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Instrument Transformer Testing

Overview and Procedural Review for NYSEMEC, Fall 2024

11/07/24

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AGENDA

- Instrument Transformer Overview
- Field Testing
  - Procedural Review
  - Technical Review
- Shop Testing
  - Procedural Review
  - Technical Review
- Advancements in Technology
  - Extended Range CTs and Testing Implications

Instrument Transformer Overview

"A **current transformer** (**CT**) is used for measurement of alternating electric currents. Current transformers, together with voltage (or potential) transformers (VT or PT), are known as **instrument transformers**. When current in a circuit is too high to apply directly to measuring instruments, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. A current transformer isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays in the electrical power industry." - Wikipedia

What are Instrument Transformers

- Specialized transformers designed to operate measurement and control devices:
  - Voltmeters
  - Ammeters
  - Watthour Meters
  - & Relays
- Transform high voltage or high current to lower values.
  - Watthour meters may handle up to 320 amps and 480 volts.
- IT's transform with a high degree of precision.
- Also used to isolate high voltage or high available fault current from both the operator and end devices.

IT Selection Criteria

- Nominal System Voltage
- Basic Impulse Level
- Environment
- Accuracy Class

- VT Considerations
  - Burden
  - Type of Circuit & Connection
  - Physical mounting requirements
  - Fusing
- CT Considerations
  - Burden
  - Physical mounting requirements
  - Expected Load Current
  - Overcurrent Capability

IT Selection Criteria

- Nominal System Voltage
  - The insulation class is based on phase-to-phase voltage
- Basic Impulse Level
  - IT BIL must match or exceed the System BIL.
  - Caution: More than one BIL may be available for a given Nominal System Voltage.
- Environment
  - Indoor or Outdoor installation.
  - Contaminating atmosphere.
  - High Altitude (Over 3,300 feet above sea level, derate transformer insulation)

IT Accuracy Class

- Accuracy Classes define an envelope of ratio accuracy and phase angle accuracy for defined burdens.
- Separate accuracy envelopes are defined for Current Transformers and Voltage Transformers.
- ANSI C57.13 defines 3 levels of performance:
  - 0.3 Revenue Metering
  - 0.6 Indicating Instruments
  - 1.2 Indicating Instruments
  - – Accuracy is defined for load power factors from 1.0 to 0.6 lagging.

- VT Accuracy
  - performance from 90% rated voltage to 110%.
- CT Accuracy
  - large performance envelope from 10% of rated current to rated current.
  - smaller performance envelope from rated current to rating factor.

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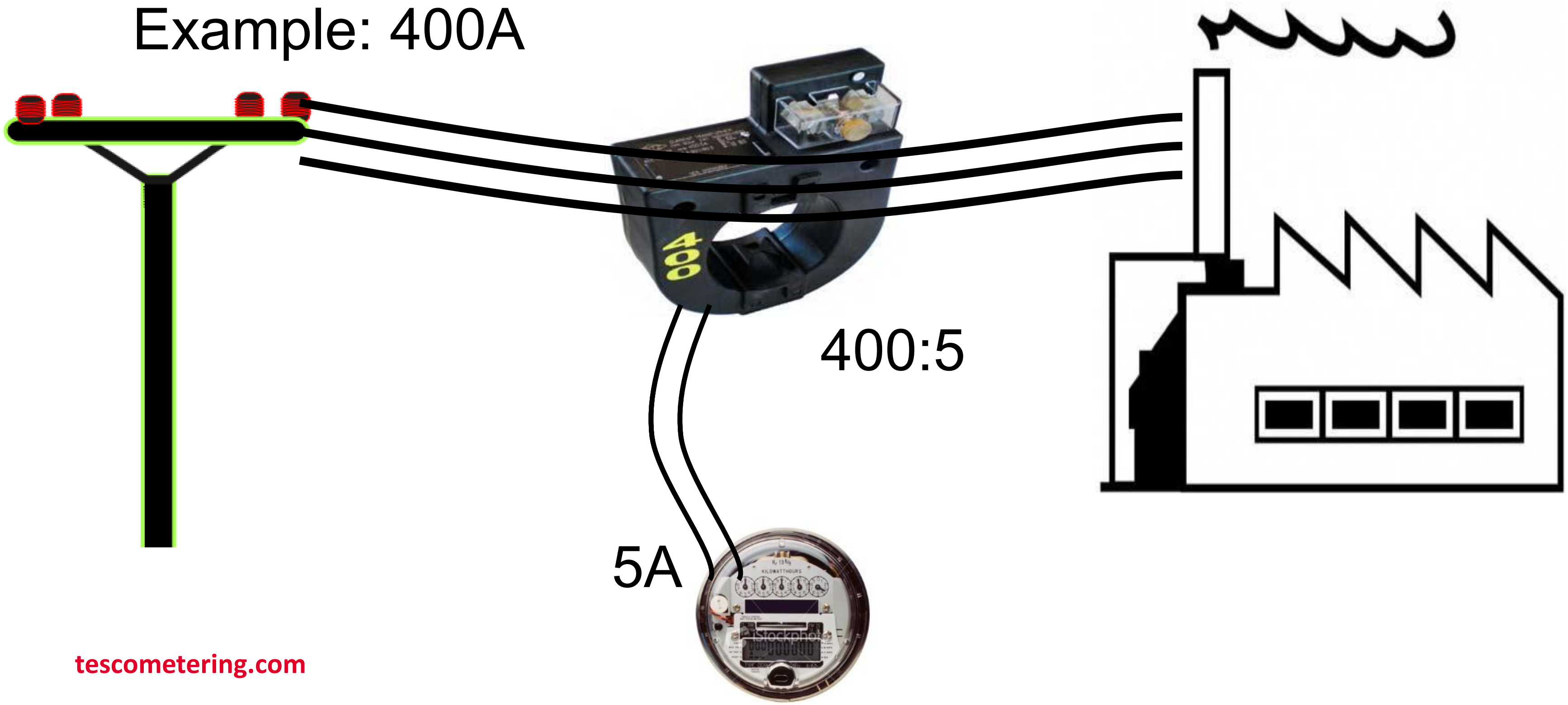
Current Transformers

Conceptual and technical overview

Transformer-Rated

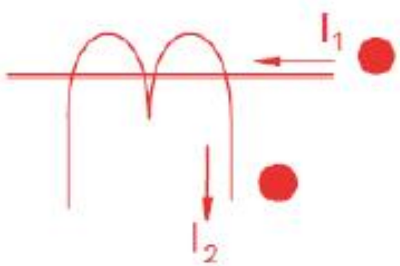
Primarily Commercial/Industrial
(9S, 16S)

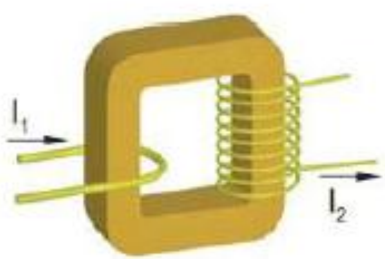
Relatively High Current
Example: 400A



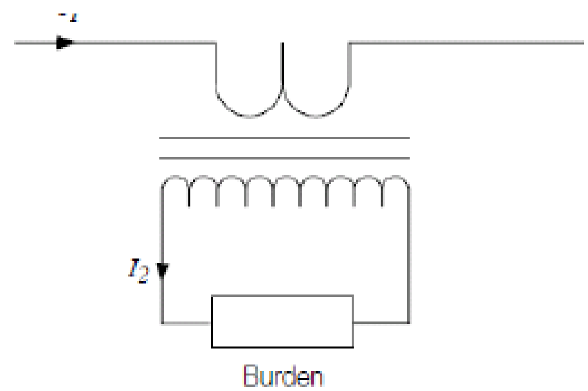
Current Transformers Conceptual Representation

Ideal. No losses

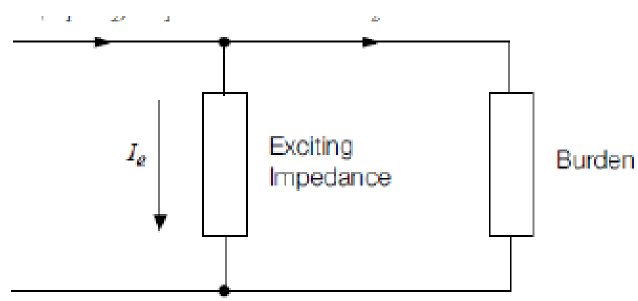




$$I_1 \times N_1 = I_2 \times N_2$$



$$I_2 = \frac{N_1}{N_2} \times I_1$$



$$I_2 = \frac{N_1}{N_2} \times I_1 - I_e$$

Real, with core losses

CT's – Functions and Terminology

Ratio

For instance, a CT with a 400:5 ratio will produce 5A on the secondary, when 400A are applied to the primary.

CT's – Functions and Terminology

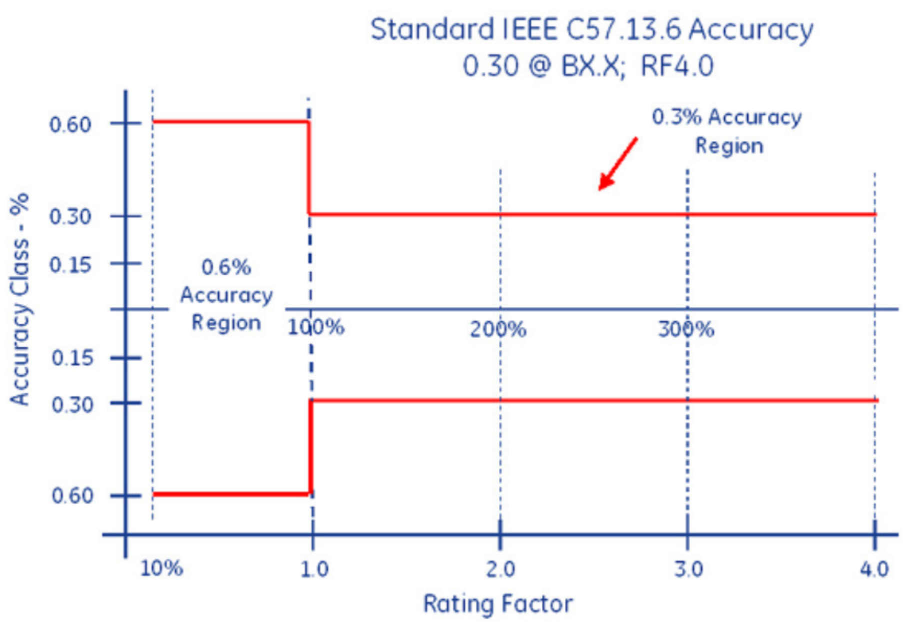
Thermal Rating Factor

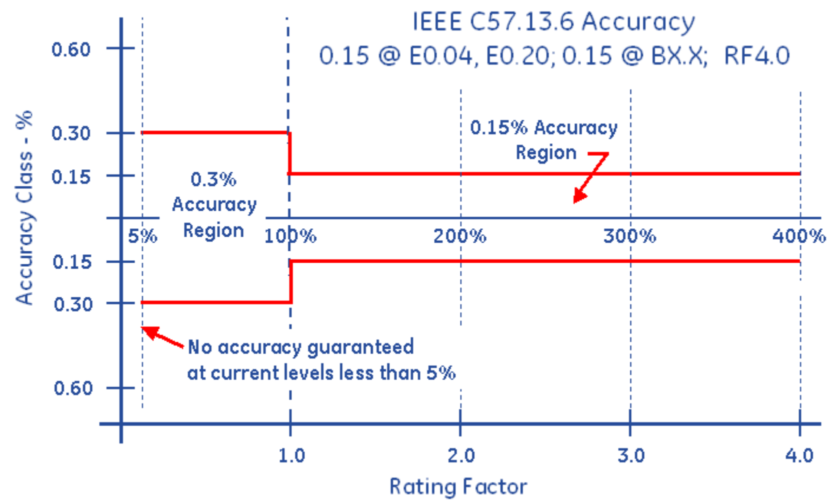
A value representing the amount by which the primary current can be increased without exceeding the allowable temperature rise. For instance, a RF of 4.0 at 30° ambient on a 400:5 ratio CT would allow for a primary current up to 1600A.

CT's – Functions and Terminology

Accuracy Classifications and Burden

All CT's fall within an accuracy class.
IEEE Standards have defined accuracy classes.

