

## 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](http://www.delta-t.co.uk)

## Overview of Delta-T Soil Moisture Sensors

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

The **WET150** is a **new** multi-parameter **digital SDI-12 Sensor** that measures the water content, electrical conductivity (EC) and temperature of soils and substrates.

- Accurate monitoring of growing conditions
- Measures Moisture, Temperature and EC
- True research-grade quality at lower cost
- Rugged, buriable and low power
- Detachable and extendable cable system
- Digital SDI-12 for easy system integration

### Overview

The product of 40 years sensor development, the WET150 is a new multi-parameter digital sensor with an exceptional price-performance ratio. It is Ideal for scientific research and horticulture system integration.

### A game-changing sensor for system integration

Delta-T Devices has been at the forefront of soil and substrate sensor technology for over three decades, with a range that includes the WET 2 - used extensively in horticulture world-wide for many years.

With a strong heritage in developing instruments for scientific research, our sensors are built to high specifications and offer both excellent accuracy and premium build quality.

Through recent in-house design innovations the WET150 Sensor delivers this proven level of quality at a price point not previously thought possible.

These engineering breakthroughs mean that a **true** research-grade multi parameter soil and substrate sensor can be integrated into systems at lower cost - making those systems even more effective, reliable and affordable.

### Measurement of three crucial variables

When buried in soil or substrate the WET150 Sensor simultaneously measures three crucial variables that influence plant growth: moisture content, temperature, and Electrical Conductivity (EC)- a strong indicator of the general nutrient level.

A key strength of the WET150 is its ability to accurately calculate pore water conductivity (ECp), which is the ion content of the water available to the plant.

Patented sensor electronics produce research grade measurement accuracy with exceptional salinity and temperature stability - essential for critical control and irrigation decisions.

When the WET150 is buried, temperature measurement, essential for compensating the EC measurement, is taken down in the root zone, ensuring highest accuracy.



When installed in grow bags, WET150s can provide the accurate data required to power sophisticated SDI-12 enabled automatic precision irrigation systems – cutting costs and waste whilst boosting produce yields and quality.

The rugged watertight build of the WET150 also makes it ideal for use in field agriculture – sensors can be left buried for years without loss of performance.

WET150 Sensors can also be buried at different depths to enable monitoring of soil moisture, temperature and EC profiles.

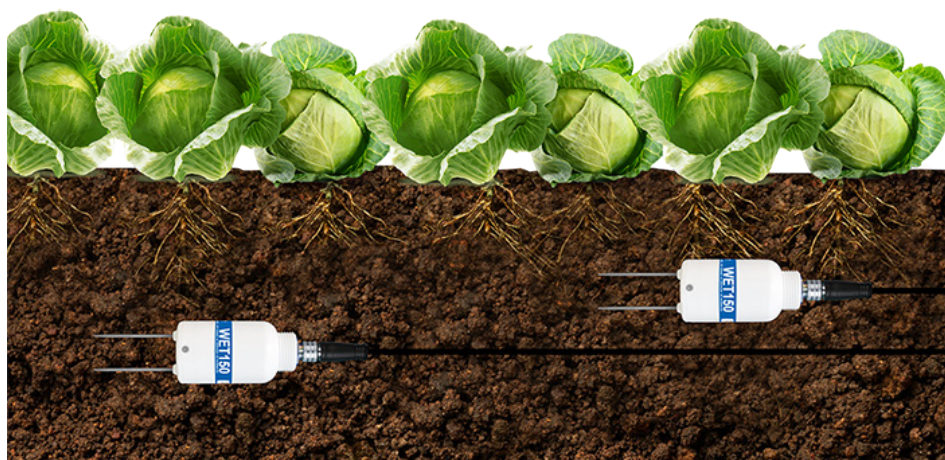
### Digital SDI-12 Interface



**SDI-12**

The WET150 is a digital SDI-12 sensor (fully compliant with 1.3 standards). SDI-12 is a standardised interface for connecting digital sensors to a master device - typically an SDI-12 compatible data logger, wireless node, controller, or computer.

