Impeller
Data Industrial®

# Flow Sensors

## Wireless Flow Sensor System

## Series 228PV


Badger Meter

SEN-UM-01662-EN-05 (March 2017)

# User Manual

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# INTRODUCTION

The Series 228PV wireless flow sensor system from Badger Meter® consists of the flow sensor mounted in a tee (flow sensor assembly), ORION® radio frequency (RF) transmitter complete with mounting kit, and ORION RF receiver/pulse transmitter. This system eliminates the need for expensive signal wires from the sensor output.

The battery powered flow sensor performs flow measurement and scaling and then transmits a total flow value to the RF transmitter. The transmitter sends an RF signal approximately every four seconds that the RF receiver detects. The RF receiver compares the previous flow total with the most recent flow total to generate a pulse output. Using the PC software, which is part of the software installation kit, the pulse output can be scaled to represent the desired volume unit and number of output pulses per unit volume that best fits the application. Pulse width can also be adjusted to meet the requirements of an interfacing control system or monitor.

# LICENSE REQUIREMENTS

ORION Fixed Network, Migratable and Classic endpoints comply with Part 15 of FCC Rules. ORION Cellular endpoints comply with Part 15, Part 22 and Part 24 of FCC Rules. Operation is subject to the following conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation of the device.

In accordance with FCC Regulations, "Code of Federal Regulations" Title 47, Part 2, Subpart J, Section 1091, transmitters pass the requirements pertaining to radiation exposure. However, to avoid public exposure in excess of limits for general population (uncontrolled exposure), a 20 centimeter distance between the transmitter and the body of the user must be maintained during operation.

No FCC license is required by a utility to operate an ORION meter reading system.

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

## IMPORTANT

***Transportation**: The Federal Aviation Administration prohibits operating endpoints and receivers on all commercial aircraft. The ORION endpoint is considered an operating transmitter and cannot be shipped by air.*


*Figure 1: Series 228PV wireless flow sensor system*

## Series 228PV Wireless Flow Sensor

The four-bladed impeller design is rugged, non-fouling and does not require custom calibration. Coupled with the proprietary patented digital detection circuit, the sensor measures flow rate from 1 foot per second (fps) to more than 20 fps, regardless of conductivity or turbidity of the liquid. The flow sensor generates a frequency which is proportional to flow rate. An integral micro controller measures the impeller frequency and uses the appropriate K factor and Offset values to compute the flow rate. By means of integration, the volume total is calculated. The output signal to the RF transmitter is a scaled output pulse. An internal lithium battery provides power for the flow sensor and is encapsulated to ensure moisture resistance.

## Wireless ORION RF Transmitter

The ORION transmitter operates in the 902…928 MHz frequency band at a power level that requires no FCC licensing. The transmitter is powered using an internal lithium battery and is encapsulated for moisture resistance. It is factory programmed and requires no configuration.

## Wireless ORION RF Receiver

The ORION receiver is powered using an external alternating current (AC) or direct current (DC) power supply. The wireless receiver receives the scaled total from the transmitter. Further scaling and unit conversion can be programmed into the receiver. The optically coupled scaled pulse output emulates a dry contact closure to ensure interfacing into various types of controller inputs.

# INSTALLATION

## General

As with all flow measuring devices, accuracy is highly dependent on proper location of the sensor in the piping system. Irregular flow velocity profiles caused by valves, fittings, pipe bends, etc. can lead to inaccurate overall flow rate indications, even though local flow velocity measurement can be accurate. A sensor located in the pipe where it can be affected by air bubbles, floating debris, or sediment can not achieve full accuracy and could be damaged.

