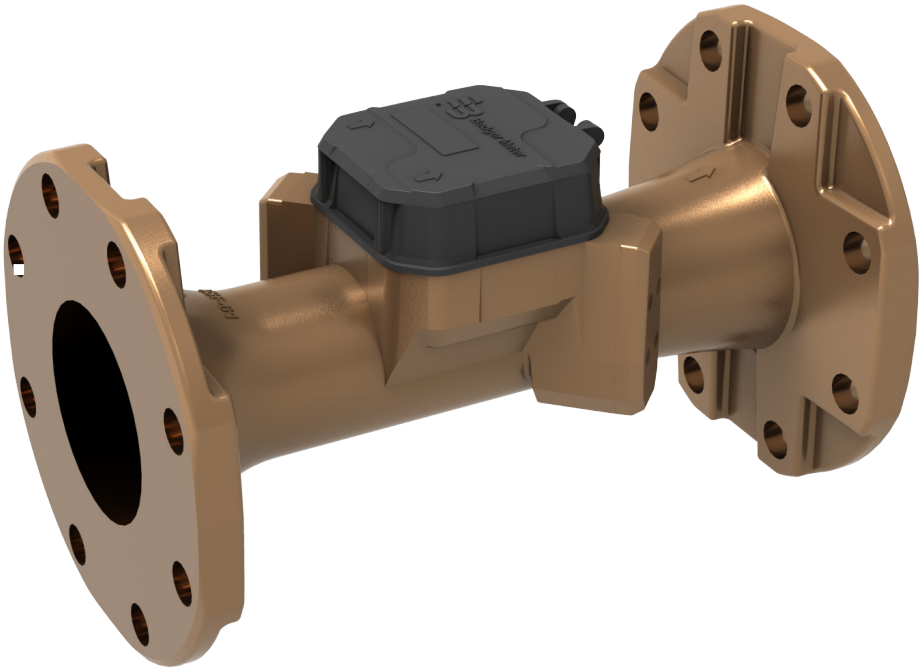
Dynasonics®
Ultrasonic Flow Meters

U500w Ultrasonic Meter

Lead-Free Bronze Alloy, 3 and 4 inch



Badger Meter®

ESM-UM-03059-EN-01 (November 2019)

User Manual

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SCOPE OF THIS MANUAL

This manual contains installation, operation and maintenance procedures for the Badger Meter® U500w 3 and 4 inch Ultrasonic meters. Proper performance and reliability of the product depend upon installation in accordance with these instructions.

ABOUT THE U500W ULTRASONIC METER

The U500w Ultrasonic meter uses solid-state technology in a compact, tamper-protected, weatherproof, and UV-resistant housing, suitable for commercial applications. The ultrasonic measurement system has no moving parts, provides long-term accuracy and minimizes measurement errors due to sand, suspended particles, air pockets and pressure fluctuations.

The registration electronics and battery are encapsulated to withstand harsh environments and protect the electronics in flooded or submerged pit applications.

Meters can be installed using horizontal or vertical piping, with water flow in the up direction. The meter will not measure flow when an "empty pipe" condition is experienced. An empty pipe is defined as a condition when the flow sensors are not fully submerged.

U500w Ultrasonic meters meet and exceed AWWA C715 and the most recent revision of AWWA C750 Standards. The lead-free bronze alloy meters comply with the lead-free provisions of the Safe Drinking Water Act and NSF/ANSI Standards 61 and 372. U500w Ultrasonic meters also conform to UL 327B and FM 1044 for fire service applications. Flanges meet AWWA Class D standards.

Construction

The U500w Ultrasonic meter features lead-free bronze alloy meter housing, ultrasonic transducers, a meter-control circuit board with associated wiring, LCD, and battery. Wetted elements are limited to the pressure vessel and transducers. The electronic components are housed and fully potted within a molded, engineered polymer enclosure, which is attached to the meter housing. The transducers extend through the housing and are sealed by O-rings, enabling turbulence-free water flow through the tube. The open flow tube design prevents obstruction of flow to reduce pressure loss and provides long-term accuracy.

