CT Theory & Practice

Prepared by Tom Lawton,
TESCO – The Eastern Specialty Company

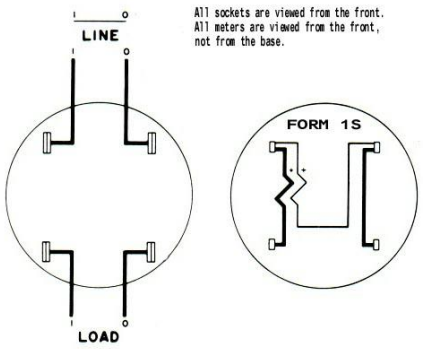
for the ECNE Spring 2017 – Wednesday, March 8, 2017

Self Contained vs. Transformer Rated

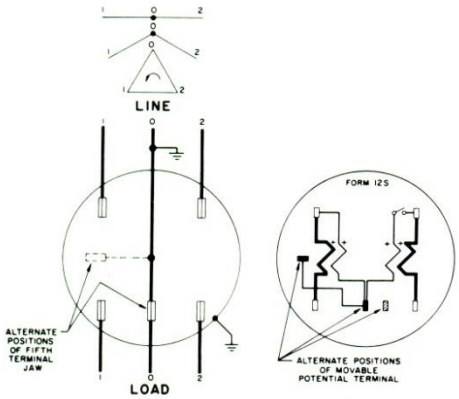
1S, 2S, 3S, 4S, 9S, 12S, 16S, 45S, etc., etc.

What's the Difference?

Different Forms for Different Services and Applications

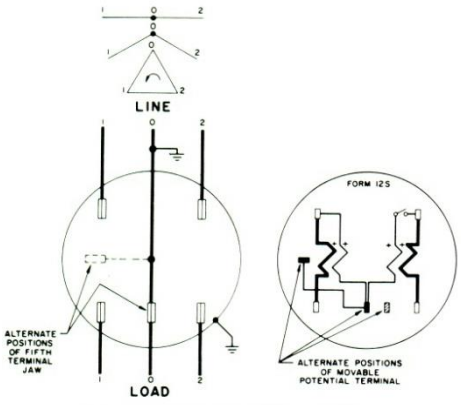


FORM 1S
1ø, 2 W CIRCUIT
1 Stator, 2 W Meter, Self-Contained



On 3-phase, 3-wire circuits, a ground is optional. Where a 3-phase circuit is grounded, the neutral connector in the socket should be grounded. Where a 3-phase circuit is ungrounded, the neutral connector in the socket should be insulated.

2 Stator, 3ø, 3 W (Network) Meter, Self-Contained



On 3-phase, 3-wire circuits, a ground is optional. Where a 3-phase circuit is grounded, the neutral connector in the socket should be grounded. Where a 3-phase circuit is ungrounded, the neutral connector in the socket should be insulated.

2 Stator, 3ø, 3 W (Network) Meter, Self-Contained

Self Contained vs. Transformer Rated

Self Contained

(direct)

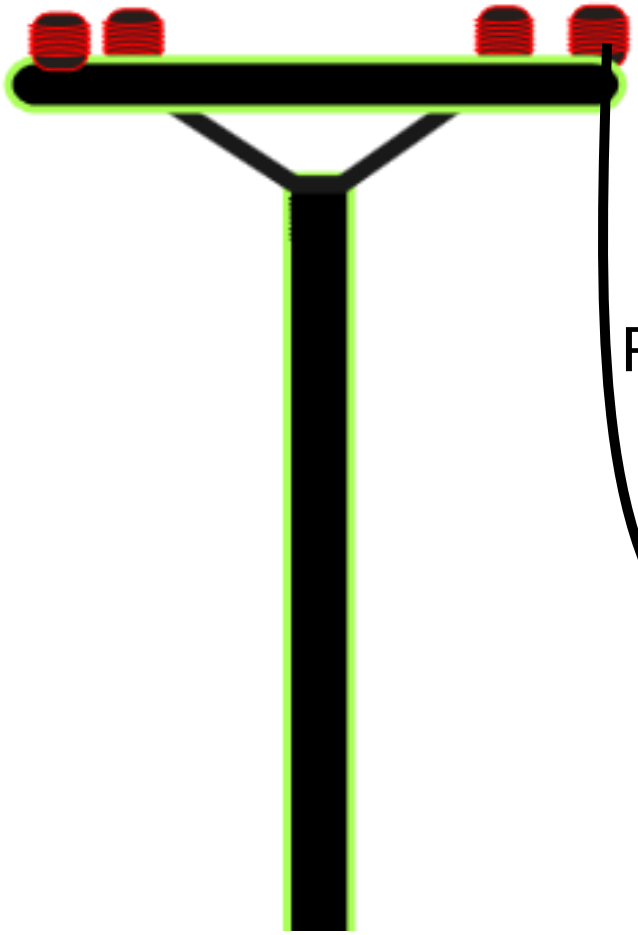
Transformer Rated

(indirect)

Self Contained

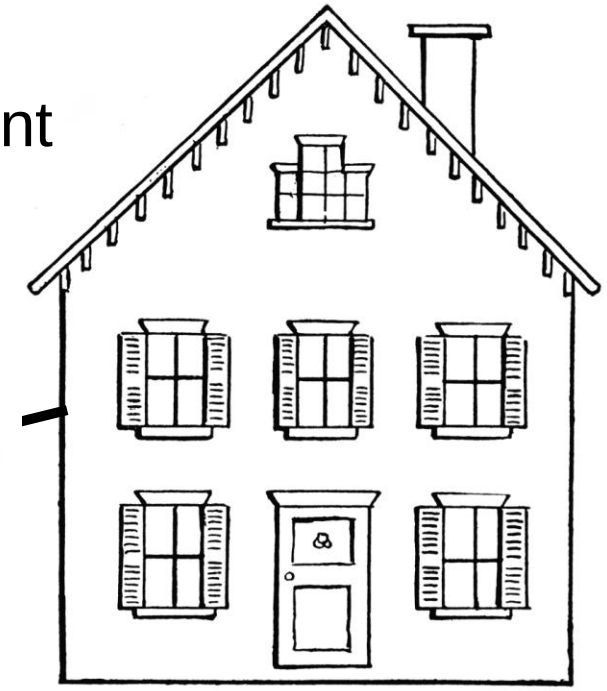
Primarily Residential

(1S, 2S, 12S)



