

# D6

## Tree growth-sensor strain gage clip sensor

- Continuous high-resolution measuring of circumferential variation of trees
- Easy mounting without damage of the bark or disturbance of growth
- Measuring of daily changes and immediate reaction with an accuracy of  $5 \mu\text{m}$
- Minimisation of the cables friction on the bark and dependence on temperature
- Measuring range easily expandable by adjusting of the cable

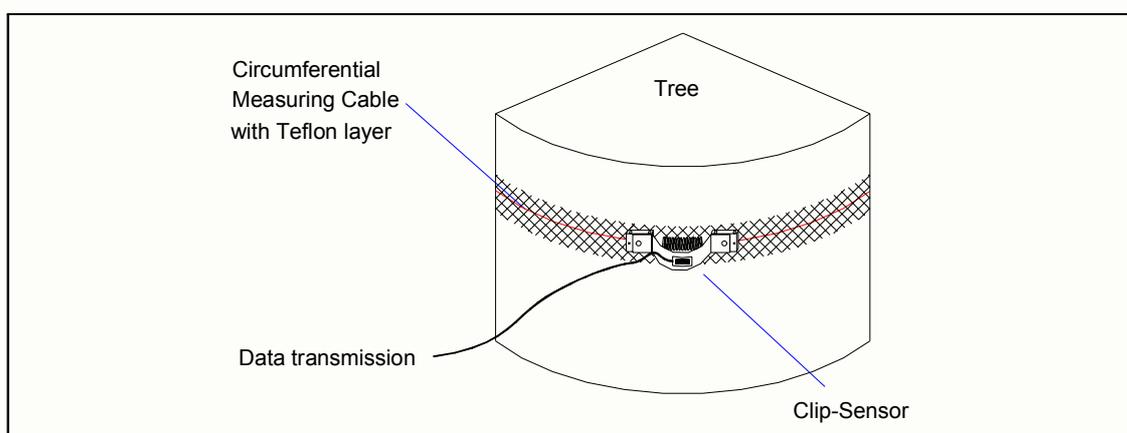


Fig 1: Principle of measurement

The *Strain-Gage Clip-Sensor* is designed for continuous high-resolution and automated measuring of circumferential variation of trees. Small in dimension and weight, the clip-sensor can easily be fixed on the trunk without any damage to the bark or disturbance of growth.

The complete sensor device is tightened like a belt and kept in position by a spring. Variations in tree dimensions are conducted directly to the sensor for recording the trees immediate reactions to environmental influences, swelling of the bark, level in water conduits or cell division.

Function: The trees dimensional changes are conveyed to the clip by a cable tied around the trunk and are transformed into a corresponding resistance change in strain gages, which are fixed on top and bottom of the clip, wired into a full Wheatstone bridge.

The cable's dependence on temperature is extremely low (1 ppm).

A special Teflon-layer is placed between cable and bark to reduce the friction of the cable and to protect it from icing, resin or callousing.

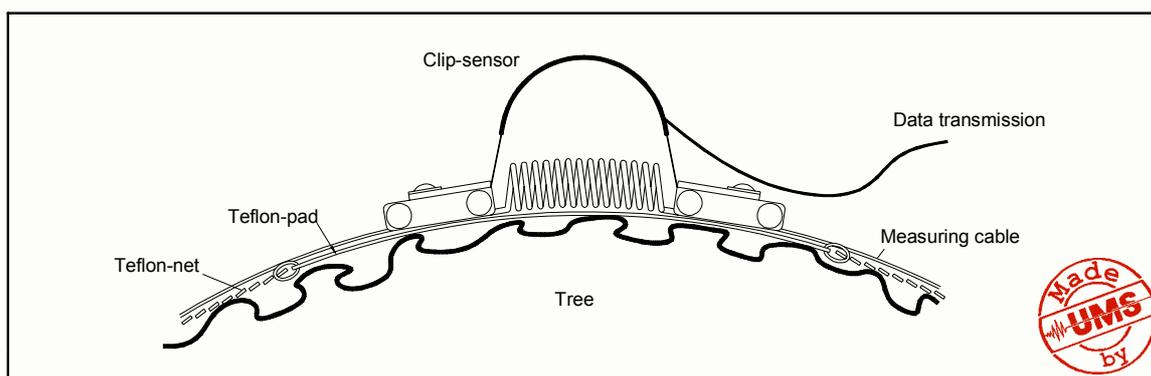
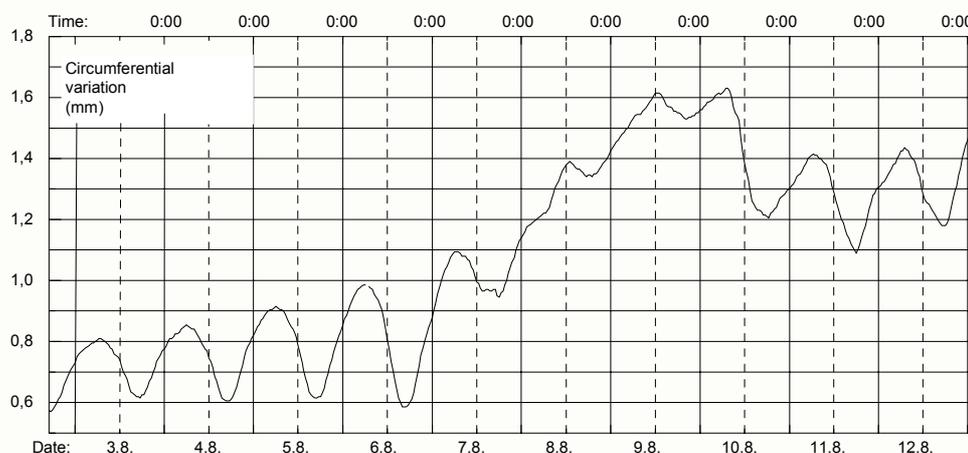


