

TECHNICAL DATA

STANDARDS

- I. Current Transformers
 - a. I.E.E.E. / A.N.S.I. Publication I.E.E.E. Std. C57.13-2008
 - b. I.E.C. Publication No. I.E.C. 61869-2
- II. Voltage Transformers
 - a. I.E.E.E. / A.N.S.I. Publication I.E.E.E. Std. C57-13-2008
 - b. I.E.C. Publication No. 61869-3

Standards listed are ones we most commonly use in the field. It should be understood that standards are not laws, but are suggested guidelines for users and manufacturers alike. The standards usually suggest test and testing procedures as well.

The following is based on U.S.A. standards (C57.13-2008) which is the standard of choice in the U.S.A.

I.E.C. (International Electro technical Commission) is the standard of choice of the international community.

CURRENT TRANSFORMERS

Accuracy & Burden – Accuracy is defined for two different types of applications (metering and relaying).

The following table defines metering accuracy classes.

The limits of transformer correction factor in standard shall be as shown in Table 1.

**STANDARD ACCURACY CLASSES
TABLE 1**

METERING ACCURACY CLASS	VOLTAGE TRANSFORMERS (at 100% rated voltage)		CURRENT TRANSFORMERS			
	RATIO CORRECTION FACTORS					
	Minimum	Maximum	*At 100% rated current		*At 100% rated current	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
0.3	0.997	1.003	0.997	1.003	0.994	1.006
0.6	0.994	1.006	0.994	1.006	0.988	1.012
1.2	0.998	1.012	0.988	1.012	0.976	1.024

*For current transformers the 100% rated current limit also applies to the current corresponding to the continuous thermal current rating factor.

Accuracy statement (0.3, 0.6, 1.2) is not complete unless it is stated at a given burden. Table 2 defines the standard burdens for metering and relaying as well.

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**STANDARD BURDENS FOR CURRENT TRANSFORMERS WITH 5 SECONDARY WINDINGS
TABLE 2**

BURDENS	BURDEN DESIGNATION**	RESISTANCE (Ω)	INDUCTANCE (mH)	IMPEDANCE (Ω)	VOLTAMPERES (at 5 A)	POWER FACTOR
Metering Burdens	B-0.1	0.09	0.116	0.1	2.5	0.9
	B-0.2	0.18	0.232	0.2	5.0	0.9
	B-.05	0.45	0.580	0.5	12.5	0.9
	B-0.9	0.81	1.040	0.9	22.5	0.9
	B-1.8	1.62	2.080	1.8	45.0	0.9
Relaying Burdens	B-1	0.50	2.300	1.0	25.0	0.5
	B-2	1.00	4.600	2.0	50.0	0.5
	B-4	2.00	9.200	4.0	100.0	0.5
	B-8	4.00	18.400	8.0	200.0	0.5

*If a current transformer secondary winding is rated at other than 5 A, ohmic burdens for specification and rating shall be derived by multiplying the resistance and inductance of the table $[5 / (\text{ampere rating})]^2$, the VA at rated current, the power factor, and the burden designation remaining the same.

**These standard burden designations have no significance at frequencies other than 60 Hz.

There is another factor which must be considered, that is, phase error. Table 3 gives the maximum acceptable phase error associated with the standard accuracy classes.

TABLE 3

ACCURACY CLASSES	± PHASE ERROR AT 100% PRIMARY CURRENT	± PHASE ERROR AT 10% PRIMARY CURRENT
0.3	15.6 MINUTES	31.2 MINUTES
0.6	31.2 MINUTES	62.4 MINUTES
1.2	62.4 MINUTES	24.8 MINUTES

If you have a metering accuracy statement of “0.3 BO.5”, it indicates the following:

(0.3) maximum ratio error of 0.3% at 100% of rated primary current or $\pm 0.6\%$ ratio error at 10% of rated primary current. With a maximum phase error of ± 15.6 minutes at 100% rated primary current or ± 31.2 minutes maximum phase error at 10% of rated primary current. All of the above is based on a burden of (BO.5) 0.5 OHMS at power factor of 0.9.