Relatively Low Current

Example: 100A



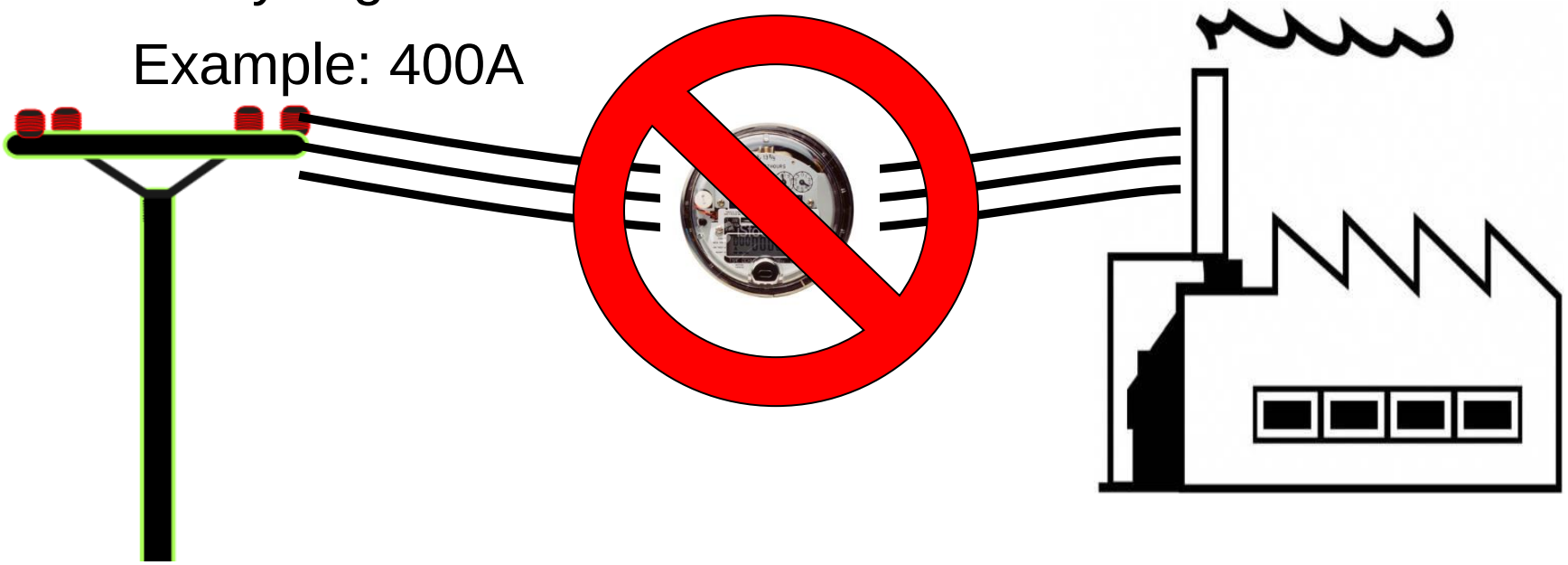
Transformer Rated

Primarily Commercial/Industrial

(9S, 16S)

Relatively High Current

Example: 400A



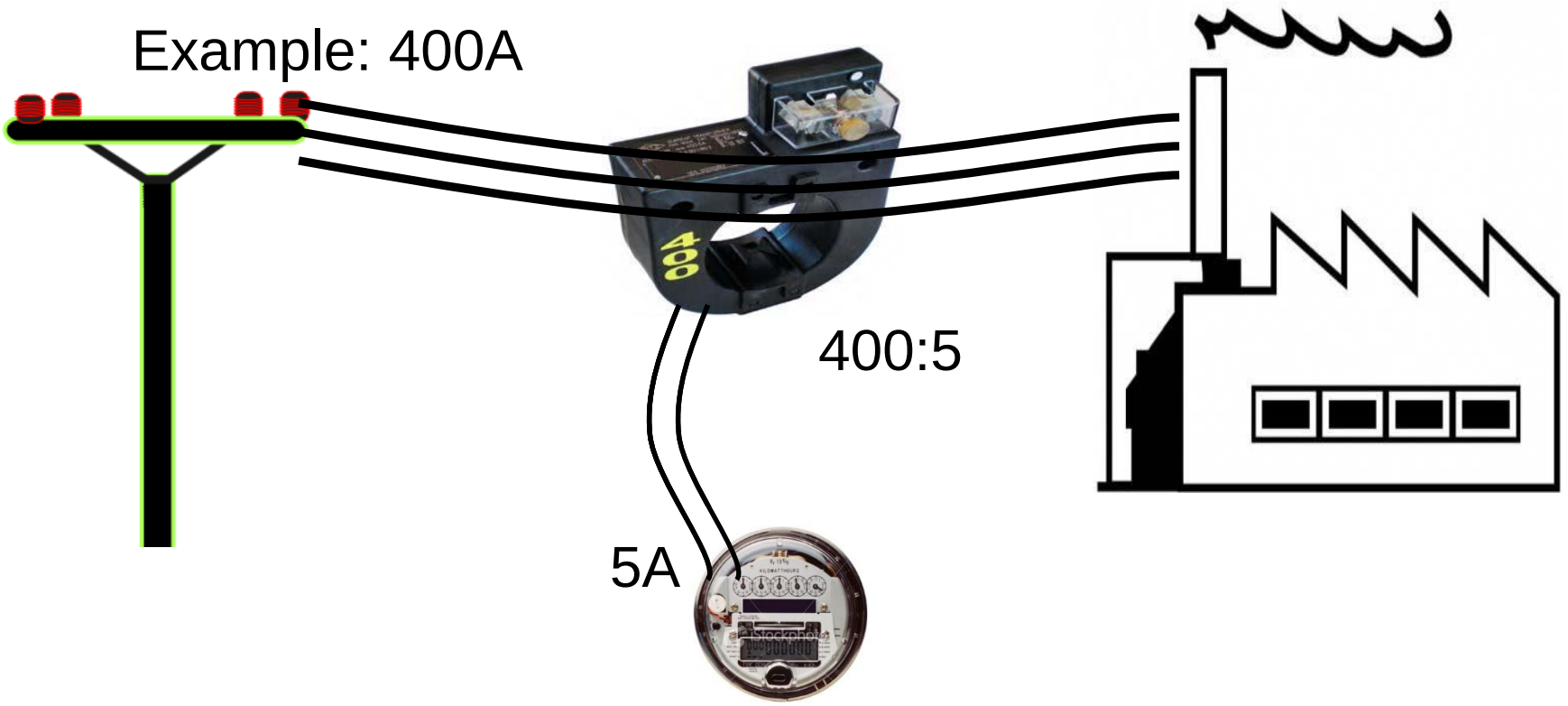
Transformer Rated

Primarily Commercial/Industrial

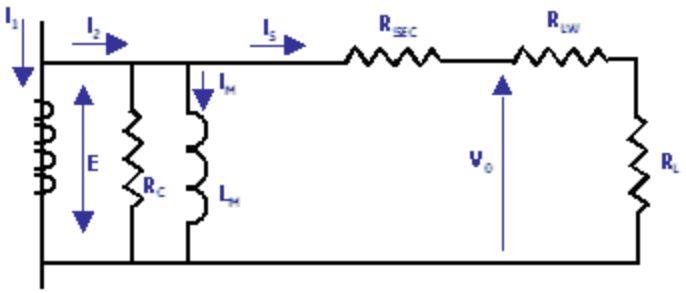
(9S, 16S)

Relatively High Current

Example: 400A



CT's – Functions and Terminology

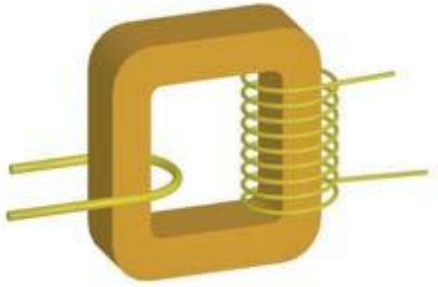


$I_2 = I_S + I_M$
I_1 = Primary Current
I_2 = Secondary Current for ideal transformer
I_s = Secondary Current seen on secondary
I_M = Magnetization Current

E = Induced Electromotive Force
V_O = Secondary Voltage
L_M = Magnetizing Inductance
R_C = Core Loss
R_{SEC} = Resistance of secondary
R_{LW} = Resistance of leadwire
R_L = Resistance of load

Equivalent Circuit w/ losses

Ratio



Conceptual Picture of a CT

As current is applied in the primary, it produces a magnetic flux in the core. This flux flows through the core and induces a current in the secondary windings and circuit that is proportional to the number of turns.

