

ICT International



PSY1 Stem Psychrometer

Continuous & non destructive measurement of stem water potential in MPa (megapascal)
Complete plant water status monitoring solutions:

- Plant response to drought.
- Irrigation scheduling for all crops eg: almond, grape & citrus.
- Critical thresholds for fruit growth & sugar accumulation.
- Eco-physiology studies.
- Plant breeding & plant selection for water use efficiency.
- Minesite vegetation monitoring.



Instrument Design

Thermocouple hygrometers (or psychrometers) of various designs have been used successfully in plant science research since the early 1950's, most commonly used on a detached leaf sample. The PSY1 Stem Psychrometer developed by Professor Mike Dixon, University of Guelph, measures water potential in-situ and has been validated against Scholander-Hammel pressure bombs with excellent results in published research since 1984. (Dixon, M.A., & Tyree, M.T., 1984) A new stem hygrometer, corrected for temperature gradients and calibrated against the pressure bomb (Plant, Cell and Environment 7, 693-697.)

The PSY1 Stem Psychrometer is attached to the stem using a clamp to hold it in position using moderate pressure. A thermocouple is lifted up from the sample chamber and placed in contact with an exposed section of sapwood while a second thermocouple remains within the sample chamber measuring the chamber air temperature.

A Peltier cooling current is then applied to the junction, the differential output of the two junctions is a measure of the temperature gradient between the sample and the dew point measuring junction. By measuring the psychrometric (wet bulb) depression and applying automatic temperature correction of the error induced by temperature gradients within the chamber, precise and repeatable measurements of plant water potential are obtained.

The PSY1 Stem Psychrometer offers significant benefits over more common leaf psychrometers through the ease of attachment which minimises energy balance disruptions and improves measurement accuracy.

