

The Delta-T Devices Soil Moisture Range

Delta-T Devices has decades of experience in creating premium-grade equipment for soil moisture measurement and recording. Our instruments are built to exacting standards - ensuring ruggedness, longevity, and optimum performance throughout their life. They are used and trusted by researchers around the world and are suited to a wide variety of applications and budgets.

The Delta-T Devices soil moisture range includes a wide choice of **sensors** and **meters** (pages 3-17) and **data loggers** (pages 18-27). More information can be found online at www.delta-t.co.uk

Overview of Delta-T Soil Moisture Sensors

	Accuracy	% Water content	Soil temp	EC	Profiling	Soil water potential
WET150 Page 4 	++	✓	✓	✓	x	x
SM150T Page 6 	++	✓	✓	x	x	x
ML3 Page 7 	+++	✓	✓	x	x	x
WET Page 8 	+++	✓	✓	✓	x	x
PR2 Page 12 	++	✓	x	x	✓	x
EQ3 Page 15 	++	x	✓	x	x	✓

The WET Sensor type WET-2 measures three vital soil properties: **W**ater content, **E**lectrical Conductivity (EC) and **T**emperature.

- Moisture and nutrient status in the root zone
- Rapid monitoring of growing conditions
- Calibrations for many soils and substrates

Rapid checks on growing conditions

The WET Sensor can easily be inserted into substrates, composts and most soils, enabling growers and researchers to make rapid checks and optimise the uniformity of growing conditions. Each reading takes less than 5 seconds and provides 3 of the most important indicators of root zone health: water content (%), pore water conductivity (EC_p) and temperature (°C). The sensor is particularly useful in horticulture for monitoring and responding to variations when applying fertigation, CRF or organic treatments.

Pore water conductivity

The WET Sensor is able to calculate pore water conductivity (EC_p) which is the EC of the water available to plant roots. The EC_p calculation is derived from an approximate relationship between dielectric properties. This applies particularly well to WET Sensor readings, which are taken at the same frequency within the same defined region of soil/substrate. The approximation is valid in most soils and is particularly accurate in mineral wool and other artificial substrates media.

Horticultural media calibrations

The WET Kit (including HH2 Moisture Meter) is equipped with a comprehensive set of calibrations (See WET-2-KIT ordering information on the opposite page for more details). When used alongside a GP1 or GP2 logger the WET sensor is equipped for generic mineral, organic, sand and clay soils. Additional specialist calibration upgrade packs are available for the GP1 and GP2 – see ordering information table on this page, directly to the right, for more details.



Applications

- Horticulture
- Agriculture
- Soil science

Data logging

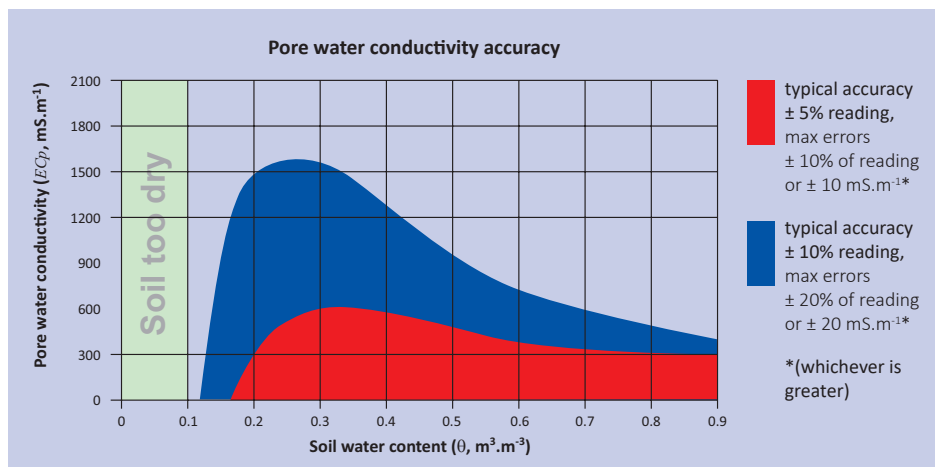
The WET Sensor can be connected to the GP2 or GP1 Data Logger in order to monitor fluctuations in growing conditions over time. The smart control relay capability of the GP2 and GP1 are fully enabled for the WET Sensor, so the system may be configured to control water content and/or EC or temperature using built-in control capabilities.

