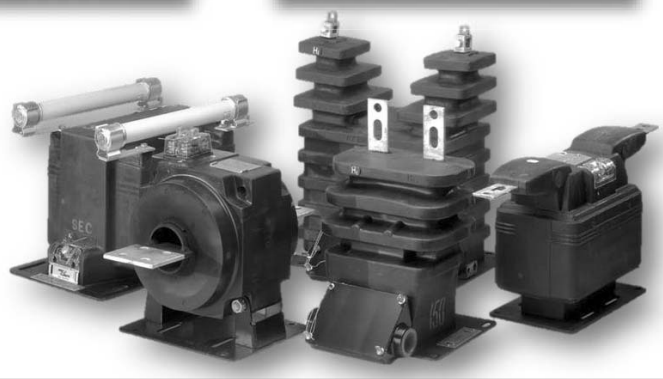
Instrument Transformer Basics
Application & Selection



Instrument Transformers

What Is An Instrument Transformer?

Instrument Transformers are used to scale down the voltage or current to a standardized value when voltage or current is too large to be conveniently used by a measurement, protection, or control instrument.

- **CT's:** Current Transformers
- **VT's:** Voltage transformers, also referred to as "potential transformers" (PT's)

Instrument Transformer Applications

Inside of…

Generator

Transformers

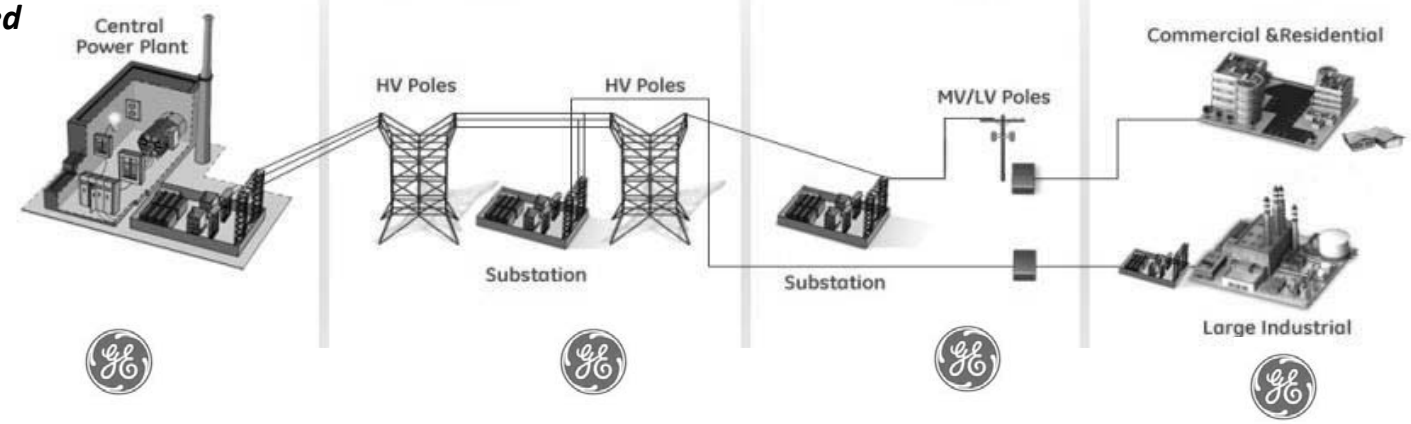
Transformers

Switchgear

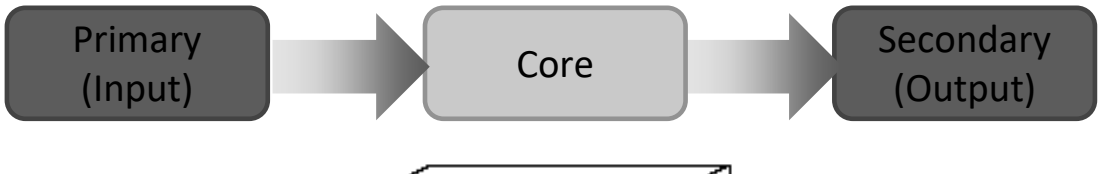
Metering Panels
LV Switchgear, MCC's

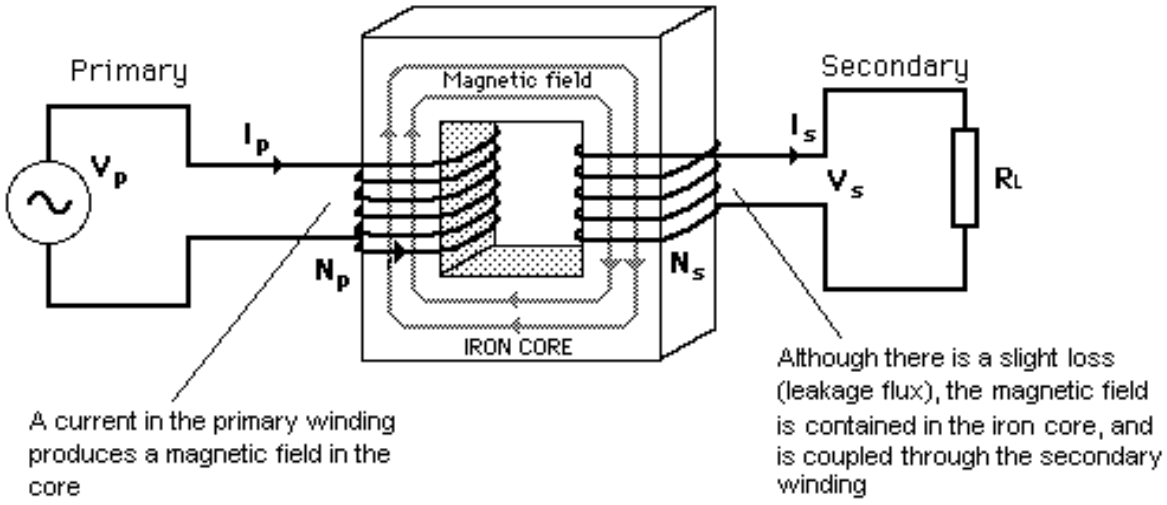
Generation | High Voltage Transmission | Medium Voltage | Low Voltage

Installed at…



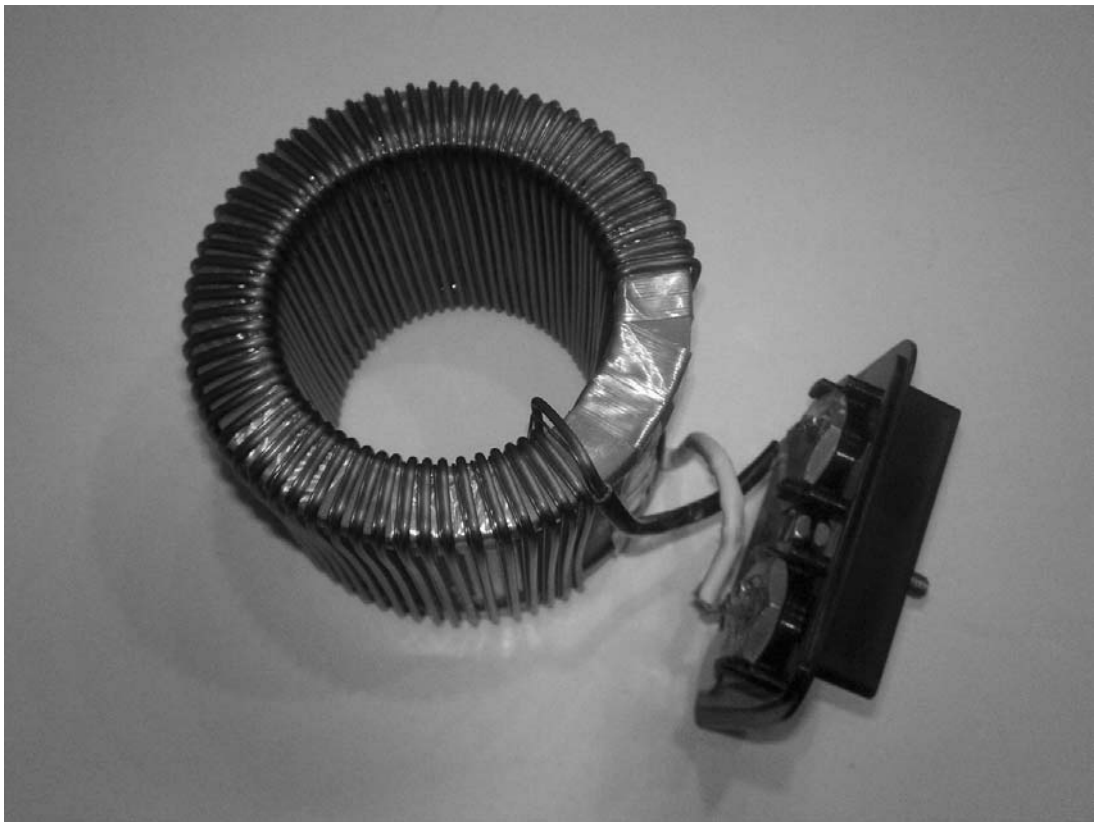
Current Transformers





Transform the voltage or current input into a standard 5 or 1 amp output

What Makes A CT Accurate?



- **Core**
- **Secondary Winding**
- **Burden**

Utility Metering CTs

What do I need to know?

B - Burden

R - Ratio

A - Accuracy

V – voltage class

E – Etc (window size, special requirements)

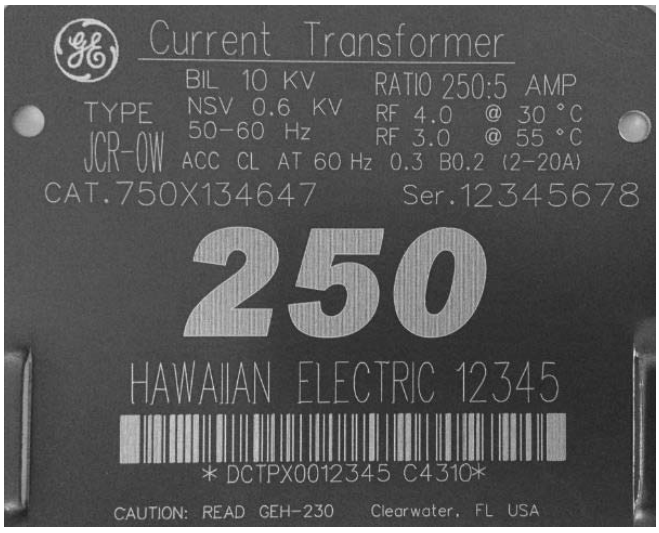
R – Rating Factor

Revenue metering application

Name Plate Information: Burden

Definition: Load connected to CT secondary

- Includes devices & connecting leads
- Expressed in ohms
- Standard values = B0.1, B0.2, B0.5, B0.9, B1.8
  E0.04, E0.2



Standard Burdens

Standard IEEE CT Burdens (5 Amp)
(Per IEEE Std. C57.13-1993 & C57.13.6)

Application	Burden Designation	Impedance (Ohms)	VA @ 5 amps	Power Factor
Metering	B0.1	0.1	2.5	0.9
	B0.2	0.2	5	0.9
	B0.5	0.5	12.5	0.9
	B0.9	0.9	22.5	0.9
	B1.8	1.8	45	0.9
	E0.2	0.2	5	1.0
	E0.04	0.04	1	1.0

VT Burden

ANSI Designation	VA	Power Factor
W	12.5	0.10
X	25.0	0.70
M	35.0	0.20
Y	75.0	0.85
Z	200.0	0.85

What's the difference between a Y VA rating and a Thermal VA rating?

Utility Metering CTs

What do I need to know?

B - Burden

R - Ratio

A - Accuracy

V – voltage class

E – Etc (window size, special requirements)

R – Rating Factor

Revenue metering application

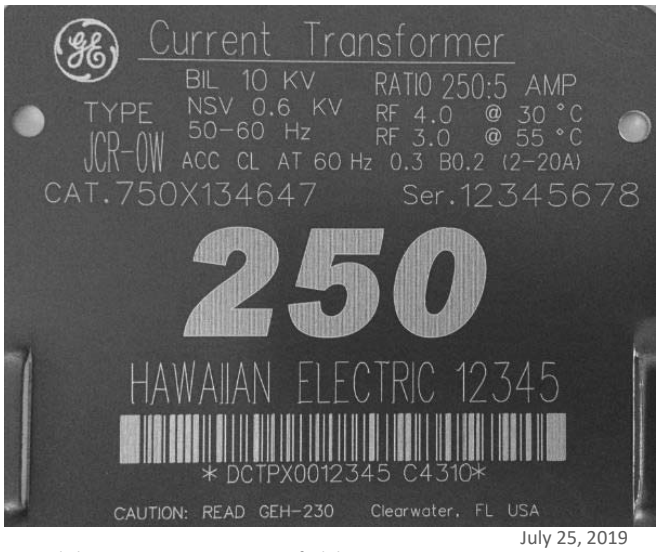
Name Plate Information: Ratio

$$\text{Transformer Ratio} = \frac{\text{Primary Current}}{\text{Secondary Current}}$$

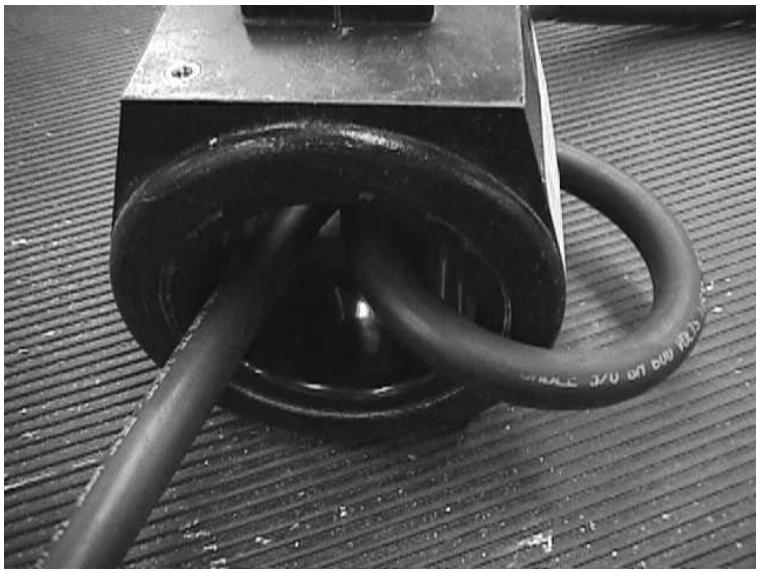
Primary Current
(250 amps)

