

# Sap Flow Sensor Installation

## A Quick Guide

### **WARNING!**

Only ever start a measurement of the Sap Flow Sensor when the needles, or probes, are embedded inside a material such as the foam block or a tree. **NEVER** start a measurement when the needles are in air. This may cause damage to the heater element and void warranty.

### **WARNING!**

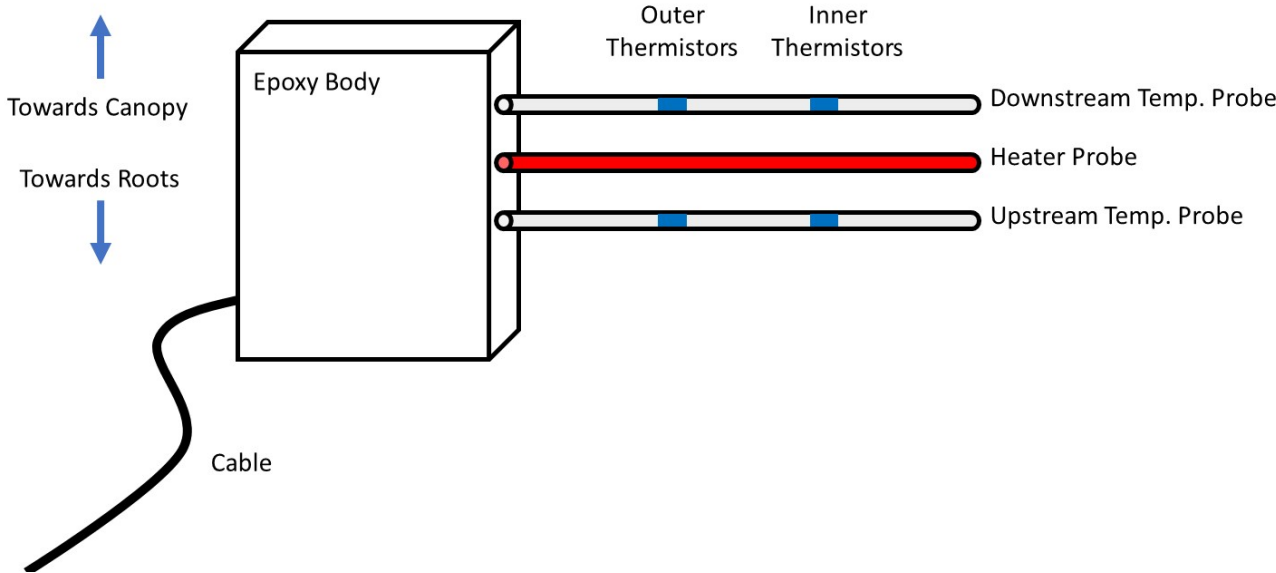
The most frequent data collect interval is 10 minutes. An SDI-12 M! command should never be sent to the sap flow sensor more frequently than 10-minute intervals.

### **WATCH THE YOUTUBE VIDEO!**

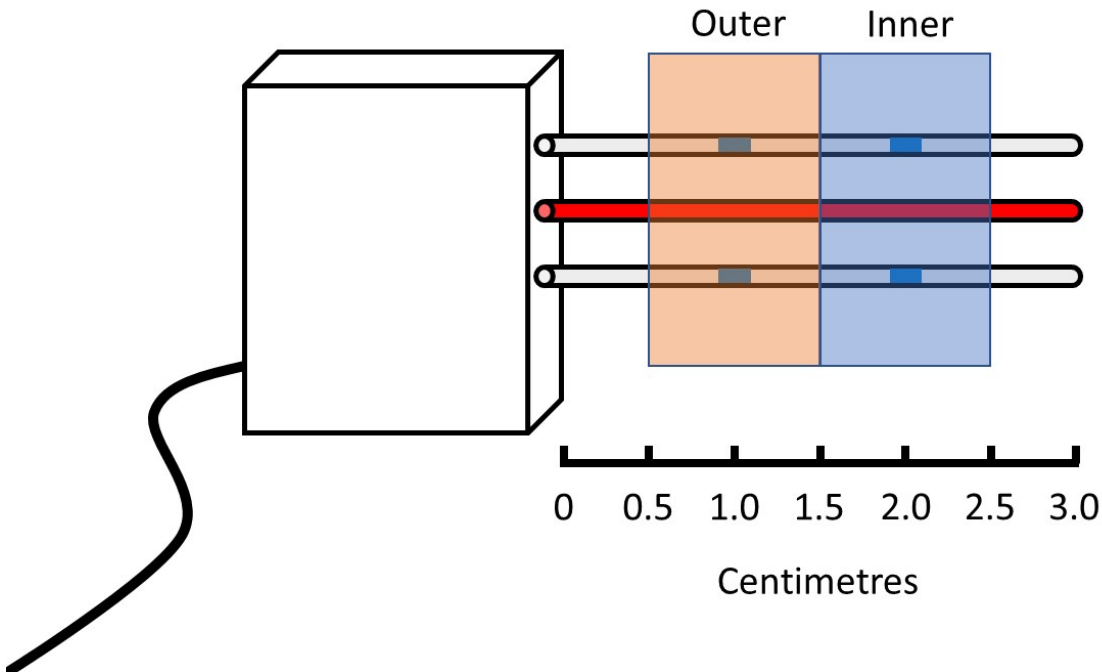
There is a brief, 2-minute YouTube video demonstrating how the Implexx sap flow sensor should be installed. We strongly recommend you watch the video now:

<https://www.youtube.com/watch?v=QJXdQWPkfeE>

# Sap Flow Sensor Design Overview



## Outer and Inner Measurement Zones



## IMPORTANT TIP!

The first set of steps is to choose a tree to measure, an installation site on the tree, and to measure some tree parameters. It's a good idea to do this step before you have received the sap flow sensors or before you begin installing sensors.

### ***Step 1: Select an installation site***

- (a) - Choose a representative or study tree of interest.
- (b) - If you are installing a single sensor on the tree, install the sensor on the north face (if you are in the Southern hemisphere) or south face (if you are in the northern hemisphere).
- (c) - If you are installing two sensors, install one on the north and south face; if you are installing four sensors, install one on the north, south, east and west face, and so on.
- (d) - To measure whole tree water use, install the sensor beneath lowest branch. That is, install the sensor beneath all the leaves so you are measuring the entire canopy. Avoid any obvious scars, decay, wounding, damage, etc.
- (e) - It's not always critical but try and install the sensor above the root stock.
- (f) - The golden rule is to be consistent. For all your installation sites on different trees, install the sensor in a similar location.

### ***Step 2: Measure tree and wood parameters***

- (a) - Measure trunk diameter (TDD), in centimetres, where the sensor will be installed.
- (b) - Measure bark depth (BDD), in centimetres, close by to where the sensor will be installed.

### ***Step 3: Measure dry density of wood (DDW) also known as sapwood density***

- (a) - DDW is a critical parameter for the calibration co-efficient. You can either measure it directly on your tree with a stem borer or contact Implexx Sense for more information.
- (b) - DDW should be measured as grams per centimetre cubed ( $\text{g/cm}^3$ ). Values range between 0.100 and 1.200  $\text{g/cm}^3$  with typical values ranging between 0.400 and 0.800  $\text{g/cm}^3$ .

## IMPORTANT TIP!

The second set of steps is to configure your sap flow sensor for your installation site. You will need to know trunk diameter (TDD), bark depth (BDD) and dry density of wood (DDW). You will also need to have some knowledge or experience with configuring SDI-12 communication style sensors. Implexx Sense can provide a device where you can talk directly to the sap flow sensor via SDI-12 communication.

### ***Step 4: Configure SDI-12 settings in the sap flow sensor***

- (a) - Consult the sap flow sensor integrator's guide for complete details on the SDI-12 settings available in the sap flow sensor.
- (b) - Use the following SDI-12 commands to perform these basic configuration functions:
- (c) - ?! ENTER – returns the sensor's SDI-12 address. The default address is 0.
- (d) - 0XTDD! ENTER – returns trunk diameter value for sensor address 0. Default value is 10.0 cm.
- (e) - 0XTDD=24.3! ENTER – changes the trunk diameter to 24.3 cm. Instead of 24.3, insert the value for your trunk diameter which you measured in Step 2(a).
- (f) - 0XBDD! ENTER – returns bark depth value for sensor address 0. Default value is 0.5 cm.
- (g) - 0XBDD=0.2! ENTER - changes the bark depth to 0.2 cm. Instead of 0.2, insert the value for your bark depth which you measured in Step 2(b).
- (h) - 0XDDW! ENTER – returns dry density of wood for sensor address 0. Default value is 0.400 g/cm<sup>3</sup>.
- (i) - 0XDDW=0.558! ENTER – changes the dry density of wood to 0.558 g/cm<sup>3</sup>. Instead of 0.558, insert the value for your dry density of wood measured in Step 3.
- (j) – You may have more than one SDI-12 sensor connected to your bus or data acquisition unit. SDI-12 sensors can never have the same address. Therefore, you will need to change the address of at least one SDI-12 sensor. To change an address, use the following command: 0A1! ENTER. This command will change sensor address 0 to address 1.
- (k) – your sap flow sensor is now configured and ready to install into the tree.

