

American National Standard

requirements for instrument transformers

ANSI/IEEE C57.13-1978



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An American National Standard

**IEEE Standard Requirements for
Instrument Transformers**

Sponsor
Transformers Committee of the
IEEE Power Engineering Society

Approved September 9, 1976
IEEE Standards Board

Secretariat
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National Electric Manufacturers Association

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Foreword

(This Foreword is not a part of ANSI/IEEE C57.13-1978, American National Standard Requirements for Instrument Transformers.)

For a number of years prior to 1942, The Sectional Committee on Transformers, Regulators, and Reactors, C57, was developing and correlating standards on transformers. The data used in this work was gathered from many sources, including the existing standards and publications of American Institute of Electrical Engineers, standards of the National Electrical Manufacturers Association, reports of the Edison Electric Institute, and others. This work resulted in the publication in 1942 of the American Standard for Transformers, Regulators, and Reactors. This standard was revised and greatly expanded in 1948 and 1949.

American Standard Requirements, Terminology, and Test Code for Instrument Transformers, C57.13-1954, was an editorial consolidation of preceding standards on instrument transformers, namely, the American Standard Test Code for Instrument Transformers, C57.23-1948. In addition, in order to eliminate cross-references wherever possible, it contained excerpts from other standards of the C57 family.

USA Standard C57.13-1968 was a revision which recognized subsequent developments. It also had been updated to conform with American National Standard General Requirements for Distribution, Power, and Regulating Transformers, ANSI/IEEE C57.12.00-1973, and American National Standard Test Code for Distribution, Power and Regulating Transformers, ANSI/IEEE C57.12.90-1973, except where instrument transformer requirements demand modifications.

Suggestions for improvement of this standard will be welcome. They should be sent to the Secretary

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An American National Standard

IEEE Standard Requirements for Instrument Transformers

1. Scope

1.1 This standard is intended for use as a basis for performance, interchangeability, and safety of equipment covered, and to assist in the proper selection of such equipment.

1.2 This standard covers certain electrical, dimensional, and mechanical characteristics, and takes into consideration certain safety features of current and inductively coupled voltage transformers of types generally used in the measurement of electricity and the control of equipment associated with the generation, transmission, and distribution of alternating current.

2. Definitions

All definitions, except as specifically covered in this standard, shall be in accordance with ANSI/IEEE Std 100-1977, Dictionary of Electrical and Electronics Terms.

bar-type current transformer. One that has a fixed, insulated straight conductor in the form of a bar, rod, or tube that is a single primary turn passing through the magnetic circuit and that is assembled to the secondary, core, and winding.

burden of an instrument transformer. That property of the circuit connected to the secondary winding that determines the active and reactive power at the secondary terminals. The burden is expressed either as total ohms impedance with the effective resistance and reactance components, or as the total volt-amperes and power factor at the specified value of current or voltage, and frequency.

bushing-type current transformer. One that has an annular core and a secondary winding insulated from and permanently assembled on the core but has no primary winding or insulation for

a primary winding. This type of current transformer is for use with a fully insulated conductor as the primary winding. A bushing-type current transformer usually is used in equipment where the primary conductor is a component part of other apparatus.

cascade-type voltage transformer. An insulated-neutral terminal type voltage transformer with the primary winding distributed on several cores with the cores electromagnetically coupled by coupling windings. The secondary winding is on the core at the neutral end of the high-voltage winding. Each core of this type of transformer is insulated from the other cores and is maintained at a fixed voltage with respect to ground and the line-to-ground voltage.

continuous-thermal-current rating factor (RF). The specified factor by which the rated primary current of a current transformer can be multiplied to obtain the maximum primary current that can be carried continuously without exceeding the limiting temperature rise from 30°C ambient air temperature. (When current transformers are incorporated internally as parts of larger transformers or power circuit breakers, they shall meet allowable average winding and hot spot temperatures under the specific conditions and requirements of the larger apparatus.)

