

AT

Delta-T Devices

Soil Moisture Measurement Catalogue





Delta-T Devices

Delta-T Devices Company Profile

Origins

Cambridge based Delta-T Devices has been at the forefront of measurement technology for environmental science since 1971.

Our experienced R&D team often collaborates with leading academic institutes to develop exciting new technologies - and we have gained a strong global reputation for innovative sensors and data loggers.

Delta-T is a co-operative company, owned and managed by the members who work within it.

Co-operative working creates a highly professional environment in which we all strive to make the business successful. We share a high level of commitment to the company and to our customers.

High quality products

Delta-T is a market leader in soil moisture monitoring, with more than 30 years' experience in providing researchers with innovative, dependable soil moisture sensors. We aim to continually improve and extend the capabilities of our products, using the most up-to-date theory and technologies.

In addition to individual instrument sales, we can also supply whole systems, such as a multi-point soil moisture measurement system with a data logger and solar power unit.

Sales and support

Delta-T has an international network of representatives who can provide local sales and service in most countries. Export sales account for more than 80% of Delta-T's business.

Delta-T has retained thousands of loyal customers all over the world who value the reliability, performance and long-term service that we provide. Their feedback is incorporated into many of our product designs to create a process of continuous improvement.

Policy statement

"We aim to manufacture and sell instruments for use in work beneficial to the environment and directly related to human and animal welfare. As a matter of conscience, we reserve the right not to sell our instruments to people or institutions involved in military work, tobacco research, environmentally destructive practices and factory farming."

ISO 9001 certified

Delta-T Devices is proud to have achieved ISO 9001 certification - an international standard in use worldwide as a benchmark for quality. Certification requires regular thorough assessment of our quality management systems by the highly respected British Standards Institution (BSI).



FS 565621



Table of Contents

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 	++	✓	✓	✓	✗	✗
SM150T Page 6 	++	✓	✓	✗	✗	✗
ML3 Page 7 	+++	✓	✓	✗	✗	✗
WET Page 8 	+++	✓	✓	✓	✗	✗
PR2 Page 12 	++	✓	✗	✗	✓	✗
EQ3 Page 15 	++	✗	✓	✗	✗	✓

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 (EC_p), 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



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.

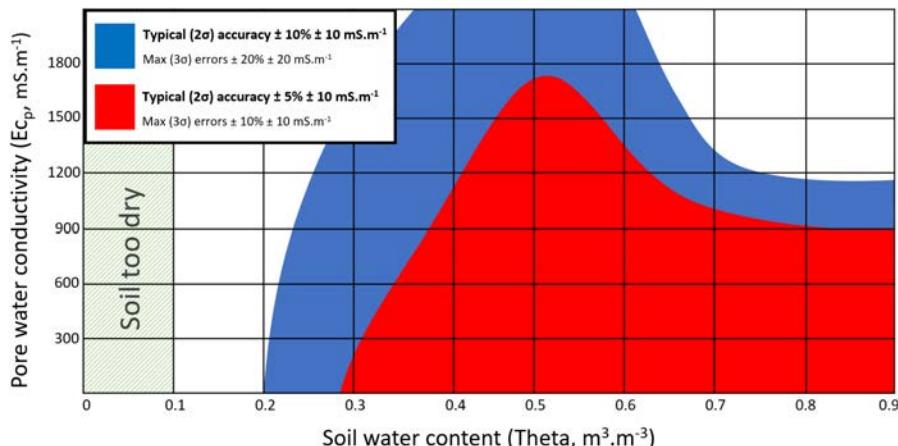
SDI-12 protocol is based on a master-slave configuration. When installed in an SDI-12 network, individually addressed WET150s (slaves) are sent data requests by the master device. These requests briefly wake all WET150s in the network - and result in a measurement and data sending response from the targeted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

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 Hilhorst 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)

Measured parameters

Permittivity, ϵ'	$\pm (3\% \text{ of reading} + 0.8 \epsilon')$ 1 → 40 for ECp $\leq 800 \text{ mS.m}^{-1}$ [1]
Bulk conductivity	$\pm (10\text{mS.m}^{-1} + 6\%)$ from 0 to 1200 mS.m^{-1} [1]
Temperature	$\pm 0.5^\circ\text{C}$ (0°C to $+40^\circ\text{C}$ range) $\pm 0.7^\circ\text{C}$ (-20°C to $+60^\circ\text{C}$ range)

Calculated parameters

Volumetric Soil Moisture, θ	$\pm 0.03 \text{ m}^3.\text{m}^{-3}$ from 0.05 to $1.0 \text{ m}^3.\text{m}^{-3}$ ECb 0 to 500 mS.m^{-1} [2]
Pore water conductivity	Based on Hilhorst equation - see graph above

Other specifications

Calibration	Calibrated sensors are fully interchangeable
Output	SDI-12
Environmental	IP68, -20 to $+60^\circ\text{C}$
Power	6 to 20 V, $\sim 22 \text{ mA}$ over 12ms (includes short 45mA peak)
Dimensions	143 x 40 mm dia
Rods	Rods: 51 mm x 2.5 mm dia
Sample volume	$\sim 55 \times 70 \text{ mm dia}$

[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.

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.



Ordering information

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

The SM150T measures soil moisture and temperature with research-grade accuracy.

- Research grade sensor at a great price
- Soil moisture and temperature
- Dependable moisture accuracy $\pm 3\%$
- Robust and buriable

Research grade sensor

Patented sensor electronics produce a highly dependable sensor with exceptional salinity and temperature stability.

The SM150T is built to withstand long term burial - the sensor, connectors and cable are all environmentally protected to IP68. Moisture accuracy is 3% (after soil specific calibration) and the built-in temperature sensor achieves 0.5°C accuracy.

Data logging and readout

The SM150T is a dual purpose probe. It can be used portably for instant moisture readings, or left installed in the soil for continuous logging - to provide moisture and temperature data.

For installed sensors - The SM150T can be logged by any Delta-T data logger and by many loggers from other manufacturers (simple 0-1 V output).

For portable applications - The SM150T is available as the convenient SM150 Kit, complete with carry case and readout meter (NB: the meter does not provide temperature indication from the SM150T Sensor). Please see page 11 for more about SM150 Kits.

Installation

The SM150T's sharp pins minimise soil disturbance, preserving the original soil structure around the measurement rods, and making the probe easy to insert and install. For burial at depth the cylindrical shape facilitates installation in augered holes. Optional extension tubes assist with placement and removal (50 cm and 100 cm lengths, connectable).

Calibration

The SM150T is provided with general calibrations for mineral and organic soils. A two-point soil specific calibration can be performed for greater accuracy if required.

Applications

- Soil science
- Horticulture
- Irrigation



Brief Specification (full spec on page 16)	
Water content	
Accuracy	$\pm 0.03 \text{ m}^3 \cdot \text{m}^{-3}$
Range	0 to $0.7 \text{ m}^3 \cdot \text{m}^{-3}$
Temperature	
Accuracy	$\pm 0.5 \text{ }^\circ\text{C}$, 0 to $40\text{ }^\circ\text{C}$ ^[1]
Output	0 to 1.0 V differential
Power	5 to 15 V, 18 mA for 1 s
Sample Volume	$\sim 55 \times 70 \text{ mm}$ diameter
Size	143 x 40 mm diameter
Environmental	IP68, with Delta-T cables

Ordering Information	
SM150T	Soil moisture sensor with built-in temperature sensor. NB: order cable separately.
SM150-KIT	Portable soil moisture kit including SM150T sensor, HH150 meter, 1 m fitted cable, manuals and carrying case.
See page 15 for cables and accessories	

For information on the **SM150T Kit**
See page 11



Product reliability tested to limit

Delta-T is committed to achieving the highest standards of performance and reliability for all our instruments.

Our rigorous testing regime includes water resistance, thermal shock, and Highly Accelerated Life Testing (HALT). HALT simulates many years usage by subjecting an instrument to high temperature over a relatively short period of time - a test would typically subject sensors to 90°C for 80 days, which is the equivalent of 5 years usage at 30°C. At the end of the test the instruments are checked to ensure they are correctly calibrated and functioning perfectly.

Depending on product type, the tests can include:

- Submergence testing
- Hot water leak testing
- Thermal shock testing
- Highly Accelerated Life Testing (HALT)
- Drop testing
- Thermal cycling testing
- Ultraviolet exposure testing
- Solar gain testing
- Water vapour diffusion testing
- Ice heave testing
- Cable strain relief testing
- Electrostatic discharge testing
- Fast transient electrical testing
- Surge testing



FS 565621

The ML3 ThetaProbe measures soil moisture and temperature with class-leading accuracy.

- Soil moisture with $\pm 1\%$ accuracy
- Built-in temperature measurement
- Simple data logger or meter connection
- Extendable cable system
- Buriable - IP68

Exceptional performance

The ML3 ThetaProbe's class leading $\pm 1\%$ accuracy, stability, build quality, and reliability have made it the preferred choice of thousands of researchers worldwide.

The ML3 is easy to use. Simply insert the probe into the soil, connect to your data logger or meter, provide 5-14 V DC at 18 mA and within seconds you can be accurately measuring soil moisture.

A built-in thermistor enables the ML3 to simultaneously measure soil temperature and soil moisture at depth (probe must be fully buried). ML3 cables and connectors are extendable, buriable and environmentally protected to IP68.

The salinity response of the ML3 has been characterised at EC values up to 2000 mS.m⁻¹. It also has a wide operating temperature range, with tests demonstrating that the ML3 can operate down to -40°C (non-flexing cables).

Installation

ThetaProbes are robust, buriable and maintenance-free. They can be inserted into augered holes or positioned in the wall of a trench (which is then carefully back-filled). Optional extension tubes assist placement and removal.

Data logging and readout

The ML3 can be logged by any Delta-T data logger, and many loggers from other manufacturers.

For portable applications the ML3 connects to the HH2 Moisture Meter - and these can be ordered together in convenient form as the **ThetaKit** - see page 11. (NB: the HH2 does not provide temperature indication from the ML3).

