
CERTIFICATE OF CALIBRATION

SUBJECT:	10K Thermistor	CERTIFICATE NO.:	0
MANUFACTURER:	Measurement Specialties	DATE OF CALIBRATION:	26-Apr-17
SERIAL NUMBER:	TC15200490	DATE OF ISSUE:	0
CUSTOMER:	0	AMBIENT TEMPERATURE:	(21 ± 3) °C
JOB NUMBER:	0	RELATIVE HUMIDITY:	(55 ± 10) % Relative Humidity
CALIBRATION POINTS (°C):	<u>0.01</u> <u>15.000</u> <u>29.7646</u>		

Method of Calibration

The thermistor has been calibrated in accordance with M&V's technical procedures TP 5.4.2-01(V0), TP 5.4.2-02(V0), TP 5.4.2-03(V0), TP 5.4.2-04(R1), TP 5.4.2-05(V0) under well monitored environmental conditions (at 8 Boon Lay Way, #09-02).

The thermistor was calibrated at Triple Point of Water (0.01°C), Gallium Melting Point (29.7646°C) and Calibration Bath maintained at 15°C. The temperature scale used is ITS-90. The fixed point cells from ITS-90 used for the calibration are water triple point cell and gallium melting point cell. The water bath temperature was measured by SPRT and super-thermometer as reference. Prior to calibration, an SPRT was used to check on the stability of the calibration equipment for measurement assurance. Upon completion of the calibration with a, b, and c constants computed for the thermistor, the thermistor then goes through a verification test where it is measured again at triple point of water and in water bath at 21°C. The measured temperatures should show a deviation of < 13mk.

Standard Used

<u>Equipment</u>	<u>Serial Number</u>
Triple Point of Water Cell (ITS-90)	C-G2109
Gallium Cell (ITS-90)	Ga-43159
SPRT	4321
SPRT	4340
Super-Thermometer	B2A105
Data Acquisition Unit	MY44080469

The reference standards used in this calibration are traceable to the SI units of measurement realised at National Metrology Centre, Singapore or other recognised national standards laboratories.

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council.

Calibrated By:

Approved by:

Serene Cheong
Calibration Officer

Thant Zaw
Approving Officer
Head of Laboratory

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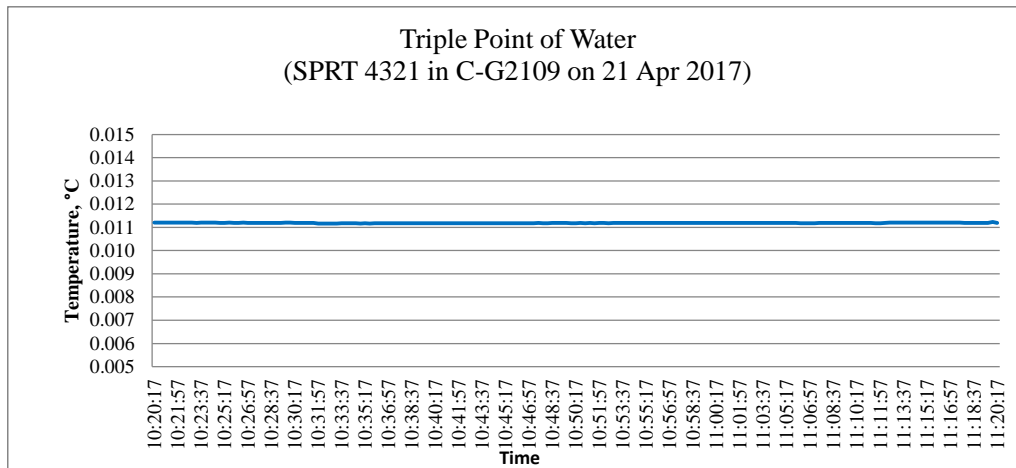
SERIAL NUMBER: TC15200490

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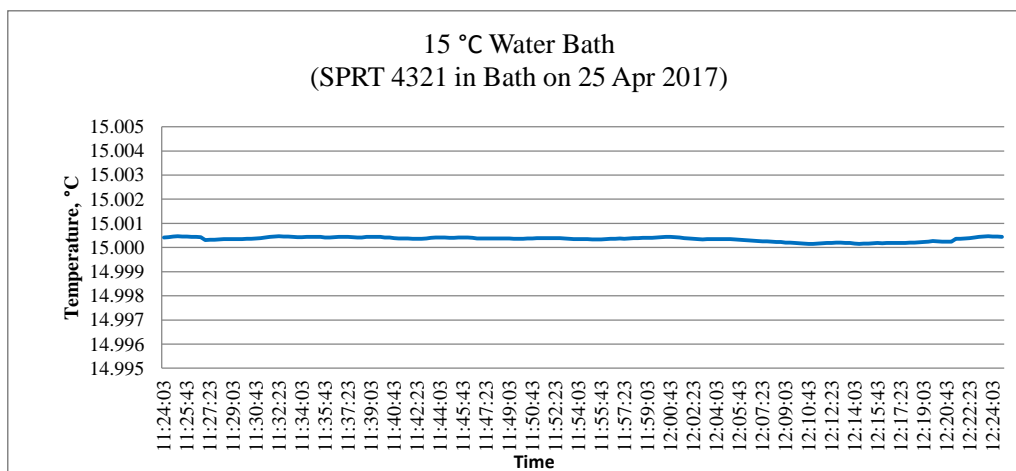
Stability of Calibration Equipment

Before the calibrations are carried out, an SPRT is used to ensure that all calibration equipments are in stable conditions.

