Section 5

Applications Information

USING WINDOW-TYPE, 600 VOLT, CURRENT TRANSFORMERS AT HIGHER VOLTAGES

Models: JAB-0, JAF-0, JAK-0, JAS-0, JCB-0, JCD-0, JCP-0, JCS-0 (Table 1)

Window-type 600-volt, current transformers may be used on higher voltage circuits, up to 15 kV, with an insulated conductor as follows:

Maximum Line-To-Line System Voltage	
Type of Primary Conductor	Maximum Nominal System Voltage
Bar or cable, no insulation	600
Bar or cable, insulated for system voltage	2,500
Cable, insulated and shielded, the shield being grounded on one side of transformer only	Above 2,500
Bar, insulated for system voltage and centered in transformer window opening, and when impulse, applied voltage, and partial discharge tests prove the arrangment satisfactory	Above 2,500

Table 1.

MAXIMUM SECONDARY LEAD LENGTH

Models: JCM-0, JCT-0 600:5 and 800:5, JKW-7 (Table 2)

Maximum distance in feet between CT and meter to meet 0.3 ANSI accuracy classification, for the more common metering applications using one or two General Electric meters, and where the line power factor is 0.8 or higher.

Maximum Secondary Lead Length	
0.3 ANSI Accuracy Classification; ≥0.8 PF	
AWG Copper Wire Size	Maximum Distance (Feet)
14	75
12	120
10	190
8	305
6	485

Table 2. Corresponds to All CTs rated 0.3 B-0.5.

Models: JCR-0, JCT-0 200 & 400:5 (Table 3)

Maximum distance in feet between CT and meter to meet 0.3 ANSI accuracy classification, for the more common metering applications using one or two General Electric meters, and where the line power factor is 0.8 or higher.

Maximum Secondary Lead Length	
AWG Copper Wire Size	Maximum Distance (Feet)
14	19
12	31
10	49
8	79
6	126

Table 3. Corresponds to All CTs rated 0.3 B-0.2.

Models: JCK-3, JCK-4, JCK-5, JKW-6, JKW-6A (Table 4)

Maximum distance in feet between CT and meter to meet 0.3 ANSI accuracy classification, for the more common metering applications using one or two General Electric meters, and where the line power factor is 0.8 or higher.

Maximum Secondary Lead Length	
0.3 ANSI Accuracy Classification; ≥0.8 PF	
AWG Copper Wire Size	Maximum Distance (Feet)
14	330
12	500
10	800
8	1,200
6	1,900

Table 4. Corresponds to All CTs rated 0.3 B-2.0.

TRANSFORMER MOUNTING METHODS

Model: JAB-0 (Table 5)

The JAB-0 is available in two different outside configurations. One has the shape of a “Grecian Urn”, with rounded corners on the bottom, and with the two lower mounting holes eliminated. Three units with this configuration can be mounted in a triangular pattern, with one unit upside down, so that they will fit on many pad-transformer bushing spacings. The other model has a rectangular outside shape for installation around the secondary bushings of larger pad transformers having wide bushing spacings. This model can also be mounted horizontally below the secondary bushing, with the cables coming up through the window, for installation where the phase-to-phase spacing will not permit vertical over-the-blade mounting without interference.

The Type JAB-0 can be mounted on, or secured to, the pad transformer in several different ways. Mounting holes in the corners, together with special brackets, can be used to support the current transformer, centering it around the porcelain bushing. Or, with the JAB-0’s exclusive locking device feature called “The Grabber”,

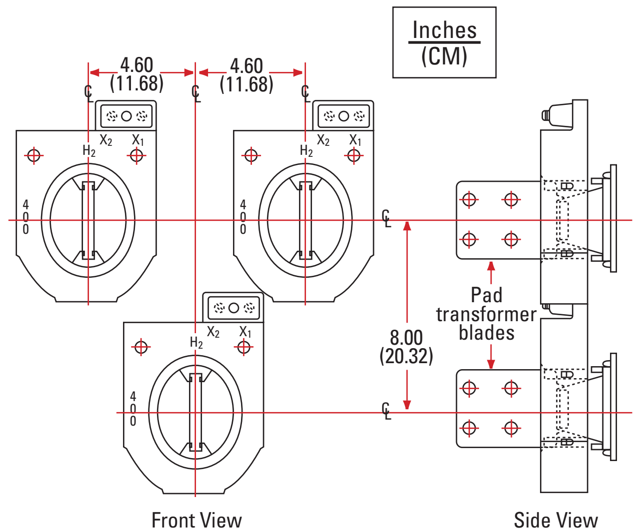

Figure 1. Three Grecian Urn Models Mounted Upright on Pad Transformers Having Adequate Spacing

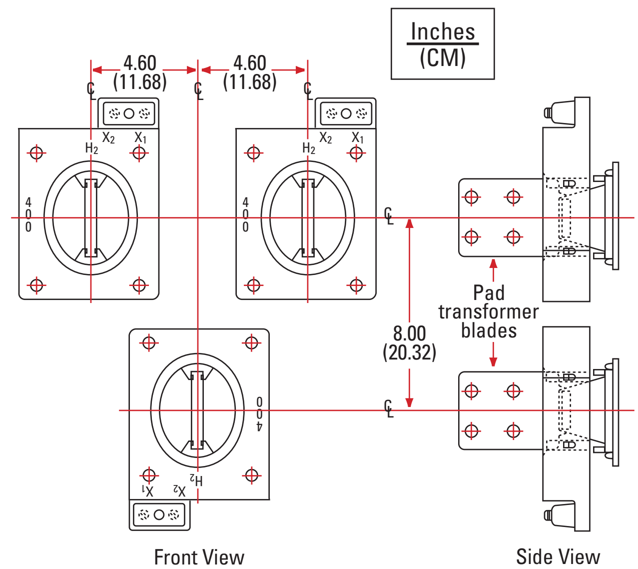

Figure 2. Three Rectangular models (One Inverted) Mounted on Pad Transformers Having Adequate Spacing.

the CT can be supported and securely held in place on the pad transformer's bushing blade. "The Grabber" consists of two butyl sections molded and bonded to the inside of the primary tube, but not connected to the remainder of the butyl insulation. These sections contain a slot, allowing the transformer to be mounted over the edges of the bushing blade. The butyl slots are carefully dimensioned to fit the width of the secondary blade of the distribution transformer with which it will be used. On transformers rated 800 Amperes and below, butyl fingers within the slots help to hold the JAB-0 CT securely in position.

The butyl slotted sections center the blade in the CT window, and maintain adequate clearance distances between the blade and the nearest grounded surface on the CT.

JAB-0 CTs of the "Grecian Urn" style mounted on pad transformers which have adequate bushing spacing to allow the use of this design in an upright mounting position. The three CTs are mounted on the secondary blades using the "Grabber" feature. The rectangular model can also be used in this configuration, but requires that the lower unit be inverted, as shown in Figure 2.

Figure 3 shows three of the "Grecian Urn" models flush-mounted on pad transformers with less bushing spacing. The closer bushing spacing requires the use of the "Grecian Urn" Type JAB-0. The JAB-0 CTs are mounted on the blades using the slotted butyl sections on the inside of the window to secure it into position and to provide adequate clearances from the blade.