SDI-12 defines both the digital communications and sensor power standards. A key strength of SDI-12 is that it supports the connection of multiple (up to 62) networked sensors to a single input on a master device.



## How does SDI-12 enhance the WET150?

The WET150 (like all SDI-12 Sensors) is low power and features an integrated microprocessor that enables it to perform two way communication with an SDI-12 master device.

The WET150 outputs readings in a standard SDI-12 format which can be sent to, and recognised by, the master device.

The inclusion of a microprocessor also gives the WET150 the ability to perform complex internal correction, compensation and averaging algorithms that enhance the quality of the data.

SDI-12 protocol is based on a master-slave configuration. When installed in an SDI-12 network, individually addressed WET150s (slaves) are sent data requests by the master device. These requests briefly wake all WET150s in the network - and result in a measurement and data sending response from the targeted WET150.

When not responding to a master request, all WET150s remain in a dormant energy saving state.

## Key SDI-12 Benefits

- **Use many sensors with just a single master device, reducing complexity and costs.**
- **Low power systems that run off battery and are powered via the interface Bus.**
- **Many parameters can be transmitted over simplified wiring.**
- **No loss of accuracy over large cable runs.**
- **Ideal for wireless comms based applications**

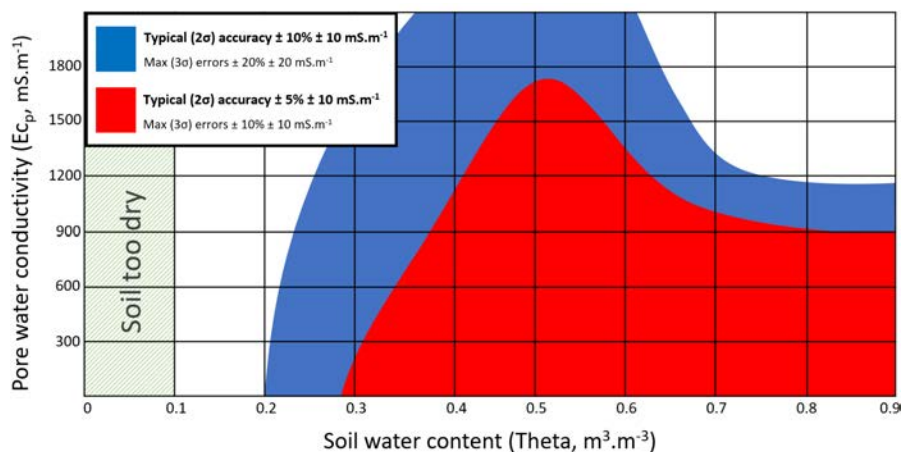
## WET150 Kit for portable use

The WET150 Sensor is available in kit form with WET150 SDI-12 readout meter and carry case. It provides users with a low cost, portable, and easy to use tool for obtaining instant accurate moisture and EC measurements\*.

For more info on the WET150 Kit see page 11.



## Pore water conductivity accuracy



Notes:

[1] The WET150 has been carefully optimised to provide accurate readings in soils and substrates- readings taken in water or air may not meet the full specification.

[2] The ECp contour map is based on measurements from 30 sensors at 20°C in NPL\* traceable media. Calculated ECp readings are derived from the Hillhorst equation, using the generalised "mineral" soil calibration and the default soil parameter = 4.1

\* NPL is the UK's National Metrology Institute, developing and maintaining the national primary measurement standards.

## Applications

**Soil Science:** The WET150 is easy to install and delivers research-grade accuracy and reliability for researchers monitoring soil and substrate conditions.

**Horticulture and Agriculture:** The WET150 Sensor is provided with substrate calibrations for coir, peat, and mineral wool, as well as soils – providing a simple, effective, rugged solution to checking the uniformity of growing conditions for many types of growing media.

**Precision Irrigation:** Accuracy and ease of use make the WET150 sensor well suited to precision irrigation applications. The WET150's compact size allows it to be easily installed in plant pots or grow bags. Readings can be used to optimise irrigation scheduling, or the WET150 can be installed as part of an automatic irrigation system.

