AT
Delta-T Devices

Soil Moisture
Measurement

AT
Delta-T Devices

Delta-T Devices Company Profile

Origins

Established in 1971, Cambridge based Delta-T Devices specialises in instruments for environmental science, in particular for soil science, agronomy, plant science, data logging, meteorology and environmental monitoring.

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 25 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. Awarded to Delta-T Devices in August 2011, ISO 9001 is an international standard in use worldwide as a benchmark for quality. The award follows a thorough assessment of our quality management systems by the highly respected British Standards Institution (BSI).

bsi. ISO 9001:2015 Quality Management

FS 565621

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 3-15) and **data loggers** (pages 16-23). 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
SM150T Page 4	++	✓	✓	✗	✗	✗
ML3 Page 5	+++	✓	✓	✗	✗	✗
WET Page 6	+++	✓	✓	✓	✗	✗
PR2 Page 10	++	✓	✗	✗	✓	✗
EQ3 Page 13	++	✗	✓	✗	✗	✓

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 ± 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 9 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 14)	
Water content	
Accuracy	± 0.03 $m^3.m^{-3}$
Range	0 to 0.7 $m^3.m^{-3}$
Temperature	
Accuracy	± 0.5 °C, 0 to +40°C [1]
Output	0 to 1.0 V differential
Power	5 to 15 V, 18 mA for 1 s
Sample Volume	~55 x 70 mm diameter
Size	143 x 40 mm diameter
Environmental	IP68, with Delta-T cables

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

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

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 13 for cables and accessories	

For information on the **SM150T Kit** See page 9

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

bsi. ISO 9001:2015 Quality Management

FS 565621

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

- Soil moisture with ± 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 ± 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 9. (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 9

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.	• 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.	• 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.	• 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 14)

Water content	
Accuracy	± 0.01 m³.m^{-3}
Range	0 to 0.5 m³.m^{-3}
Temperature	
Accuracy	± 0.5°C, 0 to +40°C ± 0.75°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	~60 x 30 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 13 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: **W**ater content, **E**lectrical Conductivity (EC) and **T**emperature.

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

Rapid checks on growing conditions

The WET Sensor can easily be inserted into substrates, composts and most soils, enabling growers and researchers to make rapid checks and optimise the uniformity of growing conditions. Each reading takes less than 5 seconds and provides 3 of the most important indicators of root zone health: water content (%), pore water conductivity (ECp) 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 (ECp) which is the EC of the water available to plant roots. The ECp 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 Sensor is supplied with default calibrations for generic mineral, organic, sand and clay soils. Special WET-GH substrate calibrations can be ordered as a set, for a variety of horticultural media including coir, peat-based potting mixes and greenhouse "mineral" soils. Alternatively, WET-ST calibrations can be ordered for mineral wool (vertical and horizontal measurement).
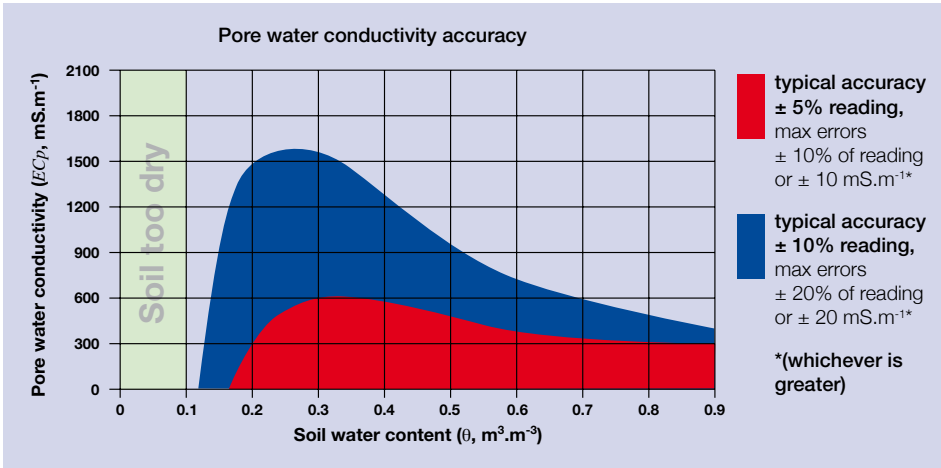
Applications

- **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 powerful built-in control capabilities.