Applications

- Environmental research
- Sports turf and golf

For information on the **ML3 ThetaKit**
See page 11



Feature	Description	Advantage
4-rod arrangement	3 rods are arranged around a central rod. This creates a defined cylindrical zone of measurement, 60 mm long x approximately 30 mm diameter.	<ul style="list-style-type: none"> • Retains soil closer to central rod in case of drying and cracking (other designs, and particularly flat PCB sensors, don't do this) • Measurements can be made close to the soil surface
Replacement rods	Made of 3 mm diameter, resilient, 304 austenitic stainless steel, with sharpened tips. The exposed rod length is 60 mm.	<ul style="list-style-type: none"> • Withstands repeated insertion in soil. Replaced at low cost if bent or damaged • Highly resistant to corrosion • Sharp, narrow rods minimise errors due to soil compaction by the rods
Compact cylindrical shape	The ThetaProbe has a 40 mm diameter body, with threaded end. Extension tubes (0.5 and 1.0 m) screw onto this thread. Case sealed to IP68.	<ul style="list-style-type: none"> • Easy to insert and remove from augered holes • Rapid attachment of extension tubes • Handy size for portable use • Rugged and buriable to 5 m

Brief Specification (full spec on page 16)	
Water content	
Accuracy	$\pm 0.01 \text{ m}^3 \cdot \text{m}^{-3}$
Range	0 to 0.5 $\text{m}^3 \cdot \text{m}^{-3}$
Temperature	
Accuracy	$\pm 0.5^\circ\text{C}$, 0 to +40°C $\pm 0.75^\circ\text{C}$, -20 to +60°C ^[1]
Output	0 to 1.0 V differential
Power	5 to 14 V, 18 mA for 1 s
Sample Volume	$\sim 60 \times 30 \text{ mm}$ diameter
Size	158 x 40 mm diameter
Environmental	IP68, -40 to +70°C

Ordering Information	
ML3	ML3 ThetaProbe Sensor NB: Order cable separately.
ML3 ThetaKit	Includes ML3 ThetaProbe, SMSC/d-HH2 Cable, 4 spare rods, HH2 Meter, USB-RS232 adapter cable, insertion kit and case.
ML-RODS-3	Pack of 12 spare rods.
ML/INK 1	Insertion kit for pre-forming holes in hard soils.
See page 15 for cables and accessories	

[1] Figures apply to sensor only and exclude logger or cabling errors

The **WET Sensor type WET-2** measures three vital soil properties: **Water content, Electrical Conductivity (EC) and Temperature**.

- 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 \pm 2.5 ^[1]
Bulk conductivity	0 to 300 mS.m ⁻¹ \pm 10 (EC _b)
Temperature	-5 to +50°C \pm 1.5°C

Calculated parameters

Volumetric Soil Moisture, θ	0 to 100% \pm 3% ^[2]
Pore water conductivity	See graph below (EC _p)

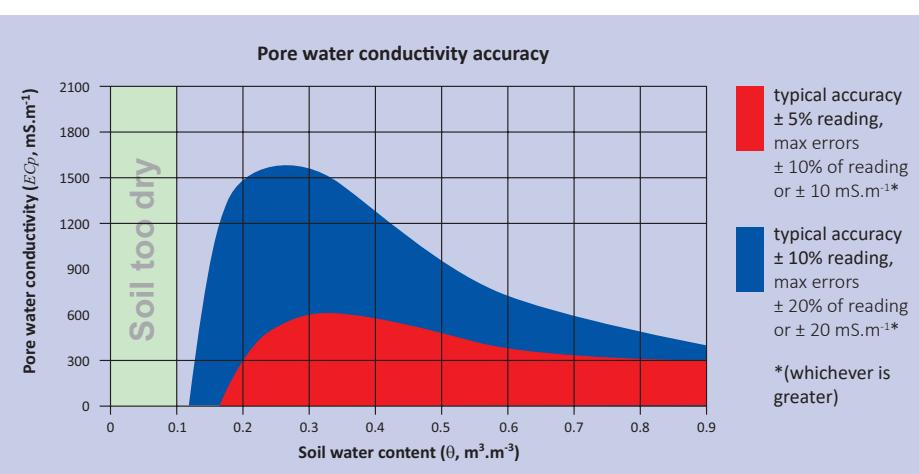
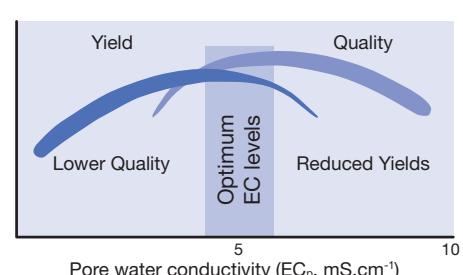
Other specifications

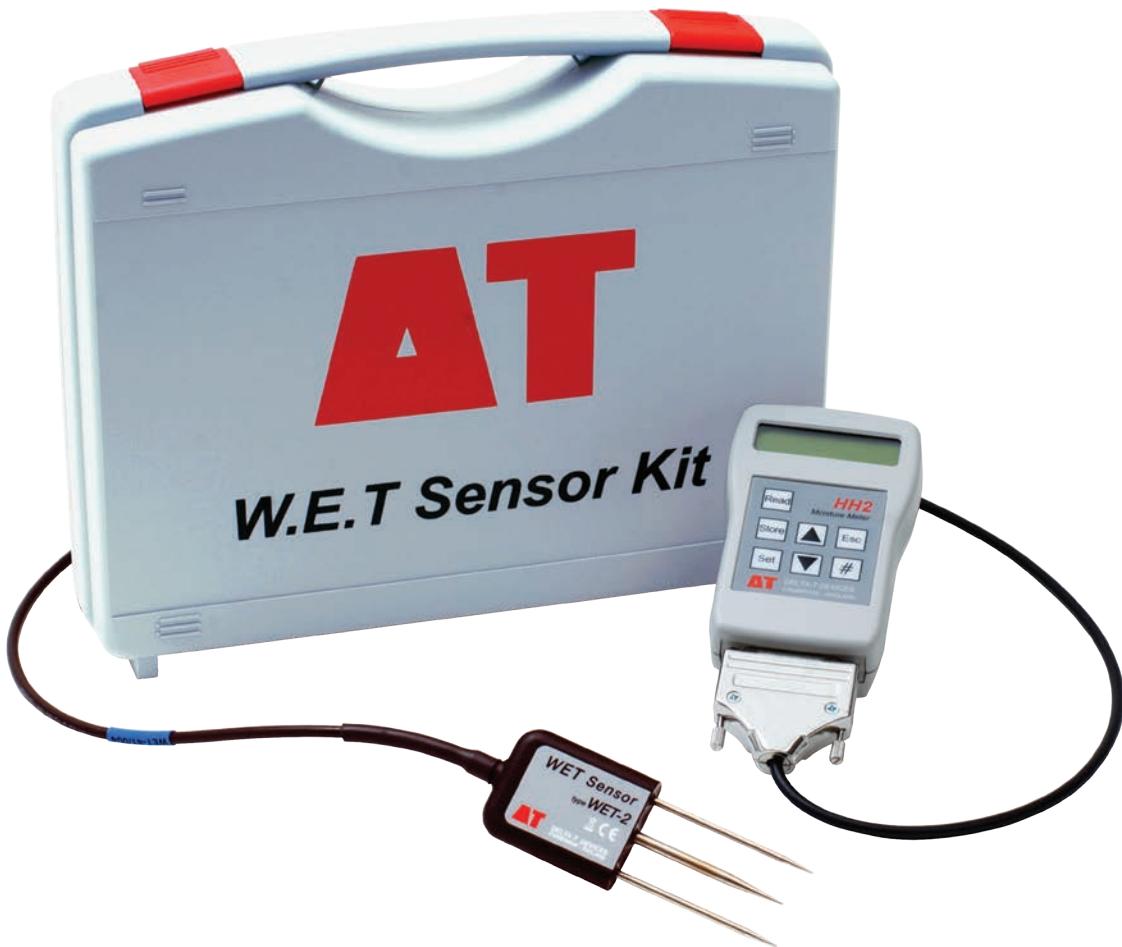
Calibration	Individual sensor calibrations stored within sensor EEPROM
Output	Serial data (TTL)
Environmental	IP68, -40 to +70°C
Power	6 to 10 V, ~38 mA for 2.5 s
Dimensions	~120 x 45 x 13 mm
Rods	~68 mm long
Sample volume	~500 ml

[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 comm 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 Cultilene 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.

The HH2 Moisture Meter provides instant readout from most Delta-T soil moisture sensors.

- Immediate display of water content
- Store up to 1500 readings
- Reads ML3, SM150T, PR2, PR2 SDI-12 or WET Sensor

Overview

The HH2 offers impressive functionality in a compact hand-held unit designed for field use. Readings are displayed on the LCD and can be stored to memory for later download to a PC. Up to 1500 time-stamped readings can be stored.

Applications

- Reads ML3*, SM150T* and WET Sensors
- Reads PR2/6 and PR2/4 Profile Probes (analog and SDI-12)

Simple versatile operation

The HH2 can be operated with one hand for convenience in the field. Each time-stamped reading includes a unique sample number, a plot identification letter (A to Z) and a sensor location number (1 to 255).

Data is transferred to a PC using the RS232 cable provided with each unit. See ordering information for USB connection.

HH2Read software downloads data in comma-separated ASCII (.csv) format ready for opening in Excel. Data can be merged with existing downloaded data, using the free Dataset Import Wizard.

Reading Profile Probes

The HH2 Moisture Meter can take readings from a PR2 Profile Probe wherever access tubes have been installed. With an installed array of access tubes, one HH2/PR2 combination can profile large areas quickly. The HH2 auto-detects the number of sensors in each Profile Probe.

The HH2 can also display readings from SDI-12 Profiles Probes. Please see page 12 for details.



Buriable Probes ML3 and SM150T Sensors can be buried and connected to a data logger for continuous monitoring - see pages 6 and 7.

Reading WET Sensors

The HH2 is able to display the 3 outputs produced by the WET Sensor and store them until downloaded to a PC. Standard calibrations for Mineral, Organic, Clay, or Sand media can be selected.

In addition, user-defined custom calibrations can be entered for soils and other substrates.

User-selectable options allow pore water and/or bulk conductivity to be displayed, and also the permittivity. The HH2 provides user-selectable temperature compensation.

WET Sensor media calibrations

When the WET Sensor is purchased with an HH2 Moisture Meter it will be equipped with 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).

Water deficit

This reading indicates the amount of water needed (in mm) to restore the soil to field capacity, down to a user-defined rooting depth. The HH2 calculates water deficit from the user-defined field capacity and from readings taken either from a single sensor or the individual sensors of a Profile Probe. The HH2 User Manual contains tables of standard soil classifications and their associated field capacities.

Soil types

Standard calibrations for generalised mineral and organic soils are supplied with the HH2 for use with the ML3*, Profile Probe and SM150T* Sensors. The HH2 also enables up to 5 extra user-defined soil calibrations to be characterised and stored. The soil calibration can be switched at any time during the collection of data, and can be specified separately for each sensor position on a single Profile Probe.



Ordering Information

Moisture Meter type HH2 with integral 25-pin D-connector, battery, RS232 cable and 25 to 9 pin adapter.

If the HH2 is intended for use with a single ML3 ThetaProbe or a single WET Sensor it can be ordered as part of a convenient kit - see page 11.

USB to RS232 Adapter Cable type

USB-RS232. 100 cm cable, connects 9 pin RS232 to USB (for connection to PC).