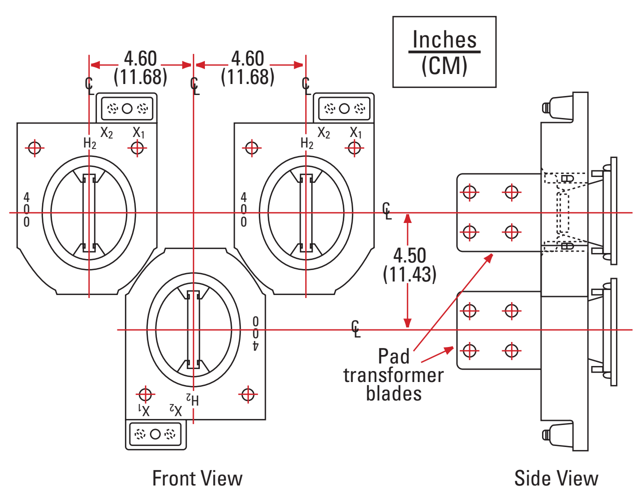

Figure 3. Three Grecian Urn Models (One Inverted) Mounted on Pad Transformers Having Confined Spacing

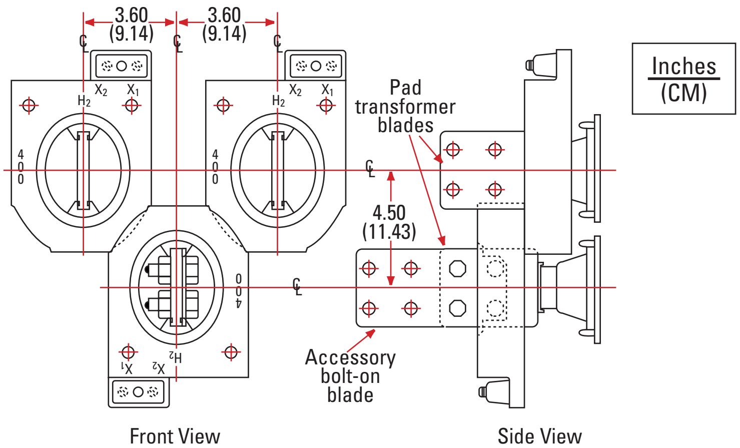

Figure 4. Three Grecian Urn Models (One Inverted) Mounted in "Stacked" Arrangement on Pad Transformers Having Very Restricted Spacing.

On very small pad transformers where spacing is even more restricted, the "Grecian Urn" style can still be used. One such mounting is the so-called "stacked" arrangement as shown in Figure 4.

Here, the JAB-0 transformers are placed over the two outside bushings (X_1 and X_3) of the pad transformer by use of the butyl slotted sections. The third JAB-0 CT for the X_2 bushing is then "stacked" in front of the other two current transformers. The "stacked" CT will then block off two holes of the four-hole nest on the secondary blade. When this is objectionable, an accessory bolt-on blade can be provided to allow access to a four-hole NEMA pad. Many distribution transformer manufacturers will also provide an extended third blade if the need is recognized at the time the order is placed. If the extended blade is part of the distribution transformer, the accessory blade extension is not required.

For large bushing spacings, the JAB-0 CT can either be placed 1) directly on the blade by use of the grabber slots, 2) directly on the porcelain bushing between the blade and the tank wall, or 3) centered on the bushing by use of the special "U" brackets bolted to the CT mounting holes and secured to the bushing flange bolts on the distribution transformer, as shown in Figure 5.

Due to the variety and arrangement of the bolted bushing flange construction available, it will be necessary to provide detailed dimensional information when placing orders for special "U" brackets.

For diagonal or other types of secondary terminal arrangements where there are a wide variety of horizontal and vertical terminal spacings used, refer to Figures 6 through 9. These figures show mounting limitations dependent on horizontal and vertical center-line to center-line blade spacings.

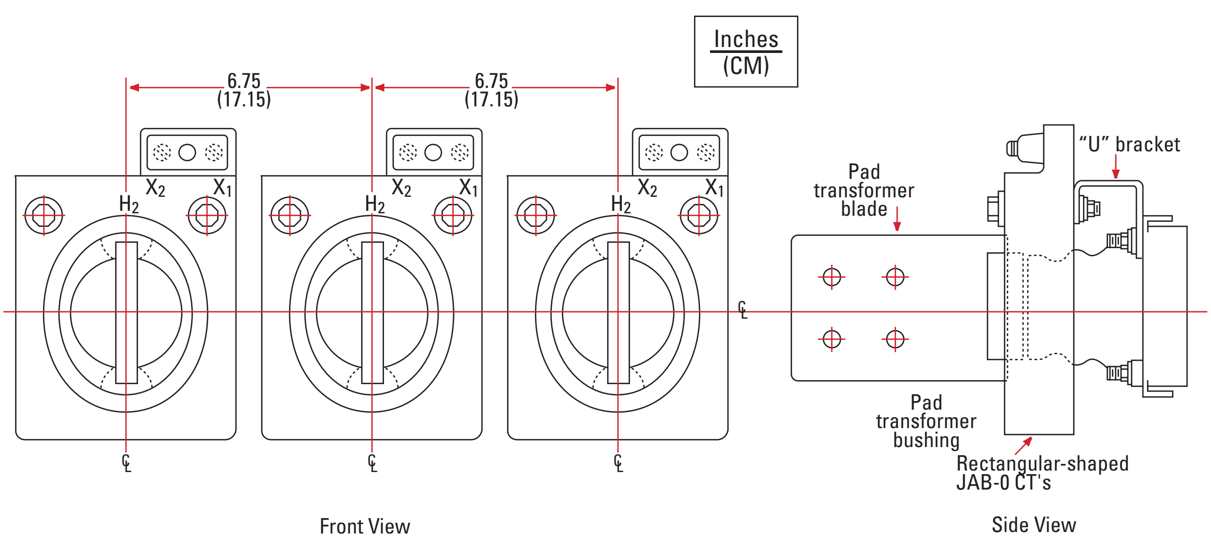

Figure 5. Three Rectangular Models Mounted to the Distribution Transformer with Special "U" Brackets.

SUGGESTED CURRENT RATING SELECTION GUIDE TO MATCH PAD-TRANSFORMER THERMAL CAPACITY						
Rating of Pad kVA	Distribution-Transformer Low Voltage Ratings					
	240 Volts	240 Volts with 120-Volt Mid-Tap	208Y/120 And 216Y/125 Volts	480 Volts	480Y/277 And 460Y/265 Volts	600 Volts
75	300:5	300:5	300:5	200:5	200:5	---
112.5	300 to 400:5	300 to 400:5	300 to 400:5	200:5	200:5	200:5
150	300 to 500:5	300 to 500:5	300 to 500:5	300:5	300:5	200:5
225	300 to 600:5	300 to 600:5	300 to 600:5	300 to 400:5	300 to 400:5	300:5
300	400 to 800:5	400 to 800:5	400 to 800:5	300 to 500:5	300 to 500:5	300 to 400:5
500	1000 to 2000:5	1200 to 2000:5	1200 to 2000:5	400 to 800:5	400 to 800:5	300 to 600:5
750	2000 to 3000:5	2000 to 3000:5	2000 to 3000:5	1000 to 1200:5	1000 to 1200:5	1000:5
1000	3000:5	3000:5	4000:5 (JAD-0) ①	1200 to 1500:5	1200 to 1500:5	1000 to 1200:5
1500	4000:5 (JCD-0) ①	4000:5 (JCD-0) ①	4000:5 (JCD-0) ①	2000:5	2000:5	1200 to 1500:5
2000	---	---	---	3000:5	3000:5	2000 to 3000:5
2500	---	---	---	4000:5 (JAD-0) ①	4000:5 (JAD-0) ①	---
Number of Current Transformers and Voltage Transformers Required						
CT	2	3	3	2	3	2
VT	0	0	0	2	2 or 3	2