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CURRENT TRANSFORMERS RELAYING ACCURACY

All relaying accuracies are $\pm 10\%$ maximum ratio error when there is 20 times current flowing in the CT secondary ($20 \times 5A=100A$). There are two designations which are “C” and “T”.

Designation “C” stands for “Calculate”. This type of CT’s performance can be very accurately calculated. The “T” designation stands for “Test”. This type of CT’s performance must be verified by testing. Table 4 gives the relaying accuracy designations:

TABLE 4

DESIGNATION	BURDEN	POWER FACTOR	SECONDARY VOLTAGE
C 10 or T10	0.1 Ω	0.5	10V
C 20 or T20	0.2 Ω	0.5	20V
C 50 or T50	0.5 Ω	0.5	50V
C 100 or T100	1.0 Ω	0.5	100V
C 200 or T200	2.0 Ω	0.5	200V
C 400 or T400	4.0 Ω	0.5	400V
C 800 or T800	8.0 Ω	0.5	800V

VOLTAGE TRANSFORMERS

Voltage transformers have the same accuracy classes as indicated in Table 1 (i.e. 0.3, 0.6 & 1.2). These accuracy classes must be given at a stated burden in order to be meaningful. Table 5 gives the standard burden data:

VOLTAGE TRANSFORMER BURDEN DATA
TABLE 5

BURDEN	VOLT AMPERES	POWER FACTOR	P.F. ANGLE
W	12.5	0.10	84.3°
X	25	0.70	45.6°
M	35	0.20	78.5°
Y	75	0.85	31.8°
Z	200	0.85	31.8°
ZZ	400	0.85	31.8°

If you have a “0.6Y” accuracy and burden statement, it indicates the following:

This means: (0.6) maximum ratio error of + 0.6% at a burden of 75VA with a power factor of 0.85.

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CURRENT TRANSFORMERS RATIO MODIFICATION

Relatively large changes in ratio may be achieved through the use of primary turns. For example:

TABLE 6

CT RATIO	NUMBER OF PRIMARY TURNS	MODIFIED RATIO
100:5A	2	50:5A
200:5A	2	100:5A
300:5A	2	150:5A
100:5A	3	33.3:5A
200:5A	3	66.6:5A
300:5A	3	100:5A
100:5A	4	25:5A
200:5A	4	50:5A
300:5A	4	75:5A

A primary turn is the number of times the primary conductor passes through the CT's window. The main advantage of this ratio modification is maintaining the accuracy and burden capabilities of the higher ratio. The higher the primary rating the better the accuracy and burden rating.

Smaller ratio modification adjustments can be made by using additive or subtractive secondary turns. For example, if a CT with a ratio of 100:5A: By adding one additive secondary turn, the ratio modification is 105:5A; by adding on subtractive secondary turn, the ratio modification is 95:5A. Subtractive secondary turns are achieved by placing the "X1" lead through the window from the H1 side and out the H2 side. Additive secondary turns are achieved by placing the "X1" lead through the window from the H2 and out of the H1 side. So, when there is only one primary turn, each secondary turn modifies the primary rating by 5 amperes. If there is more than one primary turn, each secondary turn value is changes (i.e. 5A divided by 2 primary turns = 2.5A). Table 7 illustrates the effects of different combinations of primary and secondary turns:

TABLE 7

PRIMARY TURNS	SECONDARY TURNS	RATIO ADJUSTMENT
1	-0-	100:5A
1	1+	105:5A
1	1-	95:5A
2	-0-	50:5
2	1+	52.5:5A
2	2-	45.0:5A
3	-0-	33.3:5A
3	1+	34.97:5A
3	1-	31.63:5A

The use of primary/secondary turns makes it is possible to modify any CT ratio, since low ratio CT's generally have poorer performances characteristics and high ratio CT's have

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better performance. By using added primary/secondary turns, you can modify a higher ratio CT to have a lower ratio and enjoy the better performance of the higher ratio.