Brief Specification (full spec on page 27)

Range	Zero to saturation (soil water content) 0 to 1.5 V (voltage range)
Accuracy	± 0.13% of mV reading ± 1 mV
Resolution	1 mV
Reading storage	Typically 500 to 1500 readings (depends on sensor and settings)
Connection	1 x male 25-pin D-connector used for sensor and RS232 communications
Environmental	IP54, 0 to 40°C (operating)
Size, weight	125 x 80 x 40 mm, 450 g
Battery type, life	9 V alkaline 6LR61 (PP3), ~ 5,000 readings

* NB The ML3 or SM150T can be used as a portable moisture probe with the HH2 Meter but the HH2 does not provide temperature indication from the SM150T or ML3

Soil Moisture - Portable Kits

Most of our soil moisture sensors are available in kit form providing a convenient solution for fast and accurate spot checking of soil moisture. These kits come complete with readout units, accessories and carry cases.

SM150 Kit

- Complete low-cost kit
- $\pm 3\%$ accuracy

The SM150 Soil Moisture Kit is an affordable and easy-to-use tool for obtaining reliable moisture measurements with minimal soil or substrate disturbance. The kit's low price and simplicity make it ideal for student projects.



The kit comprises an SM150T Soil Moisture Sensor, a dedicated readout meter and a carry case. The cable and connector are watertight - an essential requirement for potentially wet environments.

The meter displays volumetric water content (% volume)*.

Brief Specification

Accuracy	$\pm 3\%$ (with soil specific calibration)
Range	0 - 100% soil water content
Power	2 x AA batteries - approx 10,000 readings
Sampling volume	70 mm x 55 mm diameter cylinder
Environmental	Waterproof (IP68 for sensor only)
Memory	No storage of readings

WET150 Kit

- Lower cost multi-parameter sensor kit
- Instant measurements of moisture, temperature and EC

The WET150 Kit is a portable and rugged solution for researchers and growers who need to assess moisture, temperature and salinity conditions in soils and substrates.



The kit comprises a WET150 Sensor and WET150 Meter. The meter is an easy to use readout-only device (no data recording or other complications) making operation fast and straightforward.

Brief Specification

Accuracy	$\pm 3\%$ (with soil specific calibration) For pore water conductivity (ECp) accuracy see graph on page 5
Range	5 - 100% soil water content
Power	2 x AA batteries - approx 2,400 readings
Sampling volume	55 x 70 mm diameter
Environmental	IP68, -20 to +60°C (for sensor only)
Memory	No storage of readings

ML3 ThetaKit

- Class leading $\pm 1\%$ soil moisture accuracy
- Complete kit with readout unit and case

The ML3 ThetaKit provides researchers with a portable tool for highly accurate, near instantaneous measurement of moisture levels in soils and substrates.



The ThetaKit is easy to use. Simply switch the connected HH2 Moisture Meter on, insert the probe pins fully into the soil, and press the HH2's "Read" button to display the moisture measurement*. Readings can then be stored with a single button press (if required) - and downloaded to PC later.

The kit comprises an ML3 ThetaProbe Soil Moisture Sensor, an HH2 Moisture Meter (readout unit), replacement sensor rods, and a carry case.

See page 7 for Ordering Information.

Ideal for sports turf

The ThetaKit enables fast and precise soil moisture management, enabling turf health to be accurately monitored.

Brief Specification

Accuracy	$\pm 1\%$ (with soil specific calibration)
Range	0 -100% soil water content
Power	9 V PP3 battery - approx 5000 readings
Sampling volume	60 mm x 30 mm diameter cylinder
Environmental	Waterproof (IP68 - for sensor only)
Memory	Up to 1500 readings

For information on
the **WET Kit**
See page 7



* Please note that although the SM150T and ML3 both have a built-in temperature sensor, their accompanying hand held meters do not measure or display temperature.

The PR2 Profile Probe provides easy and accurate soil moisture profiles.

- Soil moisture content - not just trends
- Low salinity and temperature sensitivity
- Portable meter option for multi-site measurement
- GP2 and DL6 Logger options for continuous monitoring

Dual purpose

The unique PR2 Profile Probe can be installed for continuous data logging and can also be used for multi-site, portable measurements with an HH2 hand-held readout unit.

The PR2 uses patented* sensing technology, making it possible to measure soil moisture content in a range of soil types and across a wide range of nutrient levels, including saline soil conditions.

Applications

- Soil moisture profiles
- Agriculture
- Hydrology
- Civil engineering

Installation and connection

Users can choose between the PR2/4, measuring at 4 depths down to 40 cm, or the PR2/6, measuring at 6 depths down to 100 cm. The nominal sensing depths are 10, 20, 30, 40, 60 and 100 cm.

Profile probes are used in access tubes inserted into augered holes in the soil. Access tubes require an installation hole only 27 mm in diameter, allowing easy installation and minimal soil disturbance. They are manufactured to strict tolerances and are exceptionally strong and durable in the soil.

Correct installation is essential and we recommend the use of our specially designed augering equipment (see next page).

Robust

The PR2 is constructed from the highest grade components and materials to ensure robustness in harsh environments. Reliable, environmentally sealed IP68 connectors provide a wide range of cable length and connectivity options. This flexibility makes sensor connection and disconnection quick and easy.

Data logging

The GP2 and DL6 data loggers are well suited to Profile Probe recording.

See comparison table on opposite page.

SDI-12
version
See page 14



(Above) PR2/6 Profile Probe with HH2 Moisture Meter
(Right) PR2/4 Profile Probe

Brief Specification (full spec on page 16)	
Range	0 to 0.4 m ³ .m ⁻³ ^[1]
Accuracy	± 0.04 m ³ .m ⁻³
Output	PR2/6: 6 x 0 to 1.0 V ^[2] PR2/4: 4 x 0 to 1.0 V
Power	5.5 to 15 V ^[3] PR2/6: ~120 mA for 1 s PR2/4: ~80 mA for 1 s
Sensing depths (nominal)	PR2/6: 10, 20, 30, 40, 60, 100 cm PR2/4: 10, 20, 30, 40 cm
Sampling volume	Vertically: ~95% sensitivity within ± 50 mm of upper rings Horizontally: ~95% sensitivity within 200 mm diameter
Size (length x dia)	PR2/6: 1350 mm x 25.4 mm PR2/4: 750 mm x 25.4 mm
Environmental	IP67 (when installed in access tube)
Access tubes	
Size (length x dia)	ATL1: 1154 mm x 28 mm ATS1: 554 mm x 28 mm

[1] Measures full range up to 1.0 m³.m⁻³ with reduced accuracy

[2] Corresponding to 0 to 0.6 m³.m⁻³

[3] 5.5 V DC with 2 m cable, 7.5 V with 100 m



HH2 Moisture Meter

The HH2 is a versatile readout unit that provides an easy and convenient way to display and store readings from Profile Probes. With the HH2 and PR2 combination, a probe can be moved from access tube to access tube, enabling large amounts of soil moisture data to be collected at multiple sites. (See page 10).

Ordering Information

PR2/4	Profile Probe, 40 cm**.
PR2/6	Profile Probe, 100 cm**.
All Profile Probes are fitted with an IP68 connector and come with a protective tube.	
**Cable must be ordered separately.	
Standard cables	
PRC/d-HH2	1.5 m cable, IP68 M12 connector to 25-way D-socket. Connects PR2 to HH2 Moisture Meter.
PRC/M12-05	5 m cable, IP68 M12 connectors. Connects PR2 to GP2 or DL6 Logger.
PRC/w-05	5 m cable, IP68 M12 connector to bare wire. Connects PR2 to loggers.
Extension cables	
EXT/8W-05	5 m extension cable, M12.
EXT/8W-10	10 m extension cable, M12.
EXT/8w-25	25 m extension cable, M12.
The EXT/8W - xx cables can be connected together to create custom lengths - then fitted to a PRC/M12-05 or PRC/w-05 cable for data logger connection.	
Access tubes and PR2 accessories	
ATS1	Short access tube, includes cap, bung and collar. (PR2/4).
ATL1	Long access tube, includes cap, bung and collar. (PR2/6).
PR2-SP	Profile Probe spares kit.
PR-CB2	Protective carrying bag suitable for PR2 and HH2.

Patents: US7944220, EP1836483, AU2005315407, CN101080631(B)

Augering and Extraction Kits

for optimal Access Tube installation.

Profile Probes are used within access tubes inserted into augered holes in the soil - correct installation is vital for accurate measurement of soil moisture profiles. The goal of installation is to produce optimal contact between the soil and the wall of the access tube. The augered holes should be straight, smooth sided and the correct diameter.

Delta-T augering kits help you achieve the best possible access tube installation in virtually any soil. However it may not be possible to install an access tube successfully in very stony soils, or where a site features compaction, voids, foreign bodies, or soil instability.

Three types of augering kit are available (a PR-AUG2 25 mm spiral auger should be ordered in addition to the selected kit for dry sandy soils).

Augering Kit features

The key components are:

Stabilisation plate to keep the auger vertical. Reading errors can arise from conical enlargement of the hole (funnelling) during augering, especially in the top 30 cm. This results in poor contact between the surface of the access tube and the surrounding soil. The stabilisation plate minimises this effect.

Insertion rod to drive the access tube into an augered hole by applying force to the bottom of the tube (normally by hammering). This new technique reduces the flexing that can produce air gaps around the access tube and minimises soil displacement.

Finishing auger to expand augered pilot holes to the exact diameter required for an access tube. This specially designed adjustable finishing auger produces straight, smooth-sided holes in most soil types.

Extraction Kit

The optional PR-EXK1 is a heavy duty system for removing installed access tubes from the ground. The kit includes a cast iron jack, chains, jack foot and a tube clamp.



Finishing auger

Data logger options for Profile Probes

The DL6 and GP2 are versatile loggers that can be connected to many types of soil moisture sensor and other environmental sensors. See pages 18-27 for further information.

	PR2/4 Capacity	PR2/6 Capacity	Notes
DL6 Logger	1	1	Profile Probe can be instantly connected with dedicated cable and input socket.
GP2 Logger	3	2	Analog PR2s require GP2-G5-LID Expansion Lid for connection.
To connect larger numbers of Profile Probes, see SDI-12 options on page 14.			

Ordering Information	
PR-ASK1-S	Augering starter kit (short). For short access tube installation only, includes 24 mm pilot auger, stabilisation plate and access tube insertion rod.
PR-ASK1-L	Augering starter kit (long). For access tube installation (long or short tubes), includes all items in PR-ASK1-S Kit, plus finishing auger and mallet.
PR-AKC1	Augering kit (complete). For access tube installation (long or short tubes), includes all items in PR-ASK1-L Kit, plus flexicanes, carrying bag and cleaning rod.
PR-AUG2	25 mm spiral auger, for dry sandy soils.
PR-EXK1	Access tube extraction kit.

Augering Kit Selection			
Soil type and depth (normal soils)	PR-ASK1-S Starter Kit (short)	PR-ASK1-L Starter Kit (long)	PR-AKC1 Complete Kit
Up to 40 cm depth	✓	✓✓	✓✓✓
Up to 1 m depth	✗	✓✓	✓✓✓
<ul style="list-style-type: none"> For dry, sandy soils the PR-AUG2 25 mm spiral auger should be ordered in addition to the selected augering kit Only the complete kit includes a carrying bag All items can be ordered individually 			
Key: <ul style="list-style-type: none"> ✓ = Meets basic need ✓✓ = Well suited ✓✓✓ = Well suited and includes items for extra convenience ✗ = Unsuitable 			

The PR2 SDI-12 is a digital alternative to the analog PR2 Profile Probe.

