



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS C 1731-1 : 1998

**Instrument transformers
for testing purpose and
used with general instrument
Part 1 : Current transformers**

ICS 17.220.20

Descriptors : instrument transformers, current transformers, transformers

Reference number : JIS C 1731-1 : 1998 (E)

C 1731-1 : 1998

Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of International Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. By this establishment **JIS C 1731 : 1988** is withdrawn and replaced by this Standard.

Constitution of Standard

JIS C 1731-1 *Instrument transformers for testing purpose and used with general instrument Part 1 : Current transformers*

JIS C 1731-2 *Instrument transformers for testing purpose and used with general instrument Part 2 : Voltage transformers*

Date of Establishment: 1998-03-20

Date of Public Notice in Official Gazette: 1998-03-20

Investigated by: Japanese Industrial Standards Committee

Divisional Council on Electricity

JIS C 1731-1:1998, First English edition published in 2000-09

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2000

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

Contents

	Page
Introduction	1
1 Scope	1
2 Definitions	1
3 Service conditions	2
3.1 Standard service conditions	2
3.2 Special service conditions	3
4 Construction	3
4.1 Construction in general	3
4.2 Mechanical strength	3
4.3 Porcelain tubes	3
4.4 Internal construction	3
4.5 Sealing	3
4.6 Polarity	4
5 Classification and ratings	4
5.1 Highest voltage for equipment	4
5.2 Rated currents	4
5.3 Rated withstanding currents	5
5.4 Accuracy classes	6
5.5 Rated burdens	6
5.6 Rated frequencies	7
6 Performances	7
6.1 Withstanding current	7
6.2 Temperature rise	7
6.3 Dielectric withstanding voltage	8
6.3.1 Lightning impulse withstand voltage	8
6.3.2 Power frequency withstand voltage	8

C 1731-1 : 1998

6.3.3	Partial discharge	8
6.3.4	Long-time power frequency withstand voltage	8
6.3.5	Dielectric withstand voltage between winding terminals	8
6.4	Limits of ratio error and phase displacement	10
7	Tests	10
7.1	Classification of tests	10
7.2	Items and sequence of tests	11
7.3	Test methods	11
7.3.1	Withstanding current test	11
7.3.2	Temperature rise test	13
7.3.3	Dielectric withstand voltage tests	13
7.3.4	Ratio error and phase displacement	15
8	Terminals	16
8.1	Location of terminals	16
8.2	Terminal marks	16
9	Markings	18
Annex 1 (normative) Current transformers		20
Introduction		20
1	General	20
1.1	Scope	20
1.2	Normative references	20
2	Definitions	21
2.1	General definitions	21
2.2	Additional definitions for measuring current transformers	24
2.3	Additional definitions for protective current transformers	25
3	Normal and special service conditions	25
3.1	Normal service conditions	25

3.2	Special service conditions	26
3.3	System earthing	27
4	Ratings	27
4.1	Standard values of rated primary currents	27
4.2	Standard values of rated secondary currents	28
4.3	Rated continuous thermal current	28
4.4	Standard values of rated output	28
4.5	Short-time current ratings	28
4.6	Limits of temperature rise	28
5	Design requirements	29
5.1	Insulation requirements	29
5.2	Mechanical requirements	34
6	Classification of tests	34
6.1	Type tests	34
6.2	Routine tests	35
6.3	Special tests	35
7	Type tests	35
7.1	Short-time current tests	35
7.2	Temperature-rise test	36
7.3	Impulse tests on primary winding	36
7.4	Wet test for outdoor type transformers	38
8	Routine tests	38
8.1	Verification of terminal markings	38
8.2	Power-frequency withstand tests on primary windings and partial discharge measurement	38
8.3	Power-frequency withstand tests between sections of primary and secondary windings and on secondary windings	39
8.4	Inter-turn overvoltage test	39

