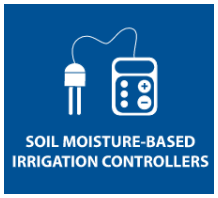
WaterSense Performance Overview: *Soil Moisture-Based Irrigation Controllers*



Equal or superior product performance is a pillar of the WaterSense label. Ensuring performance is vital for maintaining program integrity and consumer confidence in WaterSense labeled products. As part of specification development, the U.S. Environmental Protection Agency (EPA) also evaluates whether high-efficiency products will have other environmental or economic impacts. This includes whether there will be unintended or negative impacts to overall system performance, which may affect user satisfaction and health and safety. This Performance Overview details EPA's process for developing performance test methods and criteria for soil moisture-based irrigation controllers. In general, as part of the specification development process, EPA involves many WaterSense stakeholders, including manufacturers, certifying bodies and testing laboratories, standard development organizations, trade organizations, water and energy utilities, and other water efficiency experts and advocates. Each of these stakeholders offers a unique perspective and has dedicated technical expertise and other resources that have contributed to the development of performance criteria used to ensure WaterSense labeled products perform as well or better than standard products on the market.

EPA published the *WaterSense Specification for Soil Moisture-Based Irrigation Controllers* on February 11, 2021.[1] The specification applies to stand-alone controllers, add-on devices, and plug-in devices that inhibit or allow an irrigation event based on a reading(s) from a soil moisture sensor mechanism (i.e., sensor mechanism). These controllers are commonly known as soil moisture sensors (SMSs).

Summary of Performance Requirements

Table 1 summarizes the performance requirements included in the *WaterSense Specification for Soil Moisture-Based Irrigation Controllers*, including the purpose of each requirement, the applicable standard the WaterSense specification references and any specific requirements or deviations from the referenced standard.

[1] More information on EPA's rationale for establishing its efficiency and performance criteria for soil moisture-based irrigation controllers can be found in the supporting statement, response to comments, and other background documents found at www.epa.gov/watersense/product-background-materials.

Table 1. Summary of Performance Criteria Included in the *WaterSense Specification for Soil-Moisture Based Irrigation Controllers*

Performance Requirement	Purpose	Referenced Standard (if applicable)	Applies to Conventional Models	Applies to WaterSense Labeled Models
Function	Determines whether the SMS has the ability to enable and disable irrigation at a variety of moisture depletion levels.	ANSI/ASABE S633 *Testing Protocol for Landscape Irrigation Soil Moisture-Based Control Technologies*		✓
Precision	Measures whether the SMS can consistently enable and disable an irrigation event at a pre-set moisture threshold.	ANSI/ASABE S633 *Testing Protocol for Landscape Irrigation Soil Moisture-Based Control Technologies*		✓
Response to change in soil moisture	Determines whether the SMS can sense a change in soil moisture when moisture levels change.	ANSI/ASABE S633 *Testing Protocol for Landscape Irrigation Soil Moisture-Based Control Technologies*		✓
Function following freeze conditions	Evaluates whether the SMS functions after the sensor mechanism is frozen and thawed.	ANSI/ASABE S633 *Testing Protocol for Landscape Irrigation Soil Moisture-Based Control Technologies*		✓
Supplemental capability requirements	Ensures the presence of additional features (e.g., ability to accommodate watering restrictions) to ensure greater long-term water savings.	No referenced standard; requirements developed through discussions with and feedback from WaterSense stakeholders. The supplemental capabilities are summarized below.		✓

Development of Performance Requirements

WaterSense began researching SMSs in 2006, the same year research began on weather-based irrigation controllers (WBICs). Due to a lack of industry consensus around a test method, EPA put specification development for SMSs on hold until 2012, when an American Society of Agricultural and Biological Engineers (ASABE) committee, S633: *Testing of Soil Moisture Sensors for Landscape Irrigation*, was formed to develop a standardized test method for bypass

SMSs.[2,3] WaterSense participated in the ASABE S633 committee, which consisted of industry experts, as well as representatives from academia, water utilities, and manufacturers. In early 2014, the East Bay Municipal Utility District (EBMUD), an active participant on the committee, pledged conservation research funding from the California Department of Water Resources to support test method development and conduct several rounds of product testing and test method refinement. For detailed information on the evolution of committee test method development, please review the *Soil Moisture-Based Irrigation Control Technologies: WaterSense Specification Update*,[4] published in December 2017.