- Multiple PR2 SDI-12s connect to a compatible data logger via a single cable
- Enables the creation of low cost highly flexible sensor networks
- Compatible with existing PR2 access tubes and augering kits
- Flexible integration with 3rd party SDI-12 hardware
- Low power design; ideal for remote sites

Overview

The PR2 SDI-12 Profile Probe builds on the reputation and field proven technology of the analog PR2. By adopting the widely used SDI-12 interface (v1.3) the PR2 SDI-12 can be integrated with an even wider range of data loggers, sensors and equipment.

SDI-12 is an established communication standard adopted by many manufacturers of environmental monitoring and control equipment. It is popular because it allows large numbers of sensors (from many vendors) to be connected to a logger via a simple cable network, thereby reducing the cost and complexity of wiring large sensor installations.

Cables and connectors

The PR2 SDI-12 has a high quality, stainless steel IP67 rated connector (M12 x 5-way) - connecting to the standard Delta-T range of M12 x 5-way cables and accessories. The M12 x 5-way cables are also compatible with Delta-T's ML3, SM150T and EQ3 sensors.

(NB: The M12 x 8-way range of cables used for analog PR2 connection is not compatible with the SDI-12 version of the PR2. Analog and SDI-12 sensors cannot be mixed on the same cable system).

GP2 SDI-12 Data Logger

The SDI-12 enabled GP2 Data Logger and DeltaLINK Software enable quick and easy creation of sensor networks - without the need to resort to the often complex programming methods typically employed by other manufacturers.

The SDI-12 Profile Probe's electronics have been designed to improve power efficiency - reducing the overall power requirement. This is an important advantage for applications at remote sites.

Up to 50 SDI-12 PR2/6 Profile Probes, or up to 62 SDI-12 PR2/4s, can be connected to a single GP2 SDI-12 Data Logger (subject to cable length and power requirements- see GP2 manual for details).

In addition to SDI-12 inputs, the GP2 can log 12 analog channels.

Cost saving with SDI-12

- Lower cost cabling- uses standard Delta-T M12 x 5-way cable system
- Lower cost data logging for multi-probe installations
- Same price as analog PR2 Probe

Brief Specification

The PR2 Profile Probe SDI-12 shares its general specification with the analog version of the probe. See page 16

Logger compatibility and power requirements:

SDI-12 protocol version 1.3 (www.sdi-12.org)
Power consumption <60 mA at 12 V DC
Sleep current <2 mA at 12 V DC

Output: Digital

Ordering Information

PR2/4-SDI-12	Profile Probe 40 cm SDI-12 interface.
PR2/6-SDI-12	Profile Probe 100 cm SDI-12 interface.

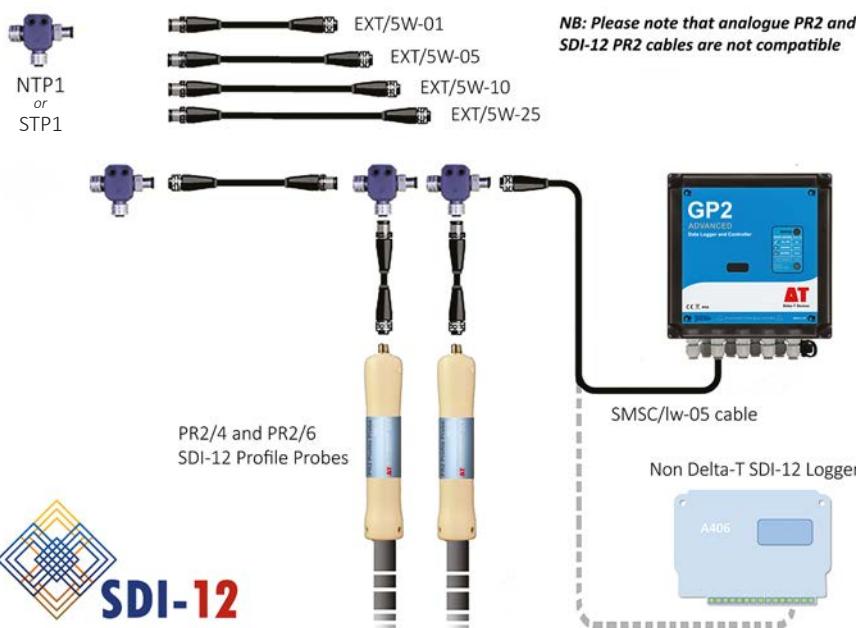
Cables must be ordered separately - see diagram below and cable information on page 15.

All Profile Probe accessories, such as augering kits and access tubes, are compatible with the SDI-12 version. Cables are an exception: the analog PR2 and SDI-12 PR2 cables are not compatible.

See page 13 for details of PR2 accessories.



Use of PR2 SDI-12 Sensors with Data Logger



HH2 Moisture Meter

The HH2 Moisture Meter can display readings from the PR2 SDI-12 Profile Probe*. This is a great advantage for customers who value the freedom to use SDI-12 Profile Probes in both installed and portable applications. Pre-February 2017 HH2s can be upgraded at low cost (via firmware) to enable PR2 SDI-12 readout. (Also requires new HH2 to PR2 cable)



For more information on upgrading firmware please contact our Tech Support department: tech.support@delta-t.co.uk

* Please note that the HH2 only reads SDI-12 digital data from the PR2 SDI-12 Probe - it is not a general purpose SDI-12 meter.

The EQ3 Equitensiometer offers maintenance-free measurement of soil water potential over 0 to -1000 kPa.

- Convenient, accurate and reliable alternative to water-filled tensiometers
- Maintenance free: no refilling, degassing, or topping up
- Built in temperature sensor
- Buriable and frost resistant (IP68)

Overview

The EQ3 Equitensiometer provides reliable matric potential and soil temperature measurement over a wide soil water potential range. The EQ3 is particularly well suited for use in dry soils.

The EQ3 uses class leading ThetaProbe technology to avoid the many problems of water-filled tensiometers. It measures water potential (matric potential) in the range 0 to -1000 kPa and provides an accurate loggable output.

Data logging

The EQ3 can be logged by any Delta-T data logger, including the powerful GP2. It is also compatible with many other manufacturers' data loggers. The EQ3 can be used with an HH2 Moisture Meter, but only the unconverted millivolt output is displayed, and the temperature reading is not available.

Installation

The EQ3 Tensiometer is buriable (IP68) and maintenance-free. It can be inserted into augured holes or positioned in the wall of a trench (which is then carefully back-filled). Optional extension tubes assist placement and removal when burying at depth and a detachable cable systems enables simple changes of cable length.

The EQ3 is rugged, maintenance-free (no refilling, degassing, or topping up required), frost resistant and low powered; this means it can be left installed at remote sites over long periods of time. In such instances it is possible to access sensor data wirelessly via a modem enabled data logger such as the Delta-T GP2.

Working principle

The EQ3's measuring rods are embedded in a porous material (the equilibrium body). This material has a known, stable relationship between water content and matric potential. When the EQ3 Tensiometer is inserted into the soil, the matric potential within the equilibrium body equilibrates to that of the surrounding soils. The water content of the matric material is measured directly by the EQ3, and this can be converted into the matric potential of the surrounding soil using the calibration curve supplied with each Equitensiometer.



Applications

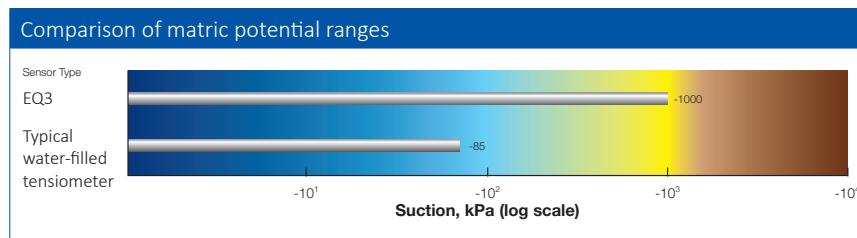
The EQ3 Equitensiometer is ideally suited to static long term monitoring of water potential in soils and substrates. It can even be left installed in frozen soils. Typical applications include environmental, plant, soil, ecology and geo-sciences research, as well as civil engineering and agricultural engineering applications.

The EQ3's full range is 0 to -1000 kPa but best accuracy is achieved between -100 and -500 kPa. This makes it well suited to plant water stress studies - even in very dry soils.

Please note that despite its many strengths, the EQ3 should not be seen as a rapid response sensor that covers the full range of water potentials at high accuracy. Such a sensor does not yet exist. EQ3 equilibration time is typically several hours.

Ordering Information (full spec on page 17)

EQ3	EQ3 Equitensiometer. See below for cable and accessory options.
------------	-----------------------------------------------------------------



Cable options and accessories for the ML3, EQ3, PR2 (SDI-12 version only), SM150T, and WET 150* Sensors

SMSC/lw-05	5 m cable terminating in bare wires for connection to data loggers.
SMSC/d-HH2	90 cm cable, M12 to 25-way D-socket, for connection to an HH2 Meter. (Not for use with WET150)
EXT/5W-01 EXT/5W-05 EXT/5W-10 EXT/5W-25	1 m, 5 m, 10 m, and 25 m extension cables, M12 connectors.
ML/EX50	0.5 m extension tube.
ML/EX100	1 m extension tube.
SM-AUG-100	Spiral auger, 45 mm diam. Installs ML3, SM150T or EQ3 at depth, length 1.2 m.
NTP1/STP1	Network T-Pieces for connection to M12 cabling network (SDI-12 networks only).

The EXT/5W-xx range of cables can be connected together to create cable runs to the length required. The final EXT/5W-xx cable is connect to an SMSC/lw-05 cable (bare wires suitable for connections to a data logger).

EXT/5W cables are compatible with ML3, SM150T, EQ3, PR2 SDI-12, and WET150 soil moisture sensors, and with GP2 cable networks.

All cables are IP68 M12 connector (f) to IP68 M12 connector (m).

*The WET150 does not require SMSC/d-HH2 cable as, in kit form, it is only compatible with WET150 Meter (Not HH2 Meter).