Ordering Information

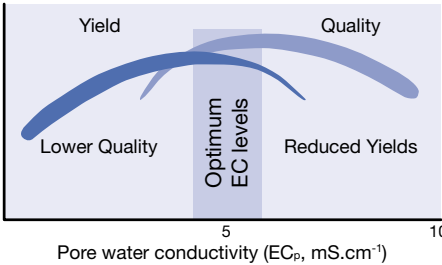| Ordering Information	
WET-2/d	Sensor with 1 m cable and 25-way D-socket for use with HH2.
WET-2/w-05	Sensor with 5 m cable terminating in bare wires for use with GP1 or GP2.

Brief Specification (full spec on page 15)

Measured parameters	
Permittivity, ε′	1 to 80 ± 2.5 [1]
Bulk conductivity	0 to 300 mS.m^{-1} ± 10 (ECb)
Temperature	-5 to 50°C ± 1.5°C
Calculated parameters	
Volumetric Soil Moisture, θ	0 to 100% ± 3% [2]
Pore water conductivity	See graph below (ECp)
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 ECp

Pore water conductivity accuracy

typical accuracy ± 5% reading, max errors ± 10% of reading or ± 10 mS.m^{-1}*

typical accuracy ± 10% reading, max errors ± 20% of reading or ± 20 mS.m^{-1}*

*(whichever is greater)

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-K1	WET Kit including WET-2/d, HH2 Moisture Meter, manuals and carrying case.
WET-2-K4	As WET-2-K1 Kit plus WET-GH1 substrate calibration upgrade.
Calibration sales codes (dependent on WET partnering equipment)	
Substrate calibration upgrades If additional horticultural substrate calibrations are required, they should be ordered at the time of purchase of the HH2, GP2 or GP1. Substrate calibrations are factory installed at Delta-T's premises.	

HH2	GP2	GP1	Substrate calibration upgrade
WET-GH-1	**WET-GH-1G2**	**WET-GH-1G**	Horticultural media including coir, peat-based potting mixes and greenhouse 'mineral' soils.
WET-ST-1	**WET-ST-1G2**	**WET-ST-1G**	Mineral wools (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 Cultilène 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 4 and 5.

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.

Horticultural media calibrations

The WET Sensor is supplied with default calibrations for generic mineral, organic, sand and clay soils. WET-GH-1 substrate calibrations can be ordered as a set, for a variety of horticultural media including coir, peat-based potting mixes and greenhouse "mineral" soils. WET-ST-1 substrate calibrations can be ordered for mineral wool (vertical and horizontal). See page 7 for calibrations ordering information.

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 9.

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 23)

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

• ± 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)*.

Ideal for horticulture

The SM150 Kit comes with substrate calibrations for perlite, coir, peat, and mineral wool, as well as soils – providing a rapid, rugged solution for checking the uniformity of growing conditions for many types of growing media.

Simple operation

The readout meter is lightweight and is very easy to use, being a readout-only device (no data recording or PC complications). Operation is simple – just insert the SM150T into the soil or substrate and press the Read button to make a reading.

Brief Specification

Accuracy	± 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

ML3 ThetaKit

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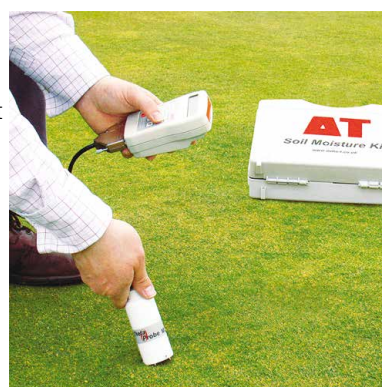
The ThetaKit is easy to use. Simply switch the connected HH2 Moisture Meter on, insert the probe pins fully into the soil, and press the HH2's "Read" button to display the moisture measurement*. Readings can then be stored with a single button press (if required) – and downloaded to PC later.

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

Ideal for sports turf

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

ML3 ThetaKit

Brief Specification

Accuracy	± 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

* 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.

Brief Specification (full spec on page 14)

Range	0 to 0.4 m³.m⁻³ [1]
Accuracy	± 0.04 m³.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 x 25.4 mm **PR2/4:** 750 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

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

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 8)

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 16-23 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	With the GP2-P2-LID option, up to 2 Profile Probes can be instantly connected to the dedicated input sockets. A third probe can be connected using screw terminals.
	To connect larger numbers of Profile Probes, see SDI-12 options on page 12.		

