



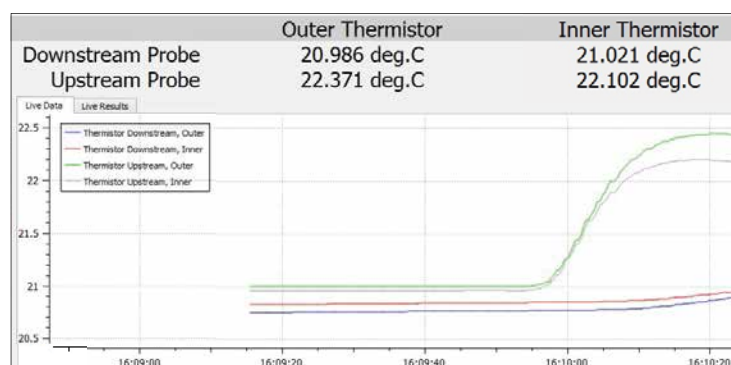
SFM1-X The IoT Sap Flow Meter



The SFM1-X Sap Flow Meter Instrument

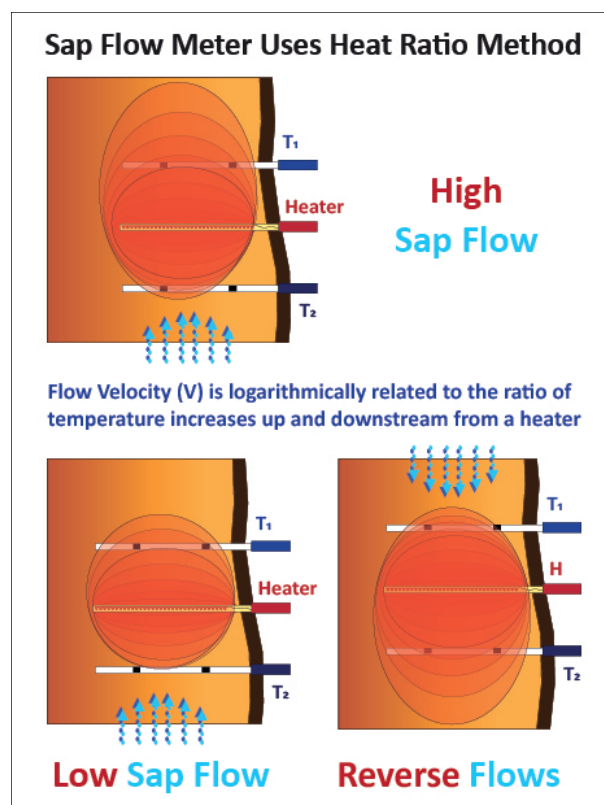
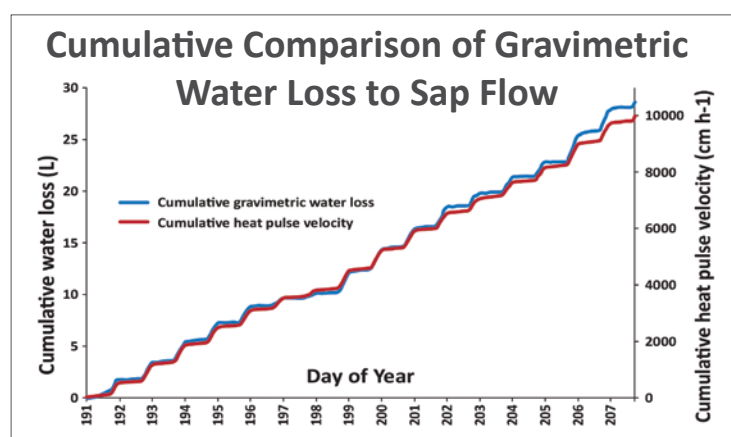
SFM1-X Design, Configuration & Operation

The SFM1-X Sap Flow Meter uses the Heat Ratio Method (HRM) to measure Sap Flow Velocity. The SFM1-X HRM probes consist of three 35mm long needles integrally connected via on-board ADC and microprocessors. The top and bottom probes contain two sets of high precision thermistors located at 7.5mm and 22.5mm from the tip of each probe. The third and centrally located needle is a line heater that runs the full length of the needle to deliver a uniform and exact pulse of heat through the sapwood. All aspects of the instrument's operation and calculations are controlled by the on-board microprocessors which automatically convert the analogue signals to a calibrated result.



Plant Water Use Accurately Monitored

The HRM principle has been validated against gravimetric measurements of transpiration and used in published sap flow research since 1998. The SFM1-X measurements of sap velocity and hence tree water use (litres/hour & litres/day) are accurate and enable true water use rates to be calculated for quantification of tree water use, critical for irrigation management, forest water use and urban tree heat index calculations as examples.*

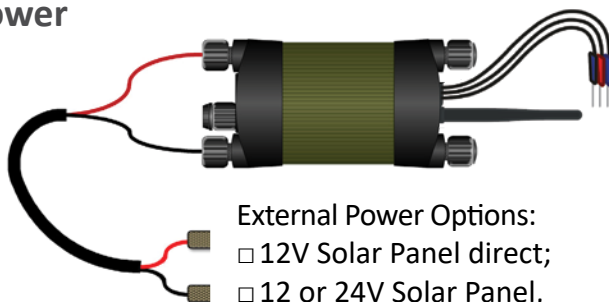


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SFM1-X Sap Flow Meter Power



Insert the ICT Bus Plugs into the endcap of the sensor. The plugs can be inserted into either polarity.



