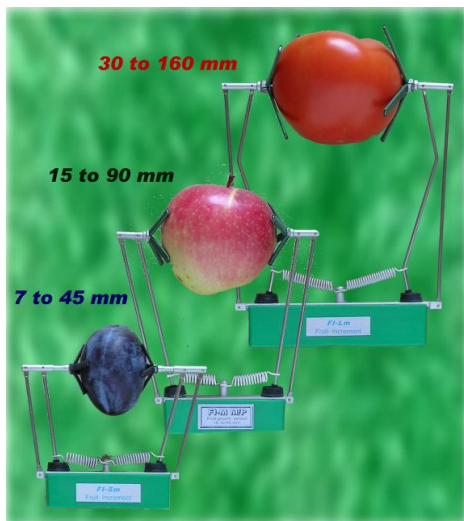




Bio Instruments S.R.L.

SENSORS AND SYSTEMS
FOR MONITORING GROWING PLANTS

FI-SM, FI-MM, and FI-LM *Fruit Growth Sensors*



www.phyto-sensor.com

Introduction

A series of absolute displacement sensors provides recording both size and growth rate of intact rounded fruits in three diameter ranges within 7 to 160 mm. Original parallelogram design of moving arms provides firm and straight positioning of the sensor on a fruit under study. The FI-type sensor consists of an LVDT transducer mounted in a special clip, and a DC powered signal conditioner (Figure 2). The probe design is illustrated on Figure 1 below:

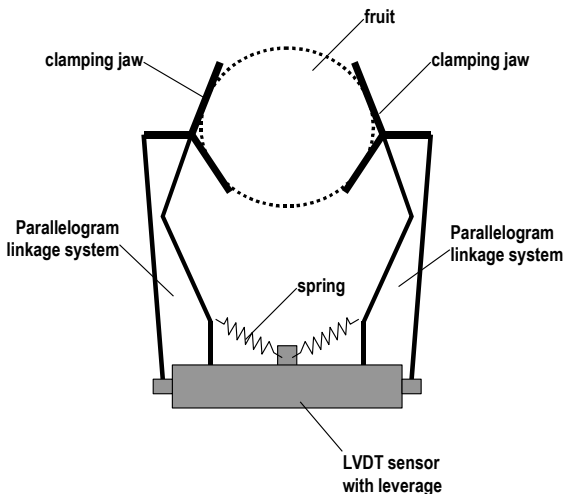


Figure 1. Fruit Growth Sensor's probe design

Standard cable length between sensor and signal conditioner is 2 meter.

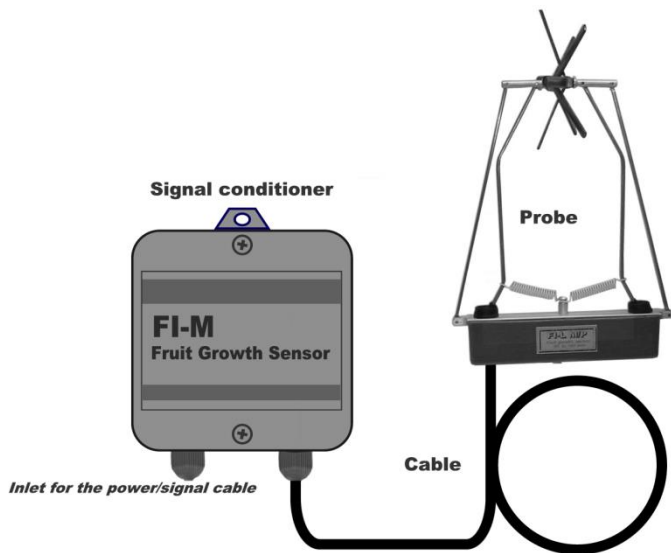
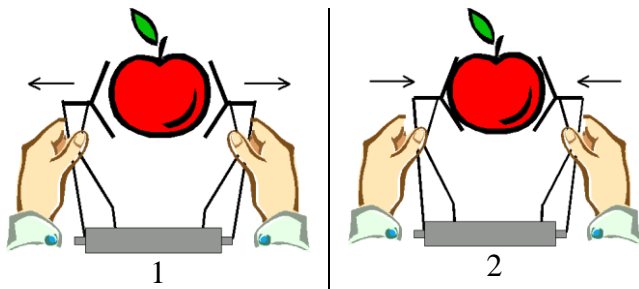


Figure 2. Fruit Growth Sensor

Installation

- Choose a fruit for attaching the sensor.
- Move clamping jaws apart so as the sensor can hold the fruit in the desired position.



- Check if the sensor holds the fruit firmly and cannot easily slide down with application of gentle force.
- Secure the sensor's cable on a stem to prevent occasional movement of the sensor.
- Check the position of the sensor regularly.

