Delta-T Devices

Leaders in Environmental Measurement

Soil Moisture Measurement

Delta-T Devices Company Profile

Origins

Established in 1971, Delta-T 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 an 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 17 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 normal 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 75% 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 have adopted the following statement to explain our sales policy:

"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."

Applications

Landmine Detection

The ThetaProbe was used in an ITEP project to assist in the testing of a multisensor mine detector. ITEP is the International Test and Evaluation Program for Humanitarian Demining and its mission is to develop standards, test materials and methods, and spread this knowledge to interested parties. ITEP contributes to the resolution of the global landmine problem by developing better, safer, and more cost-effective equipment and methods.

Despite the ban on production, stockpiling or use of anti-personnel landmines, they still pose a threat to people living and working in affected areas such as Mozambique, Bosnia and Cambodia. New multisensor detectors aim to reduce the number of false alarms faced by a deminer using a traditional metal detector, by reducing sensitivity to the thousands of tiny fragments of metal often found in the ground.

The new detectors use an additional sensor in combination with a metal detector to locate buried objects. In this trial, the additional sensor was a ground-penetrating radar which assists with the rejection of tiny fragments of metal. As the radar's performance is affected by soil moisture content, a ThetaProbe and HH2 Moisture Meter were used to monitor this throughout the trial.

www.itep.ws

Land Management Impact on Soil Hydrology (LaMa)

Ongoing work in the Lambourn catchment has involved the installation of PR2 Profile Probes to monitor the soil moisture of hillslope sites. Both organic and conventional farming practices have been compared on cereals and pasture sites using measurements within the top 100cm of the soil profile. The probes are logged using DL6 Data Loggers to provide continuous data recording, supplemented by occasional instant probe readings taken with a PR2 and HH2 hand-held meter combination. This will enable catchment-wide models to be developed and tested for plant-water use, overland-flow and groundwater recharge.

Accurate soil moisture data, in conjunction with soil hydraulic properties as well as meteorological measurements taken at each study site, enable researchers to investigate the key hydrological processes occurring in the catchment.

As part of the study, researchers from CEH Wallingford will be able to monitor the effect of land management changes on the soil moisture profile using PR2 Profile Probes.

http://www.ceh.ac.uk/sci_programmes/water.html

60% Water Saving by nursery

Outdoor beds of Spiraea (above) controlled by SM200 Soil Moisture Sensor (right) and GP1 Logger (not shown).

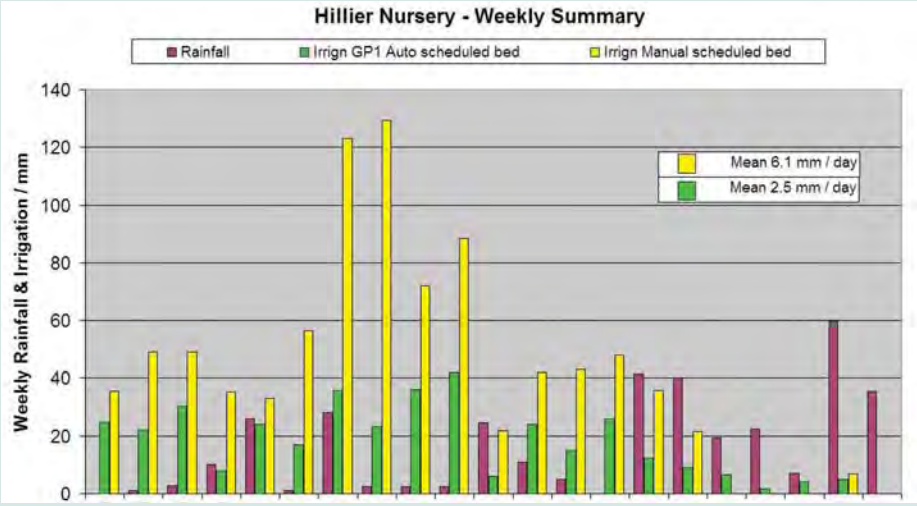


Chart shows how the GP1 + SM200 controlled bed did not suffer the excessive irrigation that was evident in the grower controlled bed. (Chart covers 20 week summer period.)

In the hot, dry UK summer of 2006, a 590 m^2 bed of Spiraea was grown in 3 litre pots, with overhead irrigation controlled by a GP1 Logger and an SM200 Sensor.

This bed consumed 60% less water than a comparable adjacent bed where irrigation was timed according to the grower's judgement. The trials were conducted in the UK at Hillier Nurseries by Chris Burgess (agronomist).

The GP1 Logger, combined with a single SM200 Moisture Probe in a representative pot, has proved very capable of automatically controlling irrigation on commercial scale production beds at several nurseries using overhead sprinkler or drip irrigation. As well as seeing improved crop quality, growers benefited from lower labour cost, reduced environmental impact, and significant water savings.

'Pulsed' irrigation during a wetting-up period can be introduced with the GP1 software if needed, to allow 'soak in' periods and reduce pot drainage losses that can occur with high output sprinklers.

Contents

Applications

Soil Moisture Measurement

The **ML2x ThetaProbe** measures volumetric soil moisture to within 1%. The ML2x is known worldwide for its accuracy, reliability and ease of use

- ±1% accuracy
- Easy data logger connection (DC in DC out)
- Excellent temperature and salinity stability
- Dual purpose: either hand-held for spot readings or left in situ for data logging

World class performance

With the ThetaProbe type ML2x it's easy to make reliable, accurate soil moisture measurements. Simply insert the probe into the soil, connect to your data logger or meter, provide 5-15V DC at 20mA, and within seconds you can be measuring soil moisture.

The ThetaProbe's 1% accuracy, stability and reliability have made it the preferred choice for thousands of researchers worldwide.

Calibration

After a single two-point gravimetric calibration, ThetaProbes will meet their full 1% accuracy specification for your chosen soil (or other medium).

For convenience, many users simply apply one of the two standard calibrations supplied by Delta-T. These "generalised" mineral or organic calibrations achieve 5% accuracy.

The ML2x has a predictable saline response and can be used even in very saline soils - up to 2000 mS.m^{-1}.

Data logging and readout

Most types of data logger can provide the 5-15V DC required to power the ThetaProbe, and will accept its 0 - 1V DC output signal.

The HH2 Moisture Meter connects to a ThetaProbe to provide a portable system for instantaneous readout of soil moisture (see page 18).

Applications

Typical application areas include:

- **Soil Science**
- **Agriculture**
- **Hydrology**
- **Civil engineering**
- **Pollution monitoring**
- **Forestry**

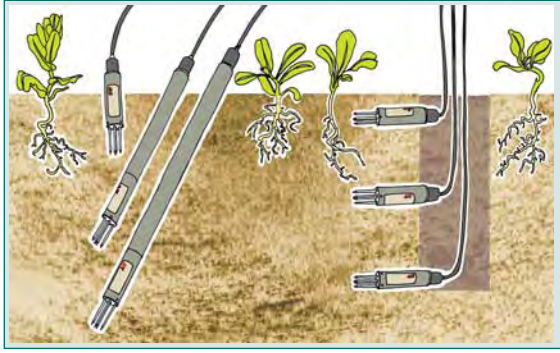
Wherever a soil moisture profile is required, Profile Probes should be considered (see page 6), but note that ThetaProbe accuracy is ±1%, compared to the Profile Probe ±4%.

