASS EPOXY
LINER THICKNESS	Numeric entry; min. 0.00, max. 5 in. (125 mm)

Submenus	Options/Descriptions
I.D. SIZE	Numeric display in inches or millimeters, based on *PIPE TYPE*

Setup > Meter > Fluid

Submenus	Options/Descriptions				
TYPE	Water - Tap Raw Sewage Water - Distilled Water - Sea 3.5% Brine - 3.5% Brine - 10%	Acetone Ammonia Benzene Ethanol Ethylene Glycol 100% Ethylene Glycol 50%	Ethylene Glycol 30% Gasoline Glycerin Isopropanol Jet Fuel A1/JP8 Jet Fuel B/JP4	Kerosene Methanol Oil Diesel #1 Oil Diesel #2 Propylene Glycol 100% Propylene Glycol 50%	Propylene Glycol 30% Stoddard Solvent Sulfuric Acid 96% Hydrochloric Acid 36% Hydrofluoric Acid 49% Custom
CUSTOM FLUID (Program with SoloCUE)	SOUND SPEED	Numeric entry; Units ft/s or m/s based on velocity units.			
	SPEED UNITS	Ft/s or m/s			
	SPECIFIC GRAVITY	Numeric entry; Specific gravity (density relative to water), pipe size and viscosity are used to calculate the Reynolds number. The Reynolds number indicates whether the fluid is in turbulent, transition or laminar flow and the flow profile.			
	VISCOSITY	Numeric entry; Units centipoise (cP) or mPa-s. Dynamic viscosity of the fluid.			
	VISCOSITY UNITS	Units centipoise (cP) or mPa-s			
	REFERENCE TEMP	Numeric entry, °F or °C. Default 15° C. Reference temperature of viscosity and specific gravity.			
	REF TEMP UNITS	°F or °C			
	SPECIFIC HEAT	Numeric entry; Units: joule/gram °C; min. 0.01, max. 65.0; Specific heat capacity is the heat capacity per unit mass of a material.			
TEMP COMPENSATION	MANUAL				
	TEMPERATURE #1				
	TEMPERATURE #2				
MANUAL REF TEMP	Numeric entry based on *REF TEMP UNITS*. Enter the fluid temperature if RTDs are not connected.				
REF TEMP UNITS	°F °C K				

Setup > Meter > TT Spacing

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions
TT SPACING	*Numeric display 0…300 units in inches or millimeters, based *PIPE* settings. The spacing required between two transit time transducers based on the pipe parameters. Take this measurement between the lines scribed into the side of the transducers or use the scale on the rails, if used. See the transducer user manual. For Cx transducers with fixed spacing, the parameter is not shown. **NOTE:** Spacing does not apply to Doppler transducers.

Setup > Meter > Advanced

An asterisk (*) indicates the parameter default.

HEAT CALCULATION (Energy meter only)	Dynasonics Calculation EN1434 TYPE *Rate of Heat Delivery = Q × (Tin – Tout) × C × ρ* Where Q = Volumetric flow rate Tin = Temperature at the inlet Tout = Temperature at the outlet C = Heat capacity ρ = Density of fluid	
DAMPING	*10 seconds	For detailed information on these parameters, see the paragraphs following this table.
SENSITIVITY	*60%	
HYSTERESIS	*5%	
BAD DATA REJECTION	*3	
FILTER METHOD	*Adaptive	
WAVE	• *AUTO automatically selects waveform based on flow speed and signal quality. • SIN CARROT TOP is best for low speed flow. • BEST BARKER is best for high speed flow.	
TEMP COMPENSATION	*MANUAL TEMP #1 TEMP #2	Selection is only available for Energy meter. For the Flow meter, manual temperature compensation is always on. Temperature compensation adjusts the viscosity of the fluid used in Reynolds number compensation and the fluid speed of sound.
MANUAL REF TEMP	Numeric entry -40…350° F (–40…176° C)	
REF TEMP UNITS	° F ° C K	Select the units for the manual reference temperature.
REYNOLDS	*ENABLED DISABLED	Flow rate compensation based on fluid Reynolds number as the fluid changes from laminar to transitional to turbulent flow.

Filter Parameters

Filter Method (Default: Adaptive)

The DXN-5P flow meter offers three levels of signal filtering:

- *None* imposes no filtering on the signal from the transducers.
- *Simple with Rejection* uses *Damping* and *Bad Data Rejection* to filter the flow data.
- **Adaptive* filtering allows the meter's software routines to alter the filtering, depending on the variability of the transducer's signal. The *Adaptive* filter uses a combination of *Damping*, *Bad Data Rejection*, *Sensitivity* and *Hysteresis* to modify the flow input data.

Damping (Range 0…100 Seconds; Default: 40 Seconds)

Damping is the approximate amount of time the filtering routines use to attain a 99% stable rate value. Generally, the higher the damping value, the more stable the rate readings are—but at the expense of response time.

Sensitivity (Range 0…100%; Default: 60%)

Sensitivity determines how fast the adaptive filtering responds to a change in rate. Increasing the sensitivity decreases the filtering, which allows the display to respond to rate changes more rapidly.

Hysteresis (Range 0…25%; Default: 5%)

Hysteresis creates a window around the average flow measurement reading, defining the limits at which the automatic damping increases occur. If the rate varies within the hysteresis window, greater damping occurs up to the maximum values set by the flow filter *Damping* entry. The filter also establishes a flow rate window where measurements outside of the window are captured by the *Bad Data Rejection* window. Enter the value as a percentage of actual flow rate.

For instance, a *Hysteresis* setting of 5% allows the flow to vary ± 5% from the currently established flow rate without automatically decreasing the value of the *Damping*.

For example, if the average flow rate is 100 gpm and the *Hysteresis* is set to 10%, a filter window of 90…110 gpm is established. Successive flow measurements that reside within that window are recorded and averaged in accordance with the *Damping* setting. Flow readings outside of the window are rejected or accepted in accordance with the *Bad Data Rejection* setting.

Filter settings for this example:

Filter Method	Adaptive
Damping	40 seconds
Sensitivity	60%
Hysteresis	10%
Bad Data Rejection	3

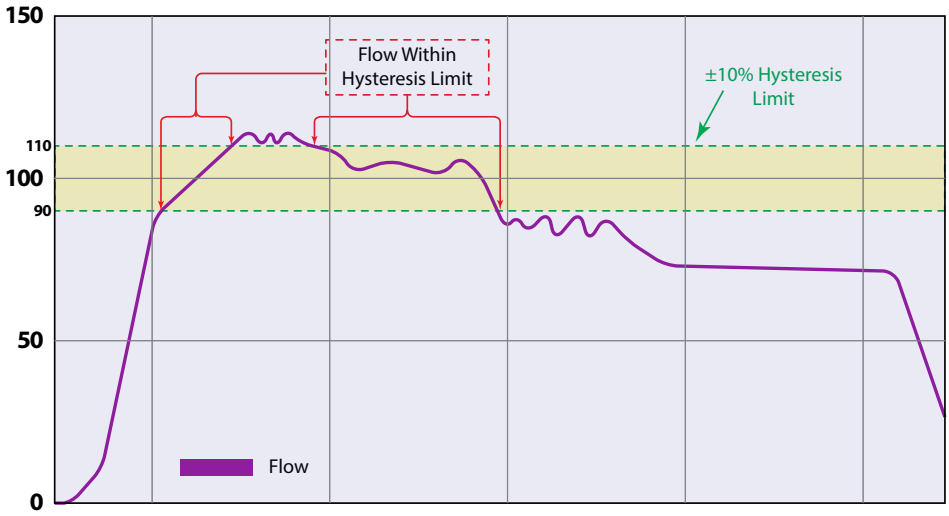


Figure 14: Hysteresis window

Bad Data Rejection (Range 0…10 Samples; Default: 3)

The *Bad Data Rejection* setting is related to the number of successive ***readings*** that must be measured outside of a the *Hysteresis* value before the flow meter considers the new flow value valid. In this example, a *Hysteresis* setting of 10% produces a ± 10% band centered on the current valid flow rate of 100 gpm.