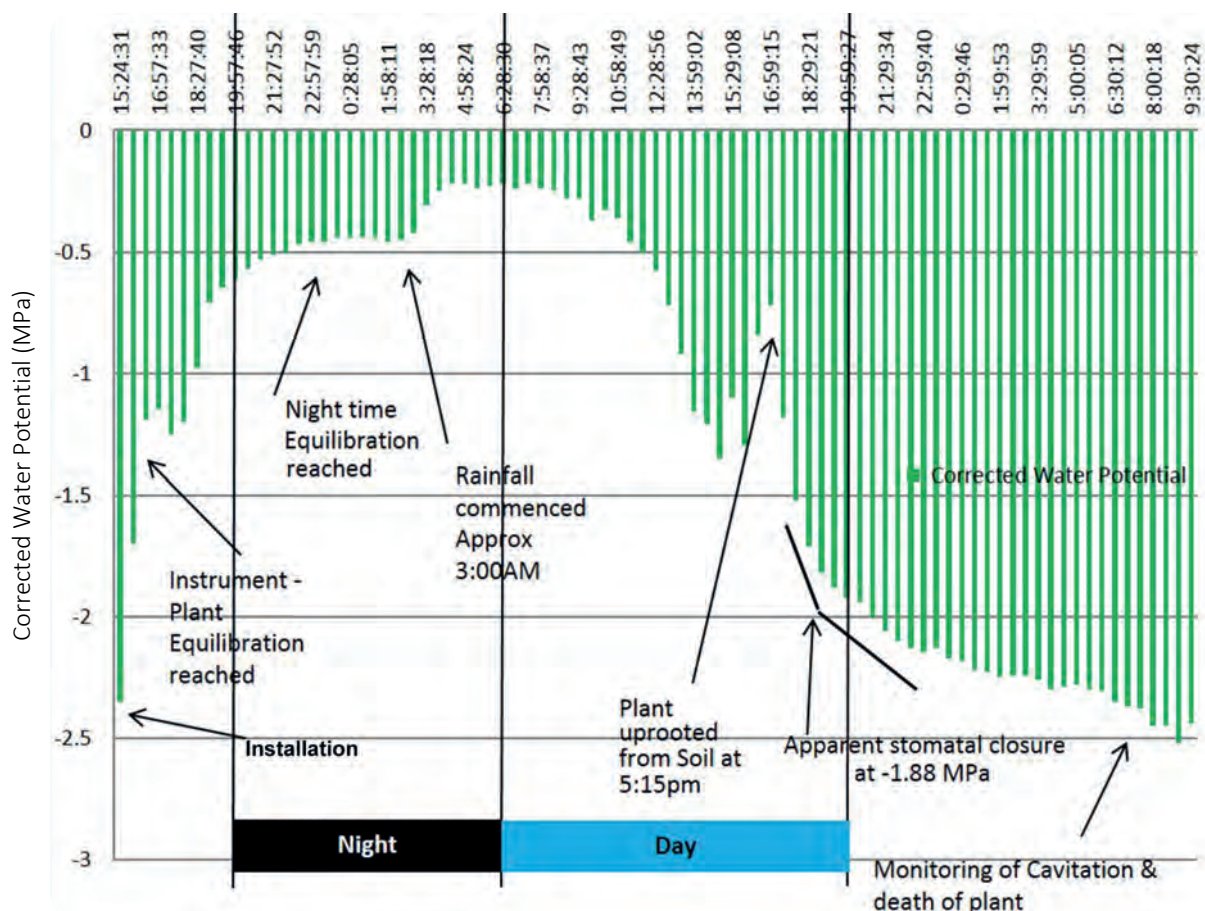
Equilibration Half-Time

Equilibration half-time for thermocouple psychrometer is varied. The range can extend from several minutes to several hours depending upon the design of the psychrometer. Variability stems from how accurately the differential temperatures are measured, whether the initial measuring junction and sample temperatures are measured or assumed and finally, how well the psychrometer is insulated from thermal gradients.

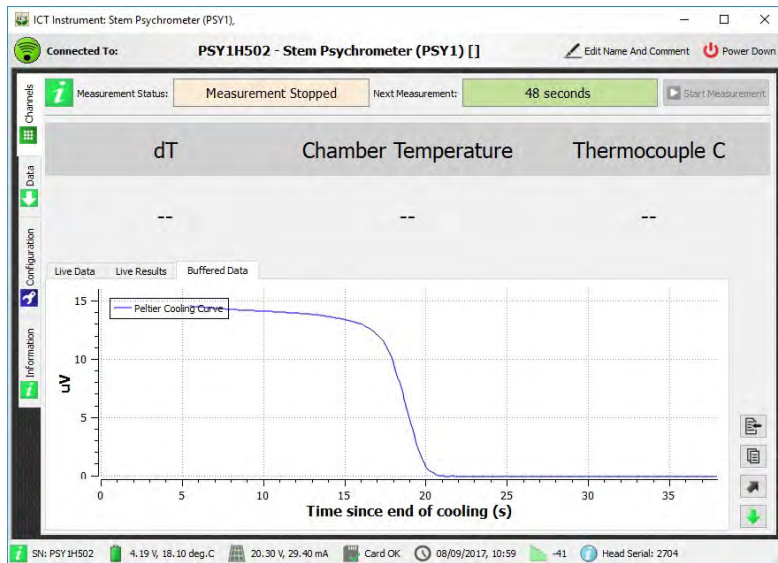
The PSY1 Stem Psychrometer measures all temperatures and assumes nothing. With good insulation, equilibration half-times as short as 60 seconds can be achieved, making it a very rapid, repeatable and reliable instrument.

Data Analysis

Data can be manually processed using a spreadsheet such as Excel by opening the comma separated Values (CSV) file provided by the PSY1. The user can customise what values are logged in the data file choosing from all raw data parameters, processed stem Water Potential in MPa and the relevant calibration and correction factors used in the data processing. Regardless of the parameters chosen all are pre-processed into engineering units ready for interpretation and analysis.



Instrument Configuration & Operation



All functions of the instrument's operation and calculations are controlled by the microprocessor, which automatically converts the analogue microvolt signals to a calibrated output. Programming variables such as; Peltier cooling pulse, duration & wait time; reverse Peltier warming, duration & wait time; Chamber heating, duration & period; measurement frequency and data logging options, are all held resident in nonvolatile memory.

