TESCO METERING

ANSI Meter Forms and Wiring Diagrams

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TESCO Metering

North Carolina Electric Meter School
Polyphase
Tuesday June 10, 2025
2:15 PM

Agenda

Meters 101 - Electro-Mechanical vs Solid-State

Meter Forms

Self-Contained vs Transformer Rated

Blondel's Theorem

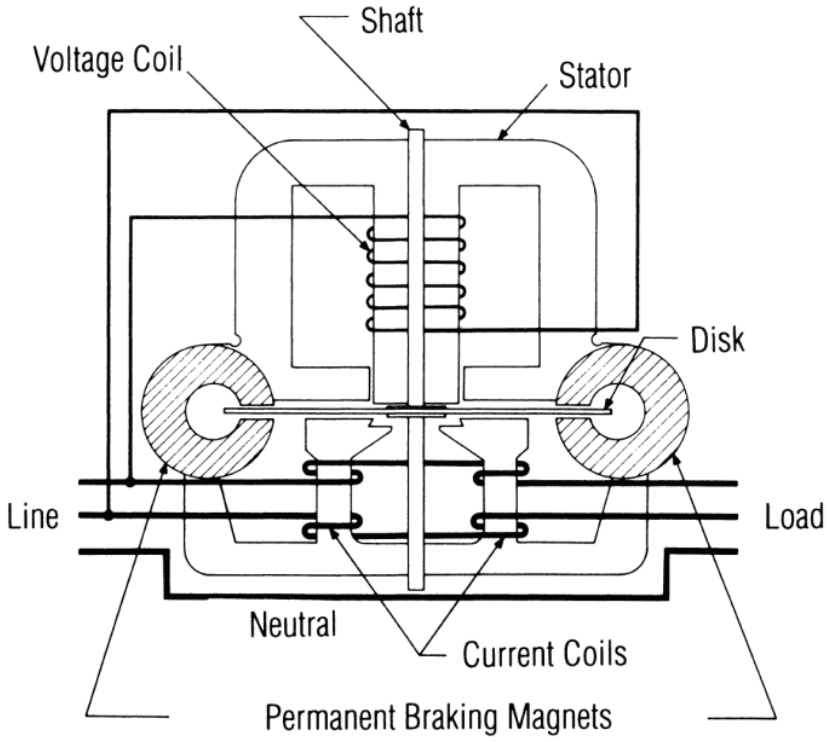
Available References (Hardy's Power Measurement Handbook, UGLY's Elect Ref)

Examples

5S, 12S, 8S, 15S, 9S, 16S

Induction Meters

- Two coils and a conducting (usually aluminum) disk. A braking magnet.
- Magnetic field from the first coil generates *eddy currents* in the disk
- Magnetic field from the second coil interacts with the eddy currents to cause motion
- Disk would accelerate without bound except for eddy currents caused by motion through fixed magnetic field which slows the disk
- The end result is that each revolution of the disk measures a constant amount of energy



Basic Energy Formula

The essential specification of a watthour meter's measurement is given by the value

K_h [Watthours per disk revolution]

A Kh of 7.2 is typical for a single-phase residential meter. In this example, each full rotation of the disk is equivalent to 7.2Wh of energy.

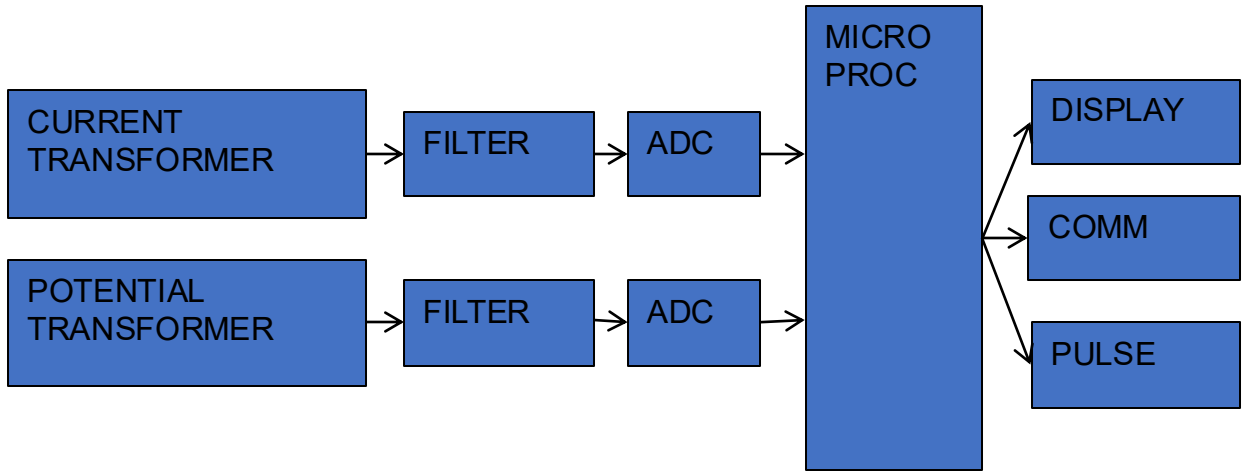
The watthour meter formula is as follows:

$$E\left[\mathbf{Watthours}\right] = K_h\left[\frac{\mathbf{watthours}}{\mathbf{disk\ revolution}}\right] * n\left[\mathbf{disk\ revolutions}\right]$$

Meters 101 – Solid-State

Overview of Functionality

- Potential and Current is scaled down and conditioned with transformers and filters
- ADC's (analog to digital converters) digitize the signals
- A micro-processor or DSP executes the calculations
- Resulting data is displayed, sent externally via the communication circuits, and used for the calibrated pulse output



Meter Forms


GENERAL ELECTRIC
KILOWATTHOURS
37 472 065


FlexNet
49861522
CL200 240V 3W 60Hz FM 2S Kh 1.0 TA 30A
*1N6031955277
sensus
Stratus
31 955 277
TYPE SSA4
Watthour Meter

