8 Powering - Charging the instrument

The SFM1 is a stand-alone instrument designed for long term deployment in remote areas for continuous, unattended logging applications. Each instrument has an internal 4.2 V (1,000 mA) lithium polymer, rechargeable battery. The microprocessor is a sophisticated low power chip and the instrument operates between 4.2 V to 3.65 V using on average only 3.5 mA in idle state. An integrated voltage inverter provides the 12 V supply required to fire the measurement Heat Pulse at the required energy level in Joules as configured by the operator in the SFM1 software.

At the heart of the instrument is a very sophisticated charging circuit that features a non-polarised, two-wire power-bus. This eliminates the chance of damaging the electronics by incorrect wiring of the positive and negative terminals from an external power supply. A purpose designed and built internal charging regulator, regulates supplied voltages, between 4-30 V DC, preventing overcharging of the internal battery to ensure a long service life.

NOTE 12: ICT recommends the use of 12V DC main powered supplies as they are readily available and minimise power loss through regulation, thus maximising power efficiency.

8.1 Power Requirements

All power inputs and requirements are monitored, controlled and logged by the SFM1 instrument. Using a sophisticated power supply circuit under microprocessor control, the SFM1 uses very little power.

8.1.1 Idle State Power Consumption

In the idle state, between heat pulses, the current consumption is only 25mA continuous. During a measurement cycle this rises to 45 mA for approx. 120 seconds, with a peak consumption of 670 mA for no more than a maximum of eight seconds during the firing of the heat pulse.

8.1.2 Communications Power Consumption

Communicating to the SFM1 via USB or radio, uses approx. 65 mA continuously during communication. The total power consumption depends on the frequency and duration of communications.

8.1.3 Heater Power Consumption

SFM1 heater filaments are manufactured to strict specifications and all have resistances of exactly 18.0 ohms. The microprocessor of the SFM1 can precisely control the amount of current flowing through the heater circuit to achieve the exact pulse energy in Joules as configured by the operator, see Pulse Energy for details. This means that all SFM1 Sap Flow Meters perform identically and should a heater need replacing, it can be replaced without any change to the instruments performance.

NOTE 13: the HRM principle being a ratio method is not sensitive to the absolute amount of heat released. The measurement is based on the ratio of the temperature rise of each symmetrically placed measurement point in the stem.

The heaters use approx. 8 watts of power when active (12 V @ 667 mA through an 18 Ohm resistor/heater). The heat pulse delivered by the heater is typically on for approx. 2.5 seconds every 30 minutes, so average power use by the heaters is only 8x2.5/(1800) = 11 mWh.

NOTE 14: All Heat Pulses are generated from the internal battery regardless of any external power source that may be connected. A Super Capacitor integral to the heater circuit buffers the instantaneous current draw on the battery to maximise the longevity of the battery.

8.2 External Power Supply Options

When the SFM1 is connected to an external power supply the instrument is powered directly from this power source bypassing the internal battery, except for the heat pulse. The measurement Heat Pulse is always supplied directly from the internal battery this is to ensure continuity of supply from a regulated stable power source for the very high, instantaneous current required for the heat pulse. The internal 4 V lithium battery of the SFM1 is trickle charged at a very low rate by the external power supply to maintain its full charge.

8.2.1 External Battery-Only Power Supply

It is possible to operate the SFM1 at hourly logging intervals on 20 Joule pulses for approx. 24 hours using only the instruments own internal battery. Whilst convenient, this is of minimal practical use for long term field deployments. A small 7 Ah external battery can operate the SFM1 (at 10 minute temporal logging and 20 Joule pulses) for up to seven (7) days before needing to be recharged or exchanged for a fully charged external battery see Appendix SFM1 External Battery Operation Test (without Solar Panel)

NOTE 15: The SFM1 can operate for up to 24 hours using its own internal battery. This provides a unique advantage in that external power supplies can be disconnected and exchanged without losing power to the instrument. This prevents disruption to logging and avoids the need to reconfigure the instrument should it be necessary to adjust or change external power supplies.

ICT recommends the use of 85 Ah to 100 Ah sealed, lead gel acid, deep cycle batteries. Deep cycle batteries are recommended because they are specifically designed to handle successive charge and discharge cycles without damage. Sealed lead gel acid batteries are preferable to standard wet cell "car batteries" because they do not require maintenance or refilling with water. Wet cell "car batteries" can be used, but are susceptible to spillage when transporting to the field and can lose electrolyte rapidly during summer conditions. They will also not have the same service life as a deep cycle battery and will require more regular replacement. Battery size and quantities of batteries can be calculated and simulated for possible experimental designs via the Solar Power Calculator on the ICT web site http://www.ictinternational.com/powercalculator.html

NOTE 16: ICT does not supply 12V batteries because the shipping & dangerous goods costs to do so are prohibitive. ICT recommends where multiple SFM1 are daisy chained to a single battery all batteries used (either wet cell "car battery" or deep cycle) should have a minimum current rating of 85 Ah (or preferably greater). ICT also recommends the use of a battery box. This is a plastic enclosure typically custom moulded to fit a large battery, that will protect the battery from environmental elements that will cause a reduced service life and supply problems. Ask your battery supplier for details.

8.2.2 Solar Power Supply

A solar panel can be connected directly to the Sap Flow Meter via the non-polarised two-wire power-bus, using the unique power-bus plugs on either side of the instrument. The SFM1 does not need a solar regulator when using it with a solar panel. Please see the schematic Connecting Power directly via a solar panel that illustrates the connection and the Solar Panels section for determining the correct solar panel capacity for your research.

WARNING 4 When connecting power to the SFM1 use the power bus-ports on either side of the instrument at the same end. Do not split the power input with on one input top and bottom on the same side of the instrument. The gold plated copper pipes run the entirety of the instrument on each side, and whilst the power supply circuit is non-polarised placing a positive and a negative input into the same pipe (top and bottom of the instrument), this would cause a short circuit.

8.3 Extension cables

Because the SFM1 regulates and trickle charges the internal battery, a low impedance, expensive extension cable is not required. A common, low cost (and readily available) “figure-8” or “lamp cord” cable is all that is required and can be used over long distances and cut to size as required to connect an external power supply and/or daisy chain multiple devices together to share a single external power supply.

NOTE 17: the outer diameter of the insulating sheath of each conductor core of the “figure-8” or “lamp cord” cable should be no greater than 3 mm.