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	$\pm 0.04 \text{ m}^3 \cdot \text{m}^{-3}$ (4%) With soil-specific calibration	$\pm 0.03 \text{ m}^3 \cdot \text{m}^{-3}$ (3%) With soil-specific calibration	$\pm 0.01 \text{ m}^3 \cdot \text{m}^{-3}$ (1%) With soil-specific calibration
Soil moisture measurement range	Full accuracy over: 0 to 0.4 m³.m⁻³ Full range: 0 to 1.0 m ³ .m ⁻³	Full accuracy over: 0 to 0.7 m³.m⁻³ Full range: 0 to 1.0 m ³ .m ⁻³	Full accuracy over: 0 to 0.5 m³.m⁻³ Full range: 0 to 1.0 m ³ .m ⁻³
Salinity range	50 to 400 mS.m⁻¹ Salinity errors included in specification	50 to 500 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	50 to 500 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 $\sim 0.6 \text{ m}^3 \cdot \text{m}^{-3}$	0 to 1.0 V differential Corresponding to 0 to $\sim 0.6 \text{ m}^3 \cdot \text{m}^{-3}$
	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 Sample volume is weighted towards soil immediately surrounding the rods or rings	~55 x 70 mm diameter Sample volume is weighted towards soil immediately surrounding the rods	~60 x 30 mm diameter 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 PR2/6: 1.2 kg, PR2/4: 0.8 kg	Overall: 158 mm x 40 mm dia Rods: 60 mm x 3.2 mm dia (Rods are replaceable) Weight: 0.1 kg (excl. cable)	Overall: 158 mm x 40 mm dia Rods: 60 mm x 3.2 mm dia (Rods are replaceable) 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.

Sensor Specifications

	Multi-parameter						Soil water potential			
WET Sensor				WET150 Sensor						
Volumetric water content	Pore water conductivity (ECp)	Temperature	Volumetric water content	Pore water conductivity (ECp)	Temperature	Soil water potential (matric potential) and soil temperature				
± 0.03 m³.m⁻³ (3%)	See graph on page 8	± 1.5°C	± 0.03 m³.m⁻³ (3%)	See graph on page 5	± 0.5°C (0°C to +40°C range)	± 10 kPa over 0 to -100 kPa 10% of reading over -100 to -1000 kPa				
					± 0.7°C (-20°C to +60°C range)	± 0.5°C, 0 to + 40°C for temp sensor ± 0.75°C, -20 to +60°C for temp sensor				
Full accuracy over: 0 to 1.0 m³.m⁻³	See graph on page 8	0 to 50°C	Full range: 0 to 1.0 m³.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 m³.m⁻³ ECb 0 to 500 mS.m⁻¹		Accurate range: 0°C to +40°C					
0 to 300 mS.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 mS.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.				

The **GP2 Data Logger and Controller** is a powerful, weatherproof, research grade data logger with unique features for recording and controlling field experiments.



- 12 differential channels
- SDI-12 capable
- High performance microvolt sensitivity
- Easy to set up and select sensors
- Versatile communication options
- Compatible with DeltaLINK-Cloud data viewing & sharing platform

Overview

The GP2 is a 12 channel field data logger with advanced control capabilities - ideal for demanding research applications and field work. It is weatherproof, rugged, battery powered and comes with 12 differential analog inputs, SDI-12 serial data interface and 2 relays as standard.

For many applications the GP2 is quicker and simpler to set up and install than competitive systems, while still providing access to a rich set of features. It can log most sensor types and accepts voltage, resistance, current, potentiometer, counter, bridge, frequency, SDI-12 and digital state inputs.

The relay outputs can control experiments and applications with exceptional sophistication using the Script Editor.

The GP2 has unique reliability- built on Delta-T's 25 years' experience in designing and manufacturing data loggers.

Sensors / Inputs

- 12 differential (or 24 single-ended) analog inputs configurable as:
 - Voltage
 - Resistance (2-wire or 3-wire)
 - Bridge
 - Potentiometer
 - Thermistor (3-wire)
- 4 digital inputs as:
 - Counters, 2 fast + 2 slow
 - Frequency
 - Digital state
- 62 SDI-12 inputs or a single Delta-T Devices WET Sensor

The GP2 provides a versatile solution for both simple and complex recording and control applications. Simple point and click software makes it easy to configure channel set-up and recording intervals. Delta-T sensors can be selected from a menu.

Flexibility and customisation

The GP2's analog inputs can be fully customised. Each channel can have its own input type and recording parameters. DeltaLINK software gives the user control over recording frequency and units, and provides recording options for sum, total, average, standard deviation, min and max, plus specialised wind options.

Users can add their own custom sensor types to the sensor library, exploiting the GP2's detailed configuration options. The GP2 provides 4 analog input ranges down to microvolt resolution with adaptive auto-ranging, excellent analog accuracy, and configurable sensor power - enabling it to support nearly all analog sensors.

Calculations based on the measurements from several input channels can be recorded and displayed as additional virtual channels (calculated measurements).

Expansion

A GP2-G5-LID Expansion Lid is required if 10 or more cables need to be connected to a GP2 (the standard GP2 Logger has 9 cable glands). The Expansion Lid provides 5 additional general purpose cable glands (see Ordering Information for compatible cable diameters). An Expansion lid is essential for the connection of analog Profile Probes.

The number of programmable control relay outputs can be increased from 2 to 6 using the optional GP2-RLY Relay Expansion Module. Up to 7 Data Loggers can be networked to create complex monitoring and control systems.



The DeltaLINK-Cloud online platform can send live GP2 data to mobile devices in animating dashboard format - see page 21.

Advanced features

Script Editor

The Script Editor creates step by step operations to control simple or complex processes or recording requirements. The sophistication it offers opens up a huge number of potential applications.

- Sophisticated control algorithms
 - create complex and powerful models such as PID (proportional-integral-derivative) control via simple step-by step operation
- No programming language skills are needed
- Custom in-line data processing
 - implement real-time data driven calculations such as dew-point, wind chill factor, evapotranspiration calculation and many more

Virtual Channels

Data can be processed to obtain max, min, sum etc. and the results logged to a virtual channel. Calculations can be made using any channel combination. Calculated measurements also allow implementation of custom formulas - including trig functions, common math functions and more.

Simulator

- Test simple or complex conditions, algebraic expressions and record result values
- Create and manipulate variables e.g. for disease risk factor

This unique software feature allows logging programs to be tested before real-world activation*. For applications involving weather data, irrigation or soil moisture recording, the environmental variables can be changed to test how the program responds.

Your program can be tested against years of data in seconds.

* SDI-12 sensors cannot be simulated.

Dependable quality

The GP2 is rugged, sealed and completely dependable. Its program editor has built-in error checking, and enables the full logger configuration (including advanced features) to be road-tested before activation. Sensor integrity, set-up and connections can also be checked before or during logging by viewing real-time measurements.

Fault tolerance is provided by intelligent statistics (rejecting erroneous sensor measurements), and safety conditions (upper and lower limits on active and rest periods). The relay outputs can be configured as intelligent alarm outputs, and LEDs on the front panel provide a quick visual reassurance that logging is proceeding correctly.

Data storage and power options

Up to 2.5 million readings (typical) can be stored in internal flash memory (4Mb).

The GP2's 6 internal AA batteries are sufficient for ~300k readings. External power (10 - 15 V DC, 2 A) can be connected if required. Delta-T can provide complete systems including enclosures, batteries and solar power (see page 21). An optional mains adapter is also available (type GP2-PSU).

Data collection, logger networks and modem communications

Data can be collected automatically and remotely using DeltaLINK-Cloud via a modem gateway (see page 21). Alternatively, data can be collected manually on-site by laptop via USB/RS232.

Up to 7 GP2 loggers can be networked to create efficient and flexible monitoring and control systems. Networked GP2s share communications and power via an M12 cabling network (see Ordering Information).

Specifications

See page 27.



3G-DLC-BX1/SP modern gateway box
(solar panel not shown)



Applications

- Demanding research projects
- Environmental monitoring
- Irrigation control
- PID control
- Soil moisture recording - simple connection to Profile Probes

Control

Up to 6 independent experiments or zones can be controlled and monitored concurrently. Control conditions can range from simple thresholding to sophisticated calculations using the Script Editor. Control parameters (e.g. target soil moisture level) can be adjusted throughout an experiment without interrupting data logging. The number of control relay outputs can be increased from 2 to 6 using the optional Relay Expansion Module.

Ordering Information

GP2 Data Logger Advanced Data Logger and Controller with 12 analog, 4 event, and 2 relay channels, plus 1 WET Sensor channel and SDI-12 interface. Includes DeltaLINK PC Software, USB cable and Quick Start Guide.

Expansion Lid with 5 cable glands type GP2-G5-LID GP2 lid with 5 general purpose cable glands. Each gland accepts either a single cable of 3 mm to 10 mm diam, or 2 cables of 4.5 mm to 3 mm diam (using gland insert). A GP2-G5 Expansion Lid is required if 10 or more cables are connected into the GP2 Logger.

Relay Expansion Module type GP2-RLY Provides 4 extra relay outputs. Increases number of relay channels from 2 to 6.

GP2 Network Power Cable type GP2-NPC For use with GP2-NTP Network T-Piece. Connects to EXT/5W-xx cables to provide power and communications to one or more GP2 Loggers. Length 1 m.

Network T-Piece type GP2-NTP Enables GP2 Data Logger to use M12 network cabling. Connects to EXT/5W-xx M12cables and to GP2-USB cable.

GP2-PSU Mains Power Supply for GP2 and GP1 Data Loggers Input: 100 - 240 V AC 50 - 60 Hz. Output: 2.5 A, 12 V via screw terminals. Must be protected from weather. Suitable for powering GP2 directly, or via GP2-NPC Network Power Cable. Requires correct IEC mains lead, type PC-UK, PC-EU, PC-US, PC-IN or PC-CN (see below). For GP1 Logger, also requires GP1-RSP-M8 cable.

GP1-RSP-M8 GP1 RS232 and power cable (M8) Combined 1 m RS232 and external power extension cable for GP1. 5-core comms cable terminating in M8 male and female connectors, with 1 m 2-core mains cable. Enables PC serial comms with logger, without interrupting external power supply. Suitable for use with external 12 V battery or with GP2-PSU Mains Power Supply.

Mains lead, national plug to IEC connector types PC-UK, PC-EU, PC-US, PC-IN, PC-CN Connects to GP2-PSU and LBC4 battery.

Mounting Plate type DL-MKT Suitable for GP1, GP2 and DL6. Comprises 320 x 190 mm stainless steel plate and fittings for mounting onto 51 mm tube or flat surface.

Modem Gateways See page 26 for ordering information.

SDI-12 Interface - the GP2's SDI-12 capability enables it to handle large numbers of SDI-12 sensors.

- Huge input capacity for SDI-12 sensors
- Existing analog and digital channels available*
- Highly flexible logger + sensor networks

Ease of Use

- Seamless integration into GP2 Program Editor
- Simple point and click configuration
- Real-time, on-demand readings for diagnostics and reassurance
- Readings from analog and SDI-12 sensors combined in same dataset

Program Editor

DeltaLINK 3.2 (or later) fully integrates SDI-12 functionality into the GP2 Program Editor, facilitating construction of sophisticated calculations and other operations from SDI-12 measurements.

After entering the SDI-12 address and other SDI-12 details, each measurement can feature in Recordings, Custom Formulas, Conditions and Scripts - in exactly the same manner as conventional analog and digital measurements, and without further reference to SDI-12 commands or measurement timings.

