

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

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

Exceptional performance

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

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

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

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

Installation

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

Data logging and readout

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




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

Applications

- Environmental research
- Sports turf and golf

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



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

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

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

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

Soil Moisture - Portable Kits

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

SM150 Kit

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

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



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

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

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

WET150 Kit

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

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



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

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

ML3 ThetaKit

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

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



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

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

See page 7 for Ordering Information.

Ideal for sports turf

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




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

For information on the WET Kit See page 7








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

Soil Moisture Sensor Specifications

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

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

Data logger (and readout meter) comparison table

	GP2 	DL6 	GP1 	HH2 Meter 	WET150 Meter 
Input connections	12 differential (or 24 single-ended) analog inputs configurable as: Voltage, Resistance (12 3-wire or 24 2-wire), Bridge (12), Potentiometer (12) 4 digital inputs as: Counters, (2 fast + 2 slow), Frequency, Digital state 1 Delta-T WET sensor channel Serial input channel: 62 SDI-12 sensors or a single WET Sensor	6 voltage channels 1 temperature 1 counter -	2 voltage channels 2 temperatures or 2 additional SM150T Sensors [3] 2 counters (33 kHz and 50 Hz) 1 WET Sensor	1 water content sensor or 1 WET Sensor -	1 WET150 multi-parameter water content sensor
Control outputs	2 relay outputs expandable to 6 (1 A)	1 relay (1 A)	1 relay (1 A)	-	-
Readings stored	2.5 Million	16,000	600,000	1,500	-
Recording rate	1 second to 24 hours	1 second to 24 hours	1 second to 24 hours	-	-
Configuration	DeltaLINK	DeltaLINK	DeltaLINK	By keypad	By Keypad
Communication options	USB, RS232, ethernet or modem	USB [1], RS232, ethernet or modem	USB [1], RS232, ethernet or modem	RS232, USB [1]	-
Sensor excitation	Calibrated 3 V reference, +5 V and +12 V regulated, or 5 to 10.5 V (battery or external power), user selectable	1 switched logger power	1 switched logger power 1.5 V precision reference	1 switched battery	Via SDI-12
Power	6 AA alkaline batteries or external power 10-15 V DC	6 AA alkaline batteries	1 9V 6LR61 (PP3) alkaline or external power 11-24 V	1 9V 6LR61 (PP3) alkaline	2 AA alkaline batteries
Battery life [4] (dependent on usage)	>310k readings, lasting >530 days	>230k readings, lasting >400 days	>76k readings, lasting >130 days	~5k readings	>2400k readings
Enclosure rating	IP65	IP67	IP67	IP54	IP65
Temperature range	-20 to +60°C	-10 to +50°C	-20 to +60°C	0 to 40°C	0 to 40°C
Display	-	-	-	2 line x 16 character	2 line x 16 character
Size	225 x 185 x 75 mm	180 x 160 x 70 mm	140 x 105 x 45 mm	125 x 80 x 45 mm	13 x 66 x 25 mm
Typical applications	<ul style="list-style-type: none"> Demanding research projects Environmental monitoring Varied control applications 	<ul style="list-style-type: none"> Monitoring soil moisture profiles Controlling irrigation 	<ul style="list-style-type: none"> Monitoring soil moisture General data logging Controlling irrigation 	<ul style="list-style-type: none"> Instantaneous reading of soil moisture / profiles / WET Sensor 	<ul style="list-style-type: none"> Instantaneous readings of soil moisture, EC, and temp

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

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

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

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

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

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

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