### ***Step 5: To remove or not remove bark?***

See diagrams on page 6 and 7 for detailed information.

- (a) – Ideally, you should minimise the impact or damage on the tree when installing a sap flow sensor.

- (b) – Bark should only ever be removed if it is thicker than 0.5 cm depth. In Step 2(b), if you measured bark depth (BDD) as greater than 0.5 cm, then you will need to remove some bark. If the BDD value is less than 0.5 cm, then do not remove bark.

- (c) – If bark depth (BDD) is greater than 0.5 cm, carefully remove bark, with a dissecting blade or chisel, so that BDD equals 0.5 cm.

### ***Step 6: Apply thermal grease to the needles or probes***

- (a) – Before you start drilling, it's always a good idea to apply thermal grease to the sap flow sensor needles.

### ***Step 7: Drilling into the tree***

- (a) – Strap or cable tie the drill guide to the tree. Ensure the 3-holes on the drill guide are aligned with the direction of sap flow.

- (b) – Insert the drill bit into the chuck of the drill. You only need to insert the drill bit 2 or 3 mm into the chuck.

- (c) – Start drilling into the tree.

- (d) – Minimise your impact on the tree by drilling in short, sharp steps. You should only drill a few millimetres at a time and frequently cleaning the flute of the drill bit.

- (e) – Golden rule – short, sharp and clean cuts!

- (f) – Only remove the drill guide after you have completed drilling all 3 holes. If the drill guide is removed before this, you will need to start again.

### ***Step 8: Inserting the sap flow sensor into the tree***

- (a) – Remove the drill guide (only after all 3 holes have been completely drilled through).

- (b) – As quickly as possible, insert the 3 needles of the sap flow sensor into the drilled holes.

- (c) – The needles should slide into the holes firmly but with no resistance.

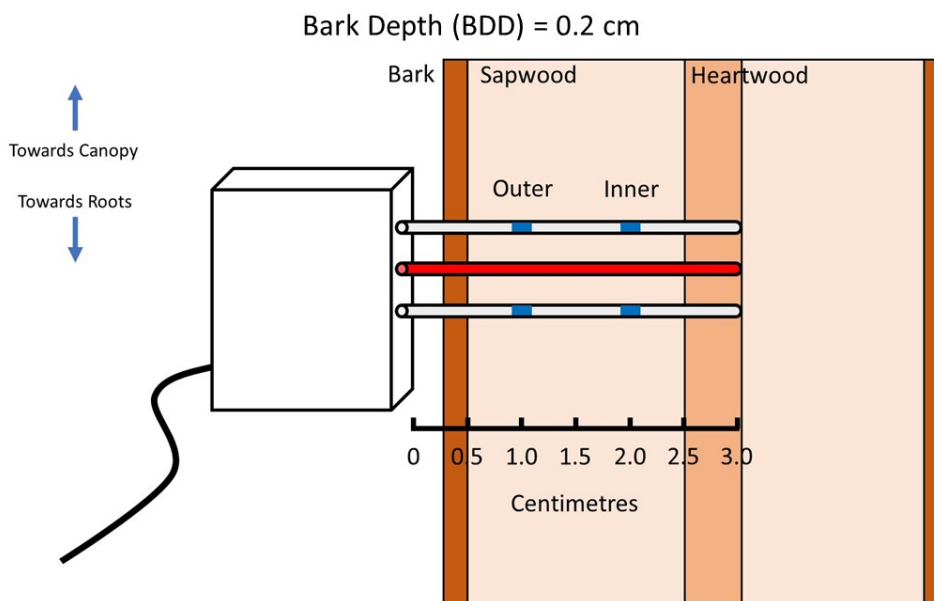
- (d) – Occasionally, the needles do not insert entirely into the holes. You may need to carefully remove the needles and re-drill the holes to a deeper depth. Always be careful with this step.

- (e) – Always position the outer thermistor at 0.5 cm depth beneath the bark or into the sapwood. See diagrams on pages 6 and 7 for further information.