Ordering Information	
WET-2/d	Sensor with 1 m cable and 25-way D-socket for use with HH2.
WET-2/w-05	Sensor with 5 m cable terminating in bare wires for use with GP1 or GP2.
Calibrations	
WET-GH-1G2	GP2 calibrations- for coir (coco fibre), peat based potting mixes, and greenhouse "mineral soils.
WET-ST-1G2	GP2 calibrations – for Stonewool artificial mineral wool substrate (vertical and horizontal measurement).
WET-GH-1G	GP1 calibrations- for coir (coco fibre), peat based potting mixes, and greenhouse "mineral soils.
WET-ST-1G	GP2 calibrations – for Stonewool artificial mineral wool substrate (vertical and horizontal measurement).

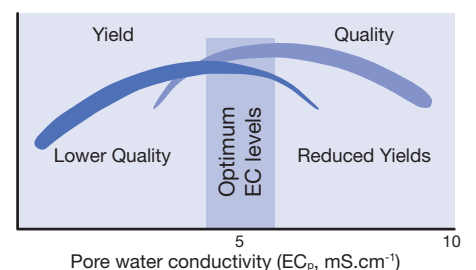
Brief Specification (full spec on page 17)

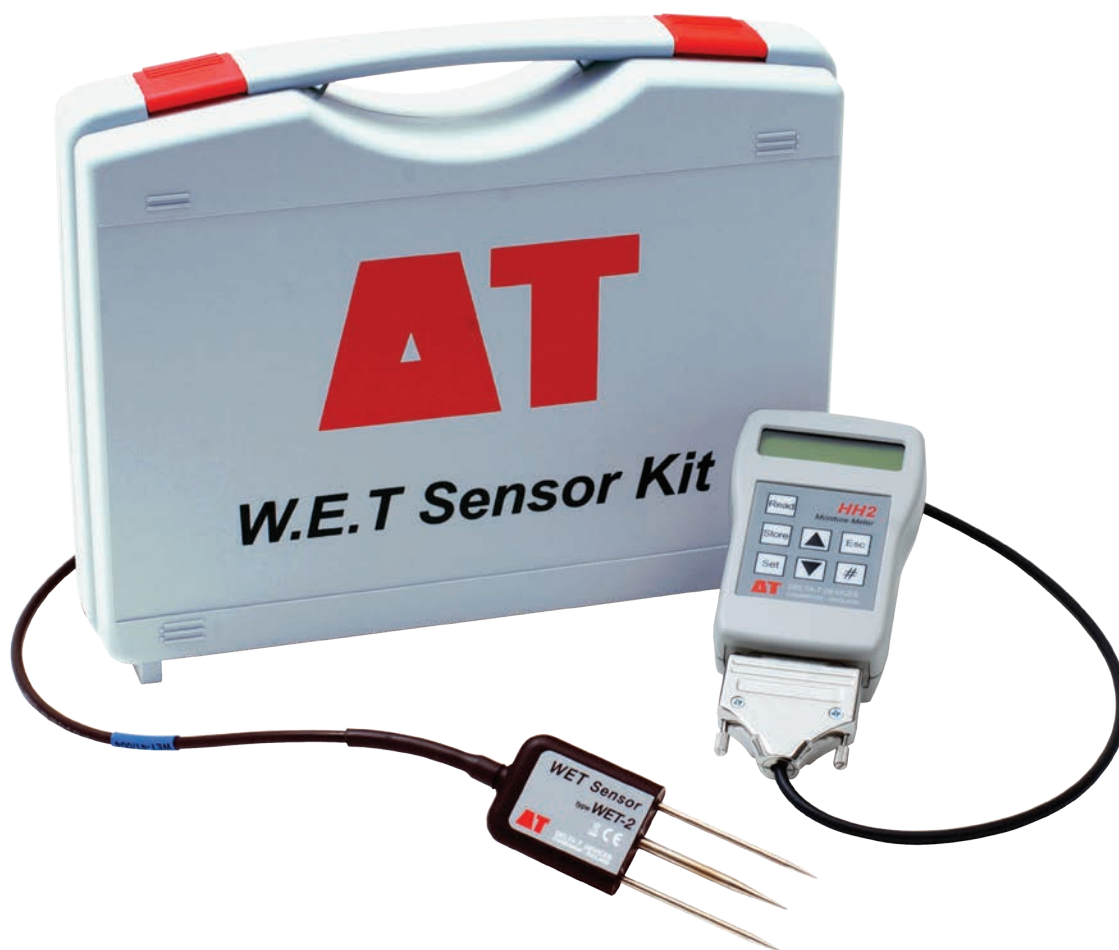
Measured parameters	
Permittivity, ε'	1 to 80 ± 2.5 ^[1]
Bulk conductivity	0 to 300 mS.m ⁻¹ ± 10 (EC _b)
Temperature	-5 to +50°C ± 1.5°C
Calculated parameters	
Volumetric Soil Moisture, θ	0 to 100% ± 3% ^[2]
Pore water conductivity	See graph below (EC _p)
Other specifications	
Calibration	Individual sensor calibrations stored within sensor EEPROM
Output	Serial data (TTL)
Environmental	IP68, -40 to +70°C
Power	6 to 10 V, ~38 mA for 2.5 s
Dimensions	~120 x 45 x 13 mm
Rods	~68 mm long
Sample volume	~500 ml