C 1731-1 : 1998

9	Special tests	40
9.1	Chopped impulse test on primary winding	40
9.2	Measurement of capacitance and dielectric dissipation factor	41
9.3	Mechanical tests	41
10	Markings	42
10.1	Terminal markings—General rules	42
10.2	Rating plate markings	43
11	Additional requirements for measuring current transformers	44
11.1	Accuracy class designation for measuring current transformers	44
11.2	Limits of current error and phase displacement for measuring current transformers	44
11.3	Extended current ratings	46
11.4	Type tests for accuracy of measuring current transformers	46
11.5	Routine tests for accuracy of measuring current transformers	46
11.6	Instrument security factor	46
11.7	Marking of the rating plate of a measuring current transformer	47
12	Additional requirements for protective current transformers	47
12.1	Standard accuracy limit factors	47
12.2	Accuracy classes for protective current transformer	47
12.3	Limits of errors for protective current transformers	47
12.4	Type and routine tests for current error and phase displacement of protective current transformers	48
12.5	Type tests for composite error	48
12.6	Routine tests for composite error	49
12.7	Marking of the rating plate of a protective current transformer	49
Annex 1A (normative)	Protective current transformers	53
Annex 1B (informative)	Multiple chopped impulse test	57

Instrument transformers for testing purpose and used with general instrument

Part 1 : Current transformers

Introduction This Japanese Industrial Standard specifies current transformers of the instrument transformers formerly specified in JIS, in the text, while the items stated in the corresponding International Standard IEC 60044-1, *Instrument transformers—Part 1 : Current transformers* published in 1996 as the first edition are adopted in Annex 1 (normative) without any modification in the technical contents.

1 Scope This Standard specifies newly manufactured current transformers for testing purpose and used with general instruments which serve within power frequency range.

2 Definitions For the purpose of this Standard, the following principal definitions apply:

- a) **instrument transformer** This is an equipment for transformation of current or voltage used with electric instrument(s) or measuring device(s). This is the generic name of current transformers and voltage transformers.
- b) **current transformer** An instrument transformer in which the primary current is transformed to the secondary current which is proportional to the former.
- c) **primary winding** The winding through which flows the current to be transformed.
- d) **secondary winding** The winding which supplies the current to electrical instrument(s) or measuring device(s).
- e) **secondary circuit** The external circuit which passes the current supplied by the secondary winding of a current transformer.
- f) **highest voltage for equipment** The highest circuit voltage which will occur normally, at which the performances specified in this Standard are ensured under the specified conditions and which is stated on the rating plate.
- g) **rated current of a current transformer** The value of the primary or secondary current on which the performance of the transformer as specified in this Standard is based under the specified conditions and which is stated on the rating plate.
- h) **actual transformation ratio** The ratio of the current actually passed through the primary winding to the current supplied by the secondary winding, which is obtained by the measurement.
- i) **rated transformation ratio** The ratio of the rated primary current to the rated secondary current.
- j) **current error (ratio error)** The error which arises from the fact that the actual transformation ratio is not equal to the rated transformation ratio and the value is expressed by the following equation:

$$\varepsilon_i = \frac{K_n - K}{K} \times 100$$

where, ε_i : current error (%)

K_n : rated transformation ratio

K : actual transformation ratio

- k) **phase displacement** The difference in phase between the primary and secondary current vectors, the direction of the vector being so chosen that the angle is zero for a perfect current transformer. The phase displacement is said to be positive when the secondary current vector leads and expressed in minutes.
- l) **burden** The load connected across the secondary terminals of a current transformer. The burden is expressed as the apparent power (VA) consumed in the load under the rated secondary current at the rated frequency and the power factor of the load.
- m) **rated burden** The burden per winding to be a reference at which the performances specified in this Standard are ensured under the specified conditions. The value is marked on the rating plate.
- n) **rated frequency** The frequency at which the performances specified in this Standard are ensured under the specified conditions. The value is marked on the rating plate.
- o) **accuracy class** The class assigned to a current transformer to indicate its accuracy and the value is marked on the rating plate. It is expressed in the limit of ratio error when the rated current at the rated frequency is passed under the rated burden.
- p) **rated withstanding current** The limit of overcurrent within which the performances specified in this Standard are ensured under the specified conditions. It is stated on the rating plate and expressed in the rated overcurrent strength (the ensured overcurrent divided by the rated primary current) or the rated overcurrent (the ensured current).
- q) **initial temperature** The initial temperature of primary winding to be established in the calculation of short-time thermal current of a current transformer.

