CERTIFICATE OF ANALYSIS

MicroK Precision Thermometry Bridge
Isotech MicroK-400
Serial Number 27384/1

Tested for
Isotech North America
Colchester, Vermont

18 April 2008

Test Folder No.: 836/276547-08

NIST

In reply refer to: 836/276547-08

Isotech North America
Attn: Scott Sabourin
158 Brentwood Drive
Unit #4
Colchester, VT 05446

Subject: Certification of an Isotech MicroK Bridge (Isotech Model MicroK-400, s/n 27384/1)
Purchase Order No.: 20302
Test Folder No.: 836/276547-08

Dear Mr. Sabourin:

The ratio accuracy and non-linearity of your precision thermometry bridge (Isotech Model MicroK-400, s/n 27384/1) was determined using a set of inter-related resistances and reciprocity techniques. Your Isotech MicroK-400 was tested using an AEONZ ratio bridge calibrator (Model RBC 100, s/n 36). The operating conditions of your Isotech MicroK-400 was with a sensing current of 1 mA, 4 sets of 9 readings, and an external reference resistor (100 Ω Tinsley model 5685A contained in a temperature controlled enclosure Tinsley model 5648). Using four base resistors, the RBC 100 yields 45 distinct ratios over the range from 0.17 to 1.29 and 70 distinctive ratios over the range from 0.17 to 5.94. A least-squares fit of the measurements is used to determine the non-linearity, ratio accuracy, and an expanded uncertainty (k=2) for the tested bridge. No correction equation is applied to the results.

Figure 1 shows, for ratios up to 1.26, the standard deviation of the residuals is 0.08×10^{-6} with 40 degrees of freedom. This yields an expanded uncertainty (95 % confidence interval) of 0.16×10^{-6}. The uncertainty ($k = 1$) for the non-linearity was calculated to be 0.07×10^{-6}. Additionally, the maximum compliments error of the 9 two-way combinations was found to be 0.09×10^{-6}. Table 1 gives the measurement results of the AEONZ RBC generated ratios and the residuals of the least-squares fit.

Figure 2 shows, for ratios up to 5.94, the standard deviation of the residuals is 0.4×10^{-6} with 64 degrees of freedom. This yields an expanded uncertainty (k=2) of 0.8×10^{-6}. The maximum compliments error of the 34 two-way combinations was found to be 0.09×10^{-6}. Table 2 gives the measurement results of the AEONZ RBC generated ratios and the residuals of the least-squares fit.

Additionally, as shown in Figures 1 and 2, a two-way complements check using two 100 Ω reference resistors gave a ratio accuracy uncertainty ($k = 1$) of 0.12×10^{-6}.

NIST
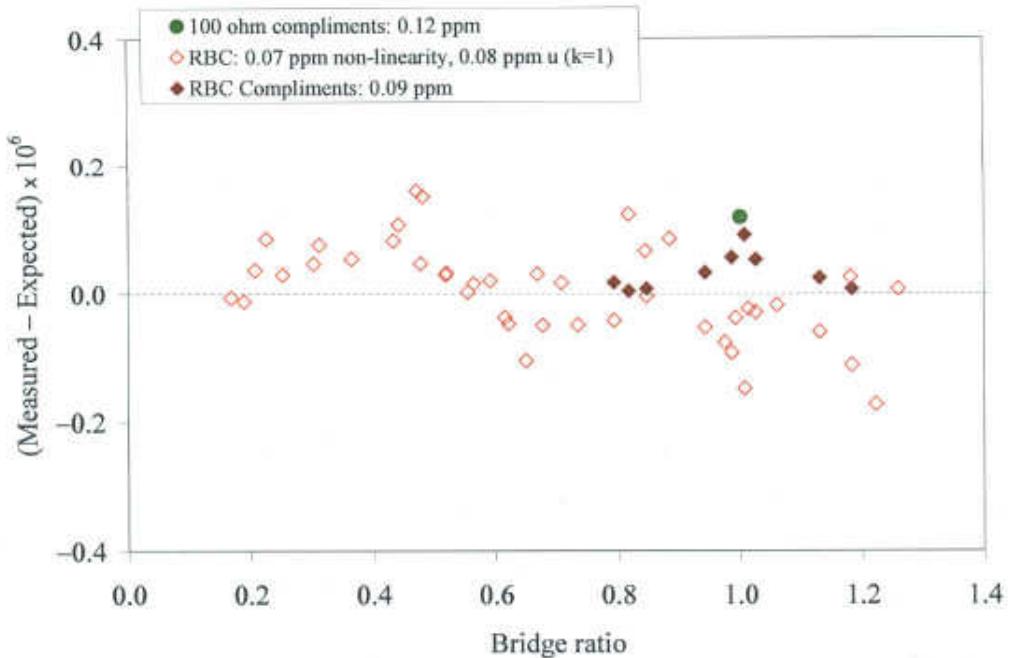
Figure 1. Isotech Model MicroK-400 (s/n 27384/1) results from the AEONZ RBC over a ratio from 0.17 to 1.26 and the two-way complements check measurements.
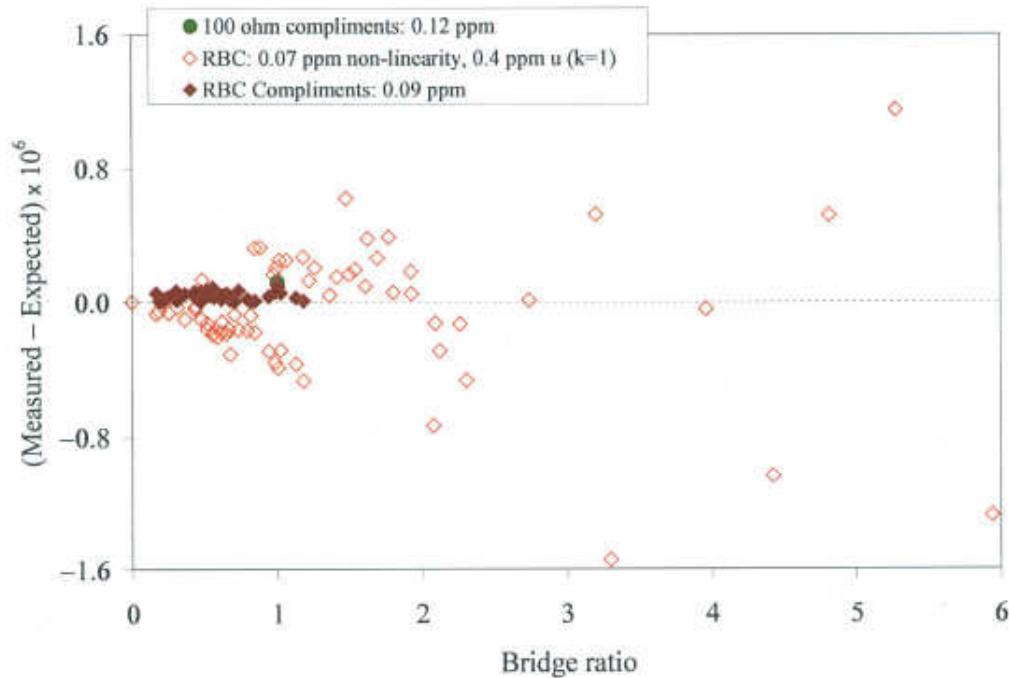


Figure 2. Isotech Model MicroK-400 (s/n 27384/1) results from the AEONZ RBC over a ratio from 0.17 to 5.94 and the two-way complements check measurements.

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Table 3 gives expanded uncertainty ($k=2$) results for various models of bridge error for the purpose of determining any possible source of problem. When bridge faults exist, the observed errors may depend on the measurement configuration. Consequently, we do not recommend the use of a correction equation. A description on the various models of bridge error are found in the following reference: D. R. White, "A Method for Calibrating Resistance Bridges", Proceedings of TEMPMEKO '96, 6th International Symposium on Temperature and Thermal Measurements in Industry and Science, pp. 129-134, 1997.

Sincerely,
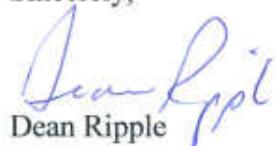
Dean Ripple
Leader, Thermometry Group
Process Measurements Division

Table 1. Isotech Model MicroK-400 (s/n 27384/1) AEONZ RBC measurement results for ratios from 0.17 to 1.26.

Index	Combination	Reading	Fitted Value	Residual x 10^6
1	R1	0.81809357	0.81809369	0.12
2	R2	0.48172649	0.48172664	0.15
3	R3	0.36512856	0.36512861	0.05
4	R4	0.31237145	0.31237153	0.08
6	R1+R3	1.18322242	1.18322231	−0.11
7	R1+R4	1.13046528	1.13046522	−0.06
8	R2+R3	0.84685526	0.84685526	0.00
9	R2+R4	0.79409821	0.79409817	−0.04
10	R3+R4	0.67750019	0.67750014	−0.05
11	R1//R2	0.30319380	0.30319385	0.05
12	R1//R3	0.25245415	0.25245418	0.03
13	R1//R4	0.22605656	0.22605665	0.09
14	R2//R3	0.20770037	0.20770041	0.04
15	R2//R4	0.18949508	0.18949507	−0.01
16	R3//R4	0.16834799	0.16834798	−0.01
17	R1+R2//R3	1.02579413	1.02579410	−0.03
18	R1+R2//R4	1.00758891	1.00758876	−0.15
19	R1+R3//R4	0.98644177	0.98644168	−0.09
20	R2+R1//R3	0.73418087	0.73418082	−0.05
21	R2+R1//R4	0.70778327	0.70778329	0.02
22	R2+R3//R4	0.65007473	0.65007463	−0.10
23	R3+R1//R2	0.66832243	0.66832246	0.03
24	R3+R1//R4	0.59118524	0.59118526	0.02
25	R3+R2//R4	0.55462368	0.55462368	0.00
26	R4+R1//R2	0.61556541	0.61556537	−0.04
27	R4+R1//R3	0.56482569	0.56482571	0.02
28	R4+R2//R3	0.52007190	0.52007193	0.03
29	R1+R2//R3//R4	0.94284513	0.94284508	−0.05
30	R2+R1//R3//R4	0.62134409	0.62134404	−0.05
31	R3+R1//R2//R4	0.51898572	0.51898575	0.03
32	R4+R1//R2//R3	0.47801719	0.47801724	0.05
33	R1//R2+R3//R4	0.47154167	0.47154183	0.16
34	R1//R3+R2//R4	0.44194914	0.44194925	0.11
35	R1//R4+R2//R3	0.43375697	0.43375705	0.08

Index	1 / Combination	Reading	Fitted Value	Residual x 10^6
36	R1	1.2223541	1.2223539	−0.17
41	R1+R3	0.8451497	0.8451497	0.07
42	R1+R4	0.8845915	0.8845916	0.09
43	R2+R3	1.1808393	1.1808393	0.03
44	R2+R4	1.2592901	1.2592901	0.01
52	R1+R2//R3	0.9748546	0.9748545	−0.08
53	R1+R2//R4	0.9924684	0.9924684	−0.04
54	R1+R3//R4	1.0137447	1.0137447	−0.02
64	R1+R2//R3//R4	1.0606197	1.0606196	−0.02

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Table 2. Isotech Model MicroK-400 (s/n 27384/1) AEONZ RBC measurement results for ratios from 0.17 to 5.94.

Index	Combination	Reading	Fitted Value	Residual x 10^6
1	R1	0.81809357	0.81809349	-0.08
2	R2	0.48172649	0.48172662	0.13
3	R3	0.36512856	0.36512846	-0.10
4	R4	0.31237145	0.31237142	-0.03
6	R1+R3	1.18322242	1.18322195	-0.47
7	R1+R4	1.13046528	1.13046491	-0.37
8	R2+R3	0.84685526	0.84685508	-0.18
9	R2+R4	0.79409821	0.79409804	-0.17
10	R3+R4	0.67750019	0.67749988	-0.31
11	R1//R2	0.30319380	0.30319381	0.01
12	R1//R3	0.25245415	0.25245409	-0.06
13	R1//R4	0.22605656	0.22605658	0.02
14	R2//R3	0.20770037	0.20770035	-0.02
15	R2//R4	0.18949508	0.18949503	-0.05
16	R3//R4	0.16834799	0.16834792	-0.07
17	R1+R2//R3	1.02579413	1.02579385	-0.28
18	R1+R2//R4	1.00758891	1.00758852	-0.39
19	R1+R3//R4	0.98644177	0.98644141	-0.36
20	R2+R1//R3	0.73418087	0.73418071	-0.16
21	R2+R1//R4	0.70778327	0.70778320	-0.07
22	R2+R3//R4	0.65007473	0.65007454	-0.19
23	R3+R1//R2	0.66832243	0.66832227	-0.16
24	R3+R1//R4	0.59118524	0.59118504	-0.20
25	R3+R2//R4	0.55462368	0.55462349	-0.19
26	R4+R1//R2	0.61556541	0.61556523	-0.18
27	R4+R1//R3	0.56482569	0.56482551	-0.18
28	R4+R2//R3	0.52007190	0.52007177	-0.13
29	R1+R2//R3//R4	0.94284513	0.94284484	-0.29
30	R2+R1//R3//R4	0.62134409	0.62134398	-0.11
31	R3+R1//R2//R4	0.51898572	0.51898556	-0.16
32	R4+R1//R2//R3	0.47801719	0.47801709	-0.10
33	R1//R2+R3//R4	0.47154167	0.47154173	0.06
34	R1//R3+R2//R4	0.44194914	0.44194911	-0.03
35	R1//R4+R2//R3	0.43375697	0.43375693	-0.04

Index	1 / Combination	Reading	Fitted Value	Residual x 10^6
36	R1	1.2223541	1.2223542	0.13
37	R2	2.0758669	2.0758662	-0.73
38	R3	2.7387621	2.7387621	0.01
39	R4	3.2013167	3.2013172	0.52
41	R1+R3	0.8451497	0.8451500	0.32
42	R1+R4	0.8845915	0.8845918	0.33
43	R2+R3	1.1808393	1.1808396	0.27
44	R2+R4	1.2592901	1.2592903	0.20
45	R3+R4	1.4760144	1.4760150	0.62
46	R1//R2	3.2982219	3.2982203	-1.54
47	R1//R3	3.9611164	3.9611163	-0.04
48	R1//R4	4.4236724	4.4236714	-1.04
49	R2//R3	4.8146278	4.8146283	0.52
50	R2//R4	5.2771822	5.2771834	1.15
51	R3//R4	5.9400806	5.9400793	-1.27
52	R1+R2//R3	0.9748546	0.9748547	0.17
53	R1+R2//R4	0.9924684	0.9924686	0.20
54	R1+R3//R4	1.0137447	1.0137449	0.25
55	R2+R1//R3	1.3620624	1.3620625	0.04
56	R2+R1//R4	1.4128619	1.4128620	0.15
57	R2+R3//R4	1.5382849	1.5382851	0.19
58	R3+R1//R2	1.4962840	1.4962841	0.17
59	R3+R1//R4	1.6915175	1.6915178	0.26
60	R3+R2//R4	1.8030249	1.8030250	0.06
61	R4+R1//R2	1.6245228	1.6245232	0.38
62	R4+R1//R3	1.7704579	1.7704583	0.39
63	R4+R2//R3	1.9228113	1.9228115	0.18
64	R1+R2//R3//R4	1.0606197	1.0606199	0.25
65	R2+R1//R3//R4	1.6094144	1.6094145	0.09
66	R3+R1//R2//R4	1.9268358	1.9268359	0.05
67	R4+R1//R2//R3	2.0919755	2.0919754	-0.12
68	R1//R2+R3//R4	2.1207034	2.1207031	-0.29
69	R1//R3+R2//R4	2.2627041	2.2627039	-0.13
70	R1//R4+R2//R3	2.3054391	2.3054387	-0.46

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Table 3. AEONZ RBC results for various models of bridge error for the purpose of determining any possible source of problem for the Isotech Model MicroK-400 (s/n 27384/1).

RBC Results for ratios from 0.17 to 1.26

Model	U ($k=2$), residual $\times 10^6$	Degrees of Freedom
None	0.16	40
Offset	0.16	39
Offset + Linear	0.12	38

RBC Results for ratios from 0.17 to 5.94

Model	U ($k=2$), residual $\times 10^6$	Degrees of Freedom
None	0.82	64
Offset	0.80	63
Offset + Linear	0.70	62

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