The *Bad Data Rejection* setting is the number of successive ***samples*** that must be outside of the *Hysteresis* window before the flow meter considers the change in flow as real. Larger values are entered into the *Bad Data Rejection* window when measuring liquids that contain gas bubbles, as the gas bubbles tend to disturb the hybrid ultrasonic signals and cause more extraneous flow readings to occur. Larger *Bad Data Rejection* values tend to make the flow meter less responsive to rapid changes in actual flow rate.

In *Figure 16 on page 26,* flow data falls outside the flow *Hysteresis* window but does not reach the minimum time specified in the *Bad Data Rejection* window. When data appears that is outside the *Hysteresis* band and shorter than the *Bad Data Rejection* window time, the data is rejected.

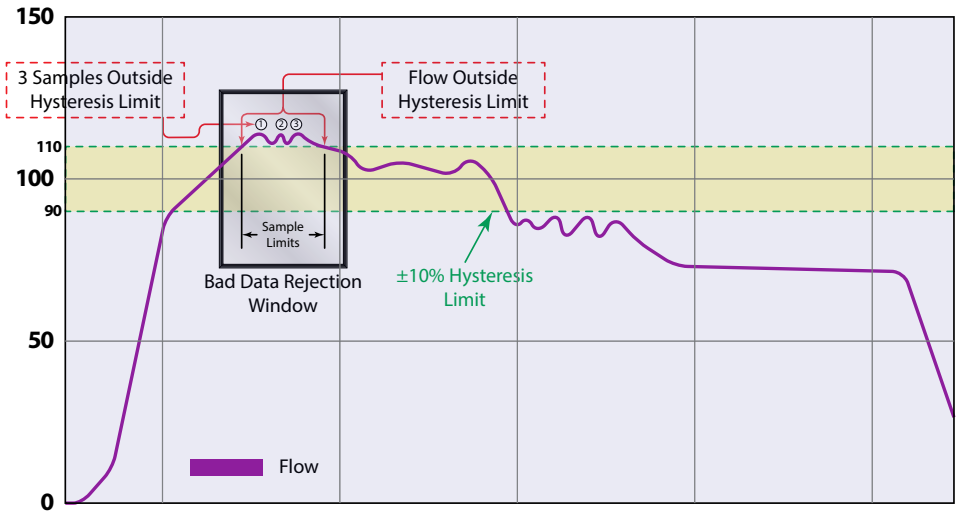


Figure 15: Bad data (rejection)

The flow rate is again outside the original ±10% *Hysteresis* window, but the data exists for a time period greater than the *Bad Data Rejection w*indow. In this instance, the meter interprets the data as a new valid flow rate and moves the *Hysteresis* window to correspond with the new established flow rate.

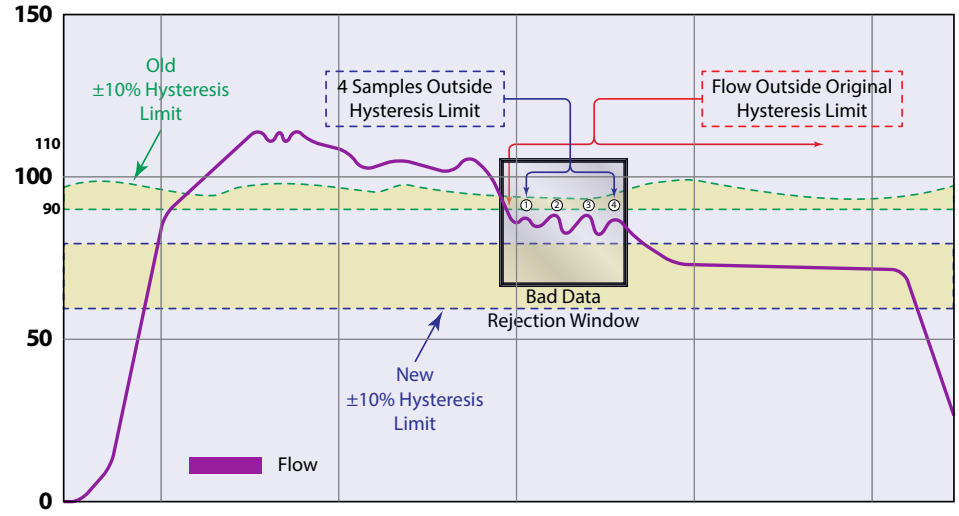


Figure 16: New valid flow data

Setup > Meter > Flow Calibration

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions	
FACTORY SETTINGS (For each transducer)	CAL FACTOR	One of two calibration factors unique to each transducer pair if the handheld was used during factory calibration. Numeric display #.###
	SENSOR FACTOR	One of two calibration factors unique to each transducer pair if the handheld was used during factory calibration. Numeric display #.###
ZERO MODE	MANUAL *NO FLOW STEADY FLOW	Due to different pipe characteristics, the meter must be zeroed in order to maintain accuracy. The recommended method is to stop flow and make sure there is no flow before zeroing the meter. In situations in which that is not feasible, you may zero the meter while the flow is steady or enter the zero manually. Select the method to zero the meter.
SET ZERO - NO FLOW	SET ZERO AT NO FLOW in process and confirmation screen	Check that the pipe is full of liquid and not flowing. Flow must be absolutely zero. Securely close any valves and allow time for settling to occur.
SET ZERO - FLOW	SET ZERO AT FLOW in process and confirmation screen	Stabilize the flow to a steady level before zeroing the meter. In situations where it is not possible to stop flow, use this method to zero the meter. When selected, the meter calculates the zero typically in 5…10 seconds and indicates if the meter was successful or not in determining the flow.
MANUAL ZERO	Numeric entry ## ### ns	Allows for manual entry of the zero value when *ZERO MODE* is *MANUAL*.
ZERO VALUE	Numeric display ## ### ns	The zero offset used to calculate the flow rate If the meter is not zeroed after installation, this value matches the factory *ZERO* setting.

NOTE: Up to 4 transit time transducers can be calibrated. The scale and sensor factors are listed for each transducer.

Calibration Submenus	Options/Descriptions	
SENSOR FACTOR	Numeric entry ## ### ns	The value used in calculating the zero value when zeroing the meter at steady flow. This value can be found on the transducer label.
SCALE FACTOR	Numeric entry	The factor used for linearizing the flow rate calculation when *FIELD* is selected for *FACTOR MODE*. Enter the *CAL FACTOR* from the transducer.

Factory Calibrated Procedure

Each transducer pair has a *CAL FACTOR* and *SENSOR FACTOR* on the label. Enter the factors from the transducer into the *CAL FACTOR* and *SENSOR FACTOR* settings.

Zero the meter after entering the *CAL FACTOR* and *SENSOR FACTOR*.

Field Calibration Procedure

To calibrate the DXN-5P flow meter, use a master meter or gravimetric test stand.

