Dendrometer

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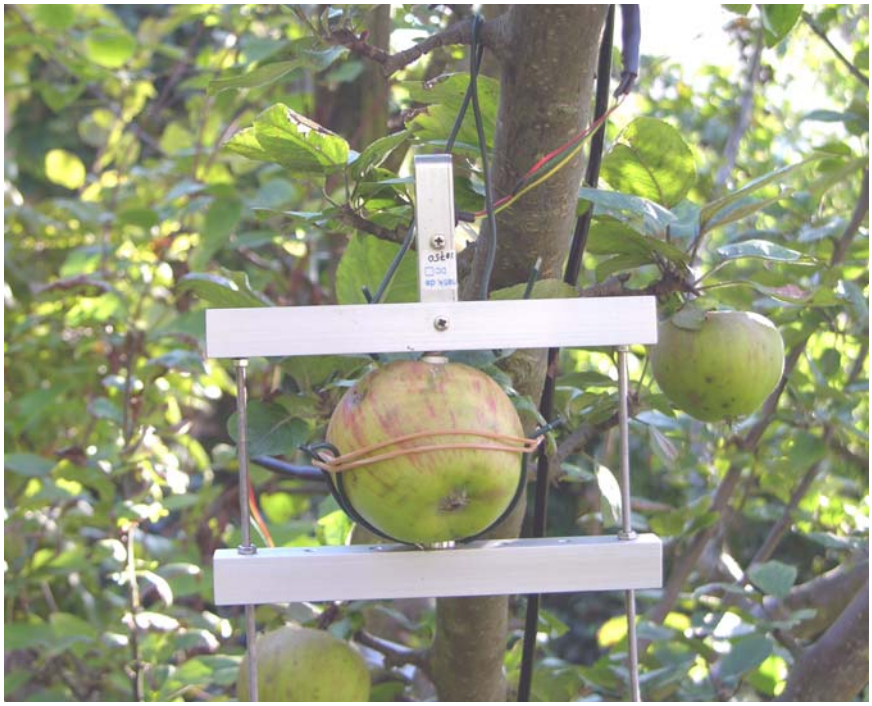
Fruit Dendrometer (Type DF)

For measuring changes in diameter of fruits and in thickness of leaves



User Manual

Version 2.0

1. Introduction

Thank you for purchasing an Ecomatik Dendrometer type DF. This is a highly precise sensor for continuous measurements of diameter changes of fruits and leaf thickness under both indoor and outdoor conditions.

This manual is written to help you install and operate your DF dendrometer with least difficulty and for desirable results. Please read it carefully before installing the sensor, and refer to it if you should have any difficulty with the sensor in the future.

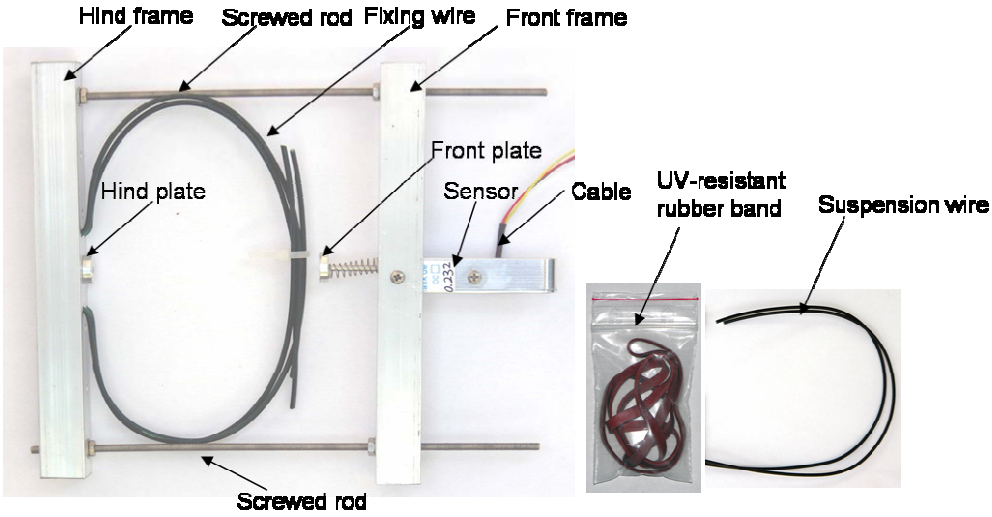
The dendrometer is the sensor part of a measuring system. This means that the dendrometer must be installed onto the experimental fruit/tree, and connected to a data logger for continuous data recording or to a simple voltmeter for discrete data display. The dendrometer is compatible with the most data logger types. At Ecomatik a low-cost, special for dendrometers developed ulogger is available.