① Not available in Type JAB-0 current transformers

Table 5. Current Rating to Pad-Transformer Thermal Capacity Matching

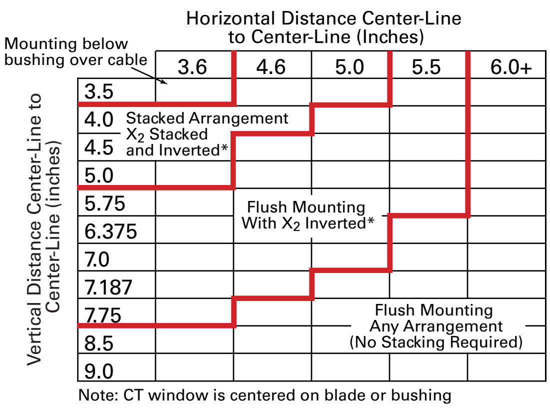

Figure 6. Pad-Mounted JAB-0 CT, Grecian Urn Model, Staggered Bushing Pattern.

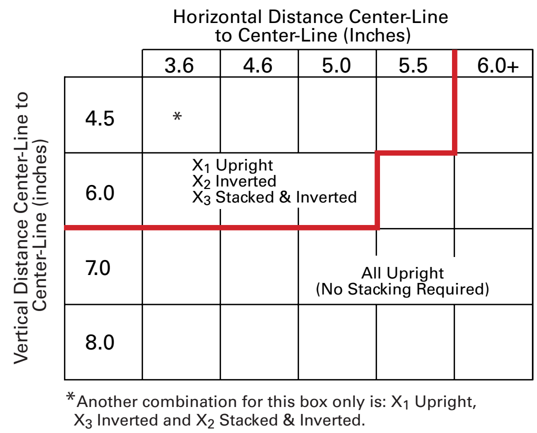

Figure 8. Pad-Mounted JAB-0 CT, Grecian Urn Model, Diagonal Secondary Bushing Pattern.

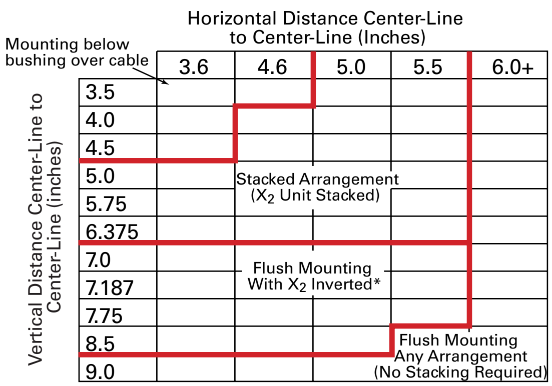

Figure 7. Pad-Mounted JAB-0 CT, Rectangular Model, Staggered Bushing Pattern.

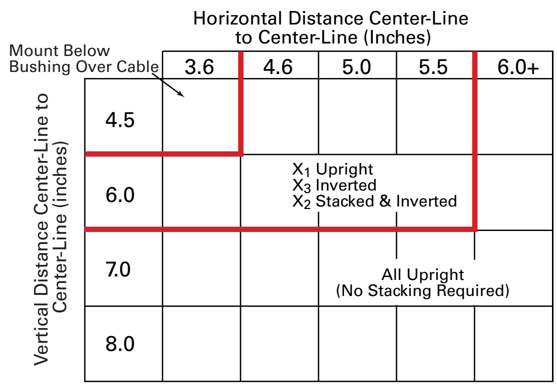

Figure 9. Pad-Mounted JAB-0 CT, Rectangular Model, Diagonal Secondary Bushing Pattern.

Customers who either do not want to mount the JAB-0 CT directly onto the distribution transformer bushings or blade, and require the use of the full window area, can remove the butyl grabber sections by peeling them away from the nylon tube with a pair of pliers. For these installations, the customer will either have to fabricate brackets or shelves to hold the CTs on a horizontal plane below the secondary bushings, or else allow them to slide down the cables until they are supported by them. The rectangular JAB-0 design must be used for any cantilever mounting. “U”-shaped mounting brackets (Figure 5) for the rectangular design can also be furnished.

For REA and REC applications requiring an insulated secondary compartment, use clamp-type brackets as shown in Figure 10.

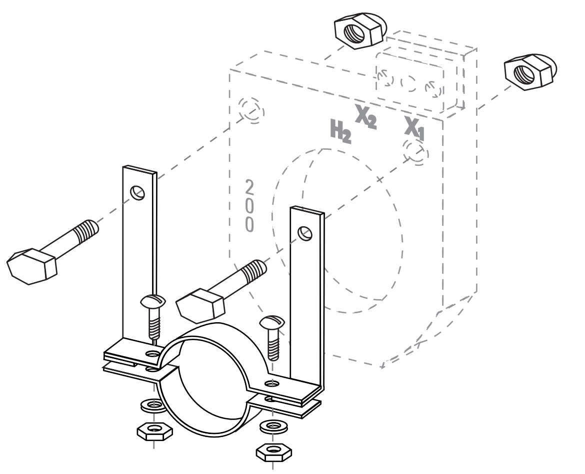

Figure 10. Clamp-Type Bracket, Catalog Number 9930972001.

A clamp-type bracket, as shown in Figure 10, is available that permits the Type JAB-0 CT to be mounted on the insulated bushing of a stud-type secondary terminal of a pad-mounted distribution transformer. This bracket is made from epoxy-coated mild steel and is attached to the JAB-0 CT using bolts and nuts in the two top mounting holes. The bracket clamps over the insulating boot and secondary bushing of the distribution transformer. Because the clamp is insulated with an epoxy coating, it provides a totally insulated secondary compartment for sales purposes.

Models: JCK-3, JCK-4, JCK-5, JKW-3, JKW-4, JKW-5, JKW-5A, JKW-6, JKW-6A

For bolting the transformer to a crossarm, a pair of “L”-shaped brackets is used. The horizontal arm of these brackets has holes for bolting to the transformer baseplate. The vertical arm has a double keyhole to take a mounting bolt.

When the transformer is to be attached to a crossarm by a “U” bolt, both a pair of “L” brackets and a pair of auxiliary “L” brackets are used.

Channel brackets are used when the transformer is to be mounted on double crossarms. Two brackets are used to mount each voltage and current transformer combination.

The “L” brackets, channel brackets, and suspension hooks are all made of steel, heavily protected by two coats of baked-paint finish.

Models: JKW-7, JVW-4, JVW-5, JVW-6, JVW-7, JVW-110

For bolting the transformer to a crossarm, a pair of “L”-shaped brackets is used. The horizontal arm of these brackets has holes for bolting to the transformer baseplate. The vertical arm has a double keyhole and a slot to take mounting bolts.

Channel brackets are used when the transformer is to be mounted on double crossarms. Two brackets are used to mount each voltage and current transformer combination.

The “L” brackets, channel brackets, and suspension hooks are all made of steel, heavily protected by two coats of baked-paint finish.

MOUNTING BRACKET ASSEMBLY

Models: JCH-0, JCH-0C

Separate mounting supports are available for the JCH-0 and JCH-0C transformers. The supports consist of four $\frac{3}{32}$ inch steel angle brackets, two $2\frac{5}{8}$ inch $\frac{3}{8}$-16 bolts, two $\frac{3}{8}$-16 thin hex nuts, and two No. 1220 Shakeproof internal washers. These parts can be assembled easily to the transformer as shown in Figure 11.