Secondary
Current
(5 amps)

$$\frac{250}{5} = 250{:}5 \text{ or } 50{:}1$$



Transformer ratio (TR)



Example: Window CT wound as a 200:5

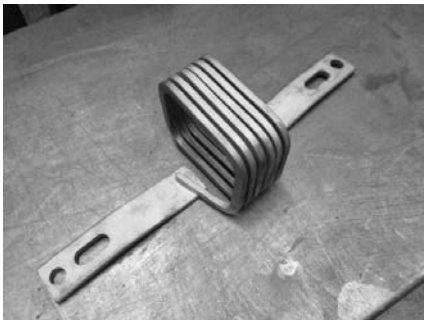
Use as a 200:5 with one primary conductor turn

Use as a 100:5 with two primary conductor turns

Use as a 50:5 with four primary conductor turns

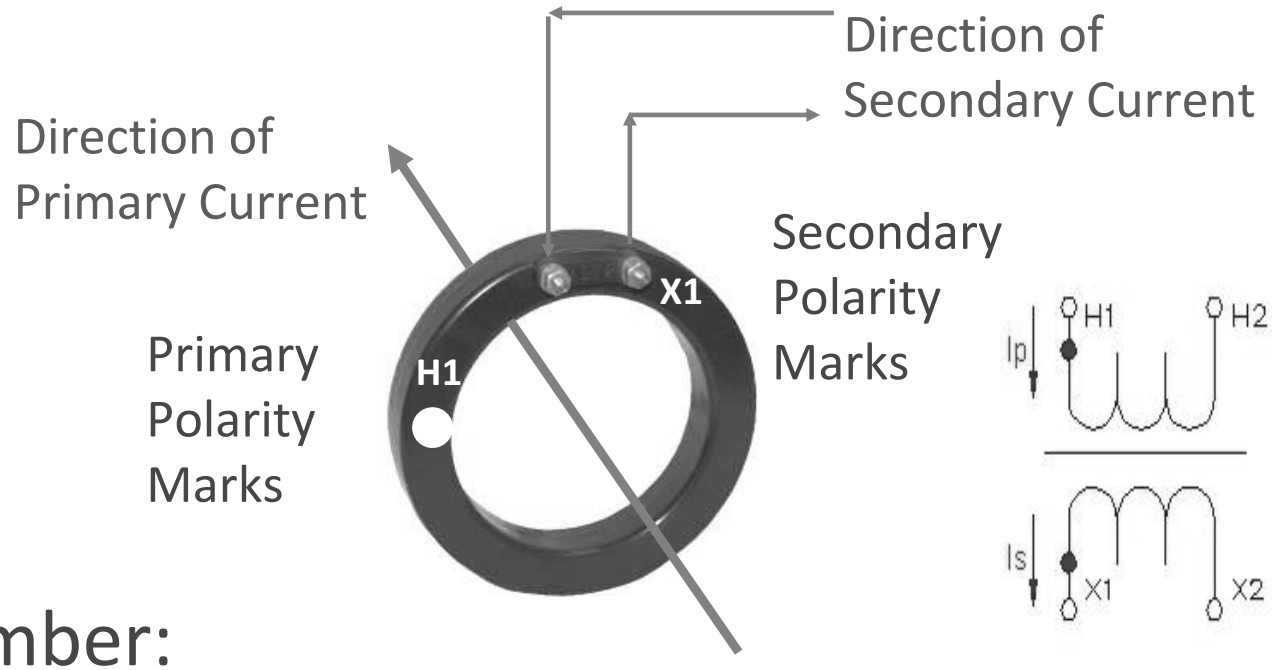
Remember: $I_p = I_s \times N_s/N_p$

Wound type CT
MV Primary Winding



Higher primary turns, means lower ratios are possible while maintaining accuracy.

Polarity

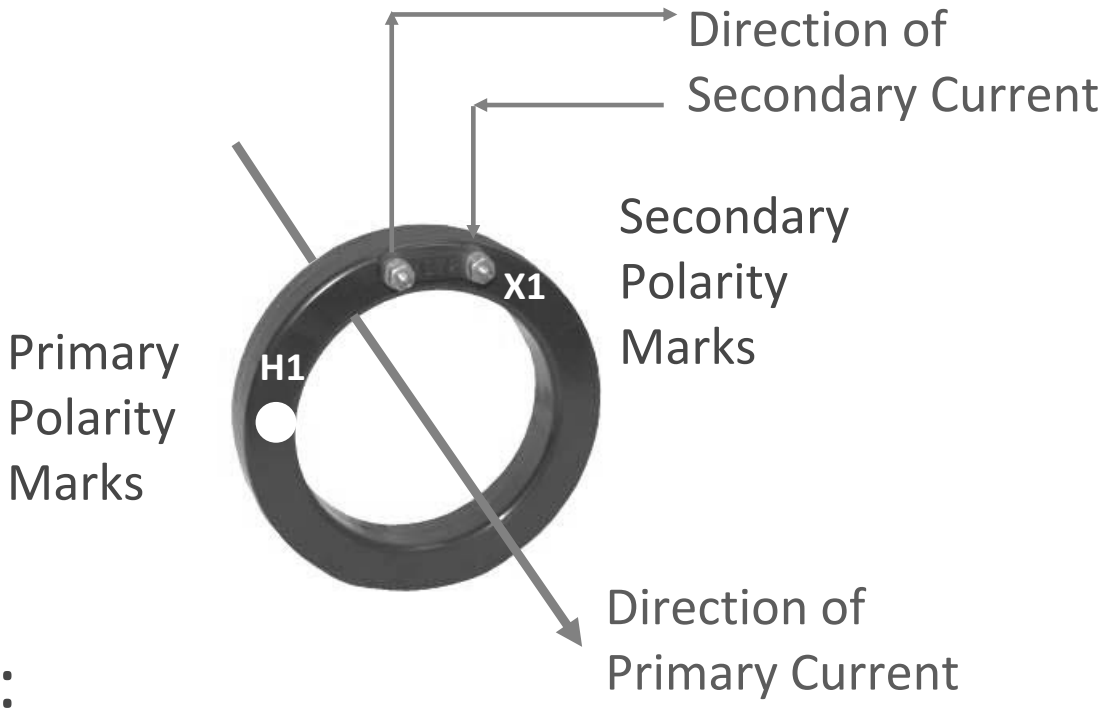


Remember:

Primary current <u>into</u> “polarity” =

Secondary current <u>out of</u> “polarity”

Polarity



Remember:

Primary current into “non-polarity” =

Secondary current out of “non-polarity”

Utility Metering CTs

What do I need to know?

B - Burden

R - Ratio

A - Accuracy

V – voltage class

E – Etc (window size, special requirements)

R – Rating Factor

Revenue metering application

CT Metering Accuracy

Actual secondary current ≠ **Rated** secondary current

Difference in % is known as the
"Accuracy"
of the CT

Definition: There are two sources of error in instrument transformers, namely ratio error and phase angle error. In a given transformer, the metering error is the combination of the two separate errors. This combination is called Transformer Correction Factor (TCF), IEEE has established accuracy classes for both current and potential transformers. The limit of permissible error in a potential transformer for a given accuracy class remains constant over a range of voltage from 10% below to 10% above rated voltage

Ratio Correction Factor (RCF)

IEEE C57.13 Terminology

RCF = True Ratio / Marked Ratio

Example: 500:5 CT

By test, CT Ratio = 100.1

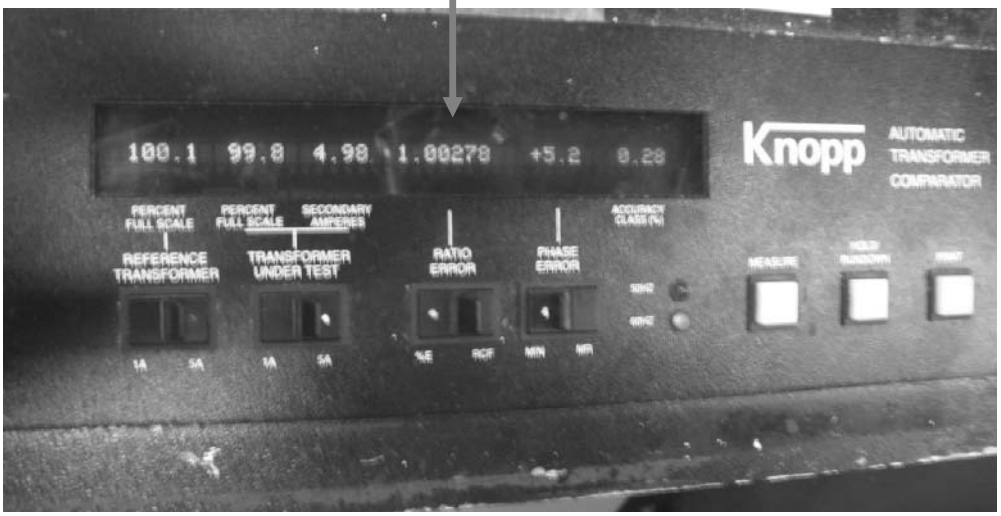
RCF = 100.1 / 100 = 1.0010

What does this mean? How many amps is the meter seeing?

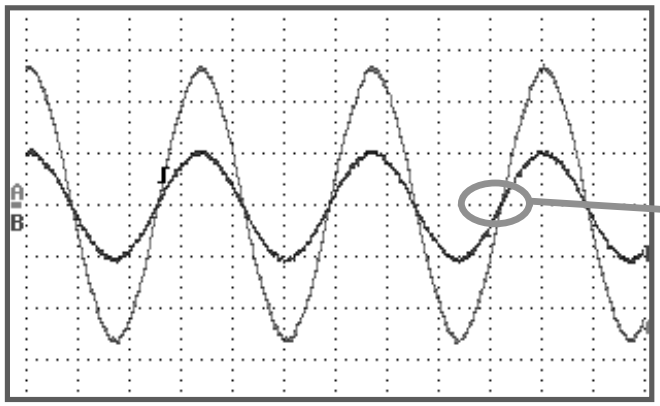
A. – With 500A through primary, only 4.995A is flowing on the secondary 4.995 x 1.001 = 5A. (Negative current error due to losses)

Ratio Correction Factor (RCF)

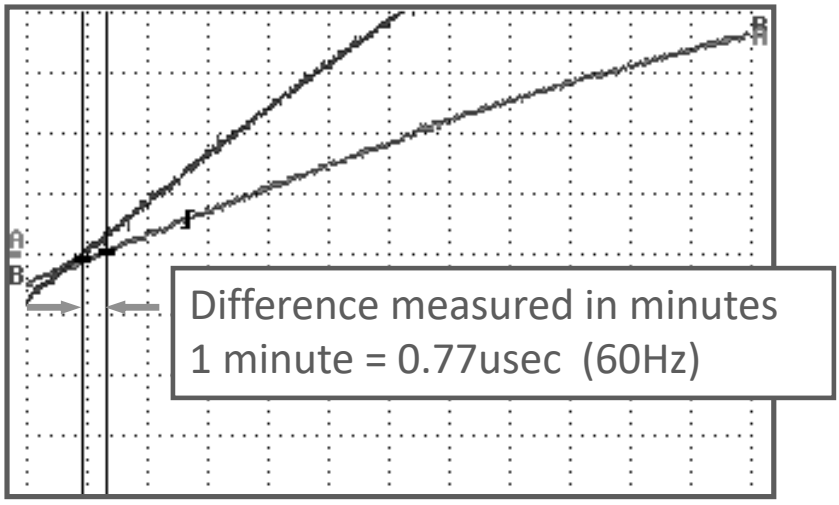
RCF on Knopp Comparator



Phase Error



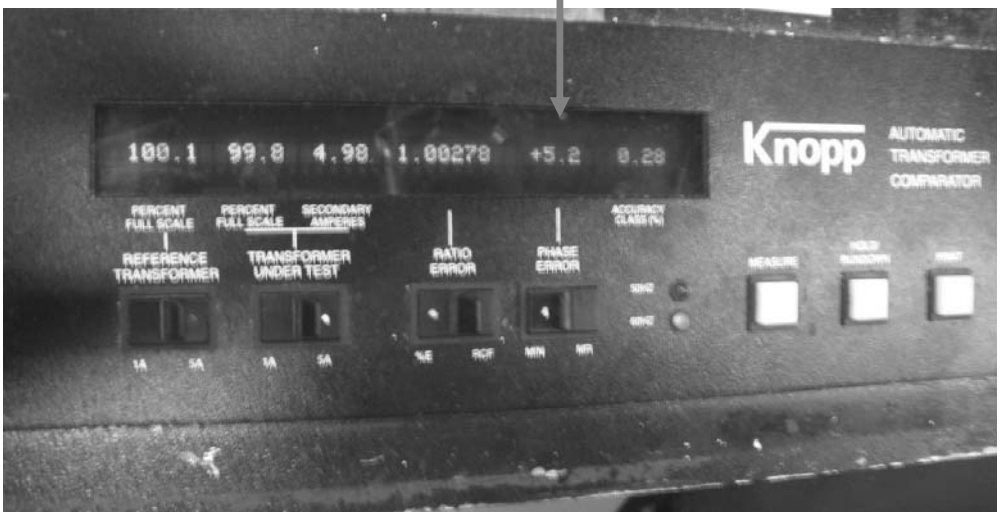
Red = Primary Current
Blue = Secondary Current



When Secondary Current (blue) **leads** the Primary Current (red), Phase Error (?) is defined as **Positive**.