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	✗	✓✓	✓✓ ✓

- 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:

✓	= Meets basic need
✓✓	= Well suited
✓✓✓	= Well suited & includes items for extra convenience
✗	= Unsuitable

The **PR2 SDI-12** is a new digital alternative to the well-established 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 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 Profile Probes can be connected to a single GP2 (subject to power requirements).

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 14

Logger compatibility and power requirements:
SDI-12 protocol version 1.3 (www.sdi-12.org)
Power consumption <60 mA at 12 V DC
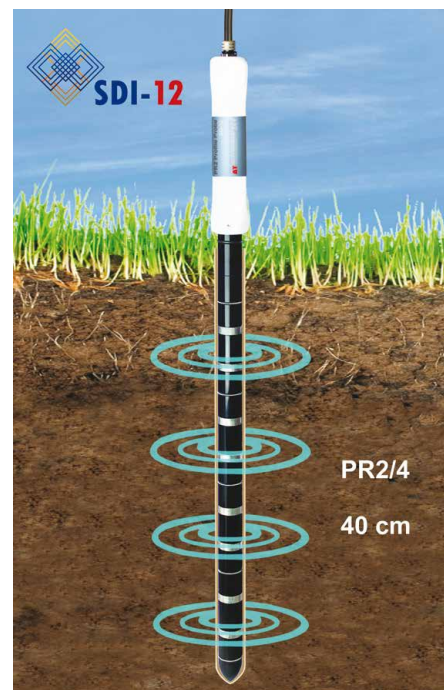Sleep current <2 mA at 12 V DC

Output: Digital

Ordering Information

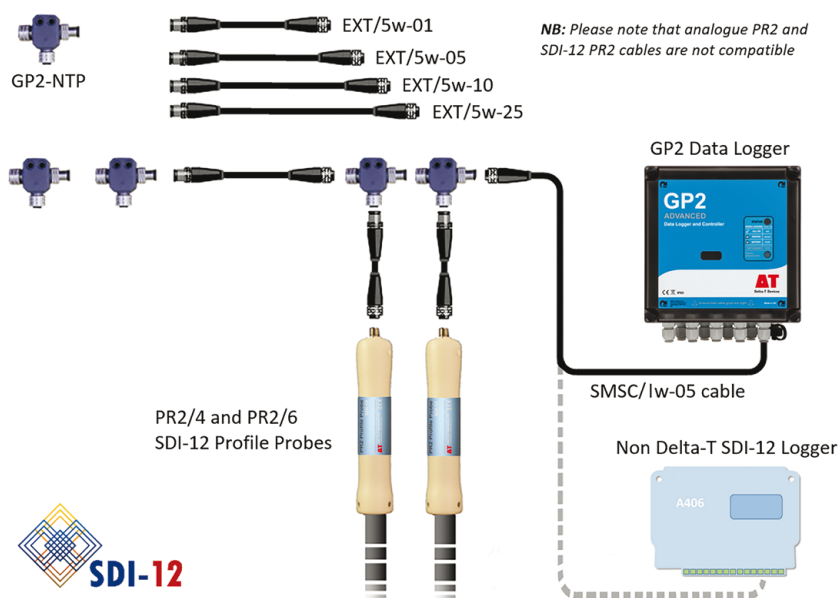| PR2/4-SDI-12	Profile Probe 40 cm SDI-12 interface.
PR2/6-SDI-12	Profile Probe 100 cm SDI-12 interface.

Cables must be ordered separately - see diagram below and cable information on page 13.

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 11 for details of PR2 accessories.

SDI-12

PR2/4

40 cm

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.

Use of PR2 SDI-12 Sensors with Data Logger

GP2-NTP

EXT/5w-01
EXT/5w-05
EXT/5w-10
EXT/5w-25

NB: Please note that analogue PR2 and SDI-12 PR2 cables are not compatible

GP2 Data Logger

PR2/4 and PR2/6 SDI-12 Profile Probes

SMSC/lw-05 cable

Non Delta-T SDI-12 Logger

SDI-12

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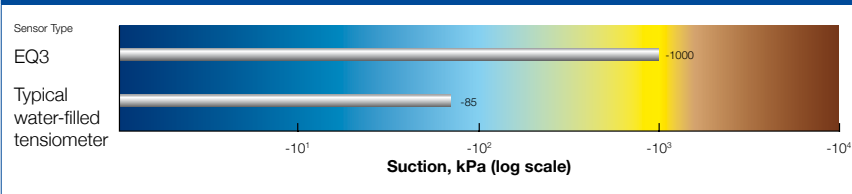
The EQ3's full range is 0 to -1000 kPa but best accuracy is achieved between -100 and -500 kPa. This makes it well suited to plant water stress studies – even in very dry soils.