Horticulture and agriculture
ThetaProbes can be used in a wide range of soils, composts and other growing media. They can be inserted into plant pots, or may be positioned horizontally in a seed tray (minimum 50mm depth of compost).

Composting
The ML2x can be used in composting material where it can tolerate temperatures up to +70°C. The accuracy between 40 and 70°C is ±2%, but media density and contaminant levels may affect the accuracy (and the probe's lifespan).

Environmental monitoring
Soil water is increasingly seen as one of the critical components for long-term studies of global climate and local environments. Many automatic weather stations can be expanded to include one or more ThetaProbes.

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 convenient placement and removal when burying at depth. Access holes should be angled to minimise water "tracking".

Brief specification
(full specs on page 12)

Range	0 to 0.5 m^3.m^{-3} [1]
Accuracy	± 0.01 m^3.m^{-3}
Output	0 to 1.0V [2]
Power	5 to 15V, ~20mA for 1s
Sample vol	~60 x 30mm diameter
Size	210mm x 40mm diameter
Sealing	IP68

[1] Measures full range up to 1.0 m^3.m^{-3} with reduced accuracy
[2] Corresponding to 0 to 0.5 m^3.m^{-3}

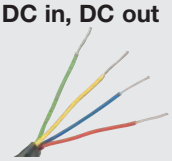
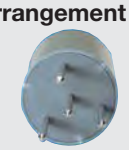
Ordering information

ML2x/w-05 [3]	ThetaProbe terminating in bare wires for data logger terminal blocks, 5m cable
ML2x/d-02	ThetaProbe terminating in 25-way D-connector for HH2 meter, 2m cable
ML2x/t-05 [3]	ThetaProbe terminating in IP68 connector for use with extension tubes, 5m cable
ML/EX50	0.5m extension tube [4]
ML/EX100	1.0m extension tube [4]
ML-RODS-2	Pack of 12 spare rods. Older ThetaProbes need modification
ML-INK1	Insertion kit for pre-forming holes in hard soils
ML2-AG1-SL	45mm dia. spiral auger to install ThetaProbes at depth, length 1.2m
TK3-BASIC	ThetaKit portable soil moisture kit, includes ML2x/d-02, pack of 4 spare rods, HH2 Meter, insertion kit, manual and case

[3] Other cable lengths available in multiples of 5m up to 100m, e.g. ML2x/w-25
[4] ML2x/d is not suitable for use with extension tubes – use ML2x/t instead

Outstanding performance for demanding applications

What do you gain when you choose the ThetaProbe?

Feature	Description	Advantage
DC in, DC out 	Requires 5 - 15V DC at 20mA. Provides 0 - 1V DC output (differential). Compatible with HH2 Moisture Meter and most data loggers.	• **Dual purpose: - for burial and data logging - for hand-held use** • **Long cable runs possible** • **Easy to include in large-scale logging set-ups**
100MHz signal 	With frequencies below ~30MHz, salinity effects can be a problem. With frequencies above ~250MHz, measuring bound-water in clay soils is a problem. 100MHz is an excellent compromise.	• **Performs well in most soil types, including clays** • **Usable in saline soils - up to 2000 mS.m^{-1}** • **±1% accuracy**
4-Rod arrangement 	3 rods are arranged in a circle around a central rod. This creates a defined cylindrical zone of measurement, 60mm long x ~30mm diameter.	• **Holds soil closer to central rod in case of drying and cracking (2 and 3 rod sensors, and particularly flat pcb sensors, don't do this)** • **Measurements can be made close to the soil surface**
Replacement rods 	Made of 3mm diameter, resilient, 304 austenitic stainless steel, with sharpened tips. Rods have threaded ends that screw into ThetaProbe body. The exposed rod length is 60mm.	• **Withstand repeated insertion in soil. Can be 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 casing is a 40mm diameter tube, with threaded end. Extension tubes (0.5 and 1.0m) screw onto this thread. Case sealed to IP68. Overall length is 210mm.	• **Easy to insert and remove from augered holes** • **Rapid attachment of extension tubes** • **Handy size for portable use** • **Rugged, waterproof and buriable to 5m**
Delta-T support AT	Thousands of ThetaProbes are in use all over the world. The ML2x design and performance have been refined over many years.	• **Worldwide availability** • **Reassurance of quality** • **Advice on complete systems**

Comparison with other techniques

ThetaProbes have some clear advantages over **TDR** systems. In general terms ThetaProbes are more stable, more reliable at high salinity, easier to log, use less power, have simpler cabling requirements and can be used to make spot readings on the move (as well as being buried for long term logging).

Neutron Probes have many drawbacks when compared with ThetaProbes. They create licensing and safety problems, they cannot measure the top 25cm of soil, they cannot be data logged and the overall cost of ownership is high. (Profile Probes are in many respects an even better alternative to neutron probes – see page 10).

Further information

The ThetaProbe has been jointly developed with the Macaulay Land Use Research Institute (MLURI), as originally described in *ThetaProbe ML2: Principles of Operation and Applications J.D. Miller and G.J. Gaskin* (available for download from www.delta-t.co.uk).

Patents
UK patent 2300485B,
US patent 5804976.
Patent applied for:
EUR 96303190.1

ML2x ThetaProbe

Soil Moisture Measurement

The **SM200 Soil Moisture Sensor** is an affordable research grade sensor that gives reliable readings in all soil types

- Dependable accuracy ±3%
- Good temperature and salinity stability
- Easy data logger connection (DC in DC out)
- Minimal soil disturbance - easy to install

Research grade sensor

The market leading SM200* offers outstanding performance in normal and saline soil conditions, and it is stable across a wide temperature range. It uses industrial grade connectors and high grade materials throughout, to produce a soil moisture sensor of outstanding quality.

Applications

- **Soil science**
- **Agronomy**
- **Horticulture and agriculture research**
- **Irrigation**

The body of the SM200 is only 86mm long, allowing it to be placed in plant pots and other confined spaces.

The accuracy and affordability of the SM200 make it a good choice for vertical soil moisture profiling in situations where Profile Probes (see page 10) would not achieve high enough accuracy or enough depth.

Calibration

The SM200 is provided with general calibrations for mineral and organic soils. A soil specific two-point calibration can be performed for improved accuracy.

Data logging and readout

The SM200 is a dual purpose probe - it can be used both with a hand-held meter (the HH2 Moisture Meter) for instant readings, and left in situ for data logging.

The SM200 is compatible with a wide range of data loggers, irrigation monitors and controllers.

The GP1 Data Logger offers a particularly competitive logging solution, accepting two SM200s, two temperature sensors (or two further SM200s), and a raingauge.

Easy to use

- Versatile cabling solutions
- Easy installation at depth
- Compact - can be used in plant pots

The SM200 minimises soil disturbance, preserving the original soil structure. It is easy to insert and install whether at the soil surface or at depth. The SM200's circular shape allows it to be installed in augered holes - a low-cost insertion rod is available.

Convenient interchangeable cables are available for the SM200. The options include bare ends for data logger connection and a dedicated connector for the HH2 Moisture Meter. 5m, 10m and 25m extension cables are available.

