Introduction to Transformer Rated Meters

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Meter Types

- **Self Contained Meters** –
  - Usually class 100, 200 or 320 (max. amps)
  - Up to 480 volts (some higher, e.g. Canada)
  - Smaller loads
  - Average homes and small commercial
  - Voltages and currents connect to same terminals; load currents flow through meter
  - The meter multiplier is 1 (typically)
• Self Contained Meters –
  – Voltages and currents connect to same terminals; load currents flow through meter
  – The meter multiplier is 1 (typically); may be 10 depending on how “dials” are displayed
• Transformer Rated Meters --
  – Class 10 or 20; generally CL 20 today
  – Load currents above 200 amps and/or voltages above 480v. (typically)
  – Used with voltage transformers and/or current transformers
  – Larger commercial and industrial customers; large homes
  – Voltages and currents connect to separate terminals on meter
  – The meter multiplier is not 1 (normally)
• Transformer Rated Meters --
  - Voltages and currents connect to separate terminals on meter
  - The meter multiplier is not 1 (normally); it is the product of the VT and CT ratios
Transformer Rated Meters - Safety

Voltage transformers should never be shorted.

Current transformers must always be shorted when not in use; never “pull” a transformer rated meter unless CT circuits are shorted.
Transformer Rated Meters

Voltage transformer – transforms the voltage; typically to 120 volts from the primary voltage

Current transformer – transforms the current; typically to 5 amps from the primary current

**Polarity must be observed for CT’s and VT’s**

The “ratio” is expressed as X to Y (X:Y) and represents the rated primary value as compared to the secondary value.
Meter Multipliers

- Current transformers but no voltage transformers -
  - Example: 400 amp primary (service)
  - 400 amp to 5 amp (400:5) current transformer
  - 80:1 ratio (400/5 = 80)
  - The meter multiplier, then, is 80
• Current transformers and voltage transformers -
  – Example: Service is 12470Y/7200 volts and rated 400 amps
  – VT’s are connected phase to neutral – 7200:120 or 60:1
  – 400 amp to 5 amp (400:5) current transformers – 80:1)
  – The meter multiplier, then, is 60 x 80 or 4800
“Dial” Multipliers and Primary Reading Registers

- Meter register must show the actual primary usage values
- Example: Transformer Factor is 4800
- Meter multiplies values by 4800 and displays result
- A dial multiplier may be required to prevent “wrap around”, e.g. x100, x1000, etc.
Blondel’s Theorem

Blondel says:

If energy be supplied to any system of conductors through N wires, the total power in the system is given by the algebraic sum of readings of N wattmeters, so arranged that each of the N wires contains one current coil, the corresponding potential coil being connected between that wire and some common point. If this common point is on one of the N wires, the measurement may be made by the use of N-1 wattmeters.

Andre E. Blondel, 1893

- We would use “watthour meters” in place of “watt meters” and “energy” in place of “power”.
- We would also consider “ground” as a possible current carrying conductor when counting “N”.

•
What is a meter Form Number?

• A Form designation tells us:
  – The number and arrangement of meter terminals, and
  – The number and *internal connection* of meter elements (stators).
• The Form designation describes the meter, not the service.
  – With modern meters, some meter Forms may be used to correctly meter more than one service configuration.
  – More than one meter Form could be used with a particular service depending on the connection of the Instrument Transformers.
• The same Form designation is usually applicable to equivalent meters of all manufacturers.
### Basic Meter Forms

<table>
<thead>
<tr>
<th>Meter Form</th>
<th>S.C./T.R.</th>
<th>Number of Stators</th>
<th>Number of Current Circuits</th>
<th>Number of External Circuit Wires</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S, 1A</td>
<td>SC</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2S, 2A</td>
<td>SC</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3S, 3A</td>
<td>TR</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4S, 4A</td>
<td>TR</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5S, 5A</td>
<td>TR</td>
<td>2</td>
<td>2</td>
<td>3 (or 4)</td>
</tr>
<tr>
<td>35S, 35A</td>
<td>TR</td>
<td>2</td>
<td>2</td>
<td>3*</td>
</tr>
<tr>
<td>45S, 45A</td>
<td>TR</td>
<td>2</td>
<td>2</td>
<td>3 (or 4)</td>
</tr>
<tr>
<td>6S, 6A</td>
<td>TR</td>
<td>2</td>
<td>3</td>
<td>4Y</td>
</tr>
<tr>
<td>36S, 36A</td>
<td>TR</td>
<td>2</td>
<td>3</td>
<td>4Y</td>
</tr>
<tr>
<td>8S, 8A</td>
<td>TR</td>
<td>2</td>
<td>3</td>
<td>4Δ</td>
</tr>
<tr>
<td>9S, 9A</td>
<td>TR</td>
<td>3</td>
<td>3</td>
<td>4Y (or Δ**)</td>
</tr>
<tr>
<td>12S, 12A</td>
<td>SC</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>14S, 14A</td>
<td>SC</td>
<td>2</td>
<td>3</td>
<td>4Y</td>
</tr>
<tr>
<td>15S, 15A</td>
<td>SC</td>
<td>2</td>
<td>3</td>
<td>4Δ</td>
</tr>
<tr>
<td>16S, 16A</td>
<td>SC</td>
<td>3</td>
<td>3</td>
<td>4Y (or Δ**)</td>
</tr>
</tbody>
</table>

* Not intended for Form 5S equivalent, 4 wire delta connections.  ** Some electronic meters may be used in 4wY or 4wΔ circuits.

SC = Self Contained; TR = Transformer Rated
S = Socket Base; A = Bottom Connected
Self Contained vs Transformer Rated

What is one of the key differences . . .
. . . when we look at ANSI forms?

Self-Contained

Transformer-Rated
Applicable ANSI Meter Forms

Form 3S*
1 Element,
Transformer Rated
2 wire, single phase,
3 wire, single phase

Form 4S*
“1-1/2” Element,
Transformer Rated
3 wire, single phase

* ANSI Forms looking from the front of the meter
Applicable ANSI Meter Forms

Form 5*
2 Element,
3 wire, network

Form 35*
2 Element,
3 wire, network

Form 45*
2 Element,
3 wire, network

* ANSI Forms looking from the front of the meter
Polyphase Meters

4 Wire Wye Services
4 wire Wye Metering

Form 9
3 Element,
4 wire, wye
Transformer-rated

Form 6
2½ Element,
4 wire, wye

Form 36
2½ Element,
4 wire, wye
4 wire, Wye Metering

Transformer-rated
4 Wire, Delta Metering
Summary

- Transformer rated meters are required when voltages and currents exceed the meter’s direct connect capability.
- A form designation tells us about the number or terminals, their location and the internal meter wiring.
- In CT and VT connections, polarity must be observed for metering to be correct.
- CT’s must be shorted when not in use; VT’s should not be shorted.
- Meter multipliers are critical in transformer rated applications.