



1. Installation guide (September 2010)

The following pictures will guide you through the installation procedure. Please note that proper installation of the measuring point is essential condition for getting reliable results.

1.1. Tools

Installation tools (and also some consumables) are placed in a soft case. The items stored here are mainly:



1/ main tool assembly



3/ bark & phloem thickness gauge



2/ lateral electrodes pointer



(asymmetrically sharpened!)



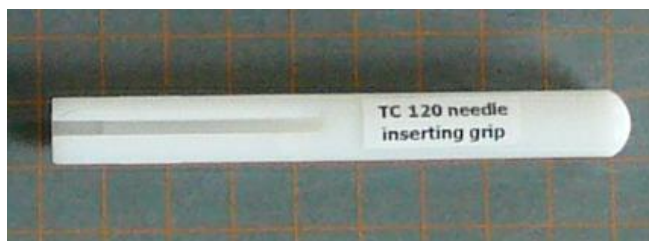
4/ electrode bumper



6/ electrode extractor



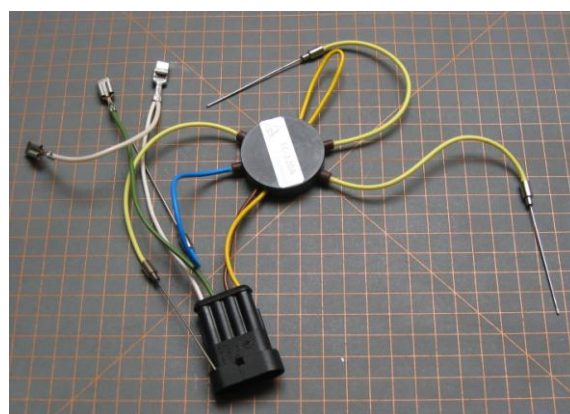
5/ needle guide



6/ needle extractor



and also a hammer, straps, pocket tape measure, electrodes and thermosensors (if they are not stored in separate boxes).





1.2. Installation procedure

1.2.1. Measurements

There are three important dimensions that should be measured:

- DBH, measured at 1.3 m [cm]. It is usually used for scaling purposes.
- Circumference at the measuring point level [cm]. Measuring point is usually located higher than 1.3 m since the sap flow variability around the trunk circumference decreases with the high above the ground.
- Bark and phloem thickness [mm]. This value is important for (i) assessment of xylem (cambium) circumference, which is necessary for exact calculation of the whole tree sap flow rate, (ii) for estimation of proper depth of electrodes. Each electrode used for xylem heating has an insulated part that has to fit to above cambium layers in order to avoid passing the electric current by high conductive phloem tissue (*Cermak et al., 2004*).

Both circumferences are measured by a common pocket tape measure, bark and phloem thickness needs a special tool and it is measured later after the main tool assembly is fixed.

1.2.2. Main tool assembly installation

Clean the bark surface by hand or by a blunt tool like hammer, piece of wood or a similar stuff. Some tree species (pine) need to remove the upper rough bark by a special sharp tool (drawknife). The rest of bark and phloem layer should not exceed 15 mm.



Find the best position for tool inside the brushed area. Think also about the space necessary for weather protection shield; avoid old knots and all kind of irregularities.



Wrap the strap around the trunk, thread it through the clip and tighten it firmly.



1.2.3. Bark & phloem thickness measurement

With respect to the formula for calculation of the whole tree sap flow:

$$Q_{tree} = Q * (A - 6.28 * B) ; [kg/hr]$$

Where: A = trunk circumference [cm] and B is bark & phloem thickness [cm].

In contrast to easy measurement of circumference, the second value needs a special gauge (see above). It should be inserted e.g. into the hole for central or reference electrode and hammered gently until the change in sound indicates the cambium layer. Then, the bark & phloem thickness value is read on the scale.





1.2.4. Lateral electrodes pointer



By smaller trunks up to ca 20 cm in diameter the lateral electrodes tend to slide along the tree rings and turn aside. This event can be reduced by using a special tool – lateral electrodes pointer. Its knife-edge is sharpened asymmetrically. When it is hammered prior to the electrode into the same place, it helps the electrode to find out the “right” direction.