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 15)

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

Comparison of matric potential ranges

Sensor Type

EQ3 — -1000

Typical water-filled tensiometer — -85

Suction, kPa (log scale): -10^1 -10^2 -10^3 -10^4

Cable options and accessories for the ML3 ThetaProbe, SM150T Sensors and EQ3 Equitensiometer

SMSC/lw-05	5 m cable terminating in bare wires for connection to DL2e.
SMSC/d-HH2	90 cm cable, M12 to 25-way D-socket, for connection to an HH2 Meter.
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.

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 and PR2 SDI-12 soil moisture sensors, and with GP2 cable networks.

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

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	**± 0.04 m³.m⁻³ (4%)** With soil-specific calibration	**± 0.03 m³.m⁻³ (3%)** With soil-specific calibration	**± 0.01 m³.m⁻³ (1%)** With soil-specific calibration
		± 0.5°C, 0 to 40°C for temp sensor **± 0.75°C**, -20 to +60°C for temp sensor	**± 0.5°C**, 0 to 40°C for temp sensor **± 0.75°C**, -20 to +60°C for temp sensor
Soil moisture measurement range	Full accuracy over: **0 to 0.4 m³.m⁻³**	Full accuracy over: **0 to 0.7 m³.m⁻³**	Full accuracy over: **0 to 0.5 m³.m⁻³**
	Full range: 0 to 1.0 m³.m⁻³	Full range: 0 to 1.0 m³.m⁻³	Full range: 0 to 1.0 m³.m⁻³
Salinity range	**50 to 400 mS.m⁻¹**	**50 to 500 mS.m⁻¹**	**50 to 500 mS.m⁻¹**
	Salinity errors included in specification	Salinity errors < 0.035 m³.m⁻³ from 0.05 to 0.4 m³.m⁻³. Can be calibrated up to 2,000 mS.m⁻¹	Salinity errors < 0.035 m³.m⁻³ from 0.05 to 0.4 m³.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 12 for PR2 SDI-12	**0 to 1.0 V** differential Corresponding to 0 to ~0.6 m³.m⁻³	**0 to 1.0 V** differential Corresponding to 0 to ~0.6 m³.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 12 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 V with 100 m cable	Minimum 5.5 V with 100 m cable
Environmental	**IP67** (when installed in access tube)	**IP68**, -40 to +70°C	**IP68**, -40 to +70°C
Sample volume	~95% sensitivity within a cylinder of **diameter 200 mm**	**~55 x 70 mm diameter**	**~60 x 30 mm diameter**
	Sample volume is weighted towards soil immediately surrounding the rods or rings	Sample volume is weighted towards soil immediately surrounding the rods	Sample volume is weighted towards soil immediately surrounding the rods
Dimensions and weight	PR2/6: **length 1350 mm** PR2/4: **length 750 mm** Both: **25.4 mm diameter**	Overall: **143 x 40 mm dia** Rods: 51 mm x 2.5 mm dia	Overall: **158 x 40 mm dia** Rods: 60 mm x 3.2 mm dia (Rods are replaceable)
	PR2/6: 1.2 kg, PR2/4: 0.8 kg	Weight: 0.1 kg (excl. cable)	Weight: 0.1 kg (excl. cable)
Sensor calibrations	Individual sensors are interchangeable	Individual sensors are interchangeable	Individual sensors are interchangeable
	Recalibration advised every 3 years (depending on use)	Recalibration advised every 5 years (depending on use)	Recalibration advised every 5 years (depending on use)
Soil calibrations	Generalised **Mineral** and **Organic** soil calibrations are supplied	Generalised **Mineral** and **Organic** soil calibrations are supplied	Generalised **Mineral** and **Organic** soil calibrations are supplied
Applications	Provides rapid moisture content readings in a vertical soil profile. Used in access tubes for easy insertion and removal. Can be left installed for data logging or used with the HH2 for multi-site portable readings.	High quality entry level sensor suited to precision agriculture and research. It is a cost effective alternative where ML3 levels of accuracy are not required. It combines research-grade soil moisture and temperature measurement (when fully buried).	Versatile, high accuracy sensor recognized as the "gold standard" for the precise determination of soil moisture content. Also provides soil temperature when fully buried.

