



Bio Instruments S.R.L.

SENSORS AND SYSTEMS
FOR MONITORING GROWING PLANTS

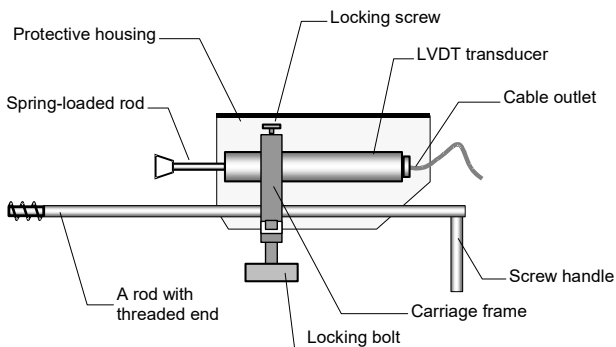
DE-1M
Dendrometer



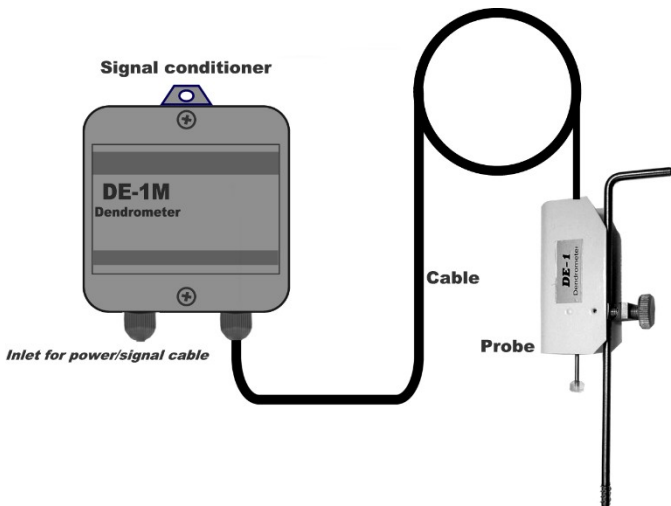
Introduction

The DE-1 Dendrometer is a highly precise incremental LVDT-based sensor for monitoring micro-variations of trunk radius in micron range.

The DE-1 Dendrometer includes a linear displacement transducer (LVDT) mounted on a special rod with threaded end. When the rod is anchored inside the trunk, the LVDT represents the movement of trunk surface. Thus, the output signal follows variations of distance between trunk surface and the end of the rod.



The DE-1M has also a DC powered signal conditioner. Standard cable length between the sensor and the signal conditioner is 1 meter.



Plant growth and water balance affect diurnal behavior of trunk diameter. The growth rate depends on a vegetation stage and environmental conditions. The diurnal variations represent mostly fluctuations of water content in plants. Two diameter-based indices are commonly used for evaluating plant water status: daily contraction amplitude and trend of daily maxima. The DE-1M Dendrometer allows investigating effects of irrigation rate and other environmental factors on water balance and growth of plants.

Installation

1. Select appropriate trunk for sensor installation.
2. In trees with rough bark over the cambium, rasp it away and pare down carefully an area of about $6L \times 5W \text{ cm}^2$. In caulis and species with smooth bark, no preparation may be needed.
3. Drill the hole with the 3.3-3.5 mm bits. It is recommended to drill slowly using a wood drill set to a low torque to prevent excessive tearing of wood fibers along the length of hole. The depth of hole must be 3 cm min. and 9 cm max.
4. Free the locking bolt and remove the rod from the carriage frame.
5. Carefully screw the rod into the tree. If there is difficulty in insertion, clear the hole carefully with the drill bit.
6. Once the rod is implanted, set the sensor on the rod and adjust its position. If a trunk is supposed to grow, the rational position the probe is close to the point where the spring-loaded rod is just touch the trunk. If the stem is supposed to be stable, choose a point somewhere in the middle of the 10-mm stroke of the rod.
7. Fix the locking bolt.
8. Secure the sensor's cable on a trunk to prevent occasional movement of the sensor.



Outputs

The DE-1M has the following analog and digital outputs:

Analog: 0 to 2 Vdc, or 0 to 20 mA, or 4 to 20 mA, selected by jumpers;

Digital: RS232, or RS485, or SDI-12, or UART-TTL, selected by micro-switches.

Only one analog output and one digital output may be active at a time.

The appropriate positions of jumpers and switches are described below.

First, please choose a right output cable for connecting the sensor to a datalogger. The cable must be round with four wires for analog outputs and five wires for digital outputs. The maximal diameter of the cable is 6.5 mm.

The cable length shall not exceed 10 m for all outputs except current outputs and RS485 with about 1 km maximal length.