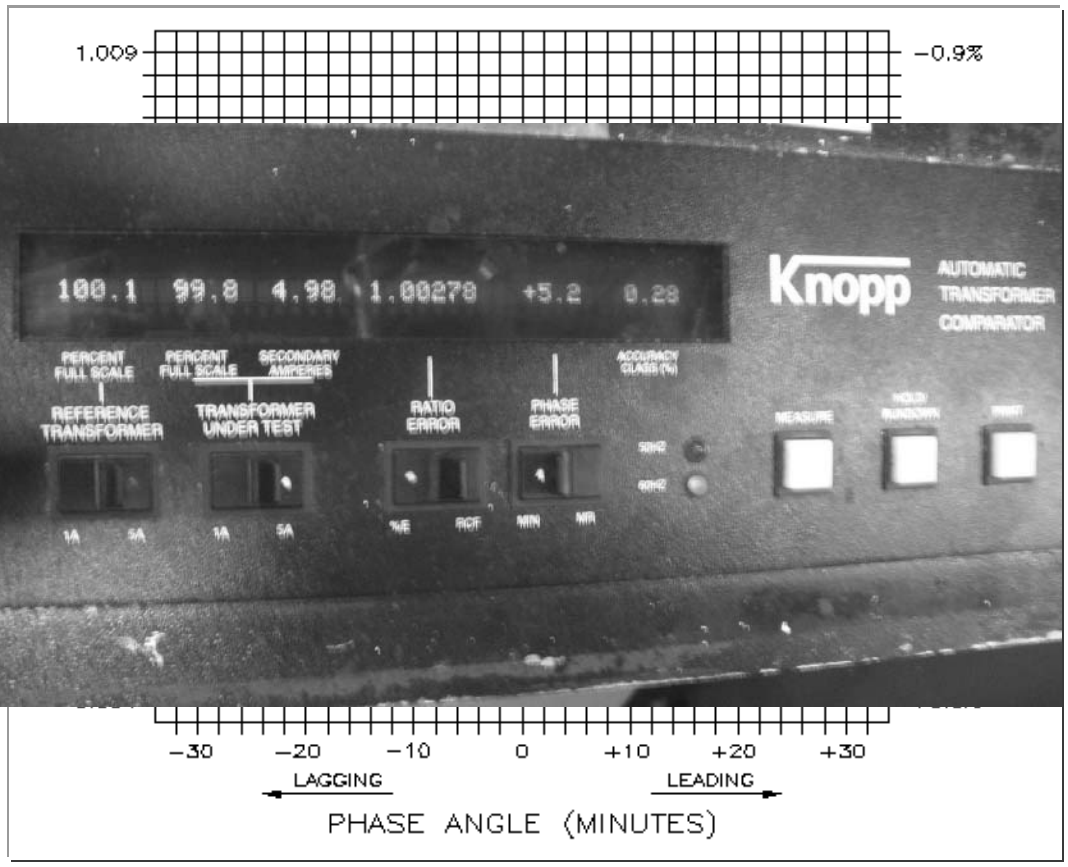
Phase Error

Phase Error on
Knopp Comparator



CT PARALLELOGRAM

IEEE Std. C57.13 limits of accuracy class for current transformers for metering 0.3 accuracy class



Recall the Knopp Comparator
The values were:

- Ratio Error = 1.00278
- Φ Angle Error = 5.2

Energy Required to Energize the Core

$$\text{mmf} = \phi \Re = k_1 \left[\frac{Z_S I_S}{N_S f} \right] k_2 \left[\frac{\text{mmp}}{A_C \mu_C} \right] = k_1 k_2 \left[\frac{Z_S I_S \text{ mmp}}{N_S f A_C \mu_C} \right]$$

ϕ = flux in the core
$\Re$ = magnetic reluctance
k_1 = constant of proportionality
k_2 = constant of proportionality
Z_S = secondary impedance
mmp = core mean magnetic path
I_S = secondary current
A_C = core cross-sectional area
N_S = number of secondary turns
μ_C = permeability of core material
f = frequency, Hz

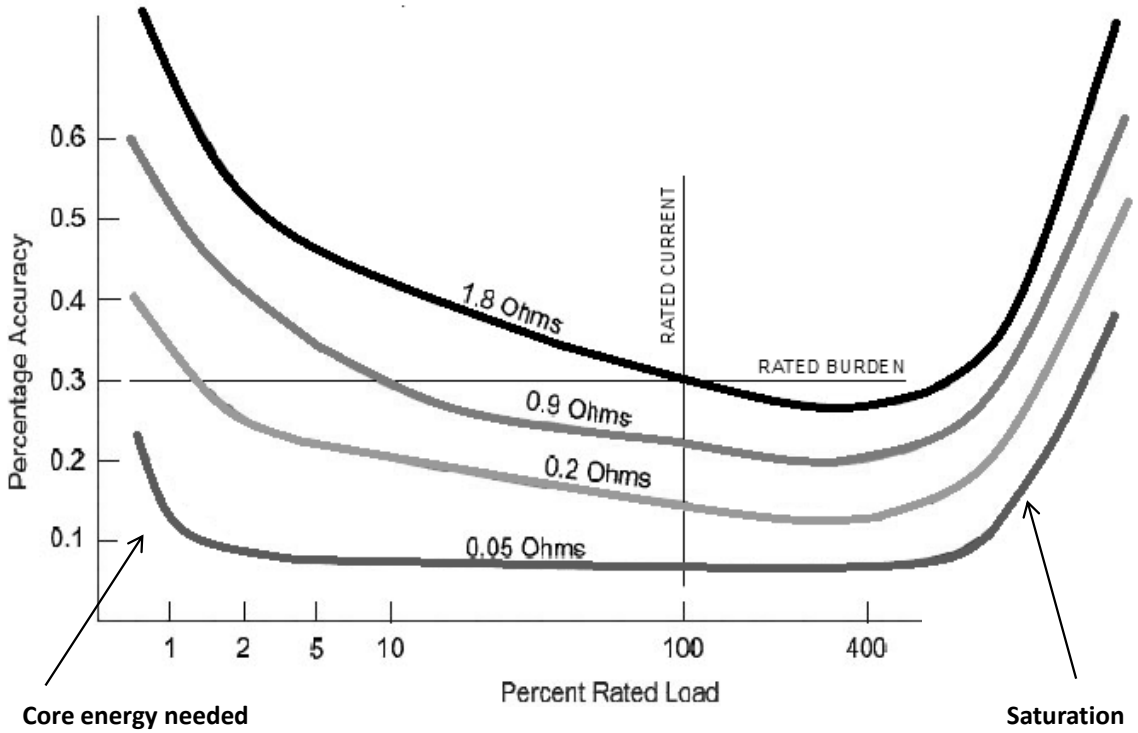
If ↑ Secondary turns or core cross section

↓ secondary impedance

Then ↓ energy required to energize core

Courtesy of Electric Power Transformer Handbook

CT – Accuracy – Burden - Load



Graph: Bill Hardy – TEC PowerMetrix

IEEE CT Metering Accuracy

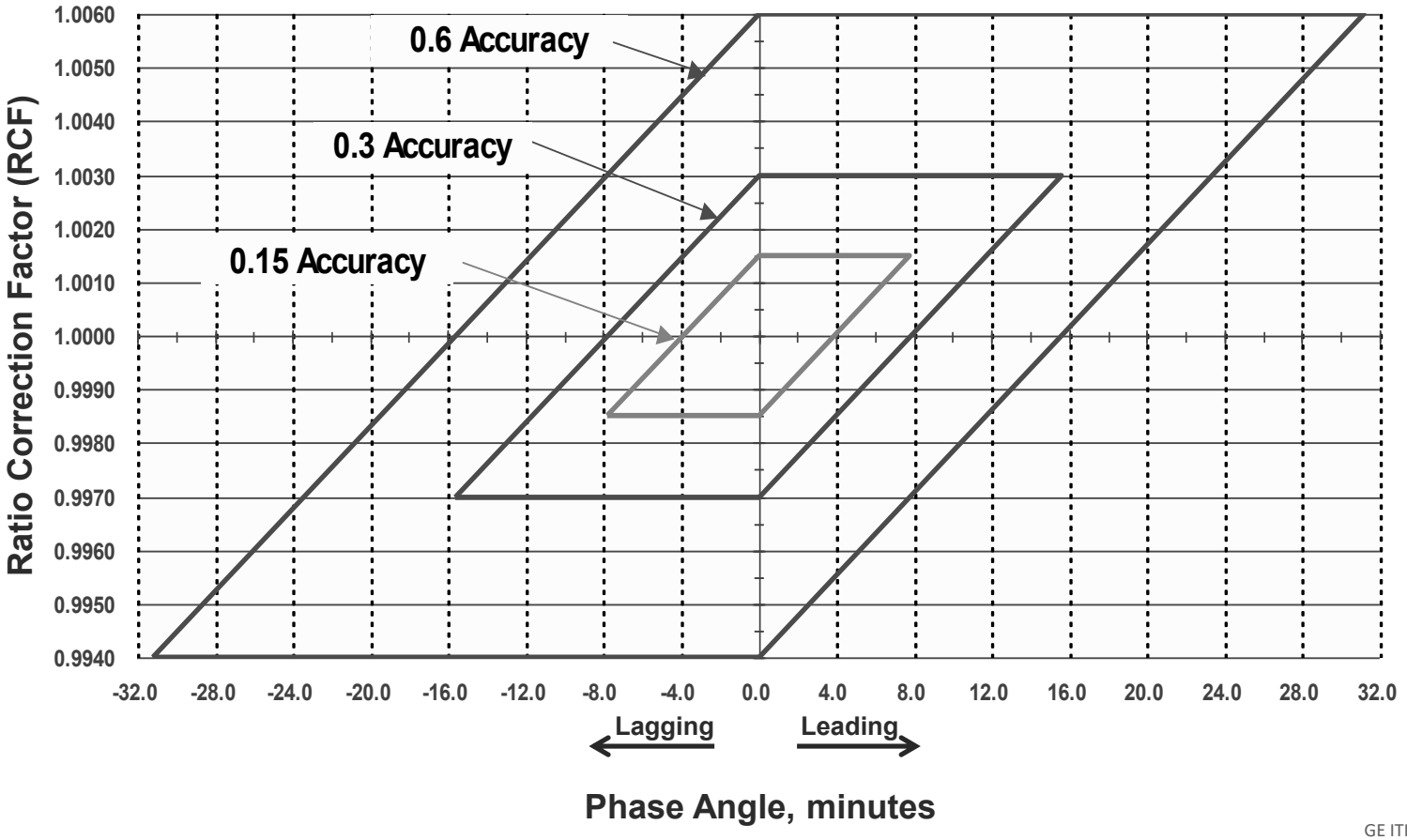
Accuracy Class (*)	Application
0.15S	“Special” High Accuracy Metering
0.15	High Accuracy Metering
0.3	Revenue Metering
0.6	Indicating Instruments
1.2	Indicating Instruments

* All accuracy classes defined by IEEE C57.13 or C57.13.6

* Accuracy classes include both ratio & phase angle error

CT PARALLELOGRAM

IEEE C57.13 – Accuracy Limits



Accuracy Class Definitions

IEEE CT Metering Accuracy

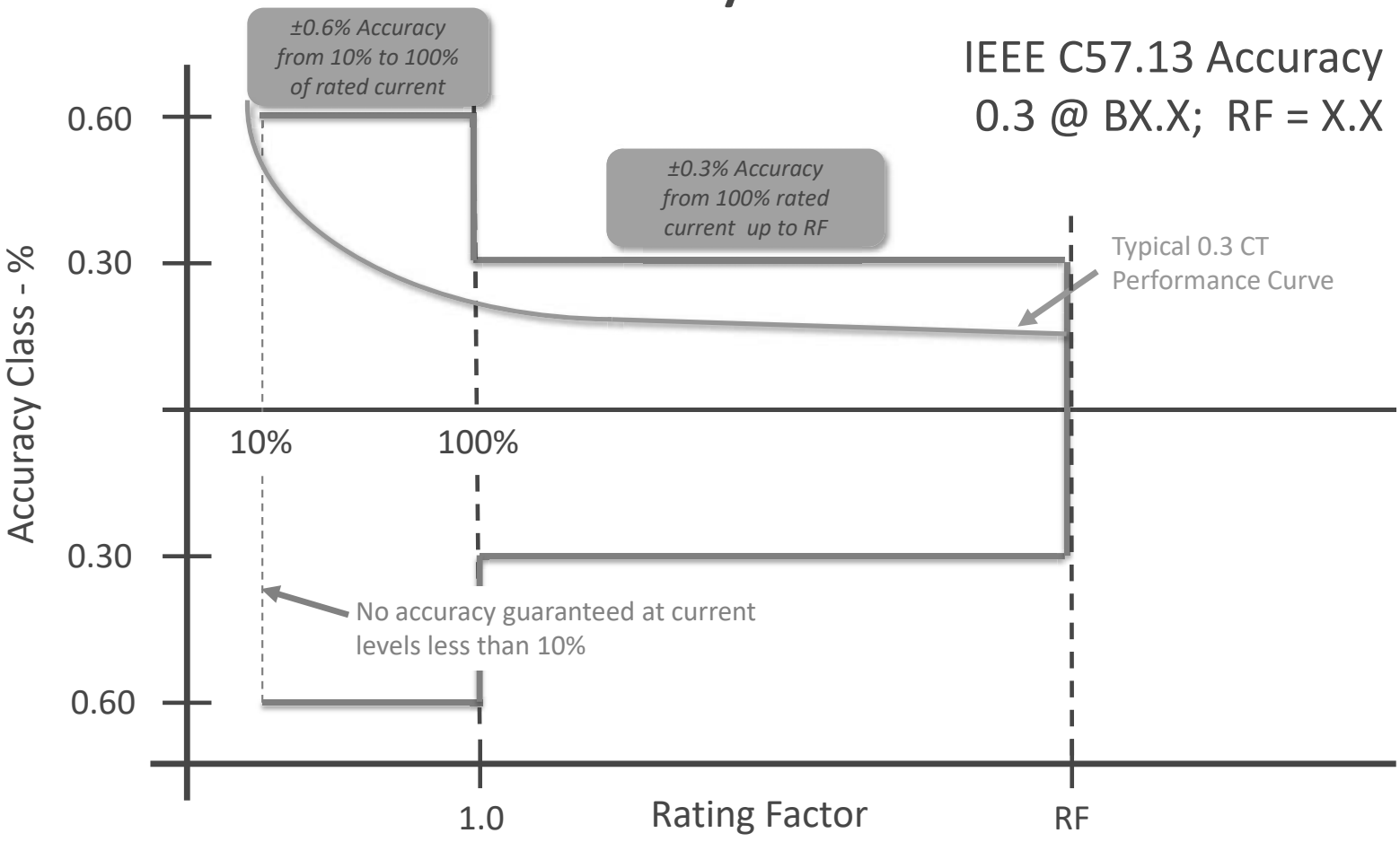
Example 1:

