User Manual

D6

Dendrometer D6

with tL-UM tensioLINK module

Art.Nr. D6
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Content

1. Introduction

1.1. Safety notes

Electrical installations must comply with the safety and EMC requirements of the country in which the system is to be used.
Please note that any damages caused by handling errors are out of our control and therefore are not covered by guarantee.
Lightning: Long cables act as antennas and might conduct surge voltage in case of lightning stroke – this might damage sensors and instruments.
Electronic installation: Any electrical installations should only be executed by qualified personnel.

1.2. Guarantee

UMS gives a guarantee of 12 months against defects in manufacture or materials used. The guarantee does not cover damage through misuse or inexpert servicing or circumstances beyond our control. The guarantee includes substitution or repair and package but excludes shipping expenses. Please contact UMS or our representative before returning equipment. Place of fulfilment is Munich, Gmunder Str. 37!

1.3. Content of supply

Delivery includes:

- D6 clip sensor
- Teflon plate 16.5 x 3 cm
- Invar-steel measuring cable, length corresponding to tree circumference
- Teflon net, length corresponding to tree circumference
- Per order 1 hexagon key, size 1.5
- Cable ties, 4 per D6

Connection options:

- Standard: 4-pin cable, 120 cm, with free wires
- Fixed 4-pin plug M12 for connecting standard cables CC-4/...
- tensioLINK amplifier, fixed non-detachable with D6 cable. Available output tensioLINK bus or analog, connectable with 8-pin cables CC-8/...
- tensioLINK-bus module – stand-alone 1-channel-logger

2. Product description

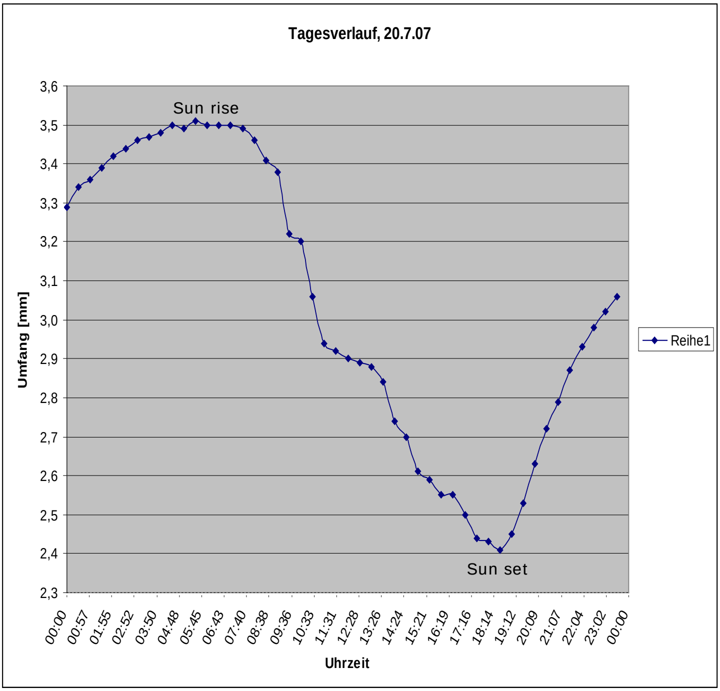
2.1. Measuring principle

The D6 Dendrometer measures the annual growth as well as diurnal circumferential variations with a high resolution, provided that the connected data acquisition system offers a sufficient resolution.
Thus, the total dimension change as well as the reversible variations can be determined.