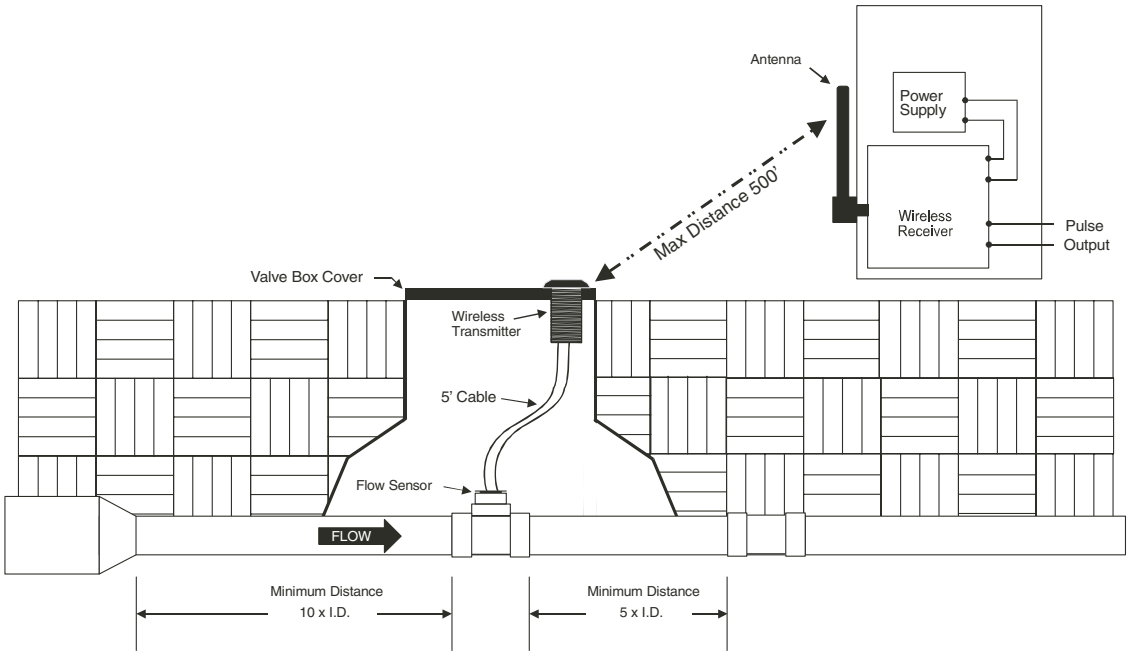


*Figure 2: Typical wireless flow sensor installation*

Badger Meter flow sensors are designed to operate reliably under adverse conditions, but the following recommendations should be followed to ensure maximum system accuracy.

1. Choose a location along the pipe with a length equivalent to 10 pipe diameters upstream and 5 pipe diameters downstream of the sensor which are free of flow disturbances. Pipe bends, valves, other fittings, pipe enlargements, and reductions should not be present in this length of pipe.
2. When the flow sensor assembly is installed in horizontal piping, the preferred orientation is vertical, on top of the pipe (*Figure 3*). If trapped air or debris could potentially interfere with sensor operation, the sensor can be installed as much as 45 degrees off the vertical.

   **NOTE:** When the sensor is installed "off the vertical", impeller friction increases, which can affect performance at low flow rates and increase wear.

   The flow sensor assembly should never be located at the bottom of the pipe, as sediment can collect there. When the flow sensor assembly is installed in vertical piping, it can be installed at any circumferential position. Rising flow is preferred to reduce the effects of trapped air.

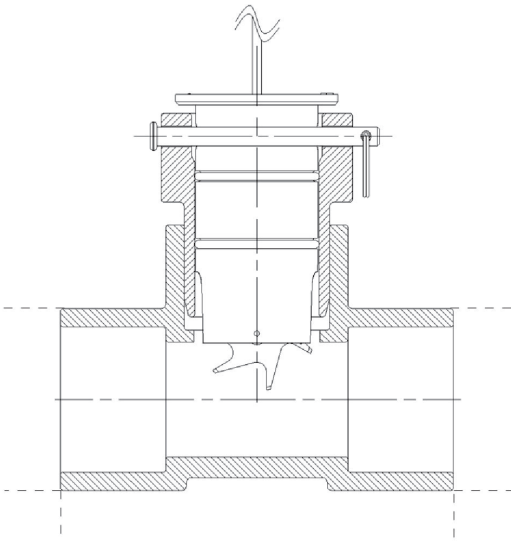

*Figure 3: Flow sensor assembly in horizontal piping*

## Wireless 228PV Plastic Tee Sensor and Transmitter Mechanical Installation

1. Note the intended direction of flow as indicated by the arrows on the tee. Make sure there is free, unrestricted pipe for at least 10 diameters upstream and 5 diameters downstream of the tee.

**NOTE:** Cable length between the sensor and wireless transmitter is 5 feet. Plan for cover removal if inserting into a valve box.

2. Remove the clevis pin and remove the sensor from the tee.
3. Properly clean the pipe ends and tee sockets.
4. For the 228PV, solvent cement the pipe to the tee.
5. Reinstall sensor in tee as follows:
   a. Align the small diameter blind hole on the top surface of the sensor with the tip of the flow arrow on the tee.
   b. Carefully press the sensor straight into the tee.
   c. Install the cotter ring.
6. Remove the wireless transmitter cap from the wireless transmitter body by unscrewing it in a counterclockwise direction.
7. Insert the wireless transmitter body through a minimum 1.625 inch (41 mm) hole in the valve box cover, maximum hole size 2.5 inches (64 mm).
8. Screw the wireless transmitter cap hand tight to the wireless transmitter body. Then screw the nut against the inside of the valve box cover so the cap is tight.