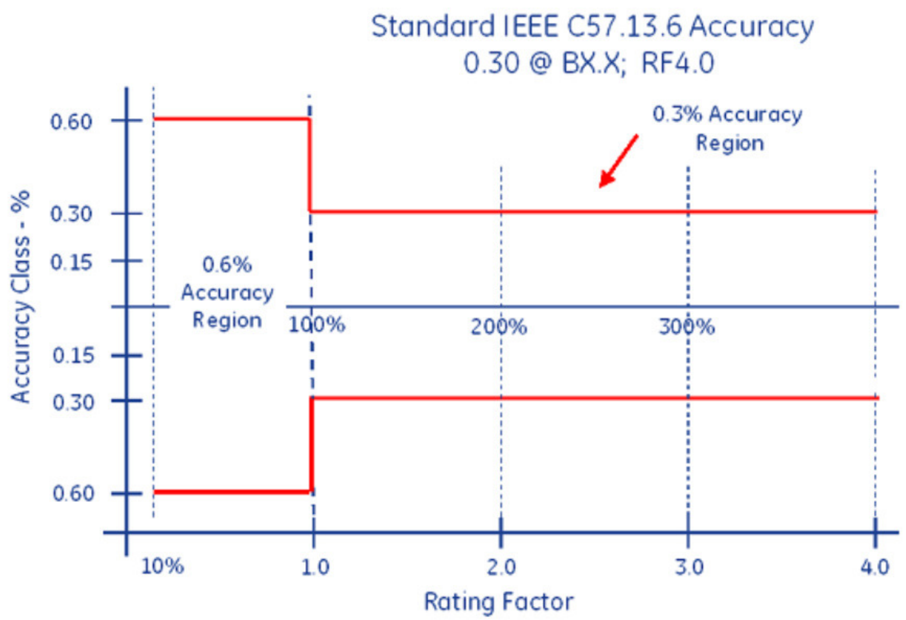




CT's – Functions and Terminology

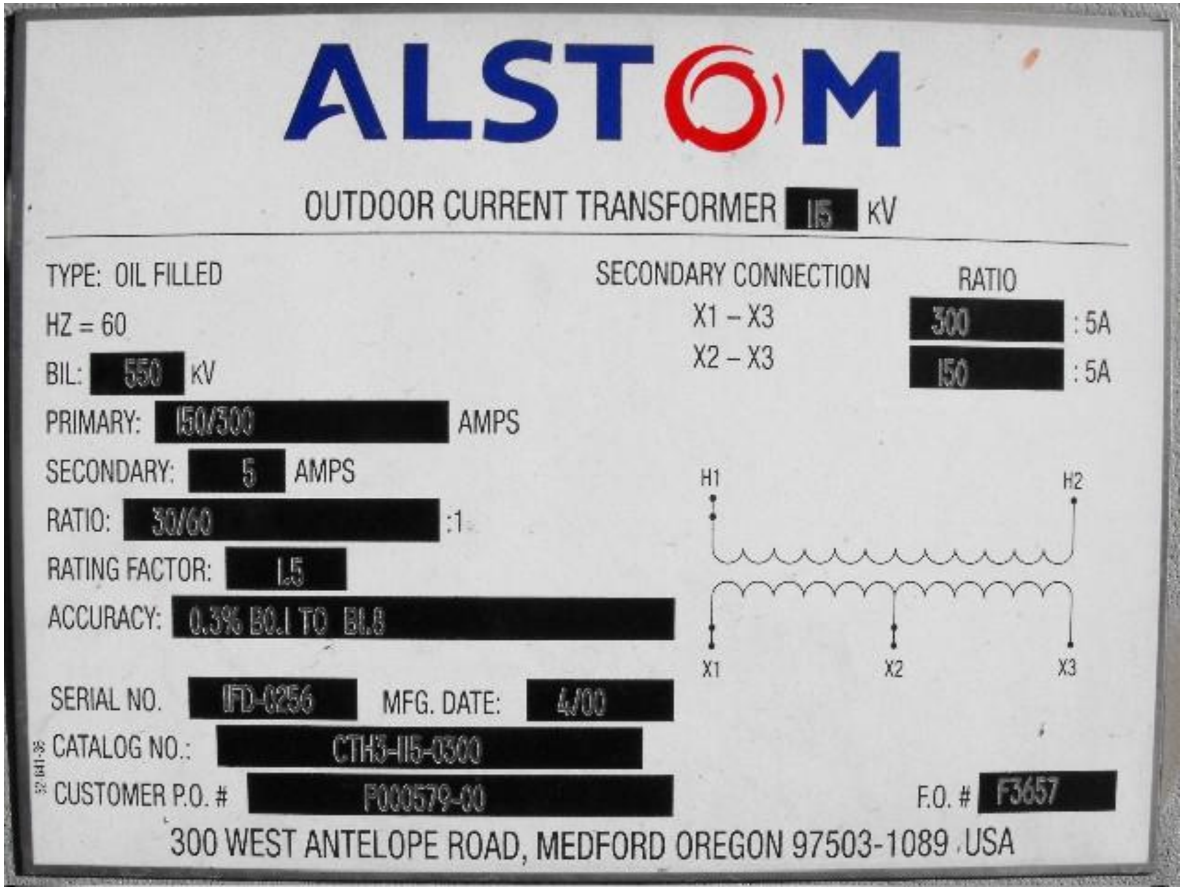
Accuracy Classifications and Burden

Example: 0.3% @ B0.1, B0.2, B0.5



CT's – Functions and Terminology

Faceplate



IT Catalog Sheet

JAB-0C Grecian Urn 600 Volt CT

APPLICATION
Designed for indoor service; especially designed for installation over the secondary bushings of pad-mounted transformers from 75 kVA to 3000 kVA. For mounting and application information, including use at higher voltages, and matching the current rating to the pad transformer thermal capability, please refer to the Applications Information section of catalog GEP-9186.

WEIGHT
Approximately ....8.25 lbs.

REFERENCE DRAWINGS
Outline: 0121C33851

INSULATION LEVEL
0.6kV; BIL 10kV full wave.

FREQUENCY
50-60 Hz

JAB-0C DATA TABLE

Current Ratio Pri : Sec	ANSI Accuracy Class @ 60 Hz					Continuous Thermal Current Rating Factor ψ		Catalog Number
	B-0.1	B-0.2	B-0.5	B-0.9	B-1.8	@30°C Amb.	@55°C Amb.	
200:5	0.3	—	—	—	—	4.0	2.9	750X136202
200:5	0.3	—	—	—	—	4.0	2.9	750X136252 ‡
300:5	0.3	0.3	—	—	—	4.0	2.9	750X136203
300:5	0.3	0.3	—	—	—	4.0	2.9	750X136253 ‡
400:5	0.3	0.3	—	—	—	4.0	2.9	750X136204
500:5	0.3	0.3	0.3	—	—	4.0	2.9	750X136205
600:5	0.3	0.3	0.3	—	—	3.0	2.2	750X136206
800:5	0.3	0.3	0.3	—	—	3.0	2.2	750X136208
1000:5	0.3	0.3	0.3	—	—	2.0	1.5	750X136210
1200:5	0.3	0.3	0.3	—	—	2.0	1.5	750X136212
1500:5	0.3	0.3	0.3	0.3	—	2.0	1.5	750X136215
2000:5	0.3	0.3	0.3	0.3	0.3	1.5	1.1	750X136220
3000:5	0.3	0.3	0.3	0.3	0.3	1.33	1.0	750X136230

Notes:
ψ A high temperature version is available for use in locations with unusually high ambient temperatures.

CT Rating Factor
The MOST Misunderstood Spec

- Rating Factor has absolutely nothing to do with burden.
- If a CT has a rating factor of 4 it means that at 30°C it can be used up to 4X its label current and maintain its accuracy Class.
- A CT with a label RF=4 only has an RF = 3 at 55°C

CT Rating Factor

- Maximum Expected load current should approach the Thermal Rating Factor of the CT.
- Rating Factor Example: 75:5, RF 3.0 @ 30°C
  - maximum expected primary "load" current = 225 amps, and
  - maximum expected secondary "meter" current = 15 amps,
  - assuming that ambient temperature does not exceed 30°C.

CT Rating Factor

- Maximum Expected Load Current
  - Rating Factors are used to keep transformer winding temperatures below 85 degree C.
  - Rating Factors may be given for:
    - Outdoor applications 30 degrees C ambient
    - Indoor applications 55 degrees C ambient
  - Rating Factors may be adjusted for ambient temperatures other than 30 and 55 degree C.

$$\frac{(\text{New RF @ New Ambient})^2}{(\text{Stated RF at 30 C})^2} = \frac{(85 - \text{New Ambient})}{\text{55 degrees rise}}$$

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%

APPLICATION EXERCISE

A commercial building is being built with a 4-wire wye main service, rated for 200 A at 12,470/7200Y. Your boss wants you to meter the building with an electronic polyphase watt-hour meter. The initial load is expected to average about 1000 kW, but may peak to 2000 kW on occasion.

Select the best CTs And PTs for the job

NSV

BIL

Type

Ratio

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Current Calculations

- Expected Current = 1,000,000W/7200volt x 3
- Expected Current = 1,000,000W/(12,470volt x 1.732)
- Expected Current = 46.3 amps

- Peak Current = 2,000,000W/7200volt x 3
- Peak Current = 2,000,000W/(12,470volt x 1.732)
- Peak Current = 92.6 amps

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CT Field Testing

Conceptual and technical overview

CT Testing is Important!

1) Test for correct ratio
2) Test for functionality at rated burdens

CT Field Testing

- Three Approaches in use today
  - Direct RATIO measurement with applied burden
    - Most accurate approach tells us exactly what we want to know
    - Measures directly the quantities we care about CT Ratio and Phase Error
    - Is more complicated to perform.

CT Field Testing

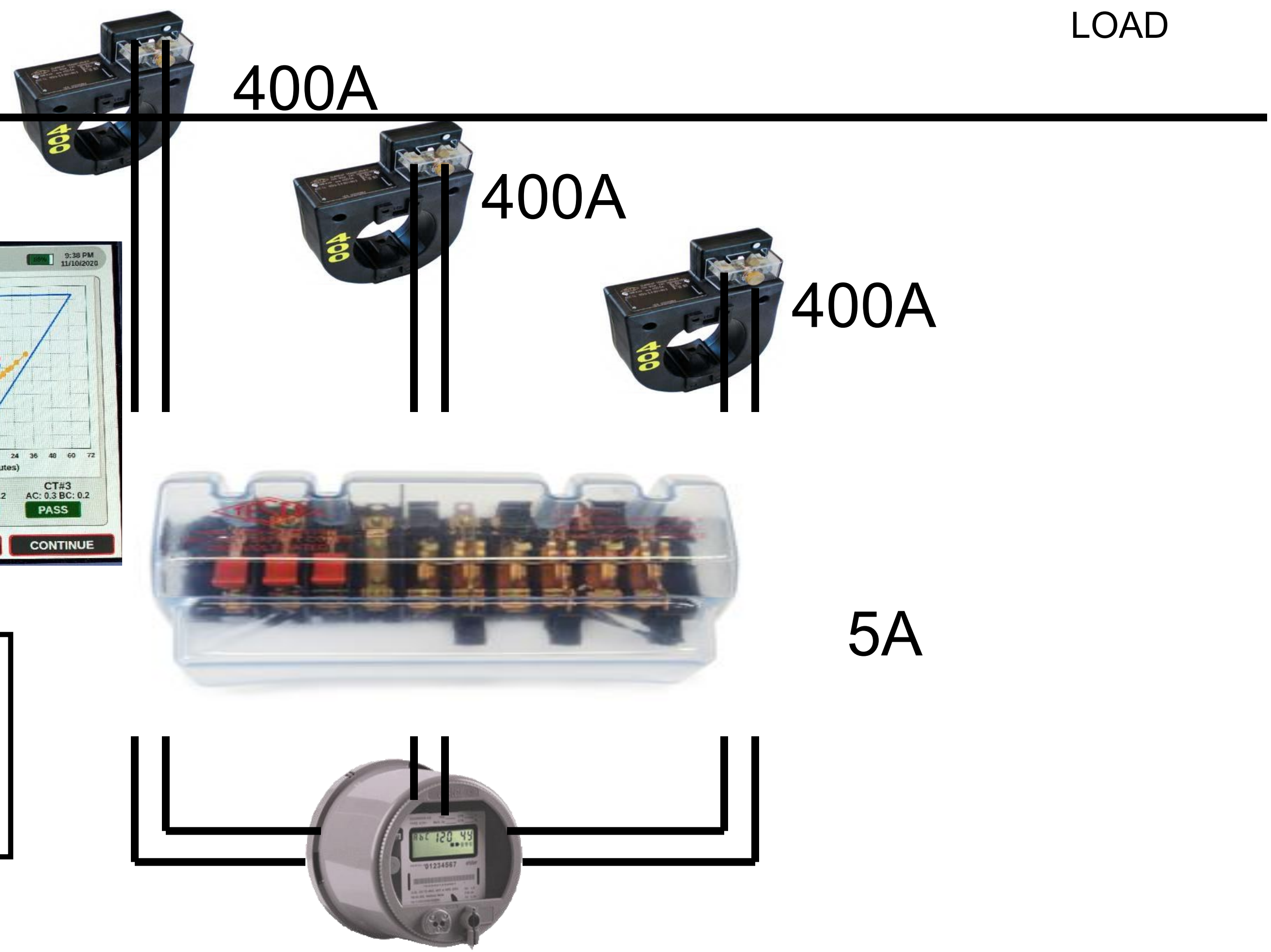
- Alternate Approaches
  - Burden only
    - A compromise: tells us if circuit is stable under excess burden
    - Can’t give us the ratio which is what we really care about.
  - Admittance Testing
    - Allows us to look for changes from previous measurements.
    - Doesn’t directly give ratio
    - Accuracy typically ±5%

