

Smart Water Application Technologies/SWAT Calibration Report

Testing Agency: Center for Irrigation Technology <http://cati.csufresno.edu/cit/>

Testing Period: April 2003 to May 2006

Product Type: Soil Moisture Sensor

Product Make and Model: Irrrometer Watermark

Product Description: Sensor reflects soil water tension or suction

SWAT Protocol*: Turf and Landscape Irrigation Equipment - SOIL MOISTURE SENSORS

Phase 1: Indoor Lab Screening Tests - 4th Draft Testing Protocol

The concept of soil moisture sensors has an extensive history of scientific study and documentation. The objective of Phase 1 lab tests is to determine sensor calibration curves over a range of conditions that affect soil moisture, including soil type, temperature and salinity. Phase 1 testing determines sensor response over manufacturer specified test ranges to continue into Phase 2. At that time the soil sensor will be integrated with an irrigation controller to measure irrigation adequacy and efficiency in a virtual landscape using the current performance criteria of 0.40 inches of rainfall and 2.50 inches of ET_o.

Phase 1 Soil Moisture Sensor testing does not test the efficacy of a sensor over the entire range of soil moisture conditions possible and does not measure the integration of a soil sensor with a controller to manage irrigation.

Sensor performance curves were developed to determine the relationship between sensor readings and soil moisture content for a soil filled container. Relationships are determined for a range of soil textures, ambient temperatures and water conductivity values.

*All SWAT protocols may be viewed at www.irrigation.org

Phase 1 SWAT Calibration Summary: Irrrometer Watermark Soil Moisture Sensor

Measures are between field capacity (i.e. practical soil water holding capacity) and a selected drying range specified by the manufacturer over which the sensor was tested.

Functions

Test of Soil Moisture Sensor	Response Function Developed ¹
Response in Fine-Textured Soil	Nonlinear (Y = -194.4x ³ + 705.68x ² - 592.25x + 156.03)
Response in Medium-Textured Soil	Nonlinear (Y = -18737x ³ + 12196x ² - 2628.6x + 206.06)
Response in Coarse-Textured Soil	Nonlinear (Y = -126102x ³ + 37507x ² - 3785.3x + 140.29)
Response in Soil at 20 °C (68 °F)	Nonlinear (Y = -12189x ³ + 8805x ² - 2211.4x + 216.57)
Response in Soil at 30 °C (86 °F)	Nonlinear (Y = -19245x ³ + 12665x ² - 2913.8x + 258.64)
Response in Soil Susceptible to Freezing	Nonlinear (Y = -13550x ³ + 7714.1x ² - 1622.1x + 156.68)
Response in Fine-Textured Soil to Irrigation with 1.5 dS/m salinity water	Nonlinear (Y = 2486.6x ³ - 1861.6x ² + 243.14x + 53.53)
Response in Medium-Textured Soil to Irrigation with 1.5 dS/m salinity water	Nonlinear (Y = -9946.5x ³ + 9843.6x ² - 3311.5x + 395.83)
Response in Medium-Textured Soil to Irrigation with 3.0 dS/m salinity water	Nonlinear (Y = -9034x ³ + 8366.6x ² - 2642.8x + 300.4)
Response in Coarse-Textured Soil to Irrigation with 1.5 dS/m salinity water	Nonlinear (Y = -4337.4x ³ + 2837.6x ² - 608.6x + 42.89)

¹Regression equations of the data gathered vs. moisture content as measured by gravimetric sampling, or the measured weight of water in the soil samples. The dynamics of variable manufacture selected calibration endpoints preclude the applicability of correlation coefficients for inter-test or inter-sensor comparisons. A Nonlinear designation means a regression equation other than a straight line was used to best describe the relationship.

Product Detail Supplied by Manufacturer

Irrrometer Watermark

www.irrometer.com

Operation	Features	Additional Hardware
Hard wired	<input type="checkbox"/> 0-200 Centibar (soil water suction) range <input type="checkbox"/> Solid state <input type="checkbox"/> Will not dissolve in soil <input type="checkbox"/> Not affected by freezing temps <input type="checkbox"/> Internal compensation for common salinity levels	Reading Equipment <input type="checkbox"/> Watermark monitor (battery operated data logger) as tested or <input type="checkbox"/> Soil moisture meter Automatic control equipment <input type="checkbox"/> Watermark Electronic Module <input type="checkbox"/> Watermark Electronic Module-Battery version <input type="checkbox"/> WaterSwitch <input type="checkbox"/> Watermark Multiple Hydrozone System <input type="checkbox"/> Watermark Soil Moisture Manager



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