1. Set *SCALE FACTOR* set to **1**.
2. Run calibration test.
3. Calculate the *SCALE FACTOR*.
   SCALE FACTOR = (actual flow)/(meter flow rate) or (actual total)/(meter total)
4. Enter the *SCALE FACTOR*.

Setup > Temperature RTD

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions	
TEMP SENSOR TYPE	Pt1000 3-WIRE	Select the temperature sensor type.
	Pt1000 4-WIRE	
	Pt100 3-WIRE	
	Pt100 4-WIRE	
DELTA TEMP	TEMP #1-TEMP #2 TEMP #2-TEMP #1	Select the order for positive and negative energy calculations.

See *"" on page 33* before adjusting the RTD input.

RTD Calibration Procedure

NOTE: RTD temperatures are calculated using the Callendar–Van Dusen equation.

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions	
TRIM RTD #1	NUMERIC ENTRY	Adjust the offset for the temperature reading for RTD #1 at the low temperature reading.
TRIM RTD #2	NUMERIC ENTRY	Adjust the offset for the temperature reading for RTD #2 at the low temperature reading.
CAL FACTOR RTD#1	NUMERIC ENTRY	Adjust the scaling to bring the low and high temperature readings within range.
CAL FACTOR RTD#2	NUMERIC ENTRY	Adjust the scaling to bring the low and high temperature readings within range.

Setup > Communications

Requires service level passcode or higher if security is enabled. For addressing information, see the *"DXN-5P Meter Modbus RTU Protocol"* user manual, available at *www.badgermeter.com*.

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions	
EIA-485 TYPE	DISABLE	Either disable this feature or select a network type.
	*MODBUS MASTER	
MODBUS RTU SETTINGS (Displayed when MODBUS RTU is selected as the option for EIA-485 TYPE.)	ADDRESS	Numeric entry 1…254
	BAUD RATE	*AUTO, 9600, 19200, 38400, 57600, 76800, 115200
	ACCESS	WRITE/READ allows full access. RESET/READ allows you to read any, but only write to *Flow Total Reset* (cannot set up meter). READ ONLY allows read only.
	PARITY	*NONE ODD PARITY EVEN PARITY
	STOP BIT	*1 STOP BIT 2 STOP BITS
	RESISTOR	*DISABLED ENABLED
	WORD ORDER	BIG ENDIAN *LITTLE ENDIAN For 32-bit numbers or data types spanning over multiple registers, select the order of the 16-bit word or register to match the Modbus RTU master.
	TIMEOUT	Numeric entry 0…10000 ms Enter 0 ms to disable the timeout option. For networks with a predictable poll rate by the master device, this parameter is an option to record and display an S60 code when the meter does not receive a message from the master device. Enter the time that the DXN-5P meter should record and display a loss of communication timeout.
Bluetooth	*ENABLE/DISABLE*	Enables or disables Bluetooth for programming the DXN-5P.

Setup > Data Logging

Log files are stored on the internal memory card in and can be transferred using SoloCUE Flow Device Manager app for Windows, iPhone, iPad or Android. The maximum size of a file is 1MB. The file name format is YYMMDD##.txt where YY is the year, MM is the month, DD is the day and ## is 1…99 for consecutive files saved in a single day.

NOTE: Selections for *Parameter #1...#8* and *Threshold* change based on the *Thermal Mode* setting.

Data Logging Submenus	Options/Descriptions
LOG MODE	New log file created when parameters are added or removed from data log. *DISABLED CONTINUOUS — Logs when handheld is on and operating. THRESHOLD — Logs when the threshold value is between the minimum and maximum values. For example, only log when process equipment is operational and flow is above cutoff.
TIME INTERVAL	1 SECOND, 2 SECONDS, 5 SECONDS, 10 SECONDS, 20 SECONDS, 30 SECONDS 1 MINUTE, 2 MINUTES, 5 MINUTES, 10 MINUTES, 30 MINUTES 1 HOUR, 2 HOURS, 4 HOURS, 6 HOURS, 12 HOURS, 24 HOURS
PARAMETER #1 …. *PARAMETER #8*	**NOTE:** For error/alarm codes, the last 10 codes in the history are logged with semicolons separating the values. FLOW RATE, FLOW TOTAL GROSS, FLOW TOTAL FORWARD, FLOW TOTAL REVERSE, FLOW TOTAL NET, VELOCITY, REYNOLDS DELTA TRANSIT TIME, TEMPERATURE #1, TEMPERATURE #2, TEMP#1 - TEMP#2, TEMP#2 - TEMP#1, ENERGY RATE, ENERGY TOTAL GROSS ENERGY TOTAL FORWARD, ENERGY TOTAL REVERSE, ENERGY TOTAL NET, MASS FLOW RATE, MASS TOTAL GROSS, MASS TOTAL FORWARD, MASS TOTAL NET SIGNAL STRENGTH, SOUND SPEED, ERROR/ALARM CODE, NONE
THRESHOLD	If THRESHOLD control is selected, this setting is active. FLOW RATE, FLOW TOTAL, TEMPERATURE #1, TEMPERATURE #2, DELTA TEMPERATURE, ENERGY RATE ENERGY TOTAL, VELOCITY, MASS FLOW RATE, MASS TOTAL GROSS, MASS TOTAL FORWARD, MASS TOTAL NET
MIN THRESHOLD	Numeric entry (plus or minus) — If *THRESHOLD* log model is selected, this setting is active.
MAX THRESHOLD	Numeric entry (plus or minus) — If *THRESHOLD* log model is selected, this setting is active.
DELETE ALL LOG	Stops recording and deletes all records. Prompt with a confirmation screen.

Display Menu

Requires operator level passcode or higher if security is enabled. An asterisk (*) indicates the parameter default.

Display Submenus	Options/Descriptions	
LANGUAGE	*ENGLISH	English
	DEUTSCHE	German
	ESPAÑOL	Spanish
	FRANÇAIS	French
	ITALIANO	Italian
DECIMAL	#.# #,#	Select whether the decimal indicator is a period or a comma.
DISPLAY TAG ID	*DISABLED ENABLED	Displays the *TAG ID* on the *Home Screen*. Default is DXN-5P. Use SoloCUE to change the *TAG ID*.
BRIGHTNESS	Select the display brightness 10…100% in increments of 10. Default is 70%.	
CONTRAST	Adjust the screen contrast 12…37. Default is 24.	
DIMMER	*ENABLED DISABLED	Enable the *DIMMER* to reduce the display *BRIGHTNESS* after the buttons are not pressed for the *TIMEOUT* period. Select the *BRIGHTNESS* level. Default is 10%. Press any button to awaken the handheld and return to normal *BRIGHTNESS*. The buttons pressed are active one second after the handheld is awakened.
DIMMER LEVEL	OFF 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%	
DIMMER TIMEOUT	5 MINUTES *10 MINUTES 20 MINUTES 30 MINUTES 60 MINUTES	
SET TIME	Numeric entry for 24 hour clock HH:MM	
SET DATE	Numeric entry for date YYYY-MM-DD	
DISPLAY TIME	24 HOUR AM / PM	Select format of the time to display on the *Home Screen* and on the SoloCUE dashboard.
DISPLAY DATE	YYYY-MM-DD MM-DD-YYYY DD-MM-YYYY	Select format of the date to display on the *Home Screen* and on the SoloCUE dashboard.
DISPLAY MODE	Select the parameters to display on the *Home Screen*. Alternatively, you can change the display from the *Home Screen* by pressing the *DOWN* button. *FLOW RATE FLOW TOTAL VELOCITY FLOW RATE / FLOW ENERGY RATE ENERGY TOTAL DELTA TEMP TEMP #1/TEMP #2 ENERGY RATE / ENERGY TOTAL MASS FLOW RATE/MASS FLOW TOTAL TEMPERATURE SIGNAL STRENGTH TIME / DATE	
SCREEN LOCK	Confirmation to lock screen and disable keypad menu navigation until keys **5**, **7** and **ENTER** are pressed or the screen is unlocked from SoloCUE.	