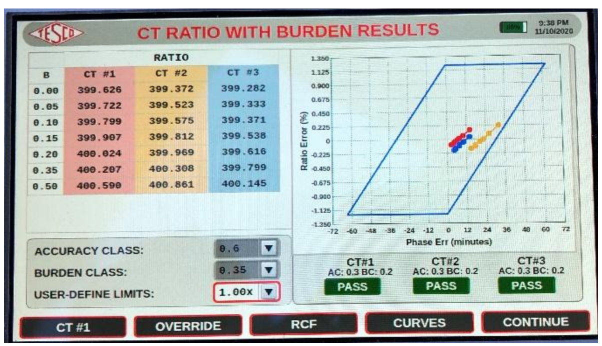
- Other Tests
  - Direct Burden Measurement
    - If you measure the voltage across the CT terminals
    - AND
    - The current output of the CT
    - Using Ohms Law you can compute the actual burden seen by the CT

SIMPLY: Burden = Voltage/Current

- A very simple and direct way to see if a CT is overburdened, but not to test its accuracy

Ratio of Primary Current to Secondary Current

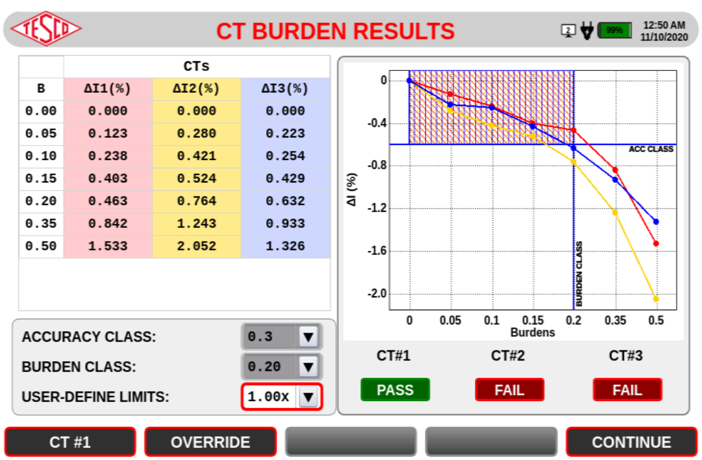




Calculate Ratio

Functionality with Burden Present on the Secondary Loop

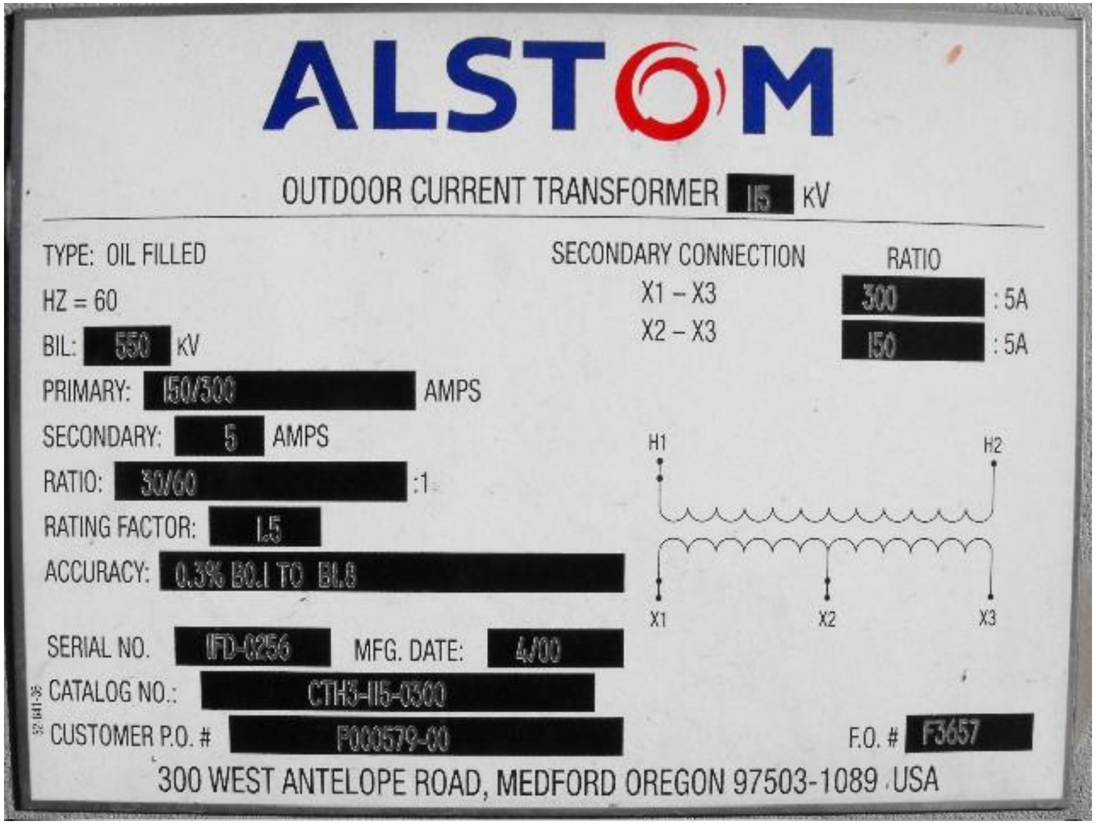
PHASE A



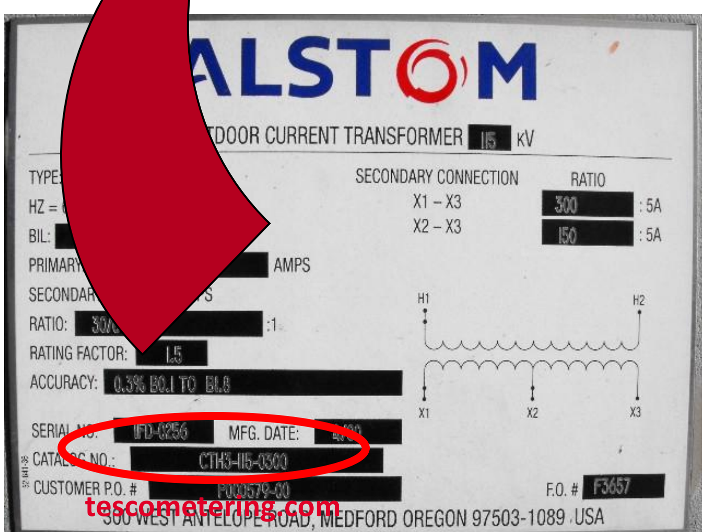
Some burden will always be present – junctions, meter coils, test switches, cables, etc.

CT's must be able to maintain an accurate ratio with burden on the secondary.

Functionality with Burden Present on the Secondary Loop



Functionality with Burden Present on the Secondary Loop



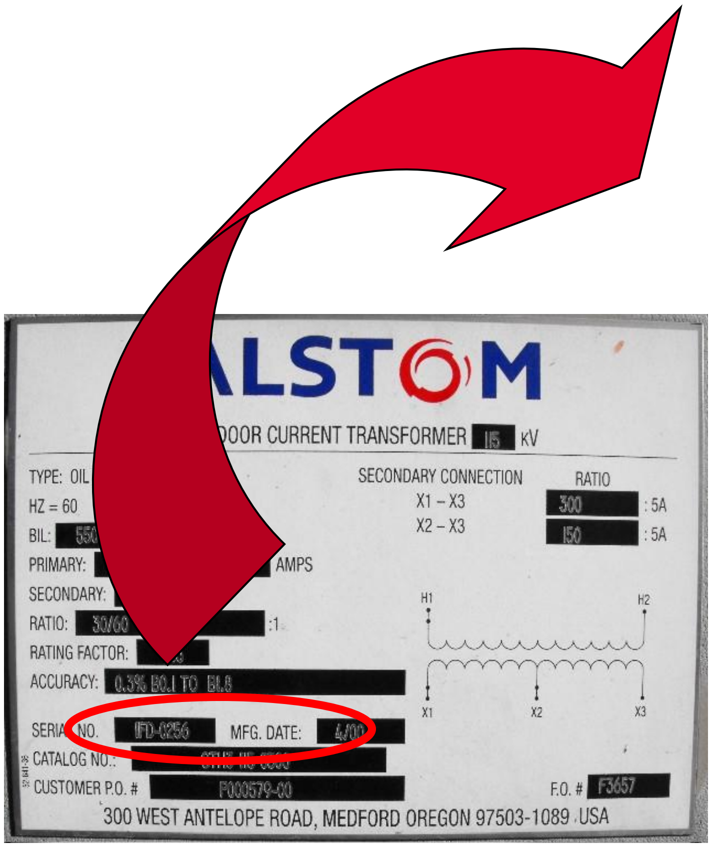
Example Burden Spec:

0.3% @ B0.1, B0.2, B0.5

or

There should be less than the 0.3% change in secondary current from initial (“0” burden) reading, when up to 0.5Ohms of burden is applied

Functionality with Burden Present on the Secondary Loop

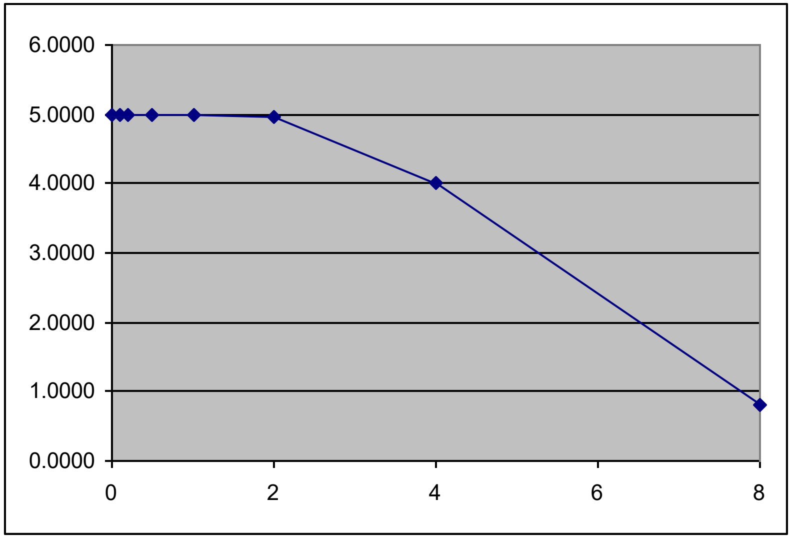


ANSI Burden Values

0.1 Ohms
0.2 Ohms
0.5 Ohms
1 Ohms
2 Ohms
4 Ohms
8 Ohms

0.3% @ B0.1, B0.2, B0.5

Initial Reading = 5Amps
0.3% x 5A = 0.015A
5A – 0.015 = 4.985A

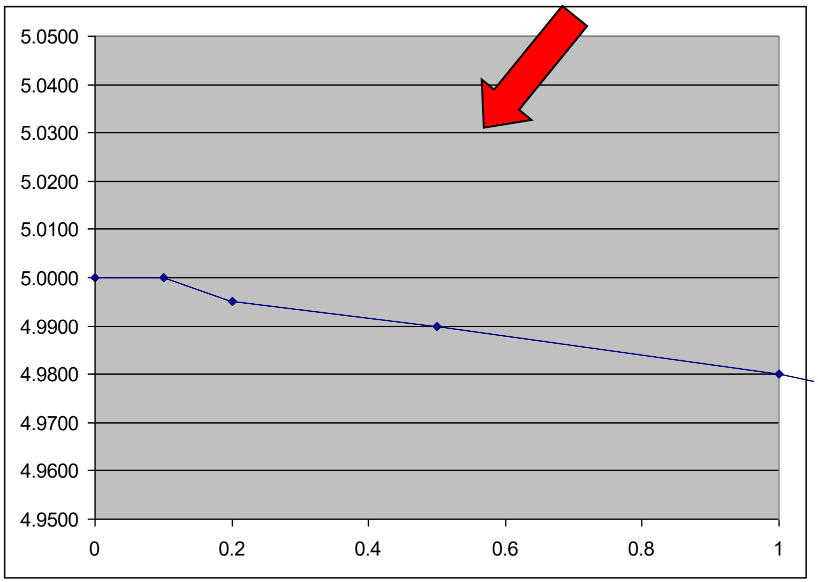


Burden	Reading
0	5.0000
0.1	4.9999
0.2	4.9950
0.5	4.9900
1	4.9800
2	4.9500
4	4.0000
8	0.8000