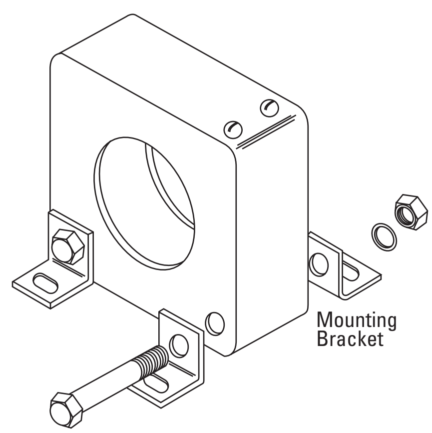

Figure 11. Method of Assembling Catalog Number 8944561001 Mounting Brackets.

Catalog Number 8944561001 covers a set of brackets for one transformer. The brackets are not supplied assembled to the transformer.

USING THE CURRENT TRANSFORMER AS A VARIABLE-RATIO CURRENT TRANSFORMER

Model: JCH-0

In a current transformer, the ratio of primary to secondary current is inversely proportional to the ratio of the number of turns in the primary winding to the those in the secondary winding.

Current ratios in window-type current transformers different from the nameplate ratio can be obtained by altering externally the effective number of primary and/or secondary turns. This can be accomplished in practice as follows:

Primary turns can be increased by looping the primary cable two or more times through the transformer window. To calculate the exact number of turns, count the number of times the primary cable actually passes through the window.

Secondary turns can be added to, or subtracted from, the number of turns in the secondary winding by looping through the window one of the conductors used to connect the secondary winding, to the indicating instrument.

To subtract secondary turns - connect a conductor to the secondary terminal with the X_1 polarity mark and pass it through the transformer window from the side with the H_1 polarity mark. Refer to Figure 12.

To add secondary turns - connect a conductor to the secondary terminal with the X_1 polarity mark and pass it through the transformer window from the side with the H_2 polarity mark. Refer to Figure 13.

NOTE: The primary and secondary conductors should not come into contact unless they are fully insulated for the circuit voltage.

In either case, the conductor connected to the other secondary terminal should be connected directly to the ammeter without going through the transformer window.

Motor-Load Indication Electric instruments are used on machine tools to indicate the motor load. However, since the magnitude of the motor-load current varies with the machine and motor size, it is customary to use an indication of "Percent of Full-Load Current".

When measuring the percent of full-load current of a motor, a standard ratio JCH-0 current transformer can be used with a transformer-rated ammeter which has scale marked 0-100 percent or 0-150 percent.

The same transformer and instruments can be used with different size motors by changing externally the effective current ratio of the transformer as described above.

To calculate the required current ratio of the transformer, proceed as follows:

1. From the motor nameplate or from motor load curves supplied by the manufacturer, determine the full-load current of the motor.

2. Multiply the full-load by the desired full-scale value of the instrument, either 100 or 150 percent. Divide this product by 100, and the result will be the primary current for a secondary current of 5 Amperes.

3. From the ratio tables, select a transformer that will give a ratio nearest to the desired ratio and determine the number of primary and secondary turns to use. If the desired ratio appears at several places in the table, select the transformer that will require the fewest number of turns, or consider the use of a different motor.

Example Full-load motor current = 103.5 Amperes

Desired scale range = 0 to 150 percent

$$\frac{103.5 \times 150}{100} = 155.25 \text{ Amperes}$$

From the ratio tables, a transformer ratio of 155:5 Amperes, which the nearest to 155.25:5 Amperes, can be obtained with a transformer with a 300:5 ratio by looping two (2) turns of the primary cable through the window, and by adding two (2) secondary turns.

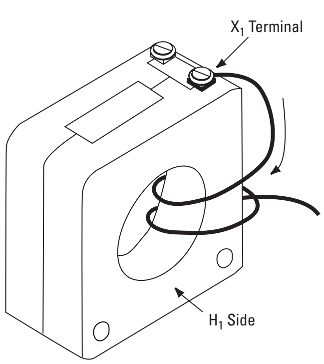

Figure 12. Subtracting secondary turns — View of variable-ratio current transformer showing how secondary turns are subtracted externally.

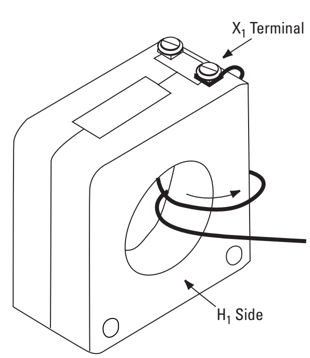

Figure 13. Adding secondary turns — View of variable-ratio current transformer showing how secondary turns are added externally.

For use with AMMETERS only.
Ratios obtainable with 100- to 250-Ampere transformers.
Maximum error of ±2.5% with burden of 5 Volt-Amperes at 60 Hz.

TRANSFORMER NAMEPLATE RATING					
100:5	150:5	200:5	250:5		
Actual Primary Current to Produce Secondary Current of 5 Amperes				Pri. Turns	Sec. Turns
145.0	195.0	245.0	295.0	1	+9
140.0	190.0	240.0	290.0	1	+8
135.0	185.0	235.0	285.0	1	+7
130.0	180.0	230.0	280.0	1	+6
125.0	175.0	225.0	275.0	1	+5
120.0	170.0	220.0	270.0	1	+4
115.0	165.0	215.0	365.0	1	+3
110.0	160.0	210.0	260.0	1	+2
105.0	155.0	205.0	255.0	1	+1
100.0	**150.0**	**200.0**	**250.0**	**1**	**0**
	145.0	195.0	245.0	1	-1
	140.0	190.0	240.0	1	-2
	135.0	185.0	235.0	1	-3
	130.0	180.0	230.0	1	-4
	125.0	175.0	225.0	1	-5
	120.0	170.0	220.0	1	-6
	115.0	165.0	215.0	1	-7
	110.0	160.0	210.0	1	-8
	105.0	155.0	205.0	1	-9
72.5	97.5	122.5	147.5	2	+9
70.0	95.0	120.0	145.0	2	+8
67.5	92.5	117.5	142.5	2	+7
65.0	90.0	115.0	140.0	2	+6
62.5	87.5	112.5	137.5	2	+5
60.0	85.0	110.0	135.0	2	+4
57.5	82.5	107.5	132.5	2	+3
55.0	80.0	105.0	130.0	2	+2
52.5	77.5	102.5	127.5	2	+1
50.0	**75.0**	**100.0**	**125.0**	**2**	**0**
	72.5	97.5	122.5	2	-1
	70.0	95.0	120.0	2	-2
	67.5	92.5	117.5	2	-3
	65.0	90.0	115.0	2	-4
	62.5	87.5	112.5	2	-5
	60.0	85.0	110.0	2	-6
	57.5	82.5	107.5	2	-7
	55.0	80.0	105.0	2	-8
	52.5	77.5	102.5	2	-9
48.3	65.0	81.7	98.3	3	+9
46.7	63.3	80.0	96.7	3	+8
45.0	61.7	78.3	95.0	3	+7
43.3	60.0	76.7	93.3	3	+6
41.7	58.3	75.0	91.7	3	+5
40.0	56.7	73.3	90.0	3	+4
38.3	55.0	71.7	88.3	3	+3
36.7	53.3	70.0	86.7	3	+2
35.0	51.7	68.3	85.0	3	+1
33.3	**50.0**	**66.7**	**83.3**	**3**	**0**
	48.3	65.0	81.7	3	-1
	46.7	63.3	80.0	3	-2
	45.0	61.7	78.3	3	-3
	43.3	60.0	76.7	3	-4
	41.7	58.3	75.0	3	-5
	40.0	56.7	73.3	3	-6
	38.3	55.0	71.7	3	-7
	36.7	53.3	70.0	3	-8
	35.0	51.7	68.3	3	-9
36.2	48.7	61.2	73.7	4	+9
35.0	47.5	60.0	72.5	4	+8
33.7	46.2	58.7	71.2	4	+7
32.5	45.0	57.5	70.0	4	+6
32.2	43.7	56.2	68.7	4	+5
30.0	42.5	55.0	67.5	4	+4
28.7	41.2	53.7	66.2	4	+3
27.5	40.0	52.5	65.0	4	+2
26.2	38.7	51.2	63.7	4	+1

