Digital Immersion Thermometer

SBE 38

DESCRIPTION

New A/D acquisition electronics, ultra-stable thermistor, and state-of-the-art calibration provide the standards-level performance of an expensive AC bridge and platinum thermometer at a small fraction of the cost. The SBE 38 Digital Immersion Thermometer is not affected by shock and vibration, has high accuracy and stability, has a rugged, corrosion-proof, 10,000 meter titanium pressure housing, and is easy to use. Real-time temperature data is transmitted in ASCII characters (in units of degrees celsius) via RS-232 or 485 standard serial interface for display or logging by PC or data logger.

The standard measurement range is -5 to +35 °C. An optional range of -5 to +50 °C is available at slightly reduced accuracy and resolution. For the standard range, absolute accuracy is better than 0.001 °C (1 mK) and resolution is approximately 0.00025 °C (0.25 mK). Each sensor includes certification which demonstrates drift of less than 0.001 °C during a six month period.

Applications include calibration baths, oceanographic/aquatic research, and environmental monitoring.

OPERATION

The SBE 38 operates in one of three modes:

1) RS-232 with one SBE 38 connected to the interface.
2) RS-485 with one SBE 38 connected to the interface.
3) RS-485 with several RS-485 sensors sharing one pair of wires (half duplex).

On power up, the SBE 38 will read its EEPROM. According to its programming, the SBE 38 will sample and transmit temperature at the set data rate, or wait for a command. In mode 3, it will only sample on command.

MEASUREMENT METHOD

Temperature is determined by applying an AC excitation to reference resistances and an ultra-stable aged thermistor with a drift rate of less than 0.002 °C per year. Each of the resulting outputs is digitized by a 24-bit A/D converter. The reference resistor is a hermetically-sealed VISHAY. AC excitation and ratiometric comparison using a common processing channel removes measurement errors due to parasitic thermocouples, offset voltages, leakage currents, and gain errors. Maximum power dissipated in the thermistor is 0.5 microwatts, and contributes less than 200 µK of overheat error.
A raw count (ratio) is related to resistance measurements as:

1048576 * (NT) / (NR);
where NR is the output from the reference resistor and NT is thermistor output.

The number of acquisition cycles (raw counts) averaged per measurement is user programmable. Increasing the number of cycles per measurement increases the time to acquire the measurement and the interval between measurements, while reducing the RMS temperature noise from the sensor. The interval between measurements is determined as follows:

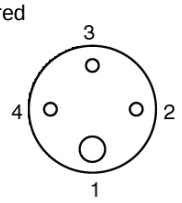
interval [sec.] = 0.133 * Ncycles + 0.339

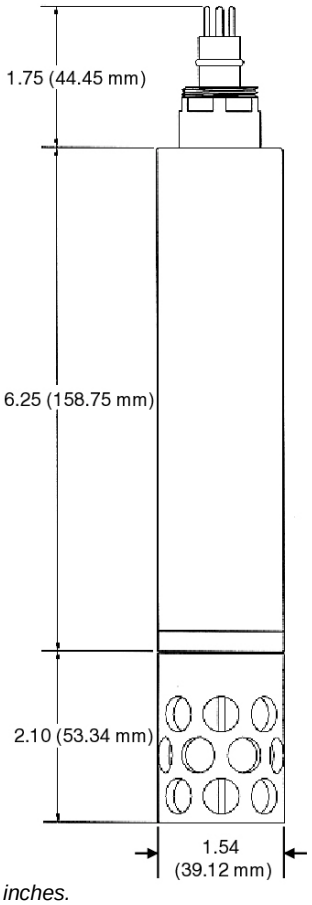
The thermometer's output is computed from the raw count and calibration coefficients stored in EEPROM.

Sea-Bird Electronics, Inc.
1808 136th Place NE, Bellevue, Washington 98005 USA
Website: http://www.seabird.com
Fax: (425) 643-9954
Tel: (425) 643-9866
Email: seabird@seabird.com

Digital Immersion Thermometer SBE 38

PIN	SIGNAL
(1)	Common, white
(2)	Receive, black or RS-485 A
(3)	Transmit, green or RS-485 B
(4)	Power, red





Dimensions in inches.