Selecting Outputs

The FI 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: 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 3) 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

Position 3-1



RS485

Position 2-1



SDI-12

Position 3-0



UART TTL

Position 2-0

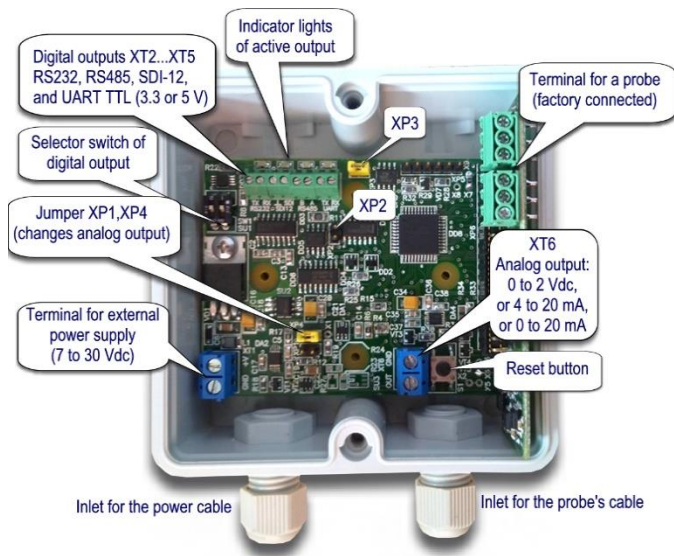


Figure 3. PCB

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

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

Jumper XP2 is used for the RS485 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 on, the voltage level is 3.3 V; in case of no jumper, the voltage level is 5 V.

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.

For current output (4 to 20, or 0 to 20 mA), the minimal power voltage shall be determined from the following conditions:

$$U > 0.24 R_2 + 0.02 R_1, \text{ and } U > 7 + 0.2 R_2$$

Where R_1 is the value of the input load resistor of the datalogger, and R_2 is the power wires resistance.

Example: $R_1 = 500 \text{ Ohm}$, and $R_2 = 100 \text{ Ohm}$.

$$U > 0.24 \times 100 + 0.02 \times 500 = 12.4 \text{ V}$$

$$U > 7 + 0.2 \times 100 = 9 \text{ V}$$

Therefore, the minimal power voltage must be above 12.4 V.

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

- Analog outputs require at least 1 second 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: XX.XX (mm).

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	Fruit diameter (int)*
30101	0x64	r	Fruit diameter (float)
40001	0x00	r/w	Slave-ID (int). Default: 247

SDI-12 :

In accordance with SDI-12 Standard (version 1.3)

*Values are stored with a scaling of 1:100 (e.g.: 3050 is equivalent to 30.5 mm)

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.

Calibration table for linear analog outputs

Voltage output	Current output		Fruit size D, mm		
			FI-SM	FI-MM	FI-LM
0 to 2 V	4..20 mA	0..20mA	7	15	30
<i>0.00 V</i>	<i>4.0 mA</i>	<i>0.0 mA</i>	<i>7</i>	<i>15</i>	<i>30</i>
<i>2.00 V</i>	<i>20.0 mA</i>	<i>20.0 mA</i>	<i>45</i>	<i>90</i>	<i>160</i>

Calibration equations for linear analog outputs:

Model	Output	Equation
FI-SM 7 to 45 mm	0..2 V	$D = 19 \times U(\text{V}) + 7, \text{ mm}$
	4..20 mA	$D = 2.375 \times I(\text{mA}) - 2.5, \text{ mm}$
	0..20 mA	$D = 1.9 \times I(\text{mA}) + 7, \text{ mm}$
FI-MM 15 to 90 mm	0..2 V	$D = 37.5 \times U(\text{V}) + 15, \text{ mm}$
	4..20 mA	$D = 4.6875 \times I(\text{mA}) - 3.75, \text{ mm}$
	0..20 mA	$D = 3.75 \times I(\text{mA}) + 15, \text{ mm}$
FI-LM 30 to 160 mm	0..2 V	$D = 65 \times U(\text{V}) + 30$
	4..20 mA	$D = 8.125 \times I(\text{mA}) - 2.5$
	0..20 mA	$D = 6.5 \times I(\text{mA}) + 30$

Specifications

	FI-L	FI-M	FI-S
Range, mm	30 - 160	15 - 90	7 - 45
Resolution, mm	<0.1	<0.05	<0.02
Operating temperature	0 to 50 °C		
Temperature effect	<0.01% FS/°C		
Analog linear output (selectable)	0 to 2 Vdc, or 4-20 mA, or 0-20 mA		
Digital output (optional)	RS232, or RS485, SDI-12 (optional), or UART-TTL		
Output auto update time	5 s		
Supply voltage	7 to 30 Vdc @ 35 mA typ.		
Excitation time	0.25s		
Protection index	IP 64		
Cable length between probe and signal	2 m typical		

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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