

Hotplate[®] TOTAL PRECIPITATION SENSOR MODEL TPS-3100

BULLETIN TPS-3100



TPS-3100 Hotplate[®] precipitation sensor

Statistically, precipitation rate can be highly variable in both time and space, and a single measurement only reflects a limited space-time domain. The measurement of liquid equivalent rate (LER) of precipitation, especially mixed/frozen precipitation, is fundamental to disciplines as diverse as transportation safety and global climate change research. The TPS-3100 has the unique ability to provide real time histograms of precipitation *rate*.

Applications

Reliable real time performance under any weather conditions makes the TPS-3100 ideal for:

- Professional grade meteorological stations
- Roadway weather information systems
- Calibration of other precipitation gauges
- Weather and global climate change research

Benefits

The TPS-3100 can be placed in difficult-to-access areas and will provide accurate readings of snowfall rates precisely at locations where vehicles are most at risk of experiencing dangerous snow and ice build-up. Snow removal operators are then able to optimize coverage during storm periods. Increased efficiency during snow and ice removal operations improves public safety and saves money. Beyond de-icing applications, the precise knowledge of precipitation rates is fundamental to better understanding the Earth's climatic mechanisms.

$$p = \frac{\rho RT}{m}$$

$$S(\lambda) = S_0(\lambda) e^{-m \cdot \delta(\lambda)}$$

$$B(T) = bT^4$$

Description

The Model TPS-3100 provides real time snow and liquid precipitation rates at remote automated weather stations. It represents the first fundamental breakthrough in basic precipitation measurement in several decades, and is ideal for mission-critical meteorological and transportation applications. Unlike conventional weighing and tipping bucket precipitation gauges that have moving parts and require anti-freeze treatments, the TPS-3100 provides exceptional accuracy and reliability over the entire $\pm 50^\circ\text{C}$ operating range.

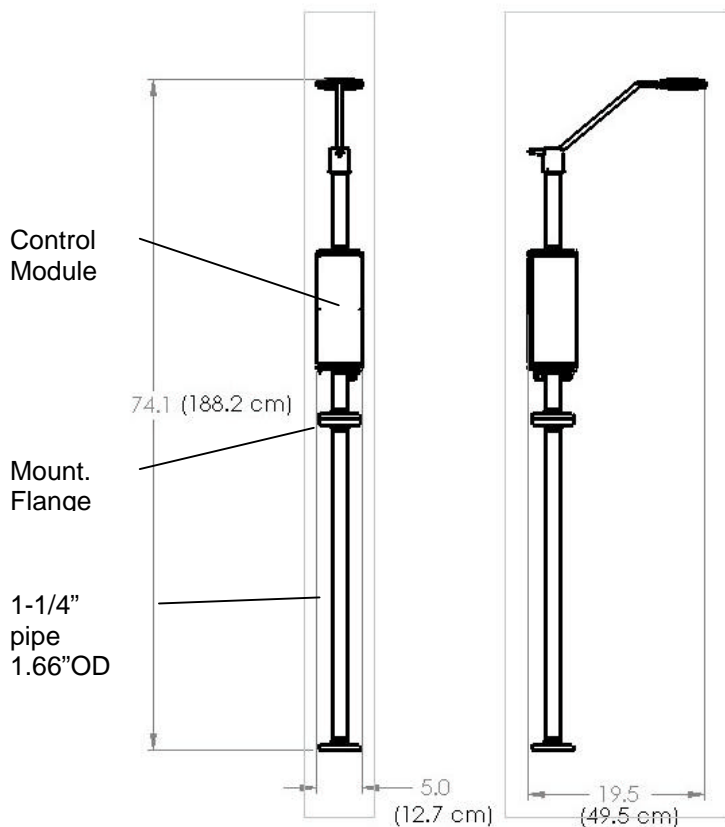
About five inches in diameter, the sensor head consists of two isolated plates warmed by electrical heaters. During storms, it measures the rate of rain or snow by how much power is needed to evaporate precipitation on the upper plate and keep its surface temperature constant. The second plate, positioned directly under the evaporating plate and heated to the same temperature as the top, is used to factor out cooling from the wind.