Information Menu

An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions
VENDOR	BADGER METER
MODEL	DXN-5P
P.N.:	Badger Meter part number
S.N.	Serial Number
FW VERSION	Firmware Version xx.xx.xxx
CAL. DATE	Calibration Date YYYY-MM-DD
DATE CODE	Manufacture Date YYYY-MM-DD
TAG ID	16 characters

Diagnostics Menu

The *DIAGNOSTICS* menu displays system status and allows you to clear the history, reset to factory defaults and reboot the system. An asterisk (*) indicates the parameter default.

Submenus	Options/Descriptions		
READINGS	SIGNAL STRENGTH	Read-only numeric with message to indicate the quality of the hybrid ultrasonic signal	
	HISTORY	Chronological list of 120 past errors, alarms and warning messages	
	DOPPLER SNR	Doppler signal to noise ratio	
	DOPPLER QUALITY	Doppler signal quality	
	DOPPLER LEVEL	Level of the Doppler signal	
	DOPPLER FREQ SHIFT	Doppler shift related to velocity of particles, air bubbles or gas bubbles	
	DELTA TIME FILTERED	Read-only ##.## ns	
	FLOW RATE RAW	Read-only unfiltered flow rate	
	FLUID SOUND SPEED	Read-only; Units are the same as *VELOCITY*; Measured ultrasound speed of the fluid	
	DELTA TIME RAW	Read-only ns	
	REYNOLDS NUMBER	Read-only; Unitless; the Reynolds Number based on the fluid viscosity, density, velocity and pipe diameter	
	REYNOLDS FACTOR	Read-only; Unitless; the factor applied to the measured flow rate based on the Reynolds Number.	
	TEMPERATURE #1	Read-only; Energy or mass mode meters only; Units are the same as the *Home Screen*.	
	TEMPERATURE #2	Read-only; Energy or mass mode meters only; Units are the same as the *Home Screen*.	
	DELTA TEMPERATURE	The temperature difference between the two RTDs, either T1 - T2 or T2 - T1, according to the setting in *INPUT/OUTPUT > RTD > DELTA TEMP*.	
	TOTAL OVERFLOW COUNT	Numeric integer	The *TOTAL OVERFLOW COUNT* increments each time the flow total exceeds the digits in the display.
	ENERGY OVERFLOW	Numeric integer	The *ENERGY OVERFLOW* is a counter that increments each time the energy total exceeds the digits in the display.
	MASS OVERFLOW	Numeric integer	The MASS OVERFLOW is a counter that increments each time the mass total exceeds the digits in the display.
BATTERY	BATTERY STATUS	Percentage	The charge remaining in the battery.
	BATTERY DETECTED	Read-only; Connected status of the main power battery.	
	BATTERY RUNTIME	Read-only; hours; Total battery runtime for the life of the battery.	
	TEMPERATURE	Read-only; Internal battery temperature; Units are the same as the *Home Screen*.	
	CHARGING	Read-only; Battery charging status.	
	DISABLE CHARGING	Read/write; *Enabled* allows the battery to charge (default). *Disabled* prevents the battery from charging when external power is connected. *Disabled* is recommended to prevent the handheld from overheating when using the meter for an extended time.	

Submenus	Options/Descriptions		
BLUETOOTH	BLUETOOTH HARDWARE	DISABLED *ENABLED	Allows Bluetooth connection to the handheld.
	BLUETOOTH MAC ADDRESS	Shows the MAC address of the handheld	
	BLUETOOTH STATUS	CONNECTED UNCONNECTED	Shows whether the handheld is connected to another device over Bluetooth such as a mobile device with SoloCUE.
SYSTEM (Requires service level passcode or higher if security is enabled.)	TIME	HH:MM:SS (24 hour clock)	Displays the time.
	DATE	YYYY-MM-DD	Displays the date.
	POWER ON TIME	In seconds	
	SIMULATION MODE	OFF 100% 90% 80% 70% 60% 50% 40% 30% 20% 10% 0%	*Flow Simulation* provides output and display simulation based on a percentage of the full scale flow. Simulation does not accumulate the totalizers and any digital outputs set to pulse totalizer is not active. The range of simulation includes 0…100% of the full scale flow. Use the *Flow Simulation* parameter to set the range of simulation in 10% increments. To change the *Flow Simulation*, from the *INPUTS/OUTPUTS* menu: 1. Select **FLOW SIMULATION** to view the *Flow Simulation* display. 2. Click **RIGHT ARROW** to increment the percentage by 10, or click **DOWN ARROW** to decrement the percentage by 10.
	CLEAR HISTORY	CLEAR HISTORY confirmation screen	Clears all alarms, warnings, errors and informational messages from the *ALARM HISTORY* buffer. This is typically done after startup or maintenance on the flow system is successfully completed.
	FACTORY RESET	FACTORY RESET confirmation screen	Resets all parameters to the values on the device when it was shipped from the factory. Any settings made reset.
	REBOOT	REBOOT confirmation screen	Reboots the device. The DXN-5P meter does not require this manual *REBOOT* for any procedure, but it may be useful for system troubleshooting.

Reset Menu

Submenus	Options/Descriptions
RESET FLOW TOTAL	Reset the *FLOW TOTAL*. See the *"Reset Flow Totalizer Procedure"* below.
UNLATCH ALARMS	Only available if alarm latch is enabled. Unlatches output if alarm condition occurred and cleared.

Reset Flow Totalizer Procedure

The flow meter accumulates the amount of flow passing through the meter into a flow totalizer. To reset the flow total:

1. Press **MENU/BACK**.
2. Select **RESET** from the *Main Menu*.
   (Press **DOWN** to scroll through the list of options. When *RESET* is the top item, press **ENTER**.)
3. Select **RESET FLOW TOTAL** from the *Reset* menu.
   (With *RESET FLOW TOTAL* as the top item, press **ENTER**.)
4. Select **OK** to confirm reset.

After selecting *RESET FLOW TOTAL*, you are prompted to confirm the reset of the flow total. Press **ENTER** to confirm or press **MENU/BACK** to cancel.

MAINTENANCE

Battery

To prevent overheating, charge the lithium-ion battery when the handheld is turned off. If the battery temperature is too high, the handheld reduces or stops charging the battery.

When using the handheld while connected to external power, check that the battery charging is turned off to prevent overheating.

For long term storage, charge the battery to 40…60% to extend the life of the battery.

Cleaning

Wipe with a clean, soft cloth. Isopropyl alcohol may be used as a cleaning agent.

Storage

Store the handheld in a location that the temperature is maintained –20…140° F (–30…60° C). Exceeding the temperature range may reduce the life of the battery.

TROUBLESHOOTING

Warning and alarm messages are classified according to NAMUR 107 standards.

Out of Specification Messages

Warning and alarm messages occur when the flow meter is operational, but the readings might be out of specification or an operator might need to take action. If a warning or alarm condition occurs, a warning/alarm icon with code appears at the bottom of the *Home Screen*. The flow rate and flow total continue to display.

