TECHNICAL DATA

STANDARDS

I. Current Transformers
   a. I.E.E.E./ A.N.S.I. Publication C57.13–1993
   b. I.E.C. Publication No. 185
   c. British Standard Publication BS 3938

II. Voltage Transformers
   a. I.E.E.E./ A.N.S.I. Publication C57.13–1993
   b. I.E.C. Publication No. 186
   c. British Standard Publication BS 3941

There are too many standards to list them all. Those listed are the ones we most commonly seen. It should be understood that standards are not laws but, are suggested guidelines for users and manufactures alike. The standards usually suggest test and testing procedures, as well.

The following is based on U.S.A. standards (C57.13–1993) which is the standard of choice in the U.S.A.

I.E.C. (International Electrotechnical 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.

TABLE 1
STANDARD ACCURACY CLASSES – The limits of transformer correction factor in standard shall be as shown in table.

METERING ACCURACY CLASS	VOLTAGE TRANSFORMERS (at 100% rated voltage)		CURRENT TRANSFORMERS			
	RATIO CORRECTION FACTORS					
			At 100% rated current*		At 10% 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	0.988	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. The following table defines the standard burdens for metering and relaying as well.

TECHNICAL DATA

TABLE 2

STANDARD BURDENS FOR CURRENT TRANSFORMERS WITH 5 A SECONDARY WINDINGS*

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-0.5	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. The following table 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 MINUTES	30 MINUTES
0.6	30 MINUTES	60 MINUTES
1.2	60 MINUTES	120 MINUTES

In summary, if you have a metering accuracy statement of "0.3 B0.5" it means the following:

(0.3) maximum ratio error of 0.3% at 100% of rated primary current or ±0.6% ratio error at 10% of rated primary current. With a maximum phase error of ±15 minutes at 100% rated primary current or ±30 minutes maximum phase error at 10% of rated primary current. All of the above is based on a burden of (B0.5) 0.5 OHMS at power factor of 0.9.

TECHNICAL DATA

CURRENT TRANSFORMERS RELAYING ACCURACY

All relaying accuracies are ±10% maximum ratio error when there is 20 times current flowing in the CT secondary (20 x 5A=100A). There are two designations, which are "C" and "T". Designations "C" stands for "Calculate" this type of CT's performanced can be very accurately calculated. The "T" designation stands for "Test". This type of CT's performance must be verified by testing. The following table 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 (ie 0.3, 0.6 & 1.2). These accuracy classes must be given at a stated burden in order to be meaningful. The following table gives the standard burden data:

TABLE 5

VOLTAGE TRANSFORMER BURDEN DATA

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°

In summary if you have a "0.6Y" accuracy and burden statement this means: (0.6) maximum ratio error of + 0.6% at a burden of 75VA with a power factor of 0.85.

TECHNICAL DATA

CURRENT TRANSFORMERS RATIO MODIFICATION

Relatively large changes in ratio may be acheived 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 you maintain the accuracy and burden capabilities of the higher ratio. The higher the primary rating the better the accuracy and burden rating.

You can make smaller ratio modification adjustments by using additive or subtractive secondary turns. For example if you have 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 acheived by placing the "X1" lead through the window from the H1 side and out the H2 side. Additive secondary turns are acheieved by placing the "X1" lead through the window from the H2 and out 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 changed (i.e. 5A divided by 2 primary turns = 2.5A). The following table illustrates the effects of different combinations of primary and secondary turns:

TABLE 7

CT RATIO 100:5A

PRIMARY TURNS	SECONDARY TURNS	RATIO ADJUSTMENT
1	-0-	100:5A
1	1+	105:5A
1	1-	95:5A
2	-0-	50:5A
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

TECHNICAL DATA

In summary, with the use of primary/secondary turns it is possible to modify any CT ratio. Since low ratio CT's generally have poorer performance characteristics and high ratio CT's have 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.

TABLE 8

USE THIS TABLE TO DETERMINE SIZE WINDOW NEEDED FOR NUMBER AND PRIMARY CONDUCTOR(S)

WINDOW DIAMETER		1/2"	3/4"	1"	1 1/2"	2"	2 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	37
	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	3	3	5	8

BURDEN

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

TECHNICAL DATA

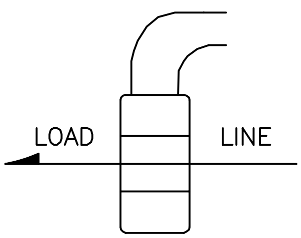
TABLE 9

VOLTAMPERE (VA)	RESISTANCE (Ω OHMS)
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

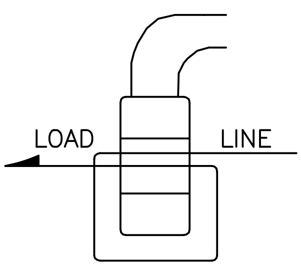
Primary Turn Ratio Modification

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.



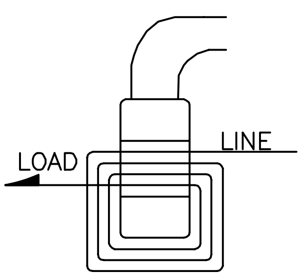
1 Primary Turn

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

Formula: $$\frac{Ip}{Is} = \frac{Ns}{Np}$$

Where:
Ip – Primary Amperage
Is – Secondary Amperage
Np – Number of Primary Turns
Ns – 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 amp–erage will result in greater secondary output.

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

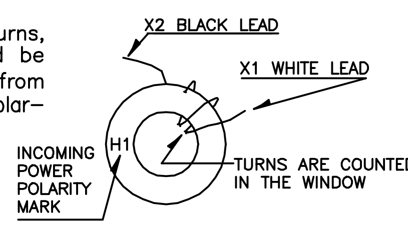
$$\frac{325\ p}{5\ s} = \frac{65\ s}{1\ p}$$

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 polar–ity mark.



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