[1] Permittivity is a measure of the dielectric properties of materials, e.g. soils and substrates.
 [2] Soil moisture accuracy refers to errors after applying a soil-specific calibration, within 10°C of calibration temperature.



Yield and Quality of Tomatoes v EC_p





WET Kit

For portable applications the WET Sensor is used with an HH2 Moisture Meter and is normally supplied as a complete kit - see Ordering Information.

Ordering Information

WET-2-KIT

Comprises WET-2/d WET Sensor, HH2 Moisture Meter (including alkaline battery and comms cable), spare battery, USB-RS232 adapter cable, user manuals and WCC1 carrying case.

Includes sensor calibrations for generic mineral soils, organic soils, sand soils, clay soils, coir (coco fibre), peat based potting mixes, greenhouse 'mineral' soils, and Stonewool artificial mineral wool substrate (vertical and horizontal measurement).

Horticultural Applications

- Fertigation and hydroponics
- Soil salinity
- Container-grown shrubs and trees

Acknowledgements

WET Sensors have been developed in co-operation with:



Plant Research International (formerly IMAG-BV), P.O. Box 16, 6700 AA Wageningen, The Netherlands.

Web site: www.pri.wur.nl

Designers of the WET Sensor & the ASIC which enables accurate measurement of permittivity and conductivity of the bulk soil or media.






Saint-Gobain Cultiène B.V. Zeusstraat 2, 5048 CA TILBURG, The Netherlands.

Web site: www.cultilene.com

Sponsors of research into horticultural media applications and suppliers of horticultural media calibrations.



