Dendrometer

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Fruit Dendrometer (Type DF6)

For continuous measurements of diameter of fruit and vegetables

User Manual

Version 01/2023

1. Introduction

Thank you for purchasing an Ecomatik Dendrometer type DF6. This is a precise sensor for continuous measurements of fruit and vegetable diameter under both indoor and outdoor conditions.

This manual is written to help you install and operate your DF6 dendrometer with least difficulty and for most 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 should be connected to a data logger for continuous data recording. The dendrometer is compatible with the most types of data loggers and microcontrollers (i.a. Arduino).

2. Product Description

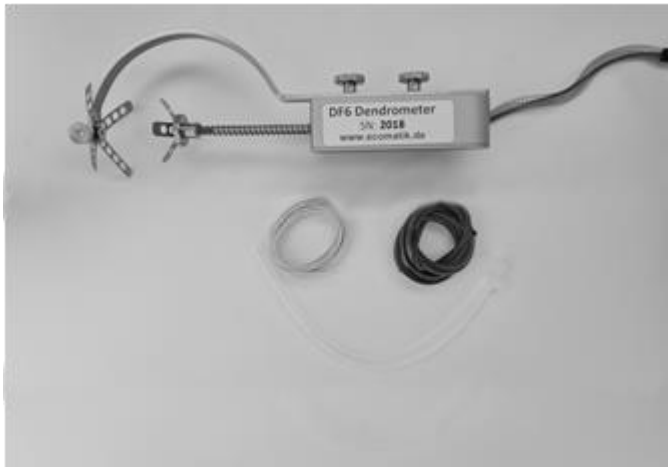
As shown below, the DF6 dendrometer consists of:

1x Sensor with quick-mount fruit gripper hook, 5 m cable

1x Piece re-usable UV-resistant rubber reusable to fix the sensor cable at the branch/stem for strain relief (rubber cord may also be delivered as separate part of a bulk delivery. Then the total length may be delivered in one piece on a roll and).

1x Piece re-usable string cord to hang sensor to release the instrumented fruit from additional sensor weight.

2x Cable strips to fix string cord to fruit carrying branch (for correct installation of the strips please refer to the below section “Installation”)



DF6 Fruit Dendrometer

The standard cable length is 5 m. if you ordered cable extension, the cable length is the ordered extension + 5 m.

3. Safety Information

The sensor is protected from rain water, but it is not sealed. Please do not immerse the sensor in water. Avoid any tension between the cable and sensor during handling and operation.
Pay attention to connections to data logger. Wrong connections will provide wrong readings.

Max. measurement range 25 mm until maintenance required, exceedance may cause sensor damage!

4. Installation

Tools & accessories:

- light resistant rubber cord for strain relief of the sensor cable.
- string cord to hang sensor on fruit carrying branch to release the instrumented fruit from additional sensor weight
- 2x cable strips to fix string cord to fruit carrying branch
- Additional tools required: scissors for cutting cords

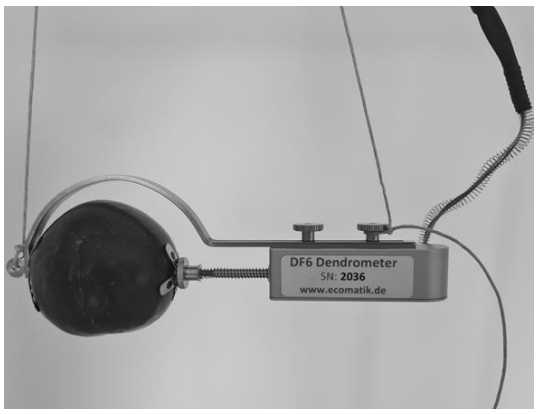
a) Select a representative fruit for instrumentation.

b) Use the included rubber cord to strain relief the sensor by fixing the sensor cable on the fruit carrying branch. Please leave enough cable between the fixation point on the branch and the sensor. In the final installation position, the fruit sensor should be able to move freely with the instrumented fruit, without tension on the cable.

c) Use the included string cord to hang the sensor at the fruit carrying branch and adjust the positioning such that the sensor in its final installation position does not exert additional weight to the instrumented fruit.