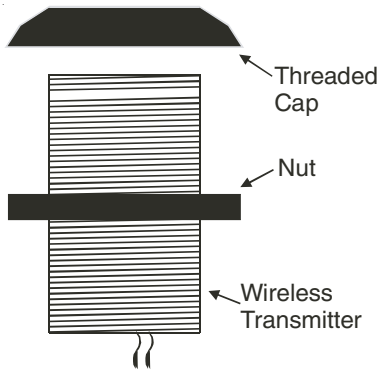


*Figure 4: ORION wireless transmitter with threaded cap removed*

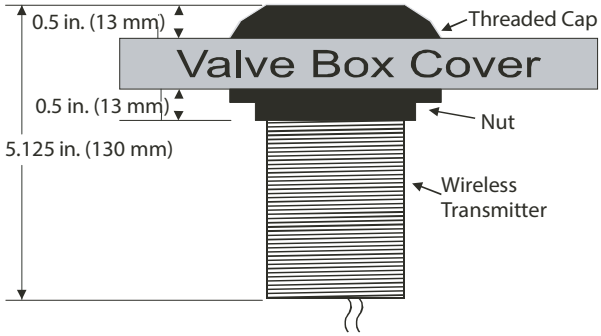


*Figure 5: ORION wireless transmitter installed in valve box cover*

## Wireless Receiver Mechanical Installation

The wireless receiver can be surface mounted onto a panel or attached to DIN rails using adapter clips.

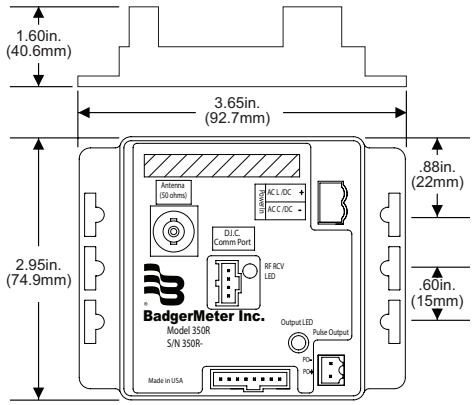


*Figure 6: ORION wireless receiver dimensions*

### Location

Although the wireless receiver is encapsulated, all wiring connections are made to exposed terminals. The unit should be protected from weather and moisture in accordance with electrical codes and standard trade practices. In any mounting arrangement, the primary concerns are ease of wiring and attachment of the programming cable.

The unit generates very little heat so no consideration needs to be given to cooling or ventilation.

The ideal receiver location is within clear line-of-sight of the flow sensor. However, this is rarely possible, with the line-of-sight hindered by obstructions such as trees and vegetation, buildings and other structures, vehicles, and uneven terrain.

### Surface Mount Installation

The wireless receiver can be mounted to the surface of any panel using double-sided adhesive tape, or by attaching fasteners through the holes in the mounting flanges of the unit.

### DIN Rail Mounting

Optional clips snap onto the mounting flanges, allowing the wireless receiver to be attached to DIN 15, 32, 35 mm DIN rail systems.

## Antenna Installation

The ORION RF receiver requires an external antenna to communicate with the RF transmitter. The antenna is typically mounted directly to a customer-supplied enclosure that houses the RF receiver. The antenna can also be installed remotely from the enclosure to be within a clear line-of-sight of the RF transmitter.

### Antenna Kits

Antenna kits are an optional accessory and can be ordered by specifying the appropriate model number from the *"" on page 3*. Badger Meter offers two antenna kits: the A355LP low profile antenna kit and the A355 whip style antenna kit.

- The A355LP kit includes a low profile antenna and antenna cable with mounting hardware. The more durable, low profile antenna is 2.3 inches (58 mm) in height and designed to operate in a frequency bandwidth of 902…928 MHz with a gain of 3 dB.
- The A355 kit includes a whip style antenna, an antenna cable, mounting hardware, and 90 degree BNC adaptor. The half-wave, whip style antenna is 8 inches (203 mm) in height and designed to operate in a frequency band of 902…970 MHz with a gain of 2.5 dB.

Both kits are supplied with an RG58C/U type antenna cable.

Optional equipment and accessories offered with the 228PV wireless system can be ordered by specifying the appropriate model number from the Ordering Matrix shown here.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 28 | PV | 00 | 0 | W | - | 1 | 2 | 1 | 1 |
| ***STYLE*** | | | | | | | | | | |
| Tee Mounted Insert Sensor | 28 | | | | | | | | | |
| ***MATERIAL*** | | | | | | | | | | |
| PVC (1.5", 2", 3", 4" Sch 80 only) | | PV | | | | | | | | |
| ***SIZE*** | | | | | | | | | | |
| 1.5" | | | 15 | | | | | | | |
| 2" | | | 20 | | | | | | | |
| 3" | | | 30 | | | | | | | |
| 4" | | | 40 | | | | | | | |
| ***ELECTRONICS HOUSING*** | | | | | | | | | | |
| PPS | | | | 0 | | | | | | |
| ***ELECTRONICS*** | | | | | | | | | | |
| Wireless - Scaled pulse output | | | | | W | | | | | |
| Wireless - Frequency output | | | | | U | | | | | |
| ***O-RING*** | | | | | | | | | | |
| EPDM (STANDARD) | | | | | | | 1 | | | |
| ***SHAFT*** | | | | | | | | | | |
| Tungsten Carbide (STANDARD) | | | | | | | | 2 | | |
| ***IMPELLER*** | | | | | | | | | | |
| Stainless Steel Only | | | | | | | | | 3 | |
| ***BEARING*** | | | | | | | | | | |
| UHMWPE (STANDARD) | | | | | | | | | | 1 |

*Figure 7: Ordering Matrix*

See *Figure 8* and *Figure 9* for suggested antenna installation, mounting hole sizes, and component part numbers.