Operation

As water flows into the measuring tube, ultrasonic signals are sent consecutively in forward and reverse directions of flow. Velocity is then determined by measuring the time difference between the measurement in the forward and reverse directions. Total volume is calculated from the measured flow velocity using water temperature and pipe diameter. The LCD shows total volume, unit of measure, rate of flow, firmware, and alarm conditions (reverse-flow, no usage, empty pipe, exceeding max flow, suspected leak, temperature, end of life, and measurement error). In addition to the other indicators and alarms, meters used with or for Badger Meter ORION® endpoints also display pressure alarms and pressure and temperature data on the LCD.

REQUIREMENTS

IMPORTANT

For proper handling of the higher reading resolution and the extended status indicator capabilities of the meter, the following are recommended to support the meter full capabilities.

- ORION Cellular LTE endpoints, firmware version 1.10.1193 or later
- AquaCUE® Flow Measurement Manager software

For assistance, please contact Badger Meter Technical Support at 877-243-1010 or the appropriate endpoint provider.

AQUACUE FIRST TIME SETUP

For meters connected to Cellular LTE-M or LTE endpoints, perform these steps to make sure the meter sensor information is accessible in AquaCUE.

1. Sign in to AquaCUE. On the main menu, select the **Assets** tab.
2. Then select **Facility Settings** from the menu on the left of the Assets page.

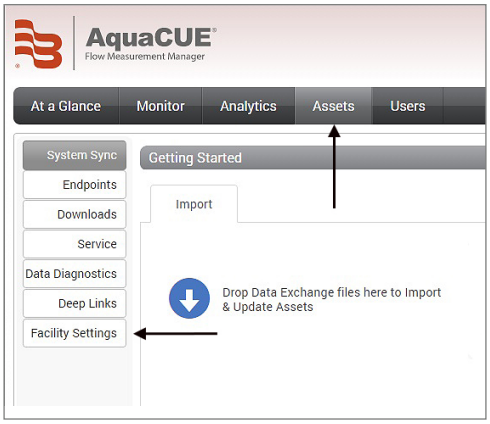

Figure 1: AquaCUE Assets> Facility Settings

3. On the **Facility Settings** page, scroll down to the *Monitor Page Filters* and find the *Sensors* section.
4. Select the **Water Pressure** and **Water Temperature** check boxes in the *Sensors* section to turn on reporting for the U500w Ultrasonic meter sensors.

Figure 2: Water Pressure and Temperature sensors selection

5. Select **Update Facility** at the bottom of the page to save your changes.

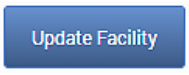

Figure 3: Select to save changes

6. Select the **At A Glance** tab and click **Add/Remove** on the right side of the page below the main tabs menu.
7. On the window that opens, select **Add** for *Water Pressure Health* and *Water Temperature Health*. Then select **Done**. *Water Pressure Health* and *Water Temperature Health* modules now display on the *At A Glance* page.

AquaCUE setup is complete.

METER OPERATING MODES

The meter automatically moves through storage and transition mode into active mode based on water flow:

- **Storage Mode**

  U500w Ultrasonic meters are delivered in storage mode so that a meter alarm is not triggered. In storage mode, the meter LCD displays an empty pipe icon on the consumption screen and empty code on the alarm screen, but no alarm code is sent to the endpoint.

- **Transition Mode**

  When the meter senses water in the pipe, it moves into transition mode. In transition mode, the meter displays water consumption and, if connected to an endpoint, sends a reading to the endpoint. After sensing a full pipe for 24 hours, the meter transitions to active mode.

  NOTE: If a meter senses an empty pipe in transition mode, the meter goes back into storage mode until water triggers the process to start again.

- **Active Mode**

  Meter is operating normally.

  For more information, see *"Alarm and Operating Mode Screen" on page 10.*

SAFETY INFORMATION

Installation of the U500w Ultrasonic meter must comply with all applicable federal, state and local rules, regulations and codes. Failure to read and follow these instructions can lead to misapplication or misuse of the meter, resulting in personal injury and damage to equipment.

PRODUCT UNPACKING AND INSPECTION

To avoid damage in transit, meters are shipped to the customer in special shipping containers. Upon receipt of shipment, be sure to follow these unpacking and inspection procedures:

If damage to a shipping container is evident upon receipt of a meter, request that a representative of the carrier be present when the meter is unpacked.