TRANSFORMER NAMEPLATE RATING					
100:5	150:5	200:5	250:5		
Actual Primary Current to Produce Secondary Current of 5 Amperes				Pri. Turns	Sec. Turns
25.0	**37.5**	**50.0**	**62.5**	**4**	**0**
	36.2	48.7	61.2	4	-1
	35.0	47.5	60.0	4	-2
	33.7	46.2	58.7	4	-3
	32.5	45.0	57.5	4	-4
	32.2	43.7	56.2	4	-5
	30.0	42.5	55.0	4	-6
26.0	36.0	46.0	56.0	5	+6
25.0	35.0	45.0	55.0	5	+5
24.0	34.0	44.0	54.0	5	+4
23.0	33.0	43.0	53.0	5	+3
22.0	32.0	42.0	52.0	5	+2
21.0	31.0	41.0	51.0	5	+1
20.0	**30.0**	**40.0**	**50.0**	**5**	**0**
	29.0	39.0	49.0	5	-1
	28.0	38.0	48.0	5	-2
	27.0	37.0	47.0	5	-3
	26.0	36.0	46.0	5	-4
	25.0	35.0	45.0	5	-5
	24.0	34.0	44.0	5	-6
21.7	30.0	38.3	49.7	6	+6
20.8	29.2	37.5	45.8	6	+5
20.0	28.3	36.7	45.0	6	+4
19.2	27.5	35.8	44.2	6	+3
18.3	26.7	35.0	43.3	6	+2
17.5	25.8	34.2	42.5	6	+1
16.7	**25.0**	**33.3**	**41.7**	**6**	**0**
	24.2	32.5	40.8	6	-1
	23.3	31.7	40.0	6	-2
	22.5	30.8	39.2	6	-3
	21.7	30.0	38.3	6	-4
	20.8	29.2	37.5	6	-5
	20.0	28.3	36.7	6	-6
18.6	25.7	32.9	40.0	7	+6
17.9	25.0	32.2	39.3	7	+5
17.2	24.3	31.4	38.6	7	+4
16.4	23.6	30.7	37.9	7	+3
15.7	22.9	30.0	37.1	7	+2
15.0	22.2	29.3	36.4	7	+1
14.3	**21.4**	**28.6**	**35.7**	**7**	**0**
	20.7	27.9	35.0	7	-1
	20.0	27.2	34.3	7	-2
	19.3	26.4	33.6	7	-3
14.4	20.6	26.9	33.2	8	+3
13.8	20.0	26.3	32.6	8	+2
13.1	19.4	25.6	31.9	8	+1
12.5	**18.8**	**25.0**	**31.3**	**8**	**0**
	18.1	24.4	30.7	8	-1
	17.5	23.8	30.1	8	-2
	16.9	23.1	29.4	8	-3
12.8	18.3	23.9	29.4	9	+3
12.2	17.8	23.3	28.9	9	+2
11.7	17.2	22.8	28.3	9	+1
11.1	**16.7**	**22.2**	**27.8**	**9**	**0**
	16.1	21.7	27.2	9	-1
	15.6	21.1	26.7	9	-2
	15.0	20.6	26.1	9	-3
11.5	16.5	21.5	26.5	10	+3
11.0	16.0	21.0	26.0	10	+2
10.5	15.5	20.5	25.5	10	+1
10.0	**15.0**	**20.0**	**25.0**	**10**	**0**
	14.5	19.5	24.5	10	-1
	14.0	19.0	24.0	10	-2
	13.5	18.5	23.5	10	-3

Data subject to change without notice.

For use with AMMETERS or WATTMETERS.
Ratios obtainable with 300- to 800-Ampere transformers.
Maximum error of ±0.6% with burden of 5 Volt-Amperes at 60 Hz.

TRANSFORMER NAMEPLATE RATING						
300:5	400:5	500:5	600:5	800:5		
Actual Primary Current to Produce Secondary Current of 5 Amperes					Pri. Turns	Sec. Turns
345.0	445.0	545.0	645.0	845.0	1	+9
340.0	440.0	540.0	640.0	840.0	1	+8
335.0	435.0	535.0	635.0	835.0	1	+7
330.0	430.0	530.0	630.0	830.0	1	+6
325.0	425.0	525.0	625.0	825.0	1	+5
320.0	420.0	520.0	620.0	820.0	1	+4
315.0	415.0	515.0	615.0	815.0	1	+3
310.0	410.0	510.0	610.0	810.0	1	+2
305.0	405.0	505.0	605.0	805.0	1	+1
300.0	**400.0**	**500.0**	**600.0**	**800.0**	**1**	**0**
295.0	395.0	495.0	595.0	795.0	1	-1
290.0	390.0	490.0	590.0	790.0	1	-2
285.0	385.0	485.0	585.0	785.0	1	-3
280.0	380.0	480.0	580.0	780.0	1	-4
275.0	375.0	475.0	575.0	775.0	1	-5
270.0	370.0	470.0	570.0	770.0	1	-6
265.0	365.0	465.0	565.0	765.0	1	-7
260.0	360.0	460.0	560.0	760.0	1	-8
255.0	355.0	455.0	555.0	755.0	1	-9
172.5	222.5	272.5	322.5	422.5	2	+9
170.0	220.0	270.0	320.0	420.0	2	+8
167.5	217.5	267.5	317.5	417.5	2	+7
165.0	215.0	265.0	315.0	415.0	2	+6
162.5	212.5	262.5	312.5	412.5	2	+5
160.0	210.0	260.0	310.0	410.0	2	+4
157.5	207.5	257.5	307.5	407.5	2	+3
155.0	205.0	255.0	305.0	405.0	2	+2
152.5	202.5	252.5	302.5	402.5	2	+1
150.0	**200.0**	**250.0**	**300.0**	**400.0**	**2**	**0**
147.5	197.5	247.5	297.5	397.5	2	-1
145.0	195.0	245.0	295.0	395.0	2	-2
142.5	192.5	242.5	292.5	392.5	2	-3
140.0	190.0	240.0	290.0	390.0	2	-4
137.5	187.5	237.5	287.5	387.5	2	-5
135.0	185.0	235.0	285.0	385.0	2	-6
132.5	182.5	232.5	282.5	382.5	2	-7
130.0	180.0	230.0	280.0	380.0	2	-8
127.5	177.5	227.5	277.5	377.5	2	-9
115.0	148.3	181.7	215.0	281.7	3	+9
113.3	146.7	180.0	213.3	280.0	3	+8
111.7	145.0	178.3	211.7	278.3	3	+7
110.0	143.3	176.7	210.0	276.7	3	+6
108.3	141.7	175.0	208.3	275.0	3	+5
106.7	140.0	173.3	206.7	273.3	3	+4
105.0	138.3	171.7	205.0	271.7	3	+3
103.3	136.7	170.0	203.3	270.0	3	+2
101.7	135.0	168.3	201.7	268.3	3	+1
100.0	**133.3**	**166.7**	**200.0**	**266.7**	**3**	**0**
98.3	131.7	165.0	198.3	265.0	3	-1
96.7	130.0	163.3	196.7	263.3	3	-2
95.0	128.3	161.7	195.0	261.7	3	-3
93.3	126.7	160.0	193.3	260.0	3	-4
91.7	125.0	158.3	191.7	258.3	3	-5
90.0	123.3	156.7	190.0	256.7	3	-6
88.3	121.7	155.0	188.3	255.0	3	-7
86.7	120.0	153.3	186.7	253.3	3	-8
85.0	118.3	151.7	185.0	251.7	3	-9
86.2	111.2	136.2	161.2	211.2	4	+9
85.0	110.0	135.0	160.0	210.0	4	+8
83.7	108.7	133.7	158.7	208.7	4	+7
82.5	107.5	132.5	157.5	207.5	4	+6
81.2	106.2	131.2	156.2	206.2	4	+5
80.0	105.0	130.0	155.0	205.0	4	+4
78.7	103.7	128.7	153.7	203.7	4	+3
77.5	102.5	127.5	152.5	202.5	4	+2
76.2	101.2	126.2	151.2	201.2	4	+1