current transformer. An instrument transformer intended to have its primary winding connected in series with the conductor carrying the current to be measured or controlled. (In window type current transformers, the primary winding is provided by the line conductor and is not an integral part of the transformer.)

double-secondary current transformer. One that has two secondary coils each on a separate magnetic circuit with both magnetic circuits excited by the same primary winding.

double-secondary voltage transformer. One that has two secondary windings on the same magnetic circuit insulated from each other and the primary.

excitation losses for an instrument transformer. The watts required to supply the energy necessary to excite the transformer, which include the dielectric watts, the core watts, and the watts in the excited winding due to the excitation current.

fused-type voltage transformer. One that is provided with means for mounting one or more fuses as integral parts of the transformer in series with the primary winding.

grounded-neutral terminal type voltage transformer. A voltage transformer that has the neutral end of the high-voltage winding connected to the case or mounting base.

instrument transformer. A transformer that is intended to reproduce in its secondary circuit, in a definite and known proportion, the current or voltage of its primary circuit with the phase relations substantially preserved.

insulated-neutral terminal type voltage transformer. A voltage transformer that has the neutral end of the high-voltage winding insulated from the case or base and connected to a terminal that provides insulation for a lower voltage than required for the line terminal.

marked ratio. The ratio of the rated primary value to the rated secondary value as stated on the nameplate.

multiple-secondary current transformer. One that has three or more secondary coils each on a separate magnetic circuit with all magnetic circuits excited by the same primary winding.

multi-ratio current transformer. One from which more than one ratio can be obtained by the use of taps on the secondary winding.

percent ratio. The true ratio expressed in percent of the marked ratio.

percent ratio correction of an instrument transformer. The difference between the ratio correction factor and unity expressed in percent.

NOTE: The percent ratio correction is positive if the ratio correction factor is greater than unity. If the percent ratio correction is positive, the measured secondary current or voltage will be less than the primary value divided by the marked ratio.

phase angle correction factor. The ratio of the true power factor to the measured power factor. It is a function of both the phase angles of the

instrument transformer and the power factor of the primary circuit being measured.

NOTE: The phase angle correction factor is the factor that corrects for the phase displacement of the secondary current or voltage, or both, due to the instrument transformer phase angles.

The measured watts or watt-hours in the secondary circuits of instrument transformers must be multiplied by the phase angle correction factor and the true ratio to obtain the true primary watts or watt-hours.

phase angle of an instrument transformer. The phase displacement, in minutes, between the primary and secondary values.

NOTE: The phase angle of a current transformer is designated by the Greek letter beta (β) and is positive when the current leaving the identified secondary terminal leads the current entering the identified primary terminal.

The phase angle of a voltage transformer is designated by the Greek letter gamma (γ) and is positive when the secondary voltage from the identified to the unidentified terminal leads the corresponding primary voltage.

polarity. The designation of the relative instantaneous directions of the currents entering the primary terminals and leaving the secondary terminals during most of each half cycle.

NOTE: Primary and secondary terminals are said to have the same polarity when, at a given instant during most of each half cycle, the current enters the identified, similarly marked primary lead and leaves the identified, similarly marked secondary terminal in the same direction as though the two terminals formed a continuous circuit.

rated current. The primary current selected for the basis of performance specifications of a current transformer.

rated secondary current. The rated current divided by the marked ratio.

rated secondary voltage. The rated voltage divided by the marked ratio.

rated voltage of a voltage transformer. The primary voltage selected for the basis of performance specifications of a voltage transformer.

ratio correction factor (RCF). The ratio of the true ratio to the marked ratio. The primary current or voltage is equal to the secondary current or voltage multiplied by the marked ratio times the ratio correction factor.

secondary winding of an instrument transformer. The winding that is intended to be connected to the measuring or control devices.

thermal burden rating of a voltage transformer. The volt-ampere output that the transformer will supply continuously at rated secondary voltage without causing the specified temperature limitations to be exceeded.

three-wire type current transformer. One that has two primary windings, each completely insulated for the rated insulation level of the transformer. This type of current transformer is for use on a three-wire, single-phase service.