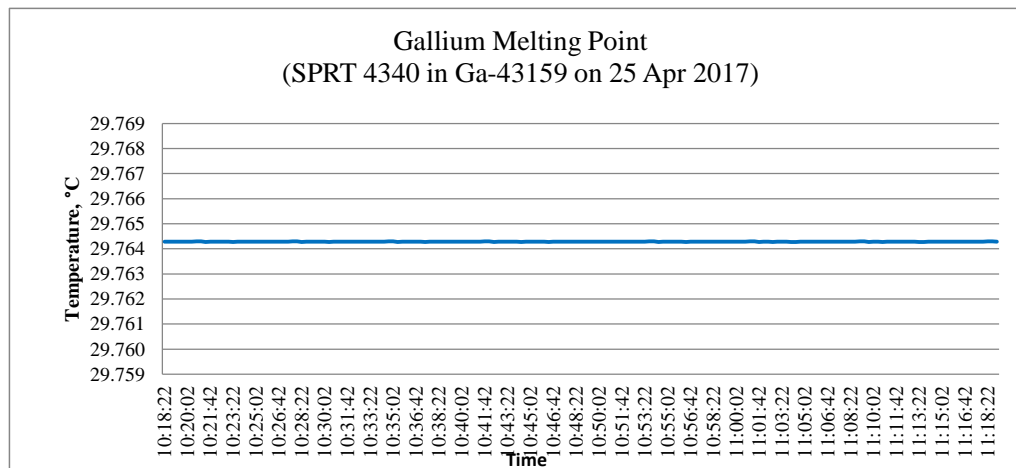
Stability Check at Triple Point of Water



Stability Check at 15°C Calibration Water Bath



Stability Check at Gallium Melting Point



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Measurement Uncertainty

The reported expanded uncertainty is **0.013°C**, a coverage factor of k=2 for a level of confidence interval of approximately 95%.

The measurement results are as follows:

Temperature (°C)	Resistance (Ω)
0.01	32,613.10
15.000	15,716.86
29.7646	8,140.82

Equation Used

$$1/T = a + b (\ln R) + c (\ln R)^3$$

Where: T = Kelvin units (°C + 273.15)
a, b, c = coefficients derived from measurement
Ln R = natural logarithm of resistance in ohms

Coefficients Derived From Measurement

a =	1.137579E-03
b =	2.327134E-04
c =	9.338077E-08

Temperature - Resistance Table

Temp (°C)	R Value (Ω)	Temp (°C)	R Value (Ω)
0	32,629.7292	16	15,004.7094
1	31,013.2469	17	14,328.5379
2	29,486.0711	18	13,686.5738
3	28,042.7958	19	13,076.9120
4	26,678.3692	20	12,497.7627
5	25,388.0689	21	11,947.4438
6	24,167.4786	22	11,424.3740
7	23,012.4671	23	10,927.0662
8	21,919.1681	24	10,454.1216
9	20,883.9626	25	10,004.2240
10	19,903.4614	26	9,576.1344
11	18,974.4897	27	9,168.6864
12	18,094.0725	28	8,780.7815
13	17,259.4209	29	8,411.3847
14	16,467.9199	30	8,059.5207
15	15,717.1166		

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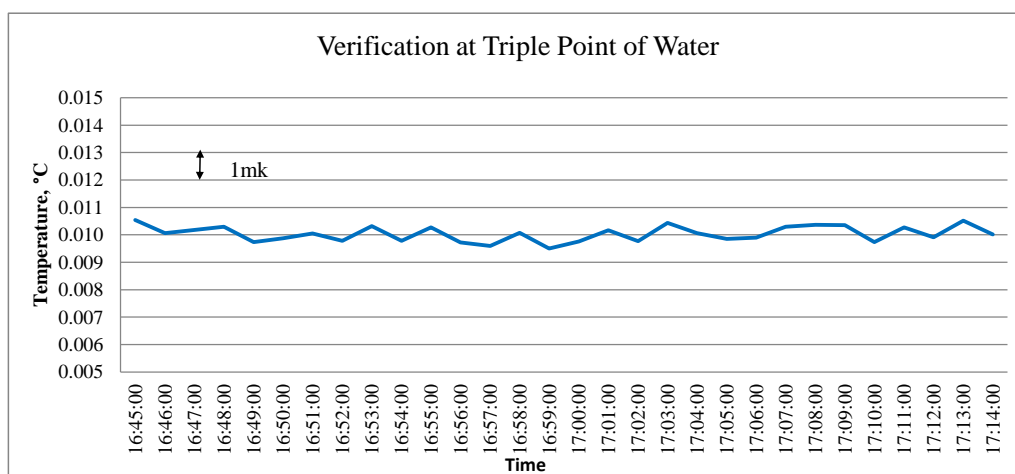
Verification Test (VT)

The computed a, b, c constants forms the characteristic of this thermistor. The constants are used for verification test on the thermistor using a ITS-90 fixed point cell (TPW Cell) and at 21°C. The verification test should show deviation less than 13mk.

