Bio Instruments S.R.L.

SENSORS AND SYSTEMS
FOR MONITORING GROWING PLANTS

SD-xM
(SD-5M, SD-6M, SD-10M)
Stem Microvariations Sensors
Quick Start Guide

phyto-sensor.com

Series 3000 (with analog and digital outputs)

Introduction

SD-type sensor is a highly precise incremental LVDT-based sensor for monitoring micro-variations of stem diameter in micron range.

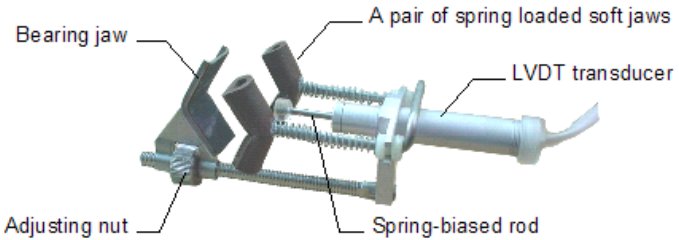
Plant growth and water balance affect diurnal behavior of stem diameter. The growth rate depends on a vegetation stage and environmental conditions. The diurnal variations represent mostly fluctuations of water content in plants. Two diameter-based indices are commonly used for evaluating plant water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

The SD-type sensor consists of an LVDT probe mounted in special fixing brackets, and a DC powered signal conditioner.

Output: Analog linear output (selectable) 0 to 2 Vdc, 4 to 20 mA, 0 to 20 mA.

Interfaces: UART-TTL, optional: RS-232, RS-485 Modbus RTU, SDI12.

Installation



- Select an appropriate stem for sensor installation.
- Move the bearing jaw apart from LVDT transducer by rotating the adjusting nut.
- Locate the stem between the sensor's jaws.
- By rotating the adjusting nut, move the bearing jaw back until the jaws touch the stem.
- Continue rotation of the adjustment nut until then rod takes necessary position. If the stem is supposed to grow, the rational position is somewhere in the beginning of the rod's stroke. If the stem is supposed to shrink, choose a point somewhere at the end of the stroke. In other cases, leave the sensor somewhere in the middle between those two positions.
- Secure the sensor's cable on a stem to prevent occasional movement of the sensor.
- Readjust the sensor when its readings become close to 0 or 5 (10) mm.

Selecting Outputs

The SD sensors have 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: UART-TTL, optional: RS-232, RS-485 Modbus RTU, SDI12, selected by micro-switches.

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

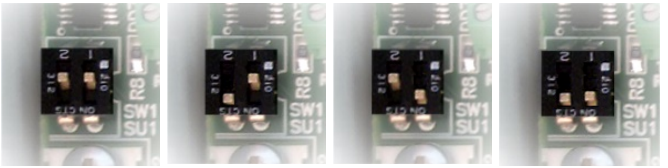
The appropriate positions of jumpers and switches are described below.

First, please choose a right output cable for connecting the sensor to a datalogger. The cable must be round with 4 wires for analog and 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, SDI12 with about 1 km maximal length, and RS-485 with about 1.2 km maximal length.

Run the cable through the appropriate inlet and connect according to the desired output:

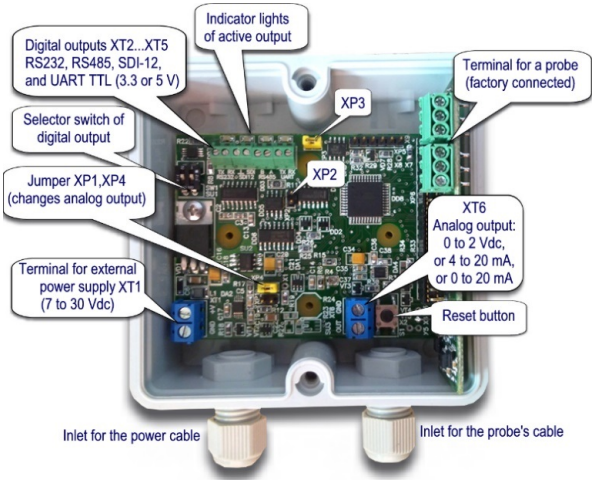
- Power wires to XT1
- Analog output to XT6
- Digital output to the appropriate contact of the terminal XT2-XT5

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



RS-232	RS-485	SDI12	UART TTL

When using an analog output, the digital selector may be in any position except SDI12!



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

0 to 2 Vdc	4 to 20 mA	0 to 20 mA
Jumper on XP4	Jumper on XP1	No jumper

Jumper XP2 is set for the terminating RS-485 output if the sensor is the last chain in the line.

