



**WaterSense® Specification for Soil Moisture-Based
Irrigation Controllers**

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1.0 Scope and Objective

This specification establishes the criteria for soil moisture-based irrigation controllers labeled under the U.S. Environmental Protection Agency's (EPA's) WaterSense program. It applies to stand-alone controllers, add-on devices, and plug-in devices that inhibit or allow an irrigation event¹ based on a reading(s) from a soil moisture sensor mechanism (i.e., sensor mechanism). EPA is defining this product category as follows, based on the definitions of the applicable components included in the American National Standards Institute (ANSI)/American Society of Agricultural and Biological Engineers (ASABE) S633 *Testing Protocol for Landscape Irrigation Soil Moisture-Based Control Technologies*:

- Soil moisture-based irrigation controllers—a sensor mechanism and interface device that enables (allows) or disables (prevents/interrupts) an irrigation event at preset or selected soil water values. These products are commonly known as, and for the purpose of this specification shall be referred to as, soil moisture sensors (SMSs).²
- Sensor mechanism—the portion of the device that contacts the soil and measures physical properties that are related to the amount of moisture in the soil.
- Interface device—the portion of the device that either enables/disables irrigation events, and/or transmits soil water information to a control system for irrigation decision-making. The interface device could be part of an irrigation controller or can be a separate component, either integrated into or separate from the sensor mechanism.

The performance criteria contained in this specification are designed to test the capability of the SMS, when programmed and operated in accordance with the manufacturer's instructions, to successfully enable or disable an irrigation event based on soil moisture readings.

This specification applies to SMSs for use in residential or commercial landscape irrigation applications.

The specification does not apply to:

- On-demand SMSs, or those that initiate irrigation at a lower preset moisture level and terminate irrigation at an upper preset soil moisture level.
- Sensor mechanisms alone (i.e., sold without an interface device).
- SMSs intended for use exclusively within agricultural irrigation systems.

2.0 Performance Criteria

SMSs shall be tested in accordance with the relevant sections of ANSI/ASABE S633, as modified in Section 2.1, and shall meet the performance criteria outlined in Section 2.2.

¹ Irrigation event is defined as landscape watering beginning at pre-determined start time(s) and run time(s) for one or more watering zones (ANSI/ASABE S633).

² More generally, SMSs are technologies that can detect the amount of moisture in the soil and override (i.e., bypass or interrupt) scheduled irrigation when a moisture threshold is met.

2.1 Testing modifications to ANSI/ASABE S633

- 2.1.1 For add-on or plug-in devices, the interface device shall be tested with a base controller, as described in Appendix A.
- 2.1.2 SMSs shall only be tested in the moderately coarse test medium and water with an electrical conductivity (EC) of 3 dS/m, as defined in ANSI/ASABE S633.
- 2.1.3 The freeze test shall be conducted in the 40 percent water depletion container using the moderately coarse medium after the initial test is complete.

2.2 Performance criteria

- 2.2.1 When tested in accordance with Section 6 of ANSI/ASABE S633, as modified in Section 2.1 of this specification, SMSs shall meet the following performance criteria:
 - 2.2.1.1 Each SMS evaluated shall enable and disable irrigation at each of the three depletion levels.
 - 2.2.1.2 The relative average deviation (RAD) of the readings (expressed as percent of full scale)³ at which the replicate SMSs enable and disable irrigation, calculated in accordance with Equations 1 through 3 below, when averaged across all water depletion level readings, shall be less than or equal to 10 percent.

Equation (1) $Average\ Deviation_x = \frac{[|\bar{x}-x_1|+|\bar{x}-x_2|+|\bar{x}-x_3|]}{3}$

Where: $Average\ Deviation_x$ is the average of the absolute value of the deviation for enable readings at a given depletion level (20, 40, or 60 percent) and disable readings at a given depletion level (20, 40, or 60 percent). In total, there are six average deviations calculated.

$$\bar{x} = \frac{(x_1 + x_2 + x_3)}{3}$$

x_1 is the first observation

x_2 is the second observation

x_3 is the third observation

³ Percent of full scale is calculated by dividing the reading by the full scale of the product (i.e., the range of readings from air to water).

$$\text{Equation (2)} \quad RAD_x = \frac{\text{Average Deviation}_x}{\bar{x}}$$

Where: RAD_x is the relative average deviation for the enable readings at a given depletion level (20, 40, or 60 percent) and disable readings at a given depletion level (20, 40, or 60 percent). In total, there are six RADs calculated. $\text{Average Deviation}_x$ is taken from Equation 1 for the given enable or disable reading and given depletion level.