**System integration:** The WET150s accurate and stable three parameter measurement, simple SDI-12 output and low power makes it the ideal sensor for system integrators. Industrial rated, UV resistant cable fitted with a waterproof IP68 connector allows the sensor to be buried indefinitely, whilst still permitting easy cable exchange or extension if necessary.

Brief Specification (full spec on page 17)	
<b>Measured parameters</b>	
<b>Permittivity, ε'</b>	± (3% of reading + 0.8 ε') 1 → 40 for ECp ≤ 800 mS.m <sup>-1</sup> [1]  ± 5% of reading 40 → 80 for ECp ≤ 500 mS.m <sup>-1</sup> [1]
<b>Bulk conductivity</b>	± (10mS.m <sup>-1</sup> + 6%) from 0 to 1200 mS.m <sup>-1</sup> [1]
<b>Temperature</b>	± 0.5°C (0°C to +40°C range)  ± 0.7°C (-20°C to +60°C range)
<b>Calculated parameters</b>	
<b>Volumetric Soil Moisture, θ</b>	± 0.03 m <sup>3</sup> .m <sup>-3</sup> from 0.05 to 1.0 m <sup>3</sup> .m <sup>-3</sup> ECb 0 to 500 mS.m <sup>-1</sup> [2]
<b>Pore water conductivity</b>	Based on Hillhorst equation - see graph above
<b>Other specifications</b>	
<b>Calibration</b>	Calibrated sensors are fully interchangeable
<b>Output</b>	SDI-12
<b>Environmental</b>	IP68, -20 to +60°C
<b>Power</b>	6 to 20 V, ~22 mA over 12ms (includes short 45mA peak)
<b>Dimensions</b>	143 x 40 mm dia
<b>Rods</b>	Rods: 51 mm x 2.5 mm dia
<b>Sample volume</b>	~55 x 70 mm dia

[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.

## Ordering information

<b>WET150</b>	Soil moisture, temperature and EC Sensor.
Cables must be ordered separately- see diagram on page 20, and cable information on page 15	
<b>WET150 accessories for burial at depth</b>	
<b>ML/EX50</b>	0.5 m extension tube
<b>ML/EX100</b>	1 m extension tube

Multi-parameter						Soil water potential
<b>WET Sensor</b> 			<b>WET150 Sensor</b> 			<b>EQ3</b> 
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 ( <a href="http://www.sdi-12.org">www.sdi-12.org</a> ) 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			<b>Operating voltage: 6 to 20 Volts</b> <b>Current consumption (typical values when powered from 12 Volts):</b> 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 <b>mineral</b> and <b>organic</b> 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.