**NOTE:** Antenna cable lengths of more than 3 feet will negatively affect signal strength. Antennas operate more effectively when well grounded (with a 3 inch (76 mm) diameter ground plane). Use the grounding washers included in both installation kits.

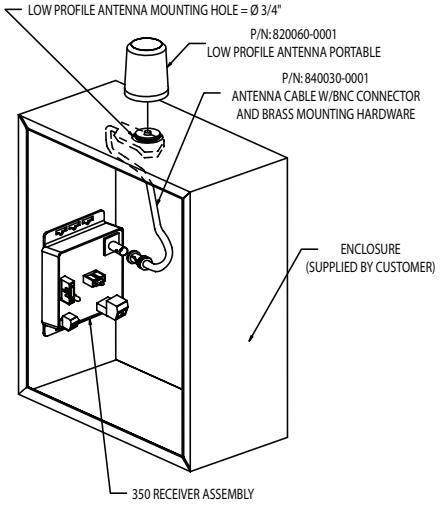


*Figure 8: A355LP antenna kit*

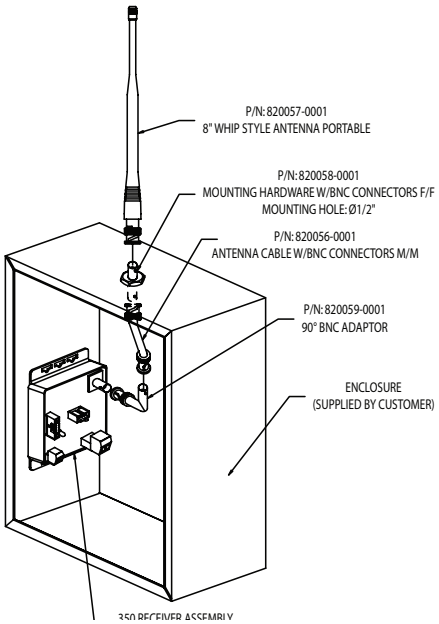


*Figure 9: A355 antenna kit*

## Wireless Receiver Electrical Installation

Per standard wiring practices, turn off the power before making any wire connections. The terminal strips have removable plug-in connectors to make wiring easier.

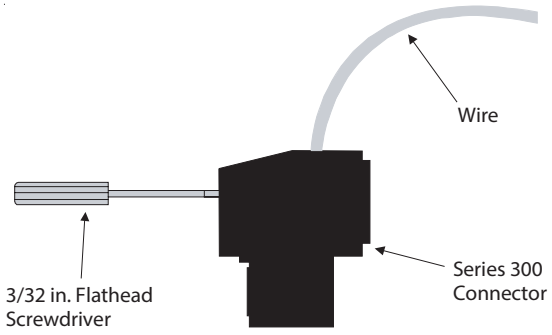


*Figure 10: Typical series 300 removable connector wiring, side view*

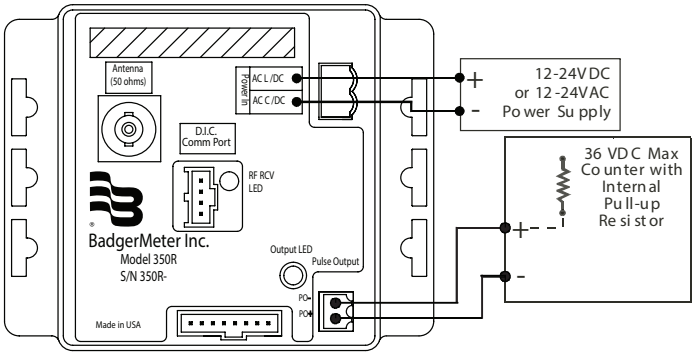


*Figure 11: Sample ORION wireless receiver electrical wiring*

**NOTE:** Follow these steps and see *Figure 11* for terminal connections and wiring example.

1. Connect DC power supply positive (+) or AC line to the wireless receiver terminal marked AC L/DC (+).
2. Connect DC power supply negative (–) or AC common to the wireless receiver terminal marked AC C/DC (–).
3. Connect pulse (+) of a pulse input device to the wireless receiver terminal marked PO (+).
4. Connect pulse (–) of a pulse input device to the wireless receiver terminal marked PO (–).
5. Connect 50 Ω (Ohm) antenna to BNC antenna connector of the wireless receiver.