Third-party SDI-12 sensors are also supported.

Delta-T Devices SDI-12 sensors

The GP2 Data Logger is the natural choice of data logger for the SDI-12 version of the PR2 Profile Probe. Up to 50 SDI-12 PR2/6 Profile Probes, or up to 62 SDI-12 PR2/4s, can be connected to a single GP2 SDI-12 Data Logger (see GP2 manual for details). The GP2 is also a perfect partner for the WET150 Multi Parameter Soil Sensor- enabling networks of up to 62 WET150s per single GP2 (see GP2 manual for details).

SDI-12 Sensor Library

An SDI-12 sensor library containing SDI-12 sensor configurations and installation notes for widely used SDI-12 sensors is available for download from www.delta-t.co.uk. When imported into DeltaLINK, ready-configured SDI-12 measurements can be easily added to a program with a single point and click menu selection.

The SDI-12 library will be continuously updated- please enquire or submit a request if a sensor of interest is not listed. Users who wish to utilise the full flexibility of SDI-12 devices can generically configure each SDI-12 measurement parameter. An SDI-12 Transparent Mode terminal is provided



for directly issuing SDI-12 commands - as required for setting the SDI-12 address, and also for advanced configuration operations such as using SDI-12 extended commands.

Cables and connectors

A field-attachable connector for SDI-12 connects to the rugged Delta-T M12 5-way sensor/RS232 cabling system. The interchangeable extension cables and T-connectors allow an SDI-12 bus to be easily assembled - and also disassembled when diagnosing the cause of SDI-12 bus operation faults. GP2 SDI-12 is compliant with SDI-12 Specification Version 1.3.

The GP2 Logger provides a regulated +12 V, 0.5 A supply, which is switched to optimise power consumption.

Scheduling

The GP2 firmware takes care of scheduling (including power switching) and issuing the necessary commands to ensure that results are available for the program to process when required. DeltaLINK's 'Read Now' feature provides additional on-demand readings, in real time, for commissioning and diagnostic use - and for reassurance that an installation is functioning as intended.

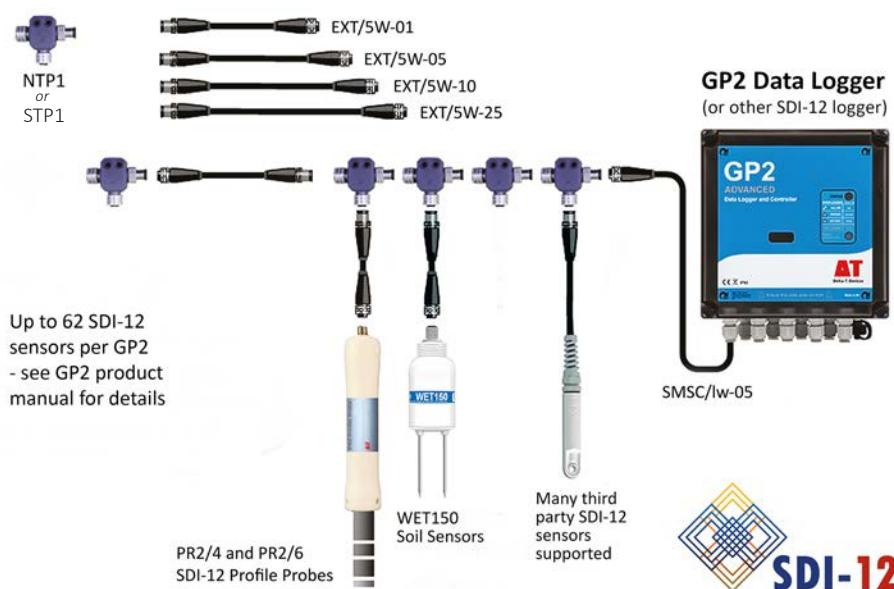
Upgrading older GP2s to SDI-12 capability

GP2s supplied before March 2016 were not SDI-12 enabled, but can be easily upgraded.

The GP2 Logger is already fitted with SDI-12 capable hardware, so the firmware upgrade can be retrospectively applied to all existing GP2 loggers without hardware modification.

To upgrade to SDI-12 simply install the latest version of DeltaLINK software (incorporating SDI-12 firmware upgrade). It is available to download free of charge from the Delta-T website - www.delta-t.co.uk.

Use of SDI-12 Sensors with a GP2 Data Logger and Controller



DeltaLINK-Cloud

DeltaLINK-Cloud is a sophisticated and secure online data viewing, management and sharing platform for Delta-T Devices data loggers.

- Remote data monitoring on mobile devices
- Animated live data dashboard graphics
- Easy data sharing for collaborative projects
- Powerful charting and reporting features
- Smart SIM card provided - for easy set-up
- Secure and encrypted
- Remote management of multiple sites
- Multi-language (Fr, De, Es, 中文)

DeltaLINK-Cloud is an advanced, yet easy to use online solution that enables remote viewing, management and sharing of sensor data.

The platform allows users to monitor the status of their devices, graph and export the uploaded data, share access to data with project collaborators/stakeholders - and use the remote logger control feature to minimise time consuming site visits

The Delta-T GP2, GP1 and DL6 data loggers can all be connected to DeltaLINK-Cloud using the modem gateway. Delta-T modems come with Smart SIM cards that enable us to provide an optimum user experience and support service. Smart SIM cards can connect to multiple providers improving the chance of a stable connection. Data generated by the data loggers can be charted per logger or aggregated and charted for multiple loggers. Charting is customisable and can be saved as reports for future use and shared via a URL link.

The remote logger control feature and DeltaLINK software enables users to remotely control the program, start or stop logging, modify program settings, set the logger's clock, or delete a dataset. Device status and errors can also be monitored remotely.

DeltaLINK-Cloud Dashboards

DeltaLINK-Cloud provides display of selected data using simple graphical devices known as widgets. Dashboards enable users to control the type, colour and position of widgets, ensuring that critical data is displayed clearly and with maximum impact.



These high quality animating data visualisations transform the ability of teams to identify and respond to trends or incidents, such as a threshold being exceeded. Dashboards are quickly linked to relevant data sources and can be viewed remotely on smart devices, enabling users to view and share real-time sensor data on-screen.

DeltaLINK-Cloud

www.deltalink-cloud.com



Data Dashboards Customisable DeltaLINK-Cloud dashboards provide high impact display of key data (optional at additional cost). Example above created for precision irrigation system.

Remote communications with Delta-T Loggers

DeltaLINK-Cloud modem gateway options

To connect Delta-T Loggers to DeltaLINK-Cloud, customers need to purchase a modem gateway and a data package. The 3G-DLC-BX1/SP and 3G-DLC-BX1/B are "plug and play" modem gateway systems that can upload your logger's status and data automatically to DeltaLINK-Cloud.

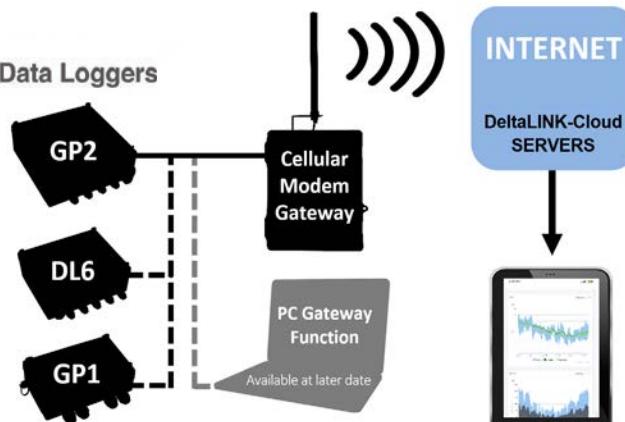


Both systems include an enclosure, battery, quad band modem, smart SIM, battery, cables, antenna and mounting kit for fixing to masts. In addition, the 3G-DLC-BX1/SP version includes a 30W solar panel. Please note that the logger (ordered separately) has to be mounted outside the modem box. A Data Package is also required to complete the system.

Modem gateways and accessories can also be ordered as separate items. This enables users to incorporate the lockable M-ENCL-B2 Enclosure into the system. The M-ENCL-B2 is large enough to house the logger, modem, battery and other accessories. It comes complete with a backplate-mounted 12 V battery wiring system. A Data Package is also required to complete the system.

See page 22 for modem gateway Ordering Information. To ensure the system meets your needs, please request a quotation before ordering.

DeltaLINK-Cloud System



SDI-12 Interface & DeltaLINK-Cloud

Key features and Benefits



Share live data in multiple forms

DeltaLINK-Cloud generates a URL which points directly to your filtered live datasets, reports & dashboards



Makes collaboration fast and easy. Simply send unique URL to colleagues and they can access data

Aggregate data online

Easily pull together datasets from multiple data loggers at multiple sites



Manage, view and share all of your project data in one convenient online location, remotely

Fast live data processing

DeltaLINK-Cloud code has been rigorously engineered to provide very fast processing of live data



Access to fully interactive live data is near instantaneous

Animated data dashboards

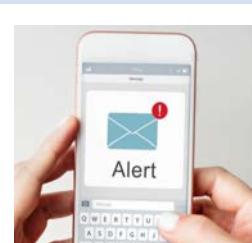
Create your own colour-coded dashboard widgets and link them to chosen data sources quickly and easily



Remotely view critical data in instantly understandable animated visuals

Automated alarms

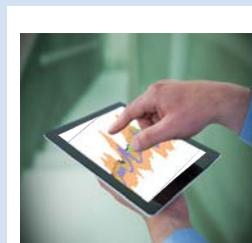
Set up alarms based on customisable data level thresholds- if the threshold is passed an SMS alert is sent to you



Reassurance that you'll be alerted whenever data moves beyond the chosen thresholds

Sophisticated charting

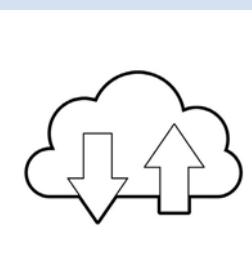
Customise your chart styles (type, colours, etc.) and navigate them via a speedy & intuitive interface



Zoom in and out of chart data with speed and ease to analyse relevant sections in high resolution

Data retrieval and download

Automatic data retrieval from data logger- and Excel compatible data download from the cloud



Data uploads automatically to the cloud and can be downloaded to Excel

Remote logger control

Allows you to remotely program, start/stop logging, set the clock and monitor status of your loggers*



Remote control reduces the need to make time consuming site visits

* With the remote logger control feature and DeltaLINK software, users can remotely control the program, start or stop logging, modify program settings, set the logger's clock, or delete a dataset. Device status and errors can also be monitored remotely.