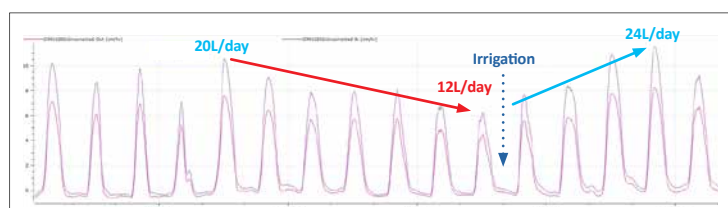
External Power Options:

- 12V Solar Panel direct;
- 12 or 24V Solar Panel, battery & charge controller;
- 12-24V DC power supply.

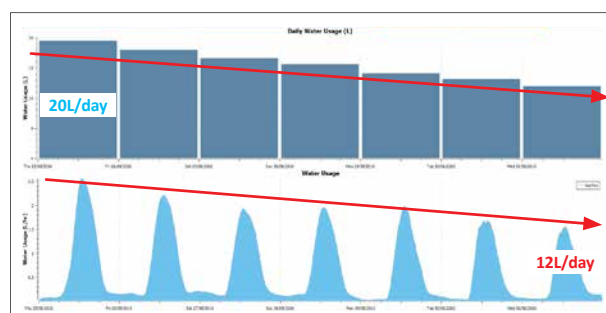


Sap Flow Data Display

The SFM1-X can be readily programmed and also data downloaded and displayed in the field. The DATAVIEW software calculates and displays sap flow in real time as well as in Litres/Hour & Litres/Day, either in the field or from a cloud API. The data is available as a .csv file in the field or from a rest API for display in DATAVIEW, or cloud-based display platforms.



Time series overlay of sap velocity (Inner & Outer) 7 days prior to irrigation showing a steady reduction in sap velocity.



Changes in Plant Water Use 7 days prior to Irrigation.

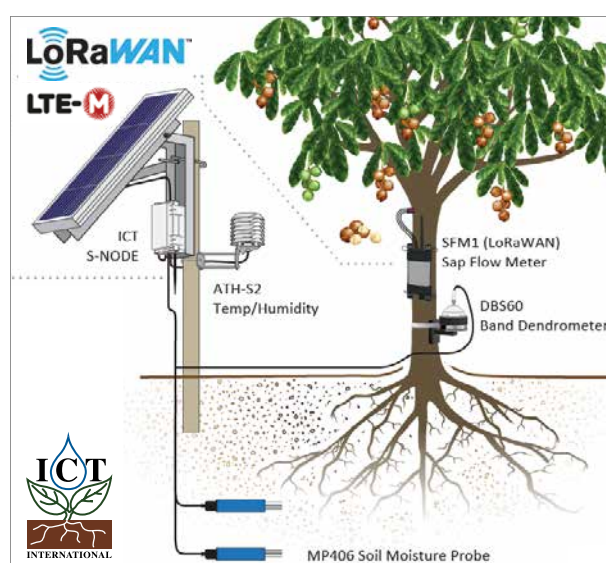
SFM1-X Communications

The SFM1-X has been designed to provide flexible communication. With an **onboard SD-Card**, it provides **stand-alone data logging capabilities** and **full data redundancy in the event of temporary loss of communications or dropped packets** – ideal for research applications. Data is stored in .csv format for ease of use.

The SFM1-X features an UCM (Universal Communications Module) that enables a customer to choose from:

- Non-IoT Communications – Download data via Bluetooth or USB;
- LoRaWAN™ – Low-Power Long-Range connectivity;
- LTE-M / Cat-M1 – Utilising existing mobile networks.

ICT LoRaWAN and LTE-M/Cat-M1 provide data which is open-format and free from proprietary formatting or decoding. This provides full control of data from the point of sensing and allows the end user full flexibility in how they collect, store and view data.



ICT International's integrated Sensor-Node IoT packages (SNIp) provide off-the-shelf configured monitoring solutions. The full range of SNIps is available in the IoT catalogue or at www.ictinternational.com.

The SFM1-X Sap Flow Meter Specifications

Measurement	
Output Options	Raw Temperatures: °C (Only SD-Card Logging); Heat Pulse Velocity: cm hr ⁻¹ ; Sap Flow: cm ³ hr ⁻¹ (Litres hr ⁻¹).
Range	-100 to +100 cm hr ⁻¹
Resolution	0.01 cm hr ⁻¹
Accuracy	0.5 cm hr ⁻¹
Measurement Duration	120 seconds
Heat Pulse	User Adjustable: 20 Joules (default) approx. equivalent to a 2.5 second heat pulse duration, auto scaling.
Logging Interval	User Adjustable; Minimum: 10 minutes.
Needle Dimensions	Needle Diameter: 1.3mm; Needle Length: 35mm.
Measurement Points	Positions: 2 per measurement needle; Spacings: 7.5 mm and 22.5 mm from the needle tip.
Data	
Communication Options	Standard: Bluetooth, USB; Optional Choice of LoRaWAN or LTE-M Cat-M1
Data Storage	Up to 16GB, 8GB MicroSD Card (Standard). Data Stored in .csv format.
Logger Body	Dimensions LxWxD: 210mm x 80mm x 35mm; Weight: 530gm.
Power	
Internal Battery Specifications	18650: 3450mAh Li-Ion, 4.2v 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	Can be connected continuously to an external power source (battery / 12-24V DC power supply) for continuous operation. A recommended power source connected, operation can be continuous. Approximately 3 days with a heat pulse of 20 joules and a measurement interval of 10 minutes - no external power present to recharge battery.

**Burgess, S.S.O., et. al. 2001. An improved heat pulse method to measure low and reverse rates of sap flow in woody plants Tree Physiology 21, 589-598.*