0.3 accuracy CT, 200:5, RF 4.0 **(Standard)**

200 amps (rated amps) to 800 amps (RF 4.0) = 0.3% accuracy

20 amps (10% of rated amps) to 200 amps (rated amps) = 0.6%

Standard 0.3 Accuracy Class



imagination at work

IEEE CT Metering Accuracy

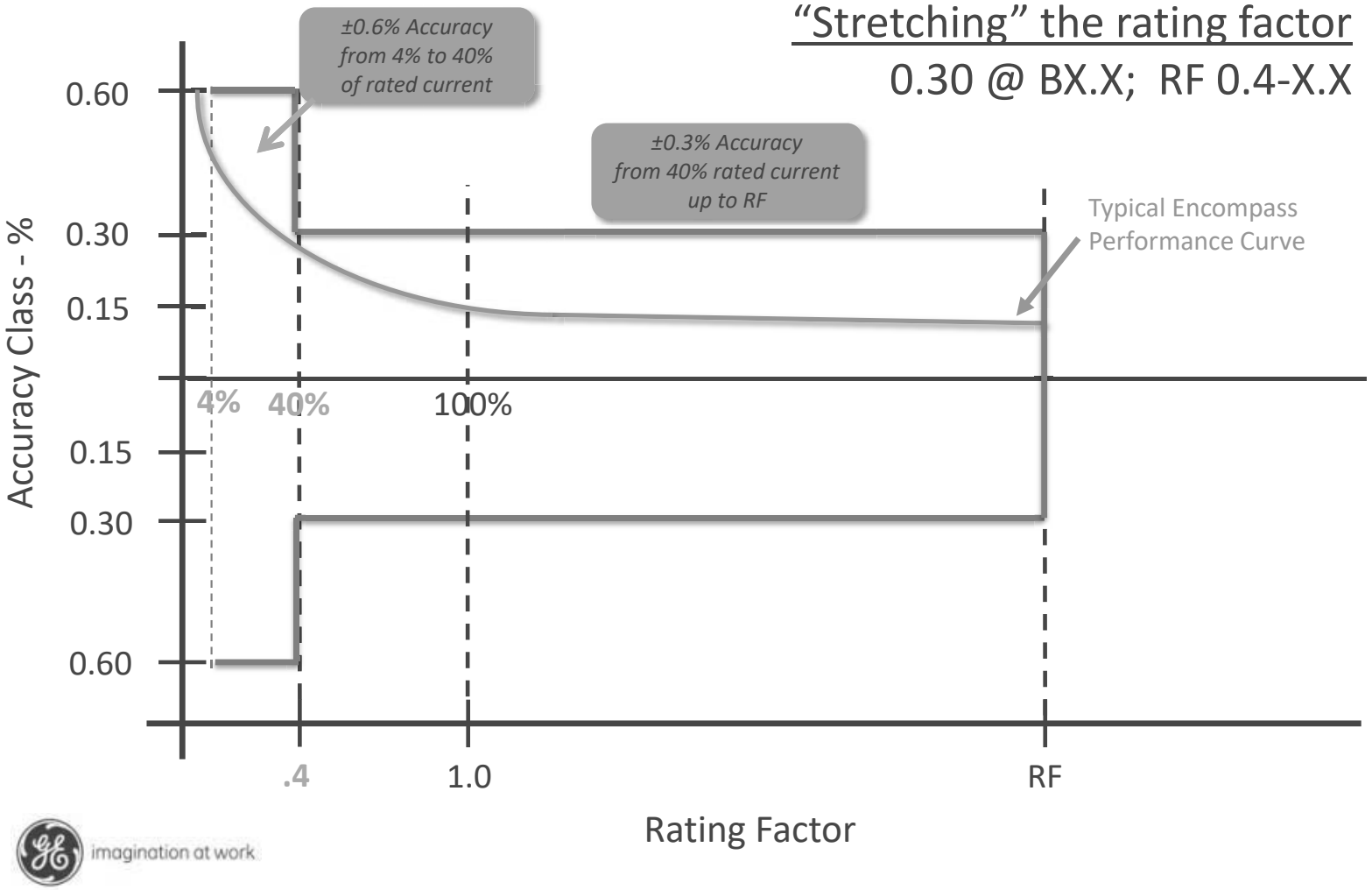
Example 2:

0.3 accuracy CT, 500:5, RF 0.4 - 4.0 **(Encompass)**

200 amps (40% of rated amps) to 2000 amps (RF 4.0)
= 0.3% accuracy

20 amps (4% of rated amps) to 200 amps (40% of rated amps)
= 0.6% accuracy

ITI Encompass



imagination at work

IEEE CT Metering Accuracy

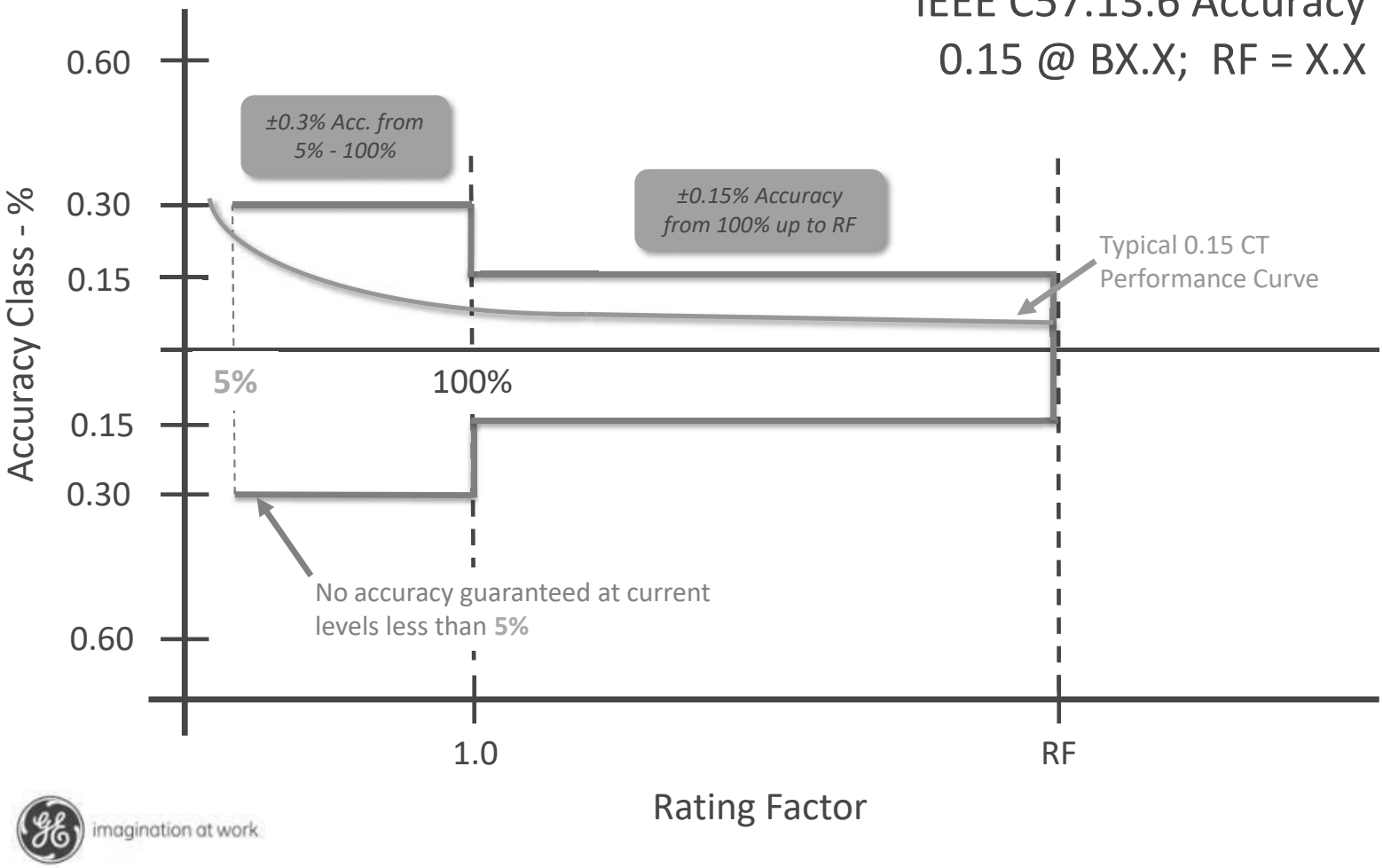
Example 3:

0.15 accuracy CT, 200:5, RF 1.5 **(High Accuracy Metering)**

200 amps (rated amps) to 300 amps (RF 1.5) = 0.15% accuracy

10 amps (5% of rated amps) to 200 amps (rated amps) = 0.3%

0.15 High Accuracy Class



imagination at work

IEEE CT Metering Accuracy

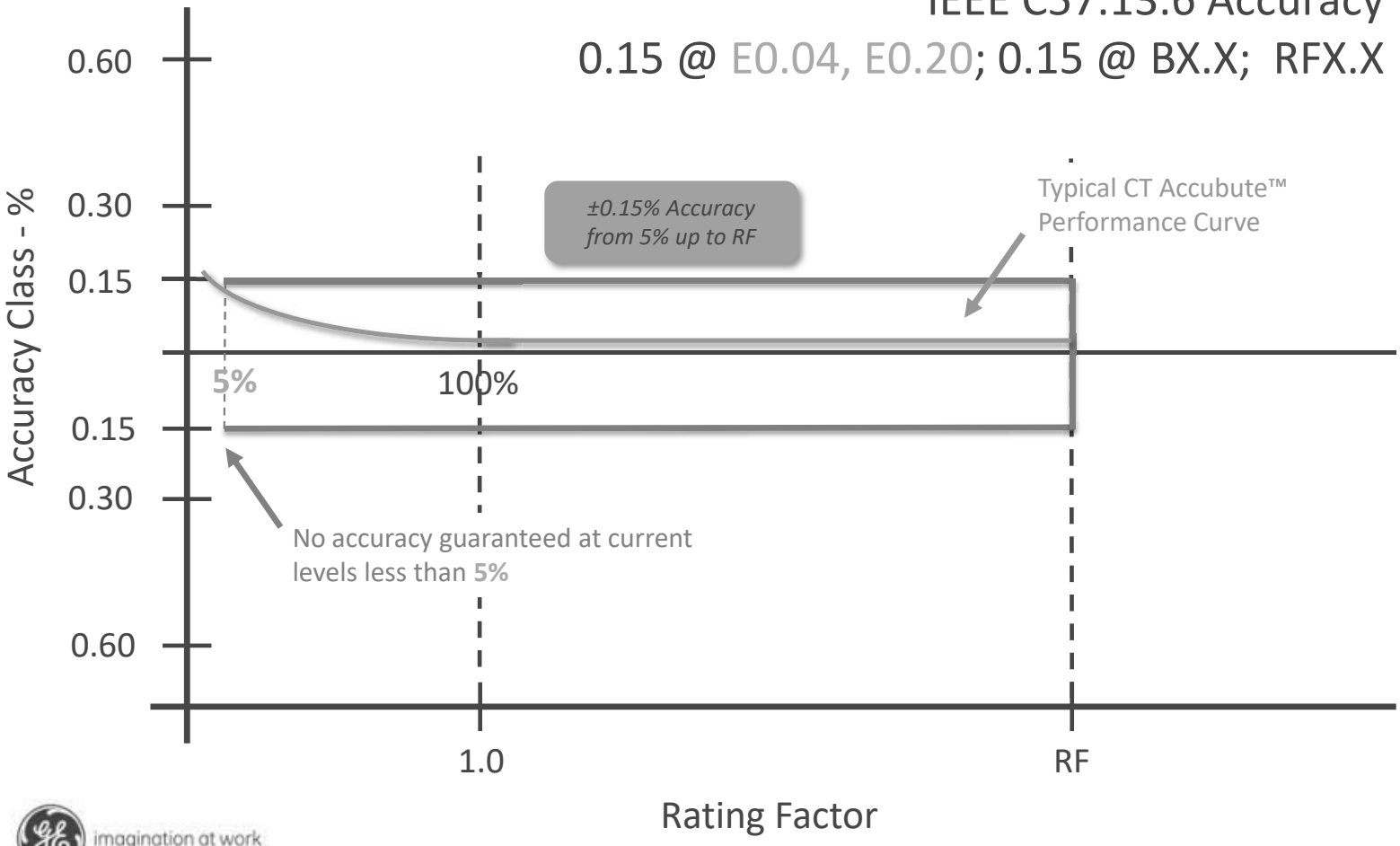
Example 4: (Accubute)