3 Service conditions

3.1 Standard service conditions This Standard is applicable to current transformers used under the conditions stated below.

The standard service conditions are the conditions meeting all of the following requirements:

- a) The ambient temperature is within the range from 40 °C to -20 °C and the average ambient temperature over 24 h does not exceed 35 °C.
- b) The altitude of installation site does not exceed 1 000 m.
- c) None of the items in 3.2 is applicable.

3.2 Special service conditions This Standard is also applicable to current transformers used under the conditions stated below.

The service conditions which include any one of the conditions stated below are regarded as special service conditions. These service conditions shall be specified especially. Transformers are used in a place:

- a) where the altitude or ambient temperature is outside the range specified in 3.1;
- b) where atmosphere is remarkably affected by salty air;
- c) where air is humid;
- d) where excessive water or oil vapour exists;
- e) where explosive, inflammable or other harmful gas exists or may come;
- f) where excessive dust exists;
- g) where abnormal vibration or shock is anticipated;
- h) where much ice and snow exist; or
- i) where special conditions other than stated above exist.

4 Construction

4.1 Construction in general Current transformers shall be so constructed that they have enough endurance electrically and mechanically, the tightened part will not work loose, and the maintenance and inspection can be made safely and easily.

4.2 Mechanical strength Each part of a current transformer shall have enough strength to withstand the following loads:

- a) Static constant horizontal acceleration of 4.9 m/s^2 .
- b) Wind pressure load at maximum wind velocity of 40 m/s (indoor transformers are excluded).

4.3 Porcelain tubes The porcelain tubes shall have prescribed good electrical and mechanical characteristics and shall be capable of serving for a long period of time.

4.4 Internal construction Materials of good quality shall be used for iron cores, windings, etc., and the assembly of transformers shall be robust so that no loosening of tightened parts nor change in relative position between components shall occur during transportation and service of a long period.

4.5 Sealing Sealing of current transformers shall be as follows:

- a) Inside of oil immersed current transformer shall be hermetically structured so that nitrogen gas is filled on the oil surface or the oil is filled entirely.
- b) Inside of gas insulated current transformer shall be filled with such insulating gas as SF_6 , and so structured that sealing of transformer itself is possible.

4.6 Polarity The polarity shall be subtractive. Primary and secondary terminals of a current transformer shall be marked clearly and indelibly with the terminal marks which indicate subtractive polarity, and the arrangement of terminals shall also indicate subtractive polarity, as a rule.

Note : As for the positions and marks of terminals, see 8.1 and 8.2.

5 Classification and ratings

5.1 Highest voltage for equipment The highest voltages for equipment (denoted by U_m) of current transformers shall be as stated in Table 1. However, current transformers which have no primary winding or conductor, i.e. no insulation for main circuit, are excluded.

Table 1 Highest voltages for equipment of current transformers

Unit : kV

Nominal voltage	Highest voltage for equipment	Nominal voltage	Highest voltage for equipment
0.22	0.23	66	69
0.44	0.46	77	80.5
1.1	1.15	110	115
3.3	3.45	132	138 ⁽²⁾
6.6	6.9	154	161
11	11.5	187	195.5 ⁽³⁾
13.2	13.8 ⁽¹⁾	220	230 ⁽³⁾
16.5	17.25 ⁽¹⁾	275	287.5 ⁽³⁾
22	23	500	550 ⁽³⁾
33	34.5		

Notes (1) Current transformers with $U_m = 13.8$ kV and $U_m = 17.25$ kV are ones used in generator circuit only.

(2) Current transformers with $U_m = 138$ kV are special ones.

(3) Current transformers with $U_m \geq 195.5$ kV are applicable to lines of effectively earthed system.

5.2 Rated currents Rated primary currents and rated secondary currents of current transformers shall be as stated in Table 2.

