Bio Instruments S.R.L.

SENSORS AND SYSTEMS
FOR MONITORING GROWING PLANTS

LT-1M, LT-1Mi
LT-4M, LT-4Mi

Leaf Temperature Sensor

www.phyto-sensor.com

Introduction

The LT-1M sensor is a subminiature touch probe that measures absolute temperature of a leaf. The lightweight stainless steel wire clip holds a high precision glass encapsulated thermistor, which is about a millimeter in diameter. Small size of the probe and its special design provide almost negligible disturbance of the natural leaf temperature. The thermistor is connected to the clip by thin 0.15 mm leads to minimize heat conduction and response time. All conductors are proofed to avoid corrosion under the wet operating conditions.

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. Every sensor is tuned and calibrated within the measurement range. The LT-4 sensor has 4 probes.

Installation

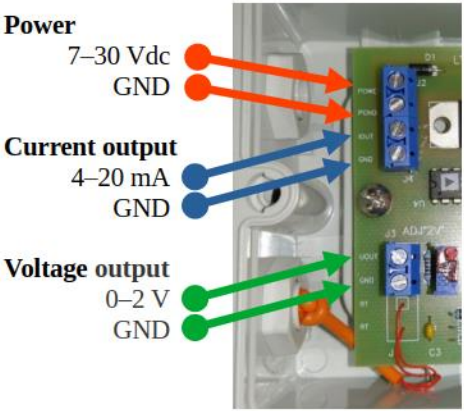
Open the clip and attach the sensor to a leaf. Thermistor should be placed at the lower shady side of the leaf.

Secure the sensor's cable on plant stem with adhesive band in order to prevent occasional movement of the sensor.

Connection

First, please choose a right output cable for connecting the sensor to a datalogger. The cable must be round with four wires. The maximal diameter of the cable is 6.5 mm. The cable length shall not exceed 10 m for 0 to 2 Vdc output (model LT-1M) and with about 1 km maximal length for 4 to 20 mA output (model LT-1Mi).

Run the cable through the appropriate inlet (see Figure below).



Connection diagram

Power supply

The 7 to 36 Vdc @ 30 mA regulated power supply may be used.
In case of using the intermittent power supply, please respect the following recommendations:
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.

Design guidelines

Selecting load resistance

Max load resistance is calculated by formula:

$R = (U - 2) / 0.02$

where:
R – max load resistance
U – power supply voltage

Example: for 12 Vdc power supply
$R = (12 - 2) / 0.02$, $R = 500$ Ohm

Calibrations table

U, Volts	I, mA	T, °C
0.0100	4.0800	0.0
0.1970	5.5760	5.0
0.3945	7.1560	10.0
0.6000	8.8000	15.0
0.8087	10.4696	20.0
1.0167	12.1336	25.0
1.2200	13.7600	30.0
1.4156	15.3248	35.0
1.6010	16.8080	40.0
1.7740	18.1920	45.0
1.9335	19.4680	50.0

For linear approximation:

U, Volts	I, mA	T, °C
0.000	4.00	0.0
2.000	20.00	50.0

Calibrations equations

Best Fit:

0 to 2 Vdc Output:

$T = 2.085 \times \mathbf{U}^3 - 4.91 \times \mathbf{U}^2 + 27.69 \times \mathbf{U} - 0.28$

4 to 20 mA Output:

$T = 0.004072 \times \mathbf{I}^3 - 0.12555 \times \mathbf{I}^2 + 4.27 \times \mathbf{I} - 15.613$

Approximation error < ±0.08 ºC

Linear fit:

$\mathbf{T} = 25 \times \mathbf{U}$

$\mathbf{T} = 3.125 \times \mathbf{I} - 12.5$

Approximation error: < ±0.5 ºC (0 to 40 ºC),

< -1.5 ºC (40 to 50 ºC)

Where: T - the temperature in degrees centigrade

U – output voltage in Volts

I – output current in mA

Specifications

Measurement range	0 to 50 C
Outputs LT-1M LT-1Mi	0 to 2 Vdc 0 to 2 Vdc; 4 to 20 mA
Max. load resistance for current output	250 Ohm (100 Ohm recommended) @ 7 Vdc
Instrumental accuracy	<0.15C
Probe weight	1.6 g
Contact area of thermistor	About 1 mm^2
Supply voltage	7 to 36 Vdc
Current consumption	30 mA approx.
Excitation time	<1 s
Probe dimensions, mm	50 W × 20 H × 10 D
Protection index	IP 64
Cable length between probe and signal conditioner	1 m

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