Crysberg

Sensor setup for Aqualogic

Sensor type: Moisture
Manufacturer: Meter Group
Model: TEROS-10
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To: OEM Partners
Purpose: Evaluate the sensor and recommend setup for the Aqualogic 500 controller using a sensor decoder to read the signal from the sensor.

General notes:
The sensor decoder setup has an expression to convert the input signal to human readable values, in this case Volumetric Water Content – VWC.

Photos:

Specification:

Volumetric Water Content (VWC)	Range	Mineral Soil Calibration: 0.0000 – 0.6400 m^3/m^3
		Soilless Media Calibration: 0.0000 – 0.7000 m^3/m^3
		Apparent Dielectric Permittivity (εa): 1 (air) to 80 (water)
		NOTE: The VWC range is dependent on the media the sensor is calibrated to. A custom calibration will accommodate the necessary ranges for most substrates.
	Resolution	0.0010 m^3/m^3
	Accuracy	Mineral Soil Calibration: ±0.03 m^3/m^3 typical in mineral soils that have solution EC <8 dS/m
		Soilless Media Calibration: ±0.05 m^3/m^3 typical in media that has a solution EC <8 dS/m
		Medium Specific Calibration: ±0.01–0.02 m^3/m^3 in any porous medium
		Apparent Dielectric Permittivity (εa): 1–40 (soil range) , ±1 εa (unitless) 40–80, 15% of measurement

Formulas for conversion (from manual):

4.1.1 MINERAL SOILS

According to METER tests, a single calibration equation will generally suffice for most mineral soil types with ECs from 0 dS/m to 8 dS/m saturation extract. VWC (θ) is given by Equation 1:

$$\theta\left(m^3/m^3\right) = 1.895\times10^{-10}\times RAW^3 - 1.222\times10^{-6}\times RAW^2 + 2.855\times10^{-3}\times RAW - 2.154 \quad \textbf{Equation 1}$$

where RAW is the output from the METER data logger.

If using a non-METER data logger, VWC is given by Equation 2:

$$\theta\left(m^3/m^3\right) = 4.824\times10^{-10}\times mV^3 - 2.278\times10^{-6}\times mV^2 + 3.898\times10^{-3}\times mV - 2.154 \quad \textbf{Equation 2}$$

A third-order equation is used for the mineral soil calibration because it provides the best predictions of VWC in the range of VWC found in mineral soils, but this equation reaches a maximum at approximately 0.77 m^3/m^3 in pure water according to Equation 1. To display data on a scale from 0 to 1.0 m^3/m^3, VWC should be modeled with a quadratic equation (which would result in a 1.0 m^3/m^3 in water). However, METER does not recommend this for mineral soils because it often makes the calibration in the range of VWC found in mineral soil less accurate.

4.1.2 SOILLESS MEDIA

TEROS 10 sensors are calibrated in potting soil, perlite, and coir. The goal is to create a generic calibration equation that will work in many nonsoil substrates with an accuracy of 0.05 m^3/m^3. For higher accuracy, performing a media-specific calibration should improve the accuracy to 0.01 to 0.02 m^3/m^3. The differences between mineral soil and soilless media calibrations are caused by high air volume in the organic soils that lowers the starting (dry

media) dielectric of the sensor. For more information on how to calibrate sensors or to learn about METER calibration service (calibrations performed for a standard fee), review the article on soil-specific calibrations or contact Customer Support.

The calibration for several potting soils, perlite, and peat moss is shown in Equation 3:

$$\theta\left(\mathrm{m}^3/\mathrm{m}^3\right) = 2.137\times10^{-10}\times RAW^3 - 1.465\times10^{-6}\times RAW^2 + 3.566\times10^{-3}\times RAW - 2.683 \quad \textbf{Equation 3}$$

where RAW is the output from the METER data logger.

If using a non-METER data logger, VWC is given by Equation 4:

$$\theta\left(\mathrm{m}^3/\mathrm{m}^3\right) = 5.439\times10^{-10}\times mV^3 - 2.731\times10^{-6}\times mV^2 + 4.868\times10^{-3}\times mV - 2.683 \quad \textbf{Equation 4}$$

4.1.3 APPARENT DIELECTRIC PERMITTIVITY

Apparent dielectric permittivity (ε_a) can be used to determine VWC using external published equations such as the Topp equation (Topp et al. 1980). Dielectric permittivity is also used for calculating pore water EC. Dielectric permittivity is given by Equation 5:

$$\varepsilon = 1.054\times10^{-4}\times e^{2.071\times10^{-3}\times RAW} \quad \textbf{Equation 5}$$

where RAW is the output from the METER data logger.