TRANSFORMER NAMEPLATE RATING						
300:5	400:5	500:5	600:5	800:5		
Actual Primary Current to Produce Secondary Current of 5 Amperes					Pri. Turns	Sec. Turns
75.0	**100.0**	**125.0**	**150.0**	**200.0**	**4**	**0**
73.7	98.7	123.7	148.7	198.7	4	-1
72.5	97.5	122.5	147.5	197.5	4	-2
71.2	96.2	121.2	146.2	196.2	4	-3
70.0	95.0	120.0	145.0	195.0	4	-4
68.7	93.7	118.7	143.7	193.7	4	-5
67.5	92.5	117.5	142.5	192.5	4	-6
66.0	86.0	106.0	126.0	166.0	5	+6
65.0	85.0	105.0	125.0	165.0	5	+5
64.0	84.0	104.0	124.0	164.0	5	+4
63.0	83.0	103.0	123.0	163.0	5	+3
62.0	82.0	102.0	122.0	162.0	5	+2
61.0	81.0	101.0	121.0	161.0	5	+1
60.0	**80.0**	**100.0**	**120.0**	**160.0**	**5**	**0**
59.0	79.0	99.0	119.0	159.0	5	-1
58.0	78.0	98.0	118.0	158.0	5	-2
57.0	77.0	97.0	117.0	157.0	5	-3
56.0	76.0	96.0	116.0	156.0	5	-4
55.0	75.0	95.0	115.0	155.0	5	-5
54.0	74.0	94.0	114.0	154.0	5	-6
55.0	71.7	88.3	105.0	138.3	6	+6
54.2	70.8	87.5	104.2	137.5	6	+5
53.3	70.0	86.7	103.3	136.7	6	+4
52.5	69.2	85.8	102.5	135.8	6	+3
51.7	68.3	85.0	101.7	135.0	6	+2
50.8	67.5	84.2	100.8	134.2	6	+1
50.0	**66.7**	**83.3**	**100.0**	**133.3**	**6**	**0**
49.2	65.8	82.5	99.1	132.5	6	-1
48.3	65.0	81.7	98.3	131.7	6	-2
47.5	64.2	80.8	97.5	130.8	6	-3
46.7	63.3	80.0	96.7	130.0	6	-4
45.8	62.5	79.2	95.8	129.2	6	-5
45.0	61.7	78.3	95.0	128.3	6	-6
47.7	61.4	75.7	90.0	118.6	7	+6
46.4	60.7	75.0	89.3	117.9	7	+5
45.7	60.0	74.3	88.6	117.1	7	+4
45.0	59.3	73.6	87.9	116.4	7	+3
44.3	58.6	72.9	87.1	115.7	7	+2
43.6	57.9	72.1	86.4	115.0	7	+1
42.9	**57.1**	**71.4**	**85.7**	**114.3**	**7**	**0**
42.1	56.4	70.7	85.0	113.6	7	-1
41.4	55.7	70.0	84.3	112.8	7	-2
40.7	55.0	69.3	83.6	112.1	7	-3
39.4	51.9	64.3	76.9	101.9	8	+3
38.8	51.3	63.7	76.3	101.3	8	+2
38.1	50.6	63.1	75.6	100.6	8	+1
37.5	**50.0**	**62.5**	**75.0**	**100.0**	**8**	**0**
36.9	49.4	61.9	74.4	99.4	8	-1
36.3	48.8	61.2	73.8	98.8	8	-2
35.6	48.1	60.6	73.1	98.1	8	-3
35.0	46.1	57.2	68.3	90.5	9	+3
34.4	45.5	56.7	67.8	90.0	9	+2
33.9	45.0	56.1	67.2	89.4	9	+1
33.3	**44.4**	**55.6**	**66.7**	**88.9**	**9**	**0**
32.8	43.9	55.0	66.1	88.3	9	-1
32.2	43.3	54.4	65.5	87.8	9	-2
31.7	42.8	53.9	65.0	87.2	9	-3
31.5	41.5	51.5	61.5	81.5	10	+3
31.0	41.0	51.0	61.0	81.0	10	+2
30.5	40.5	50.5	60.5	80.5	10	+1
30.0	**40.0**	**50.0**	**60.0**	**80.0**	**10**	**0**
29.5	39.5	49.5	59.5	79.5	10	-1
29.0	39.0	49.0	59.0	79.0	10	-2
28.5	38.5	48.5	58.5	78.5	10	-3

GENERAL

The application of power fuses in the primary circuits of voltage transformers is recognized and recommended operation practice of power systems. Their correct application is as important as the proper selection of power circuit breakers for such systems.

The function of voltage transformer primary fuses is to protect the power system by de-energizing failed voltage transformers. (Although the function of the fuses is not to protect the voltage transformer, the fuses selected will often protect the voltage transformer promptly in the event of a short in the external secondary circuit, if the short is electrically close to the secondary terminals.)

To provide the maximum protection practical against damage to other equipment or injury to personnel in the event of a voltage transformer failure, it is usually necessary to use the smallest fuse current rating which will not result in nuisance blowing. Fuses are rarely available which will fully protect the voltage transformer from overloads, or immediately clear the system of a failed voltage transformer. Increasing the fuse ampere rating to reduce nuisance blowing is usually accompanied by slower clearing and increased possibility of other damage.

Voltage transformers require fuses which combine low continuous current rating with high interrupting capacity. In this regard, it will be noted that available interrupting ratings of current limiting power fuses in each voltage class are typically comparable to the available ratings of the related power circuit breakers.

DESCRIPTION AND TYPES OF GENERAL ELECRICAL FUSES

For further information on fuses, see GET3039.

1. Type EJ current-limiting fuses afford the advantages of high interrupting capacity, high-speed interruption, silent operation and current-limiting characteristics. The EJ is a dry type of fuse, essentially consisting of a silver fusible element and granular quartz filler that is confined in a tube of high dielectric and mechanical strength.