0.15S accuracy CT, 200:5, RF 1.5 **(Special High Accuracy Metering)**

10 amps (5% of rated amps) – 300 amps (rated amps) = 0.15%

0.15S Special High Accuracy (Accubute)

IEEE C57.13.6 Accuracy
0.15 @ E0.04, E0.20; 0.15 @ BX.X; RFX.X



imagination at work

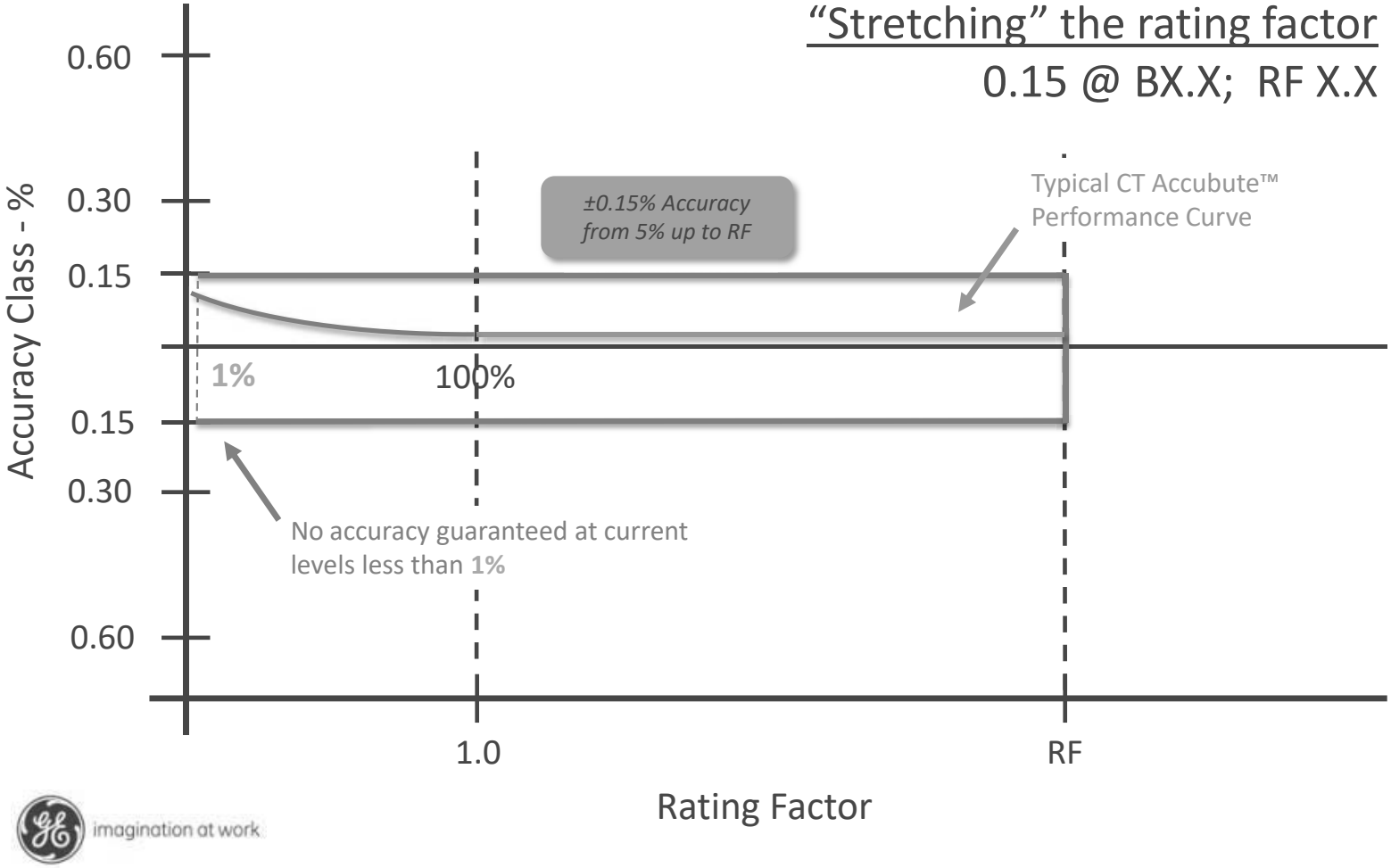
IEEE CT Metering Accuracy

Example 5:

0.15S accuracy Extended Range CT, 600:5, RF 3.0 **(RevenueSense)**

6 amps (1% of rated amps) – 1800 amps (rated amps) = 0.15%

0.15 High Accuracy Extended Range



imagination at work

Definitions

Standard Revenue Metering Accuracy (IEEE 0.3 Accuracy Class)

± 0.3% accurate from 100% Nameplate Rating, up to Rating Factor

± 0.6% accurate below 100% Nameplate Rating, down to 10% of Nameplate Rating

GE ITI Encompass CT's

± 0.3% accurate from 40% of Nameplate Rating, up to Rating Factor

± 0.6% accurate below 40% Nameplate Rating down to 4% of Nameplate Rating

High Accuracy (IEEE 0.15 Accuracy Class)

± 0.15% accurate from 100% Nameplate Rating, up to Rating Factor

± 0.3% accurate below 100% Nameplate Rating, down to 5% of Nameplate Rating

GE Somersworth Accubute™ (IEEE 0.15S Accuracy Class)

± 0.15% accurate from down to 5% of Nameplate Rating, up to Rating Factor

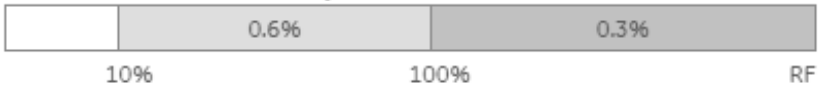
GE RevenueSense High Accuracy Extended Range (IEEE 0.15S Accuracy Class)

± 0.15% accurate from down to 1% of Nameplate Rating, up to Rating Factor

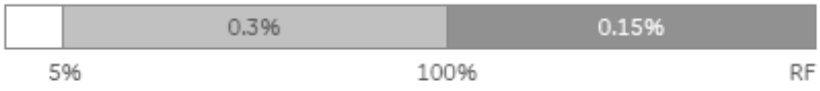
IEEE Metering Class

There are three revenue grade metering classes defined by IEEE C57.13-2008 and C57.13.6-2004. These are illustrated below, with limits shown as a percent of rated CT current:

0.3 Class - Standard Accuracy



0.15 Class – High Accuracy



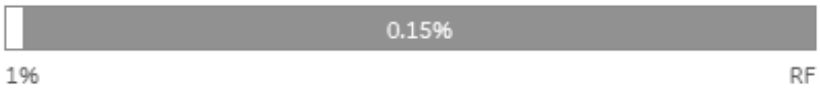
0.15S Class – Special High Accuracy

Encompass & RevenueSense Exceed IEEE Standards

Encompass and RevenueSense redefine CT performance by exceeding the operating range within their respective IEEE accuracy classes, offering utilities additional flexibility to reduce inventory, part numbers, and billing multipliers. RevenueSense also allows for a further reduction of metering losses by extending high accuracy performance down to 1% of rated current.

GE Encompass – Standard Accuracy with Extended Range

GE RevenueSense – Special High Accuracy with Extended Range



IEEE VT Accuracy Class

Metering Accuracy Classes (% error)

0.3
0.6
1.2

} Defined by IEEE C57.13

Applicable from 90% to 110% rated voltage

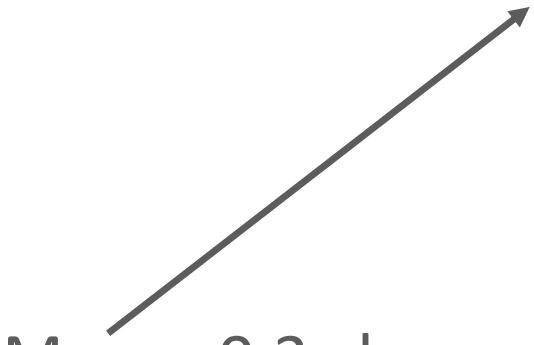
0.15 — Defined by IEEE C57.13.6

VT Accuracy/Burden Designation

Expressed as:

Accuracy Class + Burden Code

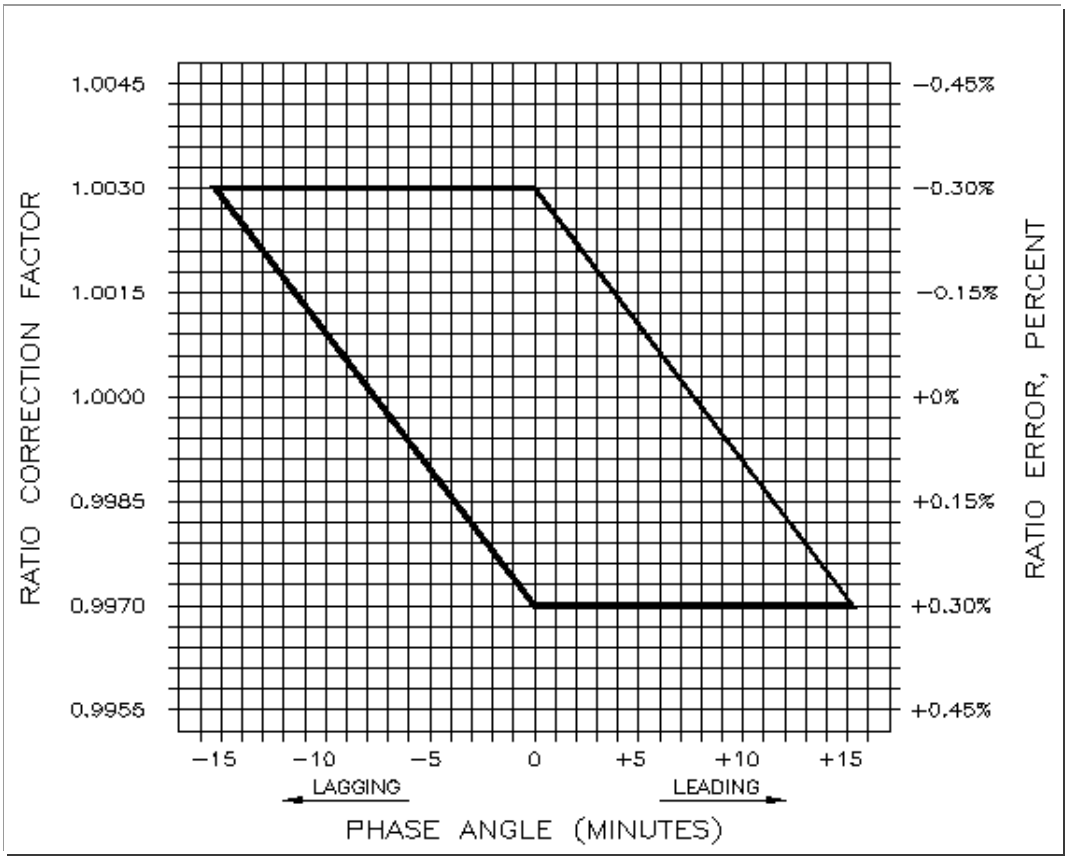
0.3 W,X,Y
0.6 Z
1.2 ZZ



Means 0.3 class up to a 75 VA burden

PT PARALLELOGRAM

IEEE Std. C57.13 limits of accuracy class for potential transformers for metering 0.3 accuracy class