NOTE: The primary windings and secondary windings are permanently assembled on the core as an integral structure. The secondary current is proportional to the phasor sum of the primary currents.

transformer correction factor (TCF). The ratio of true watts or watt-hours to the measured watts or watt-hours, divided by the marked ratio.

NOTE: The transformer correction factor for a current or voltage transformer is the ratio correction factor multiplied by the phase angle correction factor for a specified primary circuit power factor.

The true primary watts or watt-hours are equal to the watts or watt-hours measured, multiplied by the transformer correction factor and the marked ratio.

The true primary watts or watt-hours, when measured using both current and voltage transformers, are equal to the current transformer correction factor times the voltage transformer correction factor multiplied by the product of the marked ratios of the current and voltage transformers multiplied by the observed watts or watt-hours.

true ratio. The ratio of the root-mean-square (rms) primary value to the rms secondary value under specified conditions.

turn ratio of a current transformer. The ratio of the secondary winding turns to the primary winding turns.

turn ratio of a voltage transformer. The ratio of the primary winding turns to the secondary winding turns.

voltage transformer. An instrument transformer intended to have its primary winding connected in shunt with a power supply circuit, the voltage of which is to be measured or controlled.

window-type current transformer. One that has a secondary winding insulated from and permanently assembled on the core, but has no primary winding as an integral part of the structure. Complete insulation is provided for a primary winding in the window through which one turn of the line conductor can be passed to provide the primary winding.

wound-type current transformer. One that has a primary winding consisting of one or more turns mechanically encircling the core or cores. The primary and secondary windings are insulated from each other and from the core(s) and are assembled as an integral structure.

3. References

When the following American National Standards referred to in this standard are superseded by revisions approved by the American National Standards Institute, the revision shall apply.

- [1] ANSI/IEEE C37.20-1974, Switchgear Assemblies Including Metal-Enclosed Bus.
- [2] IEEE Std 4-1978, Standard Techniques for High-Voltage Testing.
- [3] ANSI C37.04-1964(R1969), Rating Structure for AC High-Voltage Circuit Breakers.
- [4] ANSI/IEEE C57.12.00-1973, General Requirements for Distribution, Power, and Regulating Transformers.
- [5] ANSI/IEEE C57.12.90-1973, Test Code for Distribution, Power, and Regulating Transformers.
- [6] ANSI/IEEE Std 21-1976, General Requirements and Test Procedures for Outdoor Apparatus Bushings.
- [7] ANSI C37.09a-1970, Supplement to ANSI C37.09-1964(R1969), Test Procedure for AC High-Voltage Circuit Breakers.
- [8] ANSI/IEEE C37.078-1972, Requirements for External Insulation for Outdoor AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
- [9] ANSI C37.09-1964(R1969), Test Procedure for AC High-Voltage Circuit Breakers.
- [10] ANSI/IEEE C37.074-1972, Requirements for Switching-Impulse Voltage Insulation Strength for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (362 kV and Above).

4. General Requirements

4.1 Service Conditions

4.1.1 Usual Temperature and Altitude Service Conditions. Usual temperature and altitude service conditions apparatus conforming to this standard shall be suitable for operation at its thermal rating, provided that the altitude does not exceed 3300 ft (1000 m).

4.1.1.1 30°C Average Ambient Temperature. If air cooled, the temperature of the cooling air (ambient temperature) does not exceed 40°C and the average temperature of the cooling air for any 24 h period does not exceed 30°C¹.

¹ It is recommended that the average temperature of the cooling air be calculated by averaging 24 consecutive hourly readings. When the outdoor air is the cooling medium, the average of the maximum and minimum daily temperature may be used. The value that is obtained in this manner is usually higher than the true daily average by not more than ¼°C.