Brief specification
(full specs on page 12)

Range	0 to 0.5 $m^3.m^{-3}$ [1]
Accuracy	± 0.03 $m^3.m^{-3}$
Output	0 to 1.0V [2]
Power	5 to 15V, ~12mA for 1s
Sample vol	~55 x 70mm diameter
Size	see diagram
Sealing	IP68, including connector

[1] measures full range up to 1.0 $m^3.m^{-3}$ with reduced accuracy
[2] corresponding to 0 to 0.5 $m^3.m^{-3}$

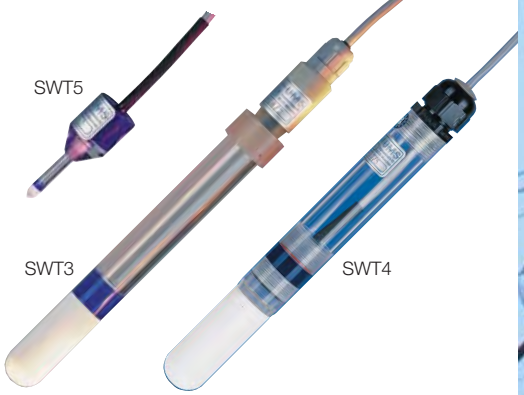
* *Int. Pat. App. WO 2006/064266*

Ordering information

SM200	SM200 Soil Moisture Sensor
SM2C/w-05	5m bare-ended cable for data logger connection
EXT/M8-05	5m M8 extension cable
EXT/M8-10	10m M8 extension cable
EXT/M8-25	25m M8 extension cable
SM2C/d-HH2	1.1m cable to connect SM200 to HH2 Meter
ML2-AG1-SL	45mm diameter spiral auger to install SM200s at depth, length 1.2m
SM-INRD1	1m insertion rod to insert SM200 in augered holes. Can be cut to shorter lengths or inter-connected for longer lengths

Soil Water Potential
(matric potential)

- Loggable water-filled pressure transducer tensiometers
- Maintenance-free wide range Equitensiometers



Tensiometers type SWT3, SWT4, SWT4R and SWT5

These precision, water-filled ceramic cup tensiometers have good accuracy (± 0.2 kPa) over the range +100 to -85 kPa.

SWT tensiometers require refilling and degassing after dry periods, and must be protected from frost. The SWT3 is a general purpose low-cost model. SWT4 and SWT4R have improved performance and better frost resistance. The SWT4R refillable version can be filled and emptied in situ. The SWT5 is a miniature version that can be used for plant pots, etc.

The tensiometers require a stabilised 10.6V DC 1.3mA power source. A DL2e Data Logger fitted with a TVB1 Voltage Regulator can power and log up to 30 tensiometers (or 60 with special cable arrangements). Alternatively, a GP1 fitted with 1 or 2 GP1-PBA1 boards can log 1 or 2 tensiometers.

For use in drier soils (< -85 kPa) or at remote sites, the Equitensiometer should be considered.

EQ2 Equitensiometer

The Equitensiometer makes clever use of the ThetaProbe to obtain readings without the familiar problems of water-filled tensiometers. The ThetaProbe rods are embedded into a specially formulated porous matric material.

The EQ2 is compatible with most data loggers, including all Delta-T loggers and the HH2 Moisture Meter. Extension tubes can be used to position EQ2s at depth.

The EQ2 is maintenance-free (no refilling, degassing or topping up), low power, and is not harmed by frost or by long-term burial, so it is very convenient for remote sites. The EQ2 achieves best accuracy over the range -100 to -1000 kPa, which makes it well suited to plant water stress studies – even in very dry soils. However, the EQ2 is not a rapid response, high accuracy device covering the full range of water potentials. Under some circumstances, the EQ2 equilibration time may extend to several days.

Applications

- **Soil science**
- **Agronomy**
- **Horticulture and agriculture research**

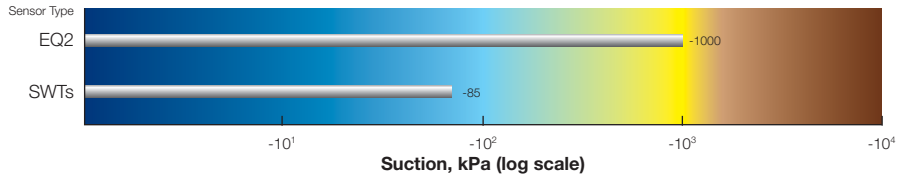
Ordering information
(full specs on page 12)

EQ2/w-05	EQ2 terminating in bare wires for data logger terminal blocks, 5m cable [1]
SWT3-s30	Basic water-filled tensiometer with 30cm shaft [2]
SWT4-s30	Higher specification water-filled tensiometer with 30cm shaft [2]
SWT4R-s30	Refillable version of SWT4 [2]
SWT5-s07	Miniature water-filled tensiometer with 7cm shaft [3]

All SWTs are fitted with a 1.5m cable and connector. An SWTCC connecting cable must be ordered with each SWT. Lengths of 5, 10 and 20m are available.

[1] See ThetaProbe (page 4) for note on EQ2 cable lengths and details of extension tubes and augers.
[2] SWT3 and SWT4 tensiometers can be fitted with other shaft lengths, minimum 5cm up to 200cm max.
[3] SWT5 can be fitted with shaft lengths 2 to 20cm.

Comparison of matric potential ranges



Soil Moisture Measurement

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 correcting for 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 which 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.

Applications

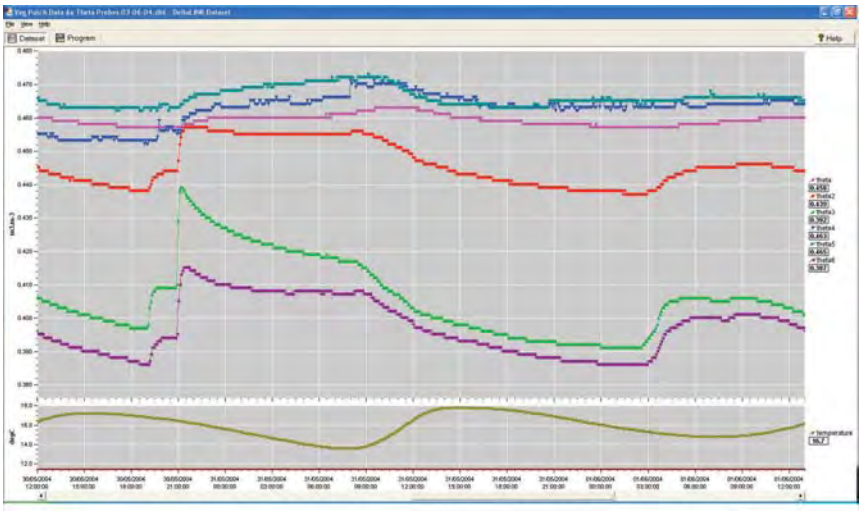
- **Horticulture**
- **Agriculture**
- **Soil science**
- **Pollution monitoring**

The WET Sensor is used throughout horticulture, especially by soft fruit growers and for crops grown in protected environments, where correct growing conditions are critical to both yield and flavour. The compact sensor can be inserted directly into the growing medium with minimal disturbance to either roots or shoots, and provides information for process optimisation or checking growing condition uniformity.

The WET Sensor can also be used to monitor the build-up of salinity when irrigating with poor quality water, though it should not be used in conditions of high salinity (see graph opposite).

Horticultural media calibrations

The WET Sensor is supplied with default calibrations for generic mineral, organic, sand and clay soils. Special 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.