Meter Forms

1S 14S 39S 17S

3S 12S 2S

35S

76S 45S 4S 10S 25S

26S 46S 66S

32S

11S

6S

5S 15S

13S

16S

24S 9S 56S

Meter Forms

SELF-CONTAINED

1S 14S 12S

2S 25S

17S 16S 32S

15S 13S

TRANSFORMER-RATED

39S 3S 36S 7S

76S 5S 29S

4S 46S 35S 45S

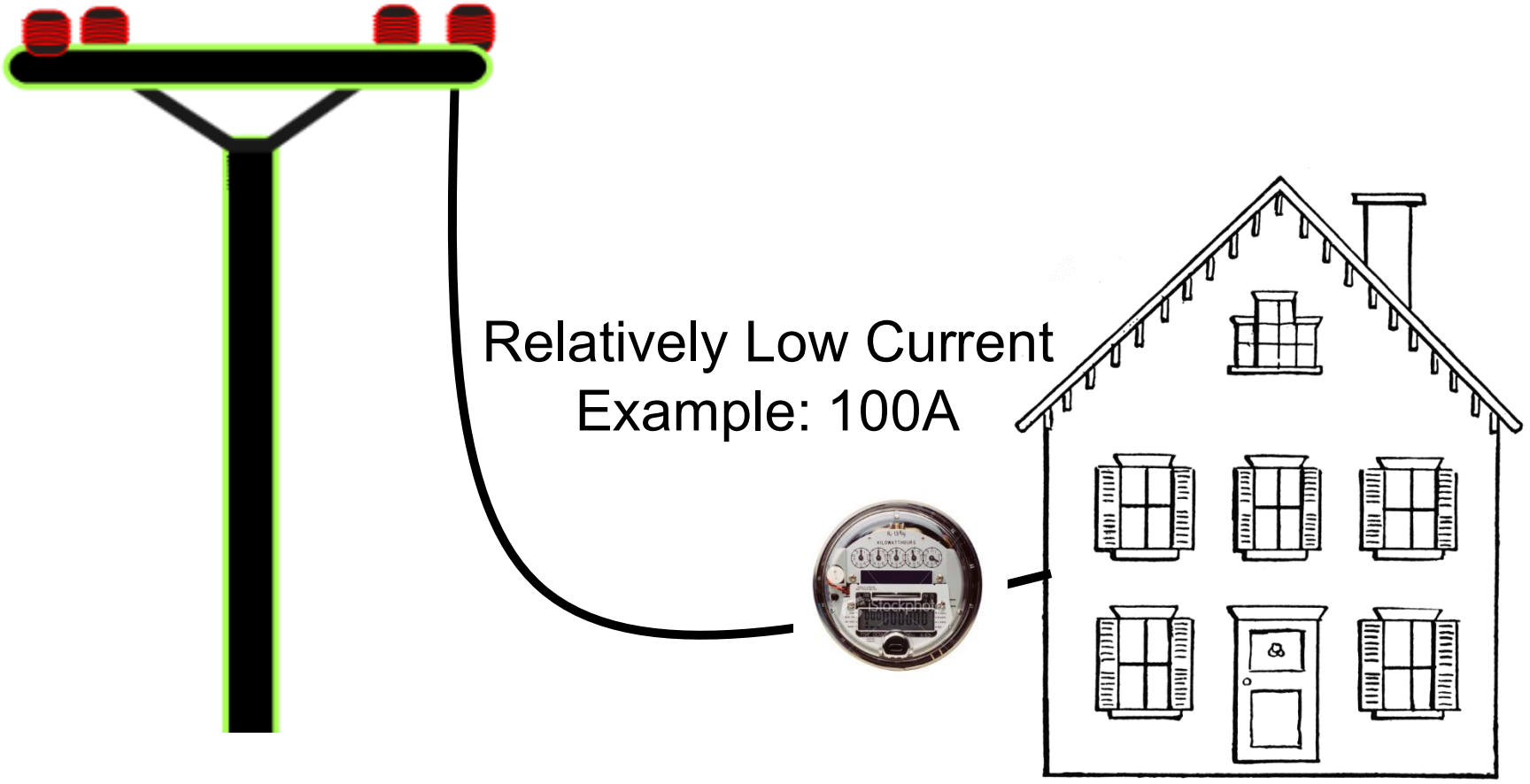
11S 8S 9S

10S 66S 24S

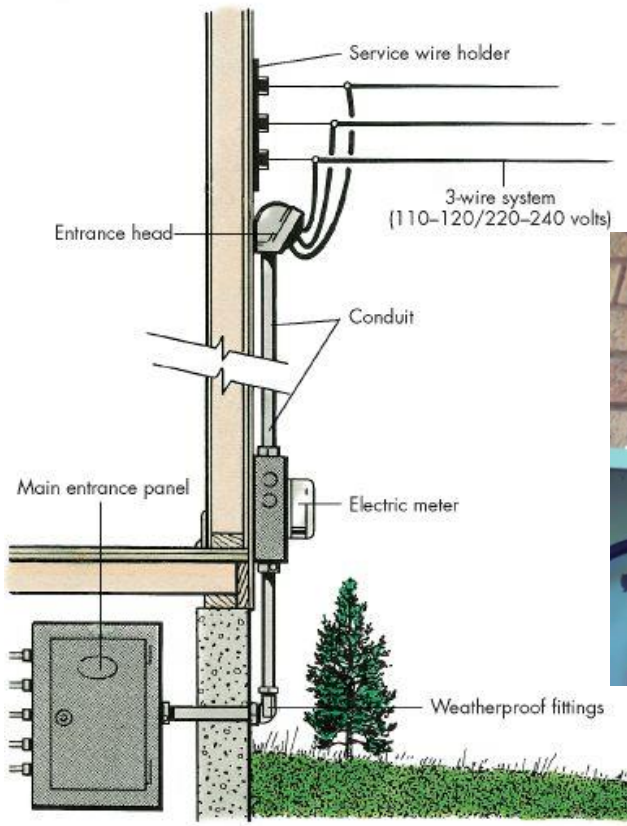
26S 6S 56S

Self-Contained Meters

Primarily Residential