4.1.1.2 55°C Ambient Temperature Inside Enclosed Switchgear. Instrument transformers may also be given ratings for operation in 55°C maximum ambient temperature inside enclosed switch gear according to ANSI/IEEE C37.20-1974, American National Standard Switchgear Assemblies including Metal-Enclosed Bus.

4.1.2. Unusual Temperature and Altitude Service Conditions. Instrument transformers may be applied at higher altitudes or higher ambient temperatures than specified in 4.1.1, but the performance may be affected and special consideration should be given to these applications. (See 4.4.)

4.1.3 Other Conditions That May Affect Design and Application. Where unusual conditions other than those discussed in 4.1.1 or 4.1.2 exist, they should be brought to the attention of those responsible for the design and application of instrument transformers. Examples of these conditions are:

- (1) Damaging fumes or vapors, excessive or abrasive dust, explosive mixtures of dust or gases, steam, salt spray, excessive moisture or dripping water, etc
- (2) Abnormal vibrations, shocks, or tilting
- (3) Ambient temperatures above 55°C or below -30°C
- (4) Unusual transportation or storage conditions
- (5) Unusual space limitations or restricted ventilation
- (6) Unusual duty, frequency of operation, difficulty of maintenance, poor wave form, unbalanced voltage, special insulation requirements, etc
- (7) Applications in switchgear assemblies including metal enclosed bus [4]
- (8) Applications with high voltage power circuit breakers [3]
- (9) Applications with power transformers [4]
- (10) Applications with outdoor bushings [6]

4.2 Effect of Air Density on Sparkover Voltage. The effect of the decreased air density due to high altitude is to decrease the sparkover voltage for a given sparkover distance. See IEEE Std 4-1978, for use of a correction factor with sphere gaps.

The dielectric strength of air decreases as altitude increases. Dielectric strength that depends on air should be multiplied by the proper altitude correction factor to obtain the dielectric strength at the required altitude (see Table 1).

4.3 Frequency. Instrument Transformers shall be designed for operation at a frequency of 60 Hz.

4.4 Effect of Altitude on Temperature Rise and Effect of Ambient Temperature on Permissible Loading

4.4.1 Loading of Current Transformers at Less Than Rated Current at High Altitudes. Current transformers may be operated at altitudes greater than 1000 m without exceeding established temperature limits provided the current is reduced below rated (or below rated times continuous thermal current factor) by 0.3 percent for each 100 m that the altitude exceeds 1000 m.

4.4.2 Operation of Current Transformers at Other Than 30°C Ambient. Current transformers designed for 55°C temperature rise above 30°C ambient air temperature may be loaded in accordance with the curves of Fig 1 for any given average cooling air temperature and continuous-thermal-current rating factor. The percent of rated primary current that can be carried continuously without causing established temperature limitations to be exceeded is given by the curves. For example, a transformer with a continuous-thermal-current rating factor (RF) of 2.0 at 30°C ambient can be used at approximately 150 percent of rated current at an ambient temperature of 55°C.

4.4.3 Loading of Voltage Transformers at Higher Altitudes or Higher Ambient Temperatures. Voltage transformers can be safely operated at higher altitudes or higher ambient tem-

Table 1
Dielectric Strength Correction Factors for
Altitudes Greater Than 1000 m (3300 ft)

Altitude		Altitude Correction Factor for Dielectric Strength
(ft)	(m)	
3300	1000	1.00
4000	1200	0.98
5000	1500	0.95
6000	1800	0.92
7000	2100	0.89
8000	2400	0.86
9000	2700	0.83
10 000	3000	0.80
12 000	3600	0.75
14 000	4200	0.70
15 000	4500	0.67

Note: Altitude of 15 000 ft is considered a maximum for instrument transformers conforming to this standard.