Irrigation events recorded with a WET Sensor connected to a GP1 Data Logger.

NEW - Logging option

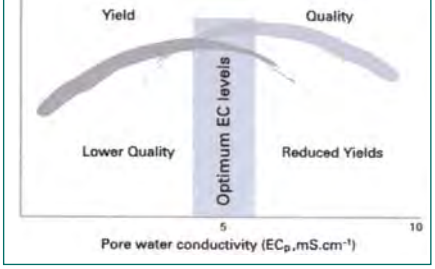
The WET Sensor can now be connected to the GP1 Data Logger in order to monitor fluctuations in growing conditions over time. The smart control relay capability of the GP1 is fully enabled for the WET Sensor, so the system may be configured to control water content and/or EC or temperature using its powerful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

Brief specification
(full specs on page 12)

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, 0 to 50°C
Power	6 to 10V, ~38mA for 2.5s
Dimensions	Probe housing: 55 x 45 x 12mm
Rods	~68mm long
Sample volume	~500ml

[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



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/d	Sensor with 1.5m cable and 25-way D-socket for use with HH2
WET-2/w	Sensor with 5m cable terminating in bare wires for use with GP1
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-GH-1 substrate calibrations upgrade
WET-GH-1	Specialist calibrations for horticultural substrates: peat-based potting mix, greenhouse "mineral" soils and coir

Acknowledgements

WET Sensors have been developed in co-operation with:

PLANT RESEARCH INTERNATIONAL WAGENINGEN UR

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

Cultilène SAINT-GOBAIN CULTILENE

Saint-Gobain Cultilène B.V.

Zeusstraat 2, 5048 CA TILBURG, The Netherlands.

Web site: www.cultilene.com

Sponsors of research into horticultural media applications & suppliers of horticultural media calibrations

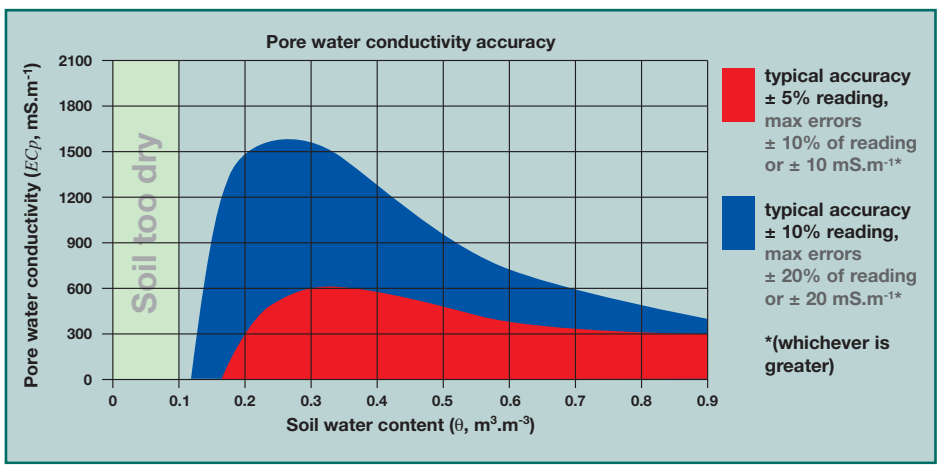
APPLIED PLANT RESEARCH WAGENINGEN UR

Applied Plant Research (PPO)

P.O. Box 167, 6700 AD Wageningen, The Netherlands

Web site: www.ppo.wur.nl

Developers of WET calibrations for horticultural media



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 convenient multi-site measurement
- Dedicated DL6 Logger option 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 newly 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 40cm, or the PR2/6, measuring at 6 depths down to 100cm. The nominal sensing depths are 10, 20, 30, 40, 60 and 100cm.

Profile probes are used in access tubes inserted into pre-augered holes in the soil. Access tubes require an installation hole only 27mm 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 DL6 is a dedicated logger optimised for use with Profile Probes and other Delta-T Moisture Sensors (see page 15).

For multi-probe applications, the DL2e Logger is ideal (see page 16).

Brief specification
(full specs on page 12)

Range	0 to 0.4 $m^3.m^{-3}$ [1]
Accuracy	± 0.04 $m^3.m^{-3}$
Output	**PR2/6:** 6 x 0 to 1.0V [2] **PR2/4:** 4 x 0 to 1.0V
Power	5.5 to 15V [3] **PR2/6:** ~120mA for 1s **PR2/4:** ~80mA for 1s
Sensing depths	**PR2/6:** 10, 20, 30, 40, 60, 100cm (nominal) **PR2/4:** 10, 20, 30, 40cm (nominal)
Sampling volume	**Vertically:** ~95% sensitivity within ± 50mm of upper rings **Horizontally:** ~95% sensitivity within 200mm diameter
Size	**PR2/6:** 1350 x 25.4mm diameter **PR2/4:** 750 x 25.4mm diameter
Sealing	IP68
Access tubes	
Size	**ATL1:** 1154mm x 28mm diameter **ATS1:** 554mm x 28mm diameter

[1] Measures full range up to 1.0 $m^3.m^{-3}$ with reduced accuracy
[2] Corresponding to 0 to 0.6 $m^3.m^{-3}$
[3] 5.5V DC with 2m cable, 7.5V with 100m

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.

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

Ordering information

PR2/4	Profile Probe, 40cm (no cable)
PR2/6	Profile Probe, 100cm (no cable)

All Profile Probes are fitted with an IP68 connector and are supplied with user manual and protective tube.
Cable must be ordered separately.

Standard cables

PRC/d-HH2	1.5m cable, IP68 M12 connector to 25-way D-socket. Connects PR2 to HH2 Moisture Meter
PRC/M12-05	5m cable, IP68 M12 connectors. Connects PR2 to DL6 Soil Moisture Logger
PRC/w-05	5m cable, IP68 M12 connector to bare wire. Connects PR2 to data loggers

Extension cables

EXT/M12-05	5m cable, IP68 M12 connectors. Connects to PR2, or to any EXT/M12 cable. (Cable is identical to item PRC/M12-05)
EXT/M12-10	10m cable, IP68 M12 connectors. Cable connects to PR2, or to any EXT/M12 cable
EXT/M12-25	25m version of EXT/M12-10

Access tubes and PR2 accessories

ATS1	Short access tube, includes cap, bung and collar. For use with PR2/4
ATL1	Long access tube, includes cap, bung and collar. For use with PR2/6
PR2-SP	Profile Probe spares kit
PR-CB2	Protective carrying bag suitable for PR2 and HH2 Moisture Meter or Pocket PC

** Int. Pat. App. WO 2006/064266*

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 25mm 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 30cm. 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.

Extraction Kit

The 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.