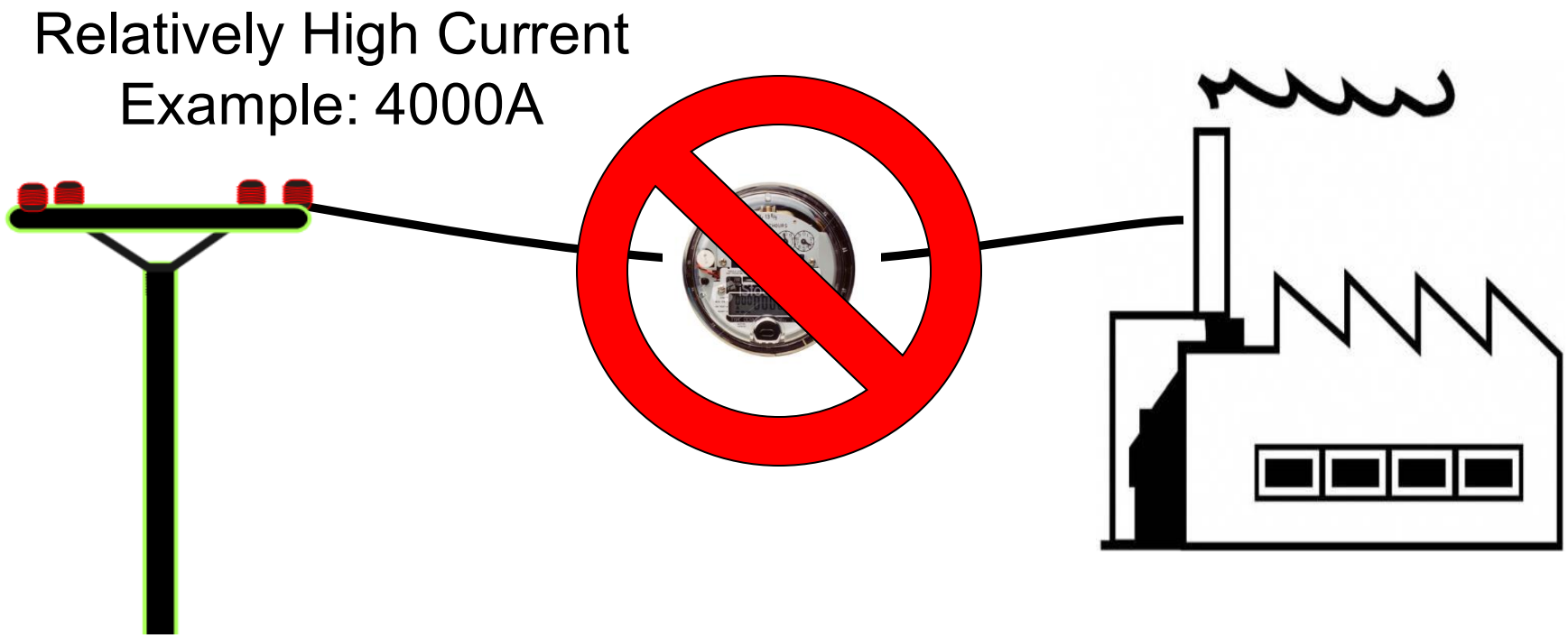


Primarily Residential



Transformer-Rated Meters

Primarily Commercial/Industrial



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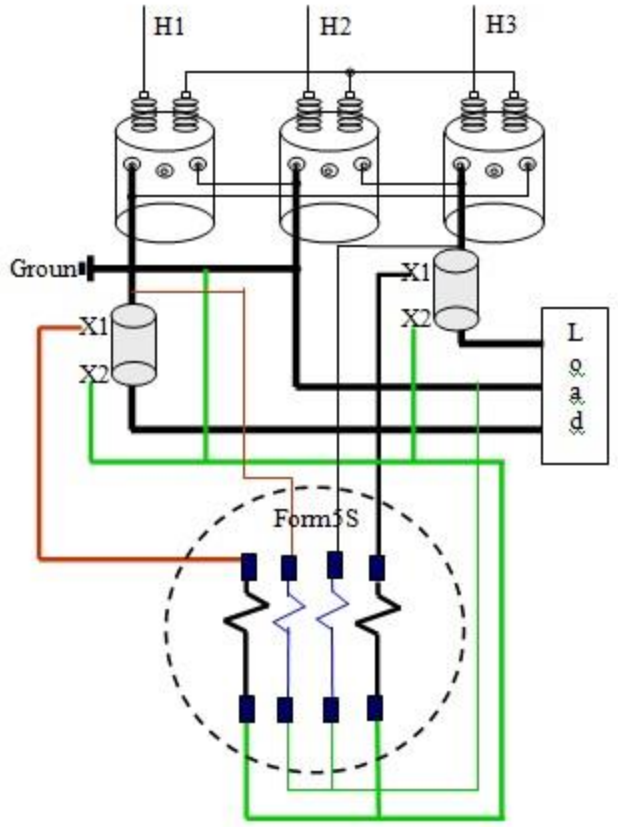
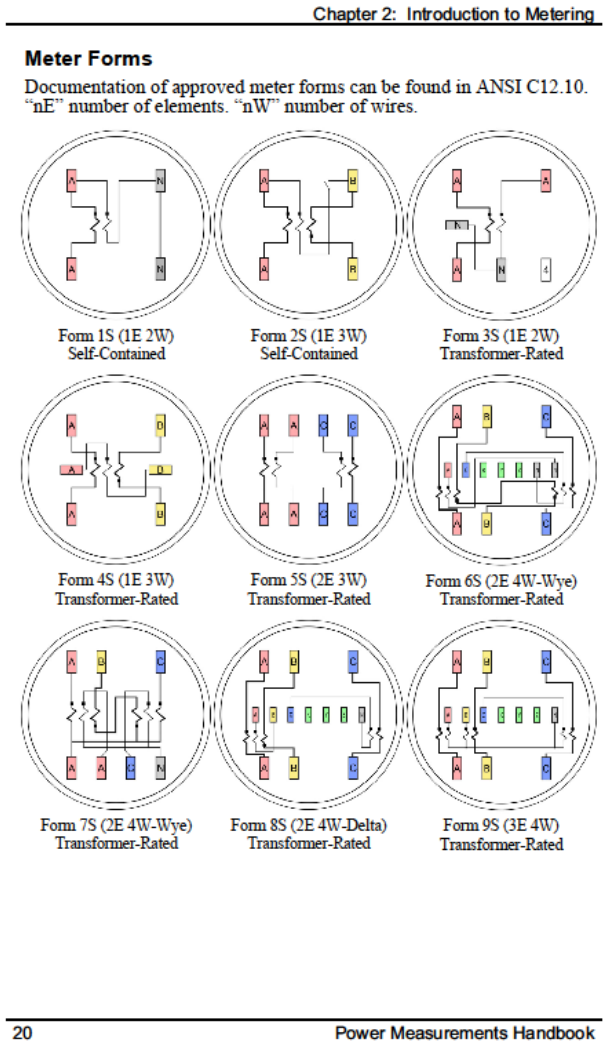


Diagram Example



Chapter 2: Introduction to Metering

Meter Forms

Documentation of approved meter forms can be found in ANSI C12.10. "nE" number of elements. "nW" number of wires.