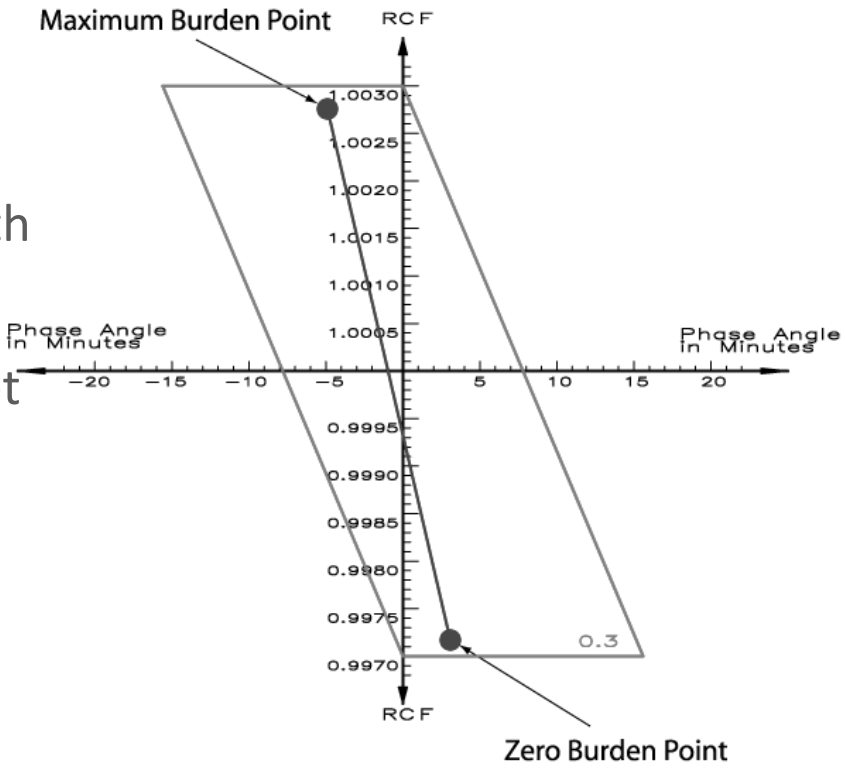


VT 0.3 Accuracy Class

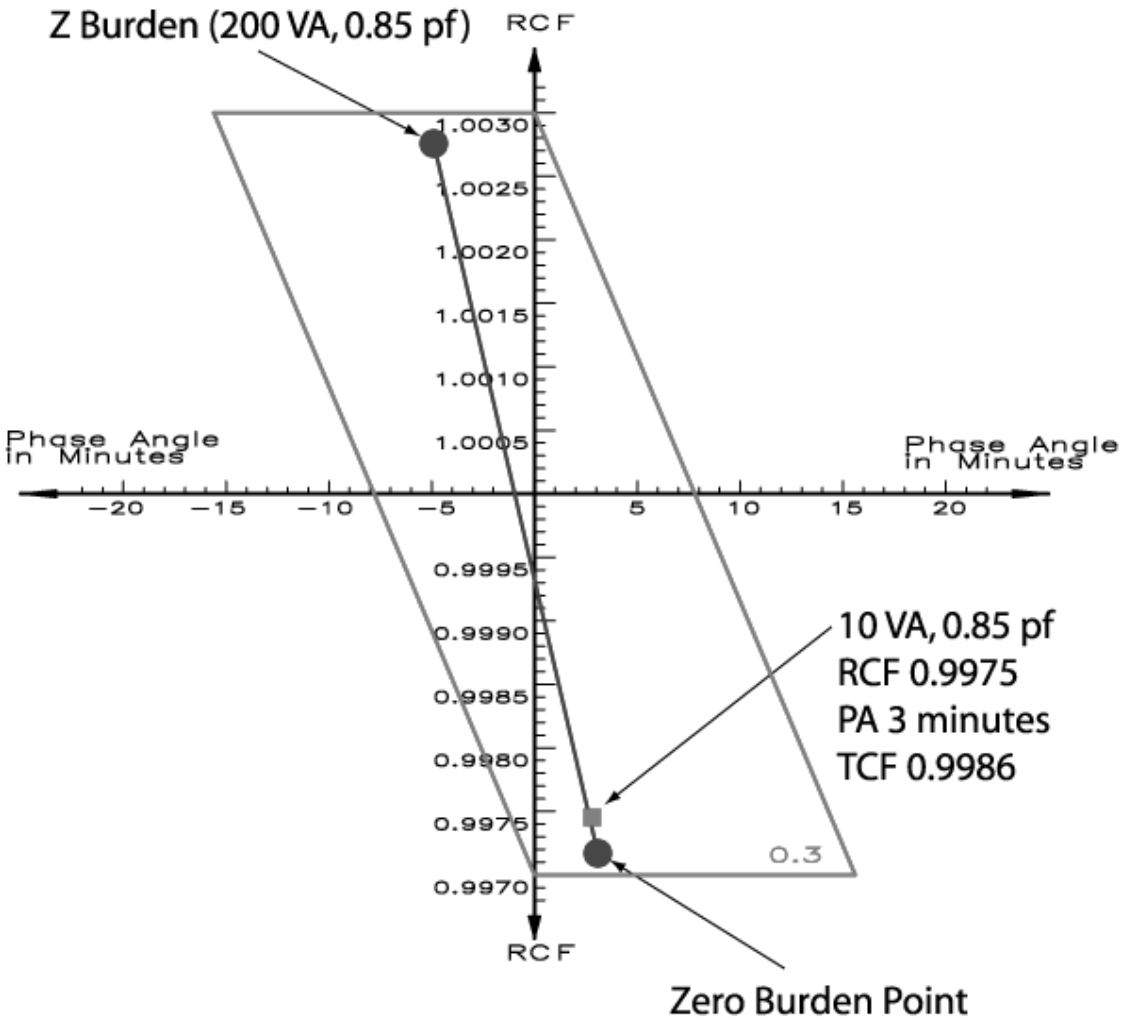
Load line is drawn between zero and full burden points.

Accuracy changes linearly with burden.

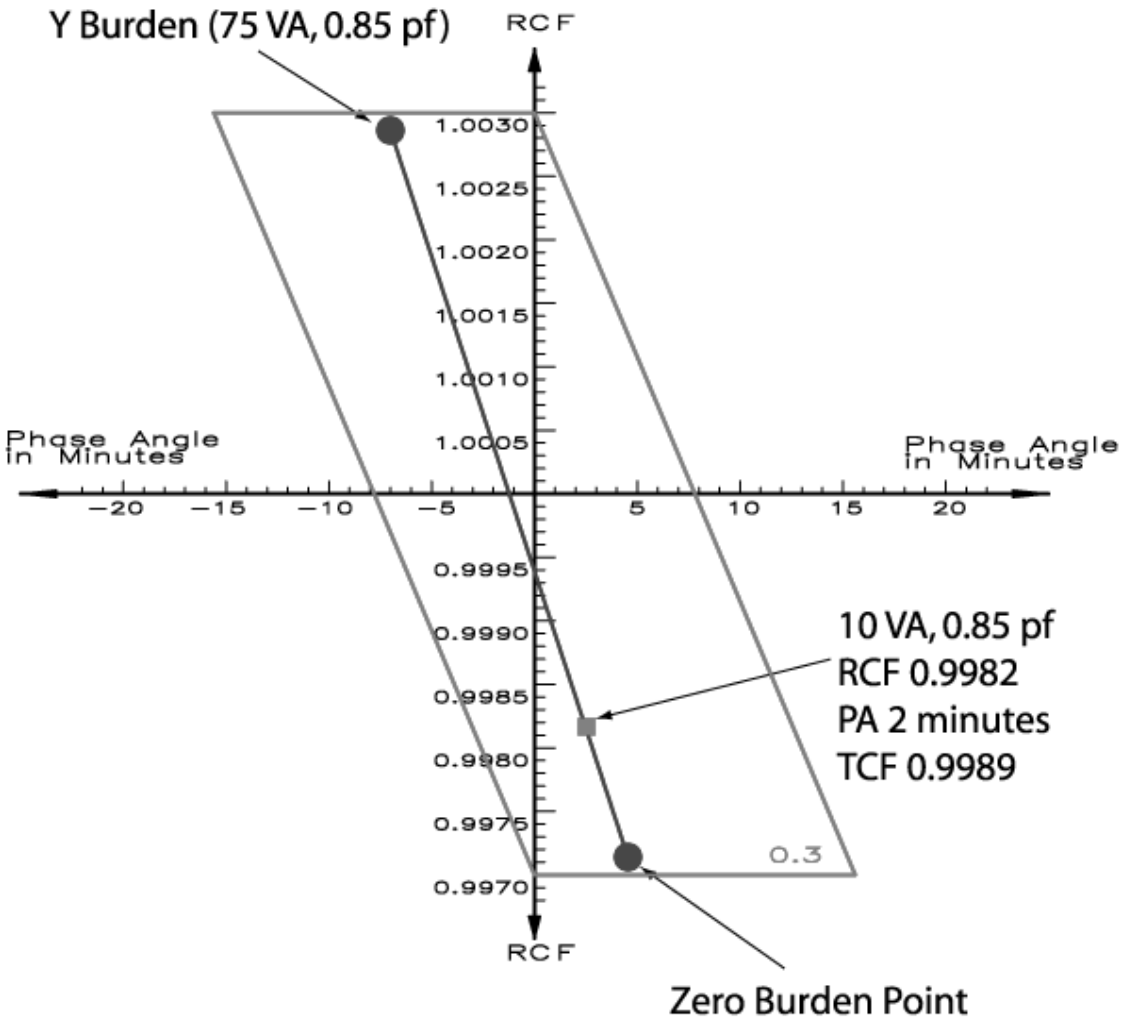
Higher burden rating does not automatically mean better accuracy performance.



VT Load Line 0.3 WXYZ



VT Load Line 0.3 WXY



Utility Metering CTs

What do I need to know?

B - Burden

R - Ratio

A - Accuracy

V – voltage class

E – Etc (window size, special requirements)

R – Rating Factor

Revenue metering application

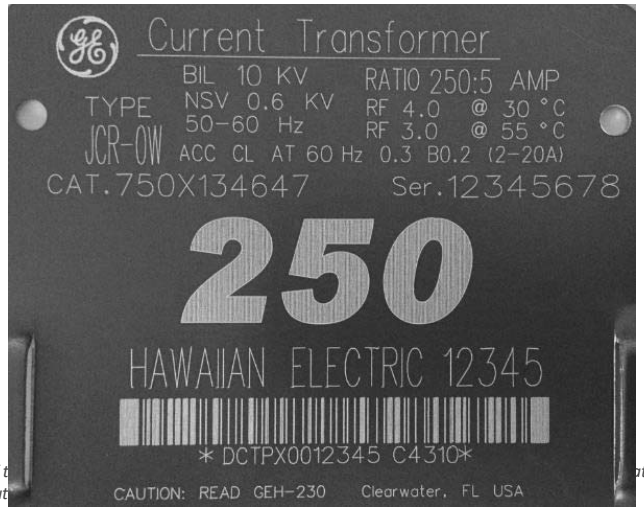
Name Plate Information: Voltage

Nominal System Voltage

- The insulation class is based on Phase to Phase Voltage

Basic Impulse Level (Simulates impulse from lightning)

- IT BIL must match or exceed the System BIL.
- Caution: More than one BIL may be available for a Nominal System Voltage.



Standard Voltage Classes

Insulation Class

(IEEE C57.13)

Class	Power Freq.	BIL
0.6kV	4kV	10kV
5kV	19kV	60kV
8.7kV	26kV	75kV
15kV	34kV	95-110kV
25kV	40-50kV	125-150kV
34.5kV	70kV	200kV

Insulation class should at least equal maximum Line-Line voltage at the point of connection.

Utility Metering CTs

What do I need to know?

B - Burden

R - Ratio

A - Accuracy

V – voltage class

E – Etc (window size, special requirements)

R – Rating Factor

Revenue metering application

Name Plate Information: Rating Factor

Rated current x (RF) = Maximum continuous current carrying capability:

- Without exceeding temperature limits
- Without loss of published accuracy class

Typical rating factors -- 1.0, 1.33, 1.5, 2.0, 3.0, 4.0

Rating Factor

Ambient rating is based on average 24hr ambient temp and the peak ambient tem cannot exceed the average ambient tem by more than 10 C.

IEEEC57.13 gives a chart for de-rating as a function of avg. ambient temperatures.

Generally, 4.0 is the highest RF used due to 20A continuous limits of most connected devices.

Different primary and secondary rating factors are often seen on tapped secondary designs.

Sometimes RF<1.0 is seen, normally for very high ratios.

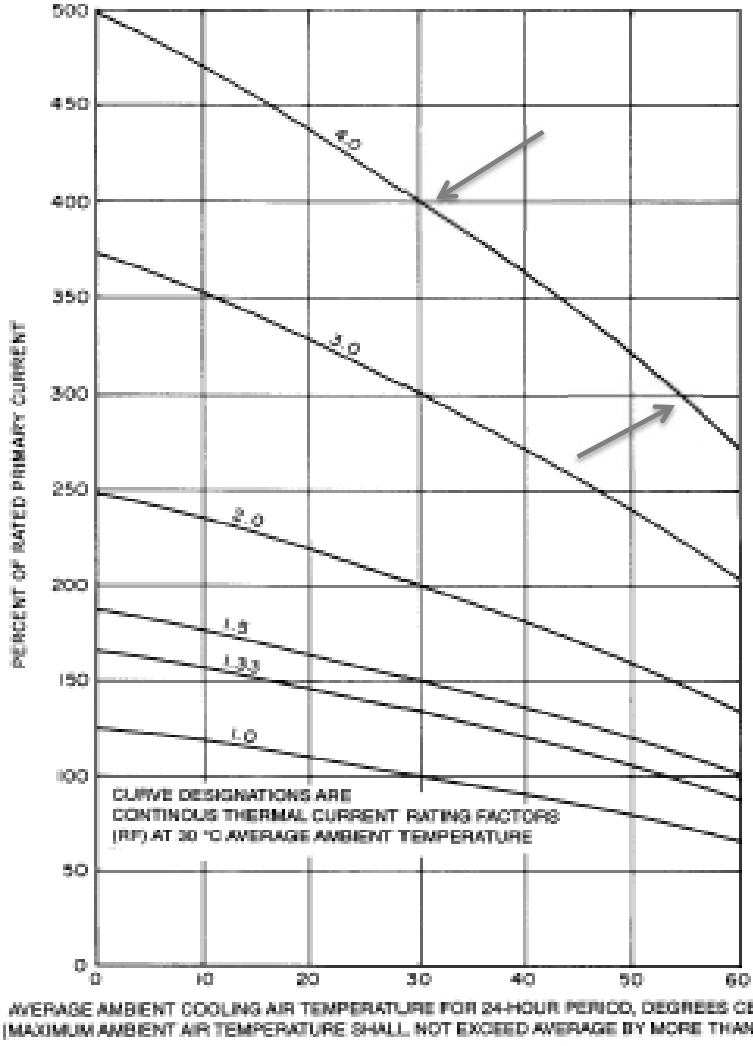
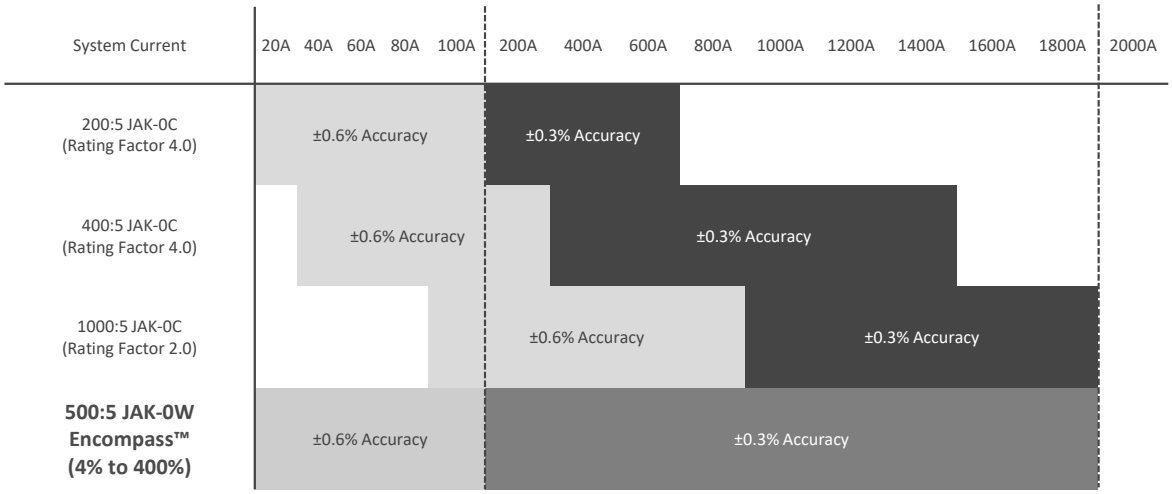


