Sap Flow Sensors and Systems

- *Dynagages for stems and trunks 2 to 125 mm diameter*
- *TDP (Granier) Probes for stems and trunks 70 to > 200 mm diameter*

The latest technology for measuring the sap flow and hence the water consumption of plants and trees. Proven methods for measuring sap flow in greenhouses, nurseries and natural environments

Why measure sap flow?

Measuring sap flow directly is a key technique in understanding and regulating plant water relations. Fields of study include irrigation, agronomy, commercial growing, crop science, hydrology, tree water use, water stress, calculating water balances in forestry and in phytoremediation.

Dynagages or TDP Probes?

The choice is mainly determined by the diameter of the stem or trunk. In the middle region of diameters either method can be used.

Dynagages: Microsensors are used for the tiniest stems (2 to 5 mm in diameter). Stem and Trunk gauges are used for medium sized stems and branches up to 125 mm in diameter. One gauge is used per stem. A reasonably straight portion of stem is needed on which to mount the gauge.

TDP (Granier) Probes: are for use with stems or trunks ranging from 70 mm to over 200 mm in diameter. For the smaller trunks, one probe per tree is required. Sap velocity can vary around the circumference of a tree, so two probes are advisable for trees greater than 125 mm diameter, and four probes for trees greater than 200 mm. However, for uniform trees in a closed canopy, only one probe per tree is needed.

TDP Probes are installed in holes drilled into the sapwood; the choice of probe length is determined by the thickness of the sapwood.

Dynagages for 2 to 125 mm

- *Measure absolute mass flow - no calibration required*
- *Strap-on sensor collar, non-invasive, harmless, conform to plant size*
- *Reliable and proven method*
- *Constant heat energy balance*
- *Re-usable, portable*

TDP probes for 70 to >200 mm

- *Measure sap velocity, hence volume or mass flow*
- *Dual stainless steel teflon coated needles*
- *Granier method - empirical thermal dissipation technique*
- *Easily inserted and removed for re-use*

SF1 Dynagage Sap Flow sensors: output in grams/hour sap flow						
Gauge Class	**Example product**	**Stem dia. range (mm)**	**Height mm**	**Heater voltage**	**Power (typ) W**	**Range covered (nominal dia.)**
Microsensor	D\SGA3	2.7 - 4.0	35	2.3	0.05	2, 3, 5
Stem Gauge	D\SGA13	12 - 16	70	4.0	0.15	9, 10, 13, 16, 19, 25
Trunk Gauge	D\SGB50	45 - 65	305	6.0	1.4	35, 50, 70, 100
Logger inputs (per gauge): 3 channels DIF (<1mV full scale), 1 channel DIF (for heater voltage, <10V full scale) Cable: 1.5m standard (8 wires, with connector). Extensions: 7.6m, 15m, 22.8m, 30.5m available						
SV1 TDP Sap Velocity sensors: output in cm/hour sap velocity						
Probe Type	**Needle length/dia**	**Trunk dia. range (mm)**	**Vertical spacing**	**Heater voltage**	**Power (typ) W**	**Sapwood thickness**
D\TDP-30	30/1.2 mm	70 - 200	40 mm	3.0	0.2	30 - 70 mm
D\TDP-50	50/1.65 mm	100 - 300	40 mm	5.0	0.35	50 - 100 mm
D\TDP-80	80/1.65 mm	Over 180	40 mm	7.5	0.5	>80 mm
Logger inputs (per probe): 1 channel DIF (<1mV full scale), 1 channel DIF (for heater voltage, up to 10V full scale) Cable: 3.0m standard (5 or 6 wires, with connector). Extensions: 7.6m, 15m, 22.8m available						
D\AVRD:	**Dual Adjustable Voltage Regulator type D\AVRD** Dynagages and TDP probes have heaters which require a continuous source of power and an adjustable voltage level to control the heater power during the initial set-up. The D\AVRD has two independently adjustable voltage outlets suitable for all probe types. Each channel outputs 1.5V to 10V (max. current 3A) and can cope with a recommended 4-8 sensors of a similar type (or voltage requirement).					

Measurement principles

Both types of sensor use a constant heat input but they derive their results in different ways. They are not heat pulse methods.

Dynagages consist of a heater element which is strapped round the stem of the plant and insulated from the ambient conditions. The plants are heated typically only 1° to 5°C. Thermocouples built in to the gauge measure the heat carried away by the sap flow, which can be converted into real-time sap flow (in g/h or kg/h). This is an absolute measurement and does not require calibration. The principles of the heat balance method have been scientifically proven over 10 years and references exist for many major crops and tree species.

TDP probes feature improved needles used with the Granier technique (ref.1). Each probe has two thermocouple needles which are inserted into the sapwood, the upper one containing an electric heater. The needles measure the temperature difference (dT) between the heated needle and the sapwood ambient temperature below. The dT variable and the maximum dTm at zero flow provide a direct and calibrated conversion to sap velocity.