Failure Messages

An error condition occurs when the flow rate cannot be determined, such as when the signal strength is too low. If an error condition occurs, the flow rate is replaced with the "failed" icon, code and description.

If conditions cause multiple messages to occur, all messages are saved to the history, however some messages may not display. If an error condition occurs, warning and alarm messages do not display. If multiple errors occur, each error message cycles through and is viewable for 5 seconds. Similarly, if multiple warning or alarm conditions occur (but no error conditions), each message cycles through and is viewable for 5 seconds.

Warning, Alarm and Error Messages automatically clear when the issue clears.

Check Function Codes

When the meter or outputs are in a test mode, a check function message appears at the bottom of the *Home Screen*.

View Alarm and Message Buffer

Up to 30 alarm or warning message codes are buffered on a first-in-first-out basis. To view the buffer, go to *DIAGNOSTICS > HISTORY.*

Warning and Alarm Message Codes

Failure Codes

Code	Description	Correction
F02 ELECTRONIC ERROR	Multiple watchdog timeouts occurred.	Contact factory
F03 ELECTRONIC ERROR	Voltage levels are out of specification.	Reboot handheld; If error repeats, repair or replace handheld.
F10 LOW TT SIGNAL	Transit time signal strength is below cutoff.	Check for empty pipe, transducer spacing and parameter settings. Check for flow disturbances such as gas/air bubbles, foaming or debris in the liquid. Check for significant scale build in the pipe or detached pipe liners. Check that the pipe surface is clean and smooth and there is sufficient couplant on the transducers.
F11 HIGH TT SIGNAL	Transit time signal strength is oversaturated.	Change transducer mounting for more paths.
F12 LOW DOPPLER	Doppler signal is below cutoff.	Check for empty pipe and parameter settings. Check for too few gas/air bubbles or particles in the liquid. For pipes with significant gas/air bubbles or particles in the liquid, position transducers side by side. Check for significant scale build in the pipe or detached pipe liners. Check that the pipe surface is clean and smooth and there is sufficient couplant on the transducers.
F13 HIGH DOPPLER	Doppler signal is oversaturated.	If transducers are positioned side by side, move a transducer to the opposite side of the pipe.
F20 RTD #1 ERROR	Unable to detect RTD #1.	Check wiring to RTD #1 connector. Change *THERMAL MODE* to **Disabled** if temperature readings are not needed.

F21 RTD #2 ERROR	Unable to detect RTD #2.	Check wiring to RTD #2 connector. Change *THERMAL MODE* to **Disabled** or **Mass** if temperature readings are not needed.

Check Function Codes

Code	Description	Correction
C60 SIMULATION MODE	Meter is running flow simulation.	Deactivate *Simulation Mode*.

Out-of-Specification Codes

Code	Description	Correction
S01 ELECTRONIC WARNING	Fault detected and handheld rebooted.	Contact factory, update firmware or repair or replace handheld.
S02 DEFAULT FAILED	Reset to factory defaults failed.	Check calibration. If it does not match the calibration settings on the transducer serial tag, enter field calibration settings. Return to the *Home Screen* and continue to operate (if the reset to factory defaults is through the handheld).
S04 LOW BATTERY	Battery charge is low.	Connect external power to charge the battery. If the battery continues to discharge, the handheld shuts down.
S05 NO BATTERY	Battery is not connected.	Check that the internal battery is connected. Refer to *"Replacing the Batteries and Memory Card" on page 38*.
S17 BATTERY TEMP LOW	Battery temperature is near or below 5° C charging threshold.	Protect the handheld from cold temperatures. Battery charging is disabled to prevent damage to the battery until internal battery temperature is within rated temperatures range.
S18 BATTERY TEMP HIGH	Battery temperature is near or above 45° C.	Protect the handheld from high ambient temperatures. Disconnect external power or disable charging by setting the *DISABLE CHARGING* parameter. Battery charging is disabled until internal battery temperature is within rated temperatures range.
S23 CHARGING DISABLED	Battery charging is disabled manually or due to internal temperature being out of range.	Check the temperature of the internal battery in the handheld. Protect the handheld from operating outside for the rated temperature range.
S50 TOTAL OVERFLOW	Accumulated flow total is greater than viewable digits.	Check the totalizer units or reset the flow total to clear the overflow counter.
S62 DISCONNECTED	Bluetooth connection timed out.	—
S63 BLUETOOTH FAIL	Unable to initialize Bluetooth.	Update firmware. If error repeats, repair or replace handheld.
S67 DATA LOG ERROR	Datalog storage card is missing or full.	Check microSD card. If data logging is not required, disable data logging.

Informational Events Codes

Information events are only displayed in the ALARM HISTORY and not on the *Home Screen*.

Code	Description
I01 POWER ON	Power on or rebooted.
I11 ZERO	Meter zeroed.
I12 FACTORY CALIBRATION	Calibration changed from Field to Factory.
I13 FIELD CALIBRATION	Calibration changed from Factory to Field.
I21 FIRMWARE CHANGED	Firmware updated or parameters set to factory defaults.
I31 FLOW TOTAL RESET	Flow total reset to zero.
I41 SD CARD NOT IN	No memory card for storing datalog and site files.

Symptoms

Symptom: Handheld does not power up. LED lights are off.

Possible Causes	Recommended Action
No power or inadequate power – battery is not charged	Connect power.

Symptom: Handheld does not power up. LED light is on.

Possible Causes	Recommended Action
No power or inadequate power – battery not charging	Connect power.

Symptom: Flow reading appears to be incorrect.

Possible Causes	Recommended Action
• Incorrect positioning of transducers • Poor contact between transducers and pipe • Poor placement of transducers • Low signal strength • Process loop issues • Incorrect pipe settings • Meter not calibrated • Display not set up correctly	Refer to the Transducer Mounting Configuration section for details on proper installation. **At the transducer:** • Verify that the spacing of the transducers is set correctly. On most transducers, a scribe mark on the side of the transducers indicates the point of measurement—NOT from the end points of the transducers. • Verify that the transducers are aligned correctly. For Z-Mount, verify the transducers are 180° from each other. • Make sure there is a good contact between the transducers and pipe and a thin coat of acoustic coupling is applied. For integral mount, check for over-tightening of the transducers. **Process or loop flow and general location:** • Make sure the transducers are on the sides of the pipe and NOT on the top of the pipe. • Check that the transducers are NOT located at the highest point in the loop where air may accumulate. • Check that the transducers are NOT on a downward flowing pipe unless adequate downstream head pressure is present to overcome partial filling or cavitation. • Check that the transducers have adequate straight pipe upstream and downstream. • Check process or loop for entrained air or particulates which impacts the flow readings. • Pipes may develop scale, product build-up or corrosion over time. As a result, the effective wall thickness may be different than a new pipe and wall thickness or liner parameters may need to be adjusted. **At the handheld:** • Verify that pipe parameters match the installation.

Symptom: Unstable flow.

Possible Causes	Recommended Action
• Installation issues • Flow instability • Transducer mounting is loose • Transducers are moved • Incorrect flow settings	• Check process loop for variations of entrained air which impacts the flow, such as a pump pulling in air or air trapped at a high point in a loop. Install Doppler transducers and use Hybrid mode on the handheld and read Doppler signal strength. If the Doppler signal strength increases with the flow rate, most likely there is air or debris in the pipes. • Check for pump induced flow instability. • Check that the transducers are secure and are in area where the transducers cannot be inadvertently bumped or disturbed. • Check low flow cutoff, minimum flow or maximum flow settings.