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.

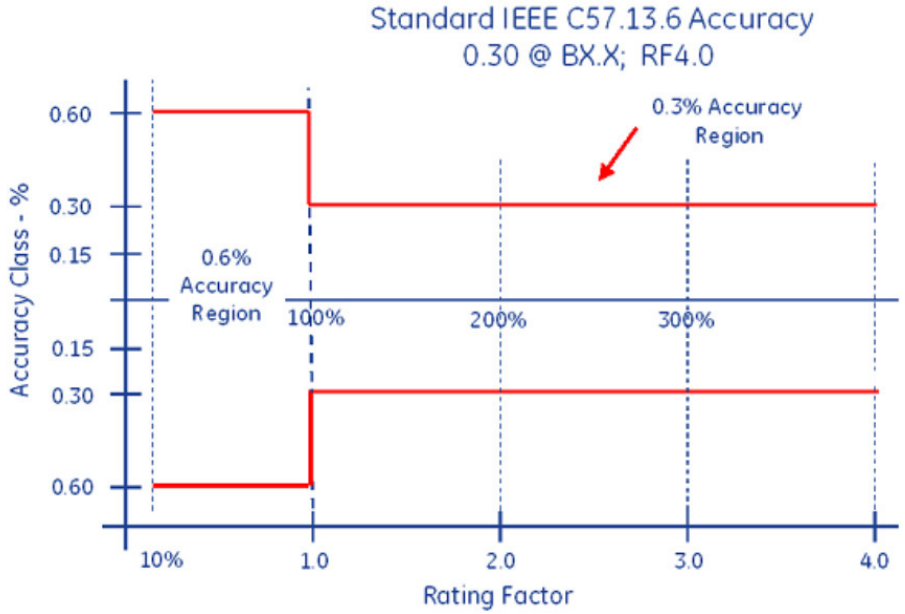
For instance, a RF of 4.0 at 30° ambient on a 400:5 ratio CT would allow for a primary current up to 1600A.

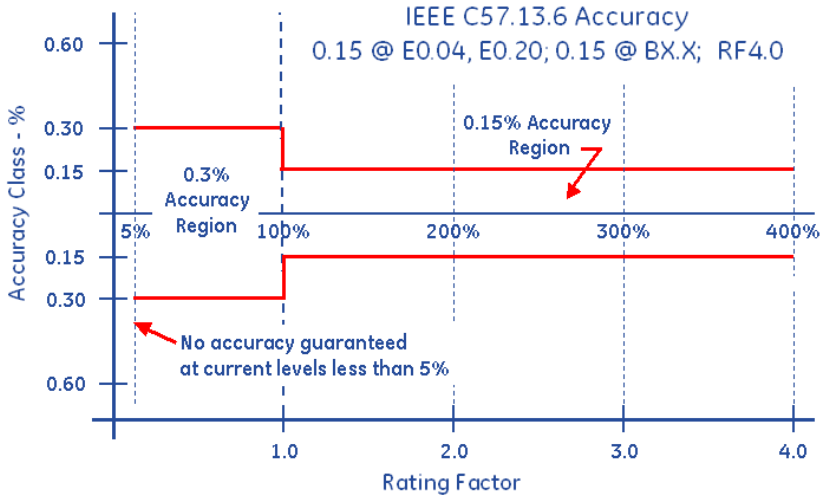
CT's – Functions and Terminology

Accuracy Classifications and Burden

All CT's fall within an accuracy class.

IEEE Standards have defined accuracy classes.