0.3% @ B0.1, B0.2, B0.5

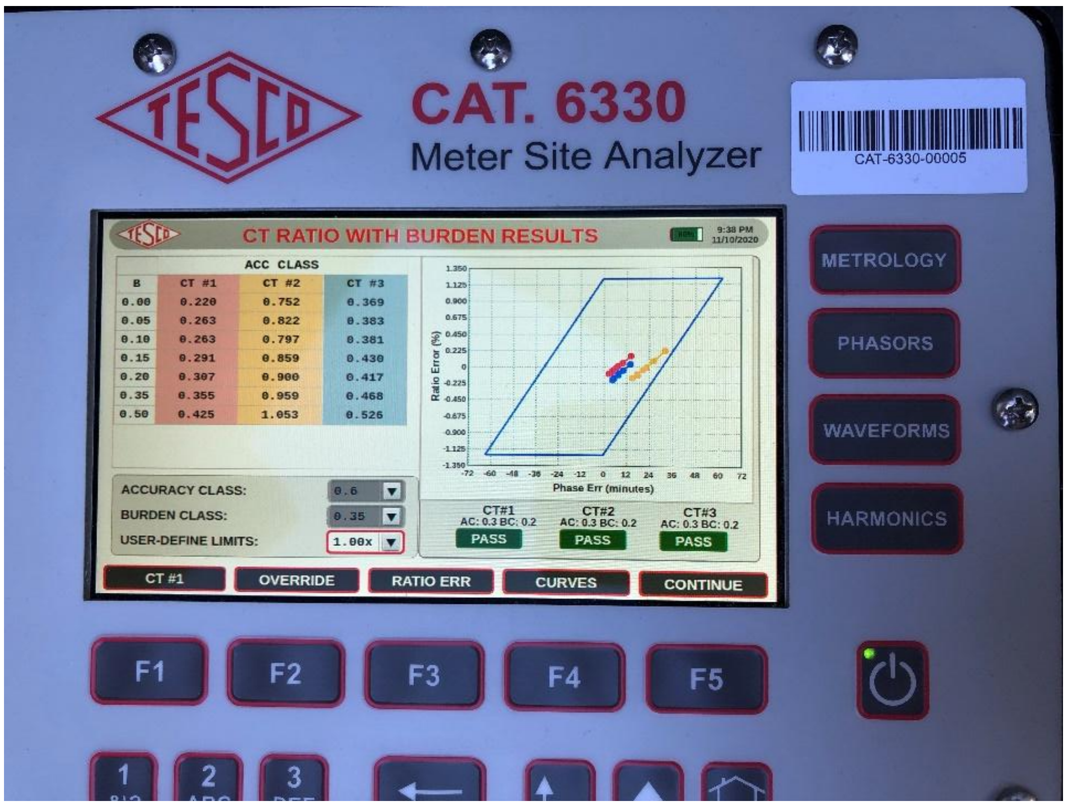
At 0.5Ohms of Burden the secondary current is still at 4.990A – Less than 0.3% change – Good CT!

Initial Reading = 5Amps
0.3% x 5A = 0.015A
5A – 0.015 = 4.985A



Burden	Reading
0	5.0000
0.1	4.9999
0.2	4.9950
0.5	4.9900
1	4.9800
2	4.9500
4	4.0000
8	0.8000

Application of Burden and Calculation



Manual reading of initial and post-burden secondary currents

Admittance Testing

What is Admittance?
Measured in units of MiliSiemens (mS)
Admittance is the inverse of impedance.
Impedance is the opposition to current.
Therefore, admittance testing measures the overall "health" of the secondary loop of the CT.

Admittance Testing

Admittance testing devices inject an audio sine wave signal into the secondary loop of the CT.
The resulting current is measured.
The voltage of the initial signal is known.
From these two parameters, the impedance, and thus the admittance can be calculated.

Admittance Testing

Admittance test results are not immediately intuitive.

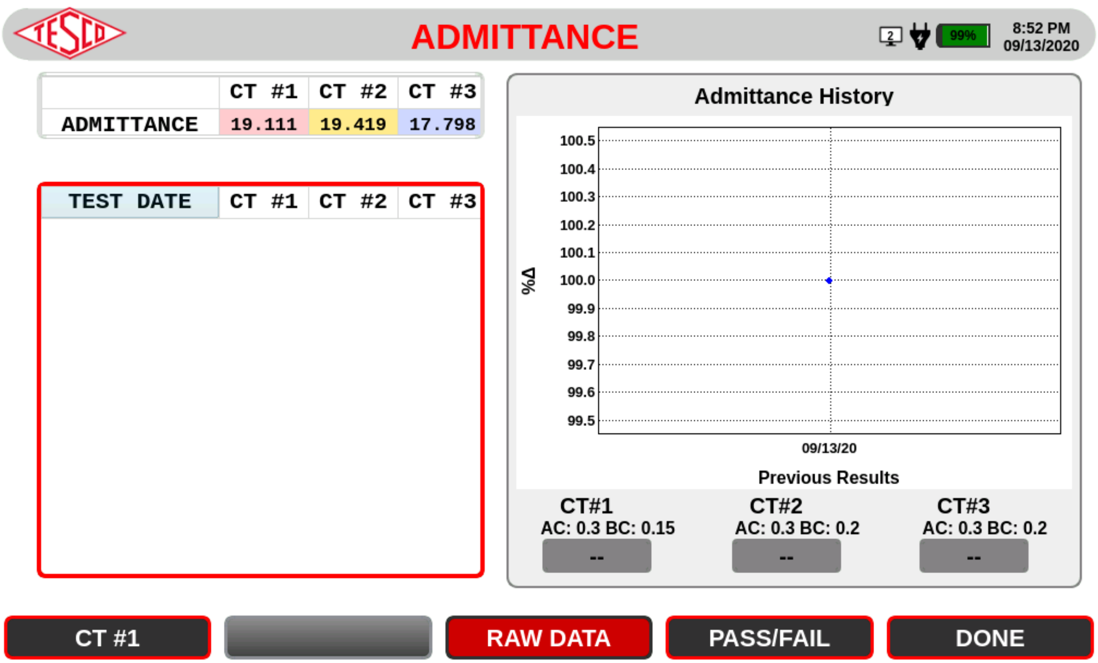
Some analysis and interpretation is need.

What do all these mS values mean?

ADMITTANCE TESTING

Three phase process is recommended.

1. Test each CT individually
2. Test the matched sets
3. Test over time

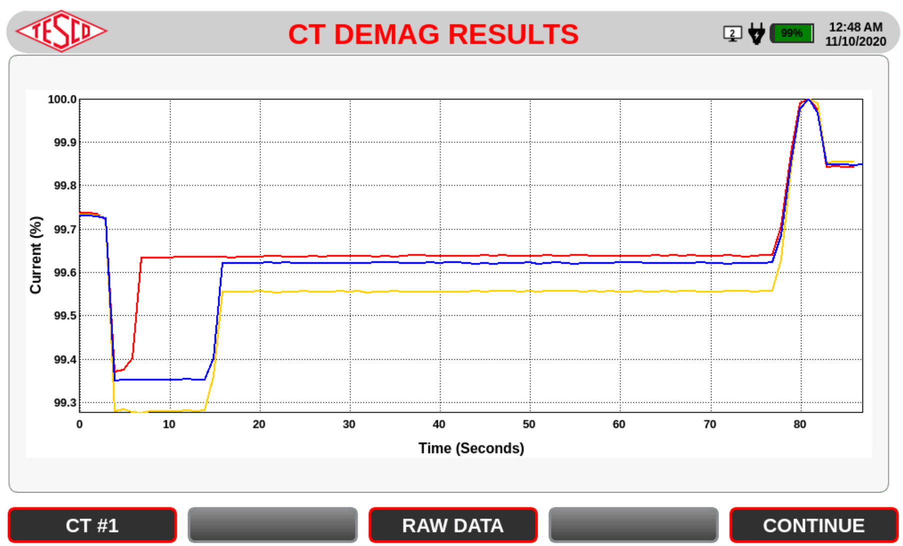


DE-MAGNETIZATION

CT's can become magnetized, due to a number of reasons, including leaving the shorting clip open, near lightning strikes, and harmonic content.

CT's can be demagnetized by slowly and smoothly increasing the secondary resistance until saturation occurs, and then slowly and smoothly decreasing the secondary resistance.

A resistance that will cause a secondary current reduction of 65% to 75% will typically put the CT into saturation.



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SHOP TESTING

Conceptual and technical overview for CTs and PTs

Shop Testing

Shop Testing Includes…

- Accuracy Testing
- Ratio and accuracy testing
- Polarity checking
- Accuracy class determination

For…

- New Transformers
  - Mfg tests
  - Utility tests

Shop Testing Programs

- 100% of all Transformers
  - If not possible then sample testing of all and 100% of all those over a certain size for CT's and all VT's (generally not a large volume)
- Transformer testing should include
  - Ratio and accuracy testing
  - Polarity checking
  - Accuracy class determination
- 100% of all transformer rated meters
  - If not possible then sample testing of all transformer rated meters and 100% of all those going into a certain size service and over
- Meter testing should include
  - Software & Firmware Verification
  - Setting Verification
  - Functional Testing
  - Disconnect/Reconnect Functionality and as left setting

CT Shop Testing - Conceptual

- CT Shop Testing is conducted to ensure the accuracy for instrument transformers of various primary ranges and across a variety of ASNI burdens

CT Shop Testing - Conceptual

- The following ANSI burdens are generally used for CT Burden Values and are available for testing:
  - B-0.1/B-0.2/B-0.5/B-0.9/B-1/B-1.8/B-2/B-4/B-8.
- Common CT IT ranges are between 5 and 8000 Amps
  - Often tested at a variety of maximum load percentage

TERMINAL A		TERMINAL B		TERMINAL C		TERMINAL D	
PRIMARY AMPS	MAX. % LOAD	PRIMARY AMPS	MAX. % LOAD	PRIMARY AMPS	MAX. % LOAD	PRIMARY AMPS	MAX. % LOAD
5	400	25	400	120	400	600	400
10	400	30	400	125	400	750	400
15	400	40	400	150	400	800	400
20	400	50	400	160	400	1000	400
		60	400	200	400	1200	400
		75	400	250	400	1500	400
		80	400	300	400	1800	400
		100	400	400	400	2000	400
				500	400	2500	200
						3000	200
						4000	200
						5000	100
						6000	100
						7500	100
						8000	100

CT Shop Testing – How it Works

- After selecting the appropriate CT Current and associated burden characteristics, test shop test equipment is ramped up to 5 Amps
- Selecting Ratio by selecting primary current on primary selector switch
- Select burden as called out by serial tag highlighted on
- Select the proper leads on the terminal as determined by the current selection switch – these correspond to the terminals on the primary side
- Once set up, you're essentially putting the reference transformer and the device under test on the same primary
  - There is a bus bar that goes from the loading transformer, through the reference transformer on the KCTS and that goes through the primary of the device under test
  - In effect, the reference the transformer and the device under test now share the same primary
  - When there are loose connections on the primary or additional resistance exists, this can lead to accuracy errors
- Completing this loop, or loading circuit, we can now run up our variacs to apply 240V to the primary of our loading transformer, which converts the voltage to our desired and selected current
- Now the reference transformer and the device under test have independently measured secondary signals
  - We compare these two values; with our calibration and SI traceability of the secondary signal on the reference transformer combined with the shared primary current we can determine accuracy of the device under test by comparing the secondary signal against the known value of the reference transformer
- Burden is only applied to the device under test – transformer manufacturer says that they guarantee that their transformers are accurate to a specific burden that is intended to mimic the resistance and inductance present on a transformer once it's installed in the field

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PT Shop Testing

Conceptual and technical overview

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Shop Testing

Shop Testing Includes…

- Accuracy Testing
- Ratio and accuracy testing
- Polarity checking
- Accuracy class determination

For…

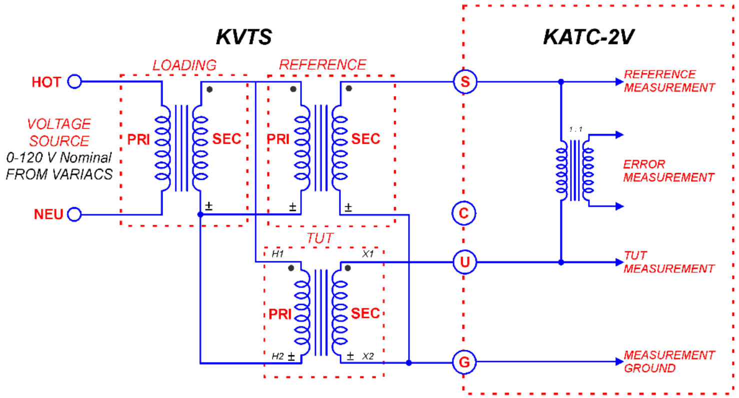
- New Transformers
  - Mfg tests
  - Utility tests