- Carefully open the shipping container, following any instructions that may be marked on the container. Remove all cushioning material surrounding the meter and carefully lift the meter from the container. Keep the container and all packing material for possible use in reshipment or storage.
- Visually inspect the meter and applicable accessory devices for any signs of damage such as scratches, loose or broken parts or other physical 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. Then file a claim with the carrier. A claim for equipment damaged in transit is the responsibility of the customer.

Rigging, Lifting, and Moving Large Units

- DO NOT lift or move a meter by the electronics, lid or cables.
- Use a crane rigged with soft straps to lift and move 3 and 4 inch meters. Place the straps around the meter body, between the flanges, on each side of the electronics.
- Use the sling-rigged method to lift large meters into a vertical position while they are still crated. Use this method to position while they are still crated. Use this method to position large meters vertically into pipelines.
- DO NOT lift a meter with a forklift by positioning the meter body on the forks, with the flanges extending beyond the lift. This could dent the housing or damage the internal components. NEVER place forklift forks, rigging chains, straps, slings, hooks or other lifting devices inside or through the meter flow tube to hoist the unit. This could damage the internal components.

INSTALLATION

⚠CAUTION

- ***DO NOT ATTEMPT TO USE ANY METER AS A LEVER OR CROWBAR TO STRAIGHTEN A MISALIGNED METER POSITION. THIS COULD DAMAGE THE METER.***
- ***DO NOT ATTEMPT TO INSTALL A METER INTO AN OPENING THAT IS TOO LONG BY FORCING THE PIPING INTO PLACE WITH THE METER'S COUPLING NUTS. THIS WILL CAUSE SERIOUS DAMAGE TO THE THREADED ENDS OF THE METER AND HOUSING.***
- ***TO AVOID POTENTIAL PROBLEMS, CORRECT ANY IRREGULARITIES IN PIPE SPACING AND MISALIGNMENT BEFORE PLACING THE METER INTO ITS POSITION.***

Pre-Installation

Before you begin an installation, do the following:

- Inspect the piping around the meter for suitable conditions. The service line, valves, connections and meter must be watertight. Repair the piping system if pipes are corroded or damaged.
- Install the meter in the pipeline in a horizontal or vertical position so that the flow arrow on the meter housing points in the same direction as water flow. Registration should be upright and protected from damage, freezing and tampering.
- Verify meters are correctly programmed.
- Position the meter so it is accessible for installation, removal and reading.
- The line opening for the meter should match the lay length of the meter, allowing slight additional space for coupling gaskets. The inlet and outlet sides of the meter should be axially aligned to the pipe.
- The installed meter must not be an obstacle or a hazard to the customer or interfere with public safety.
- To avoid cavitation, always install control valves downstream of the meter. Never install the meter on a pump suction side.
- Consider maximum flow rates when sizing and selecting the appropriate meter for the application.
- A minimum of 5 pipe diameters of straight, unobstructed pipe is recommended upstream of the meter.
- Do not install check valves or pressure reducing devices within 5 pipe diameters upstream of the meter.
- Valves immediately upstream of the meter should only be fully open gate or ball valves. Butterfly valves are acceptable if they are 5 pipe diameters or more upstream from the meter. Downstream, fully open gate or butterfly valves can be used.
- The service saddle (or reducing tee), which is used for field accuracy testing, should be at least 2 pipe diameters downstream of the meter outlet flange.
- Unweighted check valves should not be located closer than 3 pipe diameters downstream of the meter.
- Pump discharge should be installed at least 5 pipe diameters upstream of the meter.
- Externally weighted check valves and pressure reducing devices should be located no closer than 5 pipe diameters of the meter.
- When installing the meter and plate strainer of a size smaller than the pipe installation, to reduce the effect of jetting caused by the increase in flow velocity, a minimum of 5 pipe diameters of pipe equal in size to the meter is required upstream of the meter. Additional length is required if a sharp contraction or an eccentric reducer is used, rather than a concentric, tapered reducer.

Installation Instructions

1. If cutting in for new service, start here. When cutting in is not required, start at **step 2**.
   - Close the shutoff valve to relieve water pressure in the line before starting the cutting operation. Provide a high-quality upstream shutoff valve with a low pressure drop.
   - Flush the pipe to clear chips, pipe dope or other plumbing residue.
2. Close the meter inlet-side valve.
3. Open a faucet and wait until water flow stops to depressurize the system. Do not remove the meter until the flow stops.