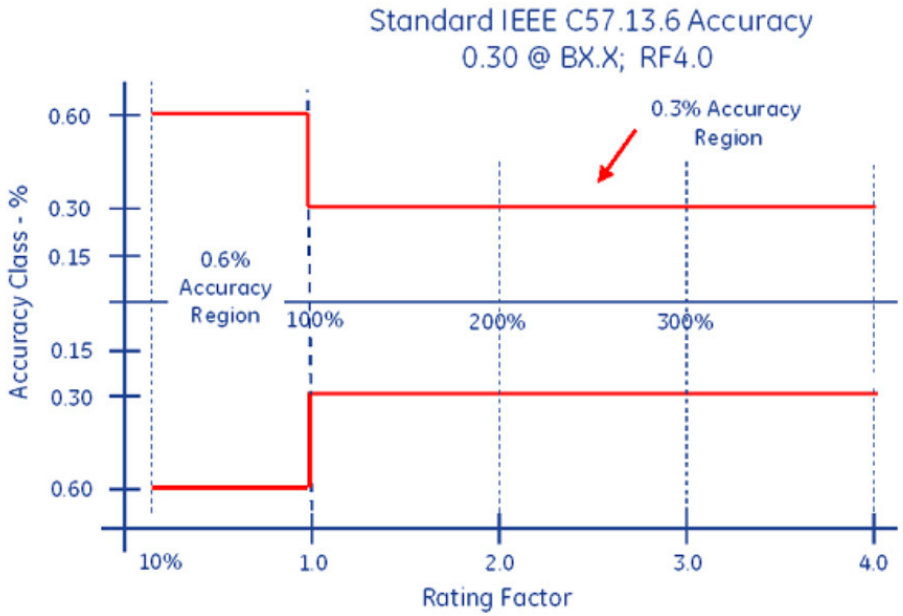




CT's – Functions and Terminology

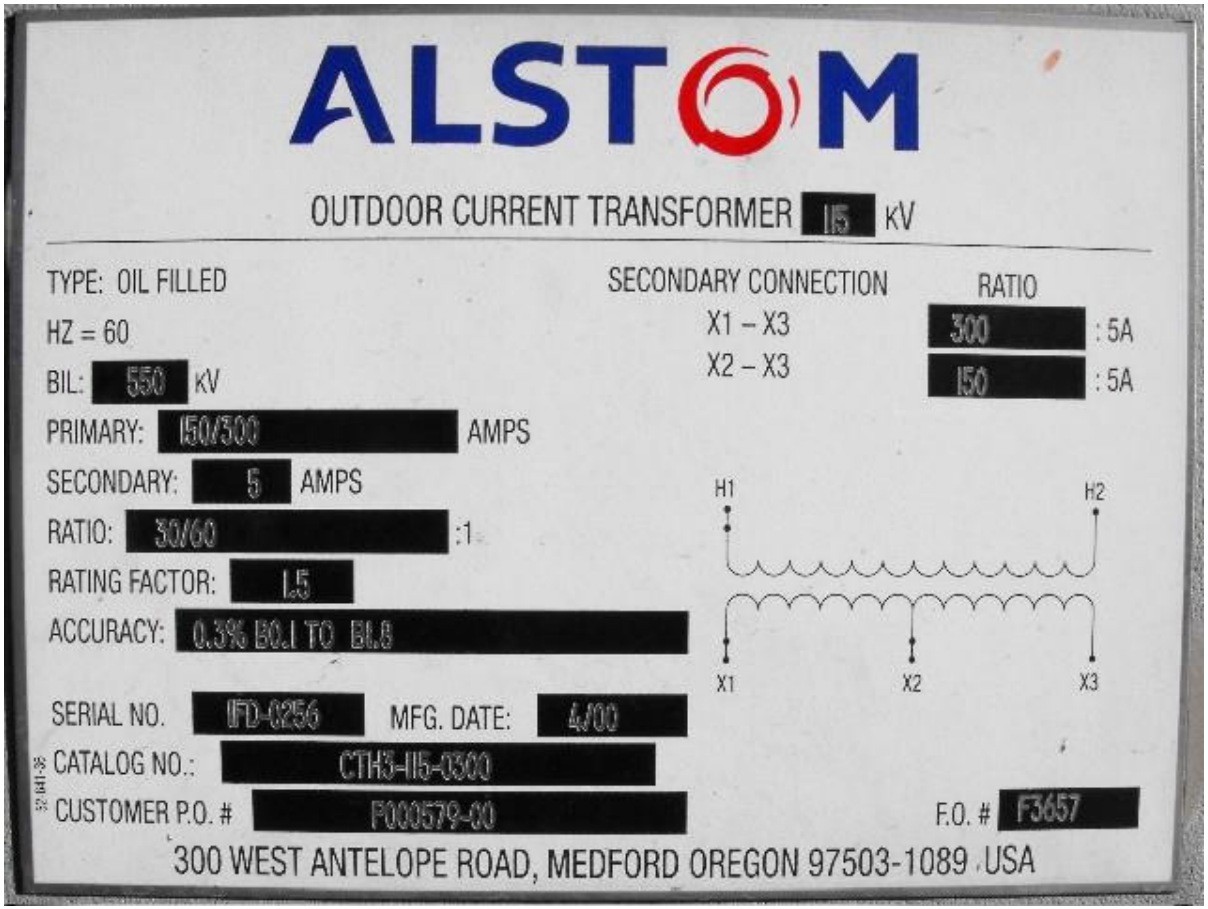
Accuracy Classifications and Burden

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



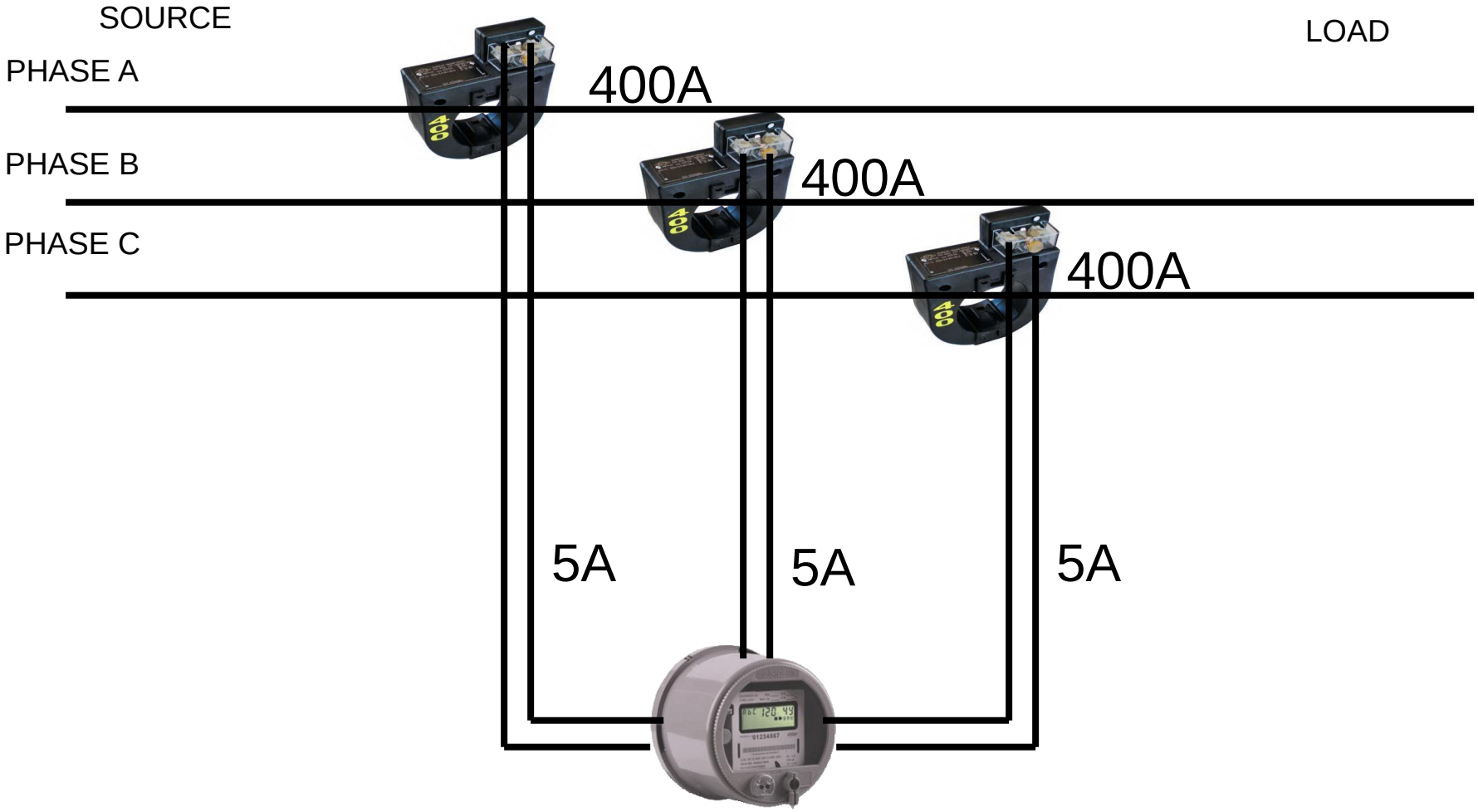
CT's – Functions and Terminology

Faceplate



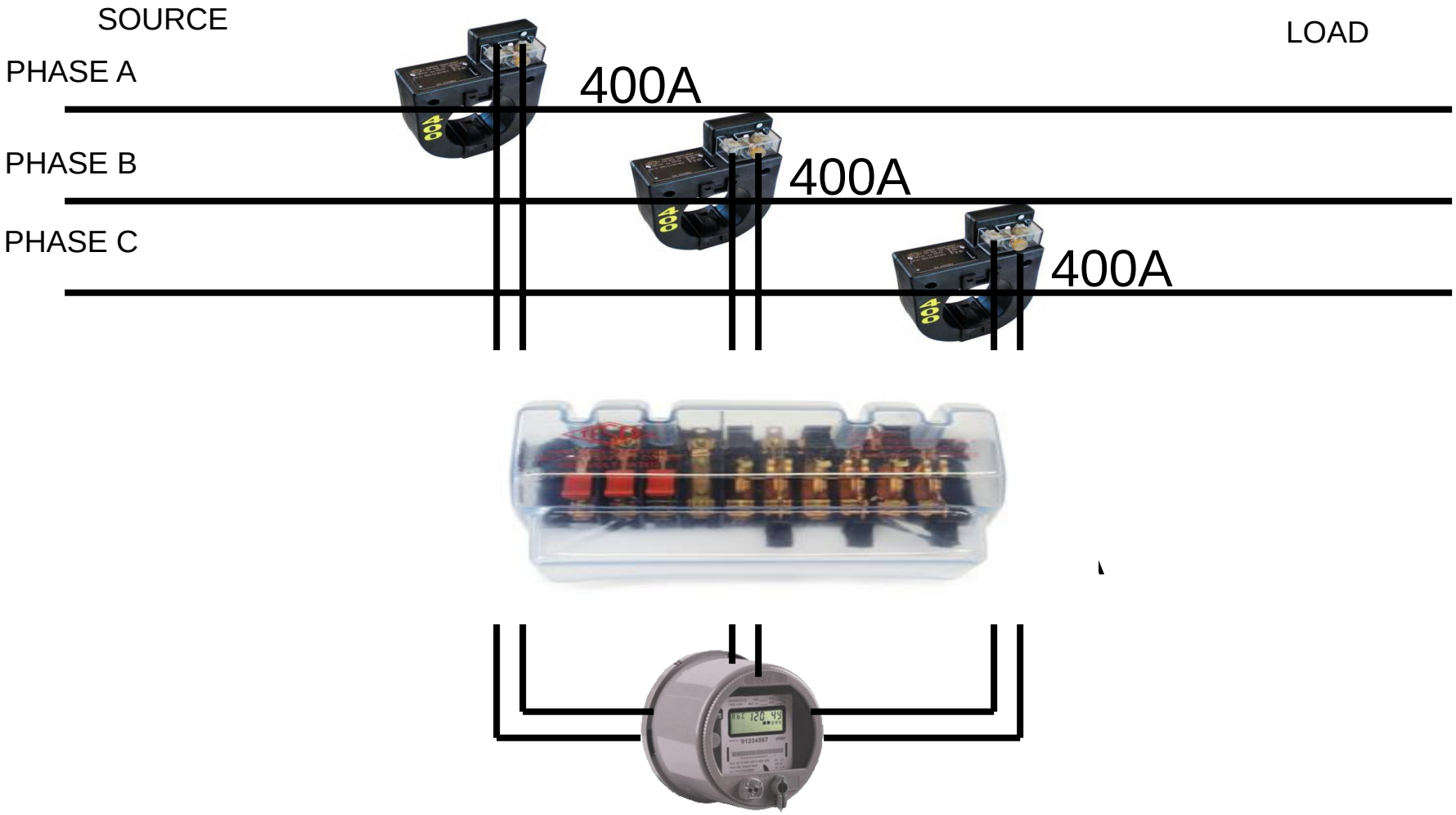