Augering kit selection

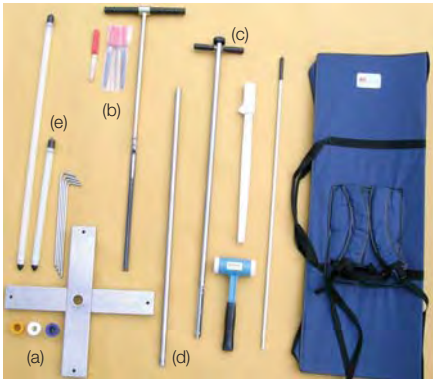
Soil type and depth	PR-ASK1-S Starter Kit (short)	PR-ASK1-L Starter Kit (long)	PR-AKC1 Complete Kit
Normal soils, up to 40cm depth	✔	✔✔	✔✔✔
Normal soils, up to 1m depth	✗	✔✔	✔✔✔

- For dry, sandy soils the PR-AUG2 25mm spiral auger should be ordered in addition to the selected augering kit
- Only the complete kit includes a carrying bag
- All augering items can be ordered individually

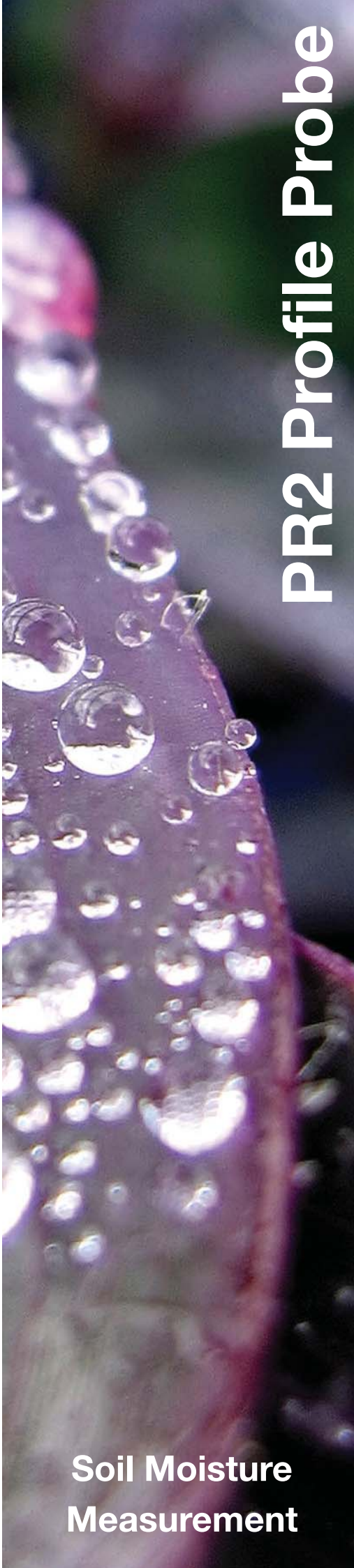
Key:
✔ = Meets basic need
✔✔ = Well suited
✔✔✔ = Well suited & includes items for extra convenience
✗ = Unsuitable

Ordering information

PR-ASK1-S	Augering starter kit (short). For short access tube installation only, includes 24mm pilot auger, stabilisation plate, access tube insertion rod and user manual
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	25mm spiral auger, for dry sandy soils
PR-EXK1	Access tube extraction kit



Complete PR-AKC1 augering kit
(a) stabilisation plate
(b) pilot auger
(c) finishing auger
(d) insertion rod
(e) short and long access tubes (not part of PR-AKC1)

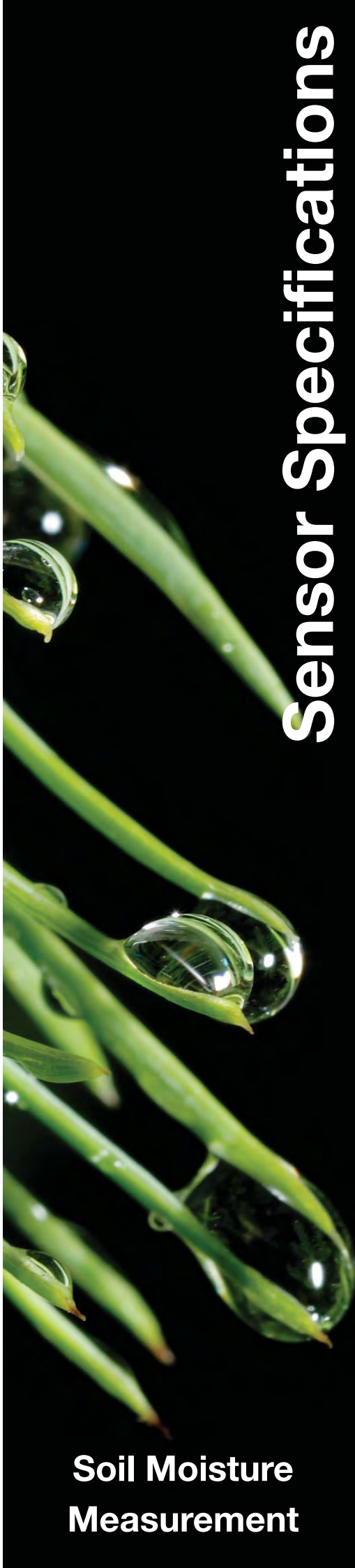


Soil Moisture Sensor Specifications

	Soil water content			Multi-
Sensor	**SM200** 	**ML2x** 	**PR2** 	**WET Sensor**
Measurement	Volumetric water content	Volumetric water content	Volumetric water content	Volumetric water content
Accuracy	**± 0.03 $m^3.m^{-3}$ (3%)**	**± 0.01 $m^3.m^{-3}$ (1%)**	**± 0.04 $m^3.m^{-3}$ (4%)**	**± 0.03 $m^3.m^{-3}$ (3%)**
	With soil-specific calibration			
Measurement range	Full accuracy over: **0 to 0.5 $m^3.m^{-3}$**	Full accuracy over: **0.05 to 0.5 $m^3.m^{-3}$**	Full accuracy over: **0 to 0.4 $m^3.m^{-3}$**	Full accuracy over: **0 to 1.0 $m^3.m^{-3}$**
	Full range: 0 to 1.0 $m^3.m^{-3}$	Full range: 0 to 1.0 $m^3.m^{-3}$	Full range: 0 to 0.6 $m^3.m^{-3}$	
Salinity range	**50 to 500 $mS.m^{-1}$**	**50 to 400 $mS.m^{-1}$**	**50 to 400 $mS.m^{-1}$**	**0 to 300 $mS.m^{-1}$**
	Salinity errors < 0.035 $m^3.m^{-3}$ from 0 to 0.4 $m^3.m^{-3}$	Salinity errors < 0.035 $m^3.m^{-3}$ from 0.05 to 0.4 $m^3.m^{-3}$. Can be calibrated up to 2,000 $mS.m^{-1}$	Salinity errors included in specification	Supplied with extended range calibrations which
Temperature range	Full accuracy over: **0 to 60°C**	Full accuracy over: **0 to 40°C**	Full accuracy over: **0 to 40°C**	**0 to 50°C**
		± 0.02 $m^3.m^{-3}$ over 40 to 70°C		
Output	**0 to 1.0V** single-ended	**0 to 1.0V** differential	**0 to 1.0V** differential	**Serial TTL data** providing permittivity, bulk conductivity
	Corresponding to 0 to ~0.6 $m^3.m^{-3}$		PR2/6: x6 outputs, PR2/4: x4	
Power requirement	**5 to 14 V, ~12mA for 1s**	**5 to 15V, ~20mA for 1s**	**5.5 to 15V** PR2/6: **~120mA for 1s**	**6 to 10V, ~38mA for 2.5s**
	0.2s warm-up at reduced accuracy	Minimum 5.5V with 100m cable	Minimum 7.5V with 100m cable	
Environmental	**IP68**	**IP68**	**IP67** (handle) **IP68** (PR2 rod when installed in access tube)	**IP68**
Sample volume	**~55 x 70mm diameter**	**~60 x 30mm diameter**	~95% sensitivity within a cylinder of **radius 100mm**	**~500ml**
	Sample volume is weighted towards soil immediately surrounding the rods or rings			Sample volume is weighted towards
Dimensions and weight	Overall: **140 x 40mm dia.** Rods: 51mm x 2.5mm dia.	Overall: **210 x 40mm dia.** Rods: 60mm x 3mm dia.	PR2/6: **length 1350mm** PR2/4: **length 750mm** Both: **25.4mm diameter**	Overall: **~120 x 45 x 12mm**
	Weight: 0.1 kg (excluding cable)	Weight: 0.5 kg	PR2/6: 1.2 kg, PR2/4: 0.8 kg	Weight: 0.1 kg
Logger/Meter compatibility	**GP1 ✔ HH2 ✔ DL6 ✔ DL2 ✔**	**GP1 ✔ HH2 ✔ DL6 ✔ DL2e ✔**	**DL6 ✔ DL2e ✔ HH2 ✔**	**GP1 ✔**
Sensor calibrations	Individual sensors are interchangeable			Sensor calibrations supplied in
	Recalibration advised every 3 years (depending on use)			Recalibration advised
Soil calibrations	Generalised **Mineral** and **Organic** soil calibrations are supplied			Generalised **Mineral, Organic, Sand** and **Clay** calibrations are
Applications	High quality sensor suited to research and irrigation applications, a cost-effective alternative where ML2x accuracy is not required.	Versatile, high accuracy sensor recognized as the "gold standard" for the precise determination of soil moisture content.	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.	Measures pore water conductivity, moisture content and