2. Product Description

As shown below, the DF dendrometer consists of:

1 Sensor with 2 m cable. The cable length is extendable to 100 m
1 Frame for fixing the sensor onto the fruit
1 Piece UV-resistant rubber band
1 Piece coated wire for hanging the dendrometer

Please contact your dealer should you miss any of these items



Fruit Dendrometer

3. Safety Information

The sensor is protected from rain water, but it is not waterproof. Please do not immerse the sensor in water.

To reduce tension on the sensor, the cable component of the sensor is isolated. Please never pull the cable from the sensor and avoid any tension between the cable and sensor during handling and operation.

Pay attention to written instructions. Wrong connections will give wrong results.

4. Installation

4.1 Adjustment of Frame

The DF dendrometer measures fruit diameter changes smaller than 11 cm. To adapt the instrument to smaller fruits the frames and the screwed rods can be shortened by cutting.

4.2 Cable Extension

The standard version is delivered with 2 m cable. It can be extended up to 100 m. Cable type 4×0.25 mm^2 shield is recommended for extensions.

4.3 Required tools for installation and for operation

Data logger: One Dendrometer requires one or two single-ended channel(s) that can measure resistance between 0 and 20 kohm range.

Tools: Cable strap, spanner (M3), screw driver, knife, and voltmeter.

4.4 Mounting

The entire mounting procedure is carried out while the fruit remains attached onto the branch/tree:

4.4.1 Detach the front frame of the dendrometer to allow you fix the fruit to be measured

4.4.2 Insert the fruit carefully between the fixing wires until it rests onto the hind plate.

4.4.3 Curve the fixing wires accordingly so as to fit the shape of the fruit. Ensure that the fruit rests on the hind plate. Fix the wires on the fruit using a rubber band so that the fruit is firmly held between the fixing wires and the hind plate. Replace the front part of the frame and fix it with screws.

4.4.4 The complete set-up should be suspended freely from a tree branch using a suspension wire. Ensure that the fruit hangs freely and that the branch from which it grows is not strained by the dendrometer.

4.4.5 Turn the screws slowly to achieve an electrical resistance between the yellow and green cable of approx. 10 kohm for installations before or in frost seasons and of approx. 2 kohm for installations in or before growth seasons.

4.4.6 Fix the cable onto the tree branch so that the sensor is protected from any accidental pull/drag on the entire cable length. This can be done using a rope or cable straps. Ensure the suspension rope/strap is not so tight as to interfere with normal tree growth and expansion during the entire measurement period. Also, there should be no tension between the sensor and cable.

Ensure that no rain water can run along the cable into the sensor casing.

5. Wiring and Logger Configuration

There three measuring possibilities to record the dendrometer data:

One single-ended Channel for resistance (range 0-20 kohm) (e.g. Dendrometer logger)

Two single-ended Channels for resistance (range 0-20 kohm) (e.g. Dl2e Logger)

Full bridge measurement (excitation voltage <= 5000 mV) (e.g. Campbell CR800, CR1000)

The use of two resistance channels or full bridge is recommended as temperature influences can be compensated for and a higher precision can be achieved (see technical specification).

The dendrometer should be connected to the loggers as listen in the table.

Connecting to data loggers

Wire color		**One single-ended channel**	**Two single-ended channels**	**Full bridge measurement**
Green	Connect to	**-** Channel 1	**-** Channel 1	**-** Signal
Yellow		**+** Channel 1	**+** Channel 1	**+** Signal
White		Not connected	**-** Channel 2	**-** Excitation
Brown			**+** Channel 2	**+** Excitation (=<5000 mV)

An interval 0.5-hour for data collection can reveal the diurnal course of diameter changes very well.

6. Data Calculation

The changes of diameter are given:

If measuring with one channel:

Changes of diameter in µm = Values of Channel 1 in Ohm × CF-Value

The CF-Value is printed on the sensor.