IMPORTANT:

- Please mind orientation of the sensor such that rod entrance, as well as wire outlet should hence always be inclined downwards.
- Please do not tie the string cord directly to the branch to avoid strangulating the branch. To fix the string cord to the branch you may either use the included cable strips, loosely fixed to the branch, or the elastic rubber cord and tie the string cord to the fixed strips, or the rubber cord respectively.



d) Untighten the knurled-head nuts such that the fruit gripper hook can be moved.

e) Open sensor clamping system and carefully insert the fruit between the fruit gripper hook and the sensor piston.

f) Move the dendrometer body along the sliding rail, so that the sensor rod is pushed in by about 5 to 10 mm and the fruit is firmly clamped between fruit gripper hook and sensor rod. Then lock the gripper hook at the desired position by firmly tightening the two knurled-head nuts.

g) Fix the cable onto the stem or on a ground stake for strain relief of the sensor cable between instrumented plant and data logger. This can be done using a rope or cable straps. There should be no tension between the sensor, fixation point at the fruit carrying branch and the remaining sensor cable.

!! IMPORTANT !!

Fix the cable onto the tree stem/branch so that the sensor is protected from any accidental pull/ drag of the entire cable length. This can be done using a rope or cable straps. In addition, there should be no tension between the sensor and cable.

Ensure that no rain water can run along the cable, or the sensor rod and enter the sensor casing. Rod entrance, as well as wire outlet should hence always be inclined downwards.

5. Wiring and Logger Configuration

The dendrometer is compatible with most data loggers and microcontrollers (i.a. Arduino). This section provides required information for wiring the sensor in to a data logger and convert raw data from volts into micrometers. Please contact us if you require further information or assistance.

Recommended is a logger measurement resolution of at least 12 bits and a switched (power up < 100 msec), stable, regulated excitation voltage (Vex) output to supply the dendrometer in the voltage range of 0.5 to 10VDC.

4-wire connection

(cable type: 4-wires + shield)

Single-ended Voltage

Cable Color	Input Port
Yellow	H (Signal, Vout +)
Green	GND
Brown	Vex
White	GND
Black	GND

Differential Voltage

Cable Color	Input Port
Yellow	H (Signal, Vout +)
Green	L (Signal, Vout -)
Brown	Vex
White	GND
Black	GND

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

In the following we describe the connection with Dendrometer Logger (DL18), Campbell Logger (CR1000). Please contact us if your logger is not described here.

Dendrometer Data Logger (DL18)

The DL18 is a battery powered, waterproof logger for connecting 4 dendrometers. It is a very effective data logger for dendrometer measurement under outdoor conditions. For details please see the user manual of the DL18.

Campbell Data Logger (CR1000)

The dendrometer can be measured both in single-ended voltage as well as differential voltage mode. Differential voltage mode provides better accuracy. But single-ended mode requires half as many channels as differential mode. One CR1000 can include 16 dendrometers in single-ended mode, but only 8 dendrometers in differential mode.

Single-ended Voltage Mode (2 dendrometers)

Connection		
Cable Color		Input Port
1st dendrometer	Yellow	1H
	Green	Ground
	Brown	Vx1
	White	Ground
2nd dendrometer	Yellow	1L
	Green	Ground
	Brown	Vx1
	White	Ground
Program Syntax *ExciteV (Vx1,2500,0)* *VoltSe(SEVolt(),2,mV2500,1,True,0,_50Hz,Mult(),Offs())* If Multiplier=10.16, Offset=0, the results are measured in microns.		

Differential Voltage Mode (2 dendrometers)

Connection		
Cable Color		Input Port
1st dendrometer	Yellow	1H
	Green	1L
	Brown	Vx1
	White	Ground
2nd dendrometer	Yellow	2H
	Green	2L
	Brown	Vx1
	White	Ground
Program Syntax *ExciteV (Vx1,2500,0)* *VoltDiff(DiffVolt(),2,mV2500,1,True,0,_50Hz,Mult(),Offs())* If Multiplier=10.16, Offset=0, the results are measured in microns.		