Sensor Specifications

parameter		Soil water potential	
		**SWT3, 4, 4R & 5** 	**EQ2** 
Pore water conductivity (ECp)	Temperature	Matric potential	Matric potential
See graph on page 9	**± 1.5°C**	**± 0.2 kPa**	**± 10 kPa** over 0 to -100 kPa **± 10% of reading** from -100 to -1000 kPa Hysteresis effects may add ± 20 kPa to errors
See graph on page 9	**0 to 50°C**	SWT3: **+10 to -75 kPa** SWT4, SWT4R and SWT5: **+100 to -85 kPa**	
		No significant effect	**50 to 400 mS.m^{-1}**
should be used for readings between 300 to 500 mS.m^{-1}			Salinity may affect readings in wetter soils
		0 to 50°C	**0 to 40°C**
and temperature, from which water content and pore water conductivity are calculated		**1mV / kPa**	**~0.15 to 0.55V** differential, for to 0 to -1000 kPa
		Precision 10.6V, ~1.3mA	**5 to 15V, ~20mA for 1s**
			Min 5.5V with 100m cable
		IP68	**IP68**
soil immediately surrounding the rods		**Depends on soil**	**Depends on soil**
Rods: 68mm long x 3mm dia (centre rod 5mm)		Enquire for details	Overall: **220 x 40mm diameter**
			Weight: 0.6 kg
HH2 ✔		**GP1 ✔** (requires PBA1) **DL2e ✔** (requires TVB1)	**GP1 ✔** **(HH2)** **DL6 ✔** **DL2e ✔**
WET Sensor EEPROM		Interchangeable sensors	Individual sensor calibrations supplied
every 3 years (depending on use)		Recalibration advised every 2 years (depending on use)	
supplied, specialist calibrations are available for horticultural substrates (see page 9)		No soil calibrations required	No soil calibrations required
temperature directly within soils and substrates.		Precision, trusted range of tensiometers for use in wetter soils – well suited to irrigation scheduling and the study of water uptake/movement. They require regular maintenance.	Maintenance-free dielectric tensiometer that can be left installed even in frozen soils. Best results in dry soils, but readings are lower accuracy than water-filled tensiometers.



Soil Moisture Measurement

The **GP1 Data Logger** is a compact research grade data logger with smart irrigation control capability

- High accuracy 7-channel data logging
- Smart relay suitable for irrigation control
- Waterproof IP67 enclosure
- 600,000 readings

Overview

The GP1 can record data from:

- 2 Soil water content sensors (or other analog voltages)
- 2 Temperature sensors (or 2 further SM200 sensors)
- 2 Pulse counters (e.g. rainfall or water meter)
- 1 WET Sensor

The GP1 provides a complete solution for recording high accuracy soil moisture data in the field. Its powerful control capabilities and simple software interface make it easy to configure the GP1 either as a stand-alone irrigation controller or for adding soil moisture sensing to existing control systems.

Applications

- **Monitoring soil moisture**
- **General data logging**
- **Controlling irrigation**

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 raingauge), or 3 years with a lithium battery.

The GP1 can be fully configured, connections checked, data collected and readings displayed in the field using a Windows Mobile PDA with the optional Pocket DeltaLINK software.

Versatile and dependable

The GP1 has been designed particularly to log SM200, ML2x and WET sensors. It is also compatible with other analog environmental sensors including: RH, temperature, light and sunshine duration, rainfall, flow rate, plus tensiometer and bridge sensors with the optional GP1-PBA1 bridge adapter board. In addition a complete GP1 based weather station, the WS-GP1, is available.

Accessories

The GP1 is available with a wide range of accessories and communication options including GSM modem systems and cable network options (see page 17).

WET sensors & tensiometers

The GP1 can take readings from a WET Sensor, recording water content, EC and temperature.

The GP1's voltage input channels can read 1 or 2 pressure transducer tensiometers using 1 or 2 optional GP1-PBA1 precision bridge adapter boards.

Ordering information

GP1	Data Logger including DeltaLINK-PC software and RS232 cable
GP1-MP1	Mounting Kit with fittings for 51mm tube or flat surface
GP1-LID2	Expansion Lid providing 4 further cable glands
GP1-EPC1	External power cable
GP1-PBA1	Precision bridge adapter board

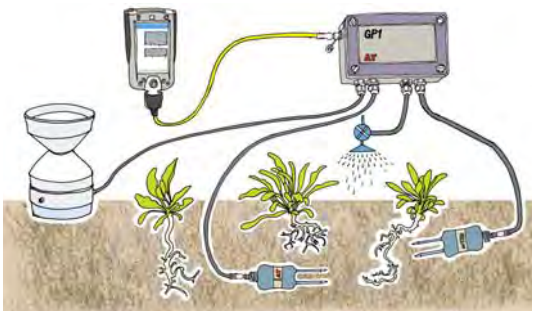
Brief specification

(full specs on page 19)

Voltage range	-0.2 to +2.7V differential
Accuracy [1]	± 0.05% ± 1.6mV
Resolution	0.1mV
Temperatures	± 0.13°C
Pulse counters	1 x 50Hz, 1 x 33kHz max
Relay output	<30V DC or <24V AC, 1A fuse
Sensor excitation	Switched battery 5 to 9V, 120mA max or precision 5V, 50mA max
Reading storage	> 600,000 readings, non-volatile
Connections	4 cable glands 5-way RS232 / external power connector
Environmental	Waterproof (IP67) -20 to +60°C with lithium battery option
Size, weight	140 x 105 x 45mm 280g
Battery type, life	9V 6LR61 (PP3), ~1 year with alkaline, ~3 years with lithium battery option

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

Smart irrigation control



The GP1 enables smart irrigation control using any combination of soil water content, matric potential, rainfall, temperature, etc. It can be configured simply to inhibit irrigation while the soil moisture is above a threshold value, but full logic control is also available - including a pulse option for matching the rate of irrigation to the absorption dynamics of the soil.