   ⚠WARNING

   DEPRESSURIZE THE LINE BEFORE STARTING ANY DISASSEMBLY OPERATION. REMOVING A METER THAT IS UNDER LINE PRESSURE CAN RESULT IN COMPONENTS BECOMING PROJECTILES, CAPABLE OF CAUSING PERSONAL INJURY.
4. Check valves and make necessary repairs to the curb (shutoff) valve or inlet side valve if necessary.
5. Before installing or removing a meter, close the outlet-side valve to relieve pressure. Protect the area around the meter against potential spills or leaks that could occur.
6. To replace an existing meter continue with **step 7**. To install a new meter skip to **step 9**.
7. Loosen the meter flange bolts and remove the meter and old gaskets.
8. Clean the flange bolts, removing any pipe dope or dirt from the bolts.
9. Check the existing position for proper alignment and spacing. Correct any misalignment or spacing issues.
10. Install the meter in the pipeline in a horizontal or vertical position with the ***flow arrow on the meter pointing in the direction of flow***. Registration should be upright. With meter and gaskets in place, tighten the flange connection bolts. Verify the nuts are properly aligned to avoid damage to the flanged ends.
11. After the meter is installed, slowly open the inlet shutoff valve until the meter is full of water and make sure there are no leaks. (The more flow you allow through the meter, appropriate for the meter size, the better.)

    ⚠CAUTION *Take caution when opening the inlet valve to avoid damage to the pressure sensor due to extreme water hammer.*
12. Slowly open the outlet valve until air is out of the meter and service line.
13. Open a service valve downstream of the meter and verify that no foreign debris in the water obstructs the operation of the system.
14. Check the read on the meter to make sure it is registering a positive number. If it is not, make sure the meter is installed in the correct direction.
    - The meter is shipped in storage mode so that customers do not experience alarms during shipment or installation. After properly purged of air, and the meter senses a full pipe, it may take up to 30 seconds to begin measurement.
    - The meter itself does not require a quantity of flow to begin measurement. The meter just requires that the pipe is cleared of air and filled with water. If the customer is attempting to purge the meter at low flow rates, it would likely be more difficult and take longer.
15. When the meter starts recording positive flow, note the reading for your records.

OPERATIONS

Display

U500w Ultrasonic meters use a 9-digit Liquid Crystal Display (LCD) that toggles to show consumption, rate of flow, temperature,* pressure,* alarm and operating mode, and firmware version. Indicator and alarm icons appear in the display as symbols that illuminate when the condition is active. See *"Meter Alarms" on page 12* for alarm duration.

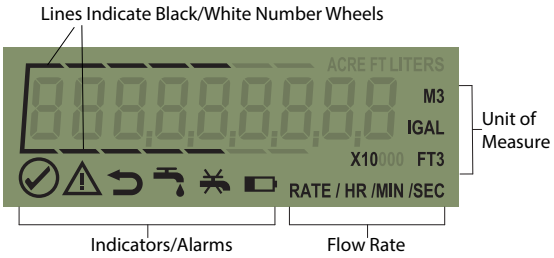

Figure 4: U500w Ultrasonic Meter LCD

*Pressure and temperature data screens are available with meters connected to ORION endpoints. Pressure alarms and temperature and pressure data are sent as part of the encoder message when used in conjunction with ORION Cellular LTE endpoints. This information is also surfaced in AquaCUE.

Activating the Display

The display illuminates when the register cover is opened. You can alternate the display among the different screens by touching the optical communication port in the center of the register face (*Figure 5*). The display reverts to sleep mode after a period of inactivity.

See *"Display Screens" on page 9* for information about each screen.