Form 1S (1E 2W) Self-Contained

Form 2S (1E 3W) Self-Contained

Form 3S (1E 2W) Transformer-Rated

Form 4S (1E 3W) Transformer-Rated

Form 5S (2E 3W) Transformer-Rated

Form 6S (2E 4W-Wye) Transformer-Rated

Form 7S (2E 4W-Wye) Transformer-Rated

Form 8S (2E 4W-Delta) Transformer-Rated

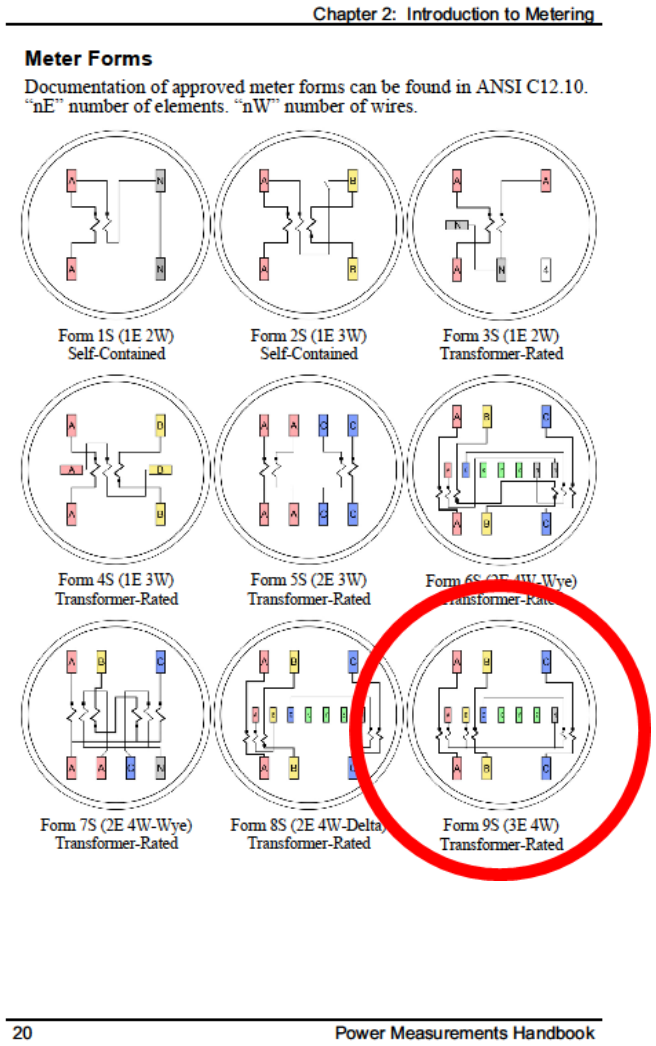
Form 9S (3E 4W) Transformer-Rated

20 Power Measurements Handbook

References

- Power Measurements Handbook, Dr. Bill Hardy
- UGLY's Electrical References
- Meterman's Handbook
- Manufacturer's websites

Diagram Example



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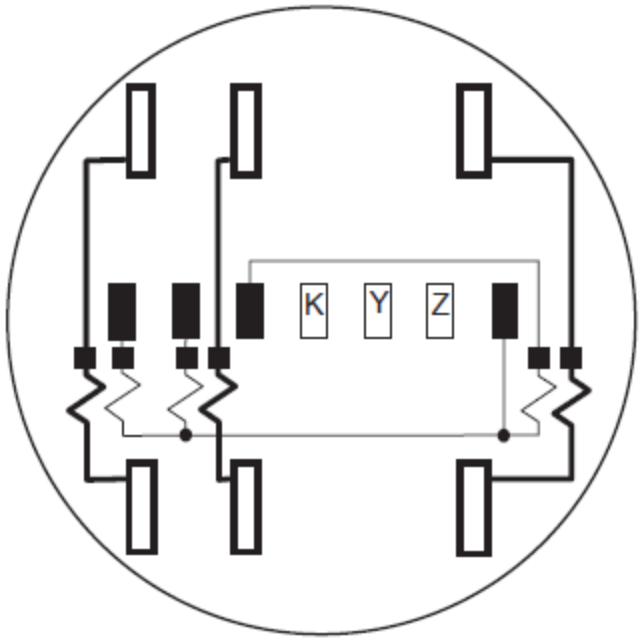


3-Element
4-Wire
FORM 9S

- 3 Current Coils
- 3 Potential Coils

Blondel's Theorem

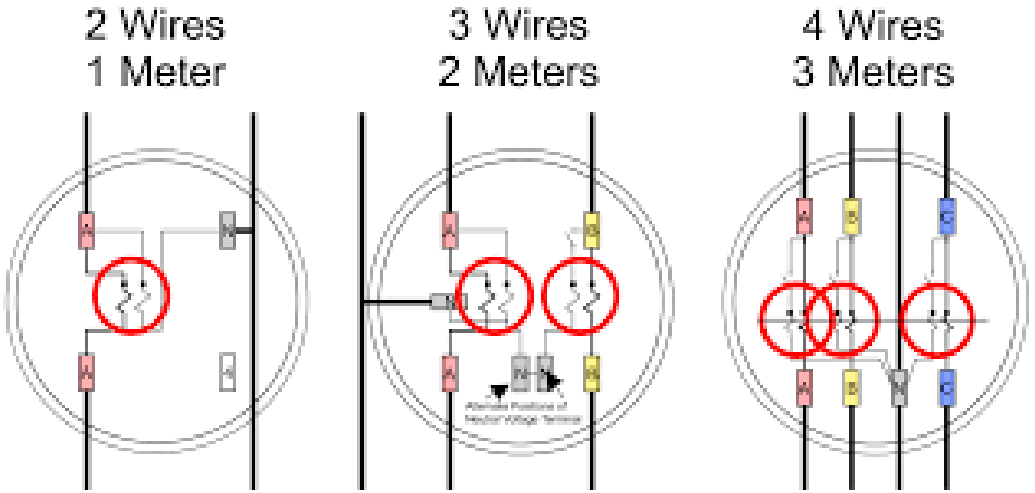
- French Electrical Engineer Andre Blondel
- Attempt to simplify electrical measurements and validation of the results
- Paper submitted to the International Electric Congress in Chicago in 1893.

$$E = n - 1$$

The theorem states that the power provided to a system of N conductors is equal to the algebraic sum of the power measured by N watt-meters. The N watt-meters are separately connected such that each one measures the current level in one of the N conductors and the potential level between that conductor and a common point. In a further simplification, if that common point is located on one of the conductors, that conductor's meter can be removed and only N-1 meters are required.

Blondel's Theorem

Blondel Compliant



1S 12S 9S

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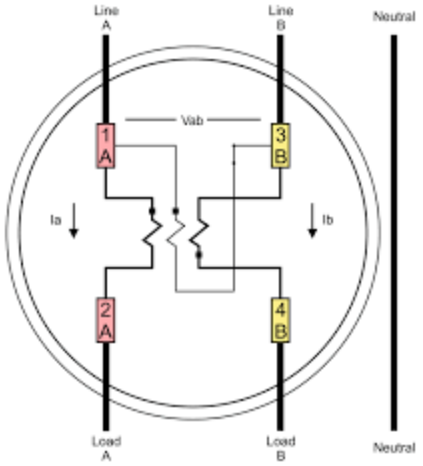
Blondel's Theorem

Non-Blondel Compliant



2S

$$E = n - 1$$

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Blondel's Theorem

Why is non-Blondel metering bad?

- Makes assumptions about the service
- Example: balanced voltages
- Assumptions might not be true
- When these assumptions are not true, then there are power measurement errors even if the meter is working perfectly.

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Blondel's Theorem

Why are non-Blondel meters used?