Multi-parameter			Soil water potential
WET Sensor			**EQ3**
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 6	± 1.5°C	**± 10 kPa over 0 to -100 kPa** 10% of reading over -100 to -1000 kPa
			± 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 6	**0 to 50°C**	**0 to -1000 kPa** (-10bar)
0 to 300 mS.m⁻¹ Supplied with extended range calibrations which should be used for readings between 300 to 500 mS.m⁻¹			Suitable for all non-saline soils.
-5 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			**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			**5 to 14 V, ~18 mA for 1 s**
IP68			**IP68**
~500 ml Sample volume is weighted towards soil immediately surrounding the rods			N/A
Overall: **~120 x 45 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			**181 mm x 40.5 mm** diameter
Weight: 0.1 kg			Weight: 0.3 kg (excl. cable)
Sensor calibrations supplied in WET Sensor EEPROM			Individual sensor calibrations supplied
Recalibration advised every 3 years (depending on use)			Recalibration advised every 2 years (depending on use)
Generalised **Mineral**, **Organic**, **Sand** and **Clay** calibrations are supplied, specialist calibrations are available for horticultural substrates (see page 7)			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.			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
- Free use of DeltaLINK-Cloud data viewing & sharing service*

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.

* Standard web service is free. Remote access requires purchase of GPRS Modem Gateway and Data Package.

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 range of expansion lids is available with additional cable entry points and configurations, including dedicated Profile Probe connectors or wider diameter cable entry glands. The number of programmable control relay outputs can be increased from 2 to 6 using the optional Relay Expansion Module. Up to 7 GP2 Data Loggers can be networked to create complex monitoring and control systems.

A GP2-G5 Expansion Lid is required if 10 or more cables are connected into the GP2 Logger.

GP2-P2-LID Expansion Lid with 2 PR2 connectors

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 19). An optional mains adapter is also available (type GP2-PSU).

Data collection, logger networks and GPRS communications

Data can be collected automatically and remotely using DeltaLINK-Cloud or other GPRS options (see page 19). 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 23

GPRS-DLC-BX1/SP modem 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.

Expansion Lid with 2 Profile Probe connectors type GP2-P2-LID GP2 lid with 2 sockets for connection to Profile Probe cables (PRC/M12-05).

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 1m RS232 and external power extension cable for GP1. 5-core comms cable terminating in M8 male and female connectors, with 1m 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.

GPRS Modem Gateways See page 22 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 - firmware handles scheduling and issuing commands
- 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.

SDI-12 Profile Probes

The SDI-12 Profile Probe is a new digital alternative to the well-established analog PR2 Profile Probe (see page 12). It shares the many strengths of the analog PR2 soil moisture probe, but with the addition of SDI-12 compatibility - allowing integration into new and existing SDI-12 systems.

The SDI-12 enabled GP2 is the natural choice of data logger for the PR2 SDI-12. Up to 50 SDI-12 Profile Probes can be connected to a single GP2 SDI-12 Data Logger (subject to cable length and power requirements).

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.

* Except for WET Sensor channel

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.
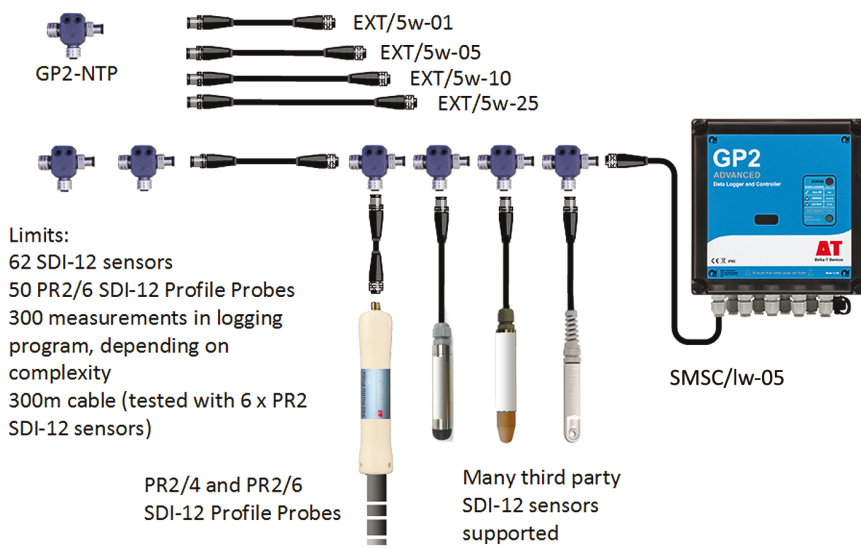
Upgrading older GP2s to SDI-12 capability