Jumper XP3 changes the level of the UART TTL output. If the jumper is set, the voltage level is 3.3 V; in case of no jumper, the voltage level is 5 V.

Connection

Analog output

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.

Digital outputs connection order

1	Ground
2	Signal wires
3	Power 7 to 30 Vdc

RS-485

1. The sensors interface meets the requirements of the EIA RS-485 (TIA-485) standard, and shall be connected accordingly. It is important to note that the terminating resistor is connected by the jumper XP2 if the sensor is the last chain in the line.

2. The EIA RS-485 Specification labels the data terminals as "A" and "B", but many manufacturers label their terminals as "+" and "-". It is commonly accepted that the "-" terminal should be connected to the "A" line, and the "+" terminal to the "B" line. Reversing the polarity will not damage a 485 device, but it will not communicate.

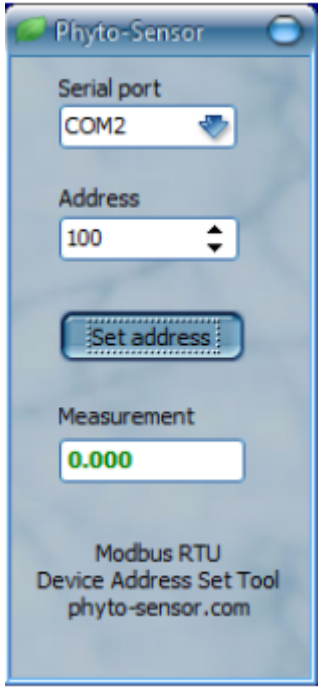
3. For proper functioning ground wires of all devices connected to RS-485 bus must be interconnected together. In case of using a separate power supply, its ground (“minus”) terminal must be connected to the ground line of the bus.

4. Please connect ground wires before all other connections.

Set Modbus RTU address

http://phyto-sensor.com/download/MbRTU_DAST

1. Download, extract and run the Modbus RTU Device Address Set Tool by using the above-mentioned link.
2. Connect the sensor to the PC via RS-485 adapter.
3. Power the sensor on.
4. Specify the RS-485 adapter's serial port.
5. Enter a desired address in 'Address' field and press 'Set address' button. The factory default address is 247.
6. The sensor will start to measure.
7. Power off the sensor.



Data reading

Analog output

Calibration table

U, Volts	I, mA 4 to 20	I, mA 0 to 20	SD-5M, SD-6M, mm	SD-10M, mm
0.0	4.0	0.0	0.000	0.000
0.5	8.0	5.0	1.250	2.500
1.0	12.0	10.0	2.500	5.000
1.5	16.0	15.0	3.750	7.500
2.0	20.0	20.0	5.000	10.000

Calibration equations

Output	SD-5M, SD-6M	SD-10M
0 to 2 Vdc	$\Delta D = 2.5 \times U$	$\Delta D = 5.0 \times U$
4 to 20 mA	$\Delta D = 0.3125 \times I - 1.25$	$\Delta D = 0.625 \times I - 2.5$
0 to 20 mA	$\Delta D = 0.25 \times I$	$\Delta D = 0.5 \times I$

where:

ΔD — measured diameter variations, mm

U — output voltage, V

I — output current, mA

UART TTL / RS-232

Baud Rate = 9600, 8 bit, parity: None, 1 stop bit.
Decimal data format: XXXX (µm), ASCII.

RS-485

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	Measured value (int) in µm
30101	0x64	r	Measured value (float) Ordering the bytes in a "C D A B" sequence known as a "word swap" *(e.g.: the number 4100* *`[00 20 80 45]` represented as* *`[80 45 00 20]`)*
40001	0x00	r/w	Slave-ID (int). Default: 247

SDI12

In accordance with SDI12 Standard (version 1.3).
Decimal data format: XXXX (µm).

Power supply

The 7 to 30 Vdc @ 50 mA (+20 mA for current output) regulated power supply may be used.

Specifications

Measurement range	*SD-5M*	0 to 5 mm
	SD-6M	0 to 5 mm
	SD-10M	0 to 10 mm
Stem diameter range	*SD-5M*	5 to 25 mm
	SD-6M	20 to 70 mm
	SD-10M	20 to 70 mm
Temperature effect		< 0.02% total stroke/°C
Outputs		0 to 2 Vdc, 4 to 20 mA, 0 to 20 mA, UART-TTL optional: RS-232, RS-485 Modbus RTU, SDI12
Output auto update time		5 s
Excitation time		200 ms
Supply voltage		7 to 30 Vdc
Current consumption		< 50 mA (+20 mA for current output)
Operating temperature		5 to 50°C
Protection index		IP64
Probe cable length		1 m

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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