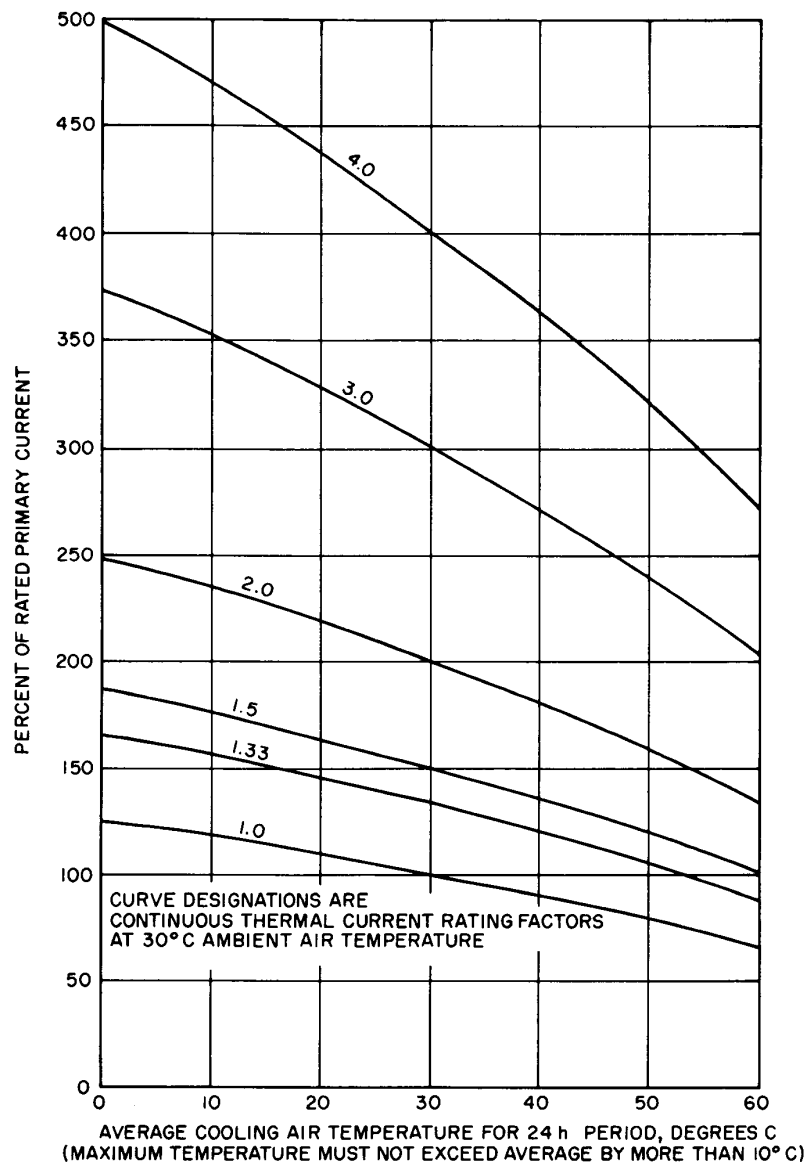


Fig 1
55°C Rise Current Transformer Basic Loading Characteristics

peratures only after consultation with the manufacturer because a large percentage of the temperature rise may be due to iron loss, which varies widely with design.

4.5 Basic Impulse Insulation Levels, Dielectric Tests, and Outdoor Instrument Transformer Creepage Distance and Wet Tests. An instrument transformer shall be as-

Table 2
Basic Impulse Insulation
Levels and Dielectric Tests

See Table 3 for current transformers with the same dielectric test requirements as power circuit breakers.
See Section 8 for test methods.