Transformer Rated

9S Meter Installation



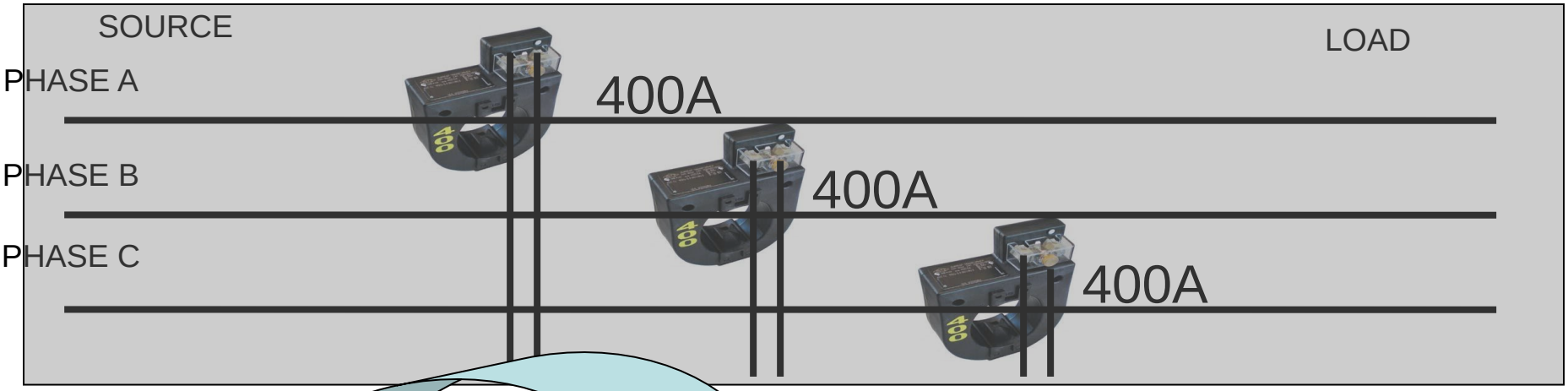
Transformer Rated

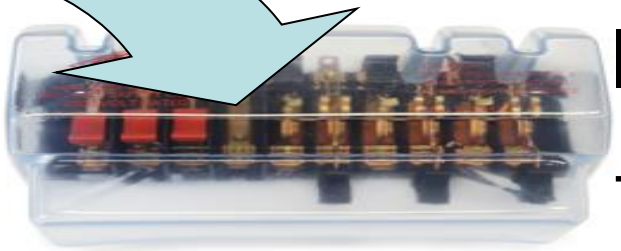
9S Meter Installation



Meter Testing

9S Meter Installation

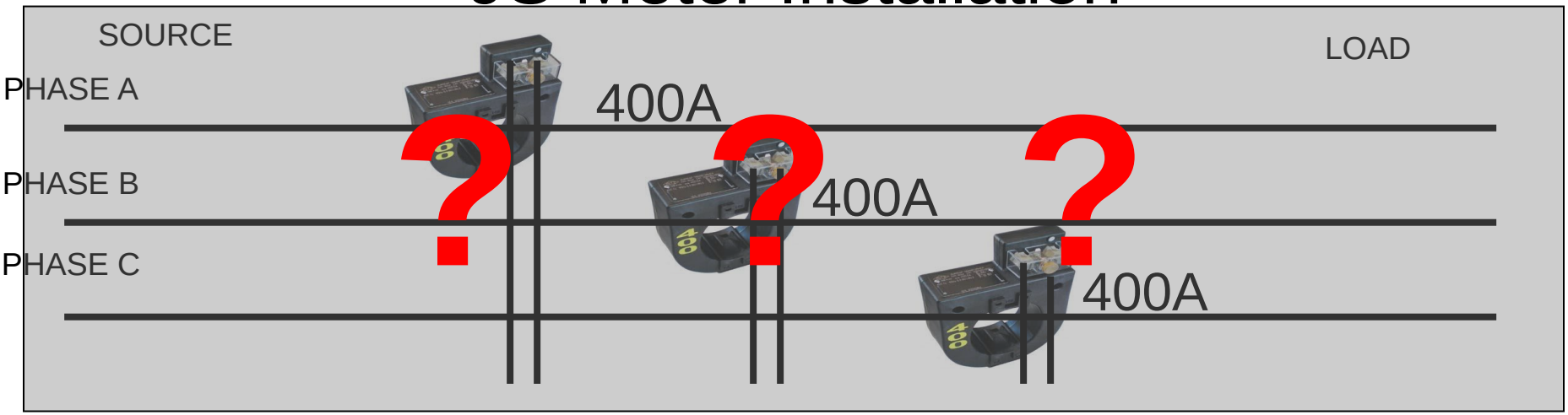


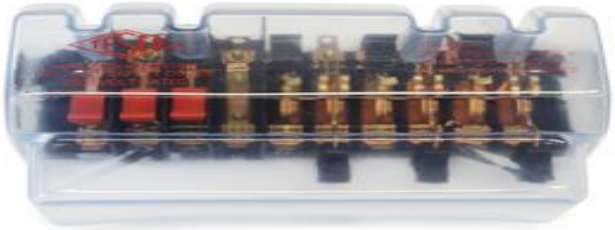


Isolate the Meter from the Service