Symptom: Flow readout is opposite of the flow direction.

Possible Causes	Recommended Action
• Integral mount handheld is mounted in reverse flow direction so display is properly oriented • Up and down transducers wiring is reversed • *Flow Direction* parameter is reversed	• Change the transducer flow direction parameter. • Rewire the up and down transducers to the handheld.

Symptoms: No flow readings and no failure codes.

Possible Causes	Recommended Action
• *Low Flow Cutoff* is set too high • *Flow Bidirectional* is disabled or set to *Unidirectional* and transducer upstream and downstream positions are swapped • Process or loop flow is blocked by a valve, air lock or other blockage • Pump is not running	• Check *Low Flow Cutoff* and *Bidirectional* parameters in the *Meter* > *Setup* > *Flow* menu are set correctly. • Check process or loop for closed valves upstream and downstream from the tranducers and pump operation. • Check that the pump is operating correctly. • On a pipe that is at a high point relative to nearby pipes, install transducers on the top and bottom of the pipe. If there is no signal it could mean there is air trapped in the pipe at that location.

If contacting Technical Support, please include:

- The name of the product Dynasonics DXN-5P, firmware version, manufacturing date and serial number
- Transducer pair part number
- Transducer mounting and location
- Couplant type
- Pipe size and material
- Fluid and flow direction (horizontal, vertical upward, vertical downward)
- Wiring if applicable
- Description of the problem

If possible, save the configuration using SoloCUE Flow Device Manager and send the saved .sol file and any photos of the installation.

REPLACEMENT PROCEDURES

⚠WARNING

DISCONNECT POWER BEFORE OPENING THE ENCLOSURE.

Tools Required

- A Phillips #2 screwdriver with torque control
- A flat blade screwdriver
- A workbench that prevents ESD damage to the electronics

⚠CAUTION

CONTAINS PARTS AND ASSEMBLIES SUSCEPTIBLE TO DAMAGE BY ELECTROSTATIC DISCHARGE (ESD). BEFORE PICKING UP AN ESD-SENSITIVE ELECTRONIC COMPONENT, DISCHARGE YOURSELF BY TOUCHING A GROUNDED BARE METAL SURFACE OR APPROVED ANTI-STATIC MAT.

OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC-SENSITIVE DEVICES.

Replacing the Batteries and Memory Card

⚠WARNING

REPLACE THE MAIN BATTERY WITH ONLY BADGER METER PART NUMBER 70237-001.

1. Remove the carrying straps and protective case from the handheld.
   a. From the back side, grab a lower corner of the protective case by the slit area.
   b. Peel away toward the front to expose the bottom endcap.
   c. Repeat for the other corner, and then slide the handheld out of the way.

Figure 17: Remove carrying straps and protective case

2. Remove the four screws holding the bottom endcap in place.

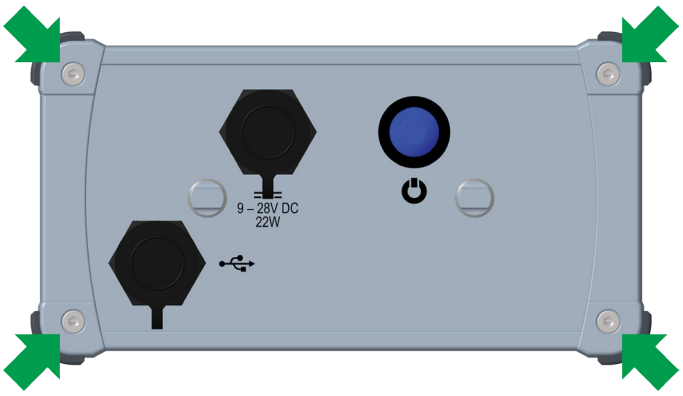


Figure 18: Remove the screws

3. Carefully remove the bottom endcap out of the way; do not disconnect any wiring.

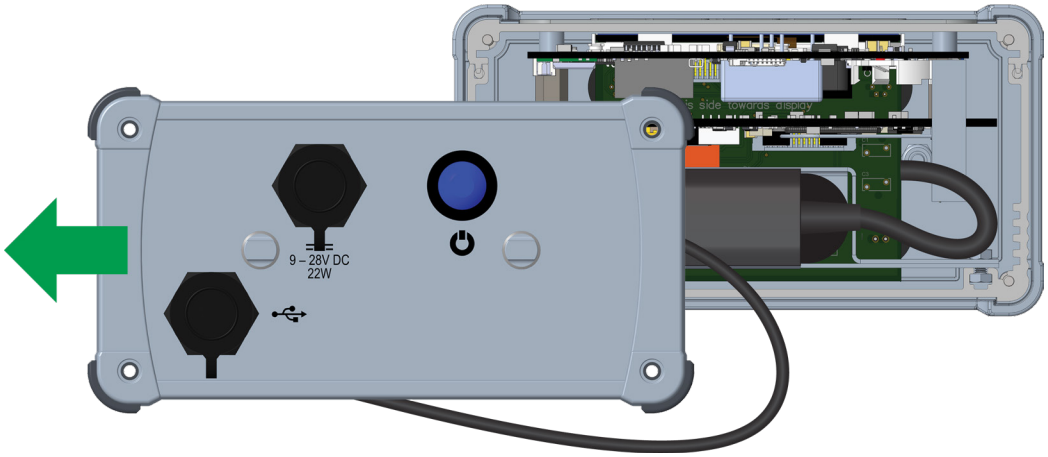


Figure 19: Remove the bottom endcap

4. Rotate the handheld back side up to gain better access to the coin battery and MicroSD card.

Figure 20: Rotate handheld to gain better access

5. To replace the MicroSD card:
   a. Remove the MicroSD card by pushing the protruding edge of the card until there is a clicking sound–ejecting the card from the tray. Refer to *Figure 21* below.
   b. Insert a new card into the tray, pushing in the protruding end until it clicks into place, which locks the card to the tray. Refer to *Figure 22* below.

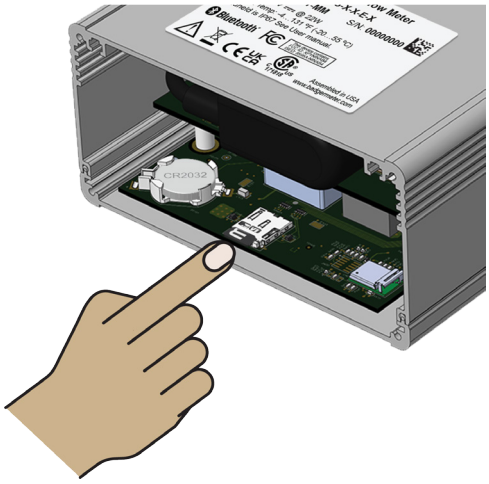


Figure 21: Remove the MicroSD card

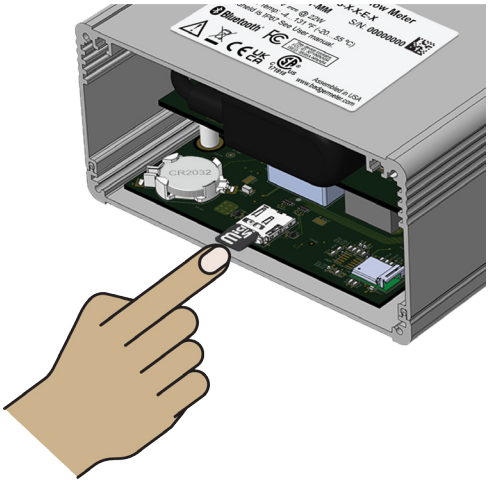


Figure 22: Insert new MicroSD card

6. To replace the coin battery (CR2032):
   a. Remove the coin battery by prying the bottom of the battery upward, releasing the battery from the holder. Refer to *Figure 23* below.
   b. Insert a new battery at an angle (see *Figure 24*). Push down on the top of the battery until it snaps in place. The battery does not snap in place if it installed incorrectly.