***Use Table 8 to determine size window needed for number and primary conductor(s)**

TABLE 8

WINDOW DIAMETER		1/2"	3/4"	1"	1 1/2"	2"	1 1/2"	3"	3 1/2"	4"	5"	6"
INSULATION TYPE RHW	AWG MCM											
	14	3	6	10	25	41	58	90	121	155	-	-
	12	3	5	9	21	35	50	77	103	132	-	-
	10	2	4	7	18	29	41	64	86	110	-	-
	8	1	2	4	9	16	22	35	47	60	94	137
	6	1	1	2	6	11	15	24	32	41	64	93
	4	1	1	1	5	8	12	18	24	31	50	72
	3	1	1	1	4	7	10	16	22	38	44	63
	2	-	1	1	4	6	9	14	19	24	38	56
	1	-	1	1	3	5	7	11	14	18	29	42
	0	-	1	1	2	4	6	9	12	16	25	47
	00	-	-	1	1	3	5	8	11	14	22	32
	000	-	-	1	1	3	4	7	9	12	19	28
	0000	-	-	1	1	2	4	6	8	10	16	24
	250	-	-	-	1	1	3	5	6	8	13	19
	300	-	-	-	1	1	3	4	5	7	11	17
	350	-	-	-	1	1	2	4	5	6	10	15
	400	-	-	-	1	1	1	3	4	6	9	14
	500	-	-	-	1	1	1	3	4	5	8	11
	600	-	-	-	1	1	1	2	3	4	6	9
	700	-	-	-	1	1	1	1	3	3	6	8
	750	-	-	-	1	1	1	1	3	3	5	8

Burden is the opposition to the flow of current from the transformers secondary. Burden may be expressed in terms of resistance of volt-amperes. The following table may be used to convert volt-ampere values to resistance values for 5 amp secondary CT's:

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BURDEN

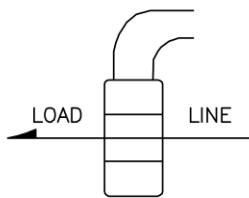
TABLE 9

VOLTAMPERE (VA)	RESISTANCE (OHMS) Ω
0.5	0.02
1.0	0.04
1.5	0.06
2.0	0.08
2.5	0.10
3.0	0.12
3.5	0.14
4.0	0.16
4.5	0.18
5.0	0.20
5.5	0.22
6.0	0.24
6.5	0.26
7.0	0.28
7.5	0.30
8.0	0.32
8.5	0.34
9.0	0.36
9.5	0.38
10.0	0.40
12.5	0.50
15.0	0.60
20.0	0.80
25.0	1.00
45.0	1.80
50.0	2.00
75.0	3.00
100.0	4.00

APPLICATION GUIDE

Primary Turn Ratio Modification

The nameplate of the current transformer is based on the condition that the primary conductor will be passed once through the transformer opening. The rating can be reduced in even multiples by looping this conductor two or more times through the opening. A transformer having a rating of 200 to 5 amperes will be changed to 50 to 5 amperes if four loops or turns are made with the primary cable as illustrated.

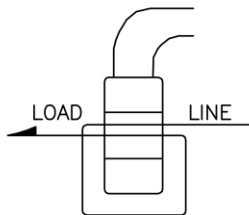


1 Primary Turn

NAMEPLATE RATIO	ACTUAL RATIO
100:5	100:5
150:5	150:5
200:5	200:5
300:5	300:5
400:5	400:5
500:5	500:5
600:5	600:5
800:5	800:5

