

---

## 5 Description

The PSY1 stem psychrometer consists of: a psychrometer chamber; calibration disk holder; and an integrated, standalone data logger with Graphical User Interface (GUI) based software for instrument configuration and data downloading. A solar panel can be directly connected to the non-polarised charging ports to trickle charge the internal battery for continuous field operation.



**Photo 1: PSY1 Stem Psychrometer.**

### 5.1 Stem Psychrometer Chamber

The psychrometer chamber is made of chrome plated brass to achieve a large stable thermal mass. Two welded Chromel-Copper, and one Constantan–Copper thermocouple are housed within the chamber. The measurement is performed by passing a Peltier cooling pulse through the C or Chamber Thermocouple to generate a Psychrometric Wet Bulb Depression (WBD). This Wet Bulb depression is automatically corrected for temperature and processed using the slope and intercept of the specific calibration for the stem psychrometer to yield Stem Water Potential (MPa)



**Photo 2: PSY1 Stem Psychrometer chamber.**

---

## 5.2 Calibration:

ICT International does not supply the stem psychrometer with a factory calibration.

Calibration of the instrument can be performed by the user. A calibration disk holder, a comprehensive software calibration function and instructions are included.

However, ICT does offer a calibration service for an additional fee. Please [contact ICT](#) for more information and a formal quotation.

## 5.3 Clamping:

A clamping device is required to attach the psychrometer to a plant stem. Two sizes of clamps are available:

- a. Small Clamp (PSY-SC) for stem sizes up to 25 mm diameter
- b. Large Clamp (PSY-LC) for stem sizes between 25 to 50 mm in diameter

Use of the stem psychrometer with larger stem sizes will require a customised clamping mechanism, and these are explained in section 17 - [Installation](#) under sub section 17.2 [Large Diameter Stems](#). However, these two basic clamp sizes should be adequate for most applications. This is because the stem water potential is an absolute measure of the integrated water potential within the plant at the point of measurement. Whilst gradients will exist vertically in the plant, stem water potential measured on a lateral branch adjacent to the stem (which may be small enough to attach a psychrometer using one of the two standard clamp sizes) will be directly representative of the stem water potential of the adjacent main stem or trunk of the plant.

## 5.4 Measurement Options:

The PSY1 Stem Psychrometer can then be used as a psychrometer for

- (1) In-situ water potential on the stem
- (2) In-situ water potential on the leaf
- (3) Water potential on excised stem tissue
- (4) Water potential on excised leaf tissue
- (5) Or as an osmometer for direct measurement of osmotic potential

## 5.5 Measurement of Stem Water Potential:

The stem psychrometer measures the psychrometric wet bulb depression, and ultimately the stem water potential of the plant, and can be used in-situ on the stem or leaf of a plant or on detached stems or leaves for dry down experiments or pressure volume curves.

---

## 5.6 Measurement of Leaf Water Potential:

Stem water potential measurements can also be performed on a prepared and insulated leaf in-situ on the plant. The leaf must be “bagged” or insulated from direct solar radiation and thermal gradients. This shuts down photosynthesis, meaning the water potential is no longer that as seen by the specific leaf, the leaf effectively becomes a manometer to the plant. The leaf is still hydraulically connected to the plant hence the stem water potential and that of the leaf come to hydraulic equilibrium. This technique has been successfully used on a range of plant types, *Shackel, K. Theoretical and Experimental errors for In-situ Measurements of Plant Water Potential, Plant Physiology, Vol. 75 1984*. Please contact ICT for more information.

## 5.7 Measurement of Osmotic Potential:

Using the calibration lid, the PSY1 can also be used to measure (destructively) osmotic potential (MPa). An abraded leaf disc or filter paper disc (saturated with extracted sap exudates from a suitably prepared sample using a freezing and physical disruption protocol to separate the symplastic fluid from the cells of the leaf), are placed in the calibration lid. To achieve good thermal insulation from ambient thermal gradients (that cause noise and measurement error), the stem psychrometer chamber must be housed inside the [Osmotic Potential Insulator \(PSY-OPI\)](#). Then, using the PSY1 software, a manual measurement can be made or repeated measurements made at a defined logging interval.

## 5.8 PSY1 Stem Psychrometer Meter:

The PSY1 is a highly accurate, high precision microvolt meter that has been custom designed to specifically measure stem water potential. It features an integrated stand-alone data logger consisting of a 24-bit resolution preamplifier and microprocessor with integrated Analog to Digital converter that outputs and logs processed data in calibrated engineering units (MPa).