- Fewer elements (meters) = lower cost
- Especially true for electro-mechanical meters
- Fewer CT's and PT's = lower cost
- Less wiring and cheaper sockets

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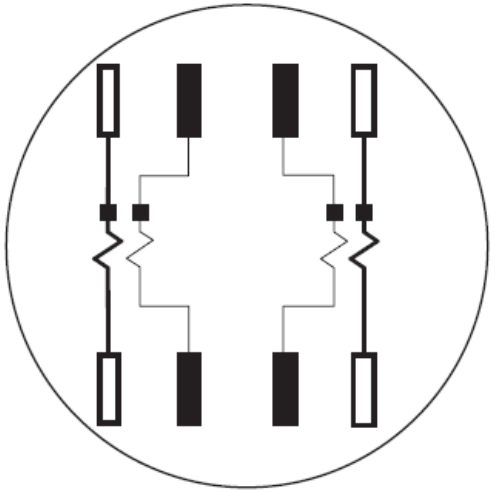
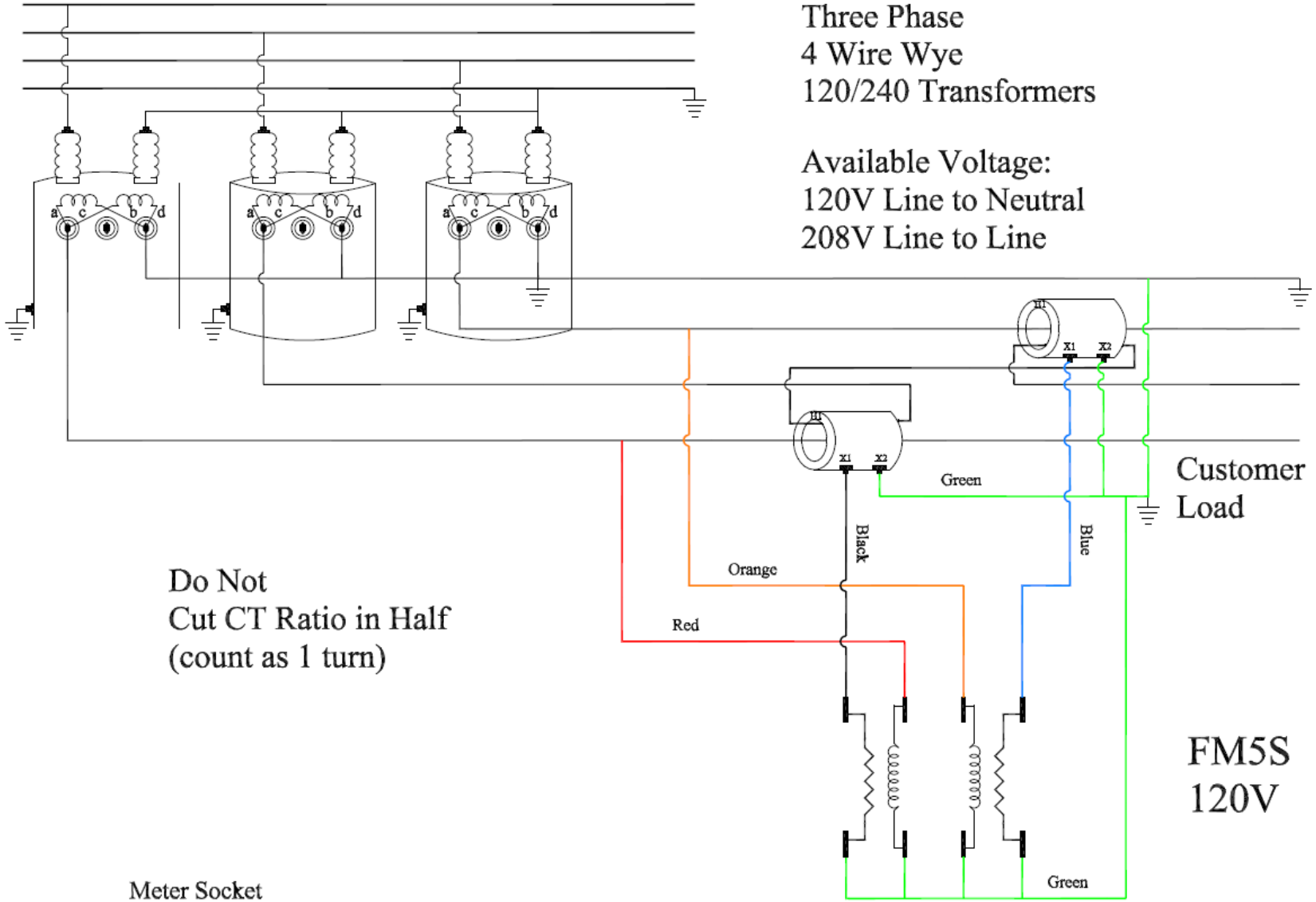
Metering Examples



Form 5S



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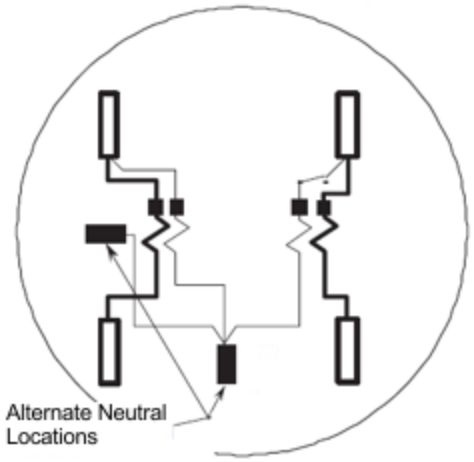
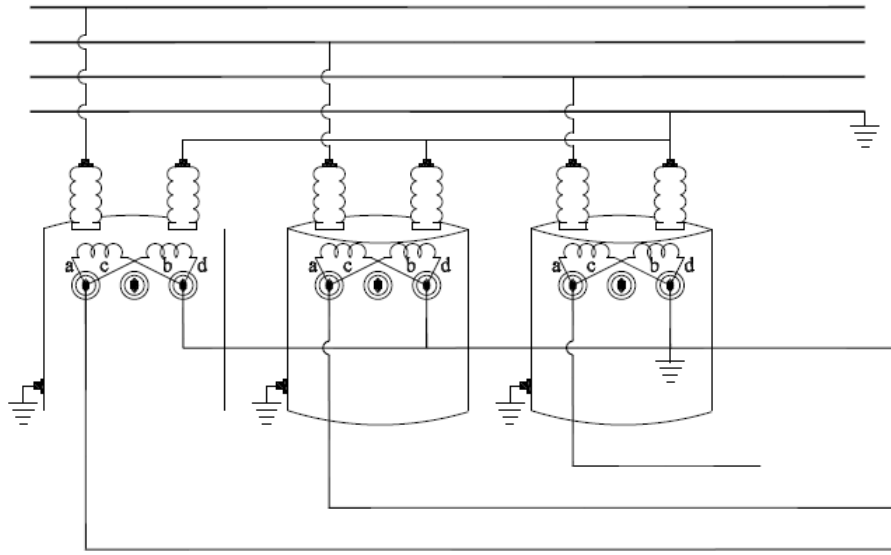