PT Shop Testing – How it Works

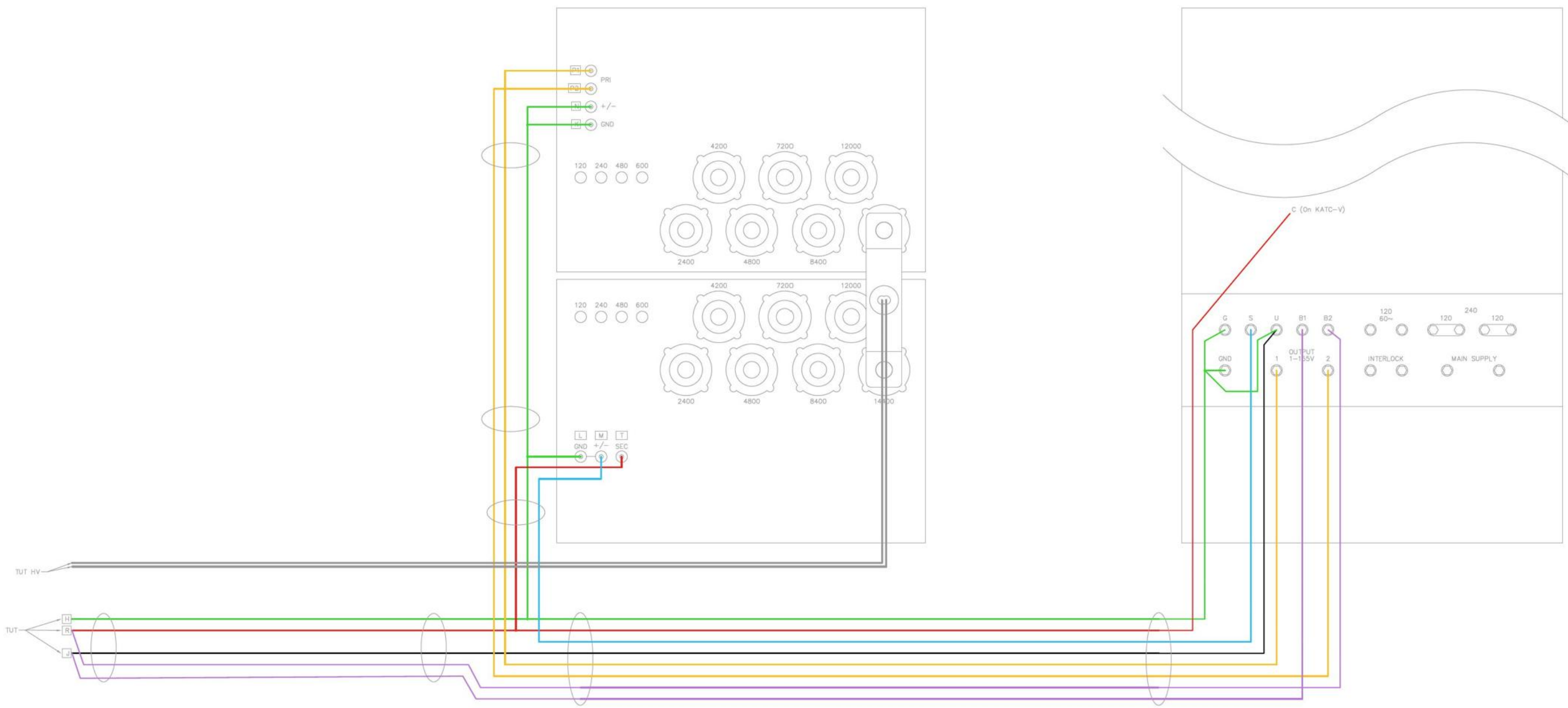
- Conceptually the same as CT
- Instead of measuring 5A secondary, we're measuring 120V secondary
- Burden is the same, only being applied to
- Control Console housing the burdens and the variacs
- The Loading and Reference transformer are additional units that take the 120V from the control console
- Use the variacs on CC induce ramping 120V secondary to the secondary of the loading/supply transformer
- Putting 120V into supply transformer which ramps up the reference/precision transformer and the Device Under Test (DUT) at the same time to place them on the same known primary voltage
- Compares the resulting 120V signal on the reference transformer versus the 120V signal on the DUT

PT Shop Testing – How it Works

VT TEST CONNECTIONS



PT Shop Testing – How it Works



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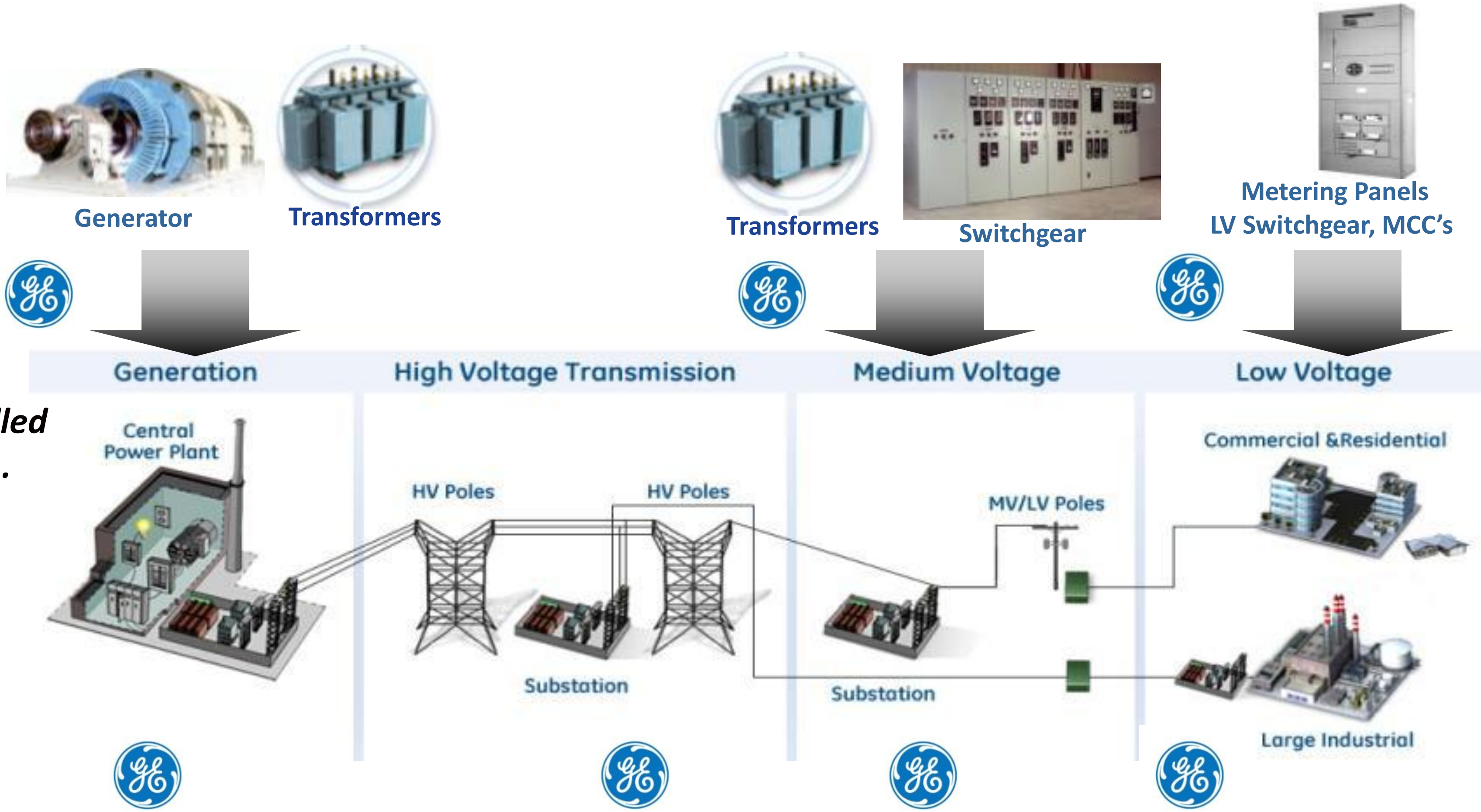
Advancement in Technology

Instrument Transformers and Shop Testing Capabilities

Where Would You Use High Accuracy CT's?

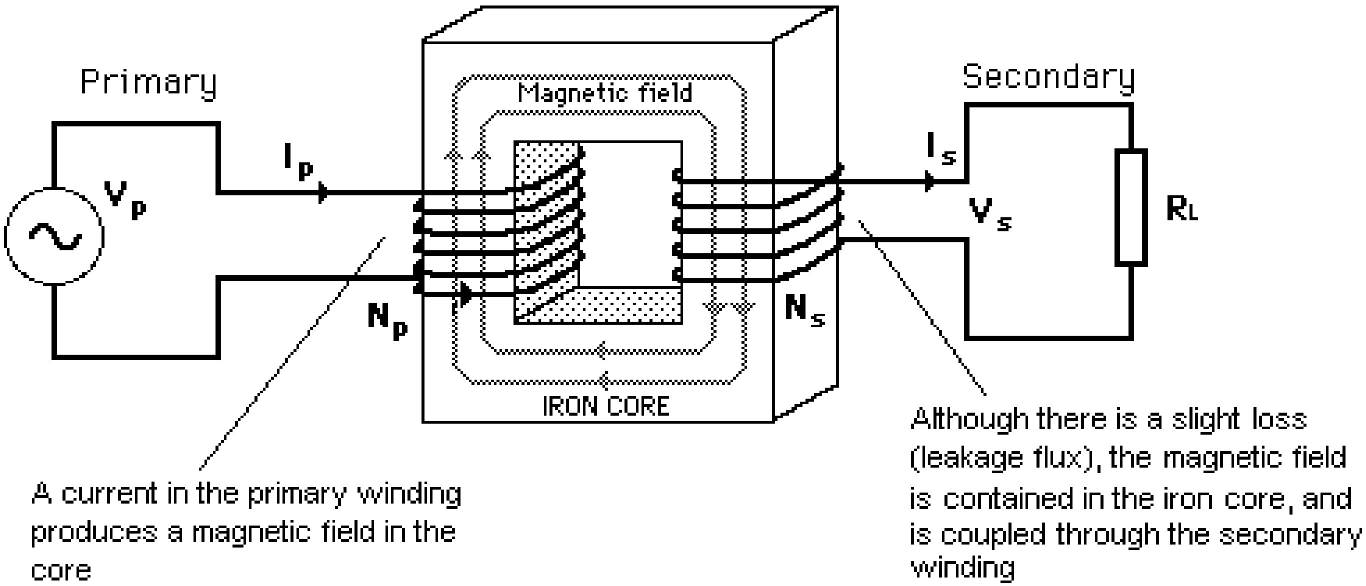
Inside of…

Installed at…



Current Transformers

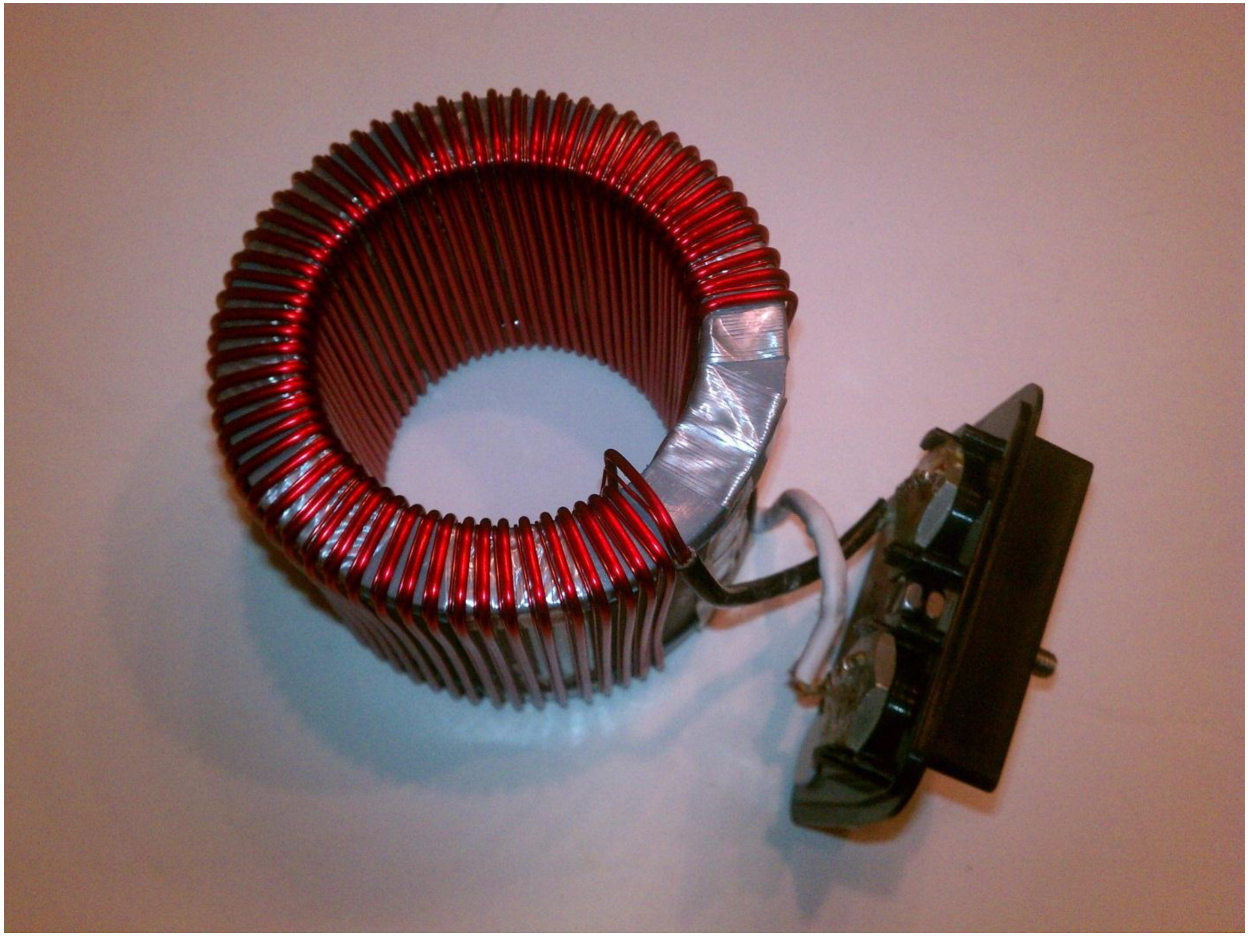
Primary (Input) → Core → Secondary (Output)



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

- **Accuracy – How close can you get it to the Gator Head.**
- **Loser must retrieve balls.**

What Impacts Accuracy?