Transportation agencies charged with public safety have traditionally relied on snow gauges with collection buckets that have open orifices. Windshields must be set up around these legacy gauges to increase collection efficiency, particularly of snow. These legacy gauges usually require troublesome anti-freeze additives with oil skin overlays. The action of wind coupled with snow sticking to the sides of open collection vessels tends to bias collection efficiency. Further, some legacy gauges require manually emptying during storm events.

With no moving parts, the all-electronic TPS-3100 sensor avoids problems associated with traditional volumetric or weighing rain gauges. It works equally well in snow and rain conditions. Liquid equivalent rates are calculated from real time measurements and output in real time.

Features

- No moving parts maintenance-free design
- Reliable solid-state technology
- No wind shield or anti-freeze required
- Microprocessor-managed "smart sensor" with RS-232 diagnostic output
- Integrates with [Vaisala's](#) WSDDM weather system.



Mechanical Interface: 72"H x 22"W

Mechanical Configuration

The aluminum weatherproof electronics enclosure and sensor heads provide long life. Electrical and components are designed to operate over a temperature span of $\pm 50^{\circ}\text{C}$. The sensing head is typically mounted at least two meters above the ground mated to a customer-supplied flange, and the temperature sensor is aimed away from the equator to shade it from direct solar radiation.

Digital Output Data Format

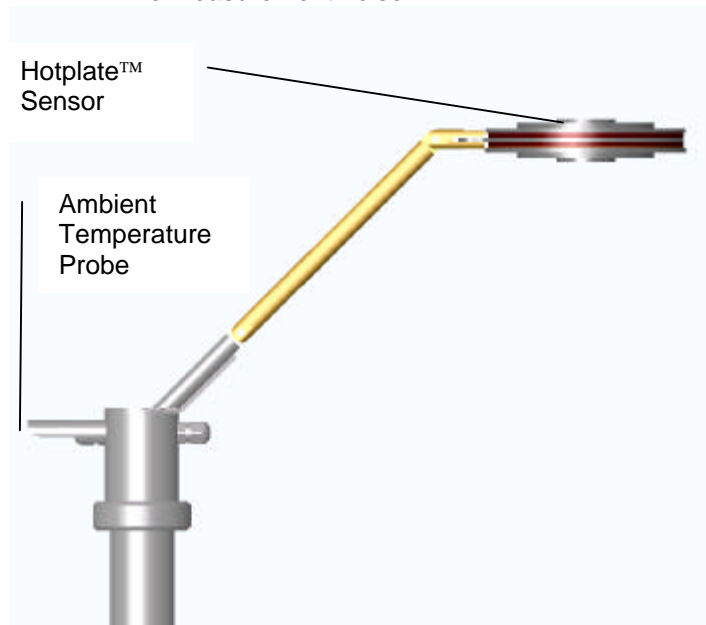
The serial port output can be streamed or respond to a "T" string. It produces a record consisting of the measured precipitation rate in mm hr^{-1} , power to the top and bottom plates in Watts, ambient temperature in $^{\circ}\text{C}$, calculated wind speed in ms^{-1} , and system status, as well as a CRC check. The system outputs fixed length output records which can feed your data management system or optional WSDM software.

Internal CPU Operation

The TPS-3100 Hotplate™ sensor is controlled by an embedded CPU that serves several functions:

- At power up, the processor initiates heating to maintain an operating temperature of $\approx 90^{\circ}\text{C}$.

- Once operating temperature is reached, power is adjusted to the top and bottom plates to maintain the plates at the temperature setpoint.
- The serial port is monitored for commands; upon receipt of the query command, the CPU outputs a single data record. Streaming is also supported.
- Continuous measurements of the plate power and ambient temperature are made by the ADC.
- Differences between the plate power indicate incident precipitation, and the rate is calculated.
- The CPU performs digital filtering of the data to minimize measurement noise.