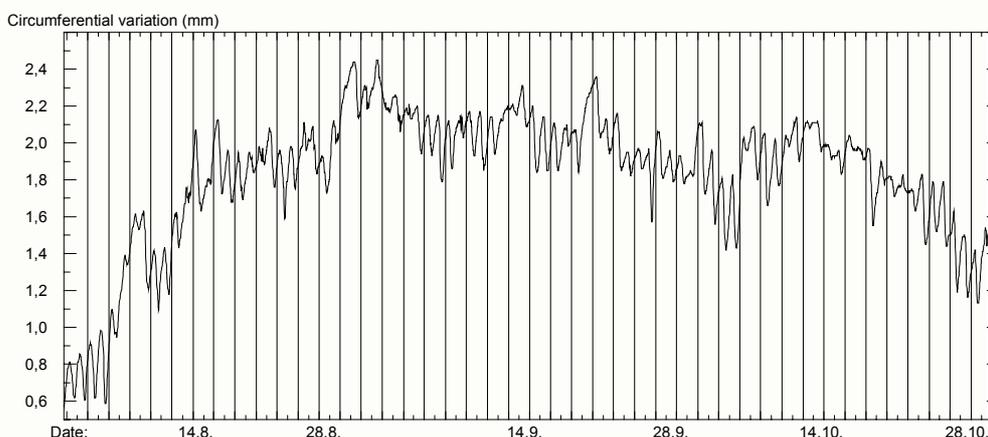
Fig. 2: Schematic view

The following diagrams show the results of measuring the circumferential variations of a fir tree. The daily changes are registered very precisely. The trees reactions are explained by the daily weather conditions which were recorded simultaneously.

**Fig. 3:**  
Circumferential variations\* of a fir tree: Largest circumference at sun rise during dry period between Aug. 3rd and 6th; circumferential increase with rainfall starting on Aug 7.



**Fig.4:**  
Recording\* of circumferential variation between August and October 1995.



(\* Data acquisition every 30 minutes)

### Technical Specifications

Art. No. D6

Sensor	4-wire full-bridge strain gages	$U_{DC}$	Power supply voltage
Measuring range	50 mm circumf. growth without adjustment	$U_{sig}$	Signal voltage
Power supply	$U_{DC} = 5...15 V_{DC}$	k	Strain gage value ( $k = 2, 1$ )
Signal full-bridge	$U_{sig} = U_{DC} * k * \epsilon_{DMS} = U_{DC} * L * \ddot{u}'$	$\epsilon_{DMS}$	Strain gage tension
Signal characteristic	$\Delta U_{sig} / \Delta L = -0,12 mV/mm * U_{DC}/V$	L	Distance between clip's ends
Range of signal	$U_{sig} \gg 9 mV ... 0.8 mV * U_{DC}/V$	$\Delta L$	Circumferential variation
		$\ddot{u}'$	Clip's transforming value
Bridge-resistance	350 $\Omega$	Weight	<20 g
Linearity	$\pm 1\%$	Embracing tension	<5 N
Accuracy	5 $\mu m$	Temperature range	-30°C ... +50°C
Max. current	50 mA	Dependence on temp.	<4 $\mu m/K$

The measuring cable is made of INVAR-steel, having an extremely low dependence on temperature (<1  $\mu m/mK$ ) and a very high resistance against corrosion. The strain-gages are covered with rubber polymer (IP67).

The clip-sensor can be used under atmospheric conditions (Rain, temperature -25 to +35°C). The full-bridge is temperature compensated.



Product  
Info

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