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

Sensor measurement value conversion:

a) Converting raw voltage signal to current Sensor position, Xsensor (mm):

⇨ **Xsensor (mm) = Vout (V)/Vrvs (V) * 25.4 mm**

b) Conversion of voltage output in mm fruit diameter:

- If final fruit diameter **<u>within</u>** maintenance-free diameter range 1 from 0 to 25.4 mm:

  Hook in start position (see image below) with 5 mm distance between hook and sensor piston:

  ⇨ **Fruit diameter, Dfruit (mm) = Xsensor (mm)**

- If final fruit diameter **<u>exceeds</u>** maintenance free diameter range of 25.4 mm, repositioning is required somewhat <u>before</u> reaching 25.4 mm:

  ⇨ Diameter range 1 from 0 to 25.4 mm, Fruit diameter, Dfruit_1 (mm):

Dfruit_1 = Xsensor_1 (mm)

⇨ Diameter range 2 from 25.4 to 50 mm: Fruit diameter, Dfruit_2 (mm):

Dfruit_2 = Xsensor_2 (mm) – Xsensor_ini (mm) + Dfruit_1 (mm)

Where Xsensor_2 is the current sensor position in range 2 at a certain time after repositioning, Xsensor_ini is the first valid reading of sensor position after repositioning (e.g. 3 mm sensor pressed in after repositioning) and Dfruit_1 (mm) is the last valid value of Dfruit_1 from measurements in range 1 before repositioning.

EXAMPLE for fruit diameter calculation in diameter range 2:

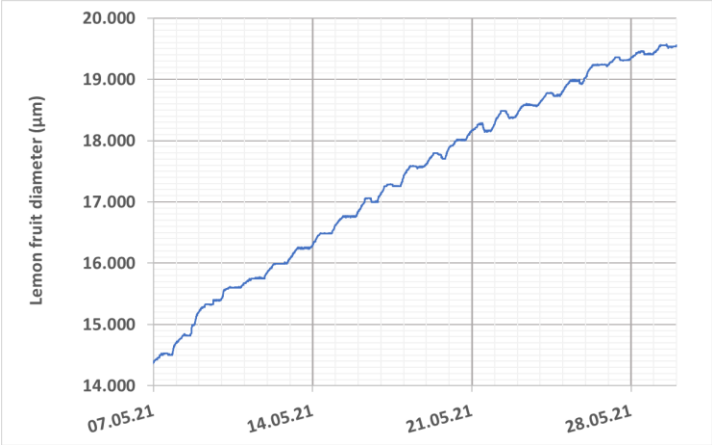
- Last valid value of the fruit diameter Dfruit_1 from range 1 before repositioning: 23 mm
- Initial first valid reading of sensor position Xsensor_ini (mm) after repositioning: 3 mm (sensor pressed in 3 mm after repositioning)
- New current reading Xsensor_2 (mm) after repositioning the sensor to range 2: 8 mm

⇨ **Current fruit size in diameter range 2 is**

Dfruit_2 = 8 mm – 3 mm + 23 mm = 28 mm

6. An Example of measured data

The figure shows the diameter changes of a lemon fruit measured with an Ecomatik DF6 fruit dendrometer.



7. Technical Specifications

Name of the Sensor	Hook-mount fruit dendrometer medium Type DF6
Use area	For measuring small-medium fruits
Suitable for fruit size	Diameter 0 - 5 cm
Range of the senor	25.4 mm
Resolution	The resolution of the sensor itself is infinite. The resolution of readings is determined by connected data logger, e.g. CR1000: 3.3 µm Dendrometer logger DL18: 0.5 µm
Accuracy	Dendrometer dependent: Max. ±1.97% of reading (stable offset) Dependent on the connected data logger, e.g.: CR1000:±(0.04% of reading+10µm) Dendrometer logger DL18: ±0.1%
Temperature coefficient - Dendrometer	<0.2 µm / °C in the whole range
Linearity	<0.7%
Environment	Outdoor condition: -25 to 70°C air temperature, 0 to 100% relative air humidity
Weight of the sensor	33 g without cable
Power supply	Stabilized Vex of 0.5 – 10 VDC, power consumption practically zero
Output signal (Vout)	0 to supplied Vex
Material	Stainless steel and Aluminium
Cable length	5 m, extendable up to 100 m