# THEORY OF OPERATION

The ORION RF receiver can be located up to 500 feet away from the RF transmitter and must be powered with 12…24V AC/DC. A BNC connector is provided on the RF receiver to accept a 50 Ohm, half-wave antenna.

There are two red LEDs on the receiver.

- The "RF RCV" LED in the middle of the unit flashes each time it receives an updated total from the RF transmitter, approximately every four seconds.
- The "OUTPUT" LED flashes each time an output pulse is generated by the receiver.

After each update, the RF receiver compares this updated total with the last one received. The difference is the total volume in gallons that has passed through the sensor for the period in question. The RF receiver then generates a continuous burst of output pulses with a duty cycle of 50%. These pulses can be scaled using the DIC Com Port and Badger Meter software to represent the desired volume unit, number of volume units per pulse, and pulse width that best fit the application. Default values for these settings are gallons, 10 gallons per pulse, and 50 milliseconds, respectively.

If the combination of volume units, volume units per pulse, and pulse width selected prevents the number of corresponding output pulses from being generated in the 4…5 second update window, the RF receiver will simply delay the next update until the pulse string has been completed.

| | |
|---|---|
| **Sensor Model** | 228PV200W-1231-000 |
| **Line Size** | 2 inches |
| **Gallons per Integer Output from Transmitter** | 1 (default) |
| **Volume Unit Selected in Receiver** | liters |
| **Volume Units per Pulse Output from Receiver** | 10 |
| **Pulse Width** | 50 milliseconds |

If 10 gallons pass through the sensor in a given 4 second window, 10 integer values are sent by the transmitter in the next update, representing a volume of 10 gallons. The receiver, in turn, converts the 10 gallons into 37.8 liters and generates three output pulses, representing a volume of 30 liters. Because partial counts exist in both the sensor and receiver, the remaining 7.8 liters are sent as part of the next update from the sensor.

**NOTE:** The Badger Meter Model A301W cable works with all Series 300 products. However, the older version of the cable (A300) does not have sufficient bandwidth to work with this receiver.

# PROGRAMMING

No programming is required for the frequency output version of this system (electronics order code "U"). Simply enter the K and Offset information from the table below into the input device:

| Model No. | K | Offset |
|---|---|---|
| 228PV150U-xxxx-xxx | 0.550342 | -5.683758 |
| 228PV200U-xxxx-xxx | 1.1544738 | -1.3758585 |
| 228PV300U-xxxx-xxx | 3.358104 | -1.668902 |
| 228PV400U-xxxx-xxx | 5.97996 | 0.440556 |

For the scaled pulse output version of this system, use the software installation and programming instructions that begin on the next page.

## Programming Software Installation

### Communications Cable Wiring

To change parameters in the wireless receiver or sensor, a Badger Meter Model A301W Programming Kit (consisting of a custom cable, IR dongle, and software) and a computer (PC) running Windows® 7 or XP is required. In order to program, the wireless receiver must be connected to power, and the communications cable must be connected to both the D.I.C. Comm port and an available DB9 Comm port on the PC.

### CDROM Installation

Insert the software CD into a CDROM drive on the PC. The software installation should start automatically. Follow the instructions from the installation Wizard to complete installation. When installation is complete, go to Windows ***Start\Programs\Badger Meter Inc.***, and select **Model 350W** to start the programming software application.

### Web Installation

Badger Meter provides free programming software updates via the Internet for all field programmable devices. The installation software can be found under *Support & Resources> Software on the website* at *www.badgermeter.com*.

## Wireless Receiver Programming

To change the settings of the wireless receiver, use the programming software to enter new values as outlined here.

1. Connect the PC with the installed software to the wireless receiver using the Model A301W IR communications cable.
   - Plug the Model A301W cable in to the socket labeled "D.I.C. Comm Port", taking care to properly align the tab on the plug and socket to maintain polarity.
   - Then plug the DB9 connector of the Model A301W communications cable to an available Com port on the PC. If a DB9 port is not available, use a (customer supplied) USB-to-DB9 adapter (example, IOGEAR GUC232A).
2. Connect the wireless receiver to a power supply.
3. Start the software.
4. Select **Device**>**350** from the main menu. Then select **Pulse Receiver** from the *Device Type* drop-down menu.

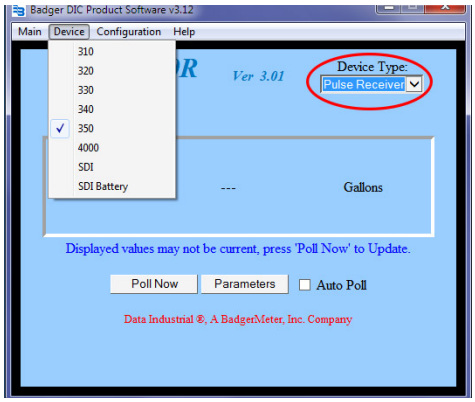


*Figure 12: Select Device and Device Type*

5. Select **Configuration**> **Set Comm Port** from the main menu to open the *Comm Settings* window. Select the appropriate Comm port for the A301W communications cable. Then click **OK**. The *Comm Settings* window closes.