CALIBRATION

The SBE 38 is calibrated in Sea-Bird's state-of-the-art calibration laboratory which maintains primary temperature standards (water triple point (TPW) and gallium melting point (GaMP) cells), ITS-90 certified and standards-grade platinum resistance thermometers, and a low-gradient temperature bath.

The calibration of the SBE 38 is accomplished using the following equation to characterize the non-linear temperature versus resistance response of the sensor. Temperature is computed using the Steinhart-Hart polynomial for thermistors (Steinhart and Hart, 1968; Bennett, 1972) which is based on thermistor physics. Thermistors require individualized coefficients to the Steinhart-Hart equation because the thermistor material is an individualized mix of dopants. (n is the SBE 38 output):

$$(A)\quad t_{90L} = \frac{1.0}{a0 + a1[\ln(n)] + a2[\ln^2(n)] + a3[\ln^3(n)]} - 273.15 \quad [°C]$$

$$(B)\quad t_{90L} = slope \times t_{90L} + offset \quad [°C, ITS\text{-}90]$$

SPECIFICATIONS

Interface: RS-232 standard
Power required: 8-15 VDC @ 10 milliamps average
Interface: RS-485 half duplex (optional)
Power required: 8-15 VDC @ 6 milliamps average

Housing:	Titanium; rated at 10,500 meters
Weights:	
Air	2.0 lbs
Water	1.2 lbs
Range:	-5 to +35 °C (Optional -5 to +50 °C)
Initial Accuracy[1]:	0.001 °C (1 mK)
Resolution:	0.00025 °C (0.25 mK)
Stability:	0.001 °C (1 mK) in six months, certified
Response Time[2]:	500 milliseconds
Self-heating Error:	less than 200 µK

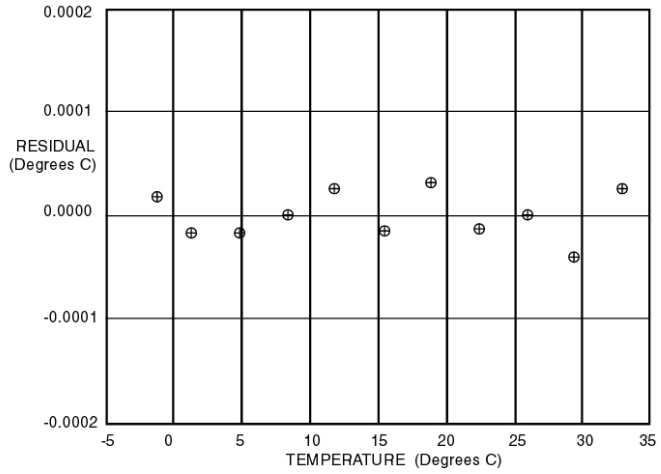
1 *NIST-traceable calibration applying over the entire range.*
2 *Time to reach 63% of final value following a step change in temperature.*

ACTUAL CALIBRATION DATA for Sensor Number #80

CALIBRATION DATE: 02 September 1997

a0 = -2.809379e-05 a2 = -2.619655e-06
a1 = 2.783483e-04 a3 = 1.598734e-07

Bath Temp [°C]	Inst Output [n]	Inst Temp [°C]	Residual (Inst - Bath) [°C]
-1.52985	824162.7	-1.52983	0.00002
1.03108	733633.1	1.03106	-0.00002
4.60520	625547.1	4.60518	-0.00002
8.11169	536776.4	8.11169	-0.00000
11.61533	462132.6	11.61536	0.00003
15.17575	398167.3	15.17574	-0.00001
18.63931	345476.6	18.63934	0.00003
22.14032	300170.8	22.14031	-0.00001
25.66793	261276.6	25.66793	0.00000
29.13948	228549.1	29.13944	-0.00004
32.61481	200420.3	32.61484	0.00003



Sea-Bird Electronics, Inc.
1808 136th Place NE, Bellevue, Washington 98005 USA
Website: http://www.seabird.com
Fax: (425) 643-9954
Tel: (425) 643-9866
Email: seabird@seabird.com