The PSY1 Stem Psychrometer displays information such as External Battery Status, Serial Number, Firmware Version, SD Card Status, Measurement Interval, Data File Logging Option, & Calibration Factors.

The utility software enables the instrument to be used in the manual mode. This provides the ability to perform lab based work with destructively sampled material, osmotic potential measurements, or to evaluate the cleanliness or reliability of the chamber using the Plot Peltier Cooling Curve recording and plotting function.

Calibration Options

PSY1 Stem Psychrometer requires calibration. Depending upon the level of accuracy required you can choose to utilise a generic batch calibration with coarse generalized accuracy or a specific chamber calibration. The specific chamber calibration can be requested from ICT International at the time of purchase and this calibration is at additional cost to the instrument. Alternatively, ICT international provides detailed calibration instructions and a calibration spreadsheet to enable the user to perform their own calibration.

The calibration function automatically records raw wet bulb depressions, chamber temperatures and corrected wet bulb depression values for plotting against known solute potentials. The plot function includes each individual data point, r2 regression analysis and line, slope & intercept of the calibration curve. You can also choose to plot the current calibration against a historical calibration evaluating and comparing r2, slope and offsets of each. The calibration function is a very powerful and time saving feature. Multiple calibration files for a Psychrometer or calibration files for multiple Psychrometer chambers can be stored on the Micro SD card of the PSY1 and recalled for use with the specific chamber.

It is recommended that a full 6 point calibration (0.1, 0.2, 0.3, 0.4, 0.5 and 1.0 Molal NaCl solutions) be performed every 6 to 12 months or immediately following a serious contamination and cleaning of the chamber. The need for a full calibration and or change of calibration can then be determined using the integrated calibration function of the utility software. Calibrations should be performed both within the range of expected water potentials and at a range of expected temperatures. An extreme environment calibration range (1.2 to 2.0 Molal equivalent to -6 to -10 MPa) is included to facilitate this.



Chamber of PSY1 Stem Psychrometer sensor.



PSY1 Stem Psychrometer attached to tree branch.

PSY1 Stem Psychrometer Specifications

INSTRUMENT LOGGING

Analogue Channels	1x Input, (1x Sensor) High precision 24bit ADC circuit 1x Output – PSY Chamber Heater Circuit
Minimum Logging Interval	1 second
Delayed Start	Suspend Logging, Customised Intervals
Sampling Frequency	10Hz

DATA

Communications	USB, Wireless Radio Frequency 2.4 GHz
Data Storage	MicroSD Card, SD, SDHC & SDXC Compatible (FAT32 format)
Software Compatibility	Windows 7, 8, 8.1, 10 and Mac
Data Compatibility	FAT32 compatible for direct exchange of SD card with any Windows PC and Mac
Data File Format	Comma Separated Values (CSV) for compatibility with all software programs
Memory Capacity	Up to 16GB, 4GB MicroSD card included.

OPERATING CONDITIONS

Temperature Range	-40°C to +80°C
R/H Range	0-100%
Upgradable	User Upgradeable firmware using USB boot strap loader function

POWER

Internal Battery Specifications

960mAh Lithium Polymer, 4.20 Volts fully charged

External Power Requirements

Bus Power	8-30 Volts DC, non-polarised, current draw is 190mA maximum at 17 volts per logger
USB Power	5 Volts DC

Internal Charge Rate

Bus Power	60mA – 200mA Variable internal charge rate, maximum charge rate of 200mA active when the external voltage rises above 16 Volts DC
USB Power	100mA fixed charge rate

Internal Power Management

Fully Charged Battery	4.20 Volts
Low Power Mode	3.60 Volts – Instrument ceases to take measurements
Discharged Battery	2.90 Volts – Instrument automatically switches off at and below this voltage when no external power connected.

Battery Life varies

- With a recommended power source connected, operation can be continuous.
- 3 days at hourly logging interval without chamber heating
- 1 day with chamber heating