After more than five years and several rounds of testing, the committee finalized a test method and published a draft standard in November 2019. Working in concert with the committee, EPA published the *WaterSense Draft Specification for Soil Moisture-Based Irrigation Control Technologies* shortly thereafter, which referenced the test method included in the draft standard. ASABE published ANSI/ASABE S633 *Testing Protocol for Landscape Irrigation Soil Moisture-Based Control Technologies* in May 2020. EPA resolved public comments on the draft specification and published the *WaterSense Specification for Soil Moisture-Based Irrigation Controllers*, which referenced the final ANSI/ASABE S633 test method, in February 2021. For additional information on the test method, please review the *WaterSense Specification for Soil Moisture-Based Irrigation Controllers Supporting Statement*.[5]

SMSs are designed to detect the amount of moisture in the ground beneath the landscape and override scheduled irrigation when plants do not need water, reducing water waste and promoting plant health. As indicated in the *WaterSense Specification for Soil Moisture-Based Irrigation Controllers*, these control technologies must be able to consistently bypass irrigation at a predetermined setpoint (based on a reading from the SMS), allowing the landscape to be watered only when plants need it. As indicated in Table 9, the specification includes criteria to evaluate the key attributes that contribute to its intended use including function, precision, SMS response to changes in soil moisture, and SMS function following freeze conditions. Specifically, the requirements are designed to ensure SMSs are able to:

- Allow and prevent a previously scheduled irrigation event at a range of moisture levels within the soil, allowing the landscape to be watered only when plants need it.

- Consistently allow and prevent a previously scheduled irrigation event at the same moisture level each time it is accessed by the controller to determine whether irrigation will occur.

[2] Bypass SMSs are defined as those that enable or disable an irrigation event based on readings(s) from soil moisture mechanisms(s) (see the ASABE S633 *Testing Protocol for Landscape Irrigation Soil Moisture-Based Control Technologies*). The specification does not apply to on-demand SMSs, or those that initiate irrigation at a lower present soil moisture level and terminate irrigation at an upper preset soil moisture level.
[3] EPA, 2021. *WaterSense Specification for Soil Moisture-Based Irrigation Controllers Supporting Statement.* February 2021. www.epa.gov/sites/default/files/2021-02/documents/ws_sms_final_spec_supporting_statement.pdf.
[4] EPA, 2017. *Soil Moisture-Based Irrigation Control Technologies: WaterSense Specification Update*. December 7, 2017. www.epa.gov/sites/default/files/2017-12/documents/ws-products-2017update-sms.pdf.
[5] EPA, 2021. *WaterSense Specification for Soil Moisture-Based Irrigation Controllers Supporting Statement.* February 2021. www.epa.gov/sites/default/files/2021-02/documents/ws_sms_final_spec_supporting_statement.pdf.

- Sense a change in soil moisture when moisture levels change, providing the user with a product that responds to increasing or decreasing moisture levels in the landscape.

- Function after freezing conditions, providing the user with assurance that a SMS can remain in the landscape in regions where winter freezes occur.

In addition, consistent with WaterSense's requirements for WBICs, EPA requires that SMSs are capable of providing supplemental features (e.g., the ability to accommodate watering restrictions) to promote greater long-term water savings and ensure user satisfaction. The list of supplemental capability requirements was initially developed for the *WaterSense Specification for Weather-Based Irrigation Controllers*[6] by water utility stakeholders who indicated that weather-based controllers should have certain features (in addition to meeting performance criteria) to promote greater performance and long-term water savings. Though WBICs and SMSs function differently, both product types aim to address irrigation scheduling inefficiencies. As such, EPA promotes the products together as "smart irrigation control technologies." EPA retained all the supplemental features, as appropriate for SMSs, to ensure an equal level of performance for this product category. Specifically, WaterSense labeled SMSs must have the following capabilities:

- 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. This ensures that information regarding the irrigation program and settings are retained when the power source is lost, and no backup battery is available.

- Be capable of independent, zone-specific programming to successfully manage landscapes that have multiple areas with various watering requirements that need to be managed separately.

- 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 (e.g., if there is a problem with the sensor mechanism that is prohibiting it from enabling or disabling irrigation).

- Be capable of interfacing with a rainfall device. Rainfall devices are an important component of an efficient irrigation system in many climate regions. Multiple states have mandated the inclusion of these devices by law.

- Be capable of accommodating watering restrictions. With the existence of utility-imposed watering restrictions, it is important that SMSs, along with their base controllers if applicable, are capable of watering efficiently, while complying with these restrictions.

- Include a percent adjust (water budget) feature. This feature allows end users to adjust water applied to the landscape without changing the detailed settings in the controller's program.

[6] For more information on the weather-based and soil moisture-based irrigation controller specifications, see the WaterSense Labeled Controllers web page at www.epa.gov/watersense/watersense-labeled-controllers#tab-3.

- Be capable of reverting to a conservative watering schedule (i.e., percent adjust or water budget feature) if the interface device loses input from the sensor mechanism.

- Be capable of automatically returning to soil-moisture mode if switched to manual mode. Often products are turned to manual mode for troubleshooting or other reasons and not returned to soil-moisture mode. This requirement ensures the product will automatically return to soil-moisture mode within a specified time period as designated by the manufacturer.

As with WBICs, each of these supplemental features offers users flexibility in how they choose to operate their WaterSense labeled SMS, while also maintaining water efficiency and contributing to local code and regulatory compliance.