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

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

Overview

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

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

Data logging

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

Installation

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

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

Working principle

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

Applications

The EQ3 Equitensiometer is ideally suited to static long term monitoring of water potential in soils and substrates. It can even be left installed in frozen soils. Typical applications include environmental, plant, soil, ecology and geo-sciences research, as well as civil engineering and agricultural engineering applications.
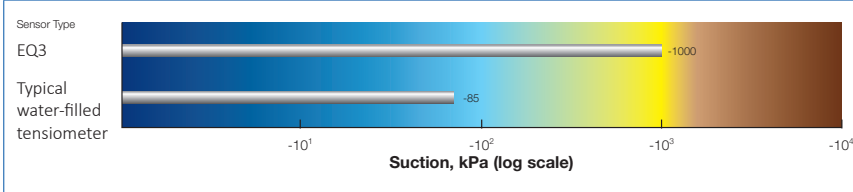
The EQ3's full range is 0 to -1000 kPa but best accuracy is achieved between -100 and -500 kPa. This makes it well suited to plant water stress studies - even in very dry soils.

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

Ordering Information (full spec on page 17)	
EQ3	EQ3 Equitensiometer. See below for cable and accessory options.

Comparison of matric potential ranges

Sensor Type

EQ3 ······ -1000

Typical water-filled tensiometer ······ -85

Suction, kPa (log scale)
-10¹   -10²   -10³   -10⁴

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

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

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

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

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

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

Soil Moisture Sensor Specifications			
	Soil water content	**Multi-parameter**	
Sensor	**PR2 and PR2 SDI-12**	**SM150T**	**ML3 ThetaProbe**
Measurement	Volumetric water content	Volumetric water content and soil temperature	Volumetric water content and soil temperature
Accuracy	**± 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 14 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 14 for PR2 SDI-12	**5 to 14 V, ~18 mA for 1 s**	**5 to 14 V, ~18 mA for 1 s**
	Minimum 7.5 V with 100 m cable	Minimum 5.5 V with 100 m cable	Minimum 5.5 V with 100 m cable
Environmental	**IP67** (when installed in access tube)	**IP68**, -40 to +70°C	**IP68**, -40 to +70°C
Sample volume	~95% sensitivity within a cylinder of **diameter 200 mm**	**~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: **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
± 0.03 m³.m⁻³ (3%)	See graph on page 8	**± 1.5°C**	**± 0.03 m³.m⁻³ (3%)**	See graph on page 5	**± 0.5°C** (0°C to +40°C range) **± 0.7°C** (-20°C to +60°C range)	**± 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 8	**0 to 50°C**	Full range: **0 to 1.0 m³.m⁻³**	See graph on page 5	Full range: **-20°C to +60°C**	**0 to -1000 kPa** (-10bar)
			Accurate range: **0.05 to 1.0 m³.m⁻³ ECb 0 to 500 mS.m⁻¹**		Accurate range: **0°C to +40°C**	
0 to 300 mS.m⁻¹			See graph on page 5			Suitable for all non-saline soils
Supplied with extended range calibrations which should be used for readings between 300 to 500 mS.m⁻¹			Sensor calibration covers the full range of water contents and ECb			
-5 to +50°C			Full accuracy over: **-20 to +50°C**			**0 to 40°C**
Serial TTL data providing permittivity, bulk conductivity and temperature, from which water content and pore water conductivity are calculated			**SDI-12 protocol 1.3 (www.sdi-12.org)** Providing water content, pore water conductivity, and temperature - together with base readings of permittivity and bulk conductivity. Outputs are exceptionally configurable			**0-1.0 V** differential, non-linear. (Calibration data and graph supplied with each sensor) Resistance 5.8Ω to 28kΩ for temp sensor
6 to 10 V, ~38 mA for 2.5 s			**Operating voltage: 6 to 20 Volts** **Current consumption (typical values when powered from 12 Volts):** Active sensing: 22mA average over 12ms (average includes short peaks at 45mA) Active results computation: 2mA over 188ms Idle: <0.5mA			**5 to 14 V, ~18 mA for 1 s**
IP68			**IP68, -20 to +60°C**			**IP68**
~500 ml			**~55 x 70 mm diameter**			**N/A**
Sample volume is weighted towards soil immediately surrounding the rods			Sample volume is weighted towards soil immediately surrounding the rods			
Overall: **~120 mm x 45 mm x 13 mm** Rods: 68 mm x 3.0 mm dia Outer rods 68 mm x 3.0 mm dia Central rod 65 mm x 5.0 mm dia			Overall: **143 mm x 40 mm dia** Rods: 51 mm x 2.5 mm dia			**181 mm x 40.5 mm** diameter
Weight: 0.1 kg			Weight: 0.77g (excl. cable)			Weight: 0.3 kg (excl. cable)
Sensor calibrations supplied in WET Sensor EEPROM			Individual sensors are interchangeable			Individual sensor calibrations supplied
Recalibration advised every 3 years (depending on use)			Recalibration advised every 5 years (depending on use)			Recalibration advised every 2 years (depending on use)
The WET Kit includes a comprehensive set of calibrations (see page 9 ordering information for details). For WET Sensor use with GP1 and GP2 data loggers please see page 8 for calibrations information.			The WET150 Sensor comes complete with calibrations for **mineral** and **organic** soils plus coir, peat, and mineral wool substrates			No soil calibrations required
Measures pore water conductivity, moisture content and temperature directly within soils and substrates. It has crucial applications in precision horticulture and soil science research.			Measures pore water conductivity, moisture content and temperature directly within soils and substrates. It has crucial applications in precision horticulture and soil science research - and can be incorporated into many types of SDI-12 measurement and control system.			Maintenance-free dielectric tensiometer with soil temperature measurement. Can be left installed even in frozen soils. Best results in dry soils. Readings are lower accuracy than water-filled tensiometers.

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

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

Overview

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

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

The relay outputs can control experiments and applications with exceptional sophistication using the Script Editor.
The GP2 has unique reliability- built on Delta-T's 25 years' experience in designing and manufacturing data loggers.

Sensors / Inputs

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

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

Flexibility and customisation

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

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

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

Expansion

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

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

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

Advanced features

Script Editor

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

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

Virtual Channels

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

Simulator

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

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

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

* SDI-12 sensors cannot be simulated.

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	• 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	• 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