The **DL6 Data Logger** is a dedicated soil moisture logger with smart moisture control capability

- High accuracy 8 channel data logging
- Ideal for Profile Probes, ThetaProbes and SM200s
- Battery-powered and waterproof (IP67)

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 is a dedicated soil moisture logger optimised for use with Delta-T soil moisture sensors, and can be used with combinations of ThetaProbes, SM200s and Profile Probes as well as a temperature sensor and raingauge. It is well suited to both research applications and irrigation monitoring.

Applications

- **Monitoring soil moisture**
- **Controlling irrigation**

Ideal logging solution for Profile Probes

The DL6 is tough, waterproof and its 6 internal AA batteries will last ~1 year when taking hourly readings. Profile Probes connect directly to the DL6 using the dedicated waterproof connector. Set-up is very straightforward and software configuration options fully support smart irrigation control features (see box on page 14). When used with a PR2/4, the DL6 can also connect to 2 ThetaProbes, SM200s or other analog voltage sensors.

Accessories

The DL6 is available with a wide range of accessories and communication options including GSM modem systems and cable network options (see page 17).

Ordering information	
DL6	Data Logger with DeltaLINK-PC software and serial cable
DL6-MKT1	Mounting Kit with 1m ground stake, brackets, clamps and fixings

Brief specification (full specs on page 19)	
Voltage range	-0.01 to +1.15V differential voltage
Accuracy [2]	± 0.3% ± 0.3mV
Resolution	0.2mV
Temperature	± 0.4°C
Pulse counter	5Hz max
Relay output	<25V DC/AC, 1A fuse
Sensor excitation	Switched battery 5 to 9V, 120mA max
Reading storage	16,000 readings, 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 70mm, 830g
Battery type, life	6 alkaline AA cells, ~1 year

[2] Accuracy applies over full -10 to 50°C

Soil Moisture Measurement

The **DL2e Data Logger** is a weatherproof field data logger with a versatile range of expansion options

- Battery powered, weatherproof and rugged
- User expandable from 15 up to 62 input channels
- Easy configuration, data collection and display

Overview

The DL2e is a versatile field logger, able to read a wide range of sensors that can be extended still further with a selection of expansion cards.

- 15 differential or 30 single-ended analog channels (voltage or resistance)
- 2 counters
- 2 relay outputs (or sensor excitation)

+ optional expansions cards (up to 64 channel limit)

- 15 differential or 30 single-ended analog channels
- 12 channels 4-wire measurement (max 2 cards)
- 15 counters
- signal attenuation and input protection options

Applications

- **General data logging for moderate to complex systems**

The DL2e is well suited to projects requiring large scale soil moisture records. When fully expanded it can read 60 ThetaProbes, 10 PR2/6 Profile Probes, 60 SM200 sensors or up to 30 tensiometers

Expandable platform

The minimum DL2e system can be quickly adapted by adding extra cards that expand the capabilities of the basic logger. The range of expansion cards covers most common analog sensors and many digital ones.

The SWT range of tensiometers can be used with the DL2e if it is fitted with a TVB1 Voltage Regulator.

There is a wide range of mounting options, power supplies, communication systems and enclosures available for creating complex logging systems. However, the DL2e is also portable, weatherproof, battery-powered and easy to set up, so it's also an excellent choice for quick-and-simple logging tasks.

Ordering information

DL2e	Data Logger including 15/30 analog channels, 128k memory, Ls2Win software and RS232 cable
LAC1	15/30 Channel Analog Input Card
LFW1	12 Channel 4-Wire Input Card
DLC1	15 Channel Counter Input Card
LPR1	30 Channel Attenuator Card
LPRV1	as LPR1 + added transorb input protection
TVB1	Voltage Regulator, provides stabilised 10.6V DC

Easy software

The DL2e is supplied with the Ls2Win software for configuring logging sessions, managing sensor libraries, graphing real-time readings and collecting stored data.

The built-in DL2e keypad and display can be used to test sensor connections in the field and to check logging status.

NB The DL2e is not compatible with DeltaLink software.

Brief specification

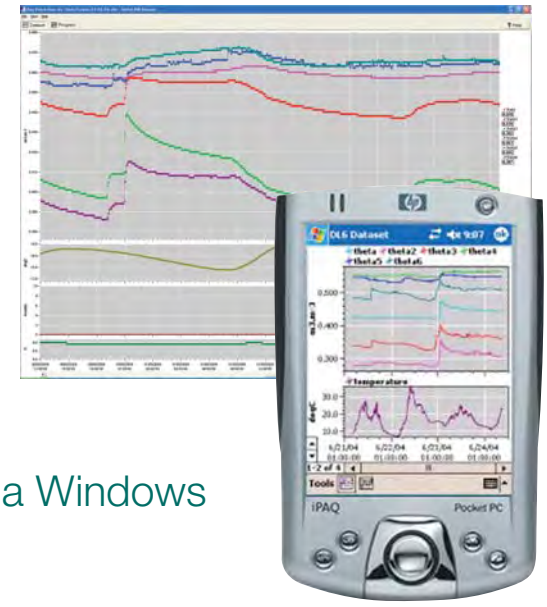
(full specs on page 19)

Voltage range	±4mV, ±32mV, ±262mV, ±2.097V
Accuracy [3]	±0.2%
Resolution	1µV, 8µV, 64µV, 0.5mV
Resistance ranges	1kΩ, 10kΩ,100kΩ, 1MΩ
Accuracy	±0.1% (±0.6% to 50°C, on lowest range)
Resolution	0.01Ω (lowest range)
Counters	100Hz max
Relay outputs	2 relays switching 1A, 24V
Sensor excitation	2 relays switching battery or external power
Reading storage	128,000 readings
Connections	13 pluggable screw connector blocks, + RS232 and external power
Display	2-line LCD
Environmental	Weatherproof (IP65) -20 to +60°C
Size, weight	280 x 220 x 140mm, 2.7kg
Battery type, life	6 alkaline AA cells, ~1 year quiescent

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

DeltaLINK-PC software enables full configuration and data collection for GP1 and DL6 data loggers from a PC or laptop

- Clear graphic data display
- Full configuration options
- Supports powerful irrigation control features



Pocket DeltaLINK provides the same full functionality using a Windows Mobile PDA

DeltaLINK PC software is supplied **free** with all GP1 and DL6 data loggers and enables you to set up the logger input channels and recording parameters, check readings from connected sensors, and collect and display data.

The optional Pocket DeltaLINK software upgrade provides full functionality for Windows Mobile PDAs [1], including sensor reading and data graphing.

NB DeltaLink software is not compatible with the DL2e Logger

Ordering information

PDLK1- M12	Pocket DeltaLINK Kit for DL6, including software, quick start guide and connection cable [1]
PDLK1- M8	Pocket DeltaLINK Kit for GP1, as above
PPC-1	Windows Mobile™ PDA

[1] Connection cable suits iPAQ hx2190, hx2000 and other PDAs with compatible RS232 serial port sockets.