BIL* and Full Wave Crest (kV)†	Chopped Wave		Applied Potential Test (kV rms)	Wet 60 Hz 10 s Withstand (kV rms)**	Minimum Creepage Distance (in)
	Crest (kV)	Minimum Time to Flashover (μ s)			
10	12	—	4	—	—
30	36	1	10	6‡	—
45	54	1.25	15	13‡	—
60	69	1.5	19	20‡	—
75	88	1.6	26	24‡	—
95	110	1.8	34	30‡	—
110	130	2	34	45	11
125	145	2.25	40	36‡	15
150	175	3	50	70	17
200	230	3	70	95	26
250	290	3	95	120	35
350	400	3	140	175	48
450	520	3	185	190	66
550	630	3	230	230	79
650	750	3	275	275	92
750	865	3	325	315	114
900	1035	3	395	385	135
1050	1210	3	460	445	170
1300	1500	3	575	555††	205
1800	2070	3	800	750††	318
2050	2360	3	920	850	442

*There is no BIL requirement on the neutral terminal of grounded-neutral or insulated-neutral terminal type voltage transformers.

†The selection of the lower BIL for a given nominal system voltage in Table 7, or for a marked ratio in Tables 12-16, also reduces other requirements as tabulated above. The acceptability of these reduced requirements should be evaluated for the specific instrument transformer design and application.

**Wet tests are type tests and may be made separately from the transformer. However, when a current transformer is a part of the breaker structure the wet tests on the breaker shall include the current transformer. For test procedures see ANSI/IEEE Std 21-1976, General Requirements and Test Procedures for Outdoor Apparatus Bushings. For "B" BILs see also ANSI/IEEE C37.078-1972, Requirements for External Insulation for Outdoor AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

‡These values are requirements for distribution transformer bushings in ANSI/IEEE C57.12.00-1973, General Requirements for Distribution, Power, and Regulating Transformers.

††Tentative values.

signed a basic impulse insulation level to indicate the factory dielectric tests that the transformer is capable of withstanding.

With the following exception, basic impulse insulation voltages, applied potential test voltages for primary windings, and creepage distances and wet tests for outdoor instrument transformers are listed in Tables 2 and 3:

(1) Applied potential tests for primary windings are not required on grounded-neutral-terminal type voltage transformers.

(2) For insulated-neutral-terminal type voltage transformers, the applied potential test for primary windings shall be 19 kV on outdoor types and 10 kV on indoor types.

(3) The applied potential test for secondary windings and between multiple-secondary windings shall be 2.5 kV.

(4) The applied potential test for auxiliary or autotransformers for use in the secondary circuits of instrument transformers shall be 2.5 kV.

Table 3
Basic Impulse Insulation Levels and Dielectric Tests for Current Transformers with the Same Dielectric Test Requirements as Power Circuit Breakers

(See ANSI C37.09-1964 (R1969), for impulse and applied potential test methods.)

BIL and Full Wave Crest* (kV)	Chopped Wave		Supplementary Chopped Wave		Applied Potential Test (kV rms)	Wet 60 Hz 10 s Withstand (kV rms)†	Minimum Creepage Distance (in)
	Crest (kV)	Minimum Time to Flashover (μ s)	Crest (kV)	Minimum Time to Flashover (μ s)			
550B	632	3	710	2	260	230	70
650B	748	3	838	2	310	275	84
750B	862	3	968	2	365	315	98
900B	1040	3	1160	2	425	350	140
						Wet Switching Surge Crest‡ (kV)	
1300B	1500	3	1680	2	555	825	209
1800B	2070	3	2320	2	860	1175	318
2050B	2360	3	2640	2	960	1425	442

†Wet tests are type tests and may be made separately from the transformer. However, when a current transformer is a part of the breaker structure the wet tests on the breaker shall include the current transformer. For test procedures see ANSI/IEEE Std 21-1976, and for "B" BILs see also ANSI/IEEE C37.078-1972.

‡For wet switching surge test methods, see ANSI/IEEE C37.074-1972.

*The letter "B" values have been established by ANSI C37 Committee for current transformers that have the same dielectric test requirements as power circuit breakers.