Table 2 Rated currents of current transformer

Unit: A

Rated primary current						Rated secondary current
—	1	10	100	1 000	10 000	1
—	—	12	120	1 200	12 000	5
—	—	15	150	1 500	15 000	
—	2	20	200	2 000	20 000	
0.25	2.5	25	250	2 500	—	
—	3	30	300	3 000	30 000	
—	4	40	400	4 000	—	
0.5	5	50	500	5 000	—	
—	6	60	600	6 000	—	
—	—	75	750	—	—	
—	8	80	800	8 000	—	

Note: The rated primary current of a multi-ratio current transformer shall be chosen from Table 2, and in the case of double ratio twice in recommended.

5.3 Rated withstanding currents The rated withstanding currents of current transformers shall be as stated in Table 3 when expressed in the rated overcurrent strength and in Table 4 when expressed in the rated overcurrent.

Table 3 Rated overcurrent strength

Rated overcurrent strength ⁽⁴⁾	Guaranteed overcurrent
40	40 times rated primary current
75	75 times rated primary current
150	150 times rated primary current
300	300 times rated primary current

Note (4) When the rated overcurrent strength exceeds 300, the transformer is deemed as special product.

Table 4 Rated overcurrents of current transformers

Highest voltage for equipment kV	Rated overcurrent ⁽⁵⁾ kA						
3.45	1.6	4	8	16	25	40	
6.9	2	4	8	12.5	20	31.5	40
11.5	25	40	50	80			
23	12.5	20	25	40	50	63	
34.5	12.5	16	25	31.5	40		
69	12.5	20	25	31.5	40		
80.5	12.5	20	25	31.5			
115	12.5	20	25	31.5	40		
161	12.5	20	25	31.5	40		
195.5	12.5	16	25	31.5	40	50	
230	20	25	31.5	40	50	63	
287.5	16	20	31.5	40	50	63	
550	40	50	63				

Note (5) When the rated overcurrent converted to the rated over-current strength exceeds 300, the transformer is deemed as special product.

5.4 Accuracy classes The accuracy classes of current transformers shall be five classes as shown in Table 5.

Table 5 Accuracy classes of current transformers

Accuracy class	Designation	Principally used for —
Class 0.1	Testing purpose	Standard apparatus for testing current transformer or special precise measurement
Class 0.2		
Class 0.5	General measurement	Precise measurement
Class 1.0		General measurement, switchboard
Class 3.0		

5.5 Rated burdens Rated burdens of current transformers shall have appropriate value given in Table 6.

Table 6 Rated burdens of current transformers

Unit: VA

Accuracy class	Rated burden				
Class 0.1	5	—	15	25	—
Class 0.2	5	—	15	25	—
Class 0.5	—	—	15	25	40
Class 1.0	5	10	15	25	40
Class 3.0	5	10	15	25	40

5.6 Rated frequencies Rated frequencies of current transformers shall be 50 Hz, 60 Hz or 50 Hz/60 Hz.

6 Performances

6.1 Withstanding current The performance of current transformers to withstand heavy current shall be as stated below. However, current transformers for testing are excluded.

- a) Current transformers shall be subjected to the test for short-time thermal current in accordance with 7.3.1 a) 1), and shall not be damaged.

When the said current is obtained by calculation from the equations stated in 7.3.1 a) 2), the final temperature shall not exceed 250 °C for class A insulation or 350 °C for class B insulation.

- b) Current transformers shall be subjected to the test for dynamic current in accordance with 7.3.1 b) and shall not be damaged.

6.2 Temperature rise The temperature rise of a current transformer shall be examined in accordance with 7.3.2, and shall not exceed the limit values stated in Table 7.

Table 7 Limits of temperature rise of current transformer

Unit : K

Measuring point		Limits of temperature rise	
		Class A insulation	Class B insulation
Winding	for dry self-cooled type	55	75
	for oil immersed self-cooled type		—
Oil	when oil in main tank comes in contact with external air directly	50	—
	when oil in main tank does not come in contact with external air directly	55	
The surface of terminal or other metallic part in contact with insulation		Temperature which will not damage adjacent insulation	

6.3 Dielectric withstanding voltage The performance on dielectric withstanding voltage of current transformers shall be as stated below.

