

**Calibration Report – December 20, 2013**  
**Precision Thermistor Scanner Model S1TH, Serial LM01**

This instrument is a very high accuracy, high resolution electronic thermometer manufactured by GEC Instruments. It includes one Thermometrics AS115, SN 2118 ultra stable thermistor probe with 4 wire shielded cable. The instrument connects to a Windows computer via a standard RS-232 serial port and is accompanied by a versatile and powerful program for display, plotting, logging and retrieval of temperature data. This program is called PinPoint Monitor (PPM).

The AS115 thermistor probe was initially calibrated on 3-25-98 by Thermometrics, Inc., Edison NJ, providing an NIST traceable calibration on the ITS-90 temperature scale, with a temperature uncertainty of less than 0.001 °C and a resistance uncertainty of less than 0.0025%. This calibration yielded the following values:

Temp (°C)	Resistance (ohms)
0.010	14318.30
15.000	7472.20
25.000	4994.73
30.000	4118.98
32.000	3819.15

A least squares regression was performed on these data by GEC Instruments to obtain coefficients for the Steinhart - Hart equation:  $1/T = a + b[\ln R] + c[\ln R]^2 + d[\ln R]^3$

Where T = temperature, °K and R = thermistor probe resistance, ohms. This regression gave the following coefficients for the thermistor probe:

AS115, SN 2118
a = 1.007892761456e-003
b = 2.797385265773e-004
c = -2.417856951376e-006
d = 2.253539833616e-007

The residuals from the regression, indicating goodness of fit, are:

Temp (°C)	Residual (°C)
0.010	- 0.000001
15.000	+ 0.000008
25.000	- 0.000039
30.000	+ 0.000082
32.000	- 0.000050

The four coefficients were placed into the configuration file for the instrument: LM01.ppc. Then a two point calibration was performed by placing the AS115 probe first into Isotech gallium melting apparatus SN 102, and then into Pond Engineering Triple Point of Water cell, Model K29 Type A13, SN 1431. The nominal ITS-90 TPW temperature of 0.01 °C was corrected for hydrostatic head to give a fixed point temperature of 0.0098 °C. The nominal ITS-90 gallium melting point temperature of 29.7646 °C was corrected for hydrostatic head to give a fixed point temperature of 29.7643 °C. At each fixed point, after readings became very stable, temperature readings were recorded by PPM every 1.5 seconds for a period of 30 minutes. These readings were then averaged, yielding a measured temperature of 29.7677 °C at the gallium melting point and 0.01316 at the TPW. A slope and offset correction were calculated by first converting the temperature readings to Kelvins. Data are shown in the table below.

	gallium °C	TPW °C			29.7643 °C	0.0098 °C
<b>Ref:</b>	29.7643	0.00980	<b>Offset</b>	<b>Slope</b>	<b>Initial Error</b>	<b>Initial Error</b>
<b>AS115</b>	29.7677	0.01316	-0.00299278	0.99999866	0.00340	0.00336

The offset and slope values were placed into the configuration file for the instrument: LM01.ppc. These offset and slope corrections are then applied to every temperature reading by the PPM software. In order to verify the two point calibration, temperatures were again measured and logged in PPM at TPW and the gallium melting point for a period of more than one hour in each. Results are shown on page 3. The reproducibility at the TPW was -0.00007 °C and at the gallium melting point the reproducibility was 0.00006 °C.

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