Table 4
Limits of Temperature Rise*

Type of Instrument Transformer	30° C Ambient		55° C Ambient	
	Average Winding Temperature Rise Determined by Resistance Method (°C)	Hottest-Spot Winding Temperature Rise (°C)†	Average Winding Temperature Rise Determined by Resistance Method (°C)	Hottest-Spot Winding Temperature Rise (°C)†
55°C Rise	55‡	65	30	40
80°C Rise Dry-Type	80	110	55	85

*Temperature rise of current transformers that are a part of high-voltage power circuit breakers or power transformers shall be in accord with ANSI C37.04-1964 (R1969), Rating Structure for AC High-Voltage Circuit Breakers, or ANSI/IEEE C57.12.00-1973, respectively.

†Temperature rise of other metallic parts shall not exceed these values.

‡Temperature rise at the top of the oil in sealed transformers shall not exceed these values.

4.6 Temperature Rise. The limits of observable temperature rise in instrument transformers when tested in accordance with their ratings shall be as given in Table 4, and the transformers shall be designed so that the hottest-spot winding temperature rise above ambient will not exceed the values given in Table 4.

4.7 Tests

4.7.1 Instrument Transformer Tests. These are the design and routine tests that are necessary to assure that the design and construction of the transformer are adequate to meet the specified requirements. The method of making tests shall be as described in Section 8, except as otherwise required in Table 3, or by equivalent alternate methods. In case of questions the method shall be as described in Section 8, except as otherwise required in Table 3.

4.7.2 Minimum Routine Tests. Each instrument transformer shall receive the following routine tests at the factory. These tests shall be made on the instrument transformer after complete assembly, where feasible.

- (1) Applied potential dielectric tests between windings and between windings and ground (except no primary insulation test for bushing type, split-core, or any current transformer designed with incomplete insulation for the primary conductor)
- (2) Induced potential tests
- (3) Accuracy tests
- (4) Polarity check

4.8 Construction

4.8.1 Polarity and Terminal Marking. The relative instantaneous polarity of terminals or leads shall be clearly indicated by permanent markings that cannot easily be obliterated.

When the polarity is indicated by letters, the letter H shall be used to distinguish the leads or terminals connected to the primary winding and the letter X (also Y and Z, etc, if multiple secondary windings are provided) shall be used to distinguish the leads or terminals connected to the secondary winding. In addition, each lead shall be numbered, for example, H1, H2, X1, X2. If more than three secondary windings are provided they shall be identified as X, Y, Z, and W for four windings; X, Y, Z, W, and V for five windings, X, Y, Z, U, W, and V for six windings, etc. H1 and X1 (also Y1 and Z1, etc, if provided) shall be of the same polarity.

When multiple primary windings are provided, the leads or terminals shall be designated by the letter H together with consecutive pairs of numbers (H1, H2, H3, H4, etc). The odd-numbered leads or terminals shall be of the same polarity.

When taps or leads are provided on the secondary winding or windings, the leads or terminals shall be lettered as required above and numbered X1, X2, X3, etc, or Y1, Y2, Y3, etc, the lowest and highest numbers indicating the full winding and intermediate numbers indicating the taps in their relative order. When X1 is not in use, the lower number of the two leads in use shall be the polarity lead.