Dielectric withstanding voltage performance of a current transformer having no insulation for main circuit is applicable to its low-voltage side only.

6.3.1 Lightning impulse withstand voltage The lightning impulse test of a current transformer with $U_m \geq 3.45$ kV shall be carried out in accordance with 7.3.3 b) and the transformer shall withstand the appropriate test voltage given in Table 8. However, current transformers for testing purpose are excluded.

6.3.2 Power frequency withstand voltage The power frequency voltage test of a current transformer with $U_m \leq 161$ kV used in non-effectively earthed system shall be carried out in accordance with 7.3.3 c) and the transformer shall withstand the appropriate test voltage given in Table 8.

Note : Such transformers as those for testing purpose for which the dielectric withstand voltage of main circuit side is not specified shall be tested at the highest voltage for equipment, and the transformer shall withstand the voltage.

6.3.3 Partial discharge Current transformers of mould type with $U_m \geq 6.9$ kV and of oil immersed or gas insulated type with $6.9 \text{ kV} \leq U_m \leq 161$ kV used in a non-effectively earthed system shall be tested for their partial discharge in accordance with 7.3.3 d), and the discharged electric charge, including effect of external noise or the like, shall not exceed 50 pC. However, current transformers for testing purpose are excluded.

6.3.4 Long-time power frequency withstand voltage The test for long-time power frequency withstand voltage of a current transformer with $U_m \geq 195.5$ kV used in effectively earthed system shall be made in accordance with 7.3.3 e), and no internal partial discharge shall be detected, throughout the period from end of application of the appropriate test voltage given in Table 8 to completion of the test. However, current transformers for testing purpose⁽⁶⁾ are excluded.

Note ⁽⁶⁾ For a current transformer for testing purpose, the withstand voltage test shall be carried out at the highest voltage for equipment in accordance with 6.3.2, and the transformer shall withstand the test voltage.

6.3.5 Dielectric withstand voltage between winding terminals The test for dielectric withstand voltage between terminals of secondary winding of a current transformer shall be carried out in accordance with 7.3.3 f), and the specimen shall withstand the voltage induced when the rated current is passed or the voltage by which peak value of 3 kV appears across terminals of winding having maximum number of turns among windings on a common core whichever is the smaller.

Note : As for the winding having intermediate tap(s), the specimen shall withstand the test at 3 kV which appear across terminals of winding having maximum number of turns. The dielectric between terminals of a winding having no maximum number of turns when there are more than one winding on a common iron core shall withstand the voltage (peak value is not exceeding 3 kV) induced across open-circuited terminals of the winding in question under such condition that the

voltage across terminals of winding having maximum number of turns is 3 kV. The dielectric withstand voltage between terminals of windings other than secondary winding(s) is deemed as that between windings having no maximum number of turns.

Table 8 Test voltages of current transformers

Unit: kV

Nominal voltage	Highest voltage for equipment	Test voltages			
		Lightning impulse (full wave)	Power frequency withstand voltage	Long-time power frequency withstand voltage	Power frequency withstand voltage (secondary side)
			Between primary windings (conductors) connected together and secondary windings and enclosure connected together		Between secondary winding(s) and enclosure
			—	Voltage application pattern ⁽¹⁾	Between windings each other of a transformer whose primary winding or secondary winding consists of two or more windings insulated each other
0.22	0.23	—	2	—	2
0.44	0.46	—	3		
1.1	1.15	—	4		
3.3	3.45	30 ^(*) 45	10 16		
6.6	6.9	45 ^(*) 60	16 22		
11	11.5	75 ^(*) 90	28		
13.2	13.8 ⁽⁷⁾	100 ^(*) 115	39		
16.5	17.25 ⁽⁷⁾	100 ^(*) 115	39		
22	23	100 ⁽¹⁰⁾ 125 ^(*) 150	50		
33	34.5	150 ⁽¹⁰⁾ 170 ^(*) 200	70		
66	69	350	140		
77	80.5	400	160		
110	115	550	230		
132	138 ^(*)	650	275		
154	161	750	325		
187	195.5	650 ⁽¹⁰⁾ 750	—	170-225-170	
220	230	750 ⁽¹⁰⁾ 900		200-265-200	
275	287.5	950 ⁽¹⁰⁾ 1 050		250-330-250	
500	550	1 300 ⁽¹⁰⁾ 1 425 ⁽¹⁰⁾ 1 550 1 800		475-635-475	

Notes (7) Current transformers of $U_m = 13.8$ kV and $U_m = 17.25$ kV are those used in generator circuit only.