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 Logger and Controller

GP2-NTP

EXT/5w-01
EXT/5w-05
EXT/5w-10
EXT/5w-25

Limits:
62 SDI-12 sensors
50 PR2/6 SDI-12 Profile Probes
300 measurements in logging program, depending on complexity
300m cable (tested with 6 x PR2 SDI-12 sensors)

SMSC/lw-05

PR2/4 and PR2/6 SDI-12 Profile Probes

Many third party SDI-12 sensors supported

DeltaLINK-Cloud is a free online data viewing and sharing service for Delta-T data loggers.

- Free service*
- Share data and collaborate
- Automatic upload
- Remote data monitoring
- Flexible charting and reporting
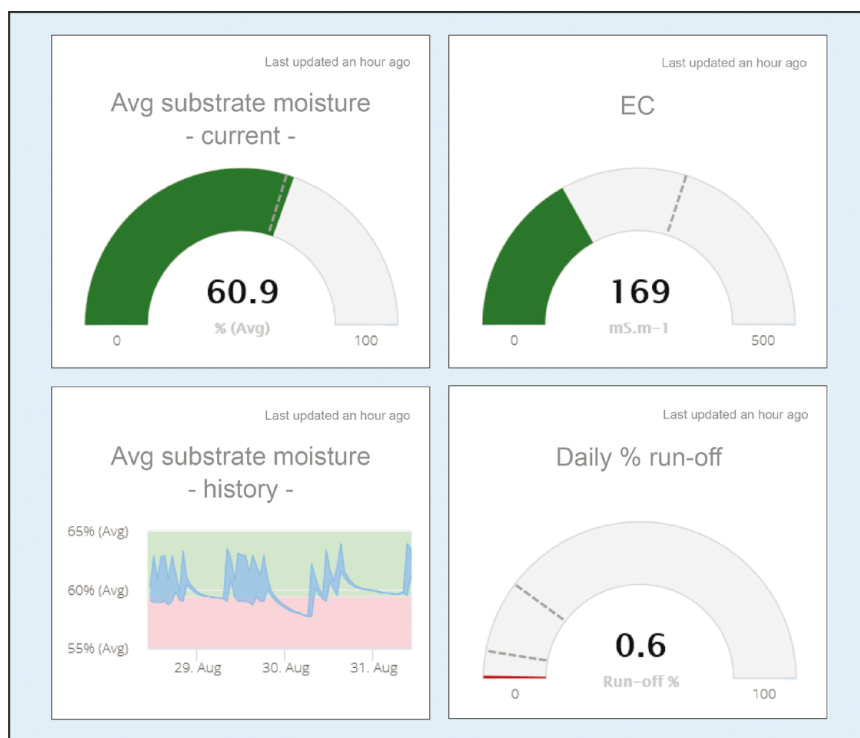- Mobile, tablet and PC compatible
- Multi-language (Fr, De, Es, 中文)

DeltaLINK-Cloud is a secure cloud based connectivity, data management and automatic data retrieval solution. The website allows a user to monitor the status of their devices, graph and export the uploaded data, share access to data with project collaborators/stakeholders and initiate a reverse channel for use with DeltaLINK. Standard website functionality comes for free and is accessible from most modern internet capable devices (phones, tablets and computers).

The Delta-T GP2, GP1 and DL6 data loggers can all be connected to DeltaLINK-Cloud using the GPRS modem gateway. Delta-T provides Smart SIM cards for GPRS modems, enabling 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 link.

DeltaLINK-Cloud can work through DeltaLINK Software to directly control the following: program, start/stop logging, modify program settings, set the logger's clock or delete a dataset. Device status and errors can also be monitored remotely.