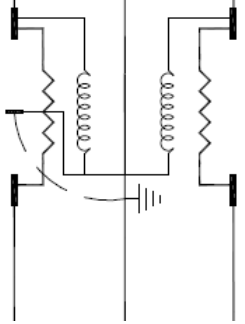
Form 12S



Three Phase
3 Wire Network
120/240 Transformers

Available Voltage:
120V Line to Neutral
208V Line to Line

(also available)
Additional 3W Network Circuits
& 4W Wye Three Phase

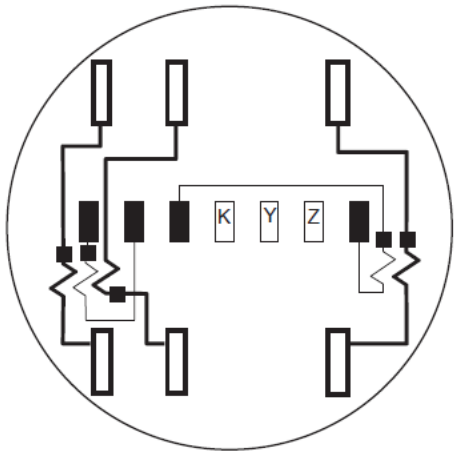


FM12S
120V

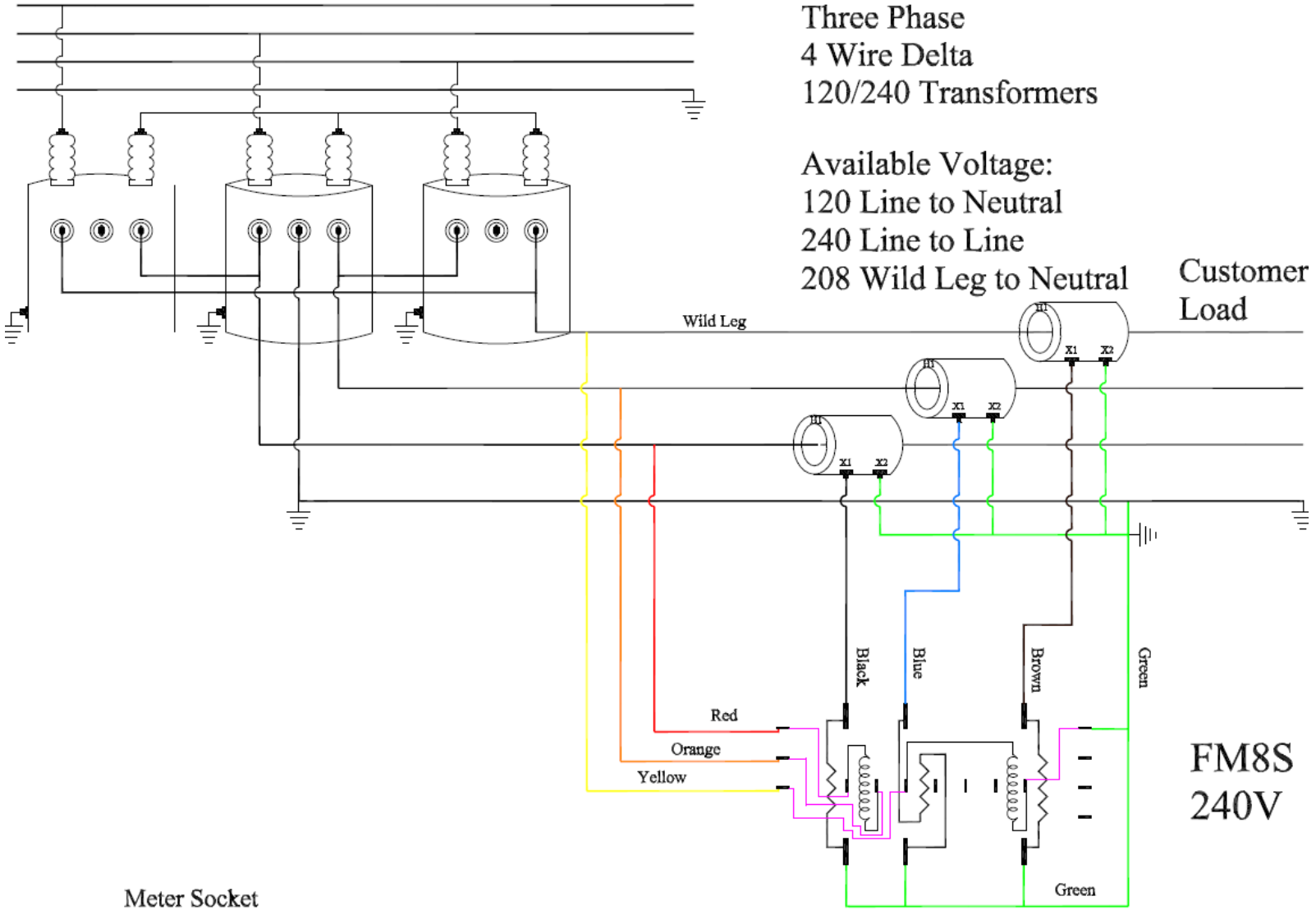
Meter Socket
Must Be Grounded

Customer