Figure 1— 55 °C rise current transformer basic loading characteristics (In air)

LV Extended Range

Encompass™

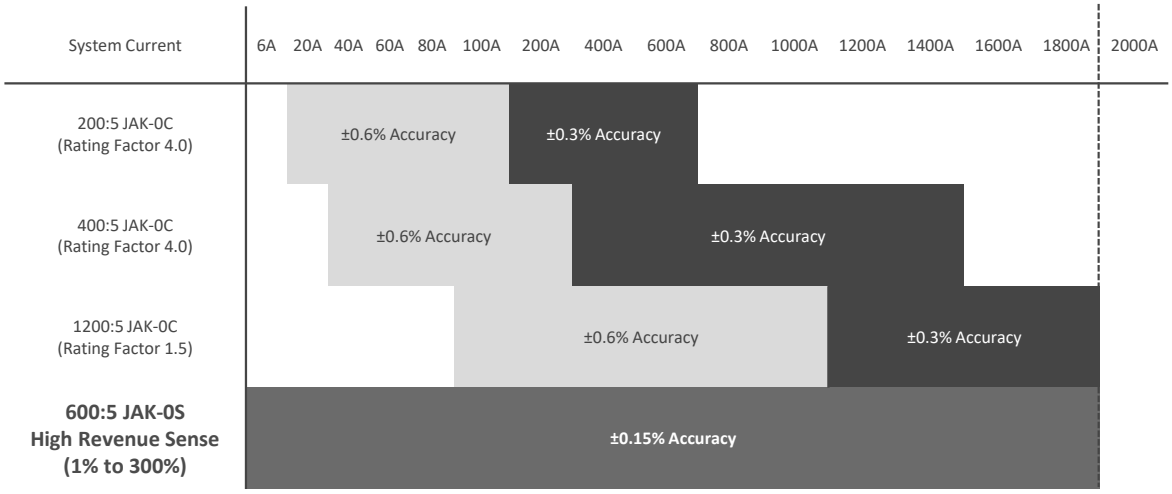
Low Voltage Encompass™ Series



One Encompass CT offers equal to, or better accuracy class over the range of multiple legacy CT's

RevenueSense™

Low Voltage RevenueSense™ Series



One RevenueSense™ CT improves accuracy over the range of multiple legacy CT's, with significant improvement at low currents

JAK-0W Encompass Data Table

CURRENT RATIO (AMPS)	IEEE METERING ACCURACY (60Hz)	RATING FACTOR		PRIMARY BAR	CATALOG NUMBER		
		30°C	55°C		NO BASE	LOW BASE	HIGH BASE
500:5	0.3B0.5[1]	4	3	No	750X133655	750X133629	750X133633
500:5	0.3B0.5[1]	4	3	Yes	750X133470	750X133630	750X133634

(1) Exceeds IEEE definition for standard accuracy. Maintains 0.6 Accuracy from 4% to 40% and 0.3 from 40% to Rating Factor.

JAK-0S RevenueSense Data Table

CURRENT RATIO (AMPS)	IEEE METERING ACCURACY (60Hz)	RATING FACTOR		PRIMARY BAR	CATALOG NUMBER		
		30°C	55°C		NO BASE	LOW BASE	HIGH BASE
600:5	0.15SB0.2[2]	3	2	No	-	750X333002	750X333003
600:5	0.15SB0.2[2]	3	2	Yes	750X333101	750X333102	750X333103
600:5	0.15SB0.5[2]	2	1.5	No	-	750X333012	750X333013
600:5	0.15SB0.5[2]	2	1.5	Yes	750X333011	750X333112	750X333113

(2) Exceeds IEEE definition for special high accuracy. Maintains 0.15 Accuracy from 1% to Rating Factor.

JAB-0W Encompass Data Table

CURRENT RATIO (AMPS)	IEEE METERING ACCURACY (60Hz)	RATING FACTOR 30°C	55°C	85°C	HI TEMP	CATALOG NUMBER
500:5	0.3B0.5[1]	4	3	-	No	750X136651
1500:5	0.3B0.5[1]	2	1.5	-	No	750X136652
500:5	0.3B0.5[1]	-	-	4	Yes	750X136464
1500:5	0.3B0.5[1]	-	-	2	Yes	750X136463

(1) Exceeds IEEE definition for standard accuracy. Maintains 0.6 Accuracy from 4% to 40% and 0.3 from 40% to Rating Factor.

JAB-0S RevenueSense Data Table

CURRENT RATIO (AMPS)	IEEE METERING ACCURACY (60Hz)	RATING FACTOR 30°C	55°C	85°C	HI TEMP	CATALOG NUMBER
1000:5	0.15SB0.5[2]	3	2	-	No	750X336001
2000:5	0.15SB0.5[2]	2	1.5	-	No	750X336002
1000:5	0.15SB0.5[2]	-	-	2	Yes	750X336101
2000:5	0.15SB0.5[2]	-	-	1.5	Yes	750X336102

(2) Exceeds IEEE definition for special high accuracy. Maintains 0.15 Accuracy from 1% to Rating Factor.

JCR-0W Encompass Data Table

CURRENT RATIO (AMPS)	IEEE METERING ACCURACY (60Hz)	RATING FACTOR 30°C	RATING FACTOR 55°C	PRIMARY BAR	CATALOG NUMBER NO BASE	CATALOG NUMBER LOW BASE	CATALOG NUMBER HIGH BASE
250:5	0.3B0.5[1]	4	3	No	750X134608	750X134609	750X134610
250:5	0.3B0.5[1]	4	3	Yes	750X134627	750X134618	750X134646
500:5	0.3B0.5[1]	2.4	1.2	No	750X134641	750X134642	-
500:5	0.3B0.5[1]	2.4	1.2	Yes	750X134643	750X134644	-

(1) Exceeds IEEE definition for standard accuracy. Maintains 0.6 Accuracy from 4% to 40% and 0.3 from 40% to Rating Factor.

JCT-0S RevenueSense Data Table

CURRENT RATIO (AMPS)	IEEE METERING ACCURACY (60Hz)	RATING FACTOR 30°C	RATING FACTOR 55°C	PRIMARY BAR	CATALOG NUMBER NO BASE	CATALOG NUMBER LOW BASE	CATALOG NUMBER HIGH BASE
600:5	0.15SB0.2[2]	2	1.5	Yes	750X323001	750X323002	750X323003

(2) Exceeds IEEE definition for special high accuracy. Maintains 0.15 Accuracy from 1% to Rating Factor.

JAD-0W Encompass Data Table

CURRENT RATIO (AMPS)	IEEE METERING ACCURACY (60Hz)	RATING FACTOR 30°C	RATING FACTOR 55°C	CATALOG NUMBER NO BASE	CATALOG NUMBER WITH BASE
1000:5	0.3B0.5[1]	4	3	750X120609	750X120612
1500:5	0.3B0.9[1]	3	2	750X120922	750X120980

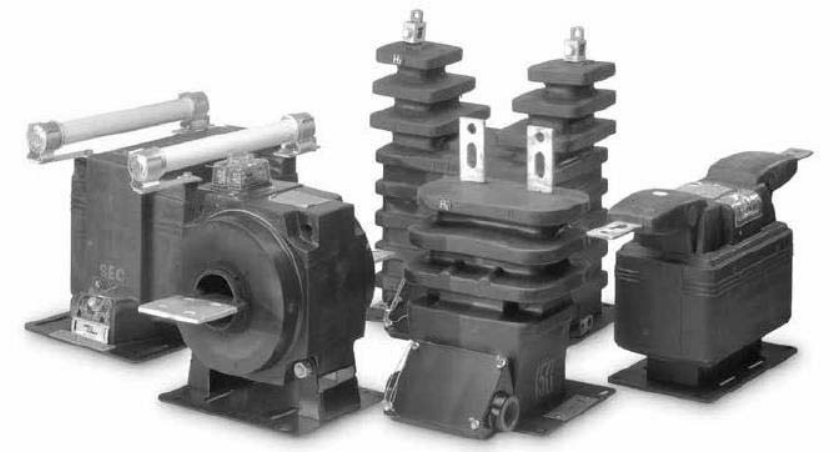
(1) Exceeds IEEE definition for standard accuracy. Maintains 0.6 Accuracy from 4% to 40% and 0.3 from 40% to Rating Factor.

JAD-0S RevenueSense Data Table

CURRENT RATIO (AMPS)	IEEE METERING ACCURACY (60Hz)	RATING FACTOR 30°C	RATING FACTOR 55°C	CATALOG NUMBER NO BASE	CATALOG NUMBER WITH BASE
1200:5	0.15SB0.9[2]	2	1.5	750X320001	750X320011
2000:5	0.15SB0.9[2]	2	1.5	750X320002	750X320012
3000:5	0.15SB0.9[2]	1.5	1	750X320003	750X320013

(2) Exceeds IEEE definition for special high accuracy. Maintains 0.15 Accuracy from 1% to Rating Factor.

MV Extended Range



SELECTION GUIDE

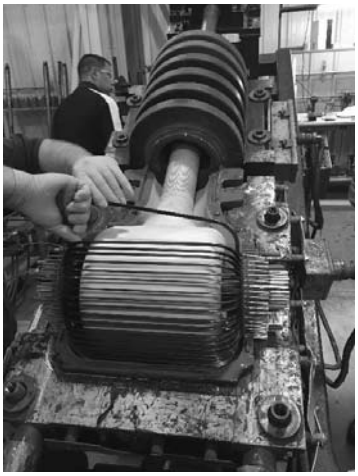
PRODUCT CLASS	5KV	8.7KV	15KV	25KV	35KV	46KV	69KV
STATION CLASS	JKW3	JKW4	JKW5	JKW150	JKW200	JKW250	JKW350
BIL	60kV BIL	75kV BIL	110kV BIL	150kV BIL	200kV BIL	250kV BIL	350kV BIL
Accuracy, RF	0.3B1.8, RF 1.5	0.3B1.8, RF 1.5	0.3B1.8, RF 1.5	0.3B1.8, RF 2.0/1.5	0.3B1.8, RF 2.0/1.5	0.3B1.8, RF 2.0/1.5	0.3B1.8, RF 2.0/1.5
Relay Class	T100	T100	T200	T200/T400	T200/T400	T200/T400	T200/T400
Creep Distance	12.5"	12.5"	24"	44.1"	56.6"	71.0"	86.6"
Net Weight	40lbs	40lbs	60lbs	323lbs	348lbs	543lbs	593lbs
DISTRIBUTION CLASS	JCK3	JCK4	JCK5	JKW6	JKW7		
BIL	60kV BIL	75kV BIL	110kV BIL	150kV BIL	200kV BIL		
Accuracy, RF	0.3B0.5, RF 3.0	0.3B0.5, RF 3.0	0.3B0.5, RF 3.0	0.3B0.9, RF 3.0	0.3B0.5, RF 3.0		
Relay Class	- - -	- - -	- - -	T100 or T200	- - -		
Creep Distance	15.5"	15.5"	15.5"	24"	27.6"		
Net Weight	35lbs	35lbs	35lbs	80lbs	72lbs		

JKW150 - 350

RATIO	IEEE METERING	IEEE RELAY ACCURACY CLASS[2]	THERMAL RATING FACTOR	CATALOG NUMBER
25/50:5	0.3 B1.8	T200/T400	2.0/1.33	759X030013
50/100:5	0.3 B1.8	T200/T400	2.0/1.33	759X030012
75/150:5	0.3 B1.8	T200/T400	2.0/1.33	759X030011
100/200:5	0.3 B1.8	T200/T400	2.0/1.33	759X030010
150/300:5	0.3 B1.8	T200/T400	2.0/1.33	759X030009
200/400:5	0.3 B1.8	T200/T400	2.0/1.33	759X030008
300/600:5	0.3 B1.8	T200/T400	2.0/1.33	759X030007
400/800:5	0.3 B1.8	T200/T400	2.0/1.33	759X030006
500/1000:5	0.3 B1.8	T200/T400	2.0/1.33	759X030005
600/1200:5	0.3 B1.8	T200/T400	2.0/1.33	759X030004
800/1600:5	0.3 B1.8	T200/T400	2.0/1.33	759X030003
1000/2000:5	0.3 B1.8	T200/T400	2.0/1.33	759X030002
1500/3000:5	0.3 B1.8	T400/T800	1.5/1.33	759X030001

1. High accuracy options available

2. First value given is for lower primary Ampere rating (tapped secondary); second value is for higher primary Ampere rating (full secondary).