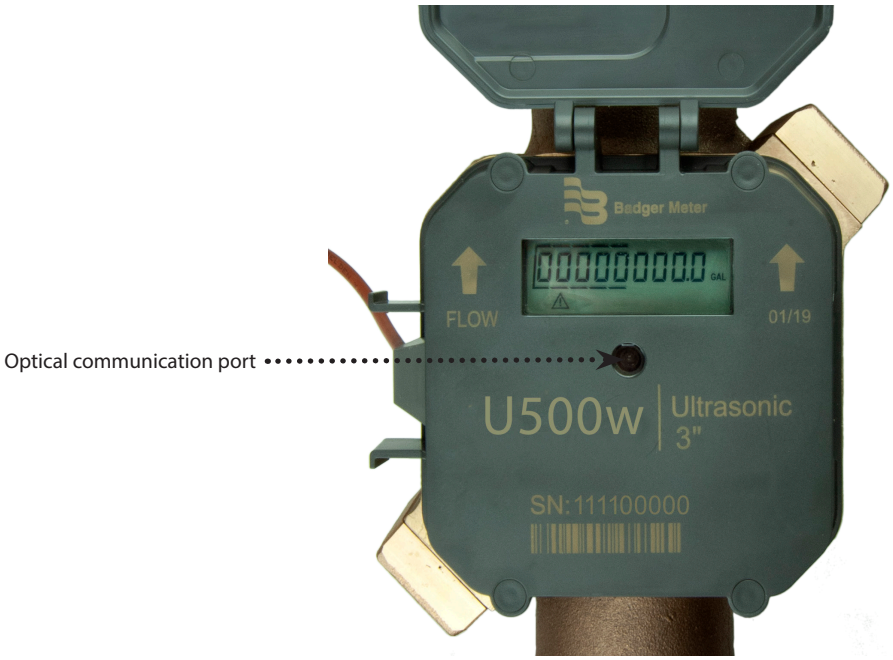

Figure 5: Meter with lid open, showing optical communication port

Flow Direction

The direction of water flow is noted on the face of the electronics housing and cast into the meter housing.

Display Screens

Total Consumption Screen

The total consumption screen shows all nine digits, including leading zeroes and a decimal point.

The displayed value is the sum of the forward flow minus the reverse flow. The display also includes indicator lines above and below the digits to represent the typical utility meter reading (electronic equivalent of white and black number wheels on mechanical registers).

Totalized flow displays up to 100 million gallons with a resolution of 0.1 gallons, 10 million cubic feet with a resolution of 0.01 cubic feet, or one million cubic meters with a resolution of 0.001 cubic meter.

Unit of measure and resolution are factory programmed for the meter. Options are gallons, cubic feet and cubic meters.

The examples show typical displays for the three different units of measure.

Gallons

Meter reading to the nearest?

	10th gallon =	12345678.9
	1 gallon =	12345678
	10 gallons =	1234567
	100 gallons =	123456
Typical Billing Units →	1000 gallons =	12345

Cubic Feet

Meter reading to the nearest?

	100th ft³ =	1234567.89
	10th ft³ =	1234567.8
	1 ft³ =	1234567
	10 ft³ =	123456
Typical Billing Units →	100 ft³ =	12345

Cubic Meters

Meter reading to the nearest?

	1000th m³ =	1234567.89
	100th m³ =	1234567.8
	10th m³ =	1234567
Typical Billing Units →	1 m³ =	123456
	10 m³ =	12345

Rate of Flow Screen

Rate of flow is factory programmed for the meter in gallons per minute. The LCD shows both the unit of measure and rate of flow. The rate of flow screen also serves as the flow indicator. The rate of flow display is shown without leading zeros. When the rate of flow screen is displayed, it is updated every two seconds.

Figure 6: Rate of flow screen

Pressure Screen*

Displays current water pressure. The pressure sensor is rated to a maximum psi of 150. If the maximum operating pressure is exceeded, **P 999 PSI** (or **P 99.9 bAr**) displays until pressure is back within the specified range. If the pressure sensor is damaged, **P Err PSI** (or **P Err bAr**) will display.

NOTE: Meters operating above 175 psi are operating outside approved specifications.

Figure 7: Pressure screen

*When used in conjunction with ORION Cellular endpoints, pressure data and alarms are sent as part of the encoder message and surfaced in AquaCUE.

Temperature Screen

Displays current water and ambient temperature. If the meter detects an empty pipe, water temperature displays **– – – F**. Ambient temperature is displayed in all modes. Water temperature is not reported in storage mode. Temperature data begins reporting in transition mode when there is a full pipe.

*When used in conjunction with ORION Cellular endpoints, temperature data is sent as part of the encoder message and surfaced in AquaCUE.