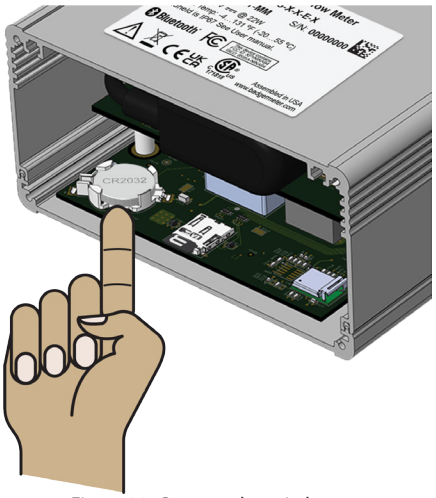


Figure 23: Remove the coin battery

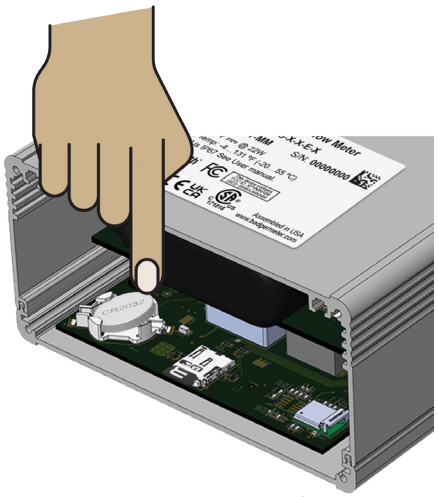


Figure 24: Insert new coin battery

IMPORTANT

To properly dispose of batteries used in this product, follow your local legislation according to EU directive 2006/66/EG.

7. Replace the main battery pack.

⚠WARNING

REPLACE THE MAIN BATTERY WITH ONLY BADGER METER PART NUMBER 70237-001.

a. Slide the battery pack out from the handheld to disconnect the terminal.

Figure 25: Slide battery pack out from handheld

b. Install a new battery into the battery cage and connect the terminal.

IMPORTANT

To properly dispose of batteries used in this product, follow your local legislation according to EU directive 2006/66/EG.

8. Reassemble the handheld.

a. Carefully reinstalling the bottom endcap, making sure the wires are not disconnected or pinched and the gaskets do not protrude more than 1 mm. Do **NOT** stretch the gaskets or run a finger along the gasket to install it in the groove. Make sure the end cap is oriented correctly with the power button closest to the side with the front keypad.

a. Reinstall the four screws in the sequence shown in *Figure 26* . and lightly thread. For the first pass, torque to 2 inch-pounds. For the final pass, torque to 2.7…3.1 inch-pounds. Be sure not to cross-thread or overtighten.

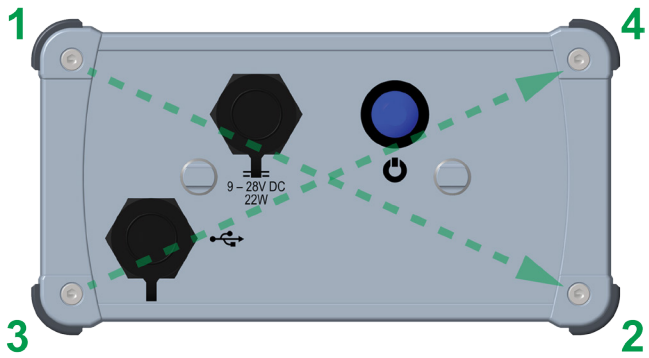


Figure 26: Sequence for screw reinstallation

9. Reassemble protective case and carrying strap.
   a. From the back side, insert top endcap of the handheld (front side down) into the top corners of the protective case.
   b. Stretch out the protective case lower corners by the slit areas to allow the bottom of the handheld to drop in place.

NOTE: Make sure the middle feet of the protective case are as shown in *Figure 27* .

Figure 27: Protective case middle feet position

NORTH AMERICAN PIPE SCHEDULES

Cast Iron Pipe, Standard Classes, 3…10 inch

Size in.		Class in.							
		A	B	C	D	E	F	G	H
3	OD	3.80	3.96	3.96	3.96	—	—	—	—
	Wall	0.39	0.42	0.45	0.48				
	ID	3.02	3.12	3.06	3.00				
4	OD	4.80	5.00	5.00	5.00	—	—	—	—
	Wall	0.42	0.45	0.48	0.52				
	ID	3.96	4.10	4.04	3.96				
6	OD	6.90	7.10	7.10	7.10	7.22	7.22	7.38	7.38
	Wall	0.44	0.48	0.51	0.55	0.58	0.61	0.65	0.69
	ID	6.02	6.14	6.08	6.00	6.06	6.00	6.08	6.00
8	OD	9.05	9.05	9.30	9.30	9.42	9.42	9.60	9.60
	Wall	0.46	0.51	0.56	0.60	0.66	0.66	0.75	0.80
	ID	8.13	8.03	8.18	8.10	8.10	8.10	8.10	8.00
10	OD	11.10	11.10	11.40	11.40	11.60	11.60	11.84	11.84
	Wail	0.50	0.57	0.62	0.68	0.74	0.80	0.86	0.92
	ID	10.10	9.96	10.16	10.04	10.12	10.00	10.12	10.00

Table 10: Cast iron pipe, standard classes, 3…10 inch

Steel, Stainless Steel, PVC Pipe, Standard Classes

NPS in.	OD in.	SCH 60		X STG.		SCH 80		SCH 100		SCH 120/140		SCH 180	
		ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.
1	1.315	—		0.957	0.179	0.957	0.179	—		—		0.815	0.250
1.25	1.660			1.278	0.191	1.278	0.191					1.160	0.250
1.5	1.900			1.500	0.200	1.500	0.200					1.338	0.281
2	2.375			1.939	0.218	1.939	0.218					1.687	0.344
2.5	2.875			2.323	0.276	2.323	0.276					2.125	0.375
3	3.500			2.900	0.300	2.900	0.300					2.624	0.438
3.5	4.000	—		3.364	0.318	3.364	0.318	—		—		—	
4	4.500			3.826	0.337	3.826	0.337			3.624	0.438	3.438	0.531
5	5.563			4.813	0.375	4.813	0.375			4.563	0.500	4.313	0.625
6	6.625			5.761	0.432	5.761	0.432			5.501	0.562	5.187	0.719
8	8.625	7.813	0.406	7.625	0.500	7.625	0.500	7.437	0.594	7.178	0.719	6.183	1.221
10	10.75	9.750	0.500	9.75	0.500	9.562	0.594	9.312	0.719	9.062	0.844	8.500	1.125

Table 11: Steel, stainless steel, PVC pipe, standard classes

Steel, Stainless Steel, PVC Pipe, Standard Classes (continued)