If using a non-METER data logger, VWC is given by Equation 6:

$$\varepsilon = 1.054\times10^{-1}\times e^{2.827\times10^{-3}\times mV} \quad \textbf{Equation 6}$$

Installation:

The sensor must be powered by an external power source. Further notes on external power supply at the end of this paper.

ELECTRICAL AND TIMING CHARACTERISTICS

Supply Voltage (VIN to GND)	
Minimum	3.0 VDC
Typical	NA
Maximum	15.0 VDC

The power shall be connected to the brown (+) and bare (-).
The sensor decoder shall have the red wire to sensor's orange (+) and black to bare (-).

Expression settings:

Mineral soils:

Description
TEROS-10 VWC in Mineral soils

Expression to modify interrupt value stored in object
0.004824 * ((x/100) ^ 3) - 0.002278 * ((x/10) ^ 2) + 0.03898 * x - 2.154
x gets replaced by value

Secondary expression, usage depends on context
x gets replaced by value
Reset io value to 0 after X seconds without interrupt, 0 = indefinitely
0

Soilless Media:

Description
TEROS-10 VWC in soilless media

Expression to modify interrupt value stored in object
0.005439 * ((x/100) ^ 3) - 0.002731 * ((x/10) ^ 2) + 0.04868 * x - 2.683
x gets replaced by value

Secondary expression, usage depends on context
x gets replaced by value
Reset io value to 0 after X seconds without interrupt, 0 = indefinitely
0

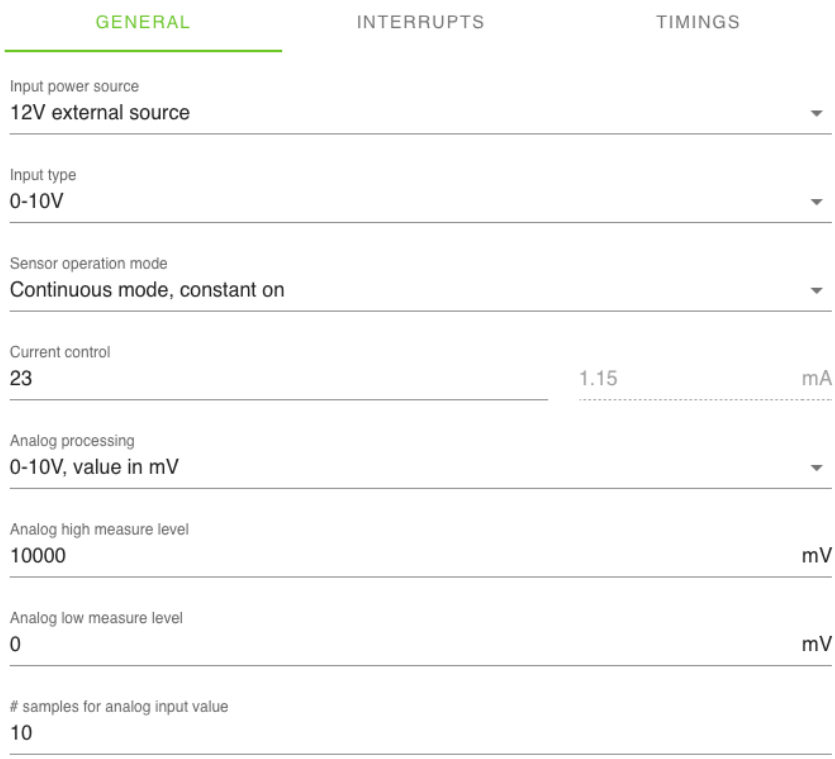
Apparent Dielectric Permitivity:

Description
TEROS-10 delectric permitivity

Expression to modify interrupt value stored in object
0.1054 * (2.71828 ^ (0.002827 * x))
x gets replaced by value