- (8) Current transformers of $U_m = 138$ kV are special products.
- (9) Applicable for such cases that overvoltage is suppressed to a low level by means of such protective device as arrestor, or the frequency of ingress of lightning overvoltage or the overvoltage level is low.
- (10) Applicable in such a case that a high-performed arrestor is installed.
- (11) For the voltage application pattern, see 7.3.3 e).

6.4 Limits of ratio error and phase displacement The tests for ratio error and phase displacement shall be made in accordance with 7.3.4, and the limits shall not exceed those stated in Table 9 or Table 10.

The limits of ratio error and phase displacement at intermediate primary current (between those stated in Table) shall be determined by interpolation method.

Table 9 Limits of ratio error and phase displacement of current transformers for testing purpose

Accuracy class	Ratio error %					Phase displacement min				
	0.025 I_n	0.05 I_n	0.2 I_n	1.0 I_n	1.2 I_n	0.025 I_n	0.05 I_n	0.2 I_n	1.0 I_n	1.2 I_n
Class 0.1	± 0.2	± 0.16	± 0.12	± 0.1	± 0.1	± 10	± 8	± 6	± 5	± 5
Class 0.2	± 0.6	± 0.5	± 0.3	± 0.2	± 0.2	± 30	± 25	± 15	± 10	± 10

Note: I_n denotes the rated primary current at rated frequency.

Table 10 Limits of ratio error and phase displacement of current transformers used with general instrument

Accuracy class	Ratio error %			Phase displacement min		
	0.05 I_n	0.2 I_n	1.0 I_n	0.05 I_n	0.2 I_n	1.0 I_n
Class 0.5	± 1.5	± 0.75	± 0.5	± 90	± 45	± 30
Class 1.0	± 3.0	± 1.5	± 1.0	± 180	± 90	± 60
Class 3.0	$0.5 I_n$ to $1.0 I_n \pm 3.0$			$0.5 I_n$ to $1.0 I_n \pm 180$		

Note: I_n denotes the rated primary current at rated frequency.

7 Tests

7.1 Classification of tests The tests are classified into the two classes stated below.

- a) **Type test** Type test means the test carried out on each type to demonstrate all transformers of this type satisfies the construction, performances, etc. required by this Standard.
- b) **Routine test** Routine test means the test to demonstrate that the delivered products have equivalent construction and performances to those of product which passed the type test.

7.2 Items and sequence of tests The tests shall be carried out by covering all the matters related with the construction and performances determined by this Standard. The items and sequence of tests shall be as stated in Table 11.

Table 11 Items and sequence of tests of current transformers

Test item	Type test		Routine test		Description
	$U_m \leq 161 \text{ kV}$	$U_m \geq 195.5 \text{ kV}$	$U_m \leq 161 \text{ kV}$	$U_m \geq 195.5 \text{ kV}$	
Construction	①	①	①	①	
Polarity	②	②	②	②	May be carried out before ratio error and phase displacement tests.
Withstanding current	③	③	—	—	Withstanding current test may be omitted subject to agreement.
Temperature rise	④	④	—	—	
Lightning impulse withstand voltage	⑤	⑤	—	—	The test under wet conditions is for outdoor transformers only and may be omitted subject to agreement.
Power frequency withstand voltage	⑥	—	③	—	The test under wet conditions is for outdoor transformers only and may be omitted subject to agreement.
Partial discharge ⁽¹²⁾	⑦	—	④	—	
Long-time power frequency withstand voltage	—	⑥	—	③	
Dielectric withstand voltage between winding terminals	⑧	⑦	⑤	④	
Ratio error and phase displacement	⑨	⑧	⑥	⑤	

Note (12) The partial discharge test is applicable to current transformers of mould type with $U_m \geq 6.9 \text{ kV}$, and of oil immersed type and gas insulated type with $69 \text{ kV} \leq U_m \leq 161 \text{ kV}$ only.