$$\bar{x} = \frac{(x_1 + x_2 + x_3)}{3}$$

x_1 is the first observation

x_2 is the second observation

x_3 is the third observation

$$\text{Equation (3)} \quad RAD_{avg} = \frac{RAD_{en20} + RAD_{en40} + RAD_{en60} + RAD_{dis20} + RAD_{dis40} + RAD_{dis60}}{6}$$

Where: RAD_x is taken from Equation 2 RAD_x results as follows:

RAD_{en20} is the RAD for enable readings at 20 percent water depletion

RAD_{en40} is the RAD for enable readings at 40 percent water depletion

RAD_{en60} is the RAD for enable readings at 60 percent water depletion

RAD_{dis20} is the RAD for disable readings at 20 percent water depletion

RAD_{dis40} is the RAD for disable readings at 40 percent water depletion

RAD_{dis60} is the RAD for disable readings at 60 percent water depletion

- 2.2.1.3 The absolute value of the slope across three depletion levels of the line generated using a least square regression plot of irrigation *enable* readings (expressed as a percent of full scale) for each replicate shall be greater than zero when rounded to two significant digits (i.e., ≥ 0.01).

The absolute value of the slope across three depletion levels of the line generated using a least square regression plot of irrigation *disable* readings (expressed as a percent of full scale) for each replicate shall be greater than zero when rounded to two significant digits (i.e., ≥ 0.01).

- 2.2.2 When tested in accordance with Section 7.2 of ANSI/ASABE S633, as modified in Section 2.1 of this specification, each SMS evaluated shall

enable and disable irrigation after the sensor mechanism is placed in a freezer for three days and thawed to pre-freeze medium temperature.

3.0 Supplemental Capability Requirements

Add-on and plug-in devices, configured for testing in accordance with Appendix A, and stand-alone controllers shall meet the following requirements in both soil moisture mode and standard mode:

- 3.1 Be capable of preserving the contents of the programmed irrigation settings and sensor mechanism settings when the power source is lost and without relying on an external battery backup.
- 3.2 Either be capable of independent, zone-specific programming or storing a minimum of three different programs to allow for separate schedules for zones with differing water needs.
- 3.3 Be capable of indicating to the user when it is not receiving sensor mechanism input and is not adjusting irrigation based on soil moisture content in the landscape.
- 3.4 Be capable of interfacing with a rainfall device.
- 3.5 Be capable of accommodating watering restrictions as follows:
 - 3.5.1 Operation on a prescribed day(s)-of-week schedule (e.g., Monday-Wednesday-Friday, Tuesday-Thursday-Saturday; any two days; any single day).
 - 3.5.2 Either even day or odd day scheduling, or any day interval scheduling between two and seven days.
 - 3.5.3 The ability to set irrigation runtimes to prevent watering during a prohibited time of day (e.g., between 9:00 a.m. and 9:00 p.m.).
 - 3.5.4 Complete shutoff (e.g., on/off switch) to accommodate outdoor irrigation prohibition restrictions.
- 3.6 Include a percent adjust (water budget) feature.⁴
- 3.7 Be capable of reverting to a percent adjust (water budget) feature if the sensor mechanism signal is lost.
- 3.8 Be capable of allowing for a manual operation troubleshooting test cycle and shall automatically return to soil moisture mode within some period of time as designated by the manufacturer.

⁴ The percent adjust (water budget) feature is defined as having the means to increase or decrease the runtimes or application rates for zones by means of one adjustment without modifying the settings for each individual zone.

4.0 Packaging and Product Documentation Requirements

SMSs shall be packaged and provided with documentation as indicated in this section.

4.1 Stand-Alone Controllers

The product shall not be packaged nor marked to encourage operation of the controller in standard mode. Any instruction related to the maintenance of the product shall direct the user on how to return the controller to soil moisture mode.

4.2 Add-on and Plug-in Devices

Add-on and plug-in devices are not required to be packaged with the base controller(s) with which they were tested or have been determined compatible, as specified in Appendix A. However, the product documentation for the add-on and plug-in devices shall list (or provide access to a list of) each compatible base controller model. The documentation shall also contain a statement to the effect that the device is only WaterSense labeled when used in combination with a base controller on the provided compatibility list.

5.0 Effective Date

This specification is effective on February 11, 2021.

6.0 Future Specification Revisions

EPA reserves the right to revise this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. Major revisions to the specification shall be made following input from industry partners and other interested stakeholders.