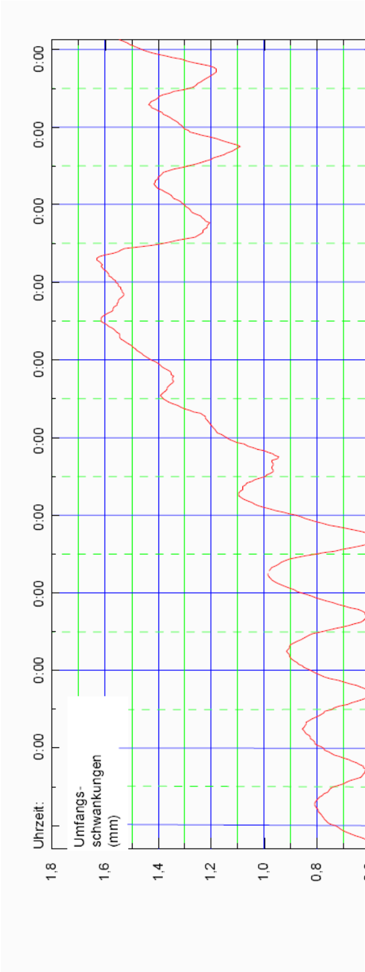
Reversible variations are caused for example by the charging level of the xylem or the swelling of the bark, and are depending on the time of the day, weather conditions, humidity and temperature.
The transpiration over the leaves starting at sunrise leads to a reduction of the circumference. Accordantly, the stopping of transpiration after sunset leads to an increase of the circumference. Both are measurable with the D6 dendrometer, as well as variations due to dry periods or precipitation. Trees can have daily variations of $\pm$ 0.5 mm to $\pm$ 2.5 mm.

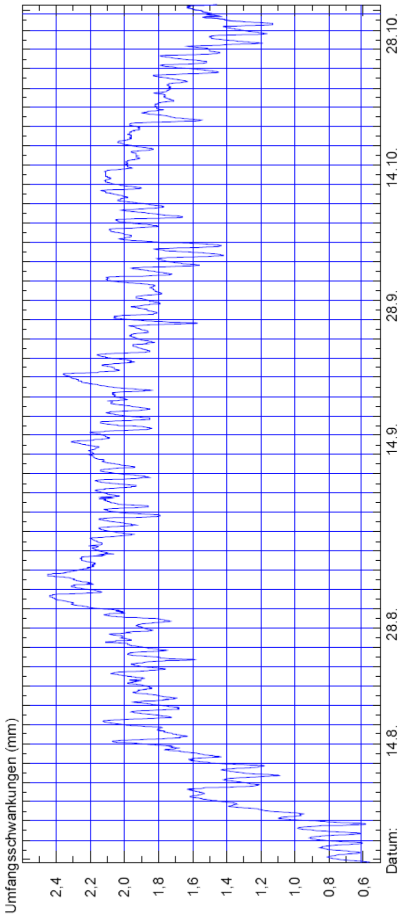
Further outstanding features of the D6 are the non-destructive way of installation, the nearly friction-less conduction of the cable, and the coverage of the complete circumference.

For a large-scale determination of the wood increment it can be advantageous to additionally install D1 tree girth tape measures.