Run the cable through the appropriate inlet (see Figure 1) and connect according to the desired output:

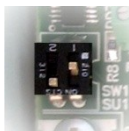
- Power wires to XT1
- Analog output to XT6
- Digital output to the appropriate contact of the terminal XT2-XT5

Select the desired type of digital output by using the selector switch as follows:



RS232

1 – OFF
2 – OFF



RS485

1 – OFF
2 – ON



SDI-12

1 – ON
2 – OFF



UART TTL

1 – ON
2 – ON

IMPORTANT! When using an analog output, the digital selector may be in any position except SDI-12!

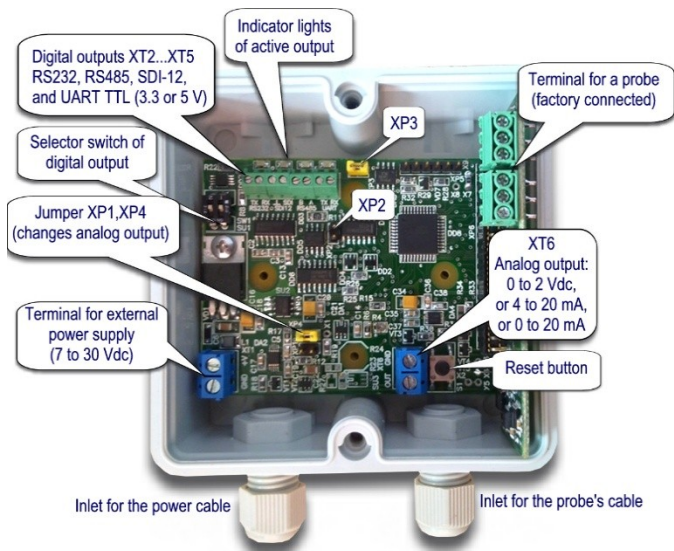


Figure 1. PCB

Select the desired type of analog output by appropriate position of the jumper XP1, XP4 as follows:



0 to 2 Vdc
Jumper on XP4



4 to 20 mA
Jumper on XP1



0 to 20 mA
No jumper

XP2 jumper must be installed for the RS485 output if the sensor is the last chain in the line.

XP2 WITH Jumper	120 Ohm termination resistor connected
XP2 NO Jumper	No termination resistor

XP3 changes the level of the UART TTL output.

XP3 WITH Jumper	3.3V logic levels
XP3 NO Jumper	5V logic levels

Power supply

The 7 to 30 Vdc@100 mA regulated power supply may be used for 0 to 2 V analog output, and for all digital outputs.

- Analog outputs require at least 2 seconds excitation time for producing stable output signal.
- Digital outputs transmit output signal a second after application of power.

Data logging

UART / RS232

Baud Rate = 9600, 8 bit, parity: None, 1 stop bit.

Decimal data format: XXXXX (mcm).

RS485

Baud Rate = 9600, 8 bit, parity: Even, 1 stop bit.

Protocol: Modbus RTU

Modbus register map

Register address	Protocol address	Access	Parameter name
30001	0x00	r	Trunk radius Variation (int)
30101	0x64	r	Trunk radius Variation (float)
40001	0x00	r/w	Slave-ID (int). Default: 247

SDI-12

In accordance with SDI-12 Standard (version 1.3)

When using analog outputs, all possible measures for reducing instrumental errors shall be undertaken:

- Screened cables.
- Cables with low impedance.
- Twisted pair cables.
- Filtration of the signal with low cutoff frequency.
- Isolated power supply and data logger.
- Digital filtration of the signal.

Calibrations table

V	mA	mcm
0	4	0
2	20	10000

Calibrations equations

0 to 2 Vdc output: $\Delta R = 5000 \times U$

4 to 20 mA output: $\Delta R = 625 \times I - 2500$

Where ΔR – trunk radius variations in mcm
 U – output voltage in Volts
 I – output current in mA

Specifications

Measurement (stroke) range	0 to 10mm
Stem diameter range	Over 6 cm
Analog linear output (selectable)	0 to 2 Vdc 4-20 mA, 0-20 mA
Digital output (selectable)	RS232, or RS485, or SDI-12, or UART-TTL
Resolution	0.004 mm
Operating temperature	5 to 50 °C
Temperature effect	< 0.001 mm/ °C
Output auto update time	5 s
Supply voltage	7 to 30 Vdc
Current consumption (depends on selected outputs)	35 mA typ. (+20 mA for current output)
Excitation time	250 ms
Protection index	IP 64

Customer Support

If you ever need assistance with your sensor, or if you just have questions or feedback, please e-mail at support@phyto-sensor.com. Please include as part of your message your name, address, phone, and fax number along with a description of your problem.



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