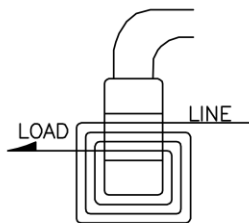
2 Primary Turns

NAMEPLATE RATIO	ACTUAL RATIO
100:5	50:5
150:5	75:5
200:5	100:5
300:5	150:5
400:5	200:5
500:5	250:5
600:5	300:5
800:5	400:5



4 Primary Turns

NAMEPLATE RATIO	ACTUAL RATIO
100:5	25:5
150:5	37.5:5
200:5	50:5
300:5	75:5
400:5	100:5
500:5	125:5
600:5	150:5
800:5	200:5



Secondary Turn Ratio Modification

$$\text{Formula: } \frac{I_p}{I_s} = \frac{N_s}{N_p}$$

Where: I_p – Primary Amperage
 I_s – Secondary Amperage
 N_p – Number of Primary Turns
 N_s – Number of Secondary Turns

Example: A 300:5 Current Transformer –

$$\frac{300 p}{5 s} = \frac{60 s}{1 p}$$

(In practicality one turn is dropped from the secondary as a ratio correction factor).

The ratio of the current transformer can be modified by altering the number of secondary turns by forward or backwinding the secondary lead through the window of the current transformer.

By adding secondary turns the same primary amperage will result in a decrease in secondary output. By subtracting secondary turns the same primary amperage will result in greater secondary output.

Again, using the 300:5 example adding five secondary turns will require 325 amps on the primary to maintain the 5 amp secondary output or:

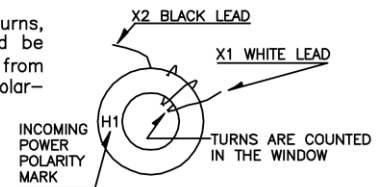
$$\frac{325 p}{5 s} = \frac{65 s}{1 p}$$

Deducting 5 secondary turns will only require 275 amps on the primary to maintain the 5 amp secondary output or:

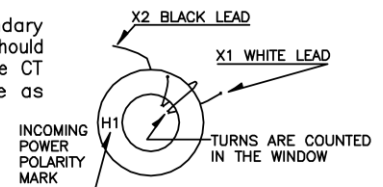
$$\frac{275 p}{5 s} = \frac{55 s}{1 p}$$

The above ratio modifications are achieved in the following manner:

To add secondary turns, the white lead should be wound through the CT from the side opposite the polarity mark.



To subtract secondary turns the white lead should be wound through the CT from the same side as the polarity mark.



Medium Voltage PT Part Number

PT G 3 - 1 - 60 - 42 2 F

Potential Transformer

Style (Base Plate)
G - GE Style
W - Westinghouse Style

Voltage Level
3 = 5.6kV
4 = 9.52 kV
5 = 15.5 kV

Poles (Outputs)
1 or 2

BIL (Basic Impulse Lvl)
60, 75 or 110

First two digits of primary voltage.

Number of zeros following first two numbers.

Number of fuses (F), switchgear style (S) or clips (C).

Control Power Transformer Part Number

CPT 3 - 60 - 0.5 - 24 2 FF

Control Power Transformer

Voltage Level
3 = 5kV

BIL (Basic Impulse Lvl)
60

Thermal Rating (VA)
0.5, 1, 1.5, 2, 3

First two digits of primary voltage.

Number of zeros following first two numbers.

Number of fuses (F), switchgear style (S) or clips (C).

Current Transformer Part Number

2 RL - 10 2 - 1 - LL 48

Model

Frame Type

RL = Round with Leads
 SHT = Square with Holes and Terminals
 SFT = Square with Feet and Terminals
 DRL = Double Core Round with Leads
 RT = Round with Terminals

First two digits of primary current.

Number of zeros following first two numbers.

Secondary if other than 5A

Lead length if longer than 24". Also for twisted leads (TL).

Customized lead length.

Low Voltage VT Part Number

450 I - 480 FF

Model

Use 'I' if IEC class (50 Hz, 110V Secondary)

Primary Voltage Rating

Number of fuses (if appropriate)