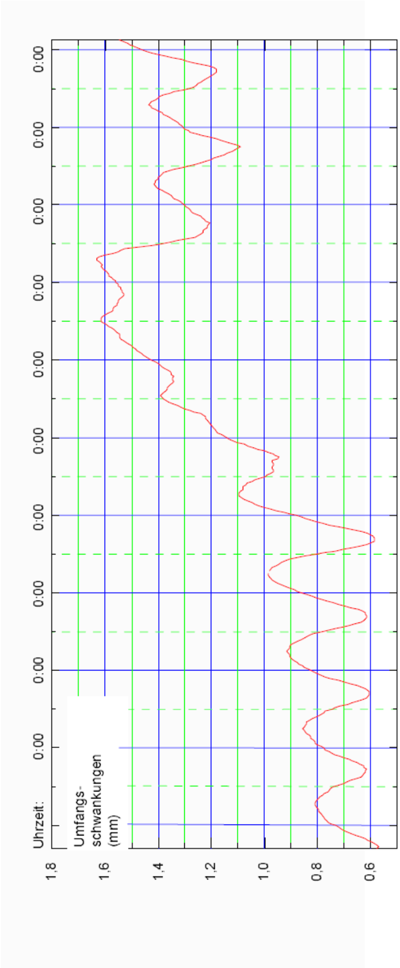
One day variations measured with a D6

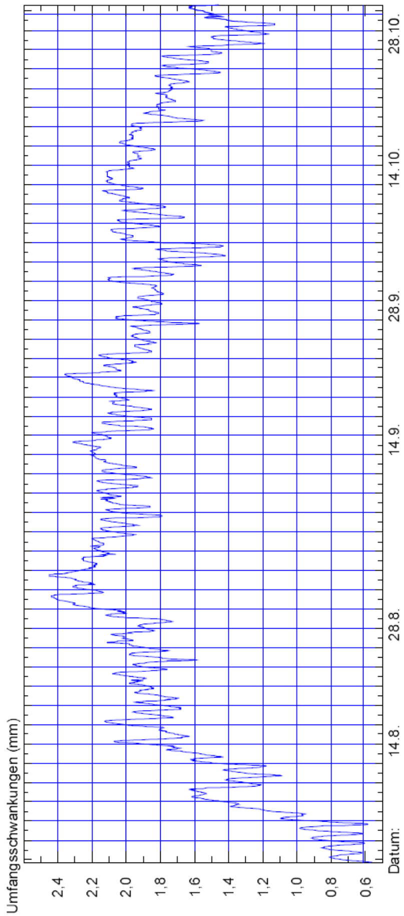




Left:
Circumferential variations of a fir tree with largest extent before sunrise, shrinking during the day.
Dry period from 3.8. to 6.8. and rising extent caused by rainfall starting on 7.8.

Right:
Circumferential variations from August to October with measuring interval 30 minutes.





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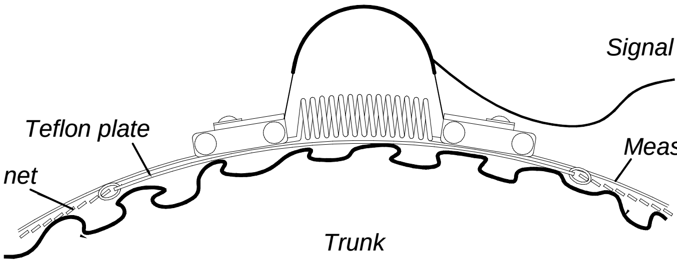
2.2. Construction



Scheme of the installed D6

Four strain-gages, wired as a Wheatstone full-bridge, are appliqued in the apex of the metal strip on the upper and bottom side. By this, the temperature elongation of the metal strip is compensated.

The sensor works as a beam in bending. Changes in the bending cause a measurable change in the resistance of the strain-gages. Due to the stiffness of the material and the small dimensions of the strain-gages this is quite linear in the finite range of the apex.

The strain-gages are applied when the metal strip is flat. Then the signal is zero and rises the more the strip is bended. Therefore, the output signal is the highest at the beginning of a measurement, and decreases with on-going growth.

This has to be considered when programming a data logger.

If the D6 is connected to a tensioLINK amplifier or tensioLINK module they have a configuration in which a growth is a positive signal.

2.3. Sensor slope

The signal response curve of the D6 has a negative slope!

The signal does not correspond to the circumference of the tree, but indicates changes of the circumference.
For example a growth of 1 mm will lead to a decrease of the output signal by -0,6 mV (with stabilised excitation voltage of 5 V_{DC})

2.4. Weatherproofness

All parts are made of stainless material.
The strain gage bridge is temperature compensated.
Measurements when frost occurs are not reasonable.

The strain-gages have a sealing which is absolutely watertight and stays lastingly elastic. The watertight layer is a black polymer adhesive (IP68) which remains sticky. Thus, a further red rubber polymer is applied. Any gaps or holes in the red layer do not reduce the water tightness of the strain gage sealing.

2.5. INVAR girth cable

The girth cable is made of INVAR steel. Unique feature of the material is a temperature elongation of less than 1 µm per meter and Kelvin.
The cable is stainless, though a nickel oxide layer will develop on the cable looking like rust and oxidation. But this stain even makes the cable surface harder and acts as a further anticorrosive protection.