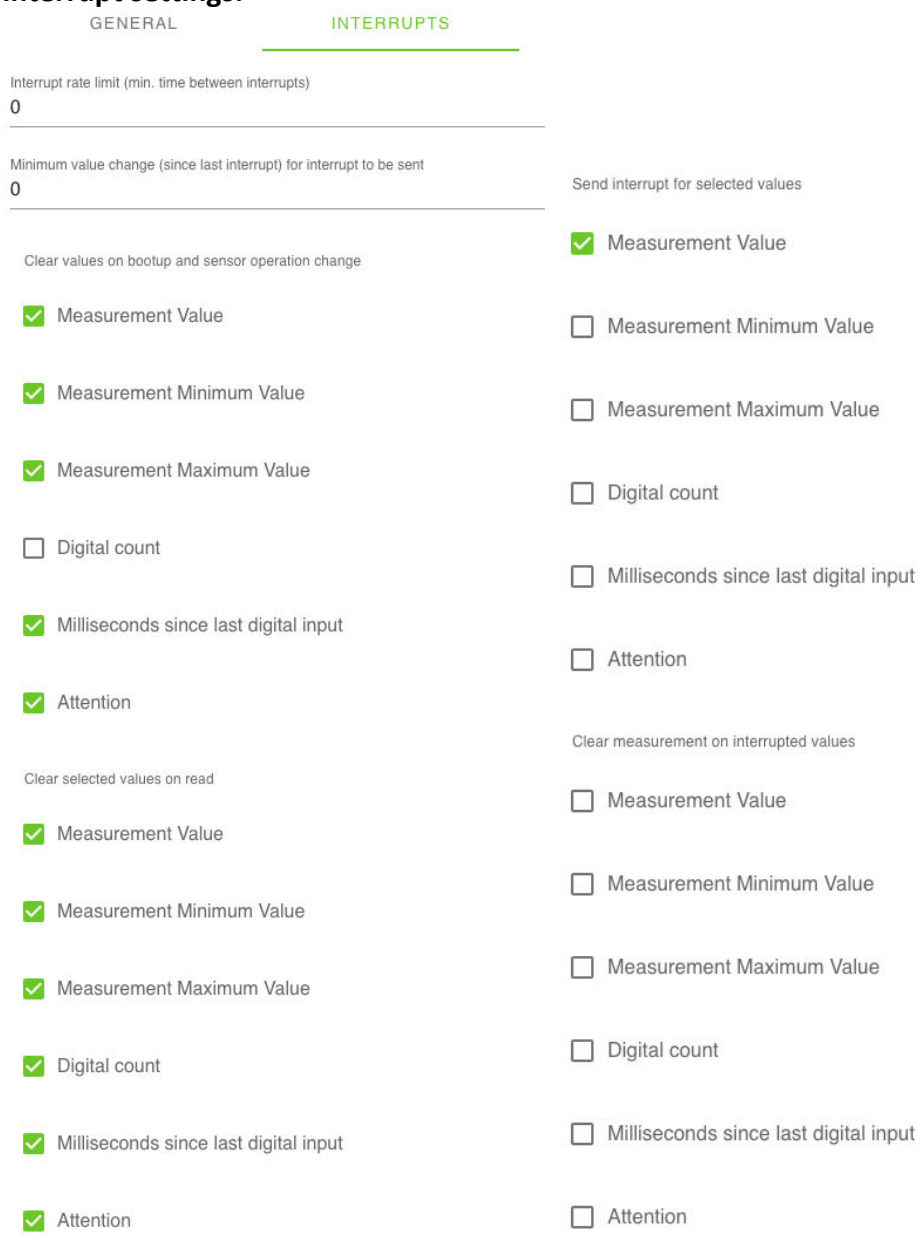
Secondary expression, usage depends on context
x gets replaced by value
Reset io value to 0 after X seconds without interrupt, 0 = indefinitely
0

Power settings:



Use the above settings for the sensor being powered by an external source.

Interrupt settings:



Use the above settings for interrupt.

Timings:
This section is irrelevant as the sensor is powered all the time.

External power supply:
As external power supply it is possible to use an extra sensor decoder setup for mA reading. It can deliver up to 25mA and the voltage can be set. Recommended configuration of the sensor decoder:

Description
TEROS-10 Power source

Expression to modify interrupt value stored in object
x gets replaced by value

Secondary expression, usage depends on context
x gets replaced by value

Reset io value to 0 after X seconds without interrupt, 0 = indefinitely
0

GENERAL INTERRUPTS TIMINGS

Input power source
8V

Input type
4-20mA

Sensor operation mode
Continuous mode, constant on

Current control
500 25 mA

Analog processing
0-20 mA, value in uA, steps of 50

Analog high measure level
20000 uA

Analog low measure level
0 uA

samples for analog input value
10

Interrupts and timing don't matter.
The extra sensor decoder to drive the TEROS-10 takes about 4-5mA of the 2-wire.

Diagram:
To connect the power supply sensor decoder and the sensor reading sensor decoder connect them as: