The Data Check on the Tc of K1 Type Superconductor (II)

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Abstract

The data check on the Tc of K1 type superconductor was made by making use of analogue to digital converter for the measurements of low temperature and voltage as we can see in the bulletin of N.I.T published in March 2002. Here, the accuracies of these measurements are greatly influenced by putting the applicable items into the designated lines of sensorial files as a matter of fact. So what I suggest is to check up again on the binary files of converting analogue to digital system to gain the confidence in such measurements. This paper deals mainly with the low temperature measurements below the room one and the measurements of the output of voltage less than 5(v) referring to the previous installment.

1. Introduction

According to the last papers, the proper measurements of the low temperature and the output of voltage less than 5(v) that will impart desirable properties and states are essential to realize significant technological applications. Remarkable advances have been made in understanding and improving the measurements of physical analogue phenomena, and the development of prototype devices and some applications are now being considered. Under the present circumstances, the aim of this paper is to inspect the accuracies of measurements on the physical analogue phenomena such as the behavior of superconducting transition temperature and its electrical resistance for the reasons as follows. (1) If the measurements are accurate, the critical temperature transferring into superconductor (Tc) found by the thermometric sensorial file is supposed to be significant data since it was about (−)85 degrees centigrade[(1)]. (2) If the measurements are accurate, it may be applicable to another analogue phenomena within the output range of less than 5(v). Therefore, this paper deals practically with the binary files of converting analogue to digital system and some examples are included as a matter of fact.

II. The subjects of this measurement

The subjects of this measurement are basically analogical phenomena such as the changes of temperature going up with the evaporation of liquid nitrogen and the output voltage by transferring into superconductor. This is because such measurements are essential to realize significant properties of the unidentified high Tc superconductors in this research. So the first necessary matter for investigation is to understand the program files of analogue to digital converter used here[(2)].

III. Analogue to digital converter

According to the manual of this converter, it has an ability to indicate the solvable values in a thirteen places of binary number. Namely, this means that the computer will make use of the binary number of 1111111111111 at its maximum since it goes up to the top like 0, 1, 10, 11, · · . And so these binary number are equivalent to the integral number of 0, 1, 2, 3, · · in a decimal system . Therefore, the solvable value in a decimal system (Dn) is found to be 8191 by substituting binary places 13 for n in the following algebraic equation. That is,

$$Dn = D_{(n-1)} + 2^{(n-1)} = D_{12} + 2^{12}$$
$$= 4095 + 4096 = 8191$$

where the n represents binary places and is greater than or equal to 1 . Considering the circumstances mentioned above, this converter plays an important part in the conversion of the analogical phenomena into the binary digital values. Because the digital measurement making use of computer is maybe impossible if the binary numbers are denied admission to the digitization of the analogical phenomenon. But it is not true as a matter of fact since the binary numbers are admitted as if it was an electrical signal such as on and off at the switching

Table 1 : An example of the sensorial file that have been used to make sure the properties of high-Tc superconductors.

Line	Sense	Program	Line	A, B	Line	A, B	Line	A, B	Line	A, B	Line	A, B
1	Mood	Analogue	45	44, -165	89	112, -121	133	179, -77	177	487, -33	221	2766, 11
2	Controllable no.	300	46	46, -164	90	113, -120	134	181, -76	178	511, -32	222	2844, 12
3	Name for the program	T -sensor	47	47, -163	91	115, -119	135	182, -75	179	536, -31	223	2925, 13
4	Unit	℃	48	49, -162	92	116, -118	136	184, -74	180	562, -30	224	3007, 14
5	Name for the sensor	Thermocouple	49	50, -161	93	118, -117	137	185, -73	181	589, -29	225	3089, 15
6	Minimum	−196	50	52, -160	94	119, -116	138	186, -72	182	617, -28	226	3172, 16
7	Maximum	50	51	53, -159	95	121, -115	139	188, -71	183	646, -27	227	3255, 17
8	Fixed at zero	0	52	55, -158	96	122, -114	140	190, -70	184	676, -26	228	3338, 18
9	Gain	1	53	56, -157	97	124, -113	141	191, -69	185	707, -25	229	3421, 19
10	Offset	0	54	58, -156	98	125, -112	142	193, -68	186	739, -24	230	3505, 20
11	Fixed at one	1	55	59, -155	99	127, -111	143	194, -67	187	772, -23	231	3589, 21
12	Fixed at zero	0	56	61, -154	100	128, -111	144	196, -66	188	806, -22	232	3672, 22
13	Division of Y axis	1	57	62, -153	101	130, -109	145	197, -65	189	842, -21	233	3755, 23
14	Fixed at zero	0	58	64, -152	102	131, -108	146	199, -64	190	879, -20	234	3839, 24
15	Decimal place	2	59	65, -151	103	133, -107	147	200, -63	191	918, -19	235	3921, 25
16	A,B (Start of this table)	0, -196	60	67, -150	104	134, -106	148	202, -62	192	958, -18	236	4004, 26
17		2, -193	61	68, -149	105	136, -105	149	203, -61	193	999, -17	237	4086, 27
18		3, -192	62	70, -148	106	137, -104	150	205, -60	194	1042, -16	238	4169, 28
19		5, -191	63	71, -147	107	139, -103	151	206, -59	195	1087, -15	239	4250, 29
20		6, -190	64	73, -146	108	140, -102	152	208, -58	196	1133, -14	240	4331, 30
21		8, -189	65	74, -145	109	142, -101	153	209, -57	197	1180, -13	241	4410, 31
22		9, -188	66	76, -144	110	143, -100	154	211, -56	198	1229, -12	242	4490, 32
23		11, -187	67	77, -143	111	145, -99	155	212, -55	199	1280, -11	243	4569, 33
24		12, -186	68	79, -142	112	146, -98	156	214, -54	200	1332, -10	244	4646, 34
25	Note;	14, -185	69	80, -141	113	148, -97	157	217, -53	201	1386, -9	245	4723, 35
26	A is an integer of de-	15, -184	70	83, -140	114	149, -96	158	221, -52	202	1442, -8	246	4799, 36
27	cimal system and is de-	17, -183	71	85, -139	115	151, -95	159	226, -51	203	1499, -7	247	4875, 37
28	tected by the binary file	18, -182	72	86, -138	116	154, -94	160	232, -50	204	1558, -6	248	4949, 38
29	named bin8192 sdf.	20, -181	73	88, -137	117	155, -93	161	239, -49	205	1618, -5	249	5021,39
30		21, -180	74	89, -136	118	157, -92	162	247, -48	206	1680, -4	250	5094, 40
31		23, -179	75	91, -135	119	158, -91	163	256, -47	207	1743, -3	251	5165, 41
32	B is the indicated	24, -178	76	92, -134	120	160, -90	164	266, -46	208	1808, -2	252	5235, 42
33	measurements obtained	26, -177	77	94, -133	121	161, -89	165	277, -45	209	1874, -1	253	5303, 43
34	by using this program	28, -176	78	95, -132	122	163, -88	166	289, -44	210	1942, 0	254	5371, 44
35	named T-sensor.	29, -175	79	97, -131	123	164, -87	167	302, -43	211	2011, 1	255	5437, 45
36		31, -174	80	98, -130	124	166, -86	168	316, -42	212	2081, 2	256	5503, 46
37		32, -173	81	100, -129	125	167, -85	169	331, -41	213	2152, 3	257	5567, 47
38		34, -172	82	101, -128	126	167, -84	170	347, -40	214	2225, 4	258	5630, 48
39		35, -171	83	103, -127	127	170, -83	171	364, -39	215	2300, 5	259	5691, 49
40		37, -170	84	104, -126	128	172, -82	172	382, -38	216	2376, 6	260	5752, 50
41		38, -169	85	106, -125	129	173, -81	173	401, -37	217	2452, 7		【EOF】
42		40, -168	86	107, -124	130	175, -80	174	421, -36	218	2529, 8		
43		41, -167	87	109, -123	131	176, -79	175	442, -35	219	2607, 9		
44		43, -166	88	110, -122	132	178, -78	176	464, -34	220	2686, 10		

actions. Therefore, the computer aided digital measurement system to analyze an analogical phenomenon can be designed by making use of binary numbers at first. And after the analogical phenomenon is converted into the binary numbers, it is converted into the decimal numbers again for setting a solvable value equivalent to a binary worth. So we can see the decimal numbers on the left side of the sensorial file called the binary file. Then, I would like to show you the Table 1 as the examples of the binary files that have been using to make measurements of the critical temperature transferring into superconductor. As listed in Table 1, A is an integer and is detected by the binary file named bin8192.sdf, so the conversion into the binary digitization of an analogue phenomenon is supposed to do at this stage. Therefore, it is necessary to inspect the accuracy of an output unit in the range of 0.00[v]up to practically 4.99[v]. So as to the results of an experiment on the accuracy of the output unit, I can find the remarkable one in the manual of the analogue to digital converter(2) published in 1997 by TORICA.LTD. According to that data, if the voltage corresponding to the output of an analogue phenomenon is 0.00 [v], then the binary file bin8192.sdf indicates the 0 as the solvable value. If the output increase the 0.00 [v] to 0.01 [v], then the bin8192.sdf indicates [11] as the solvable value in a decimal system and just then the binary number converted by the analogue to digital converter must be [1011]. Namely, it is said that the analog phenomenon such as an increasing of the voltage occurs at the first stage in the measurement and the output of the phenomenon 0.01 [v] is sensed with the analogue to digital converter at the second stage, then the output, that is , the voltage 0.01 [v] is converted into the binary number [1011] to digitalize the analog phenomenon at the third stage. Further, the binary number [1011] is converted into the [11] in the decimal system with the binary file bin8192.sdf for the purpose of getting the solvable value in the range of 0 to 5 [v]. Thus the solvable value such as the [11] is gotten by this way and is essential to realize significant technological measurements. Therefore, if the voltage corresponding to the output of an analogue phenomenon is 0.02 [v],then the binary file bin8192.sdf indicates the [48] as the solvable value in the same way just like that mentioned above. And Just then the binary number must be [10000] if the digitization was in correct. So the solvable value is essential to this method of measurements isn't it? Incidentally, the rest of solvable values detected by this binary analysis are as follows, namely, to each voltage,

100 to 0.05 [v], 148 to 0.10 [v], 320 to 0.20 [v], 469 to 0.30 [v], 807 to 0.50 [v], 1630 to 1.00 [v], 3292 to 2.00 [v], 4925 to 3.00 [v], 6561 to 4.00 [v], 7366 to 4.50 [v], 7853 to 4.80 [v], 8031 to 4.90 [v], 8095 to 4.95 [v], 8140 to 4.98 [v], 8162 to 4.99 [v],8162 to 5.00 [v]. Furthermore, they say that these solvable values are the results of experiment controlled by the binary file bin8192.sdf in fact. As we can see in these results, the solvable value 8162 to 5.00 [v] is a little different from the value 8191 of 13 bits being required. So, this means that the upper limits on the sensible output of voltage should be set within the range of 4.99 [v] to get the accurate solvable value. Thus, we can find the voltage, that is, the output of an analog phenomenon corresponding to each solvable value. Taking the table 1 for this example, this means that we can find the voltage corresponding to each solvable value A. In the table 1, since the maximum of the solvable value is [5752], so we should calculate that the voltage is about 3.52 [v] using the expression [output [v]]=[5752×4.99]／[8162]. In the same way as this one, since the minimum of the solvable value is [0], so we should calculate that the voltage is also zero[v] using the expression [output [v]]=[0×4.99]／[8162]. Therefore, the table 1 is designed to indicate the temperature within the range of (+)50(℃) to (−)196(℃) as the sensorial file of the output of voltage. And, for that reason, we may be able to design a new model sensorial file if we get the both maximum and minimum outputs of voltages, because the indication such as the thermometric one is dependent on these limit values.

IV. Output of Voltage

In the case of such measurement, the thermocouple doesn't always sense the output of an analog phenomenon within the proper range of voltage, namely, when we tried to measure the temperature, we should know the generating capacity of the output unit at the beginning of the measurement. According to a catalogue(3), the temperature sensor by means of thermocouple of copper and constantan has the generating capacity of about 10 [m v] in the range of (−)200(℃) to 50(℃).However, it is too small for such an output of voltage as compared with sensible one i.e. 4.99 [v]. So, I used an amplifier to get the suitable voltage for the output of this measurement. Therefore, we can fix the suitable voltage at our disposal within the limits of the voltage 4.99 [v] even if it is too small one such as 10 [m v] in the case of this generating capacity. As mentioned above, the suitable voltage was fixed at 3.52 [v] according to my wishes when I designed the sensorial file shown as the table 1. So, this 3.52[v]is practically output in the case of this temperature measurement even if it is not indicated on the sensorial file table 1. Well I'm on the subject, let me give one more example. As we can see in the table 1, the solvable value [A] is zero at the line number 16, then the indication [B] is (−)196. This means that the output of voltage is also zero in practice. So we should write the minimum value (−)196 in the 6th line on the application form because the minimum value of the output is also zero. By way of precaution, the amplifier used in this measurement was for the exclusive use of the direct current. Considering circumstances mentioned above, it seems to be able to produce a new sensorial file on the basis of the application form such as is used in the binary file bin8192.sdf.

V. The Way How To Design the Sensorial File

Since the analogue to digital converter aided measurement has brought us together, so we should say that it is significant to explain the way how to design the sensorial file isn't it?. For the understanding of the design on the sensorial file, it is better to calculate the main points in practice and is better to compare with that of the each values on the sensorial file, table.1. So, I would like to write down the some arrangements as follows, namely,

(1) I think the first thing we had better do is to install the binary file bin8192.sdf in the directory to get the each solvable values [A].

(2) Then, we should enter the maximum (or minimum) value of the measurement on the seventh line (or the sixth line) from the top of the page in the directory as well as the table.1.

(3) Then, we should enter the minimum value (−)196(℃) in the range of measurement on the sixteenth line from the top of the page in the directory as well as the table.1. (Note that the zero is the one of the solvable values and is calculated by the expression [3.52×0]／[5752].)

(4) Then, we should enter the second minimum value (−)193(℃) in the range of measurement on the seventeenth line from the top of the page in the directory as well as the table.1. (Note that the two is the one of the solvable values and is calculated by the expressions [3.52×2]／[5752]≒0.001223922 and [0.001223922] × [8162] ／ [4.99]≒2.001934328.)

(5) Then, we should enter the third minimum value (−)192 (℃) in the range of measurement on the eighteenth line from the top of the page in the directory as well as the table.1. (Note that the three is the one of the solvable values and is calculated by the expressions [3.52 × 3] ／ [5752] ≒0.001835883 and [0.001835883] × [8162] ／ [4.99] ≒ 3.002901491.)

(6) Then, we should enter the fourth minimum value (−) 191(℃) in the range of measurement on the nineteenth line from the top of the page in the directory as well as the table.1. (Note that the five is the one of the solvable values and is calculated by the expressions [3.52×5]／[5752]≒0.003059805 and [0.003059805] × [8162] ／ [4.99] ≒ 5.004835819.)

(7) Then, we should enter the fifth minimum value (−)190 (℃) in the range of measurement on the twentieth line from the top of the page in the directory as well as the table.1. (Note that the six is the one of the solvable values and is calculated by the expressions [3.52×6]／[5752]≒0.003671766 and [0.003671766] × [8162] ／ [4.99]≒6.005802983.)

(8) Then, we should enter the sixth minimum value (−)189 (℃) in the range of measurement on the twenty first line from the top of the page in the directory as well as the table.1. (Note that the eight is the one of the solvable values and is calculated by the expressions [3.52×8]／[5752]≒0.004895688 and [0.004895688] × [8162] ／ [4.99]≒8.00773731.)

(9) Then, we should enter the seventh minimum value (−) 188(℃) in the range of measurement on the twenty second line from the top of the page in the directory as well as the table.1. (Note that the nine is the one of the solvable values and is calculated by the expressions [3.52×9]／[5752]≒0.00550765 and [0.00550765]×[8162]／[4.99]≒9.008704474.)

(10) Then, we should enter the eighth minimum value (−) 187(℃) in the range of measurement on the twenty third line from the top of the page in the directory as well as the table.1. (Note that the eleven is the one of the solvable values and is calculated by the expressions [3.52×11]／[5752]≒0.006731572 and [0.006731572]×[8162]／[4.99]≒11.0106388.)

(11) Then, we should enter the ninth minimum value (−)186 (℃) in the range of measurement on the twenty fourth line from the top of the page in the directory as well as the table.1. (Note that the twelve is the one of the solvable values and is calculated by the expressions [3.52×12]／[5752]≒0.007343533 and [0.007343533]×[8162]／[4.99]≒12.01160597.)

(12) Then, we should enter the tenth minimum value (−)185(℃) in the range of measurement on the twenty fifth line from the top of the page in the directory as well as the table.1. (Note that the fourteen is the one of the solvable values and is calculated by the expressions [3.52×14]／[5752]≒0.008567455 and [0.008567455]×[8162]／[4.99]≒14.01354029.)

(13) Then, we should enter the eleventh minimum value (−) 184(℃) in the range of measurement on the twenty sixth line from the top of the page in the directory as well as the table.1. (Note that the fifteen is the one of the solvable values and is calculated by the expressions [3.52×15]／[5752]≒0.009179416 and [0.009179416]×[8162]／[4.99]≒15.01450746.)

(14) Then, we should enter the twelfth minimum value (−) 183(℃) in the range of measurement on the twenty seventh line from the top of the page in the directory as well as the table.1. (Note that the seventeen is the one of the solvable values and is calculated by the expressions [3.52×17]／[5752]≒0.010403338 and [0.010403338]×[8162]／[4.99]≒17.01644178.)

(15) Then, we should enter the thirteenth minimum value (−) 182(℃) in the range of measurement on the twenty eighth

line from the top of the page in the directory as well as the table.1. (Note that the eighteen is the one of the solvable values and is calculated by the expressions [3.52×18]／[5752]≒0.011015299 and [0.011015299]×[8162]／[4.99]≒18.01740895.)

(16) Then, we should enter the fourteenth minimum value (－)181(℃) in the range of measurement on the twenty ninth line from the top of the page in the directory as well as the table. 1. (Note that the twenty is the one of the solvable values and is calculated by the expressions [3.52×20]／[5752] ≒ 0.012239221 and [0.012239221] × [8162] ／ [4.99] ≒20.01934328.)

(17) Then, we should enter the fifteenth minimum value (－)181(℃) in the range of measurement on the thirtieth line from the top of the page in the directory as well as the table. 1. (Note that the twenty one is the one of the solvable values and is calculated by the expressions [3.52×21]／[5752] ≒ 0.012851182 and [0.012851182] × [8162] ／ [4.99] ≒21.02031044.)

(18) Then, we should enter the sixteenth minimum value (－)179(℃) in the range of measurement on the 31st line from the top of the page in the directory as well as the table. 1. (Note that the twenty three is the one of the solvable values and is calculated by the expressions [3.52×23]／[5752] ≒ 0.014075104 and [0.014075104] × [8162] ／ [4.99] ≒23.02224477.)

Considering these examples mentioned above, we can even get the values of [A] when the thermometer indicates zero. Then the expression to calculate the output of voltage is [3.52×1942] ／ [5752] ≒1.188428373[v], where, the [1942] is the value indicated by the binary file bin8192.sdf using the expression [1.188428373[v]]×8162]／[4.99]≒1943.878232. Therefore, we have to know that there is an error of less than 0.1 percent in the value of 1942 at this stage. And then, in the case of designing for the sensorial file, we have to take care that the value indicated by the binary file bin8192. sdf is not always [zero] even if the thermometer indicates the [zero]. Well, shall we skip the most of lines after the 31st or the 210th line and come to the end of the line? Now, the 260th line is the last one in the table 1 and we should enter the maximum value 50(℃) in the range of measurement on the line. (Note that the value of [5752] is the one of the solvable values and is calculable beforehand by the expression [3.52×8162]／[4.99]≒5757.563126. Therefore, we have to know that there is still an error of less than 0.1 percent in the value of 5752 at this stage. Considering circumstances mentioned above, if we enter up all the values in the binary file bin8192. sdf and replace the old name with new one, it is possible to make a new named sensorial file experimentally. As you know, the sensorial file T-sensor used in the table 1 is the one of the examples of such trial products and the results of the measurement by means of T-sensor.sdf seem to be not negligible because the Tc[1] detected by this sensorial file is unusually high in comparison with the Y.B.C.O's one[4] as far as I know.

Just for your information, I hope figure.1 is useful. Note that a dim thing on this side in the photograph is the thermocouple working at the low temperature and the magnet is floating in the air on the basis of superconductor.

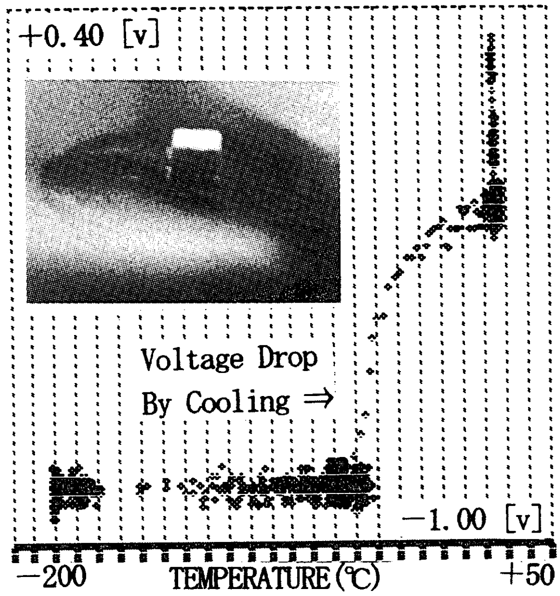

Fig 1: Watch carefully how the magnet is on the photo, and you can see the Meissner effect signal. A whitish dim thing on this side is the thermocouple working at the low temperature.

References

(1) K. Sugimoto. The Data Check on the Tc of K1 Type Superconductor. Bulletin of Nagoya Institute of Technology vol.54.P21－28(2002)

(2) A. Asai. The Manual on the A/D Converter (0-5V). P7 (1997) TORICA. Ltd

(3) CHINO WORKS AMERICA inc. TEMPERATURE SENSORS Cat.no.CE-01-11 FEB 1989.5 Printed in JAPAN

(4) S. Yano. The Manual on the HIZIRCO BYCO (1990) HAYASI Chemical Industrial inc.