**Photo 3: PSY1 logger.**

---

### 5.8.1 Water Proofing:

The custom designed enclosure of the PSY1 has an IP65 rating. This protection is across all electrical circuitry preventing water damage that is common among other field equipment.

Water proofing is achieved through a unique physically separated, but electrically linked dual chamber enclosure design. This ensures that the internal circuitry and battery can be electrically linked and charged from an external power supply without providing any physical pathway for water ingress. For this reason it is important not to open the enclosure because opening the enclosure will void the warranty and water proofing guarantee.

**NOTE 2** - there is no reason to open the enclosure as ICT have provided water proofed access to all necessary interfaces of the instrument such as USB communication port, MicroSD card and power switch.

**WARNING 2** – Water proofing cannot be achieved if the communication port cover is left unscrewed. Water entry via this port WILL cause damage and is not covered under warranty.

### 5.8.2 Power Management:

The instrument has its own internal 4.2V (950 mA) lithium-polymer battery. It features: a non-polarised power circuit; internal voltage regulation; a voltage inverter to drive a 12V heater inside the psychrometer chamber if chamber heating to prevent condensation is necessary; a regulated current generator to provide the Peltier cooling current; and optical isolation lightning protection.

### 5.8.3 External power:

External power can be supplied with a DC voltage supply from either a 20W solar panel or mains powered DC power supply. See [Charging – Powering the Instrument](#) for specific details and charging options.

### 5.8.4 Tools:

No custom tools are required for connection of power supply or instruments. External power is inserted through the non-polarised power-bus ports of the instrument utilising a unique bare wire, push fit connection mechanism. The stem psychrometer is fitted with a water proof Bulgin connector that screws to the instrument.

### 5.8.5 Power Fail Safe Mode:

In the event that power is lost due to adverse radiation levels, such as extended monsoonal cloudy conditions, the logger will enter a hibernation mode, much like a laptop. However, as soon as the battery is recharged the whole system will reactivate and recommence logging at the preconfigured intervals without human intervention. Data will not have been recorded for the period that the

---

system was in hibernation, but no data collected prior to hibernation will be lost. It is permanently stored in non-volatile memory on the MicroSD card.

#### 5.8.6 Lightning Protection:

Lightning protection is achieved through the design of optical isolation, physical interrupts and barriers into the circuit boards of the instrument. This prevents electrical discharge from lightning running throughout the circuit and destroying the instrument. This is an important protection feature against electrical discharge, but it will not prevent damage and complete destruction from a direct lightning strike on the instrument. Nothing can.

#### 5.8.7 Data Storage & Memory:

Data is stored to a 4GB MicroSD card (standard). Larger capacity MicroSD cards (up to 16GB tested) can be used if required. All SD card memory formats are supported including SD, SDHC and SDXC.

The memory capacity of the standard 4GB MicroSD card is, in theory, in excess of 500 years for the primary data file when all parameters are logged at a 10 minute temporal interval (the maximum frequency).

#### 5.8.8 Communication:

Communication with the instrument is via a direct USB cable interface to a computer. No RS232 serial to USB adapters are required. Alternatively, every instrument includes a 2.4 GHz transceiver for wireless two way communication. This feature is standard in all PSY1 instruments manufactured after April 2012 and does not require activation or upgrading of the instrument. Wireless communication up to a distance of 250m (line of sight) is achieved when used with an [MCC-Mini](#) radio modem.

#### 5.8.9 Software & Firmware:

Software and firmware updates are automatically available via the ICT web site [www.ictinternational.com/support/software](http://www.ictinternational.com/support/software). Every time you run the software and/or the instrument with internet access the web site is automatically checked for possible updates. If an update is available you are given the option to download and install the update. Firmware within the microprocessor of the instrument is automatically updated via the USB Boot Strap Loading function. The process takes less than 10 minutes and ensures your system is updated with the latest functionality and features.

#### 5.8.10 Operating Temperature Range:

Maximum operating range is between 80°C and -40°C. A minimum temperature of -40°C is possible due to the incorporation of heaters built under the microprocessor chips to warm them to -20°C, the minimum international standard operating temperature for silicon chips and microprocessors to operate at.

**NOTE 3** - whilst the instrument can operate at these extremes it is unlikely that the plant will.