- Number of Secondary Turns
- Core material and/or cross section
- Secondary Burden

ENERGY REQUIRED TO ENERGIZE THE CORE

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

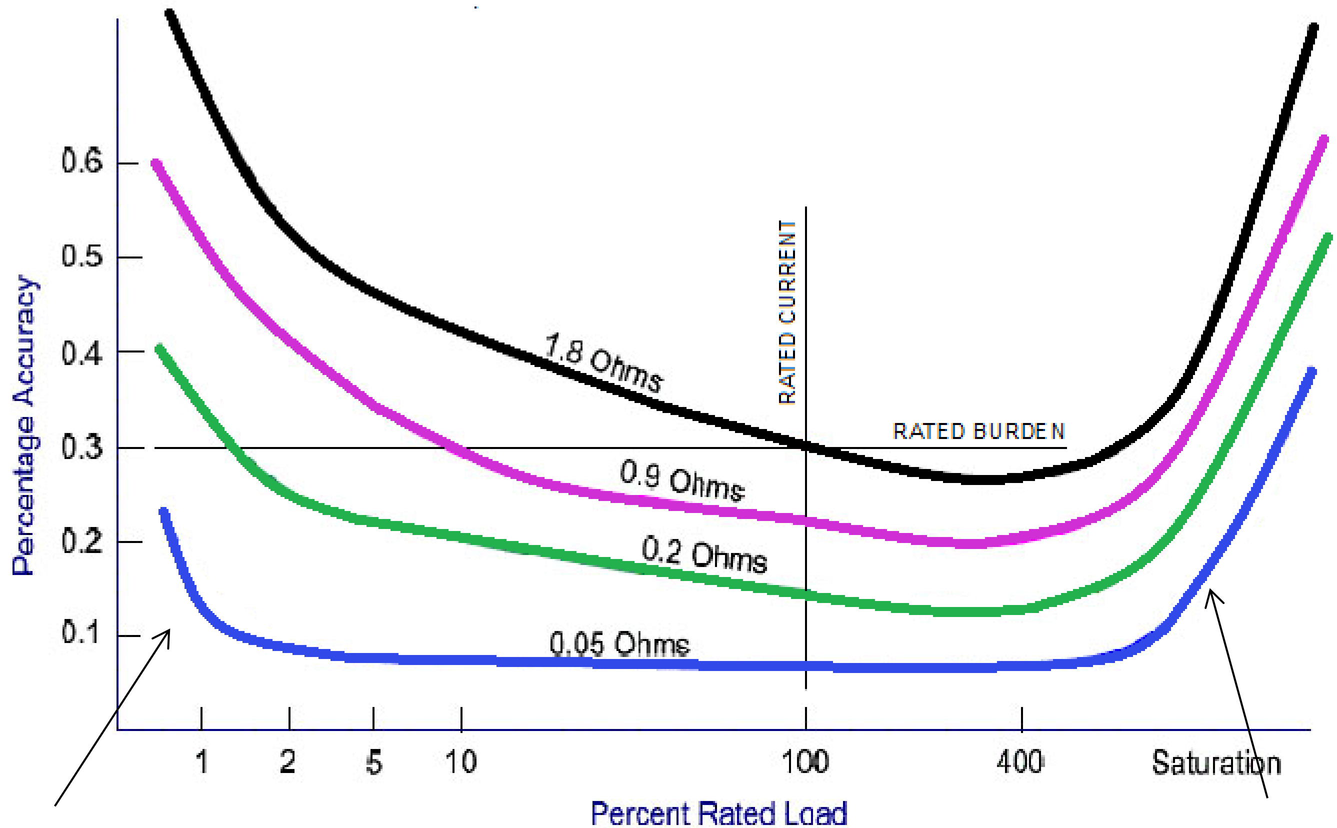
ϕ = flux in the core
$\Re$ = magnetic reluctance
k_1 = constant of proportionality
k_2 = constant of proportionality
Z_S = secondary impedance
mmp = core mean magnetic path
I_S = secondary current
A_C = core cross-sectional area
N_S = number of secondary turns
μ_C = permeability of core material
f =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



Core energy needed **Saturation**

Graph: Bill Hardy – TESCO

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

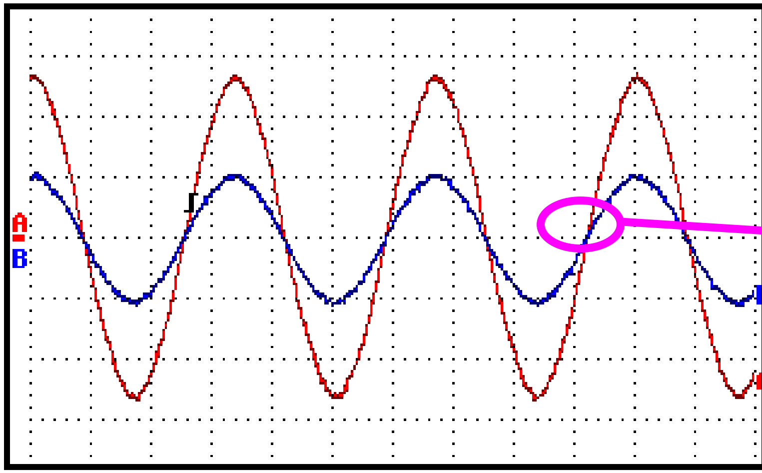
What does this mean? How many amps is the meter seeing?

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)

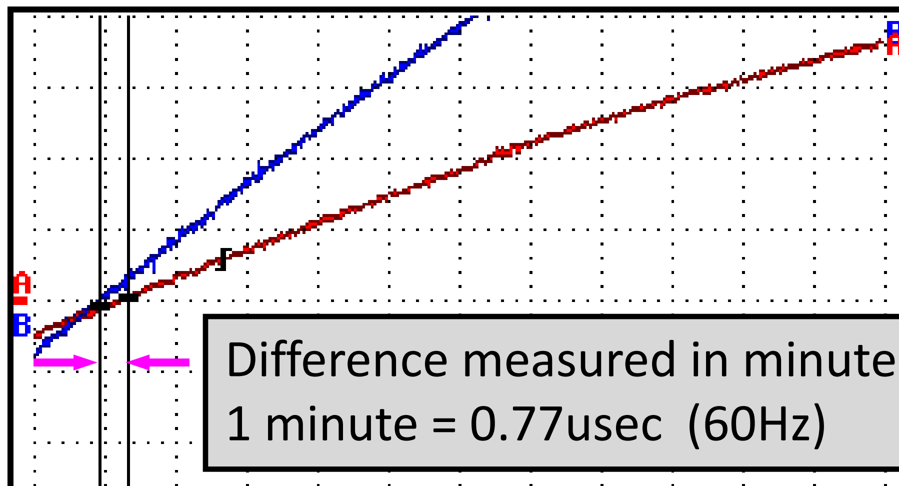
RCF on Knopp Comparator

Phase Error



Red = Primary Current
Blue = Secondary Current

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

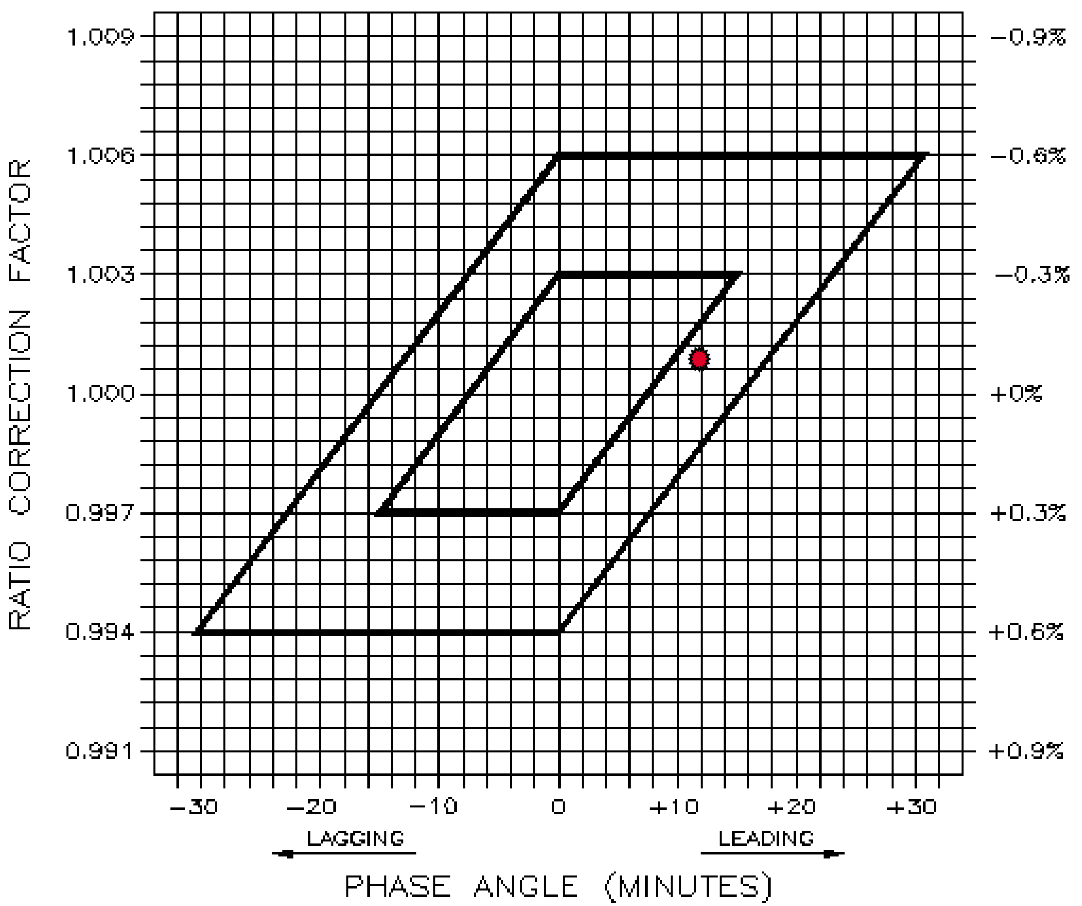


Difference measured in minutes
1 minute = 0.77usec (60Hz)