NPS in.	OD in.	SCH 5		SCH 10 (Lt Wall)		SCH 20		SCH 30		STD		SCH 40	
		ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.	ID in.	Wall in.
1	1.315	1.185	0.065	1.097	0.109					1.049		1.049	0.133
1.25	1.660	1.53	0.065	1.442	0.109					1.380		1.380	0.140
1.5	1.900	1.77	0.065	1.682	0.109					1.610		1.610	0.145
2	2.375	2.245	0.065	2.157	0.109	—		—		2.067	—	2.067	0.154
2.5	2.875	2.709	0.083	2.635	0.120					2.469		2.469	0.203
3	3.500	3.334	0.083	3.260	0.120					3.068		3.068	0.216
3.5	4.000	3.834	0.083	3.760	0.120					3.548	—	3.548	0.226
4	4.500	4.334	0.083	4.260	0.120	—		—		4.026	0.237	4.026	0.237
5	5.563	5.345	0.109	5.295	0.134					5.047	0.258	5.047	0.258
6	6.625	6.407	0.109	6.357	0.134					6.065	0.280	6.065	0.280
8	8.625	8.407	0.109	8.329	0.148	8.125	0.250	8.071	0.277	7.981	0.322	7.981	0.322
10	10.75	10.482	0.134	10.42	0.165	10.25	0.250	10.13	0.310	10.02	0.365	10.02	0.365

Table 12: Steel, stainless steel, PVC pipe, standard classes (continued)

Copper Tubing, Copper and Brass Pipe, Aluminum

Nominal Diameter in.		Copper Tubing in. Type K	Type L	Type M	Copper & Brass Pipe in.	Alum. in.	Nominal Diameter in.		Copper Tubing in. Type K	Type L	Type M	Copper & Brass Pipe in.	Alum. in.
0.5	OD	0.625	0.625	0.625	0.840	—	3-1/2	OD	3.625	3.625	3.625	4.000	—
	Wall	0.049	0.040	0.028	0.108			Wall	0.120	0.100	0.083	0.250	
	ID	0.527	0.545	0.569	0.625			ID	3.385	3.425	3.459	3.500	
0.6250	OD	0.750	0.750	0.750	—	—	4	OD	4.125	4.125	4.125	4.500	4.000
	Wall	0.049	0.042	0.030				Wall	0.134	0.110	0.095	0.095	0.250
	ID	0.652	0.666	0.690				ID	3 857	3.905	3.935	3.935	4.000
0.75	OD	0.875	0.875	0.875	1.050	—	4-1/2	OD	—	—	—	—	5.000
	Wall	0.065	0.045	0.032	0.114			Wall					0.250
	ID	0.745	0.785	0.811	0.822			ID					4.500
1	OD	1.125	1.125	1.125	1.315	—	5	OD	5.125	5.125	5.125	5.563	5.000
	Wall	0.065	0.050	0.035	0.127			Wall	0.160	0.125	0.109	0.250	0.063
	ID	0.995	1.025	1.055	1.062			ID	4.805	4.875	4.907	5.063	4.874
1.25	OD	1.375	1.375	1.375	1.660	—	6	OD	6.125	6.125	6.125	6.625	6.000
	Wall	0.065	0.055	0.042	0.146			Wall	0.192	0.140	0.122	0.250	0.063
	ID	1.245	1.265	1.291	1.368			ID	5.741	5.845	5.881	6.125	5.874
1.5.	OD	1.625	1.625	1.625	1.900	—	7	OD	—	—	—	7.625	7.000
	Wall	0.072	0.060	0.049	0.150			Wall				0.282	0.078
	ID	1.481	1.505	1.527	1.600			ID				7.062	6.844
2	OD	2.125	2.125	2.125	2.375	—	8	OD	8.125	8.125	8.125	8.625	8 000
	Wall	0.083	0.070	0.058	0.157			Wall	0.271	0.200	0.170	0.313	0.094
	ID	1.959	1.985	2.009	2.062			ID	7.583	7.725	7.785	8.000	7.812
2.5	OD	2.625	2.625	2.625	2.875	2.500	10	OD	10.125	10.125	10.125	10 000	—
	Wall	0.095	0.080	0.065	0.188	0.050		Wall	0.338	0.250	0.212	0.094	—
	ID	2.435	2.465	2.495	2.500	2.400		ID	9.449	9.625	9.701	9.812	—
3	OD	3.125	3.125	3.125	3.500	3.000	—	—	—	—	—	—	—
	Wall	0.109	0.090	0.072	0.219	0.050		—	—	—	—	—	—
	ID	2.907	2.945	2.981	3.062	2.900		—	—	—	—	—	—

Table 13: Copper tubing, copper and brass pipe, aluminum

DIMENSIONS

NOTE: Installation instructions begin on *page 7*.

Handheld

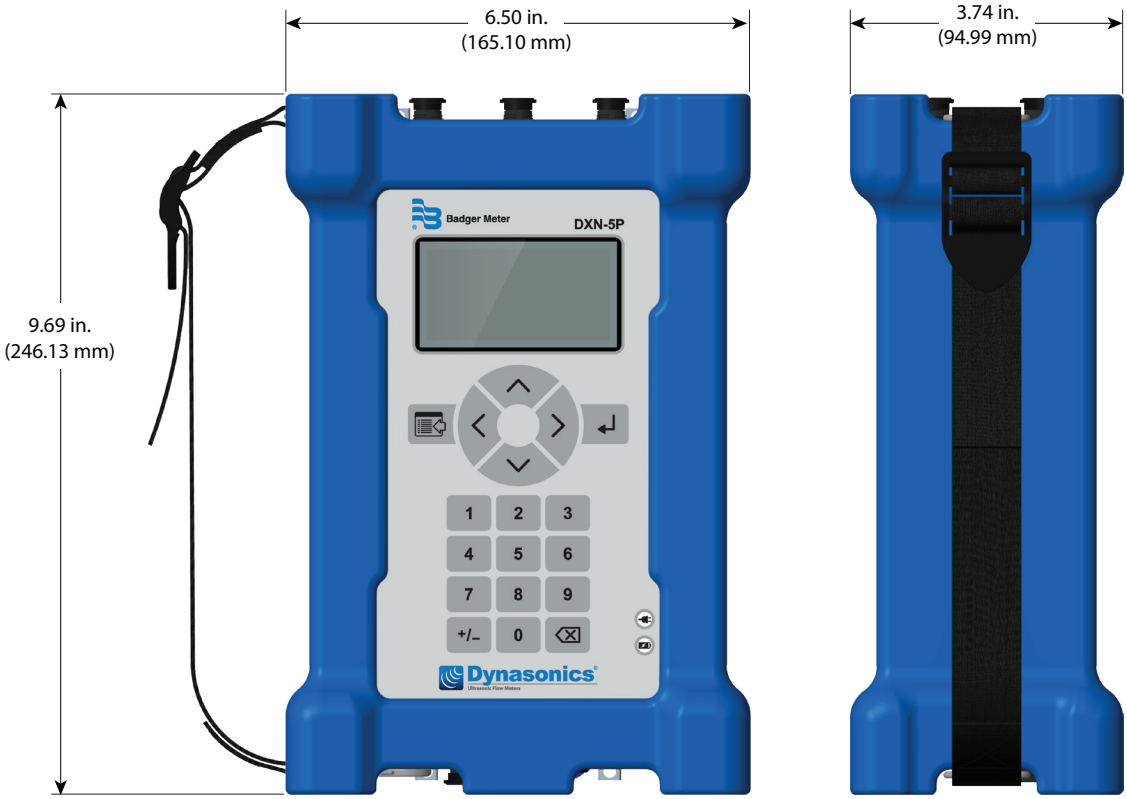


Figure 28: Handheld dimensions

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