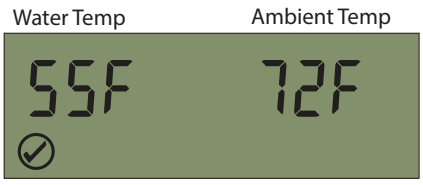

Figure 8: Temperature screen

Alarm and Operating Mode Screen

Displays alarm condition and meter operating mode. This screen is only visible in active mode if an alarm is detected. Screen is always visible in storage and transition mode.

Display format: **ErXXX.YYY.Z**

Figure 9: Alarm and operating mode screen in storage mode

XXX **Position 1**

First set of 3 characters displays an alarm code that has occurred. See duration of each individual alarm in alarms chart on *page 8*.

YYY **Position 2**

Second set of 3 characters displays an alarm code that is currently active. The alarm is stored in this position until reported to the endpoint.

- Up to 15 min. with ORION Cellular
- Up to 1 hr. with ORION SE/ME
- Up to 35 days if not connected to an ORION endpoint

Alarm code reappears if condition is still present or reoccurs, and resends message to the endpoint.

Figure 10: Alarm and operating mode screen in transition mode

Z **Position 3**

The character in the last position is the code for the meter operating mode. The meter has three operating modes: storage (*Figure 9*), transition(*Figure 10*) and active mode (*Figure 11*).

S Storage r Transition A Active

Also see *"Meter Operating Modes" on page 5*.

Figure 11: Alarm and operating mode screen in active mode

Firmware Version Screen

Displays current meter firmware version.

Figure 12: Firmware version screen

OUTPUTS

Encoder Output

Programmed to the high resolution industry standard ASCII encoder protocol, U500w Ultrasonic meters have the ability to transmit meter status indicators to AquaCUE connectors as part of the extended encoder/meter reading message. The details can also be read through an IR interface and the HR programming software.

Reading Resolution

The standard electronic encoder output resolution of the meter is 9 digits. Though the meter output is 9-digit resolution, the reading resolution sent to the AquaCUE system software is dependent on the endpoint to which the U500w Ultrasonic meter is connected. Readings reported from the endpoints are the left-most significant digits of the encoder reading.

Technology	High Res U500w Encoder
ORION Cellular	9 digit reading

Wire Connections

The meter is available with an in-line connector for easy connection and installation to AMR/AMI devices. It is also available with a flying lead for field splice connection. An in-line connector is recommended for pit applications.

Figure 13: Wiring options

METER ALARMS

U500w Ultrasonic meter alarms appear on the display as icons that illuminate when the condition occurs. Alarms are displayed for the number of days listed in the table below. Alarms also appear as 3-character codes on the alarm and operating mode screen. See *"Alarm and Operating Mode Screen" on page 10* and *"Alarm Codes" on page 13*.

Alarms are sent as part of the encoder message to AquaCUE systems that are capable of receiving an extended message, such as ORION Cellular endpoints. The details can also be read through an IR interface.

NOTE: Meters are delivered in storage mode so that an alarm is not triggered. In storage mode, the meter LCD displays an empty pipe icon, but no error code is sent to the endpoint.

For alarms reported within AquaCUE, refer to *helpaquacue.com*.

Alarms	Icon	Alarm Description	Number of Days Icon Displays	High Resolution with ORION Cellular Endpoint
Normal Meter Operation		Meter operating correctly	n/a	n/a
Temperature		Temperature outside limits: above 140° F or below 34° F. Meter continues to operate but is outside specified accuracy range.	Alarm clears after 35 days unless condition continues	Meter sends consumption and alarm to the endpoint once per occurrence
Pressure*		Pressure sensor is damaged, or pressure is outside specified threshold limits: above 130 psi or below 20 psi.	Alarm clears after 35 days unless condition continues	
Empty Pipe		Empty or partially filled pipe. Last known good read is displayed.	Alarm clears when pipe is is filled	
Measurement Error		Interference of ultrasonic signal. Meter is not measuring properly. Meter continues to operate unless sensors are damaged.	Alarm clears after 35 days unless condition continues	
Exceeding Max Flow		Maximum flow rate exceeded. No consumption is accumulated until flow is back within specified range.	Alarm clears after 35 days unless condition continues	Meter sends consumption and alarm to the endpoint once per occurrence
Reverse Flow		Meter detects 10 gal of reverse water flow, triggers the reverse flow alarm icon on the display and sends alarm message to the endpoint.	Alarm clears after 35 days unless condition continues	Meter detects reverse flow and sends alarm to the endpoint once per occurrence
No Usage		Flow rate less than the low flow operating rate for 30 days.	Alarm clears automatically once flow occurs	Meter detects no usage and sends alarm to the endpoint once per occurrence
Suspected Leak		Flow rate more than the low flow operating rate for 24 hours.	Alarm clears automatically when flow rate drops below low flow operating rate	Meter detects suspected leak and sends alarm to the endpoint once per occurrence
End of Life		Battery nearing end of life.	Alarm is activated after 9.5 years and does not clear	Meter sends alarm message to the endpoint once per occurrence
Program Alert	n/a	Meter has been programmed in last 35 days.	n/a	Meter sends alarm message to the endpoint once per occurrence.