Sizing Installation

Review of a typical installation

- 13.8 kV, Grounded Wye
- Max Load: 60 amps
- Normal Load: 20 amps

Review of a typical installation

13.8 kV Phase to Phase, 8 KV Phase to Ground

- 7.2 KV, 60:1 – 133V Secondary Voltage
- 8.4 KV, 70:1 – 114V Secondary Voltage

JVW-4/JVW-5 DATA TABLE								
Line-To-Line Circuit Voltage For Permissible Primary Connection				Transformer Rating ①		Catalog Number		
						JVW-4	JVW-5	
						BIL 75 kV	BIL 110 kV	
Δ	Y	Y Only	GY Only ④	Primary Voltage	Ratio	Two-Bushing Model	Single-Bushing Model	Two-Bushing Model
2,400	2,400	4,160	---	2,400	20:1	764X030011	---	---
4,200	4,200	7,280	---	4,200	35:1	764X030012	---	---
4,800	4,800	8,320	---	4,800	40:1	764X030013	---	---
7,200	7,200	---	---	7,200	60:1	764X030014	---	---
---	---	---	7200 ⑤	7,200	60:1	---	765X030051	765X030042
---	---	---	8400 ⑥	8,400	70:1	---	765X030052	765X030044
12,000	12,000	12,000	---	12,000	100:1	---	---	765X030045
14,400	14,400	14,400	---	14,400	120:1	---	---	765X030046

Review of a typical installation

Catalog Number	Current Ratio	Relay Class 60 Hz	Metering Class 60 Hz	Rating Factor
Single Ratio Type JKW-5C 15kV, 110kV BIL				
755C150001	5:5	C200	0.3 B-1.8	1.5
755C150002	10:5	C200	0.3 B-1.8	1.5
755C150003	15:5	C200	0.3 B-1.8	1.5
755C150004	20:5	C200	0.3 B-1.8	1.5
755C150005	25:5	C200	0.3 B-1.8	1.5
755C150006	30:5	C200	0.3 B-1.8	1.5
755C150007	40:5	C200	0.3 B-1.8	1.5
755C150008	50:5	C200	0.3 B-1.8	1.5
755C150009	75:5	C200	0.3 B-1.8	1.5
755C150010	100:5	C200	0.3 B-1.8	1.5
755C150011	150:5	C200	0.3 B-1.8	1.5
755C150012	200:5	C200	0.3 B-1.8	1.5
755C150013	300:5	C200	0.3 B-1.8	1.5
755C150014	400:5	C200	0.3 B-1.8	1.5
755C150015	600:5	C200	0.3 B-1.8	1.5
755C150016	800:5	C200	0.3 B-1.8	1.33
755C150017	1000:5	C150	0.3 B-1.8	1.33
755C150018	1200:5	C200	0.3 B-1.8	1.1

	1	2	3	4	5	10A	15A	20A	25A	30A	35A	40A	45A	50A	55A	60A
0.3B1.8, RF 1.5, 40:5						*±0.6 Accuracy*						±0.3 Accuracy				

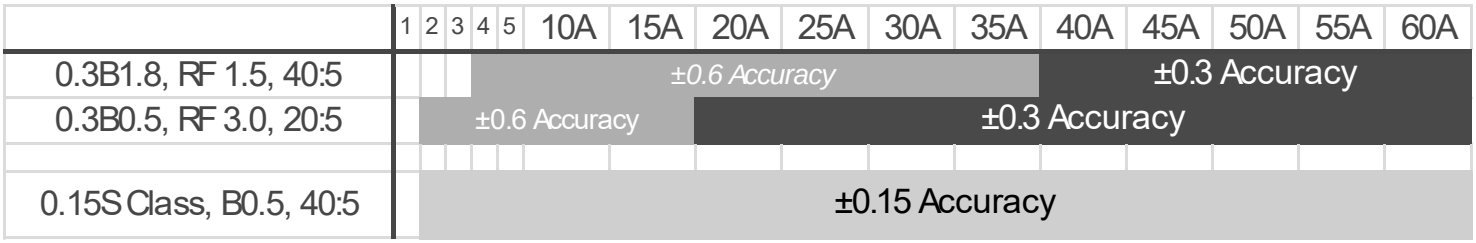
Review of a typical installation

Catalog Number	Current Ratio	Relay Class 60 Hz	Metering Class 60 Hz	Rating Factor
Single Ratio Type JCK-5C 15kV, 110kV BIL				
755C152001	5:5	C40	0.3 B-0.5	3.0
755C152002	10:5	C40	0.3 B-0.5	3.0
755C152003	15:5	C40	0.3 B-0.5	3.0
755C152004	20:5	C40	0.3 B-0.5	3.0

	1	2	3	4	5	10A	15A	20A	25A	30A	35A	40A	45A	50A	55A	60A
0.3B1.8, RF 1.5, 40:5						*±0.6 Accuracy*						±0.3 Accuracy				
0.3B0.5, RF 3.0, 20:5						±0.6 Accuracy						±0.3 Accuracy				

Review of a typical installation

JKW-5A DATA TABLE				
Current Ratio (in Amps) Pri : Sec	**Continuous Thermal Current Rating Factor 30°C Ambient**	**Mechanical Limit; Amperes**	**One-Second Thermal Limit, Amperes**	**Catalog Number**
5:5	1.5	625	465	**755X053101**
10:5	1.5	1,250	930	**755X053102**
15:5	1.5	1,875	1,470	**755X053103**
20:5	1.5	2,500	1,860	**755X053104**
25:5	1.5	3,125	2,300	**755X053105**
30:5	1.5	3,750	2,460	**755X053106**
40:5	1.5	5,000	3,720	**755X053107**
50:5	1.5	6,250	4,600	**755X053108**



Review of a typical installation

		1	2	3	4	5	10A	15A	20A	25A	30A	35A	40A	45A	50A	55A	60A						200A
1	0.3B1.8, RF 1.5, 40:5				±0.6 Accuracy									±0.3 Accuracy									
2	0.3B0.5, RF 3.0, 20:5		±0.6 Accuracy							±0.3 Accuracy													
3	0.15S Class, B0.5, 40:5		±0.15 Accuracy																				
4	**Extended Range 200:5**		±0.15 Accuracy																				

Review of a typical installation

Which is least expensive?
Which is most expensive?
Which offers the “fastest’ payback?

			1	2	3	4	5	10A	15A	20A	25A	30A	35A	40A	45A	50A	55A	60A	
1		0.3B1.8, RF 1.5, 40:5				*±0.6 Accuracy*								±0.3 Accuracy					
2	10% less	0.3B0.5, RF 3.0, 20:5			±0.6 Accuracy						±0.3 Accuracy								
3	10-20% more	0.15S Class, B0.5, 40:5						±0.15 Accuracy											
4	considerably more	**Extended Range 200:5**	±0.15 Accuracy																

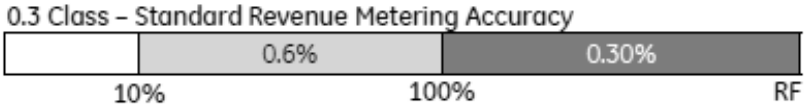
Review of a typical installation

- 13.8 kV, Grounded Wye
  - 70:1 PT
- Max: 60amps
  Normal: 20amps
  Min: 2amps
  - 20:5 CT, RF3.0 – Cost less, 0.3
  - 40:5 CT, RF1.5 – Cost more, 0.15

What Would You Select?
Current Range – 30amps – 1200amps

JAK-0C DATA TABLE

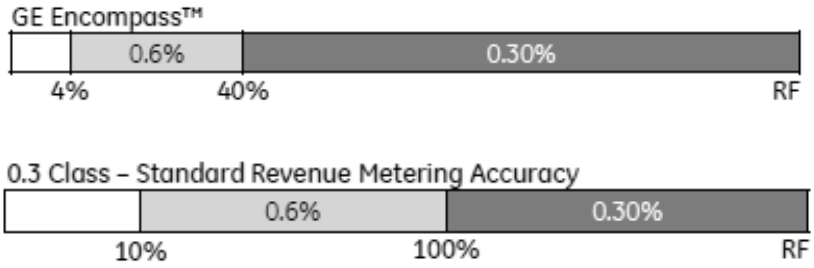
Current Ratio (Amps) Pri : Sec	Continuous Thermal Current Rating Factor		Window I.D. (inches)	Burden
	@ 30°C Amb.	@ 55°C Amb.		
				Window-Typ
100:5	4.0	4.0	1.50	B0.2
**100:5	4.0	4.0	2.60	B0.1
150:5	4.0	4.0	2.60	B0.1
200:5	4.0	4.0	2.60	B0.5
200:5	4.0	2.9	2.60	B0.2
200:5	4.0	2.9	3.062	B0.1
250:5	4.0	4.0	2.60	B0.5
**300:5	4.0	2.9	3.062	B0.5
400:5	4.0	2.9	3.062	B0.5
500:5	3.0	2.4	3.062	B0.5
600:5	2.0	1.8	3.062	B0.5
800:5	2.0	1.5	3.062	B0.5
1000:5	2.0	1.5	3.062	B0.5



What Would You Select?
Current Range – 30amps – 1200amps

Encompass™ MODEL JAK-0W

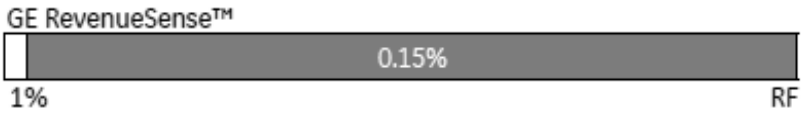
Current Ratio (Amps)	IEEE Metering Accuracy (60Hz)	Rating Factor 30°C	Rating Factor 55°C
500:5	0.3 B0.5[1]	4.0	3.0

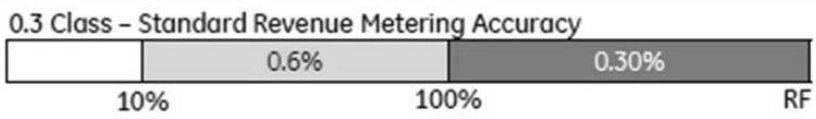


What Would You Select?
Current Range – 30amps – 1200amps

RevenueSense™ MODEL JAK-0S

Current Ratio (Amps)	IEEE Metering Accuracy (60Hz)	Rating Factor 30°C	Rating Factor 55°C
600:5	0.15SB0.2[1]	3.0	2.0
1000:5	0.15SB0.5[1]	2.0	1.5





Sizing CTs for Metering

- Use as low of a ratio as possible with the RF covering the maximum current level
- CT error is **almost** always negative
- Using a more accurate metering class will almost always result in higher revenue levels
- Burden adversely affects accuracy, the lower the applied burden, the better the accuracy performance

Installation Suggestions

Check and Double-Check Polarity!

Be cautious - Ground a point in circuits connected to VT and CT Secondaries.

Never Open Circuit a CT Secondary while the primary is energized.

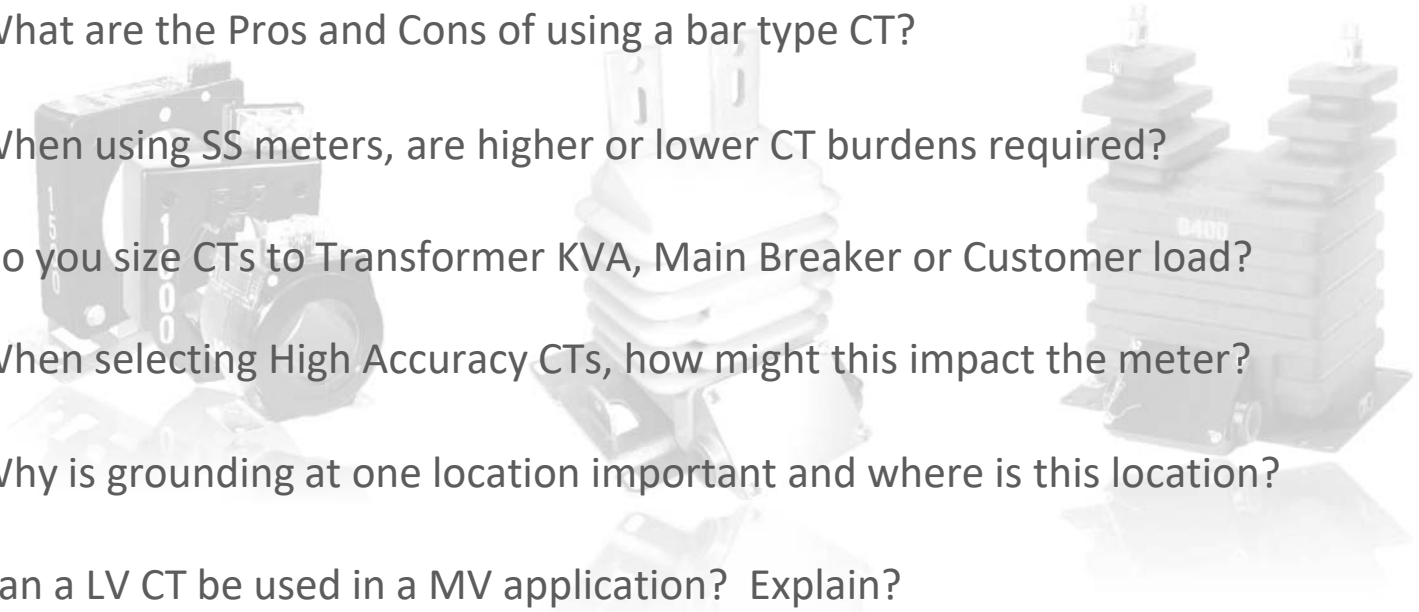
- **For Tapped Secondary CT's, DO NOT short circuit the unused terminals.**

Never Short Circuit the Secondary Terminals of a voltage transformer.

After CT windings have been exposed to direct current, demagnetize the CT to eliminate errors that may be caused by residual magnetism.

Random Thoughts and Questions?

- Is there an advantage to using AWG10 over AWG12 for secondary wiring? Why?
- What are the Pros and Cons of using a bar type CT?
- When using SS meters, are higher or lower CT burdens required?
- Do you size CTs to Transformer KVA, Main Breaker or Customer load?
- When selecting High Accuracy CTs, how might this impact the meter?
- Why is grounding at one location important and where is this location?
- Can a LV CT be used in a MV application? Explain?
- What does a phase angle (Site Genie) tell you about a metering circuit?



Thank You For Your Time

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imagination at work