If measuring with two channels:

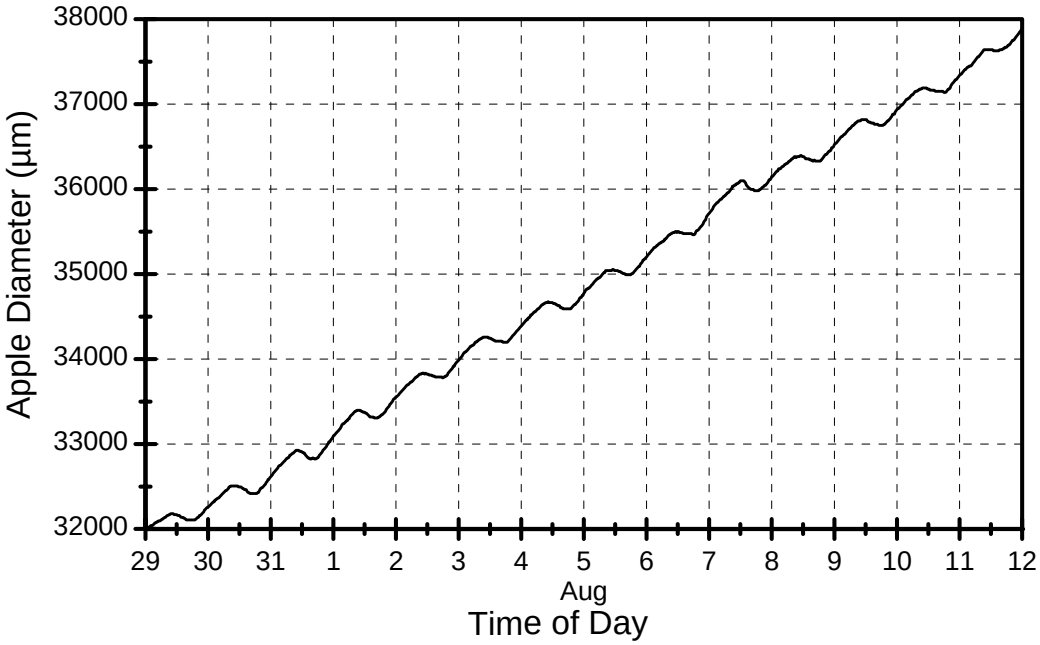
$$\text{Changes of diameter in µm} = \frac{\text{Values of Channel 1 in Ohm}}{\text{Values of Channel 2 in Ohm}} \times 15\,000$$

If measuring with full bridge :

Changes of diameter in µm =-Output of Channel 1 x 15 000

7 An Example of measured data

The figure shows the diameter changes of a apple measured by an Ecomatik fruit dendrometer.



8. Adjustment and maintenance

The measuring range of the sensor is up to 15 mm. Depending on the growth rate of the fruits, the sensor should be reset after a few days or months. **If the outputs of channel 1 (between green and yellow wires) exceed 18 kohm, a reset must be carried out.** . In case of full bridge measurement the reset should be carried out if the outputs exceed 0.95.

For resetting the sensor relax the screws slowly to achieve an electrical resistance between the yellow and green cable of approx.2 kohm for resetting before or in frost seasons and of approx. 1 kohm for resetting in and before growth seasons.

Ensure that no falling branches, fruits or snow land on the sensor. The sensor is protected against water drops, but is not waterproof.

When the sensor is correctly installed, it will function under outdoor conditions without further maintenance.

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9. Technical Specification

Type:	Fruit dendrometer (DF)
Use area:	For measuring changes in diameter of fruits and in thickness of leaves
Diameter of fruit:	0-11 cm (>11 cm on request)
Range of the senor:	15 mm
Accuracy of the sensor:	±2 µm (measurement with two channels) ±7 µm (measurement with one channel)
Temperature coefficient of the sensor:	Measurement with two channels<0.1 µm/K Measurement with one channel <0.04 %/K of the values measured
Environment:	Outdoor condition: -30 to 40°C air temperature, 0 to 100% relative air humidity
Weight of the sensor:	13 g without cable
Output:	Analog output, 0-20 kohm
Power supply:	No power consumption
Material:	Stainless steel and Aluminum
Cable length:	2 m, extendable up to 100 m