Note : The numerals in ○ show the sequence of tests.

7.3 Test methods

7.3.1 Withstanding current test Verification of withstanding current of a current transformer shall be carried out by the method stated below.

- a) **Short-time thermal current** The short-time thermal current of a current transformer shall be examined directly or by obtaining the final temperature by calculation.

- 1) **Direct test** The rated short-time thermal current shall be passed under 25 % of the rated burden (at any one point between power factor 1 and 0.8 lagging current, provided that under 2.5 VA for a current transformer with rated secondary current of 5 A and rated secondary burden of 5 VA) for one second. Either of 50 Hz or 60 Hz may be employed as the test frequency.

In the case where the same type transformer has been verified, the data may be used as the substitutes subject to the agreement.

- 2) **Calculation** The final temperature shall be calculated from the equations stated below. Provided that the initial temperature shall have the appropriate value given in Table 12.

$$T = T_0 + 0.008\sigma^2 t$$

where, T : final temperature (°C)

T_0 : initial temperature (°C)

σ : current density of primary winding (copper) at rated short-time thermal current (r.m.s. value of a.c. component) (A/mm²)

t : ensured time (s)

The relation of the short-time thermal current and the ensured time is expressed by the following equation:

$$S_1 = S_t \sqrt{t}$$

where, S_1 : short-time thermal current converted to one second

S_t : rated short-time thermal current at t seconds

The initial temperature when the ensured time of short-time thermal current is other than one second, the table is applicable while the short-time thermal current is converted to S_1 as stated above.

Table 12 Initial temperature to short-time thermal current of current transformer

Value of short-time thermal current, S_1 converted to overcurrent strength ⁽¹³⁾	Initial temperature °C	
	Class A insulation	Class B insulation
40	105	130
75	75	90
150	55	65
300	45	—

Note ⁽¹³⁾ When the value converted to overcurrent strength differs from the value in Table, refer to Explanation Fig. 1.

- b) **Dynamic current** The dynamic current of a current transformer may be verified by means of a test method similar to the direct test stated in 7.3.1 a) 1) (provided that the time of current flow is 5 cycles) or at the same time of carrying

out the direct test for short-time thermal current. Provided that the crest value of the first wave is 2.5 times or more of the rated short-time thermal current (r.m.s. value).

When the dynamic current has been verified on the product of the same type, this test may be omitted subject to the agreement.

7.3.2 Temperature rise test The temperature rise test of a current transformer shall be carried out by passing the rated primary current at the rated frequency under the rated burden.

The measuring positions and the measuring method in the temperature rise test shall be as stated in Table 13.

Table 13 Measuring positions and methods in temperature rise test of current transformer

Measuring position	Measuring method
Winding	Resistance method ⁽¹⁴⁾
Oil	Thermometer method
Surface of terminal or other metal parts adjacent to insulation	Thermometer method

Note ⁽¹⁴⁾ For a heavy current transformer, thermometer method may be adopted if the temperature of primary conductor can not be measured by resistance method.

7.3.3 Dielectric withstand voltage tests Dielectric withstand voltages of current transformers shall be as stated below.

- a) **Dielectric withstand voltage in general** The dielectric withstand voltage tests in the type test of current transformers shall be carried out in the sequence given in Table 11 following to the temperature rise test. However, the tests shall be carried out at ordinary temperature when the temperature rise test is not carried out.
- b) **Lightning impulse withstand voltage** In the lightning impulse withstand voltage test of a current transformer, an impulse voltage with standard waveform⁽¹⁵⁾ of +1.2/50 μ s shall be applied between the primary windings connected together and the secondary windings and enclosure connected together. The sequence of test shall be such that a reduced voltage of 50 % to 75 % is applied once, and 100 % voltage is applied once under dry state, then 100 % voltage is applied once under wet state. However, the test under wet state is applicable to outdoor transformers only.