Accessories for Delta-T data loggers

- Modem, networking and direct cable connections
- Batteries and solar recharging systems
- Complete mast kits
- Enclosures for building complex systems

GP1 and DL6 modem systems

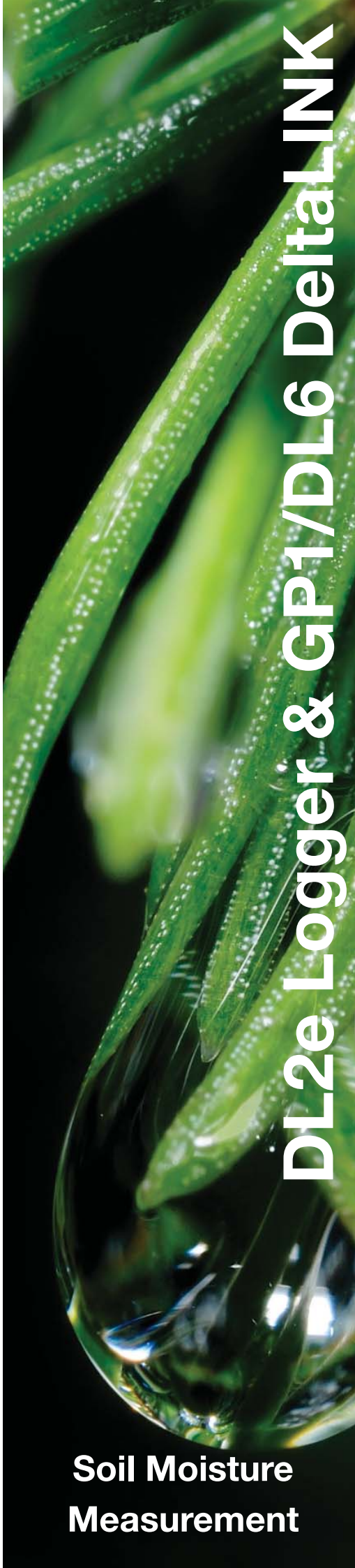
Battery-powered GSM Modem communications systems can be used to extend the range of GP1 and DL6 Logger applications. These systems can be integrated into GP1 or DL6 networks.

GP1 and DL6 networks

GP1 and DL6 Loggers can be connected together in a GP1 cable network. A range of network cables and junction boxes allow GP1 and DL6 users to optimise logger, computer, power supply and modem connections. Up to ten GP1 or DL6 Loggers may be connected to each network.

Batteries and solar recharging

Additional 12V batteries with capacities ranging from 1.8 Ah to 115 Ah can be supplied, complete with solar recharging if required. Delta-T can assist with calculating the power requirements for any combination of sensors and loggers, including the correct sizing of solar panels for specific geographical locations.



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 ML2x, SM200, PR2 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 ML2x, SM200 and WET Sensors**
- **Reads PR2/6 and PR2/4 Profile Probes**

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. The HH2Read software provides a Dataset Import Wizard for direct download into Excel. Data can also be downloaded in comma-separated ASCII (.csv) format.

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.

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 pemittivity. 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. Special 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.

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 ThetaProbe, Profile Probe and SM200 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. The unconverted mV readings can be stored alongside the soil water readings.

Ordering information

Moisture Meter type HH2 with integral 25-pin D-connector, battery, user manual, PC software and RS232 cable.

If the HH2 is intended for use with a single ThetaProbe or a single WET Sensor it can be ordered as part of a convenient kit – see pages 4 or 9.

Brief specification
(full specs on page 19)

Range	Zero to saturation (soil water content) 0 to 1.5V (voltage range)
Accuracy	± 0.13% of mV reading ± 1 mV
Resolution	1mV
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	150 x 80 x 40mm, 450g
Battery type, life	9V alkaline 6LR61 (PP3), ~ 5,000 readings

Logger specification and comparison table

	GP1	DL6	DL2e	HH2 Meter
Input connections	2 voltage channels	6 voltage channels	15 analog/digital channels expandable to 30, 45, 60 (see detailed data sheet)	1 water content sensor or 1 WET Sensor
	2 temperatures *or 2 additional SM200 Sensors*	1 temperature		
	2 counters (33kHz & 50Hz)	1 counter	+2 counters expandable	
	1 WET Sensor	–	–	
Control outputs	1 smart relay (1A)	1 smart relay (2A)	2 relays (1A)	-
Readings stored	600,000	16,000	128,000	1,500
Recording rate	1 second to 24 hours	1 second to 24 hours	1 second to 24 hours	-
Configuration	DeltaLINK-PC or Pocket DeltaLINK (PDA option)	DeltaLINK-PC or Pocket DeltaLINK (PDA option)	Ls2Win	By keypad
Communication options	RS232 or modem	RS232 or modem	RS232 or modem	RS232
Sensor excitation	1 switched logger power 1 5V precision reference	1 switched logger power	2 relay switched logger or external power	1 switched battery
Power	1 9V 6LR61 (PP3) alkaline/ lithium or external power 11-24V	6 AA alkaline batteries	6 AA alkaline batteries or external power 7-15V	1 9V 6LR61 (PP3) alkaline
Battery life	~ 1 year	~ 1 year	~ 6 months	~ 5,000 readings
Enclosure rating	IP67	IP67	IP65	IP54
Temperature Range	-20 to +60°C (with lithium battery)	-10 to +50°C	-20 to +60°C	0 to +40°C
Display	-	-	2 line x 16 character	2 line x 16 character
Size	140 x 105 x 45mm	180 x 160 x 70mm	280 x 220 x 140mm	125 x 80 x 45mm
Typical applications	▪ Monitoring soil moisture ▪ General data logging ▪ Controlling irrigation	▪ Monitoring soil moisture profiles ▪ Controlling irrigation	▪ General data logging for moderate to complex systems	▪ Instantaneous reading of soil moisture / profiles / WET Sensor

Sensor compatibility (maximum number of sensors that could be connected*)

	GP1	DL6	DL2e	HH2 Meter
ML2x	✓ (2)	✓ (6)	✓ (60)	✓
SM200	✓ (4)	✓ (6)	✓ (60)	✓
PR2		✓ (1)	✓ (10 PR2/6)	✓
WET Sensor	✓ (1)			✓
EQ2	✓ (2 as mV only)	✓ (6 as mV only)	✓ (7, + 53 mV only)	✓ (mV only)
Temperature	✓ (2)	✓ (1)	✓ (60)	
Tensiometers	✓ (2, requires PBA1)		✓ (30)	
Counters or Events	✓ (2)	✓ (1)	✓ (2 + 60)	
Relay output	✓ (1)	✓ (1)	✓ (2)	

**With appropriate expansion cards and power supply arrangements*

Logger specification & comparison table

Soil Moisture Measurement

Ordering Information

UK customers

SALES AND TECHNICAL ENQUIRIES: should be made directly to Delta-T in the 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 more than three quarters 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 12 months from the date of delivery. Full details including terms and conditions of sale, and arrangements for servicing and recalibration are available on request.

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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**
- **Root length systems**
- **Image analysers for leaves**

GP1 Data Logger controlling precision gantry irrigation within a glasshouse at Hillier Nurseries. The GP1 is connected to a single SM200 Soil Moisture Sensor installed in a representative pot.

Representative

SMM-01-08 Printed in U.K.