Data logger (and readout meter) comparison table

	GP2 	DL6 	GP1 	HH2 Meter 	WET150 Meter 
<b>Input connections</b>	12 differential (or 24 single-ended) analog inputs configurable as: Voltage, Resistance (12 3-wire or 24 2-wire), Bridge (12), Potentiometer (12) 4 digital inputs as: Counters, (2 fast + 2 slow), Frequency, Digital state 1 Delta-T WET sensor channel Serial input channel: 62 SDI-12 sensors or a single WET Sensor	6 voltage channels 1 temperature 1 counter -	2 voltage channels 2 temperatures or 2 additional SM150T Sensors [3] 2 counters (33 kHz and 50 Hz) 1 WET Sensor	1 water content sensor or 1 WET Sensor -	1 WET150 multi-parameter water content sensor
<b>Control outputs</b>	2 relay outputs expandable to 6 (1 A)	1 relay (1 A)	1 relay (1 A)	-	-
<b>Readings stored</b>	2.5 Million	16,000	600,000	1,500	-
<b>Recording rate</b>	1 second to 24 hours	1 second to 24 hours	1 second to 24 hours	-	-
<b>Configuration</b>	DeltaLINK	DeltaLINK	DeltaLINK	By keypad	By Keypad
<b>Communication options</b>	USB, RS232, ethernet or modem	USB [1], RS232, ethernet or modem	USB [1], RS232, ethernet or modem	RS232, USB [1]	-
<b>Sensor excitation</b>	Calibrated 3 V reference, +5 V and +12 V regulated, or 5 to 10.5 V (battery or external power), user selectable	1 switched logger power	1 switched logger power 1 5 V precision reference	1 switched battery	Via SDI-12
<b>Power</b>	6 AA alkaline batteries or external power 10-15 V DC	6 AA alkaline batteries	1 9V 6LR61 (PP3) alkaline or external power 11-24 V	1 9V 6LR61 (PP3) alkaline	2 AA alkaline batteries
<b>Battery life [4] (dependent on usage)</b>	>310k readings, lasting >530 days	>230k readings, lasting >400 days	>76k readings, lasting >130 days	~5k readings	>2400k readings
<b>Enclosure rating</b>	IP65	IP67	IP67	IP54	IP65
<b>Temperature range</b>	-20 to +60°C	-10 to +50°C	-20 to +60°C	0 to 40°C	0 to 40°C
<b>Display</b>	-	-	-	2 line x 16 character	2 line x 16 character
<b>Size</b>	225 x 185 x 75 mm	180 x 160 x 70 mm	140 x 105 x 45 mm	125 x 80 x 45 mm	13 x 66 x 25 mm
<b>Typical applications</b>	<ul style="list-style-type: none"> <li>• Demanding research projects</li> <li>• Environmental monitoring</li> <li>• Varied control applications</li> </ul>	<ul style="list-style-type: none"> <li>• Monitoring soil moisture profiles</li> <li>• Controlling irrigation</li> </ul>	<ul style="list-style-type: none"> <li>• Monitoring soil moisture</li> <li>• General data logging</li> <li>• Controlling irrigation</li> </ul>	<ul style="list-style-type: none"> <li>• Instantaneous reading of soil moisture / profiles / WET Sensor</li> </ul>	<ul style="list-style-type: none"> <li>• Instantaneous readings of soil moisture, EC, and temp</li> </ul>

Sensor compatibility (maximum number of sensors that could be connected[2])

	GP2	DL6	GP1	HH2 Meter	
<b>ML3</b>	✓ (6) with temp / (12) without temp	✓ (1) with temp (5) excl. temp	✓ (2) with temp ✓ (4) excl. temp [3]	✓ without temp	-
<b>SM150T</b>	✓ (6) with temp / (12) without temp	✓ (1) with temp (5) excl. temp	✓ (2) with temp ✓ (4) excl. temp [3]	✓ without temp	-
<b>WET150</b>	✓ (62)	-	-	-	✓
<b>PR2</b>	<b>SDI-12</b>	(50) PR2/6 (62) PR2/4	-	✓	(address setting only)
	<b>Analog</b>	(2) PR2/6 [5] (3) PR2/4 [5]	✓ (1)	✓	-
<b>WET Sensor</b>	✓ (1)	-	✓ (1)	✓	-
<b>EQ3</b>	✓ 6 with temp / 12 without temp	✓ (1) with temp (5) excl. temp	✓ (2 as mV only)	✓ (mV only)	-
<b>Temperature</b>	✓ (12)	✓ (1)	✓ (2)	-	-
<b>Tensiometers</b>	✓ (12)	-	✓ (2) each requires GP-PBA-X50	-	-
<b>Counters or Events</b>	✓ (4) 2 fast 2 slow	✓ (1)	✓ (2) 1 fast 1 slow	-	-
<b>Relay output</b>	✓ (2) expandable to (6)	✓ (1)	✓ (1)	-	-

[1] With USB to RS232 Adapter Cable type USB-RS232.

[2] With appropriate expansion cards and power supply arrangements.

[3] Temperature channels provide only single-ended inputs so should not be used with long cables or in noisy environments when used with soil moisture sensors. The accuracy figures quoted for GP1 soil moisture readings do not apply to these resistance channels when configured as soil moisture inputs.

[4] Battery life is based on recording the soil moisture and temp outputs from 2 x SM150T Sensors logged every 10 minutes. NB: For the DL6 Logger, data storage may be the limiting factor rather than battery life.

[5] Requires GP2-G5-LID Expansion Lid for analogue PR2