Use of Electronic Sensors (E-Sensors) for Tensiometers - Model 3V 500 and 3V 1000

1. Use

Electronic pressure gauges constantly measure the soil water potential on a tensiometer as a measurement of the moisture available in a substrate (= the sub pressure in the tensiometer tube). The measurements are transformed into voltage (V) and sent as an analogue signal. This signal is created by a piezoresistive differential pressure sensor in a ventilated housing with an integrated transformer for amplification of the signal (without use of an additional transmitter). The signal is radiometric and changes according to the power supply. For further use of the signal, it is necessary that it be digitalized, for example, by connection to an irrigation controller, a data-logger or a PC.

The sensors are designed for above ground usage. It is advisable to install the sensor perpendicular to the surface (operating position). However, due to the water tolerant input port, the sensors are also suited to be placed at an angle (max. horizontal to surface).

Fill the tensiometer with clean water to a level about 1-(2) mm below the upper edge of the threaded connector piece. The sensor should be firmly connected onto the tensiometer using a screw-on cap attached to the threaded connector. Pay attention that the connection does not leak: the o-ring in the screw-on cap must be clean and properly positioned!
For further operation of the tensiometer, follow the directions for use of Surface and Insertion Tensiometers.

2. Electrical Connection

Wiring Configuration			Type of Sensor
Colour	Assignment	Polarity	3V
white	power supply DC	**plus**	**3,1-3,4 V** konstant
brown	signal	minus/plus	0,3-3,0 V
green	power supply	**minus** (ground)	✓
yellow (blank) green-yellow	shield	Shield at ground	✓
	power consumption		≈ 2 mA

Constant direct voltage (DC) power is supplied via a connected device or externally. The supply cable is shielded; the shield should be attached to the ground of the connected device (pre-installed).

Caution, risk of sensor damage:
Correct polarity is imperative – false polarity will result in a short circuit of the sensor!
Damage to sensor also caused by overvoltage!

The cable should not exceed about 50 m in length; the minimum operating voltage of each sensor must be taken into consideration because of loss of voltage due to cable length.
Pay attention to moisture protection when using extension cables in order to avoid the build up of blockages or corrosion. Moulded plugs must be waterproof, min. IP 68. Alternatively, open plugs may be used as long as condense water and spray is able to dry quickly.

bambach GbR • Peter-Spring-Str. 18 • 65366 Geisenheim • Germany
Gesellschafter: Edith Bambach, Daniela Bambach • Tel: +49(0)6722-972168 • Fax: +49(0)6722-75157 • info@tensio.de • USt-Id Nr.: DE 815129733
Filiale: bambach GbR • Karlsbader Str. 28 • 74211 Leingarten • Telefon: +49(0)7131-6421200 • Fax: +49(0)7131-740981 • shop@blumat.de

3. Technical data / Maintenance

Measuring range: Model 3V 0-500 hPa; Model 3V 0-1000 hPa

Dimensions: Ø 26 mm, size: approx. 70 mm, weight: approx. 20 g, threading of screw-on cap: GL 14; operating temperature: -20° …+85°C, protection class: IP 54 (protected against splashing water). Connecting cable: 3 x 0.14 mm², length: 5 m. Maximum pressure load: 2.0 bar (by 500 hPa) and 5 bar for the 1000 hPa measuring range.

Sensor maintenance is not required. Please be sure to keep the opening between the housing and screw-on cap free for ventilation purposes (pressure equalization).

In addition, be aware of the moisture level at the operating location. It is not advisable to expose the device to longer periods of intense condensation or constant use at high humidity (>95%). Submersion must be strictly avoided, since moisture in the interior of the housing can eventually cause damage over time.

4. Sensor accuracy

Model	Reference	Measuring point	Face value	Possible deviations
3V 500	3,3 V	Zero	0,30 V	0,290 - 0,308
		Span	3,00 V	2,990 - 3,010
3V 1000	3,3 V	Zero	0,30 V	0,290 - 0,308
		Span	1,65 V *	1,60- 1,665

* The measuring range of 1000 hPa is calibrated using 500 hPa

General sensor accuracy: (range -20°…+85°C) ± 1.5 % of the maximum measured value (full scale).

Adjustment and testing of sensor: it is not possible for the user to make adjustments to values directly on the sensor. Therefore, it is strongly recommended that a connecting device is used which allows for the input of a measuring range. This is especially important for adjusting the zero point to the value actually measured (calibration) and for defining the range

⇨ Checking the zero point: connect the sensor without the tensiometer and take a reading

The maximum value (500 hPa) is usually entered digitally (see connecting device). A complete on location calibration of the sensor is difficult, because the exact end value of the pressure must be set using a calibrated manometer or an appropriately long water column (water column in cm = pressure in hPa). Therefore, one is usually limited to simply adjusting the zero point. It is advisable to occasionally check the accuracy of the zero point.

Accuracy requirements: the purpose for which the measurements are made and possible external influences are decisive for determining accuracy requirements. Generally, measurement errors of 1-2 % of the measuring range fall within the acceptable tolerance (for scientific measurements). Differences of 10 hPa are absolutely negligible when measuring soil water potential with tensiometers, especially in consideration of factors such the high variability of soil. Measuring in very wet ranges or in special substrates presents more of a challenge. Here it is more important to observe the influence of temperature and the height of the water column in the tensiometer. Technically related fluctuations in readings due to electrical influences are not unusual. Therefore, it is advisable to employ measurement damping or a not too frequent scan of the sensor input by the read-out device.

5. Considerations when measuring soil water potential

An increase in the surrounding temperature will cause a temporary decrease of the soil water potential in the tensiometer tube; this is more or less quickly compensated depending on the porosity of the tensiometer material. The larger the air volume is in the tensiometer tube, the greater the influence of temperature will be on the measured data. Therefore, in order to achieve the most accurate measurements, it is important to bleed air from the tensiometer tube regularly and, if possible, to keep the tensiometer out of direct sunlight.
When measuring with long tensiometers, it is necessary to make a correction to the measured value for the length of the water column in the tensiometer tube. The equation for the correction is:

Water potential as measured in the clay part of the tensiometer = value in hPa minus the height of the water column in cm

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