DeltaLINK-Cloud

Case Studies

DeltaLINK-Cloud

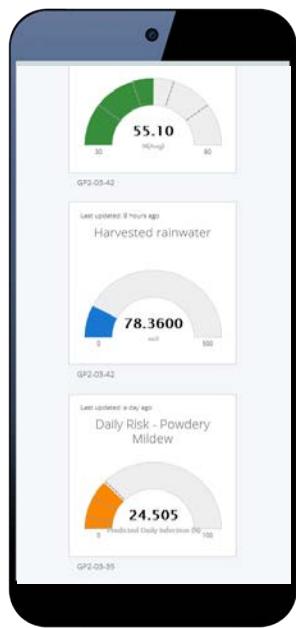
www.deltalink-cloud.com



Precision Irrigation

The NIAB EMR WET (Water Efficient Technologies) Centre houses an integrated portfolio of cutting-edge growing techniques and trickle irrigation systems for the soft fruit sector. It provides commercial scale demonstrations, one to one expert technical advice, and training workshops.

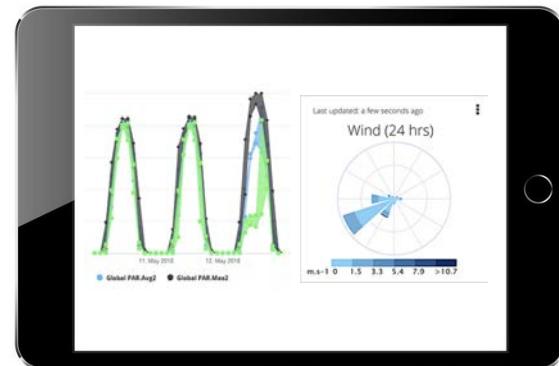
The Centre's commercially available Precision Irrigation Package system features our SM150T Soil Moisture Sensor and advanced GP2 Data Logger and Controller. Live system data is remotely monitored by the Centre's managers using DeltaLINK-Cloud to ensure optimum performance at all times.



Quinta Field Study Centre

The Quinta de São Pedro Field Study Centre in Portugal is visited by many of Europe's leading Universities.

A Delta-T Devices weather station system- complete with soil moisture monitoring and solar radiation analysis provides reference data for the Centre, and is linked to the DeltaLINK-Cloud platform for immediate remote data access.



Ordering Information

Use of the DeltaLINK-Cloud website is free, but remote access requires the purchase of:

- Cellular Modem Gateway (supplied complete with Smart SIM)
- 120 MB Data Package (provides access to cellular services worldwide)
- 12 or 36 month Dashboard subscription (optional item)

The optimal combination of hardware and data package depends on usage rates and geographical location.

To request a quotation - email: sales@delta-t.co.uk

Compatible Products



GP2 Data Logger - see page 18



DL6 Data Logger - see page 26



GP1 Data Logger - see page 24



WS-GP2 Weather Station
visit www.delta-t.co.uk for info

DeltaLINK-Cloud

The GP1 Data Logger is a compact, research grade data logger.

- High accuracy 7 channel data logger
- 600,000 readings
- Compatible with DeltaLINK-Cloud data viewing and sharing service

Overview

Depending on the combination of sensors and accessories used, the GP1 can take readings from:

- 2 ML3 or SM150T Soil Moisture Sensors (or other voltages)
- 2 Pressure transducer tensiometers
- 2 Temperature sensors (or 2 SM150Ts)
- 2 Pulse counters (for rainfall or water meter)
- 1 Delta-T WET sensor

The GP1 provides 2 differential voltage channels that are ideal for connecting ML3 and SM150T soil moisture sensors.

The two temperature channels are optimised for 10k thermistor probes and provide accurate temperature readings over the range -20 to +60°C. They can be used to log the temperature outputs from ML3 or SM150T sensors. Either channel can alternatively be used to log the soil moisture output from additional SM150T sensors.^[2]



Ease of use

The GP1 is very simple to set up and maintain, particularly for outdoor data logging applications. Its small size and waterproofing (IP67) allow it to be fitted wherever is most convenient, and no secondary enclosures are required. The internal alkaline battery lasts for >1 year (when taking hourly readings from 2 moisture sensors, 2 temperatures and a rain gauge).

The GP1 can be fully configured, connections checked, data collected and readings displayed in the field using a notebook PC.

GP1 Sensor Capability

2 x Differential voltage channels

The GP1 provides 2 differential voltage channels that are ideal for connecting ML3 or SM150T soil moisture sensors. Each channel has an input range of -0.2 to +2.7 V and a resolution of 1 mV, enabling it to support a wide range of environmental sensors. Sensors can be powered by a configurable warm-up from either the switched battery power or from the +5 V reference.



2 x Counter channels

The GP1 includes one fast and one slow counter for connection to pulse output and contact closure sensors. The fast counter can record pulses up to 33 kHz and is suitable for most digital anemometers. Either counter can record switch closures up to 50 Hz and so is suitable for connection to a rain gauge or flow meter.



2 x Temperature channels

The two temperature channels are optimised for 10k thermistor probes and provide accurate temperature readings over the range -20 to +60°C. Either channel can alternatively be used with an SM150T Sensor in order to log moisture readings from additional soil moisture sensors.



1 x WET Sensor channel

The GP1 can connect to a Delta-T WET Sensor to provide readings of water content, electrical conductivity and temperature. Specialist calibrations are available for a range of horticultural substrates including mineral wool, peat based composts and coconut fibre (coir).



Bridge sensors, tensiometers

The optional GP-PBA-X50 precision bridge adapter board converts the input from a voltage channel into a precision bridge suitable for recording readings from a compatible pressure transducer tensiometer. It is possible to fit 2 PBA adapters into each GP1. Other pressure transducers and bridge sensors can also be used with the PBA adapter.

1 x Relay channel output

The GP1 has a highly versatile relay channel which can be controlled by multiple sensor thresholds, allowing researchers to set alarm conditions or to control and adjust experimental conditions. Both simple and highly complex control is possible.



Other Features

Communications: Data can be collected by a laptop via RS232, or via USB (USB to RS232 Adapter Cable type USB-RS232 required), or remotely using the modem options. Up to 10 GP1s can be networked together in order to share power and communications.

Reading frequency: The GP1 can be configured to record readings at any frequency from 1 second to 24 hours. All sensors are recorded at the same rate.

Power: The GP1 is very power efficient and a single 9 V alkaline battery will typically last for a full year when taking hourly readings. Alternatively it can be powered from an 11 to 24 V DC external power source or from a solar panel.

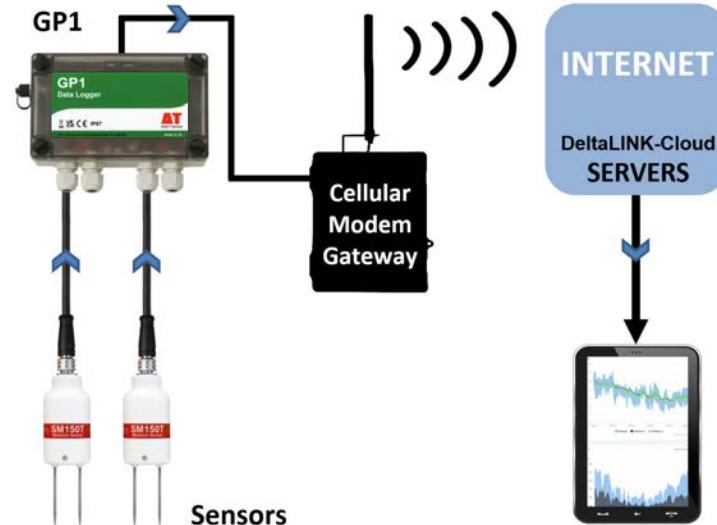
Configuring the GP1 with DeltaLINK:

The free DeltaLINK software supplied with the GP1 enables full configuration, sensor checking (including real-time graphing) and data collection from the logger. Collected data can be graphed directly in DeltaLINK or imported into Excel using the data import wizard.

Memory: The GP1 stores over 600,000 readings in non-volatile flash memory ensuring data security in the event of a flat battery.

Sealing: The small (140 x 105 x 45 mm) enclosure is fully sealed to IP67, doing away with the need for an expensive additional enclosure for simple field applications. It is also easy to conceal if security is an issue.

Data collection and remote communications



Data can be collected on-site by laptop via USB/RS232, or remotely using a modem gateway which uploads data automatically to DeltaLINK-Cloud (see page 21 for further details).



Irrigation control

The GP1 Data Logger can use soil moisture to control irrigation directly (and/or rainfall and/or temperature), or act as a sophisticated interface between these sensors and many types of programmable timer.

Specialist configuration programs are provided for irrigation control.

NB: Our GP2 Data Logger (page 18) offers even more advanced irrigation control capabilities.

Brief Specification (full specs on page 27)

Voltage range	-0.2 to +2.7 V differential
Accuracy ^[1]	± (1.6 mV + 0.05% of reading)
Resolution	± 0.1 mV
Temperatures ^[2]	± 0.07°C, typical at 20°C (10k thermistor)
Pulse counters	1 x 50Hz, 1 x 33kHz max
Relay output	<30 V DC or <24 V AC, 1 A fuse (resettable)
Sensor excitation	Switched battery 5 to 9 V, 120 mA max or precision 5 V, 50 mA max
Reading storage	600,000 readings, typical
Connections	4 cable glands 5-way RS232 / external power connector
Environmental/operating temperature	Water resistant to IP67 -20 to +60°
Size, weight	140 x 105 x 45 mm 280 g
Battery type, life	9 V 6LR61 (PP3), alkaline, ~1 year

[1] Accuracy applies over full -20 to 60°C.

[2] The 2 temperature channels can be configured as SM150T soil moisture inputs, but they provide only single-ended inputs so should not be used with long cables or in noisy environments. The accuracy figures quoted for GP1 soil moisture readings do not apply to these resistance channels when configured as soil moisture inputs.

Ordering Information

GP1	Data logger including DeltaLINK software and RS232 cable.
Optional accessories	
DL-MKT	Mounting Plate suitable for GP1, GP2 and DL6. Comprises 320 x 190 mm stainless steel plate and fittings for mounting onto 51 mm tube or flat surface.
GP1-EPC1	External power cable (11 to 24 V DC source).
GP-PBA-X50	Precision bridge adapter. Max of 2 x GP-PBA-X50 per GP1.
USB-RS232	Adaptor Cable- connects to PC's USB port.
GP2-PSU	Mains power supply for GP1 and GP2 loggers (See page 19). Requires GP1-RSP-M8 cable.
GP1-RSP-M8	RS232 and power cable for GP1. Length 1 m.



DeltaLINK-Cloud
www.deltalink-cloud.com

For Information on our
cloud-based data viewing
and sharing service see
page 19

The **DL6 Data Logger** is optimised for use with Delta-T soil moisture sensors.



- High accuracy 8 channel data logging
- Ideal for Profile Probes, ThetaProbes and SM150Ts

Overview

The DL6 can record data from:

- 6 Soil water content sensors (or other analog voltages)
- 1 Temperature sensor
- 1 Pulse counter (e.g. rainfall)

The DL6 can be used with combinations of ThetaProbes, SM150Ts and Profile Probes as well as a temperature sensor and raingauge. It is well suited to both research applications and environmental monitoring.

Applications

- Monitoring soil moisture
- Profile Probes

Brief Specification (full spec on page 27)

Voltage range	-0.01 to +1.15 V differential
Accuracy	$\pm 0.3\% \pm 0.3 \text{ mV}$
Resolution	0.2 mV
Temperature	$\pm 0.4^\circ\text{C}$
Pulse counter	50 Hz max
Relay output	<25 V DC/AC, 1 A fuse
Sensor excitation	Switched battery 5 to 9 V, 120 mA max
Reading storage	16,000 non-volatile
Connections	8 cable glands, 8-way PR2 connector, RS232 connector
Environmental	Waterproof (IP67)-10 to $+50^\circ\text{C}$
Size, weight	180 x 160 x 70 mm, 830 g
Battery type, life	6 alkaline AA cells, ~1 year

Ordering Information

DL6	Data Logger with DeltaLINK-PC software and RS232 cable.
DL-MKT	Mounting Plate suitable for GP1, GP2 and DL6. Comprises 320 x 190 mm stainless steel plate and fittings for mounting onto 51 mm tube or flat surface.
USB-RS232	As page 25.

Modem Systems for Delta-T Data Loggers - enabling access to DeltaLink-Cloud

Ordering Information

3G Modem Gateway - Complete Systems with Pre-assembled Modem Boxes

A choice of 2 modem box solutions for 3G communications - one with battery and solar power, the other with just a battery. Please note that the logger (ordered separately) has to be mounted outside the modem box - on a mast pole for example.

Typical application: provides "plug-and-play" modem communications and (if ordered) solar power to Delta-T Weather Stations. Easy set-up.

Order code and description	Solar power
3G-DLC-BX1/SP 3G/2G Modem Gateway Box with Solar Power and Smart SIM Solar powered 3G/2G Modem Gateway box with battery and Smart SIM. For use with GP2, GP1 and DL6 Loggers*. Includes 3G/2G quad band modem with 30 W solar panel, solar regulator, Smart SIM, 10 Ah sealed lead acid battery, and 1 m comms and power extension cable. Supplied with mounting bracket for solar panel and mounting kit for fixing modem box to tubular masts or poles (42 - 51 mm diameter). Includes antenna with mounting bracket/ground plane and 5 m coaxial cable. NB: Mounting pole/mast and data package must be ordered separately (see below).	✓
3G-DLC-BX1/B 3G/2G Modem Gateway Box with Battery and Smart SIM 3G/2G Modem Gateway Box with battery and Smart SIM. For use with GP2, GP1 and DL6 Loggers*. Includes all items in 3G-DLC-BX1/SP system, except for solar power items.	✗

* Modem Boxes for use with a GP2 or DL6 logger require an additional cable to be ordered. For GP2, order GP2/GP1-M8 cable. For DL6, order GP1/DL6-M8 cable.

3G Modem Gateway - Flexible Standalone Options

3G modem gateway standalone options for use with GP2, GP1 and DL6 Loggers. Can be installed in M2-ENCL-B2 Enclosure or other suitable enclosure (metal only).

Typical application: adds modem communications and (if ordered) solar power to a Delta-T Logger and sensors system, or to a WS-GP2 Weather Station. Enclosure provides security for logger, battery and modem and enables system expansion and customisation.

Order code and description	Solar power	Enclosures
MD-3G-DLC 3G/2G Modem Gateway for GP2, GP1 and DL6 Loggers Quad band 3G/2G modem (requires protection from weather). Supplied with Smart SIM installed. Includes antenna with mounting bracket/ground plane and 5 m coaxial cable antenna must be fitted onto a metal enclosure. NB: Mounting pole/mast, enclosure, battery, solar power and Data Package must be ordered separately.	Add SOL4-KIT2 and LBAT4, if required	Requires M-ENCL-B2
M-ENCL-B2 Enclosure and 12 V wiring kit Lockable IP53 steel enclosure for mounting onto Delta-T poles and masts. Includes backplate mounted 12 V wiring system, trunking and 12 cable glands (as standard, more available on request). Dimensions 500 (h) x 400 (w) x 250 (d) cm. The cost of the enclosure includes the fitting and partial pre-wiring of logger power supplies and modems ordered at the same time.	Add SOL4-KIT2 and LBAT4, if required	-
SOL4-KIT2 Solar powered charging system 30 W solar panel with mounting kit, regulator and cabling.	Requires LBAT4	Requires M-ENCL-B2
LBAT4 10 Ah Rechargeable lead acid battery With spade terminals. Requires protection from weather.	-	Requires M-ENCL-B2
LBC4 Charger for LBAT4 battery For indoor use only	-	-

Data Packages

Provide access to 3G/2G services worldwide

Data Packages are supplied in blocks of 120MB; each Package is valid for use for up to 3 years from the date of purchase and line rental is included in the Package cost. To ensure the Data Package is able to access the appropriate networks, please request a quotation, stating the precise location required. (The Delta-T MD-GPRS-DLC Modem is supplied with a Smart SIM that can connect to multiple providers, maximising the chance of a stable connection being established. For almost all locations with network coverage, the Smart SIM will be able to make a connection).

Mountings and Support Poles

Enable convenient and secure access to hardware

The **Modem Gateway Systems** and the M-ENCL-B2 Enclosure are designed to be attached to a Delta-T mast or support pole. However, some customers may prefer to provide their own mountings (requires tubular mast/pole 42-51 mm diameter). In the case of the M-ENCL-B2, it is also possible to mount it on a suitable wall or fence. If the modem enclosure is located in a weatherproof area with mains power available, the modem and GP2 can be powered by a GP2-PSU mains power supply (see page 19 for details). To ensure you are supplied with a complete and compatible system we strongly recommend that you request a quotation, providing as much information as possible about your requirements.

Data logger (and readout meter) comparison table

	GP2	DL6	GP1	HH2 Meter	WET150 Meter
Input connections	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]	1 water content sensor or 1 WET Sensor	1 WET150 multi-parameter water content sensor
Control outputs	2 relay outputs expandable to 6 (1 A)	1 relay (1 A)	1 relay (1 A)	-	-
Readings stored	2.5 Million	16,000	600,000	1,500	-
Recording rate	1 second to 24 hours	1 second to 24 hours	1 second to 24 hours	-	-
Configuration	DeltaLINK	DeltaLINK	DeltaLINK	By keypad	By Keypad
Communication options	USB, RS232, ethernet or modem	USB [1], RS232, ethernet or modem	USB [1], RS232, ethernet or modem	RS232, USB [1]	-
Sensor excitation	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
Power	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
Battery life [4] (dependent on usage)	>310k readings, lasting >530 days	>230k readings, lasting >400 days	>76k readings, lasting >130 days	~5k readings	>2400k readings
Enclosure rating	IP65	IP67	IP67	IP54	IP65
Temperature range	-20 to +60°C	-10 to +50°C	-20 to +60°C	0 to 40°C	0 to 40°C
Display	-	-	-	2 line x 16 character	2 line x 16 character
Size	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
Typical applications	<ul style="list-style-type: none"> Demanding research projects Environmental monitoring Varied control applications 	<ul style="list-style-type: none"> Monitoring soil moisture profiles Controlling irrigation 	<ul style="list-style-type: none"> Monitoring soil moisture General data logging Controlling irrigation 	<ul style="list-style-type: none"> Instantaneous reading of soil moisture / profiles / WET Sensor 	<ul style="list-style-type: none"> Instantaneous readings of soil moisture, EC, and temp
Sensor compatibility (maximum number of sensors that could be connected [2])					
	GP2	DL6	GP1	HH2 Meter	
ML3	✓ (6) with temp / (12) without temp	✓ (1) with temp (5) excl. temp	✓ (2) with temp ✓ (4) excl. temp [3]	✓ without temp	-
SM150T	✓ (6) with temp / (12) without temp	✓ (1) with temp (5) excl. temp	✓ (2) with temp ✓ (4) excl. temp [3]	✓ without temp	-
WET150	✓ (62)	-	-	-	✓
PR2	SDI-12	(50) PR2/6 (62) PR2/4	-	-	✓ (address setting only)
	Analog	(2) PR2/6 [5] (3) PR2/4 [5]	✓ (1)	-	✓ -
WET Sensor	✓ (1)	-	✓ (1)	✓	-
EQ3	✓ 6 with temp / 12 without temp	✓ (1) with temp (5) excl. temp	✓ (2 as mV only)	✓ (mV only)	-
Temperature	✓ (12)	✓ (1)	✓ (2)	-	-
Tensiometers	✓ (12)	-	✓ (2) each requires GP-PBA-X50	-	-
Counters or Events	✓ (4) 2 fast 2 slow	✓ (1)	✓ (2) 1 fast 1 slow	-	-
Relay output	✓ (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

Ordering Information

UK customers

SALES AND TECHNICAL ENQUIRIES: should be made directly to Delta-T in the UK. sales@delta-t.co.uk

PRICES: are available on request, and a detailed quotation can be provided if required.

PAYMENT: for new customers, we usually ask for payment in advance. Account facilities are available for customers placing regular orders. Details can be obtained from Delta-T.

Customers outside the UK

OVERSEAS REPRESENTATION:

Delta-T has an extensive network of representatives. A list is available on our website. In these countries, all sales and technical enquiries should be directed to our representatives.

DIRECT SUPPLY: if there is no Delta-T representative in your country, we will supply you directly from the UK. Export sales account for 80% of our business and we have many years' experience of dealing with enquiries from overseas clients.

PRICES: are available on request from your local representative or Delta-T. Detailed quotations can also be provided when needed, including costs for freight, insurance and documentation.

PAYMENT: our normal terms are payment in advance of shipment, or by irrevocable documentary credit. Account facilities may be available for customers placing regular orders. Details of these facilities and documentary credit conditions can be obtained from Delta-T.

GUARANTEE AND SERVICE:

Delta-T guarantees its products against defects in manufacture or materials for a period of 2 years from the date of delivery. For the SM150T Sensor, ML3 Sensor and AP4 Porometer the warranty can be extended to 5 years (requires on-line registration). Full details, including the terms and conditions of sale, and arrangements for servicing and recalibration are available on our website.



Delta-T Devices

Delta-T Devices Ltd.
130 Low Road, Burwell
Cambridge CB25 0EJ, UK

T: +44 (0)1638 742922
E: sales@delta-t.co.uk

Co-operatively owned and managed.

Other Delta-T Products

As well as sensors for soil moisture measurement, Delta-T specialises in instruments for:

- **Meteorology**
- **Solar radiation studies**
- **Canopy analysis**
- **Leaf area index**
- **Plant physiology**
- **Environmental monitoring**

...and our products include:

- **Weather stations**
- **Sunshine pyranometers**
- **Data loggers**
- **Porometers**
- **Canopy analysers**
- **Image analysers for leaves**



GP1 Data Logger controlling precision gantry irrigation within a glasshouse at Hillier Nurseries.

Representative