Phase Error

Phase Error on Knopp Comparator

CT PARALLELOGRAM



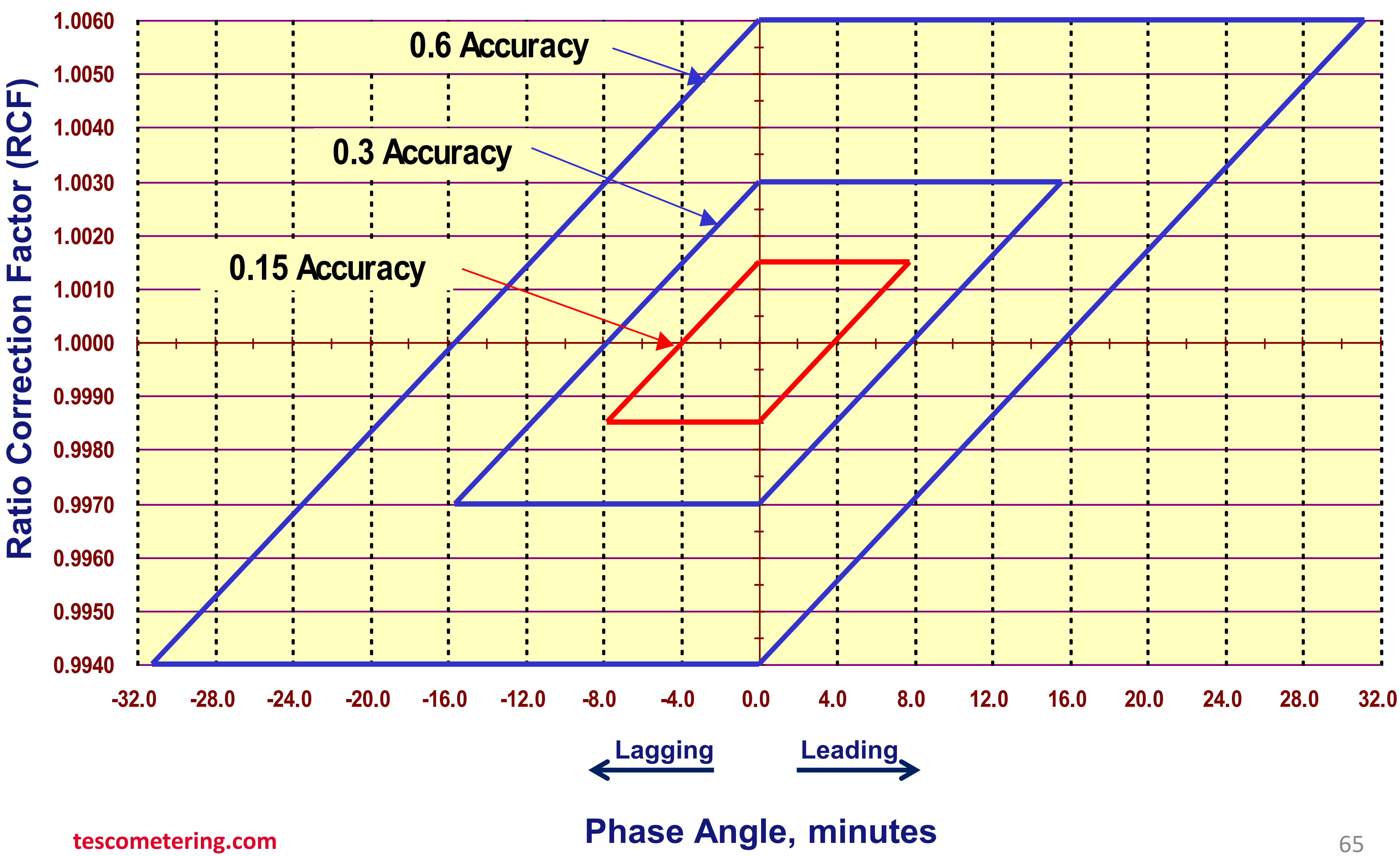
IEEE STD. C57.13 LIMITS OF ACCURACY CLASS FOR CURRENT TRANSFORMERS FOR METERING
0.3 ACCURACY CLASS

Recall the Knopp Comparator
The values were:

- Ratio Error = 1.00278
- Φ Angle Error = 5.2

CT Parallelogram

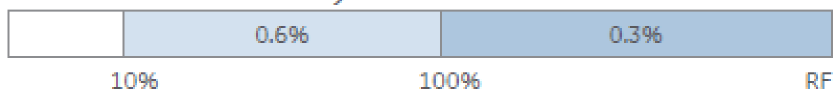
IEEE C57.13 – Accuracy Limits



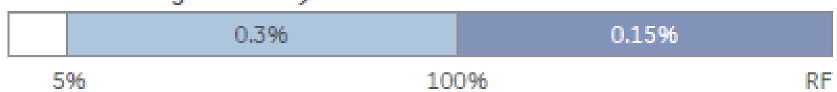
IEEE Metering Class

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:

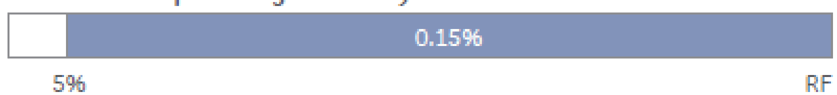
0.3 Class - Standard Accuracy



0.15 Class – High Accuracy



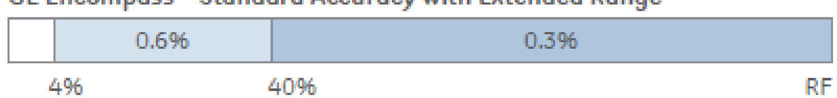
0.15S Class – Special High Accuracy



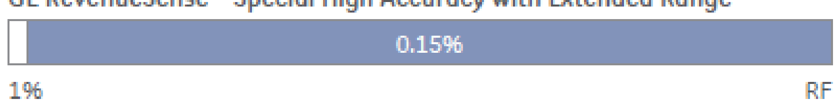
Encompass & RevenueSense Exceed IEEE Standards

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.

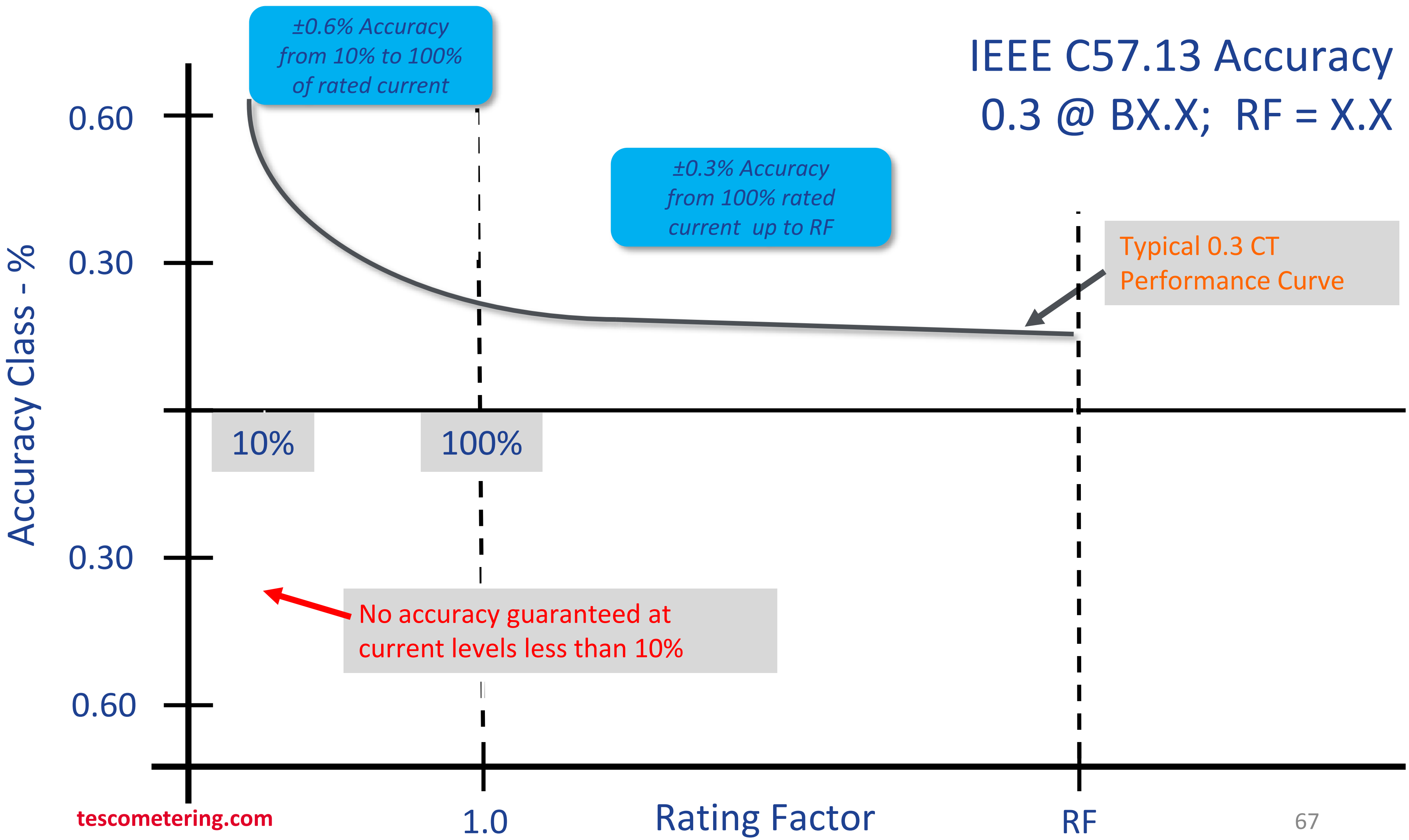
GE Encompass – Standard Accuracy with Extended Range