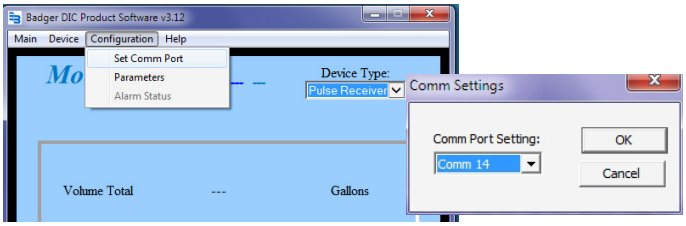


*Figure 13: Comm settings*

6. Click **Poll Now** to update the current values.
7. Select **Configuration**> **Parameters** to open the *Parameters* screen. You can also select the **Parameters** button. See *Figure 14*.

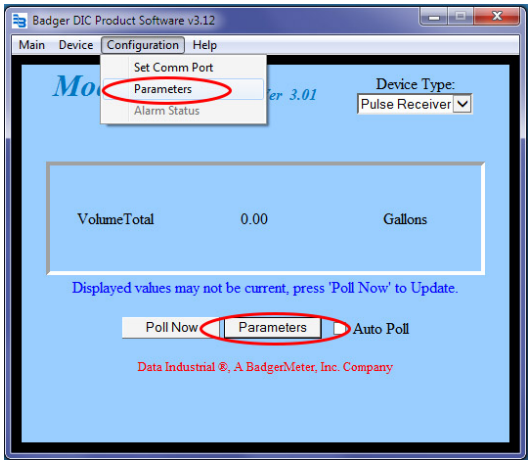


*Figure 14: Select Parameters*

8. Program the wireless receiver using the Parameters screen in *Figure 15* as a reference.

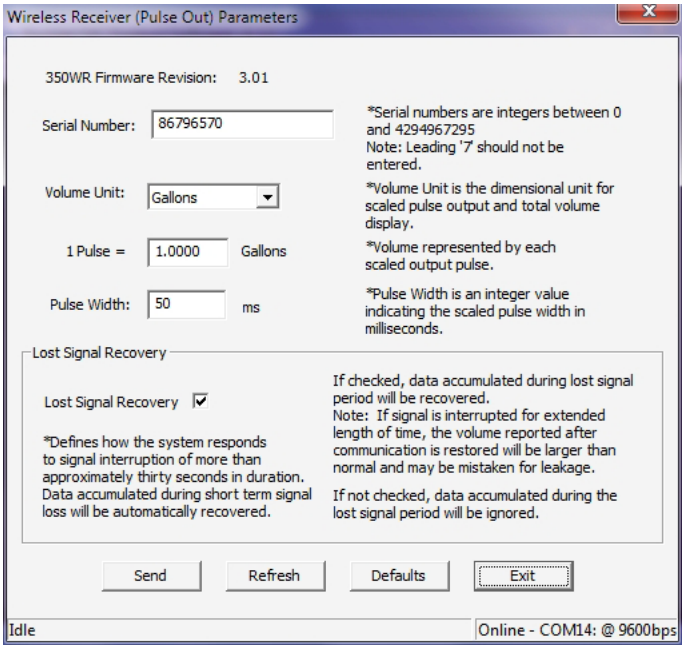


*Figure 15: Receiver parameters*

   a. **Serial Number**: Enter the serial number of the wireless receiver.'
   b. **Volume Unit**: Select the desired volume unit for scaled output pulses.
   c. **1 Pulse**: Enter the desired volume per scaled output pulse.
   d. **Pulse Width**: Enter the scaled output pulse width.

      **NOTE:** The default pulse width is 50 milliseconds. Minor variation in pulse width may be required, depending on controller interface.

   e. **Lost Signal Recovery**: Configure this section depending on the application requirements. If checked, the data accumulated during a lost signal period will be recovered. See the instructions on the screen for more information.
   f. **Send**: Click to calibrate the wireless receiver with the information that was entered.
   g. **Refresh**: Click to see the current programming.
   h. **Defaults**: Click to enter the factory default programming.

      **NOTE:** Selecting **Defaults** overwrites all settings.

   i. **Exit**: Click to exit and close the Parameters screen.

9. Click the **X** in the top right corner of the screen to exit the programming software.

## Wireless Flow Sensor Programming

The wireless flow sensor is factory programmed based on the line size for your application, using the default settings given in the table below (based on 15 fps flow velocities).

| Model No. | K | Offset | Recommended Volume / Pulse Output (gallons) | Minimum…Maximum Flow Range (gpm) |
|---|---|---|---|---|
| 228PV150W-xxxx-xxx | 0.275171 | -11.367570 | 1 | 6…95 |
| 228PV200W-xxxx-xxx | 0.577369 | -2.751717 | 1 | 10…156 |
| 228PV300W-xxxx-xxx | 1.679052 | -3.337804 | 10 | 23…345 |
| 228PV400W-xxxx-xxx | 2.989980 | 0.881112 | 10 | 39…595 |

These factory settings consist of the *K* and *Offset* values and *Gallons per Pulse Output*.