(a) The Type EJ-1 fuse is for indoor service or can be used outdoors when mounted in suitable enclosures. The size A, having a ferrule diameter of $^{13}/_{16}$ inches, and size B, with a ferrule diameter of 1 $^{9}/_{16}$ inches, are used with indoor voltage transformers, mounted on those transformers listed "with fuses" or in available mountings when mounted separate from the voltage transformer.

(b) The Type EJO-1 fuse is designed for outdoor. The size C, having a ferrule diameter of two inches, 2,400 to 23,000 volts, and size D, with a ferrule diameter of three inches, 34,500 volts, are used with voltage transformers and can be mounted in conventional outdoor fuse supports or fuse disconnecting switches.

2. For outdoor applications, the Type EG-1 expulsion fuse is sometimes used with voltage transformers.

APPLICATION OF EJ FUSES

Special consideration may be necessary for applications involving capacitor switching, current surge, cable network, and VT saturation. Consult the fuse and/or transformer manufacturer.

In applying current-limiting fuses, it is necessary to adhere to certain established principles with respect to voltage, frequency, and interrupting ratings, as well as location and mounting.

The factors involved have been taken into consideration in listing the voltage transformers "with fuses" as listed in the Product Data Sheet section of this volume, as well as the recommendation of fused when separately mounted.

Figure 1 shows various methods of connecting voltage transformers and primary fused to a power system. The methods of connection fall into two classes, arbitrarily called Class I and Class II.

Class I includes those connections in which each fuse carries the exciting current of only one transformer. This is the case in single-phase connection, (Figure 1, a) delta connections in which the transformer primaries are each fused separately (Figure 1, b and c), and wye connections (Figure 1, d).

Class II included delta and open delta connections (Figure 1, e and f) in which a fuse must pass the exciting current of more than one transformer.

For indoor voltage transformers "with fuses", listed in the Product Data Sheet section of this volume, the connections are necessarily Class I, hence the fuses have been selected on the basis of Class I connections. On non-handbook items "with fuses", the fuses are provided on the basis of Class I connections.

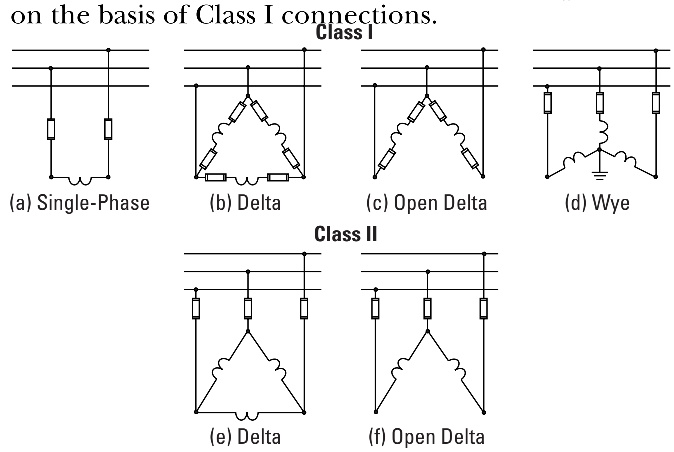

Figure 1. Primary Fuse and Voltage Transformer Connections

For indoor voltage transformers "without fuses", for which the fuses must be mounted separately, Table 1 recommends fuses for Class I connections and for Class II connections.

For outdoor voltage transformers where fuses are always mounted separately, Table 2 recommends fuse units for Class I connections and for Class II connections.

The use of a fuse in the connection of a voltage transformer terminal to ground is not recommended. For grounded wye connections, it is preferred practice to connect one primary lead from each voltage transformer directly to the grounded neutral, using a fuse only in the line side of the primary. With this connection, a transformer can never be "alive" from the line side with a blown fuse on the grounded side.

SELECTION OF EJ FUSES—VOLTAGE RATINGS

System maximum operating line-to-line voltage should be in the range of 70 to 100 percent of the fuse rated voltage. This range of application voltage is recommended because the current-limiting action of the fuse is characterized by the generation of transient recovery voltages above normal circuit voltage values. The magnitude of these over-voltages increases nonlinearly as available short-circuit current increases. The maximum voltage permitted at fuse-rated short-circuit current is specified in ANSI C37.46-1998.

Therefore, it is important that the voltage rating of high voltage fuses be coordinated with the voltage levels of the associated system equipment to avoid inducing destructive voltages during fuse operation.

One permissible exception to the general rules above is the use of the 2,400-volt, size A, Type EJ-1 fuse, on 24,00/4,160- volt solidly grounded wye systems.

For separately mounted fuses where over-insulation is required or specified, the fuse must be selected on the basis of actual service voltage. The mounting for the fuse can be provided with insulators of a higher voltage rating so as to provide additional insulation to ground.

SELECTION OF EJ FUSES—AMPERE RATINGS

In selecting primary fuses for voltage transformers the chief objectives are:

1. System short-circuit protection

2. Clearing the system of failed voltage transformers

3. Freedom from unnecessary fuse operation

Note: Fuse ratings apply to GE VT's only.

DATA TABLE

System Voltage Nominal Line-to-line	Transformer		Current Limiting Fuse Unit Type EJ-1 ① ②			
	Primary Voltage	Type	Fuse Voltage Rating	Fuse Size ③	Fuse Ampere Rating for Connection Class I	Fuse Ampere Rating for Connection Class II
240	240	JVP-1	600	A	5E	7E
416Y	240	JVP-1	600	A	5E	...
480Y	288	JVP-1	600	A	5E	...
480Y	300	JVP-1	600	A	5E	...
480	480	JVP-1	600	A	5E	5E
600	600	JVP-1	600	A	3E	5E
2,400	2,400	JVM-2	2,400	A, B or C	1E	2E
4,160Y	2,400	JVM-2	2,400	A, B or C	1E	...
2,400	2,400	JVM-3	2,400	B or C	1E	2E
4,160Y	2,400	JVM-3	4,800	B or C	1E	...
4,200	4,200	JVM-3	4,800	B or C	0.5E	1E
4,800	4,800	JVM-3	4,800	B or C	0.5E	1E
4,200	4,200	JVM-4	4,800	B or C	1E	2E
7,280Y	4,200	JVM-4	7,200	B or C	2E	...
4,800	4,800	JVM-4	4,800	B or C	1E	2E
7,200	7,200	JVM-4	7,200	B or C	1E	2E
7,200	7,200	JVM-5	7,200	B or C	1E	2E
12,470Y	7,200	JVM-5	14,400	B or C	1E	...
14,560Y	8,400	JVM-5	14,400	B or C	0.5E	...
12,000	12,000	JVM-5	14,400	B or C	0.5E	1E
14,400	14,400	JVM-5	14,400	B or C	0.5E	0.5E
24,000	24,000	JVM-6	23,000	C	0.5E	0.5E
20,780Y	12,000	JVM-6	23,000	C	0.5E	---
24,940Y	14,400	JVM-6	23,000	C	0.5E	---

① Fuses selected must always have voltage rating equal to or nearest rating above the line-to-line voltage of the system.

Exception: Fuse units rated 600 volts may be applied on circuits rated 220 to 600 volts.

② Size C fuse units, 7200 volts and 14,400 volts, are Type EJ0-1.

③ A- and B-size fuses can be mounted directly on the transformer. C-size fuses must be mounted separately.

Table 1. Recommended Fuses for Class I and II Indoor Connections

Primary Fuses For Voltage Transformers

Note: Fuse ratings apply to GE VT's only.