Verification at Triple Point of Water

TC15200490 @ TPW		
Date	Time	Temp
25/04/17	16:45:00	0.01054
25/04/17	16:46:00	0.01007
25/04/17	16:47:00	0.01018
25/04/17	16:48:00	0.01030
25/04/17	16:49:00	0.00973
25/04/17	16:50:00	0.00987
25/04/17	16:51:00	0.01005
25/04/17	16:52:00	0.00978
25/04/17	16:53:00	0.01032
25/04/17	16:54:00	0.00979
25/04/17	16:55:00	0.01027
25/04/17	16:56:00	0.00972
25/04/17	16:57:00	0.00959
25/04/17	16:58:00	0.01007
25/04/17	16:59:00	0.00950

TC15200490 @ TPW		
Date	Time	Temp
25/04/17	17:00:00	0.00976
25/04/17	17:01:00	0.01017
25/04/17	17:02:00	0.00977
25/04/17	17:03:00	0.01044
25/04/17	17:04:00	0.01006
25/04/17	17:05:00	0.00986
25/04/17	17:06:00	0.00990
25/04/17	17:07:00	0.01030
25/04/17	17:08:00	0.01037
25/04/17	17:09:00	0.01036
25/04/17	17:10:00	0.00973
25/04/17	17:11:00	0.01027
25/04/17	17:12:00	0.00991
25/04/17	17:13:00	0.01052
25/04/17	17:14:00	0.01002
	Average	0.01004



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Verification at 21°C in Calibration Water Bath

TC15200490 @ 21 °C		
Date	Time	Temp
25/04/17	17:19:00	20.95540
25/04/17	17:20:00	20.95560
25/04/17	17:21:00	20.95650
25/04/17	17:22:00	20.95550
25/04/17	17:23:00	20.95530
25/04/17	17:24:00	20.95550
25/04/17	17:25:00	20.95550
25/04/17	17:26:00	20.95530
25/04/17	17:27:00	20.95550
25/04/17	17:28:00	20.95540
25/04/17	17:29:00	20.95560
25/04/17	17:30:00	20.95650
25/04/17	17:31:00	20.95490
25/04/17	17:32:00	20.95440
25/04/17	17:33:00	20.95550

TC15200490 @ 21 °C		
Date	Time	Temp
25/04/17	17:34:00	20.95370
25/04/17	17:35:00	20.95560
25/04/17	17:36:00	20.95450
25/04/17	17:37:00	20.95550
25/04/17	17:38:00	20.95490
25/04/17	17:39:00	20.95320
25/04/17	17:40:00	20.95540
25/04/17	17:41:00	20.95560
25/04/17	17:42:00	20.95650
25/04/17	17:43:00	20.95490
25/04/17	17:44:00	20.95490
25/04/17	17:45:00	20.95580
25/04/17	17:46:00	20.95570
25/04/17	17:47:00	20.95490
25/04/17	17:48:00	20.95530
	Average	20.95509

SPRT Reference Temperature in 21°C Calibration Bath

SPRT 4340 @ 21 °C		
Date	Time	Temp
25/04/17	17:19:00	20.95423
25/04/17	17:20:00	20.95425
25/04/17	17:21:00	20.95424
25/04/17	17:22:00	20.95424
25/04/17	17:23:00	20.95423
25/04/17	17:24:00	20.95424
25/04/17	17:25:00	20.95425
25/04/17	17:26:00	20.95426
25/04/17	17:27:00	20.95428
25/04/17	17:28:00	20.95429
25/04/17	17:29:00	20.95430
25/04/17	17:30:00	20.95432
25/04/17	17:31:00	20.95434
25/04/17	17:32:00	20.95434
25/04/17	17:33:00	20.95433

SPRT 4340 @ 21 °C		
Date	Time	Temp
25/04/17	17:34:00	20.95432
25/04/17	17:35:00	20.95432
25/04/17	17:36:00	20.95431
25/04/17	17:37:00	20.9543
25/04/17	17:38:00	20.95425
25/04/17	17:39:00	20.95426
25/04/17	17:40:00	20.95428
25/04/17	17:41:00	20.95429
25/04/17	17:42:00	20.9543
25/04/17	17:43:00	20.95432
25/04/17	17:44:00	20.95434
25/04/17	17:45:00	20.95434
25/04/17	17:46:00	20.95433
25/04/17	17:47:00	20.95432
25/04/17	17:48:00	20.95432
	Average	20.95429

ΔT (°C)
0.00080