**NOTE:** The *K* and *Offset* values, empirically derived from flow tests using NIST traceable instruments, are used in the calibration equation (Frequency = GPM/K – Offset) to calculate sensor frequency at any flow rate within its operational range. Factory settings for *K* and *Offset* values are normally changed only when installing the sensor in a different line size, or when custom values are required (example, non-standard piping). If custom values for *K* and *Offset* values are required, contact the factory for assistance. If no line size is specified at the time of order placement, default values of 0.5 and 0, respectively, will be used for *K* and *Offset*.

The value for *Gallons per Pulse Output* sets the system resolution. Lowering the factory default value for *Gallons per Pulse Output* is not recommended because it will decrease transmitter battery life and can affect transmitter operation.

Badger Meter sensors will operate both above and below the suggested flow range for each tee size. Test results have shown, however, that the highest accuracy and best repeatability are achieved in the suggested flow range.

### Programming New Flow Sensor Values

To change the settings of the wireless sensor, use the programming software to enter new values as outlined here.

1. Start the programming software.
2. Connect the infrared cable (IR cable) to the computer.
3. Select **Device**>**350** from the main menu. Then select **Sensor** from the *Device Type* drop-down menu.

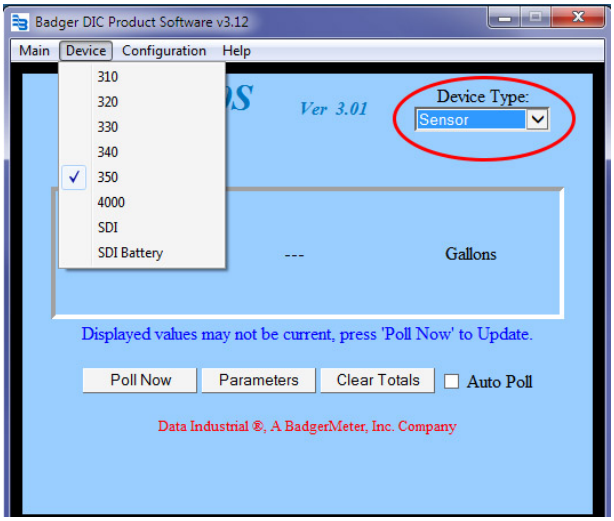


*Figure 16: Select Device and Device Type*

4. Select **Configuration**> **Set Comm Port** from the main menu to open the *Comm Settings* window. Select the appropriate Comm port for the IR cable. Then click **OK**. The *Comm Settings* window closes.

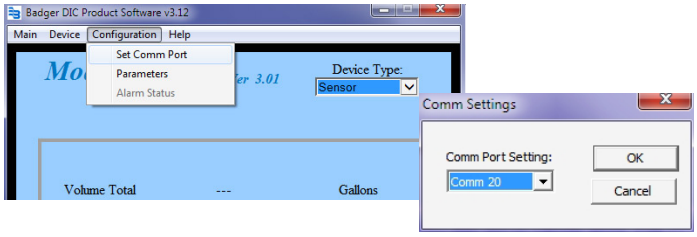


*Figure 17: Comm settings*

5. Align the IR cable with the IR LED port of the sensor and click **Poll Now** to update the current values.

**NOTE:** Hold the IR cable no more then 2 inches from the top of the sensor.

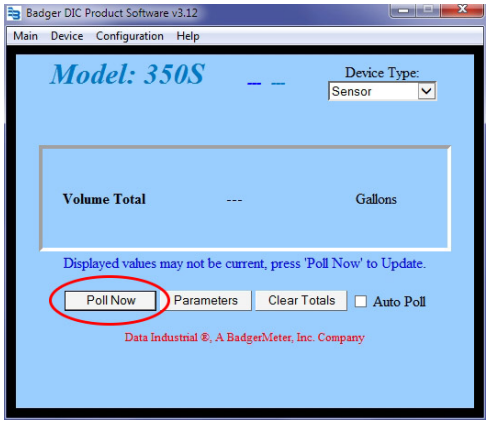


*Figure 18: Poll Now*

6. Select **Configuration**> **Parameters** to open the *Parameters* screen. You can also select the **Parameters** button. See *Figure 19*.