Meter Testing

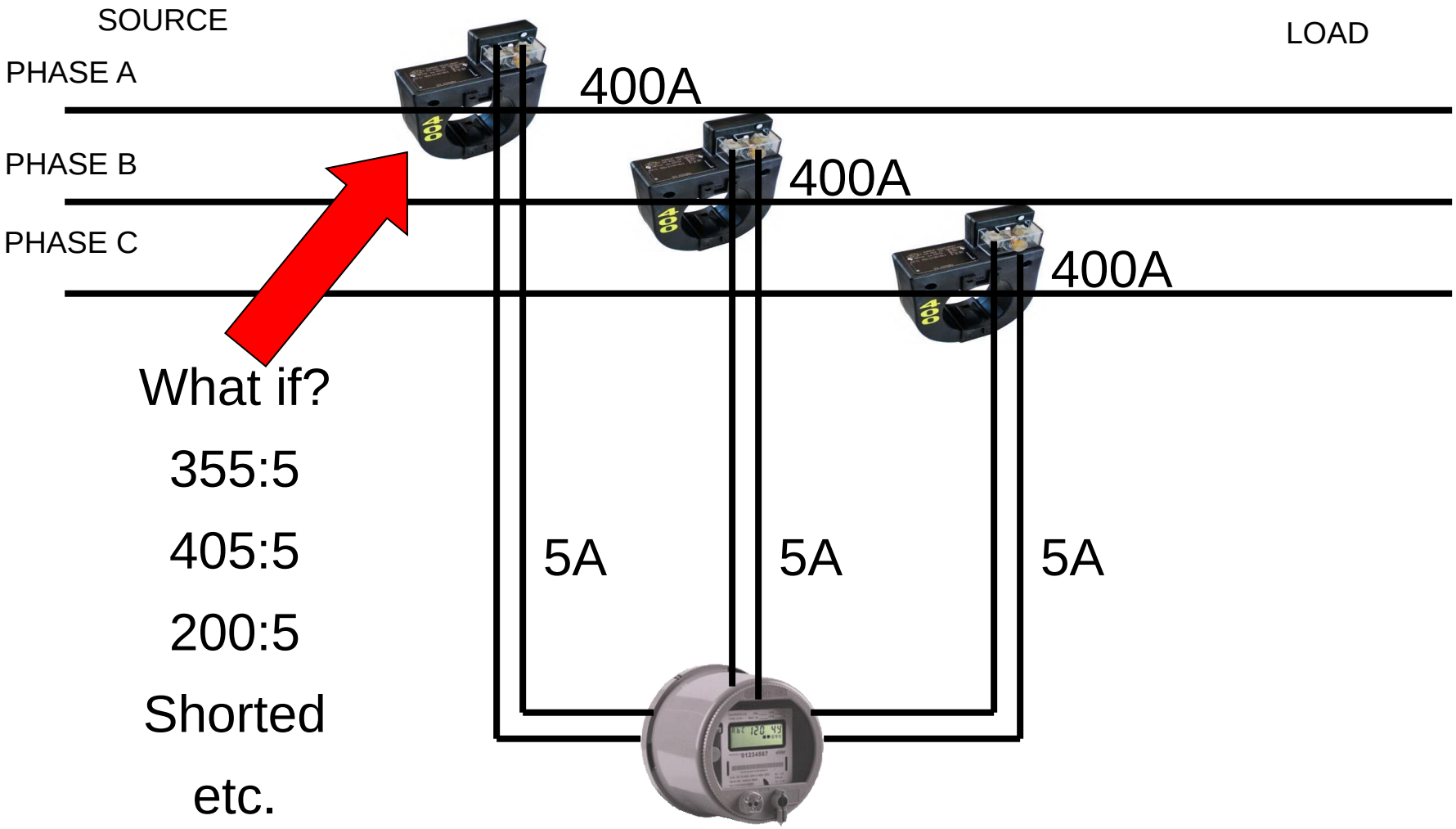
9S Meter Installation





Meter Testing

9S Meter Installation



CT Testing

CT Testing is Important!

1) Test for correct ratio

2) Test for functionality at rated burdens

Ratio Testing

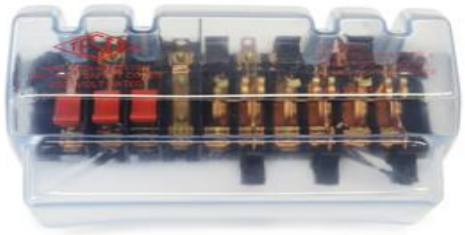
Ratio of Primary Current to Secondary Current