Load

Metering Examples



Form 8S



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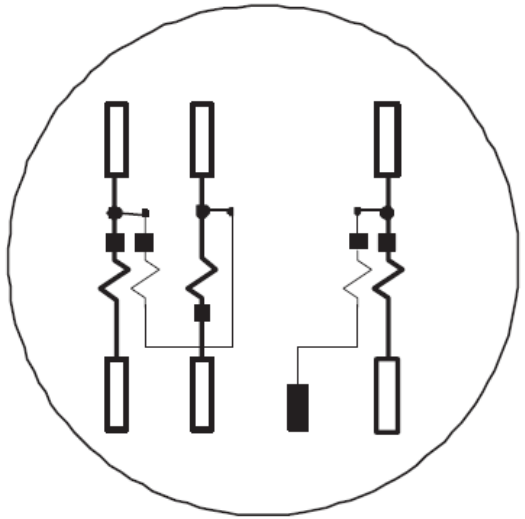
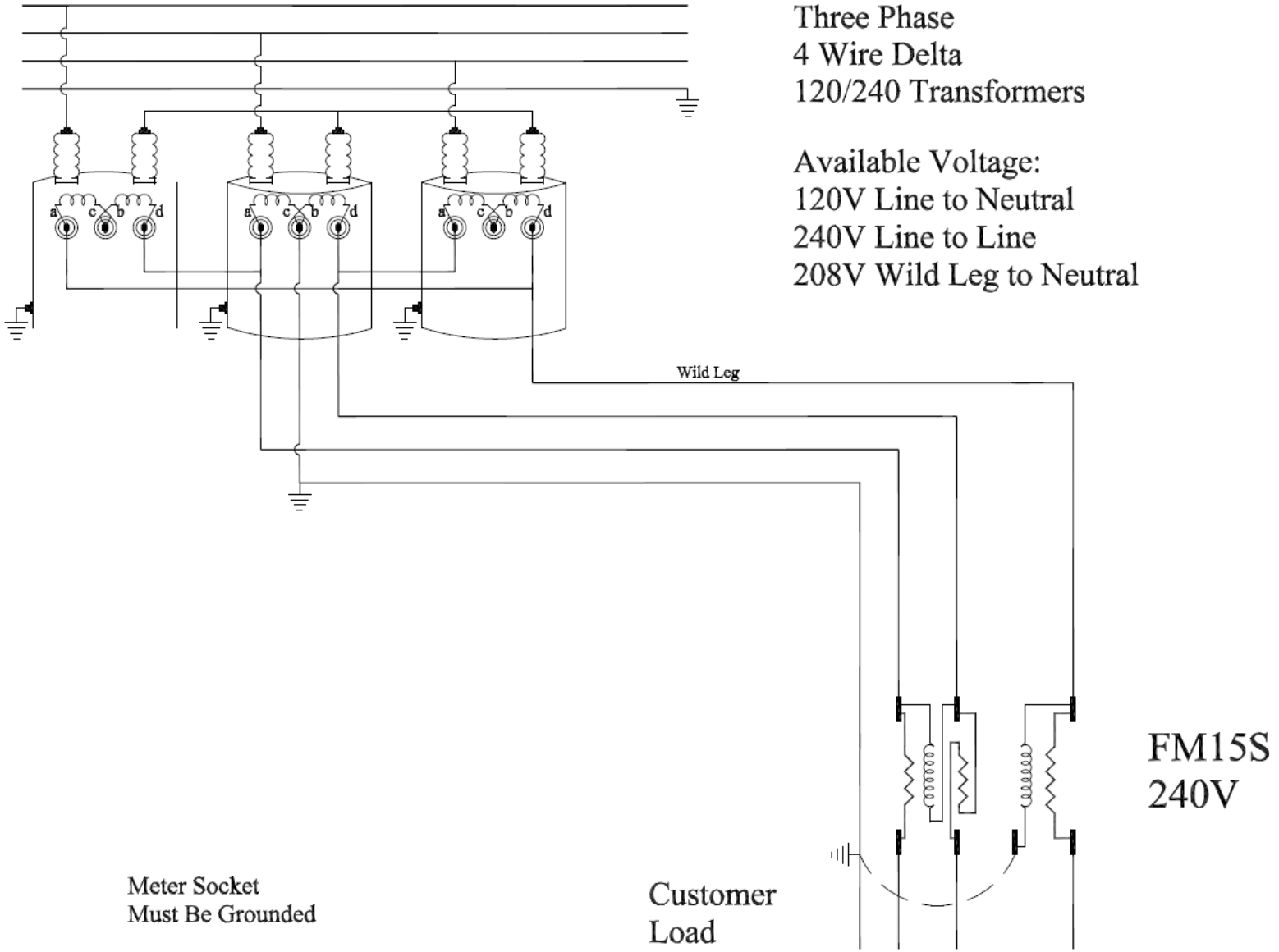


Form 15S



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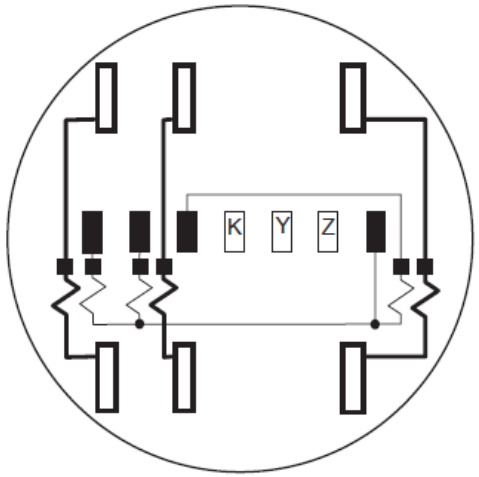
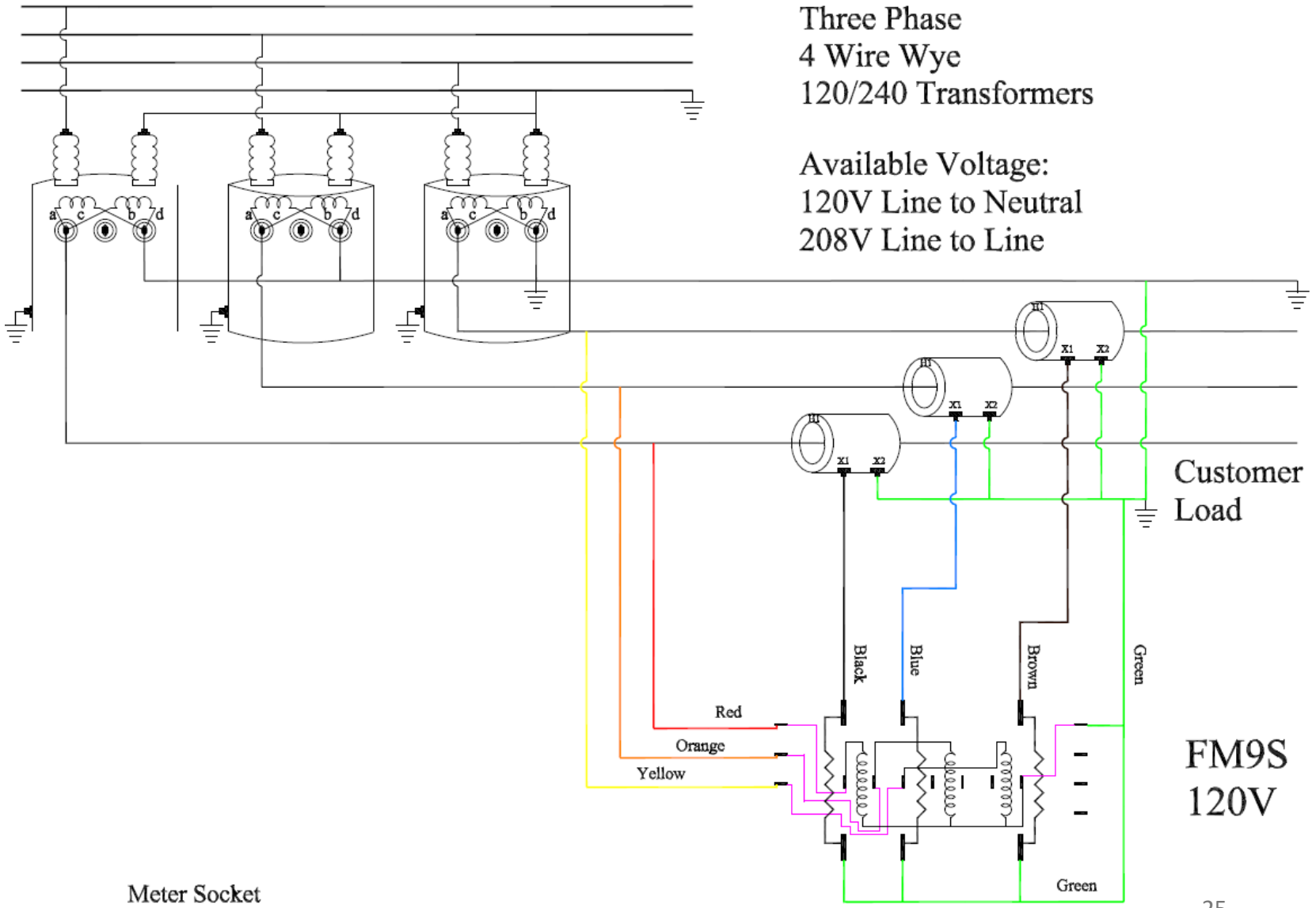
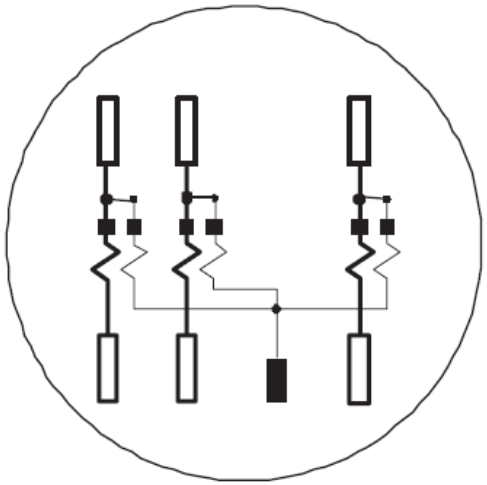