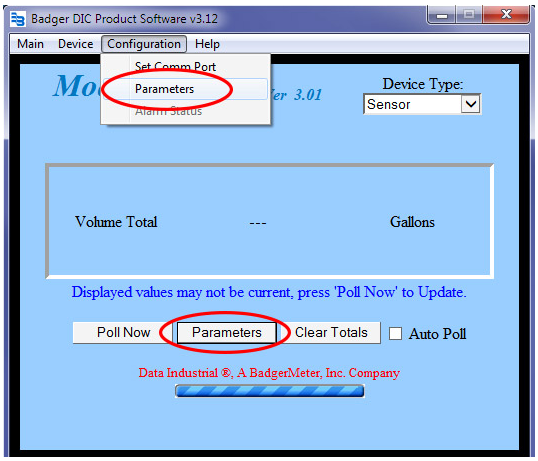


*Figure 19: Select Parameters*

7. Program the wireless flow sensor using the Parameters screen in *Figure 20* as a reference.

   **a. Pipe Size**: Select sensor size from the drop-down menu. If custom K and Offset values are required, select **Other (Unlisted)**.

   **b. Sensor Configuration**: The K and Offset values will automatically display in these fields for the flow sensor size selected in Pipe Size. If **Other (Unlisted)** was selected, enter the desired values in each field.

   **c. Rate Unit**: Select the desired unit for flow rate display.

   **d. Pulse Output Control**: Enter the desired volume per output pulse.

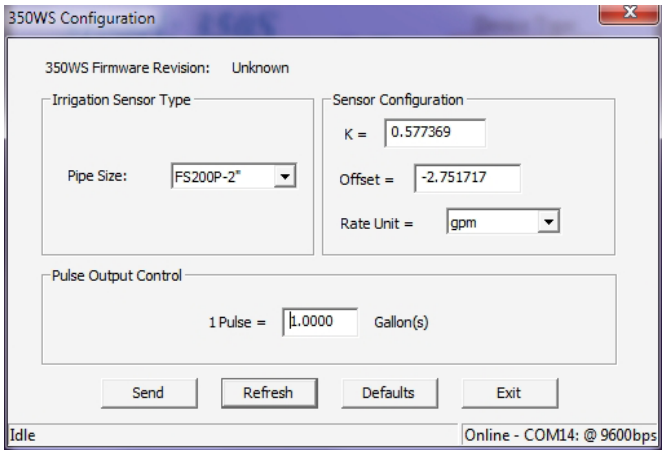


*Figure 20: Flow sensor parameters*

## IMPORTANT

*Align the IR cable with the IR LED port of the sensor before selecting* **Send**, **Refresh** *or* **Defaults**.

   **e. Send**: Click to calibrate the wireless receiver with the information you entered.

   **f. Refresh**: Click to see the current programming.

   **g. Defaults**: Click to enter the factory default programming.

   **NOTE:** Selecting **Defaults** overwrites all settings.

   **h. Exit**: Click to exit and close the Parameters screen.

8. Click the **X** in the top right corner of the screen to exit the programming software.

# SPECIFICATIONS

| | | |
|---|---|---|
| **Wetted Materials (Except Tee)** | Refer to the Ordering Matrix | |
| **Tee for 228PV** | Schedule 80 PVC per ASTM D-2462 and D-2467. Virgin, unplasticized PVC resin, Type 1 cell classification 12454-B. Fittings and solvent carry approval for potable water by NSF and IAMPO. | |
| **Power Requirements** | Flow sensor-lithium battery powered (typical battery life > 5yr) | |
| | ORION transmitter, battery powered (typical battery life > 10yr) | |
| | ORION receiver, external power 12…24V AC/DC | |
| | **Current Draw** | 36 mA @ 12V DC |
| | | 16 mA @ 24V DC |
| | | 40 mA rms @ 12V AC rms |
| | | 30 mA rms @ 24V AC rms |
| **Recommended Flow Range** | 5…20 fps | |
| **Extended Flow Range** | 1 to 20 fps | |
| **Accuracy** | Standard ± 2% of rate of full scale over recommended design flow range | |
| | Repeatability ± 0.5% of full scale over recommended design flow range | |
| **Maximum Operating Temperature** | 32…150° F (0…65° C) | |
| **CSA-approved Temperature Rating** | 140° F (60° C) | |
| **Sensor Pressure Drop** | 0.5 psi or less at 10 fps for all pipe sizes 1.5 in. (38 mm) diameter and larger | |
| **Programming** | Sensor and transmitter programming is accomplished using PC software via an infrared (IR) link | |
| | ORION RF receiver programming is accomplished using PC software via the A301W-20 connector cable | |
| **Flow Sensor Programmable Parameters** | K & Offset dependent upon pipe size | |
| | Flow units (gpm, gph, lps, lpm, $ft^3$/sec, $ft^3$/min, $m^3$/sec, $m^3$/min) | |
| | Scaled pulse output (units/pulse) | |
| **ORION Receiver Programmable Parameters** | Serial number (unique to the ORION Transmitter ID) | |
| | Volume units (gallons, $ft^3$, $m^3$, liters) | |
| | Scaled pulse output (units/pulse) | |
| | Scaled pulse output (pulse width) | |
| **Performance Range** | 500 ft line of sight | |

## Control. Manage. Optimize.



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