SF-xM
(SF-4M, SF-5M)
Sap Flow Sensors
Quick Start Guide
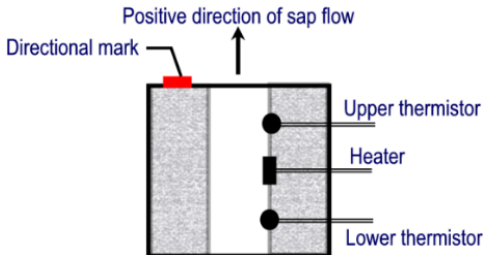

phyto-sensor.com

Series 3000 (with analog and digital outputs)

Introduction

The SF sensors is designed for monitoring relative variations of sap flow rate in a leaf petiole or small shoot. The sensor's probe is made as a hollow collapsible heatinsulating cylinder.

A spring loaded heater and a pair of bead thermistors are located inside the cylinder.

A signal conditioner provides powering of the heater and conditioning of the output signal.

All SF-type sensors are tested on the water filled hose within the approximate measurement range of 12 ml/h.

The probe is connected by a standard 1-meter cable to the waterproof box with the signal conditioner inside.

The output cable length should be specified in the order if required.

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

- Choose an appropriate part of stem for installing the sensor. Make sure that sap flow rate in the stem does not exceed 12 ml/h. The rough estimation may be done assuming the average transpiration rate equal to 1.5 ml/h per square decimeter of leaf surface.

- Open the sensor wide enough to place it on the stem. Make sure that the red directional mark corresponds to upward flow.

- Make sure that the sensor is firmly placed and cannot slide or twist with application of gentle force.

- Carefully cover the sensor with two or three layers of aluminum foil in order to protect the sensor from external heat effects. It is absolutely necessary for reliable measurements.

- To provide the firm positioning of a sensor on stems with diameter below 4 mm for SF-4M and 8 mm for SF-5M, insert a foam-rubber bar into the internal empty part of a sensor as it is shown below.

Selecting Outputs

The SF 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:
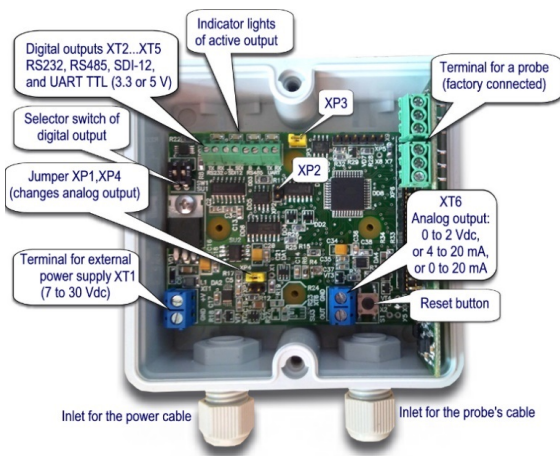
RS-232   RS-485   SDI12   UART TTL

> ⚠ **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

Important notes:

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, if necessary, is connected by the jumper XP2.

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

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.
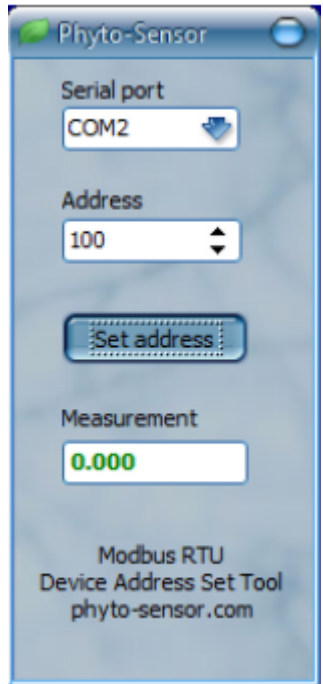
Data reading

Analog output

Calibration table

U, Volts	I, mA 4 to 20	I, mA 0 to 20	Sap flow relative units
0.0	4.0	0.0	0.000
0.5	8.0	5.0	0.500
1.0	12.0	10.0	1.000
1.5	16.0	15.0	1.500
2.0	20.0	20.0	2.000

Calibration equations

0 to 2 Vdc Output	$SF = U$
4 to 20 mA Output	$SF = 0.125 \times I - 0.5$
0 to 20 mA Output	$SF = 0.1 \times I$

where:

SF — relative variations of sap flow, relative units

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: X.XXX (Relative units), 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) Value is stored with a scaling of 1:1000 *(e.g.: 400 is equivalent to 0.400 analog voltage output — relative units)*
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 1.234 [B6 F3 9D 3F] represented as [9D 3F B6 F3])*
40001	0x00	r/w	Slave-ID (int). Default: 247

SDI12

In accordance with SDI12 Standard (version 1.3).

Decimal data format: X.XXX (Relative units).

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.

In case of using the intermittent power supply, please respect the following recommendations:

- Output require at least 15 minutes excitation time for producing stable output signal.

- Output refreshes every 5 seconds (except SDI12).

Specifications

Measurement range		Not specified *
Analog linear output (selectable)		0 to 2 Vdc, 4 to 20 mA, 0 to 20 mA
Digital output (selectable, optional)		UART-TTL, SDI12, RS-232, RS-485 Modbus RTU
Output signal zero offset		0.4 Relative units aprox.
Output signal range		0 to 2 Relative units
Suitable stem diam.	*SF-4*	1 to 5 mm
	SF-5	4 to 8 mm
Operating temperature		0 to 50°C
Warm-up time of the probe		15 min
Output auto update time		5 s
Overall dimensions	*SF-4*	30 × 30 × 40 mm
	SF-5	30 × 35 × 40 mm
Power supply		from 7 to 30 Vdc @ 100 mA
Cable length between probe and signal conditioner		1 m

* Approximate range of 12 ml/h was determined on a stem simulator – a fiber-filled PVC hose with 5 mm in diameter.

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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