2.6. Teflon bark layer

The friction of a wire or band with direct contact to the bark would prevent that small regression of the circumference are conveyed to the sensor. With the Teflon net the circumferential measuring cable moves almost frictionless: all variations around the complete trunk, also from the opposite side of the trunk, are conducted smoothly to the sensor.

The net structure has further advantages:

- The net adapts to the growth.
- The tension of the cable is distributed evenly avoiding constriction.
- The bark is not sealed off.

3. Installation

3.1. Teflon net and plate

Lead cables ties trough the holes on the Teflon pad and connect it with one end of the Teflon net.
Cut the net depending on the tree circumference, lead it around the trunk, and connect it to the other end of the pad.
Important: Teflon net and pad must be fixed tightly with enough tension to stay in its position and to fit closely to the stem.

3.2. Sensor and steel cable

Lead the measuring steel cable around the trunk and cut it off with the required length. The length should be 5 cm longer than the circumference to allow a readjustment of the cable when the end of the measuring range is reached.
Then insert one end of the cable into the eyelet on the Aluminium block and fix it with the screw (requires 1,5 hex key). Lead the cable around the trunk and through the other eyelet.
The spring must have enough initial tension – the tension must be high enough that the sensor is pressed onto the Teflon pad. The gap between the two aluminium blocks should be about 4 to 5 cm.
Place the sensor into the centre of the Teflon pad.

Clamp a wire end sleeve on the end of the cable or attach a piece of tape to prevent that the cable wires untwist.

3.3. Pull relief for the signal cable

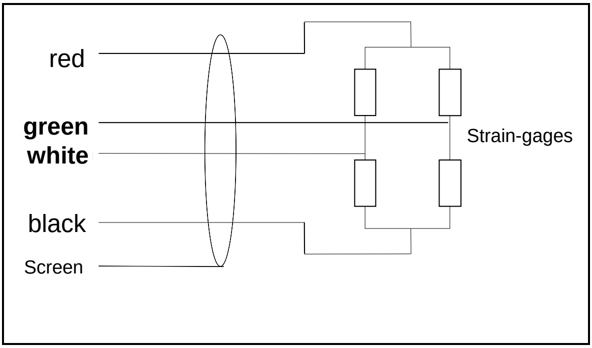
The signal cable should not just hang down as then the sensor might be pulled out of its position. Use a cable tie to fix the cable to a branch or a pole.

4. Sensor connection

4.1. As full bridge

D6 can be connected to a logger which is capable of reading a ratio-metric voltage from a strain-gage full-bridge. The resolution depends on the max. resolution of the logger. The logger resolution must be high enough to resolve the small signal changes.
Bridge specifications and signal characteristics in chapter 7.

Full bridge scheme:



4.2. tensioLINK amplifier

The amplifier is electronically identical with the amplifier which is integrated in for example in T8 Tensiometer.
The same functions are available, which are for example:
- Amplified voltage output 0...1 V, 0...2 V or 0...5 V (can be changed with the tensioVIEW software and a USB-converter).
- tensioLINK bus interface to create a network connectable to a digital logger channel.

Please read the separate instruction for the tensioLINK amplifier.

Signal incline of a D6 with tensioLINK-amplifier:

Growth in mm	0	10	20	30	40	50	60
Signal in mV	0	170	340	510	680	850	1000

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4.3. 1-channel tensioLINK bus module

Please read the separate instruction for the tL-bus module with descriptions of programming the module (measuring interval), data upload and using all bus and interface functions.

Normally the D6 cable is already connected when delivered, and the module is pre-set to read the D6.

Wiring scheme	*****	**green**
	+	**red**
	-	**black**
	#	**white**

On channel 2 a further sensor can be connected (single-ended or resistance), for example a temperature probe (internal or external).