Calculate Ratio

Burden Testing

Functionality with Burden Present on the Secondary Loop

PHASE A

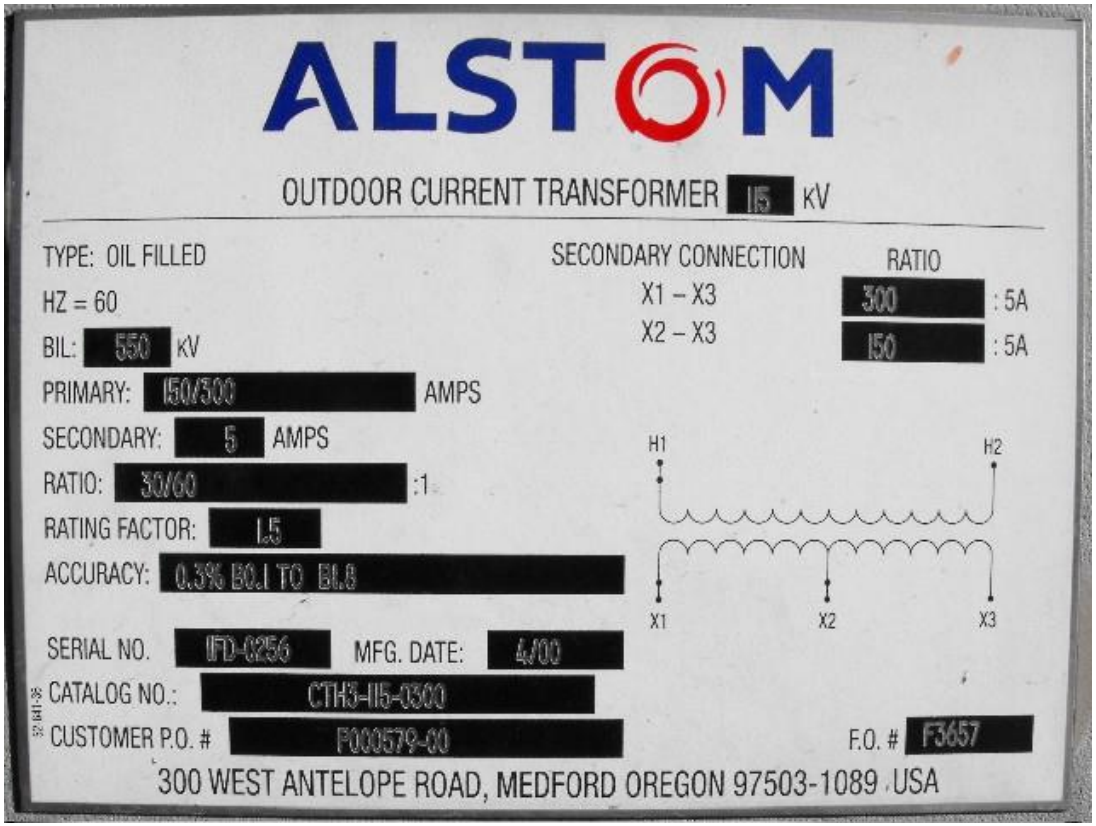


Some burden will always be present – junctions, meter coils, test switches, cables, etc.

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

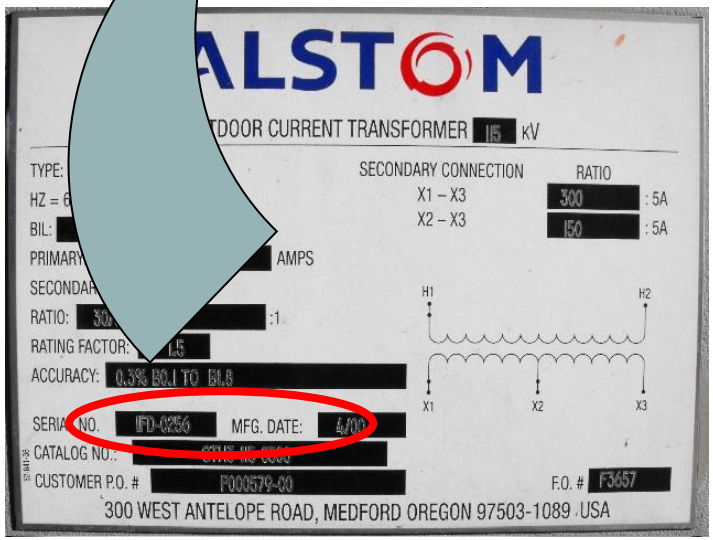
Burden Testing

Functionality with Burden Present on the Secondary Loop



Burden Testing

Functionality with Burden Present on the Secondary Loop



Example Burden Spec:

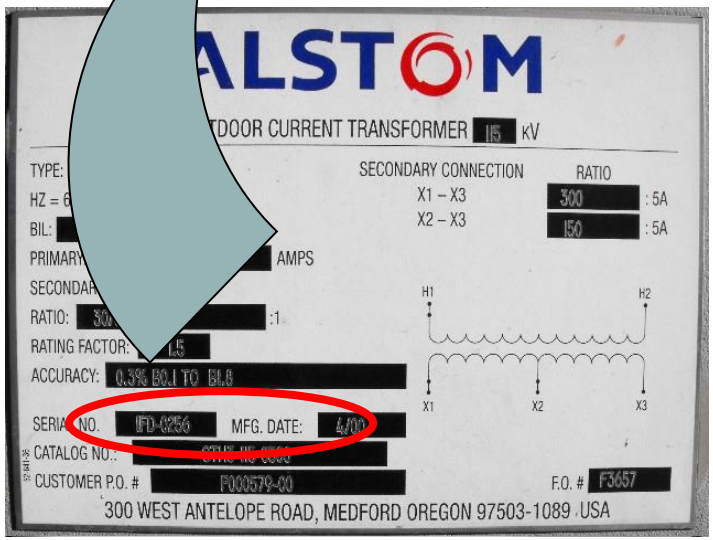
0.3% @ B0.1, B0.2, B0.5

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

Burden Testing

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

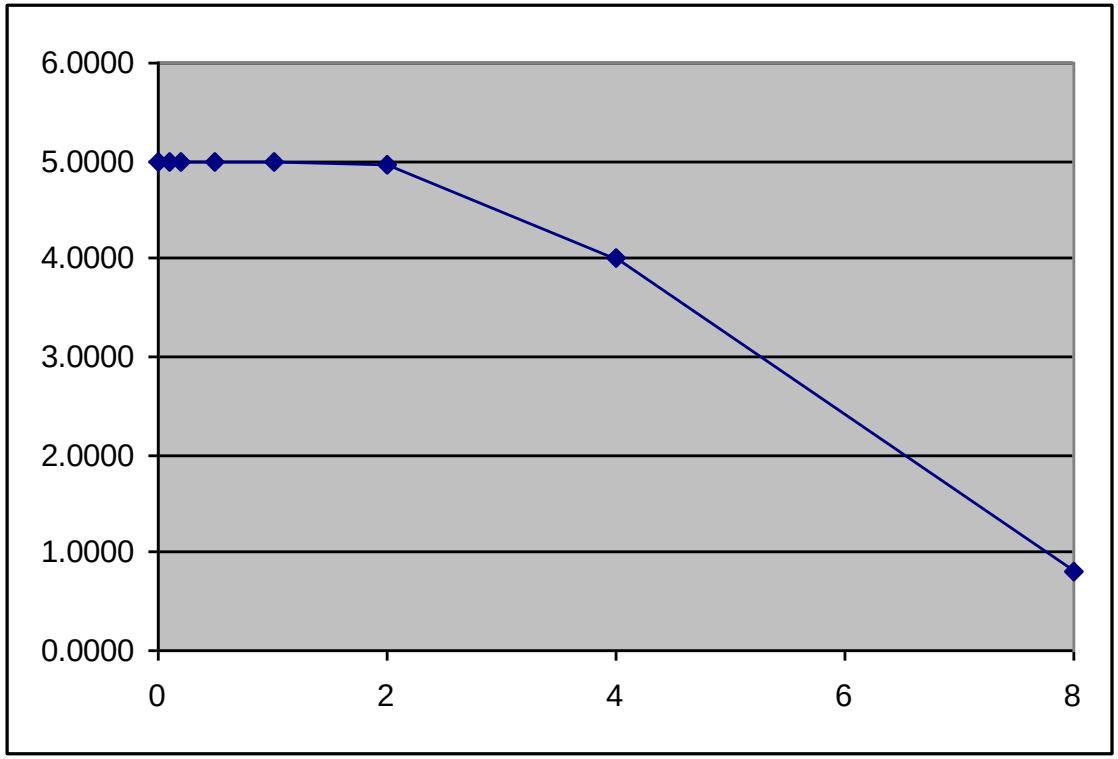
Burden Testing

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

Initial Reading = 5Amps

0.3% x 5A = 0.015A

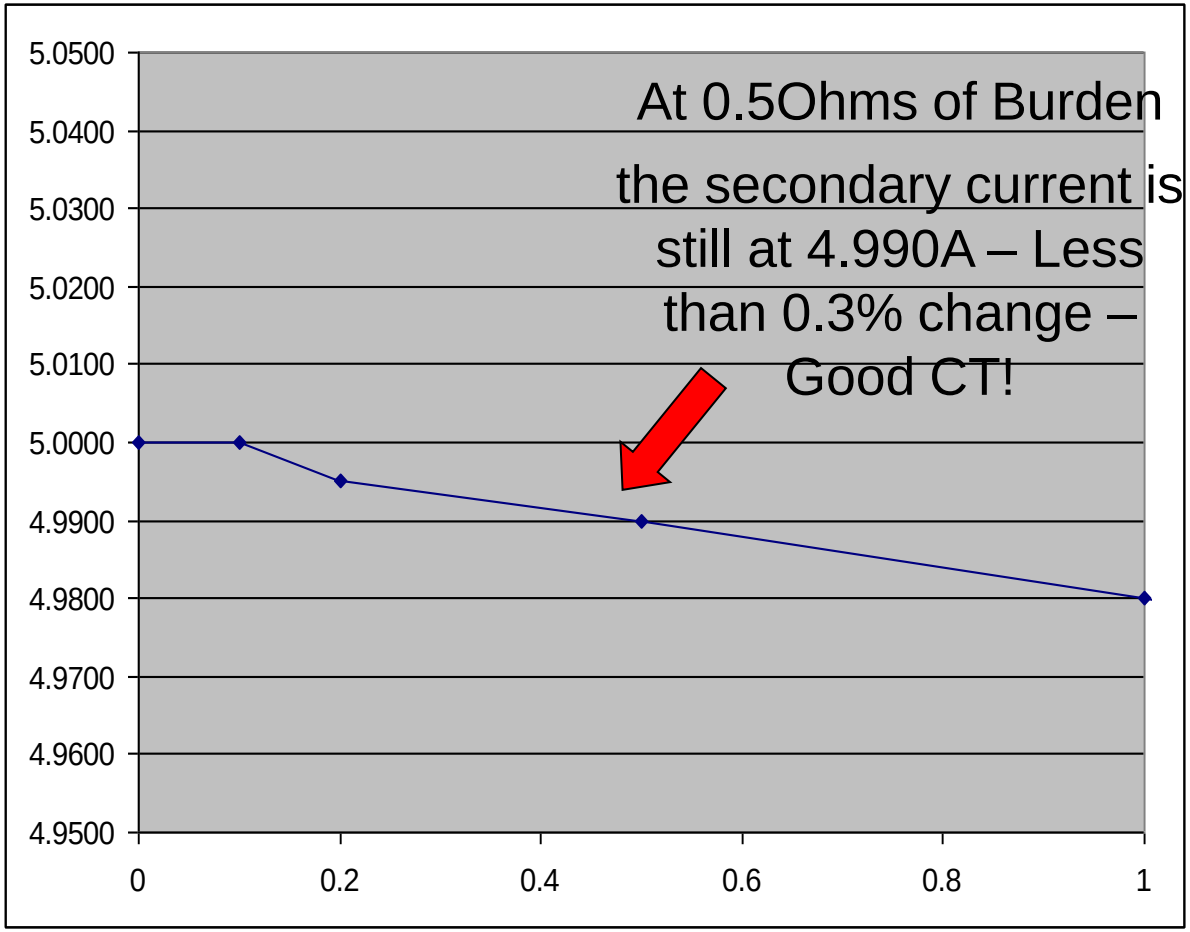
5A – 0.015 = 4.985A



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

Burden Testing

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



Initial Reading = 5Amps

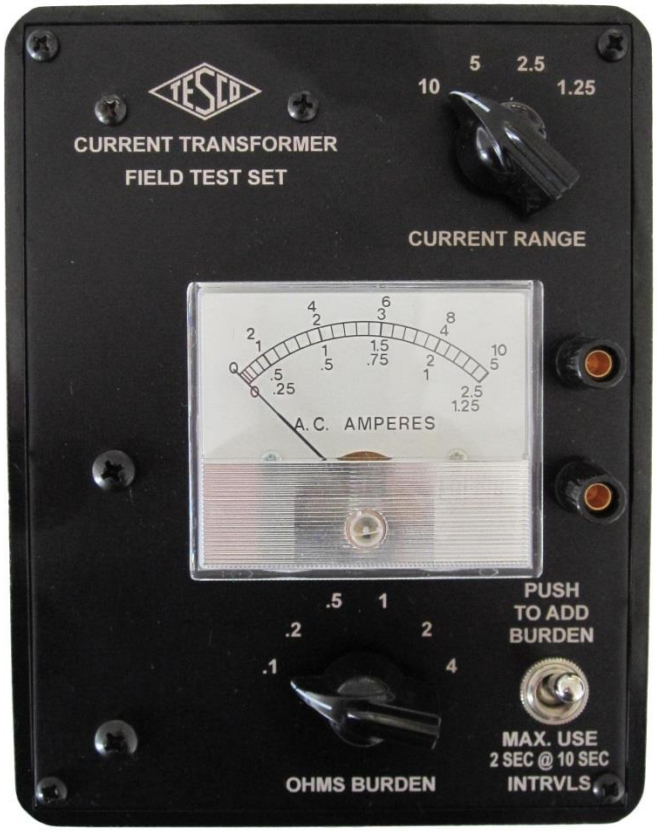
0.3% x 5A = 0.015A

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

Analog Testing

Application of Burden and Calculation



Manual reading of initial and post-burden secondary currents

Digital Testing

Application of Burden and Calculation

- Reads the initial current immediately prior to applying the selected burden
- Applies the selected burden to the secondary
- Reads the current immediately following current application
- Calculates the percentages change

Questions and Discussion

Tom Lawton

TESCO – The Eastern Specialty Company

Bristol, PA

1-800-762-8211

This presentation can also be found under Meter Conferences and Schools on the TESCO web site: www.tesco-advent.com