* Standard web service is free. Remote access requires purchase of GPRS Modem Gateway and Data Package.

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.

GPRS remote communications with Delta-T Loggers
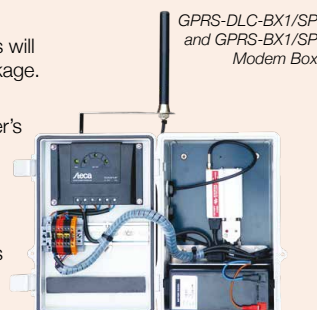
DeltaLINK-Cloud GPRS options

To connect Delta-T Loggers to DeltaLINK-Cloud, customers will need to purchase a GPRS modem system and a Data Package.

The GPRS-DLC-BX1/SP and GPRS-DLC-BX1/B systems provide a GPRS Modem gateway which uploads your logger's status and data automatically to DeltaLINK-Cloud.
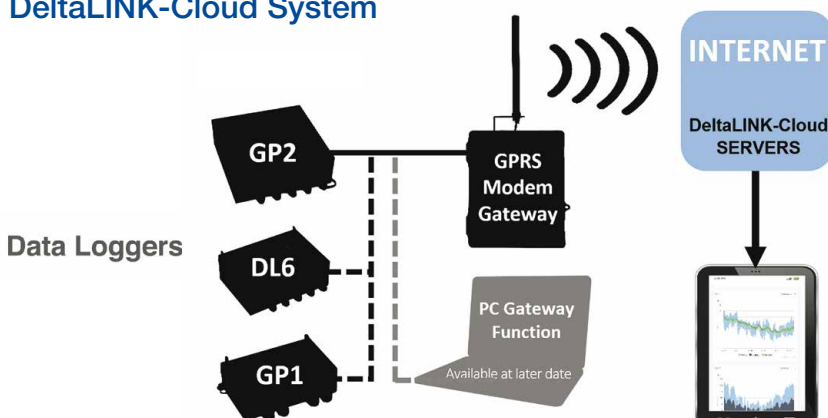
The GPRS-DLC-BX1/SP and GPRS-DLC-BX1/B systems include an enclosure, battery, quad band modem, smart SIM, battery, cables, antenna and mounting kit for fixing to masts. In addition, the GPRS-DLC-BX1/SP version includes a 30W solar panel. Please note that the logger (ordered separately) has to be mounted outside the modem box. A Data Package is also required to complete the system and must be ordered separately.

GPRS-DLC-BX1/SP and GPRS-BX1/SP Modem Box

For GP2 Loggers (but not the GP1 or DL6), the GPRS modem gateway and accessories can be ordered separately. This enables users to incorporate the lockable enclosure (type M-ENCL-B2) into the system. The M-ENCL-B2 is large enough to house the GP2 Logger and modem, and comes complete with a backplate mounted 12 V battery wiring system.

To ensure the system meets your needs, please request a quotation before ordering. Modems and accessories can also be ordered separately if required.

DeltaLINK-Cloud System

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

- High accuracy 7 channel data logger
- 600,000 readings
- Free use of 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 GPRS 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.

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 16) offers even more advanced irrigation control capabilities.

Data collection and GPRS remote communications

Data can be collected on-site by laptop via USB/RS232, or remotely using a GPRS modem gateway which uploads data automatically to DeltaLINK-Cloud (see page 19 for further details).

The WS-GP1, a complete GP1-based weather station is also available (image below)

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

Brief Specification (full specs on page 23)	
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, 1A 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 17). Requires GP1-RSP-M8 cable.
GP1-RSP-M8	RS232 and power cable for GP1. Length 1 m.

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 23)

Voltage range	-0.01 to +1.15 V differential
Accuracy	± 0.3% ± 0.3 mV
Resolution	0.2 mV
Temperature	± 0.4°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°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 21.