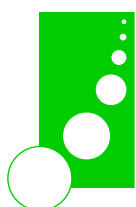
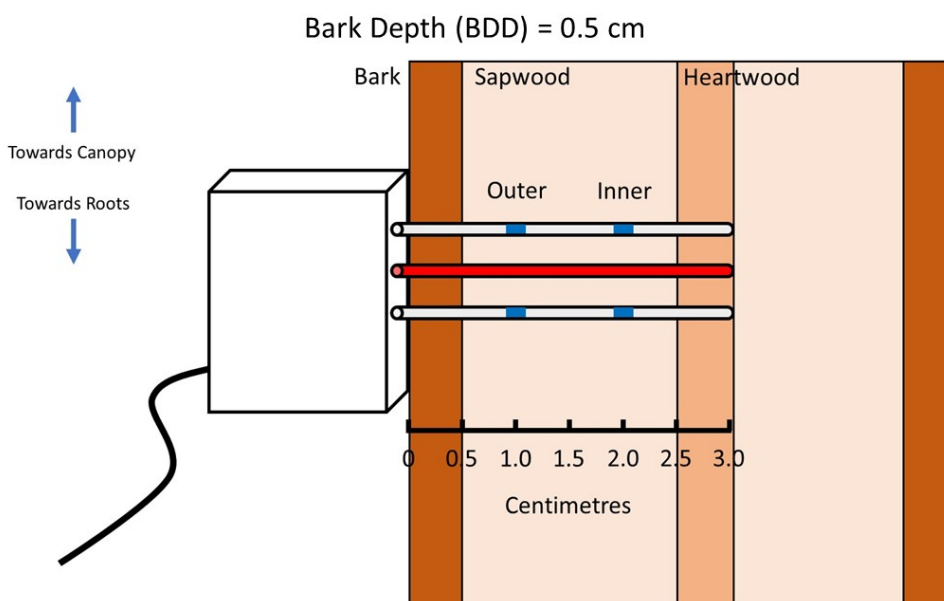
## WARNING!

The sap flow sensor must always be installed so the outer thermistor is at 0.5 cm depth into the sapwood. If the bark depth (BDD) is less than 0.5 cm, this will mean a small portion of the sap flow needles will not be inside the tree. This is not a problem. Simply insulate the exposed portion of the needles with foam and aluminium foil.

Thinner bark: a portion of the probes will be outside of the tree. Insulate this with foam/aluminium.

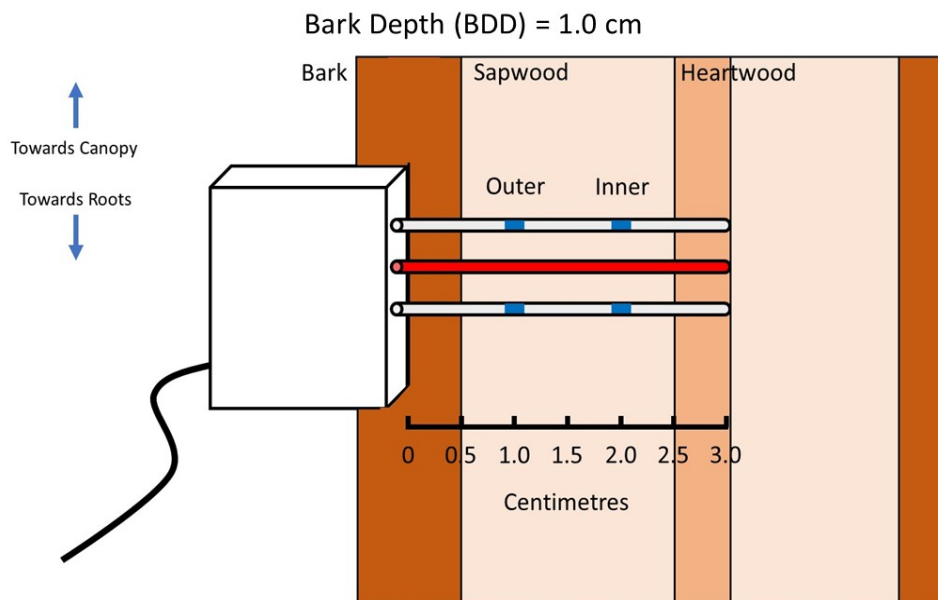


“Normal” bark: do not remove any bark when thickness is approximately 0.5cm.



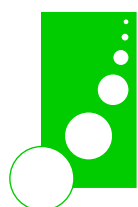
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Thicker bark: carefully remove a portion of the bark with a dissecting blade or chisel until bark depth is approximately 0.5 cm.



### ***Step 9: Insulate Sensor Installation with Aluminium Foil***

- Wrap a generous amount of foil around the sensor and stem. This reflects direct sunlight and external heat to avoid any errors associated with thermal gradients.



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***Step 10: Connect the sap flow sensor cable to the data unit***

- (a) – The sap flow sensor has a 3-core (wire) cable that must be connected to a data acquisition unit, data logger or data transmission unit. Wiring: Red – 12 VDC power; Black – ground; White – data. Or: Brown – 12VDC power; Green – ground; White – data.

***Step 11: Tidy up the installation site***

- (a) – Carefully mount the sap flow sensor digital interface box to the tree or stake. Ensure there is no tension on the cables or wire. Always place cable inside conduit.

***Step 12: Start collecting data***

- (a) – Ensure your data unit is properly programmed, connected to enough power (e.g. solar panels and batteries).

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