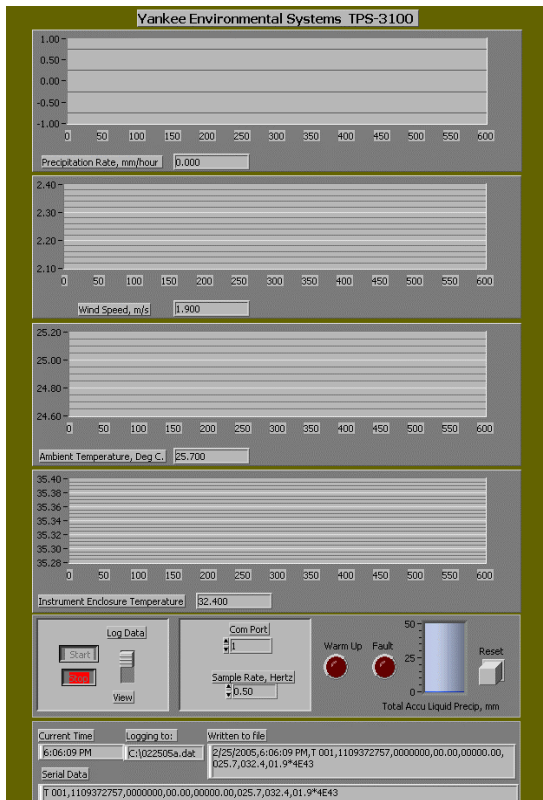
Side view of TPS-3100 Hotplate sensor.

Electrical Connections

Separate AC and communications conduit ports are located on the bottom of the electronics enclosure. Cabling between the sensing head and the enclosure is encased within the support arm. Inside the system electronics enclosure, a DB-9 female RS-232 connector provides digital interface (3 wire no handshaking), while a terminal strip provides AC input termination. Typically, two flexible conduits are used to connect power and serial data communications to a user-provided junction box.

Available Options

- Dual version for detection of blowing snow
- WSDM Software
- Dialup Telco Modem for POTS telephone lines
- Ethernet 802.3 10/100BaseT for LANs



Real time data display software for MS-Windows.

Development History

The Hotplate™ technology was developed by scientists at the Nation Center for Atmospheric Research (NCAR) and the Desert Research Institute (DRI), funded by the Federal Aviation Administration. The NCAR/DRI research effort was aimed at improving public safety in adverse weather conditions. Prototypes were operated experimentally in Denver for several and patented Hotplate™ technology was licensed for manufacture. Historically, manual techniques as simple as a ruler against a vertical wooden board have been used for measuring snowfall. Particularly in colder climates, direct measurement of liquid equivalent rate using weighing or volumetric gauges has been problematic as the sensor often freezes up and fails. Problems with the use of oil-covered antifreeze in liquid precipitation gauges drove the development of the Hotplate™ technology.

The Hotplate™ technology is protected by U.S. Patent #5,744,711, titled "Winter Precipitation Measuring System," U.S. Patent #6,546,353 B1 titled "Hotplate Precipitation Measuring System," and five (5) continuation patent applications filed on February 18, 2003 (serial #s. 10/368,548, 10/368,504, 10/368,506, 10/368,508, 10/368,509).

Specifications

Size:	72" H; 22"D; 8"W	Materials:	Aluminum
Weight:	17 lbs. (8 kg)	Electrical Connections:	DB9-F RS-232,
Power on Delay:	10 minutes	Data communications:	6' (1.8m), AC (to
Running Average:	5 minutes	AC line power:	terminal strip)
Power Required:	110/220 Vac, 50/60Hz, 1Φ 600W max 100W nominal	Environmental operating temperature range:	±50°C

PRECIPITATION MEASUREMENT

Measurement range	0-50 mm hr ⁻¹
Liquid Equivalent Rate accuracy	±0.5 mm hr ⁻¹
Slew rate	1 minute T _c , ≈0.5 mm s ⁻¹
Repeatability	±0.25 mm hr ⁻¹
Hysteresis	None
Resolution	0.1 mm hr ⁻¹
Digital output	RS-232, 9600 baud 8-N-1, ASCII (14-bit 0.01mm/hr resolution)
	Separate pulse output simulates tipping bucket for interface to data loggers with counter inputs



Hotplate® R&D testing at Denver, Colorado, USA



YANKEE ENVIRONMENTAL SYSTEMS, INC.
 Airport Industrial Park
 101 Industrial Blvd., Turners Falls, MA 01376 USA
 Tel: (413) 863-0200 Fax: (413) 863-0255
 E-mail: info@yesinc.com http://www.yesinc.com