Please note the sign on the moving part – it must always point to central electrode!

Note: Both last mentioned tools sometimes have to be drawn out by means of the toll used mainly for extracting of electrodes and thermosensor needles:



Watch your fingers!



1.2.5. Inserting electrodes

Inserting electrodes requires the most important and just on the first look simple tool - electrode bumper. The tool has flexibly fixed hammering rod that considerably eliminates accidental side strokes sideways the tool axis. Using of the tool is clear, however, **hammering needs forceful strokes**.



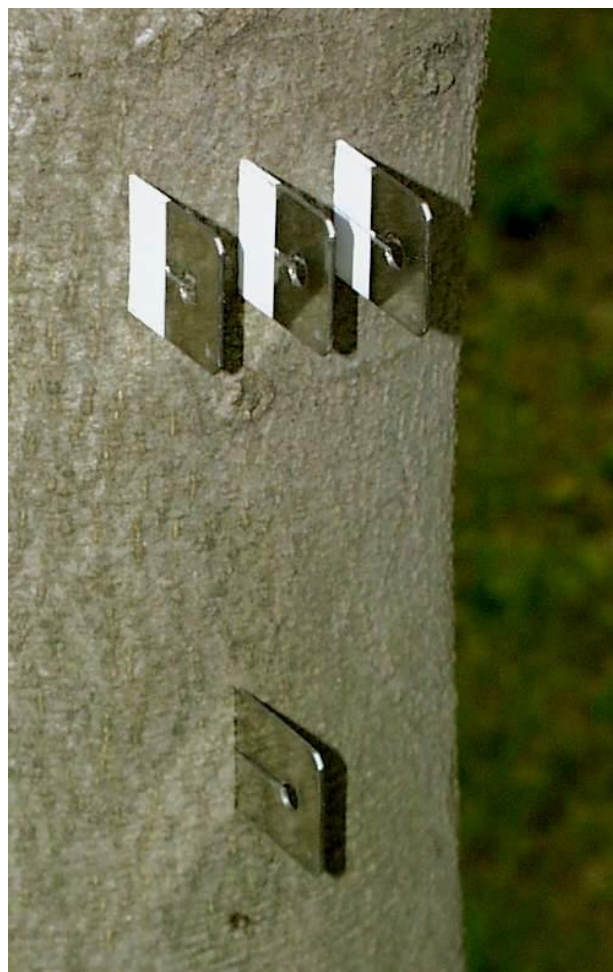
The hammering has to be stopped as the bark and phloem thickness value is reached on the scale. This way assures the proper position of insulated part of electrode in radial direction.





The good result is indicated by easy removing of main tool assembly from electrodes. Outstanding parts of electrodes have to be parallel to each other. Invisible parts of white insulation cover the phloem and living parts of the bark in order to avoid their heating by electric current passing between electrodes.

Important: the reference electrode is not used as an electric terminal. Therefore it is not insulated. It must not be used as a terminal one! And vice-versa – originally insulated electrodes must not be used instead of reference one – their slots are too narrow for reference thermosensor needle!