Soil Moisture Sensor Specifications

	Soil water content	Multi-parameter	
Sensor	PR2 and PR2 SDI-12 	SM150T 	ML3 ThetaProbe 
Measurement	Volumetric water content	Volumetric water content and soil temperature	Volumetric water content and soil temperature
Accuracy	$\pm 0.04 \text{ m}^3.\text{m}^{-3}$ (4%) With soil-specific calibration	$\pm 0.03 \text{ m}^3.\text{m}^{-3}$ (3%) With soil-specific calibration	$\pm 0.01 \text{ m}^3.\text{m}^{-3}$ (1%) With soil-specific calibration
Soil moisture measurement range	Full accuracy over: 0 to 0.4 m³.m⁻³	Full accuracy over: 0 to 0.7 m³.m⁻³	Full accuracy over: 0 to 0.5 m³.m⁻³
	Full range: 0 to 1.0 m ³ .m ⁻³	Full range: 0 to 1.0 m ³ .m ⁻³	Full range: 0 to 1.0 m ³ .m ⁻³
Salinity range	50 to 400 mS.m⁻¹	50 to 500 mS.m⁻¹	50 to 500 mS.m⁻¹
	Salinity errors included in specification	Salinity errors < 0.035 m ³ .m ⁻³ from 0.05 to 0.4 m ³ .m ⁻³ . Can be calibrated up to 2,000 mS.m ⁻¹	Salinity errors < 0.035 m ³ .m ⁻³ from 0.05 to 0.4 m ³ .m ⁻³ . Can be calibrated up to 2,000 mS.m ⁻¹
Temperature range	Full accuracy over: 0 to 40°C	Full accuracy over: 0 to 40°C	Full accuracy over: 0 to 40°C
Output	0 to 1.0 V differential See page 14 for PR2 SDI-12	0 to 1.0 V differential Corresponding to 0 to ~0.6 m ³ .m ⁻³	0 to 1.0 V differential Corresponding to 0 to ~0.6 m ³ .m ⁻³
	PR2/6: x6 outputs, PR2/4: x4	Resistance 5.8Ω to 28kΩ for temp sensor	Resistance 5.8Ω to 28kΩ for temp sensor
Power requirement	5.5 to 15 V PR2/6: ~120 mA for 1 s PR2/4: ~80 mA for 1 s See page 14 for PR2 SDI-12	5 to 14 V, ~18 mA for 1 s	5 to 14 V, ~18 mA for 1 s
	Minimum 7.5 V with 100 m cable	Minimum 5.5 V with 100 m cable	Minimum 5.5 V with 100 m cable
Environmental	IP67 (when installed in access tube)	IP68 , -40 to +70°C	IP68 , -40 to +70°C
Sample volume	~95% sensitivity within a cylinder of diameter 200 mm	~55 x 70 mm diameter	~60 x 30 mm diameter
	Sample volume is weighted towards soil immediately surrounding the rods or rings	Sample volume is weighted towards soil immediately surrounding the rods	Sample volume is weighted towards soil immediately surrounding the rods
Dimensions and weight	PR2/6: length 1350 mm PR2/4: length 750 mm Both: 25.4 mm diameter	Overall: 158 mm x 40 mm dia Rods: 60 mm x 3.2 mm dia	Overall: 158 mm x 40 mm dia Rods: 60 mm x 3.2 mm dia (Rods are replaceable)
	PR2/6: 1.2 kg, PR2/4: 0.8 kg	Weight: 0.1 kg (excl. cable)	Weight: 0.1 kg (excl. cable)
Sensor calibrations	Individual sensors are interchangeable	Individual sensors are interchangeable	Individual sensors are interchangeable
	Recalibration advised every 3 years (depending on use)	Recalibration advised every 5 years (depending on use)	Recalibration advised every 5 years (depending on use)
Soil calibrations	Generalised mineral and organic soil calibrations are supplied	Generalised mineral and organic soil calibrations are supplied	Generalised mineral and organic soil calibrations are supplied
Applications	Provides rapid moisture content readings in a vertical soil profile. Used in access tubes for easy insertion and removal. Can be left installed for data logging or used with the HH2 for multi-site portable readings.	High quality entry level sensor suited to precision agriculture and research. It is a cost effective alternative where ML3 levels of accuracy are not required. It combines research-grade soil moisture and temperature measurement (when fully buried).	Versatile, high accuracy sensor recognized as the "gold standard" for the precise determination of soil moisture content. Also provides soil temperature when fully buried.