DATA TABLE						
	Transformer		Current Limiting Fuse Unit Type EJ-1 ①			
					Fuse Ampere Rating for Connection	
System Voltage Nominal Line-to-line	Primary Voltage	Type	Fuse Voltage Rating	Fuse Size	Class I	Class II
2,400	2,400	JVW-3	2,400	C	1E	2E
4160Y	2,400	JVW-3	4,800	C	1E	...
4,200	4,200	JVW-3	4,800	C	0.5E	1E
4,800	4,800	JVW-3	4,800	C	0.5E	1E
2,400	2,400	JVW-4	2,400	C	2E	3E
4160Y	2,400	JVW-4	4,800	C	2E	...
4,200	4,200	JVW-4	4,800	C	1E	2E
7,280Y	4,200	JVW-4	7,200	C	2E	...
4,800	4,800	JVW-4	4,800	C	1E	2E
7,200	7,200	JVW-4	7,200	C	1E	2E
7,200	7,200	JVW-5	7,200	C	1E	2E
12,470Y	7,200	JVW-5	14,400	C	1E	...
14,560Y	8,400	JVW-5	14,400	C	0.5E	...
12,000	12,000	JVW-5	14,400	C	0.5E	1E
14,400	14,400	JVW-5	14,400	C	0.5E	0.5E
12,470Y	7,200	JVW-110	14,400	C	1E	...
14,560Y	8,400	JVW-110	14,400	C	0.5E	...
12,000	12,000	JVW-110	14,400	C	0.5E	1E
14,400	14,400	JVW-110	14,400	C	0.5E	0.5E
24,000	24,000	JVW-6	23,000	C	0.5E	0.5E
20,780Y	12,000	JVW-6	23,000	C	0.5E	...
24,940Y	14,400	JVW-6	23,000	C	0.5E	...
34,500	34,500	JVW-7	34,500	D	1E	1E
34,500Y	20,125	JVW-7	34,500	D	1E	...
23,000	24,000	JVT-150	23,000	C	0.5E	0.5E
34,500	34,500	JVT-200	34,500	D	1E	1E
24,940Y	14,400	JVT-150	23,000	C	2E	...
34,500Y	20,125	JVT-200	34,500	D	1E	...

① Fuses selected must always have voltage rating equal to or nearest rating above the line-to-line voltage of the system.
Exception: Fuse units rated 600 volts may be applied on circuits rated 220 to 600 volts.

Table 2. Recommended Fuses for Class I and II Outdoor Connections

To attain the first objective, it is necessary to use a fuse with interrupting rating at least equal to the maximum current obtainable in the system at the point of fuse installation.

To attain the second objective with the maximum protection practical against damage to other equipment or injury to personnel, it is necessary to use the smallest fuse ampere rating which will not result in nuisance blowing. Fuses are rarely available which will fully protect the voltage transformer from overloads, or immediately clear the system of a failed voltage transformer. Increasing the EJ-1 fuse ampere rating to reduce nuisance blowing is always accompanied by slower clearing and the increased possibility of other damage.

To attain the third objective of freedom from unnecessary fuse blowing, it is necessary to choose fuses having sufficient inrush current capacity to safely pass the transformer magnetizing inrush.

The heat generated in the fuse line is proportional to the square of the current and the time during which it flows. It is logical, therefore, to evaluate the inrush capacity of the fuse in terms of the ampere-squared-seconds required to melt its current-responsive element. This may be written i^2t, where "i" is the current flowing for "t" seconds.

The i^2t inrush capacity of any fuse is readily obtained from the time-current curves of the fuses under consideration.

These curves are plotted on "log-log" paper, and it may be seen that, for fast melting at high currents, the melting-time-current curve becomes practically a straight line with a negative slope of 2 to 1 (-63.43°). It is necessary only to project the straight-line portion of the curve back to the one-second line and square this current. Of course, the current from the straight-line portion of the curve, at any time, squared and multiplied by time will give the same result.

The maximum inrush current to the transformer can be recorded with an oscillograph, but the most practical way to get it is from the transformer manufacturer, in amperes-square-seconds. This may be written I^2T, to distinguish it from the fuse i^2t.

For satisfactory fuse application, the fuse i^2t should exceed the transformer I^2T by a reasonable factor of safety. The recommended factor of safety is 1.5. Therefore, for Class I applications:

$$i^2t \geq 1.5\ I^2T$$

For Class II applications, the fuse must pass the magnetizing current of two transformers and the heating effect of inrush in one line could be approximately three times that occurring for one transformer. Therefore, for Class II applications:

$$i^2t \geq 4.5\ I^2T$$

The I^2T of the transformers is typically calculated at 110% of rated primary voltage.

When possible damage to other equipment or injury to personnel, due to delayed clearing of a failed voltage transformer, is an important consideration, Class II connection should be avoided if this connection requires a higher fuse ampere rating than the Class I connection.

It should be noted that in Class II (Figure 1, f), two of the fuses carry the excitation current of only one transformer. These two can be selected on the basis of Class I connections, provided approximately the same protection as provided in Class I (Figure 1, c).

The inrush I^2T increases very rapidly with increases in applied voltages, and, in requesting the I^2T value from the manufacturer, the voltage specified should be the maximum expected in service.

In some applications, particularly cable circuits, there is a possibility that the inherent capacitance of the circuit will give rise to a discharge current through the primaries of connected voltage transformers when the circuit is disconnected from the bus. The magnitude and duration of this discharge current may be calculated from the circuit constants, and in some instances may result in blowing of primary fuses. Such cases have been found to be rare, however, and for most installations, unnecessary operation of primary fuses can be prevented by selecting the fuse ampere rating on the basis of the magnetizing inrush current of the voltage transformers.

The following table shows Canadian Approval numbers for GE Voltage and Current Instrument Transformers. If there are questions, please contact GE Canada – Marketing Department 418-682-8504 or 418-682-8505.

CANADIAN APPROVALS	
Type	**Approval Number**
JAS-0	AE-0390
JVA-0	T-83
JAB-0	T-86; T-86-1
JAD-0	AE-0327; T-168; T-168-1; T-326; T-326-1
JAF-0	AE-0588
JAH-0	T-3
JAK-0	AE-0325; T-48
JCD-0	S-EA.505
JCP-0	SD-EA.225
JCS-0	AE-0391
JCW-0	S-EA.622
JVM-2	AE-0311
JVM-3	AE-0372
JVW-3	SD-EA.391
JKM-3	SD-EA.17; AE-0326; AE-0486
JCM-3	AE-0740
JKW-3	SD-EA.390
JCW-3	AE-0306; AE-0328
JKW-4	SD-EA.390
JVW-4	SD-EA.525
JKM-4	AE-0415
JKW-5	AE-0305; SD-EA.390; AE-0392
JVM-5	AE-0314; AE-0705
JVW-5	SD-EA.525
JKM-5	AE-0312; AE-0320; T-285
JCM-5	AE-0310; AE-0383
JCB-5	AE-0408; AE-0408-1; AE-0408-2
JVW-6	AE-0445; T-147; T-147-2
JVS-150	T-118
JVS-200	T-118
JVS-250	T-118
JVS-350	T-118
JVT-150	T-118
JVT-200	T-118
JVT-250	T-118
JVT-350	T-118
JKW-6	T-87; T-327
JKW-6A	AE-0817
JKW-7	AE-0540
JKW-150	T-117
JKW-150	T-117
JKW-200	T-117
JKW-250	T-117; T-242
JKW-350	T-117