4.8.2 Symbols. Instrument transformer symbols are given in Table 5.

Table 5
Instrument Transformer Symbols

Symbols	Voltage Transformers	Current Transformers
:	Ratio expression only, to show ratio to 1 between primary and secondary voltages or between primary and tertiary voltages <i>Example:</i> Voltage transformers with primary and secondary winding 14 400 V Ratio: 120:1	Ratio between primary and secondary amperes <i>Example:</i> Current transformer with single primary winding and secondary winding Current ratio 100:5 A
x (lower case)	Voltage ratings or ratios of transformer with a winding in two or more coils for series or multiple connection <i>Example:</i> Voltage transformer with primary in two coils for series or multiple connection for two ratings 2400 x 4800 V Ratio: 20 x 40:1	Current ratings of transformer with a winding in two or more coils for series or multiple connection <i>Example:</i> Current transformer with primary winding in two coils for series or multiple connection for two ratios Current ratio 100 x 200:5 A
// (double slant line or double virgule)	(Not used)	Ampere ratings of separate secondary windings each having an independent core <i>Example:</i> Current transformer with two separate secondary windings and two cores Current ratio 100:5//5 A
& (ampersand)	Voltage ratings or ratios of separate windings on one core <i>Example:</i> Voltage transformer for connection line-to-ground, with three windings, primary, and two secondaries 14 400 (25 000 GrdY) V Ratio: 120 & 200:1	Ampere ratings of separate primary windings on one core. (a) Transformer with two or more primary windings used individually <i>Example:</i> Current transformer with two primary windings Current ratio 100 & 600:5 A (b) Totalizing transformer with two or more primary windings all used simultaneously and connected in different circuits <i>Example:</i> Totalizing current transformer with three primary windings Current ratio 5&5&5:5 A (c) Transformer for 3-wire single-phase circuit with two separate primary windings <i>Example:</i> Current transformer for 3-wire single-phase circuit Current ratio 100&100:5 A

(Continued on page 18)

Table 5
Instrument Transformer Symbols
(Continued)

Symbols	Voltage Transformers	Current Transformers
(single slant line or virgule)	Two or more primary or secondary voltage ratings obtained by taps in the secondary winding <i>Example:</i> Voltage transformer with taps in the secondary winding for additional ratios 8400/12 000/14 000 V Ratio: 70/100/120:1 <i>Example:</i> Voltage transformer with a tap in the secondary for additional secondary voltage ratings 69 000 for 115 000 GrdY Ratio: 600/1000:1	Different primary current ratings obtained by taps in the secondary winding <i>Example:</i> Current transformer with taps in secondary winding for additional ratios Current Ratio 300/400/600:5 A
(... GrdY)	Circuit voltage (line-to-line) to which a grounded-neutral or insulated-neutral terminal type voltage transformer can be connected from line to ground <i>Example:</i> Voltage transformer for connection line-to-ground, with three windings, primary, and two secondaries 14 000 (25 000 GrdY) V Ratio: 120&200:1	(not used directly)

5. Accuracy Classes for Metering Service

5.1 Basis For Accuracy Classes. Accuracy classes for metering are based on the requirement that the transformer correction factor (TCF) shall be within specified limits when the power factor (lagging) of the metered load has any value from 0.6 to 1.0, over specified ranges as follows:

(1) For current transformers, at the specified standard burden (see 6.2 for standard burdens) and at 100 percent of rated primary current (also at the current corresponding to the RF if it is greater than 1.0). At 10 percent rated current the permissible error is twice as great as at 100 percent rated current. The accuracy at a lower standard burden is not necessarily equal to that at the specified standard burden.

(2) For voltage transformers, from any burden in volt-amperes from zero to the specified standard burden, at the specified standard burden power factor (see 7.2 for standard burdens) and at

any voltage from 90 to 110 percent of the rated voltage. The accuracy at a lower standard burden of different power factor is not necessarily equal to that at the specified standard burden.

5.2 Expression for Transformer Correction Factor at 0.6 and 1.0 Power Factor of Metered Load. From the definition in Section 2, it can be shown² that *TCF* at 0.6 power factor (lagging) of the metered load is:

(1) For voltage transformers,

$$TCF = RCF + \gamma/2600$$

(2) For current transformers,

$$TCF = RCF - \beta/2600$$

where

RCF = ratio correction factor

γ, β = phase angle in minutes, for voltage transformers and current transformers respectively.

² This is true for errors within the range of the standard metering accuracy classes.