Form 9S

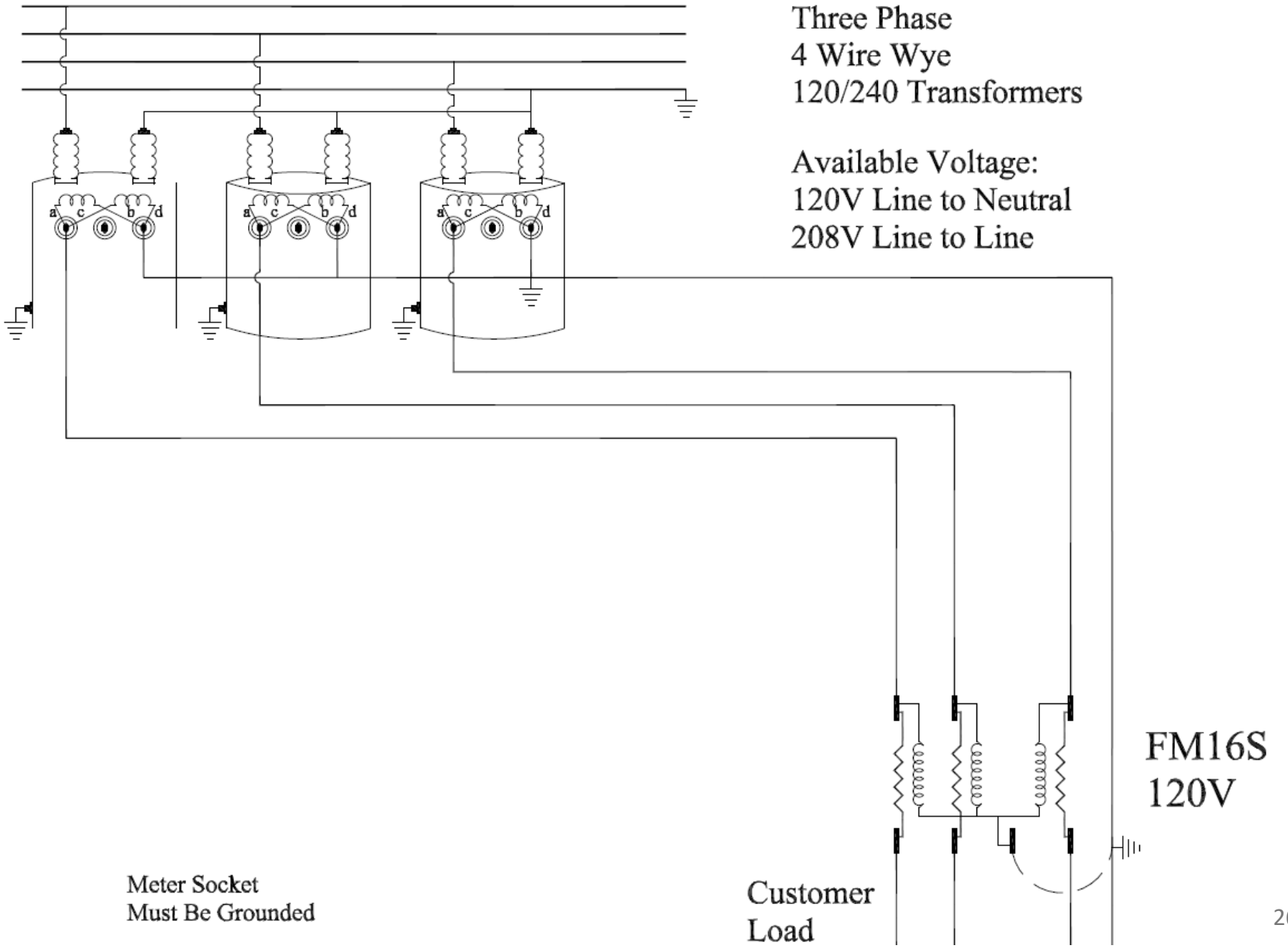


Meter Socket
Must Be Grounded

Metering Examples



Form 16S



References

- Wikipedia – of course
- https://en.wikipedia.org/wiki/Blondel%27s_theorem

- Power Measurement Handbook – Dr. Bill Hardy – TESCO CTO Emeritus
- http://www.powermeasurements.org/library/Presentations/NCMS%20201 3%20-%20Non-Blondel%20Metering.pdf

Agenda

Meters 101 - Electro-Mechanical vs Solid-State

Meter Forms

Self-Contained vs Transformer Rated

Blondel's Theorem

Available References

Questions and Discussion

John Williams

VP Engineering

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TESCO Hospitality Suite

We would like you to join us in the TESCO Hospitality Suite for networking and more discussions about metering. The discussion will not be exclusively metering…….but we love metering and that is the most common topic.

TESCO Hospitality Suite 301 – Brighton Tower

Monday and Tuesday 8:00 PM – 10:00 PM

We Hope you Can Join Us!