22

GPRS Modem Systems for GP2, GP1 and DL6 Data Loggers - Ordering Information

GPRS Modem Gateway - SYSTEMS Enabling access to DeltaLINK-Cloud*. Data Packages ordered separately				
Order code and description	Solar power	Suitable for data logger types		
		GP2	GP1	DL6
GPRS-DLC-BX1/SP GPRS Modem Gateway Box with Smart SIM, Solar Power and Battery Includes quad band GPRS modem with solar regulator and Smart SIM, 30 W solar panel with mounting bracket, 10 Ah sealed lead battery, mounting kit to attach modem box to tubular masts/poles (42-51 mm dia) and antenna with mounting bracket/ground plane.	✓	✓	✓	✓
GPRS-DLC-BX1/B GPRS Modem Gateway Box with Smart SIM, and Battery Includes all items in GPRS-DLC-BX1/SP system, except for solar power items.	✗	✓	✓	✓

GPRS Modem Gateway - INDIVIDUAL ITEMS Enabling access to DeltaLINK-Cloud*. Data Packages ordered separately					
Order code and description	Solar power	Enclosure and battery requirements	Suitable for data logger types		
			GP2	GP1	DL6
MD-GPRS-DLC Quad band GPRS Modem for GP2 Includes Modem with Smart SIM installed, 3db antenna and cables. (Antenna must be fitted onto a metal enclosure). Requires protection from weather.	Add SOL4-KIT2 and LBAT4, if required	Requires M-ENCL-B2	✓	✗	✗
M-ENCL-B2 Enclosure and 12 V wiring kit for GP2 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). Dimensions 500 (h) x 400 (w) x 250 (d) cms.	Add SOL4-KIT2 and LBAT4 if required	-	✓	✗	✗
SOL4-KIT2 Solar powered charging system 30 W solar panel with mounting kit, regulator and cabling.	✓	Requires M-ENCL-B2 and LBAT4	✓	✗	✗
LBAT4 10 Ah rechargeable lead acid battery Requires protection from weather.	-	Requires M-ENCL-B2	-	-	-
LBC4 Charger for LBAT4 Battery. For indoor use only.	-	-	-	-	-

*For customers who prefer not to use DeltaLINK-Cloud, or whose local GPRS service cannot be accessed by the Delta-T Smart SIM, alternative systems are available. Please see below for details.

Data Packages
Provide access to GPRS 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

The GPRS 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 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 17 for details).

To ensure you are supplied with a complete and compatible system we recommend that you request a quotation, providing as much information as possible about your requirements.

GPRS options without DeltaLINK-Cloud access
For use with customer's own SIM card

GPRS-BX1/B and GPRS-BX1/SP Modem Systems are available for customers who would prefer not to use the free DeltaLINK-Cloud service, or whose local GPRS service cannot be accessed by the Delta-T Smart SIM. They only provide access via DeltaLINK PC software and not DeltaLINK-Cloud.

These systems are supplied without a SIM but in all other respects the hardware is identical to the GPRS-DLC-BX1/SP and GPRS-DLC-BX1/B systems. Please note that to activate the system customers need to obtain their own SIM card and to make arrangements with a network provider. (The SIM must have a fixed IP address and be GPRS enabled).

Logger comparison table

	GP2	DL6	GP1	HH2 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)	6 voltage channels	2 voltage channels	1 water content sensor or 1 WET Sensor
		1 temperature	2 temperatures or 2 additional SM150T Sensors [3]	
	4 digital inputs as: Counters, (2 fast + 2 slow), Frequency, Digital state	1 counter	2 counters (33 kHz and 50 Hz)	
	1 Delta-T WET sensor channel Serial input channel: 62 SDI-12 sensors or a single WET Sensor	-	1 WET 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
Communication options	USB, RS232, ethernet or modem	RS232, USB [1] or modem	RS232, USB [1] 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
Power	6 AA alkaline batteries or external power 10-15 V DC	6 AA alkaline batteries	19 V 6LR61 (PP3) alkaline or external power 11-24 V	19 V 6LR61 (PP3) alkaline
Battery life [4] (dependent on usage)	>310k readings, lasting >530 days	>230k readings, lasting >400 days	>76k readings, lasting >130 days	~5k readings
Enclosure rating	IP65	IP67	IP67	IP54
Temperature range	-20 to +60°C	-10 to +50°C	-20 to +60°C	0 to +40°C
Display	-	-	-	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
Typical applications	• Demanding research projects • Environmental monitoring • Varied control applications	• Monitoring soil moisture profiles • Controlling irrigation	• Monitoring soil moisture • General data logging • Controlling irrigation	• Instantaneous reading of soil moisture / profiles / WET Sensor

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
PR2	✓ (2 PR2/6 with expansion lid) (3 PR2/4 with expansion lid) (Up to 50 SDI-12 PR2s)	✓ (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.

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

www.delta-t.co.uk