GE RevenueSense – Special High Accuracy with Extended Range



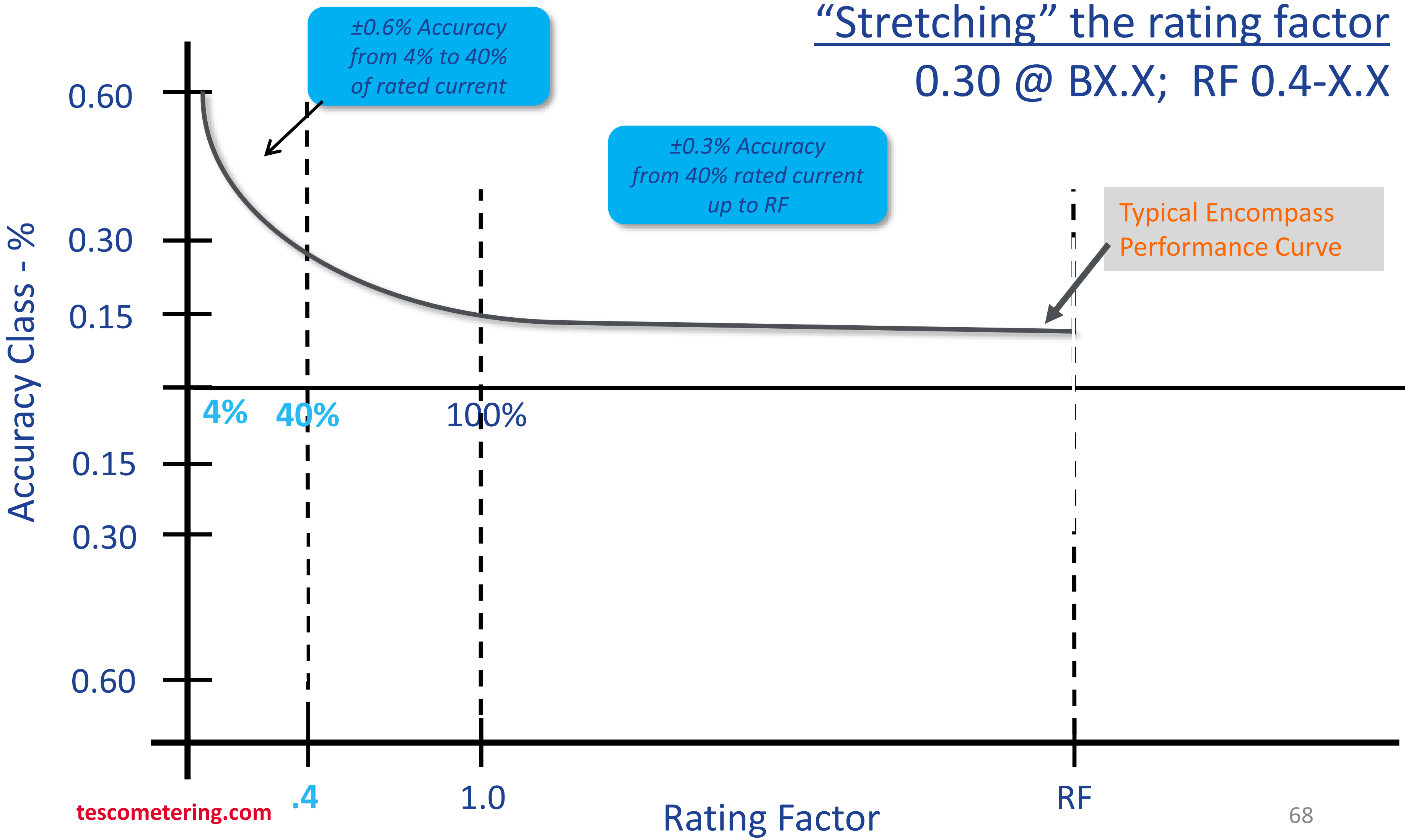
Standard 0.3 Accuracy Class



ITI Encompass

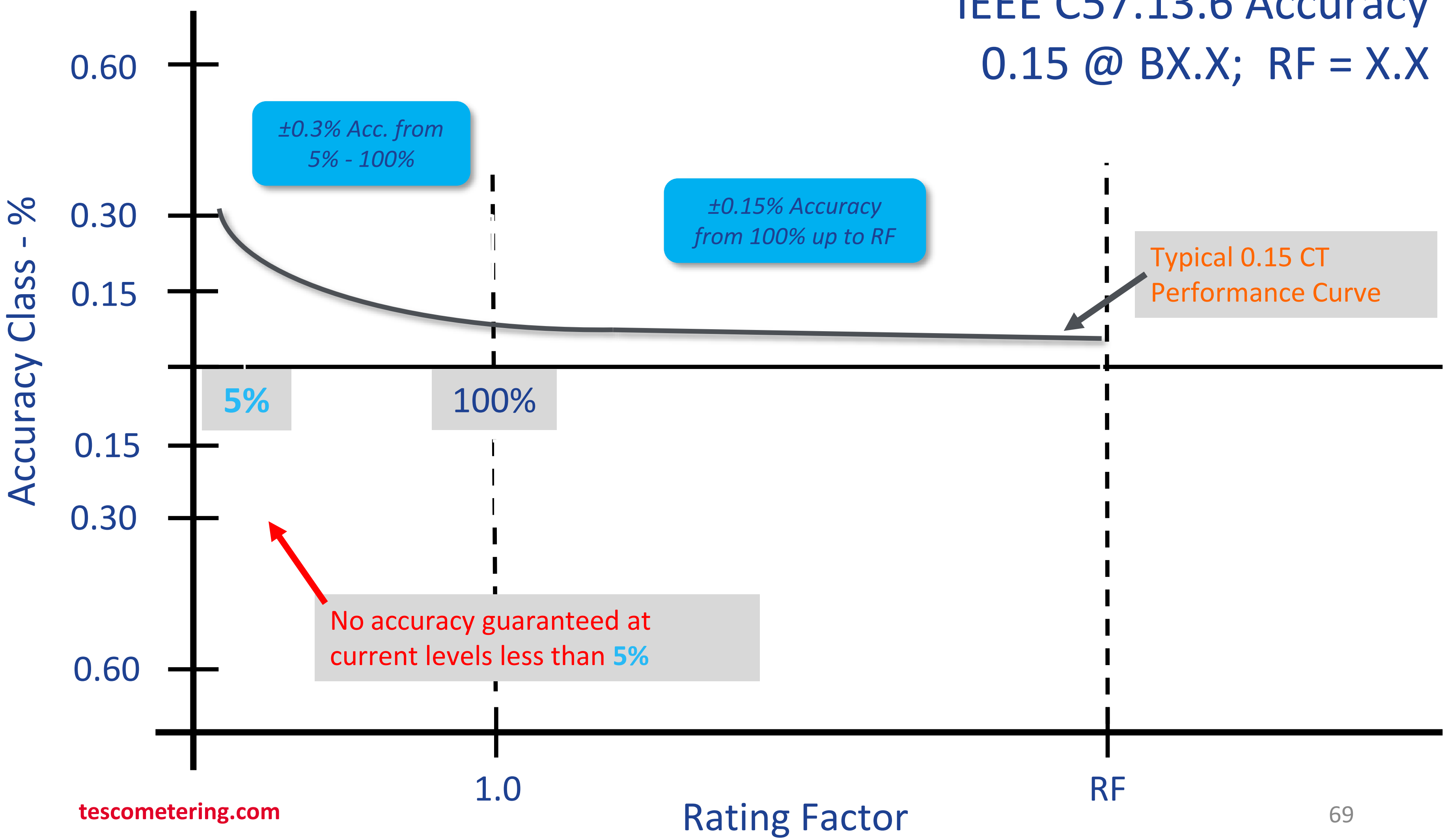
"Stretching" the rating factor

0.30 @ BX.X; RF 0.4-X.X



0.15 High Accuracy Class

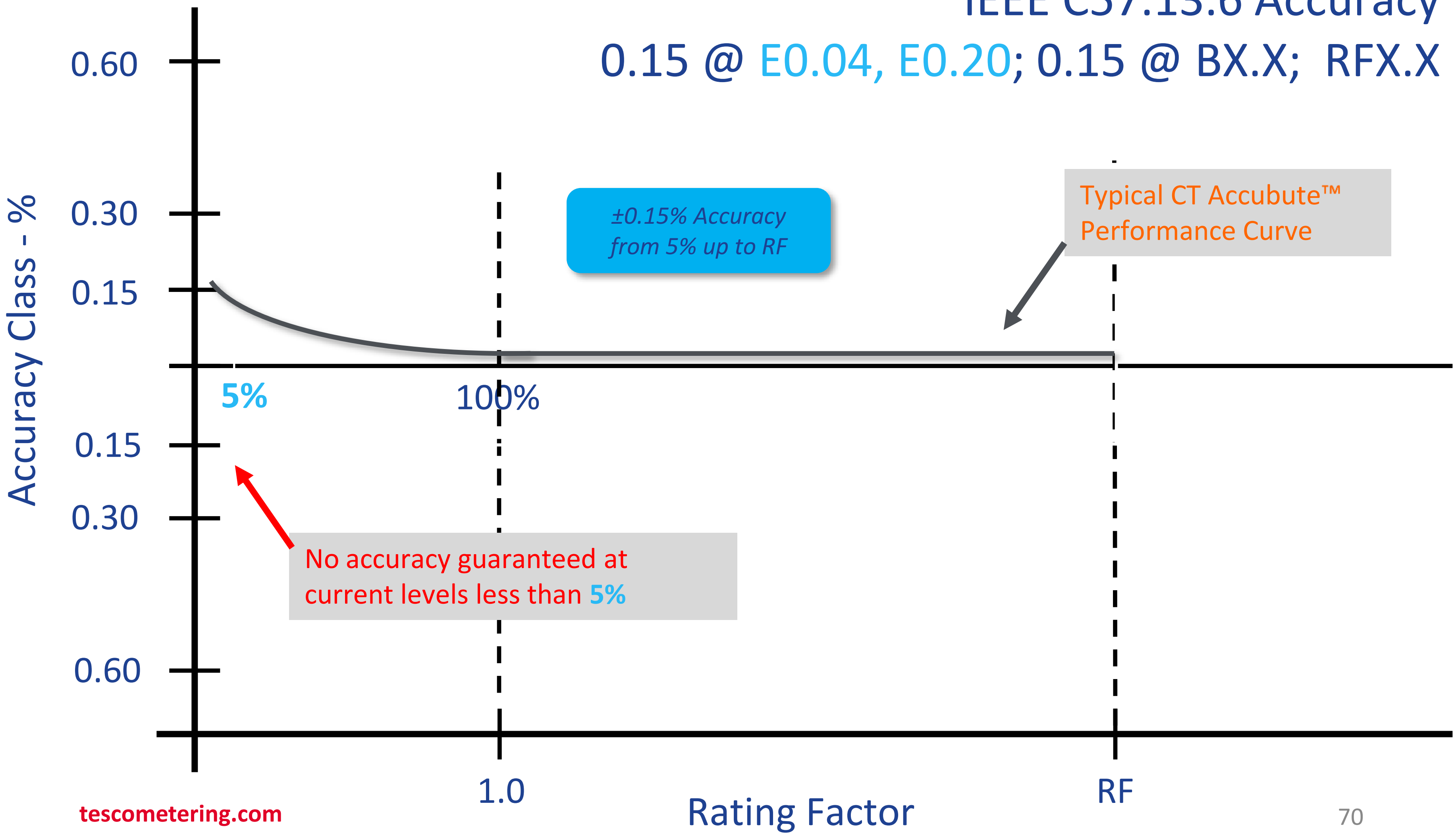
IEEE C57.13.6 Accuracy
0.15 @ BX.X; RF = X.X



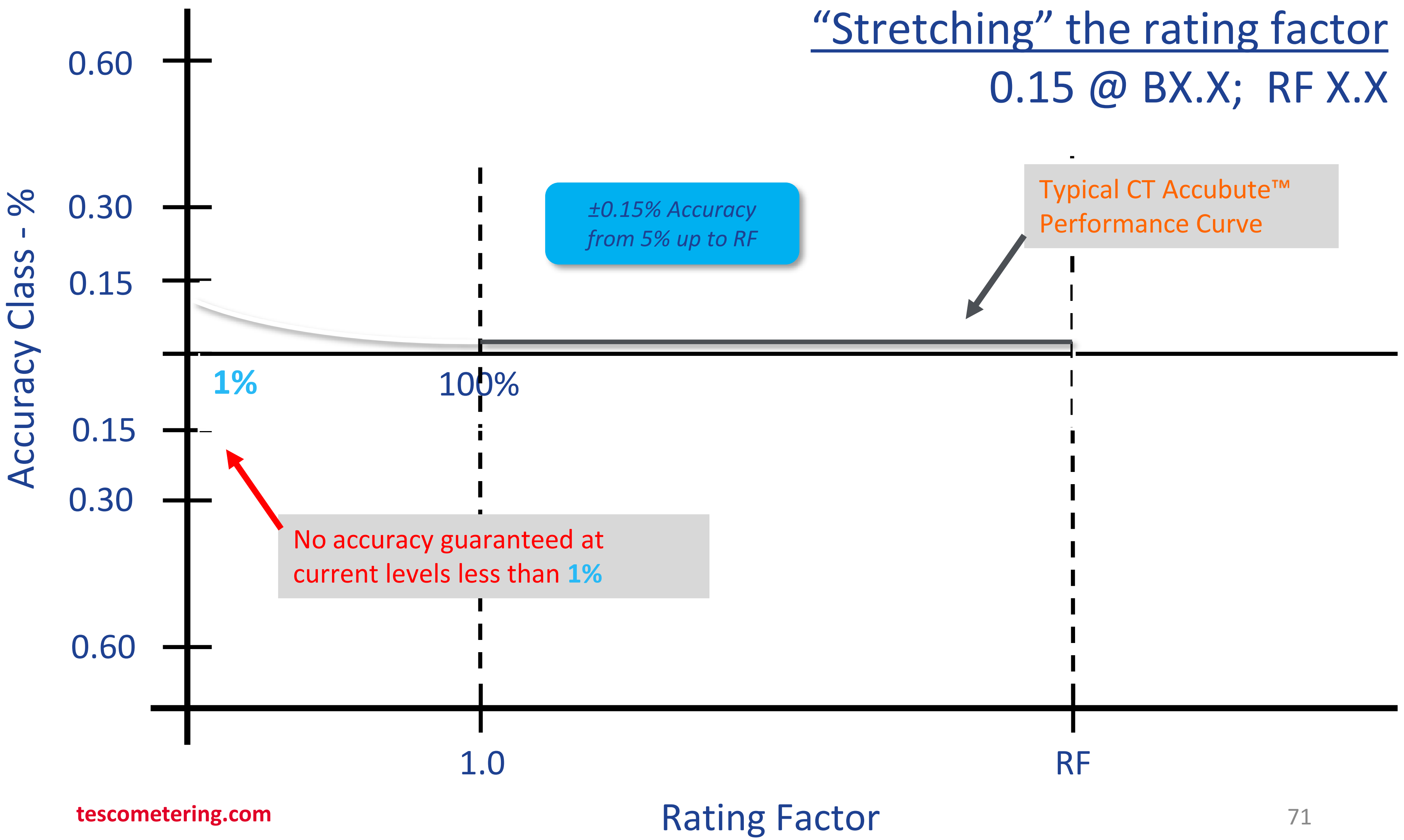
0.15S Special High Accuracy (Accubute)

IEEE C57.13.6 Accuracy

0.15 @ E0.04, E0.20; 0.15 @ BX.X; RFX.X



0.15S High Accuracy Extended Range



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

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 CT 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

tescometering.com

STANDARD ACCURACY EXTENDED RANGE

TESCO's Meter School

TESCOOL

Low Voltage Encompass™ Series

tescometering.com

System Current	20A 40A 60A 80A 100A	200A 400A 600A 800A 1000A 1200A 1400A 1600A 1800A	2000A
200:5 JAK-0C (Rating Factor 4.0)	±0.6% Accuracy	±0.3% Accuracy	
400:5 JAK-0C (Rating Factor 4.0)	±0.6% Accuracy	±0.3% Accuracy	
1000:5 JAK-0C (Rating Factor 2.0)		±0.6% Accuracy / ±0.3% Accuracy	
500:5 JAK-0W Encompass™ (4% to 400%)	±0.6% Accuracy	±0.3% Accuracy	

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

tescometering.com

HIGH ACCURACY EXTENDED RANGE

TESCO's Meter School

TESCOOL

Low Voltage RevenueSense™ Series

System Current	6A	20A	40A	60A	80A	100A	200A	400A	600A	800A	1000A	1200A	1400A	1600A	1800A	2000A
200:5 JAK-0C (Rating Factor 4.0)				±0.6% Accuracy				±0.3% Accuracy								
400:5 JAK-0C (Rating Factor 4.0)					±0.6% Accuracy						±0.3% Accuracy					
1200:5 JAK-0C (Rating Factor 1.5)									±0.6% Accuracy				±0.3% Accuracy			
600:5 JAK-0S High Revenue Sense (1% to 300%)									**±0.15% Accuracy**							

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

TESCO
tescometering.com

PRODUCT LINE SUMMARY

Encompass


Size	Mini	Intermediate	Padmount*	Large
Model	JCR-0W	JAK-0W	JAB-0W	JAD-0W
Ratio	250:5 or 500:5	500:5	500:5 or 1500:5	1000:5 or 1500:5

**Hi Temp available*

RevenueSense


Size	Mini	Intermediate	Padmount*	Large
Model	JCT-0S	JAK-0S	JAB-0S	JAD-0S
Ratio	600:5	600:5 or 1000:5	600:5, 1000:5 or 2000:5	1200:5 or 3000:5

**Hi Temp available*

Factors Influencing CT Accuracy

Current Ratio

"Low ratio" and "high accuracy" are not friends!!

Burden

"High burden" and "High Accuracy" are not friends!!

Physical Size

"Large windows, small cross-section"
and "High accuracy" are not friends!!

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

Questions and Discussion

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This presentation can also be found under Meter Conferences and Schools on the TESCO website: tescometering.com