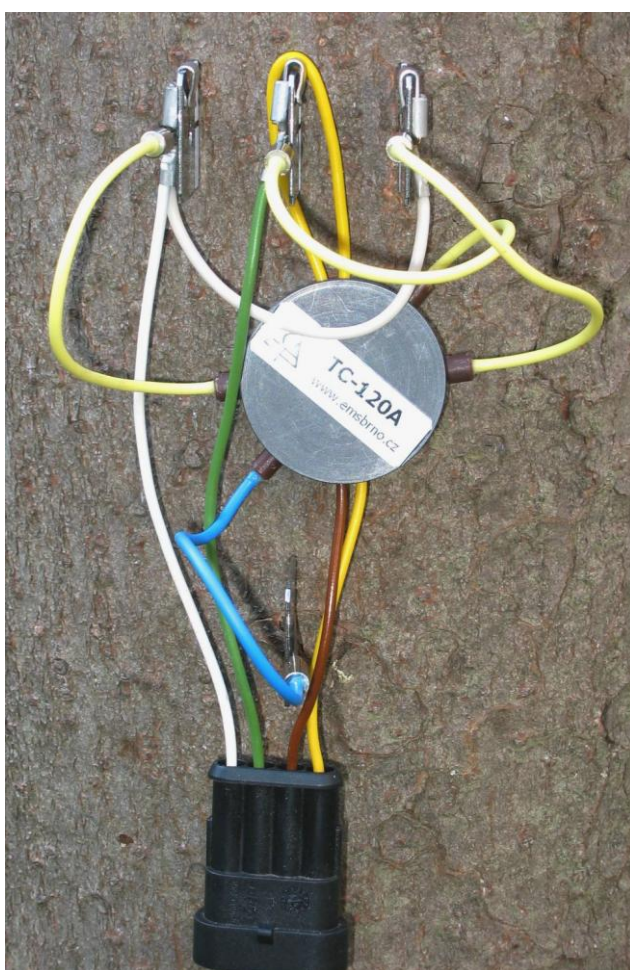




1.2.6. Sensor installation

The sensor needles are to be pushed into slots of the electrodes. Therefore, needle installation does not need any drilling. For easy inserting, using of needle guide is highly recommended in order to avoid an accidental needle bending. The metal cup of 70 and 80 mm long needles should touch the upper edge of electrodes, by 60 mm long type it overlaps it ca 4 mm.

The thermosensor assembly with the electrode terminals should be hanged firstly on the central electrode. Than insert the needles to the slots in electrodes (using the needle guide) and finally set up the terminals.



Yellow needles are pushed in upper electrodes, the blue needle is pushed in the reference bare electrode.



After all needles are properly inserted, the terminals can be put on the electrodes. Set the **green one on the central electrode**, the white ones on both lateral electrodes. Finally, the cable connector is hooked to the sensor.



1.2.7. Weather protection

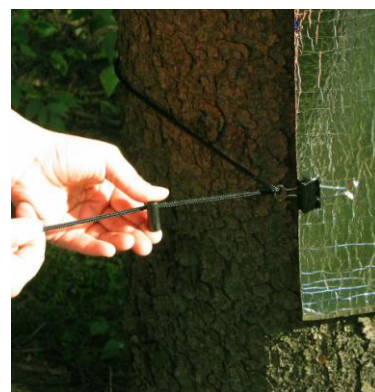
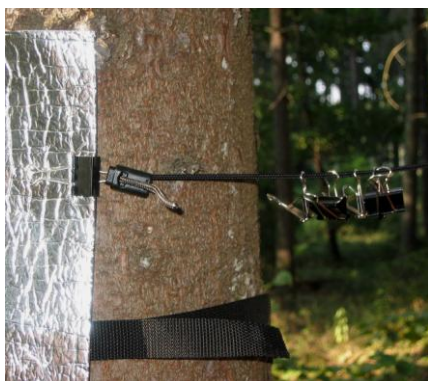
In comparison with former THB arrangements the version described in this manual is much less sensitive to external disturbing factors as stem flow and all types of ambient temperature gradients. However, good protection against solar irradiation is always necessary. The weather protection consists of two parts – a “hat” covering the measuring point in order to keep relatively homogeneous environment inside and a “skirt” protecting the part of tree trunk below the measuring point and its surrounding against direct sunshine.

The hat has to be put symmetrically over the measuring point. The correct vertical position is indicated by lower corner of the hat covering the cable connector boot. See following pictures:





The skirt is fixed to hat by Velcro and fastened down to trunk against wind by a string with ordinary binder clips. Never tight the skirt to tree trunk – the free space under the skirts is important for ventilation necessary for good heat exchange.





1.3. Sensor removal

After removing the weather protection, thermosensors and electrodes have to be pulled out by special extractors.

1.3.1. Extracting of thermosensor needles

Use the same extracting tool as for electrodes (see below) completed with a special adapter. Pull out needles with gently hits to upper backstop:



1.3.2. Extracting of electrodes:

Fix the tool to the electrode with the pin. Check the pin position carefully. Apply strong hits to backstop.



Important: For safety reasons always stand sideways the tool axis in order to avoid the harm of your face. Also, watch your fingers – see the picture below.