Note ⁽¹⁵⁾ Negative polarity impulse is applied if it is more severe.

- c) **Power frequency withstand voltage** In the power frequency withstand voltage test, a substantially sinusoidal a.c. voltage at a frequency 50 Hz or 60 Hz shall be used, and the voltage shall be applied for one minute under dry state and for 10 s under wet state to the positions stated below. However, the test under wet state is applicable to outdoor transformers only.

- 1) Between primary windings connected together and secondary windings and enclosure connected together.
 - 2) Between secondary windings and enclosure.
 - 3) Between winding sections each other when primary winding or secondary winding consists of two or more winding sections insulated each other.
- d) **Partial discharge test** In the partial discharge test of current transformers of moulded type with $U_m \geq 6.9$ kV, of oil immersed type and gas insulated type with $69 \text{ kV} \leq U_m \leq 161 \text{ kV}$ used in non-effectively earthed system, a substantially sinusoidal a.c. voltage at a frequency 50 Hz or 60 Hz shall be used. In the test circuit shown in Fig. 1, the said voltage equal to 1.2 times U_m is applied between the primary windings connected together and the secondary windings and enclosure connected together for 10 seconds then the voltage is gradually decreased to $1.1/\sqrt{3}$ times U_m and maintained at this voltage for at least one minute, and then the discharged electric charge shall be measured.
- However, the test may be carried out on gas insulated current transformers under the same conditions as those for gas insulated switching device subject to the agreement.
- e) **Long-time power frequency withstand voltage test** The long-time power frequency withstand voltage test of current transformers with $U_m \geq 195.5$ kV shall be carried out in the test circuit exemplified in Fig. 1 by using a substantially sinusoidal a.c. voltage at a frequency 50 Hz or 60 Hz. The appropriate long-time power frequency test voltage given in Table 8 shall be applied to the specimen as illustrated in the application pattern given below and the electric charge partially discharged from voltage application to completion of the test shall be measured. External noises shall be suppressed as low as possible.

Voltage application pattern

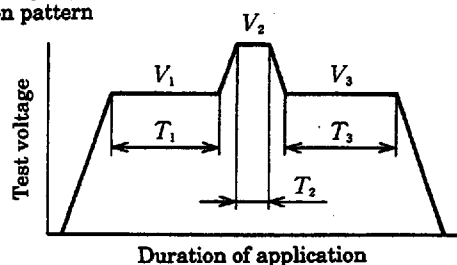
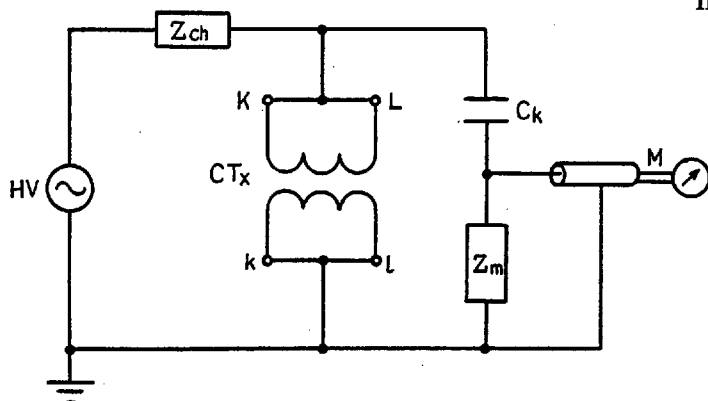


Table 14 Duration of application

Unit: min			
	T_1	T_2	T_3
Type test	30 ⁽¹⁶⁾	1	30 ⁽¹⁶⁾
Routine test	5	1	5

Note ⁽¹⁶⁾ For current transformers other than gas insulated ones this shall be as agreed.



where, HV : high voltage power supply

Z_{ch} : filter

Z_m : detecting impedance

C_k : coupling capacitor

CT_x : current transformer to be tested

M : measuring device

Fig. 1 Example of current transformer partial discharge test circuit