

## APPLICATIONS

Whole plant water potential  
In-situ plant water potential  
Cut stem water potential  
Stem sizes > 5mm  
Crop & forest applications  
Arid ecosystems & drought

## FEATURES

Measurement options:

- Psychrometric (wet bulb)
- Hygrometric (dew point)
- Raw Temperatures

Very short equilibration half-times

Automatic temperature compensation

Microprocessor controlled

Factory calibration

User calibration options

Plug & Play operation

# Stem Hygrometer

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 stem hygrometer developed by Professor Mike Dixon, University of Guelph, has been validated against Scholander-Hammel pressure bombs with excellent results and used 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.*



Stem hygrometers offer significant benefits over more common leaf hygrometers through the ease of attachment which minimizes energy balance disruptions that improve measurement accuracy. Although a technique of vast potential, difficulty of interfacing the sensor with existing devices slowed its adoption. ICT International has now made the Dixon stem hygrometer Plug & Play once again reviving the vast potential offered by this technique for plant science research

## Sensor Design

The stem hygrometer consists of two welded chromel-constantan thermocouples connected in series within a chromium plated brass chamber that forms a large insulating thermal mass. Inside the chamber one thermocouple is in contact with the stem sample and the other simultaneously measures the chamber air temperature, and subsequently, wet bulb depression. A third soldered copper-constantan thermocouple is located within the sample chamber body to measure the instrument temperature for the purpose of temperature compensation. All temperature measurements are then included in the determination of plant water potential.

## Principle of measurement

The stem hygrometer 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. Using either a psychrometric (wet bulb) or hygrometric (dew point) measurement option and automatic temperature correction of the error induced by temperature gradients within the chamber, results in precise and repeatable measurements of plant water potential.



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## Equilibration half-time

Equilibration half-time for thermocouple hygrometers is varied. The range can extend from several minutes to several hours depending upon the design of the hygrometer. 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 hygrometer is insulated from thermal gradients. The Dixon stem hygrometer 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 unit.

## Plug & Play

Each stem hygrometer consists of a Smart Sensor interface that converts the micro-volt signal to a calibrated stem water potential in MPa. The integrated microprocessor holds resident in memory the selected calibration equation, measurement frequency and supplies a regulated excitation voltage and Peltier cooling current. This eliminates the need for any complicated programming or wiring of the stem hygrometer sensor. When used with the ICT Smart Logger the stem hygrometers can be used accurately, conveniently and economically to suit specific applications without the need for large capital expenditure.



## User defined calibration options

Each stem hygrometer is supplied with a default factory calibration surface indicative of a three dimensional surface equating the two independent variables (thermocouple voltage and temperature) to the water potential. The output of the sensor either being automatically converted to MPa or given as raw temperatures in °C together with the chamber temperature in °C for manual calculation of the psychrometric depression and conversion to MPa.

Future calibration options available under a user accessed menu system will include:

- (1) Single point calibration at a single temperature. A single NaCl solution of molality 0.05, 0.1, 0.2, 0.5 or 1 The user selecting the most appropriate solution for the application via the sensor set-up menu. The integrated microprocessor recording the microvolts and temperature to adjust the calibration surface accordingly.
- (2) Multi point calibration of between two to five NaCl solution molalities at a single temperature.
- (3) Multi point calibration at five NaCl solution molalities and multiple temperature from 5 to 35 °C.

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## SPECIFICATIONS

**Measurement range:**  
-0.01 to -10 MPa  
**Accuracy:** +/- 0.01 MPa  
**Resolution:** 0.002 MPa  
**Equilibration; half-time:** 60 s

**Sensor output:**  
**Smart Output:** Serial data  
**Raw Temperatures:** °C  
**Hygrometric (Dew Point):** MPa  
**Psychrometric (Wet Bulb):** MPa

**Sensor design:**  
**Measurement Thermocouple:**  
Chromel/Constantan  
**Quantity:** 2 in series for differential measure of sample & chamber temperatures

**Reference Thermocouple:**  
Copper/Constantan  
**Quantity:** 1 embedded in chamber body for temperature compensation

**Chamber Heater:** 1/4 mW resistor for heating/drying measurement chamber

**Calibration Disc Holder:**  
Custom machined Chromium plated brass

**Power requirements:**  
**Power Supply:** 5V DC  
**Heater Resistance:** 180 Ohms  
**Power Consumption:** 25 mW

**Cable lengths:**  
Standard cable length is 5m  
Maximum cable length 4km using Databus communications

### Dimensions:

**Hygrometer**  
**Height:** 20 mm  
**Diameter:** 25 mm  
**Weight:** 200g (including clamp)

**Interface**  
**Length:** 125 mm  
**Width:** 50 mm  
**Depth:** 25 mm  
**Weight:** 250g (including cable)

**Combined weight:** 450gm

**Related products:**  
**Plant Field Station** Unlimited channel logging system  
**EnviroStation** Automatic Weather Station  
**SL5** Smart Logger  
**HRM-30** Sapflow Sensor  
**Model 3005** Scholander Pressure Bomb