NOTE: Pressure alarms are only available with meters connected to ORION Cellular LTE-M or LTE endpoints.

Alarm Codes

Alarm codes are shown on the alarm and operating mode screen. See *"Alarm and Operating Mode Screen" on page 10*. Contact Badger Meter Technical Support for any codes not listed here.

001	Empty pipe	**010**	Reverse flow	**083**	Empty pipe, Temperature, Measurement error
002	Temperature	**011**	Empty pipe, Reverse flow	**089**	Empty pipe, No usage, Measurement error
003	Empty pipe, Temperature	**012**	Temperature, Reverse flow	**0C0**	Program alert, Measurement error
004	End of life	**013**	Empty pipe, Temperature, Reverse flow	**100**	Pressure
008	No usage	**018**	No usage, Reverse flow	**101**	Empty pipe, Pressure
009	Empty pipe, No usage	**020**	Suspected leak	**140**	Program alert, Pressure
00A	Temperature, No usage	**040**	Program alert	**150**	Reverse flow, Program alert, Pressure
00B	Empty pipe, Temperature, No usage	**080**	Measurement error	**200**	Exceeding max flow
00C	End of life, No usage	**081**	Empty pipe, Measurement error	**202**	Temperature, Exceeding max flow
00D	Empty pipe, End of life, No usage	**082**	Temperature, Measurement error	**204**	End of life, Exceeding max flow
				300	Pressure, Exceeding max flow

SPECIFICATIONS

U500w Ultrasonic Meter Size	3 in.	4 in.
Normal Test Flow Limits	0.75…560 gpm	1.5…1100 gpm
Minimum Test Flow Limits	0.37 gpm	0.75 gpm
Safe Maximum Operating Condition (SMOC)	560 gpm	1100 gpm
Typical Pressure Loss	2.6 psi @ 350 gpm	2.1 psi @ 630 gpm
Operating Performance	In the normal temperature range of 45…105° F (7…41° C), new meter consumption measurement is accurate to: • 100% ±1.5% over the normal test flow limits • 100% ±3.0% for the minimum test flow limits	
Storage Temperature	–40…140° F (–40…60° C)	
Maximum Ambient Storage (Storage for One Hour)	150° F (66° C)	
Measured Fluid Temperature Range	34…140° F (1…60° C)	
Humidity	0…100% condensing; meter is capable of operating in fully submerged environments	
Maximum Working Pressure of Meter Housing	175 psi (12 bar) AWWA Class D	
Maximum Operating Pressure of Pressure Sensor	150 psi (10 bar)	
Pressure Sensor Accuracy	±2% of full scale pressure, up to 150 psi (10 bar)	
Register Type	Straight reading, permanently sealed electronic LCD; digits are 0.28 in. (7 mm) high	
Register Display	• Consumption (up to nine digits) • Rate of flow • Alarms • Pressure • Temperature • Firmware version • Unit of measure factory programmed for gallons, cubic feet and cubic meters	
Totalization Display Resolution	• Gallons: 0.1 • Cubic feet: 0.01 • Cubic meters: 0.001	
Battery	3.6-volt lithium thionyl chloride; battery is fully encapsulated within the register housing and is not replaceable; 10-year battery life	
Outputs	4-20 mA external power pulse output; open collector, voltage range, pulse width	

MAINTENANCE

Badger Meter U500w meters are designed and manufactured to provide long-term service with no maintenance. The enclosure, which includes the electronic meter's ultrasonic sensors, battery and display, is completely potted, permanently sealed and non-removable.

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Control. Manage. Optimize.

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