<u>Important:</u> after installation of the sensor and to start the logging it is necessary to synchronize date and time and to enter a logging interval. Reasonable interval for D6 is 10 minutes.

Check if data is recorded before you leave the site. Regularly upload the data and check the battery voltage.

5. Readjust the measuring range

The D6 can measure a circumferential growth up to approximately 50 mm. The end of the measuring range is reached when the spring tension gets too high.
To readjust the sensor open the small headless screws with a 1.5 hexagon key on the side where some additional cable is left. Release some cable to relax the spring, then tighten the hexagon screw again.
If the cable is crimped too much replace the cable.

6. Protecting the site

6.1. Theft and vandalism

A proper protection against theft and vandalism should be given, for example by fencing or signs explaining the research project.

6.2. Forest inhabitants

The measuring setup should be protected from forest inhabitants.
A collar can keep mice from running up the tree.
Cables should be protected against rodent bites, for example with plastic protection tubes. Fix cables to branches or poles.

7. Appendix

7.1. Technical specifications

Sensor	Strain-gage full-bridge
Measuring range	0...50 mm circumferential growth, resettable
Supply	5...15 V_{DC} stabilised
Bridge resistance	350 Ohm
Max. current burden	50 mA
Non-linearity	±1%
Reasonable min. logger resolution	5 µm
Operating temperature	> 0°C
Temperature resistance	-30°C ... +50°C
Temperature error	< 4 µm/K
Sealing	IP 68
Materials	Aluminium, stain-less steel, Teflon

with supply voltage	*5 V*	*10 V*
Measuring range for 0 ... 50 mm growth (negative incline)	< 50 mV to 0 mV	< 100 mV to 0 mV
Max. signal to destroy the strain gages ($\varepsilon_{straing\text{-}gage\ max}$ < ±1%)	max. 100 mV	max. 200 mV

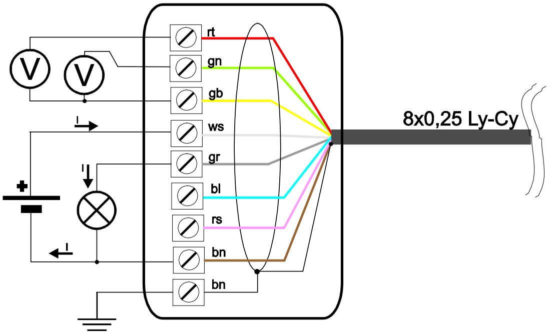
7.2. Signal characteristic

Linearized (negative) incline	**$\Delta U_M / \Delta L$ = -0,13 mV/mm x U_B/V**
... with 5 V DC excitation voltage (stabilised)	**$\Delta U_M / \Delta L$ = -0,65 mV/mm**

U_B/V = integer value of the applied excitation voltage, e.g. U_B/V = 5 for U_B = 5V

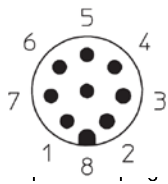
7.3. Wiring scheme

<u>Only for 8-pin cable type CC-8 !</u>



Connection scheme

Configuration of 8-pin cable and plug:

Wiring connections				
Signal	**Wire**	**Pin**	**Function**	
V_{in}	**white**	**1**	**Supply +6…+18 V_{DC}**	
GND	**brown**	**2**	**Supply minus**	
A-OUT+1	**green**	**3**	**Analog signal plus**	
A-OUT-	**yellow**	**4**	**Analog signal minus**	
Digital	grey	5	Digital OUT	
RS485-A	pink	6	RS485-A 2-wire	
RS485-B	blue	7	RS485-B 2-wire	
A-OUT+2 / SDI12	red	8	Analog output 2 or SDI12	

Cut off not required wires or portect from short-cut!

8. Your addressee at UMS

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Strictly observe rules for disposal of equipment containing electronics.
Within the EU: disposal through municipal waste prohibited - return electronic parts back to UMS.

Rücknahme nach Elektro G
WEEE-Reg.-Nr. DE 69093488

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