Microstructure Temperature Sensor SBE 8

FEATURES

High-Speed Micro-Scale Resolution:

- -3 db at 22 Hz (sensor)
- -3 db at 1000 Hz (electronics)

Extremely Low-Noise:

- 5 x 10^{-12} (°C)^2/Hz
- pre-emphasized response to overcome system thresholds

Temperature Element:

- high-speed thermistor, Thermometrics type FP07
- cabled (up to 3 meters) remote stainless steel probe assembly

Output (Pre-Emphasized):

- voltage, +6 to -6 for -3 to 30 °C nominal at 0 frequency
- output increases in proportion to frequency beginning at 0.1 Hz and ending at 200 Hz

Power Required:

- ± 15 volts ± 3% at 15 ma

Pressure Housing:

- 4.8 cm diameter x 18 cm long
- hard-anodized 7075-T6 aluminum, zinc anode protected
- 10,000 psi pressure capability

Connector:

- 6-pin Impulse AG 306 (1/2-20 thread)

Weight:

- in air - 710 grams
- in water - 330 grams

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DESCRIPTION

The SBE 8 Microstructure Temperature Sensor is a reliable, lightweight instrument intended for use in marine profiling applications where its high speed and spatial resolving power offer the ability to characterize small scale ocean temperature features. Used in conjunction with the Sea-Bird SBE 7 Microstructure Conductivity sensor, the SBE 8 can provide comparably sensitive resolution of salinity and density fields.

The sensing element is a remote-cabled, probe-mounted thermistor (Thermometrics type FP07). The sensor probe is a small, stainless steel assembly which may be mounted at distances up to 3 meters from the sensor electronics housing; this arrangement minimizes the effect of field perturbations associated with the instrument housing and its wake. The thermistor body is 'O'-ring sealed into the sensor assembly to insure pressure integrity.

The thermistor has a 25 °C resistance of 270 K ohms and is driven by a DC current derived from a low-noise, 6.9 volt reference and 1 mega-ohm resistor. The thermistor voltage is buffered by a low-noise FET op amp, the output of which is subsequently 'pre-emphasized' so that the sensor's output increases as a function of the frequency components in the temperature signal. The effect of pre-emphasis is to magnify the sensor output for rapidly changing temperature, thereby overcoming the restrictions on system resolving power that would otherwise be imparted by the use of conventional (e.g., 16-bit) digitizers. The SBE 8's pre-emphasis response magnifies a 20 Hz temperature signal by a factor of 200, thus facilitating acquisition of signals 200 times smaller than could be characterized by conventional CTD sensors.

Although the SBE 8 is intended primarily for determination of temperature gradients, it is configured to respond also to absolute temperatures. There are three reasons for this: 1) the gradient sensitivity of the sensor is a function of its average zero-frequency response and may be evaluated by integrating that response; 2) the functionality of the instrument is verified by its proper 'static' response; 3) the SBE 8 is accurate enough as an absolute sensor (typically within 0.01 °C for periods of several hours at atmospheric pressure) to provide absolute temperature data. The following equations describe the relationship between sensor output voltage V_o, thermistor resistance R_t, and temperature:

$$Rt = 10^6 (V_o + 12.282) / (22,508 - V_o)$$

$$T = -273.15 + 1/((\ln(R_t/R_{to})/B) + 1/273.15)$$

where R_{to} is the 0 °C value for the thermistor resistance (about 825 K ohms) and B is a thermistor sensitivity coefficient (typically 3600).

General characteristics of similar sensors are described in a paper by Gregg, et al[1]. A discussion of field experiences with instruments of this type may be found in another paper by Gregg[2].

CALIBRATION:

The response of the SBE 8 electronics is determined with fixed resistors substituting for the thermistor. The completed sensor is calibrated by measuring its output voltage at four widely spaced temperatures in the range of 0 to 30 °C. Noise is measured with the thermistor in a thoroughly equilibrated Dewar flask using a 100 Hz low-pass filter and true RMS volt meter.

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[1] Gregg, M.C.; T.B. Meagher; A.M. Pederson; and E. Aagaard, "Low Noise Temperature Microstructure Measurements with Thermistors", Instruments and Methods, Deep-Sea Research, Vol 25, pp 843-856, 1978.

[2] Gregg, M.C., "Variations in the Intensity of Small-Scale Mixing in the Main Thermocline", Journal of Physical Oceanography, Vol 7, pp 436-454, 1977.