7.0 Definitions

Definitions within ANSI/ASABE S633 *Testing Protocol for Landscape Irrigation Soil Moisture-Based Control Technologies* are included by reference. The following definitions are additional terms that are referenced in the specification:

Add-on device: An SMS in which the interface device is separate from the controller (either a separate component or part of the sensor mechanism). It communicates the sensor mechanism readings to a base controller. For purposes of this specification, add-on devices are defined as those that are designed to work with multiple brands of base controllers.

Base controller: The irrigation controller with which the add-on or plug-in device communicates, through a wired or wireless connection, for full operation. Mostly commonly, a base controller is a standard clock-timer controller but may also be a weather-based controller that uses weather data as a basis for irrigation scheduling.

Plug-in device: An SMS in which the interface device is separate from the controller (either a separate component or part of the sensor mechanism). It communicates the sensor mechanism readings to a base controller. For purposes of this specification, plug-in devices are defined as those that are designed to work specifically with one brand of controller.

Rainfall device: A device that either senses or measures rainfall to reduce or interrupt irrigation in response to rain events. For the purpose of this specification, this includes, but is not limited to, rainfall interrupt devices and tipping bucket rain gauges.

Stand-alone controller: An SMS in which the interface device is integrated into the controller. This includes a single controlling device (i.e., the irrigation controller) and the sensor mechanism(s) that provide the soil moisture data.

Soil-moisture mode: The operating mode in which the stand-alone controller, or plug-in and add-on device and associated base controller, is using readings from the sensor mechanism to modify the irrigation schedule.

Standard mode: The operating mode in which the stand-alone controller, or plug-in and add-on device and associated base controller, is not using readings from the sensor mechanism to modify the irrigation schedule.

Appendix A: Testing Configuration and Compatible Base Controller Determination

The requirements of this appendix apply to add-on or plug-in devices.

1.0 Initial Configuration for Testing

The manufacturer shall specify a base controller model with which the add-on or plug-in device shall be tested. Together, the unit shall be capable of meeting the requirements of this specification, including the supplemental capability requirements specified in Section 3.0.

2.0 Determining Additional Compatible Base Controllers

At the discretion of the licensed certifying body (LCB), additional base controller models with which the add-on or plug-in device can be paired, and that together as a unit meet the requirements of this specification, including the supplemental capability requirements specified in Section 3.0, can be identified in order to be listed as compatible base controllers according to Section 3 of Appendix B. See the *Supplemental Guidance for WaterSense Certification and Labeling of Irrigation Controllers* and the *WaterSense Product Certification System* for more information.

Appendix B: Informative Annex for WaterSense Labeling

The following requirements must be met for SMSs to earn the WaterSense label.

1.0 WaterSense Partnership

The manufacturer of the SMS must have a signed WaterSense partnership agreement in place with EPA.

2.0 Conformity Assessment

Conformance to this specification must be certified by a licensed certifying body accredited in accordance with the *WaterSense Product Certification System*.

3.0 WaterSense Labeling

- 3.1 For add-on devices and plug-in devices, only the devices certified to meet the requirements of this specification may bear the WaterSense label. Base controllers with which the add-on or plug-in devices are tested and/or determined to be compatible with shall not bear the WaterSense label. Product documentation shall indicate that the add-on or plug-in device is only WaterSense labeled when used in combination with the base controller(s) listed in product documentation described in Section 4.0 of this specification.
- 3.2 Base controllers that are tested, or determined to be compatible with an add-on or plug-in device, may bear the WaterSense promotional label and include language similar to “Look for the WaterSense labeled [plug-in or add-on device] to improve the water efficiency capabilities of this controller.” See the *WaterSense Program Mark Guidelines* for more information about the use of the WaterSense promotional label.
- 3.3 Products (i.e., stand-alone controllers, plug-in and add-on devices) that are packaged and sold as a single unit and integrate soil moisture-based scheduling (i.e. an allowance or prevention of an irrigation event based on readings) from a soil moisture mechanism) and weather-based scheduling (i.e., the use of current weather data as a basis for scheduling irrigation) shall be certified to meet the requirements of this *WaterSense Specification for Soil-Moisture Based Irrigation Controllers* and the *WaterSense Specification for Weather-Based Irrigation Controllers* in order for the product to bear the WaterSense label.

4.0 Product Sampling for Certification

SMSs shall be sampled and selected for testing in accordance with Section 5.1 of ANSI/ASABE S633 (i.e., each test shall consist of three SMSs per manufacturer model randomly selected from a lot of at least 10 items supplied by the manufacturer).