Multi-parameter			Soil water potential			
WET Sensor 			WET150 Sensor 			EQ3 
Volumetric water content	Pore water conductivity (ECp)	Temperature	Volumetric water content	Pore water conductivity (ECp)	Temperature	Soil water potential (matric potential) and soil temperature
$\pm 0.03 \text{ m}^3.\text{m}^{-3}$ (3%)	See graph on page 8	$\pm 1.5^\circ\text{C}$	$\pm 0.03 \text{ m}^3.\text{m}^{-3}$ (3%)	See graph on page 5	$\pm 0.5^\circ\text{C}$ (0°C to +40°C range) $\pm 0.7^\circ\text{C}$ (-20°C to +60°C range)	$\pm 10 \text{ kPa}$ over 0 to -100 kPa 10% of reading over -100 to -1000 kPa $\pm 0.5^\circ\text{C}$, 0 to + 40°C for temp sensor $\pm 0.75^\circ\text{C}$, -20 to +60°C for temp sensor
Full accuracy over: 0 to 1.0 $\text{m}^3.\text{m}^{-3}$	See graph on page 8	0 to 50°C	Full range: 0 to 1.0 $\text{m}^3.\text{m}^{-3}$	See graph on page 5	Full range: -20°C to +60°C	0 to -1000 kPa (-10bar)
			Accurate range: 0.05 to 1.0 $\text{m}^3.\text{m}^{-3}$ ECb 0 to 500 $\text{mS}.\text{m}^{-1}$		Accurate range: 0°C to +40°C	
0 to 300 $\text{mS}.\text{m}^{-1}$			See graph on page 5			Suitable for all non-saline soils
Supplied with extended range calibrations which should be used for readings between 300 to 500 $\text{mS}.\text{m}^{-1}$			Sensor calibration covers the full range of water contents and ECb			
-5 to +50°C			Full accuracy over: -20 to +50°C			0 to 40°C
Serial TTL data providing permittivity, bulk conductivity and temperature, from which water content and pore water conductivity are calculated			SDI-12 protocol 1.3 (www.sdi-12.org) Providing water content, pore water conductivity, and temperature - together with base readings of permittivity and bulk conductivity. Outputs are exceptionally configurable			0-1.0 V differential, non-linear. (Calibration data and graph supplied with each sensor) Resistance 5.8Ω to 28kΩ for temp sensor
6 to 10 V, ~38 mA for 2.5 s			Operating voltage: 6 to 20 Volts Current consumption (typical values when powered from 12 Volts): Active sensing: 22mA average over 12ms (average includes short peaks at 45mA) Active results computation: 2mA over 188ms Idle: <0.5mA			5 to 14 V, ~18 mA for 1 s
IP68			IP68, -20 to +60°C			IP68
~500 ml			~55 x 70 mm diameter			N/A
Sample volume is weighted towards soil immediately surrounding the rods			Sample volume is weighted towards soil immediately surrounding the rods			
Overall: ~120 mm x 45 mm x 13 mm Rods: 68 mm x 3.0 mm dia Outer rods 68 mm x 3.0 mm dia Central rod 65 mm x 5.0 mm dia			Overall: 143 mm x 40 mm dia Rods: 51 mm x 2.5 mm dia			181 mm x 40.5 mm diameter
Weight: 0.1 kg			Weight: 0.77g (excl. cable)			Weight: 0.3 kg (excl. cable)
Sensor calibrations supplied in WET Sensor EEPROM			Individual sensors are interchangeable			Individual sensor calibrations supplied
Recalibration advised every 3 years (depending on use)			Recalibration advised every 5 years (depending on use)			Recalibration advised every 2 years (depending on use)
The WET Kit includes a comprehensive set of calibrations (see page 9 ordering information for details). For WET Sensor use with GP1 and GP2 data loggers please see page 8 for calibrations information.			The WET150 Sensor comes complete with calibrations for mineral and organic soils plus coir, peat, and mineral wool substrates			No soil calibrations required
Measures pore water conductivity, moisture content and temperature directly within soils and substrates. It has crucial applications in precision horticulture and soil science research.			Measures pore water conductivity, moisture content and temperature directly within soils and substrates. It has crucial applications in precision horticulture and soil science research - and can be incorporated into many types of SDI-12 measurement and control system.			Maintenance-free dielectric tensiometer with soil temperature measurement. Can be left installed even in frozen soils. Best results in dry soils. Readings are lower accuracy than water-filled tensiometers.