Seattle City Light

Technical Metering Unit

Guidelines For

Transformer Rated

Meter Installations

Revision 4.9

August 2007

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To those who got us this far

Revision 4.9

August 2007

Bert McClellan

Document File: Seattle City Light CT Connections49.doc

Drawing File: Transformer Connections Booklet49.vsd

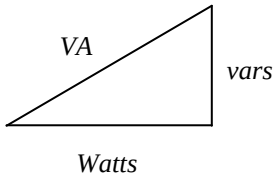
This reference is a guide for installing secondary and primary voltage transformer rated metering.

Installations should conform to the installation guides as shown in this booklet.

Some installations will not fit into the patterns as shown.

In cases where field engineering is required, consult with your Crew Chief for available options for the installation.

Formulas



$$PF = \cos\theta = \frac{Watts}{VA} = \cos\left(\tan^{-1}\left(\frac{varhours}{Watthours}\right)\right)$$

$$VA = I * E = \frac{Watts}{\cos\theta} = \sqrt{Watts^2 + var\,s^2}$$

$$Watts = VA * \cos\theta = \sqrt{VA^2 - \text{var}\,s^2}$$

$$\text{var}\,s = VA * \sin\theta = \sqrt{VA^2 - Watts^2}$$

$$Q = I * E\cos(\alpha \pm \theta)$$

$$Q = I * E\cos\alpha\cos\theta \pm \sin\alpha\sin\theta$$

Time Load Check:

$$Watts = \frac{PK_h * Re\,vsObserved * 3600}{time(\,in\,sec\,onds\,)}$$

For ABB Programming:

$$K = \frac{Kh * TF * SF}{Kp * K_r}$$

$$CTR * VTR * K_h * R_s * R_r = 10{,}000 * K_r$$

K_r – Actual Display Multiplier, Dial Multiplier, Register Multiplier

R_r – Register Ratio

R_s – Shaft Reduction, First Reduction. Formerly W_r, G_r

K_h – Watthours per disk revolution or equivalent

*PK_h – CTR*VTR*K_h*

$$3\phi ML = \frac{I_{max} * V_{LL} * \sqrt{3} * 0.8}{1000 * K_r}$$

$$1\phi ML = \frac{I_{max} * V_{LL} * 0.8}{1000 * K_r}$$

3Ø kW Max Limits When TF=K_r		Rating Factor			
		1.0	2.0	3.0	4.0
L-L Service Voltage	208	1.44	2.88	4.32	5.76
	240	1.66	3.33	5.0	6.65
	480	3.33	6.65	9.97	13.3

1Ø kW Max Limits When TF=K_r		Rating Factor			
		1.0	2.0	3.0	4.0
L-L Service Voltage	120	0.48	0.96	1.44	1.92
	240	0.96	1.92	2.88	3.84
	480	1.92	3.84	5.76	7.68

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Conductor Size, Color Coding and Considerations

- **Instrument transformers installed and wired observing proper polarity.**
- **#10 solid conductors for current circuits up to 75'.**
- **#8 conductors for current circuits from 75' to 150'.**
- **#6 conductors for current circuits from 150' to 250'.**
- **Current return will be one continuous conductor including extension to ground.**
- **#12 solid conductors for potential circuits, neutral and bonding.**
- **CT's return grounded at only one point, preference in CT enclosure.**
- **Fuse blocks will be fed from the top or left side.**
- **If fusing provisions are used on a test switch, line side is the top of the fuse position. This fusing option is to be used if access to the C.T. can is or will become difficult or restricted.**
- **Fuse blocks are recommended unless the installation is exposed to the elements where inline fuses may be used, e.g. transformer bushings, vaults.**

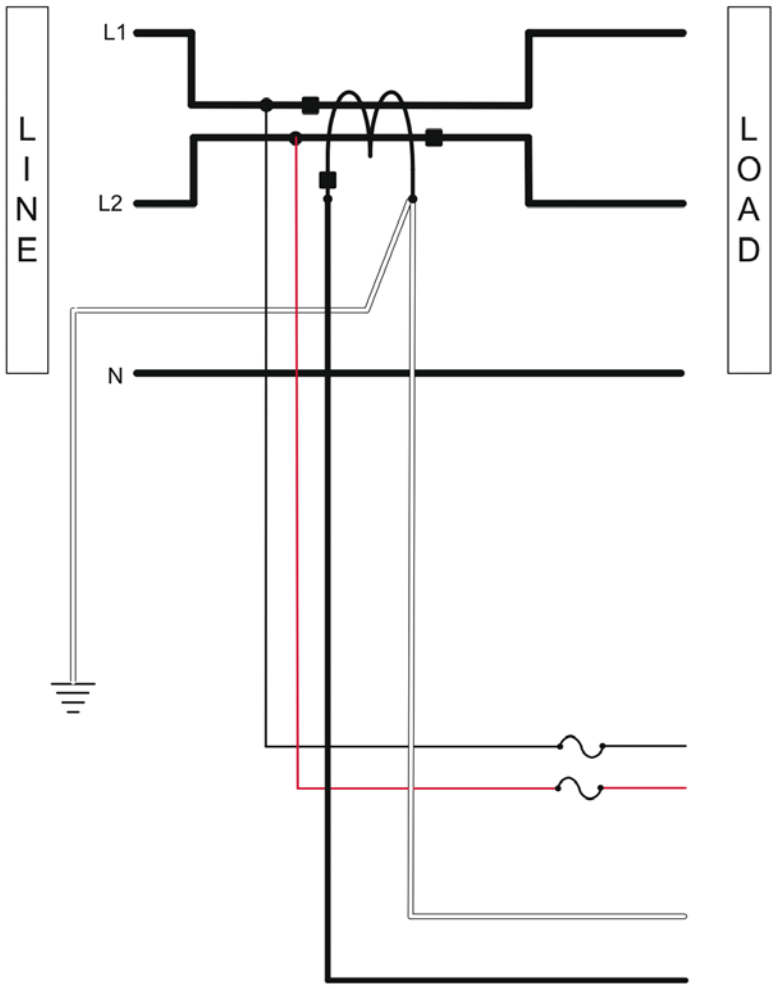
Color Code:

- **Currents are Black, Red and Blue, and White return.**
- **Potentials are Black, Red and Blue, and White neutral.**
- **#16 or #18 conductors for Pulses, Red=K, Yellow=Y, Black=Z.**
- **#12 Green for equipment bonding ground.**
- **Refer to drawings for specific color code scheme. In the following illustrations, wire colors used between the test switch and socket are colors used by the shop. When field wiring the socket, follow through using same phase colors as used in secondary run.**

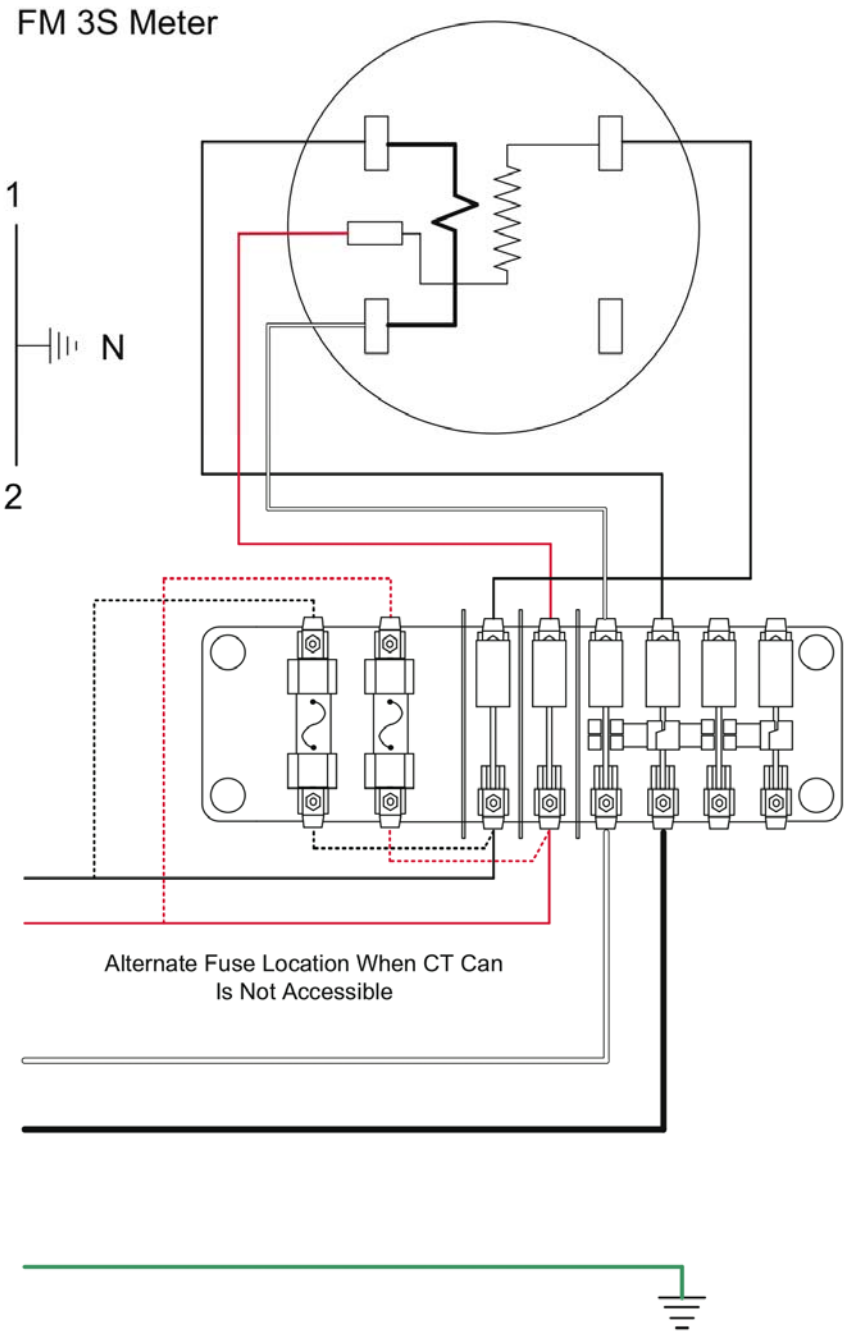
Verify:

- **Meter equipped with pulse outputs as needed.**
- **Meter equipped with load profile recording as needed.**
- **Telephone line required for installation of Totalized Services.**
- **Totalizing meter equipped with modem and load profile recording.**
- **Isolation relay(s) installed as needed.**

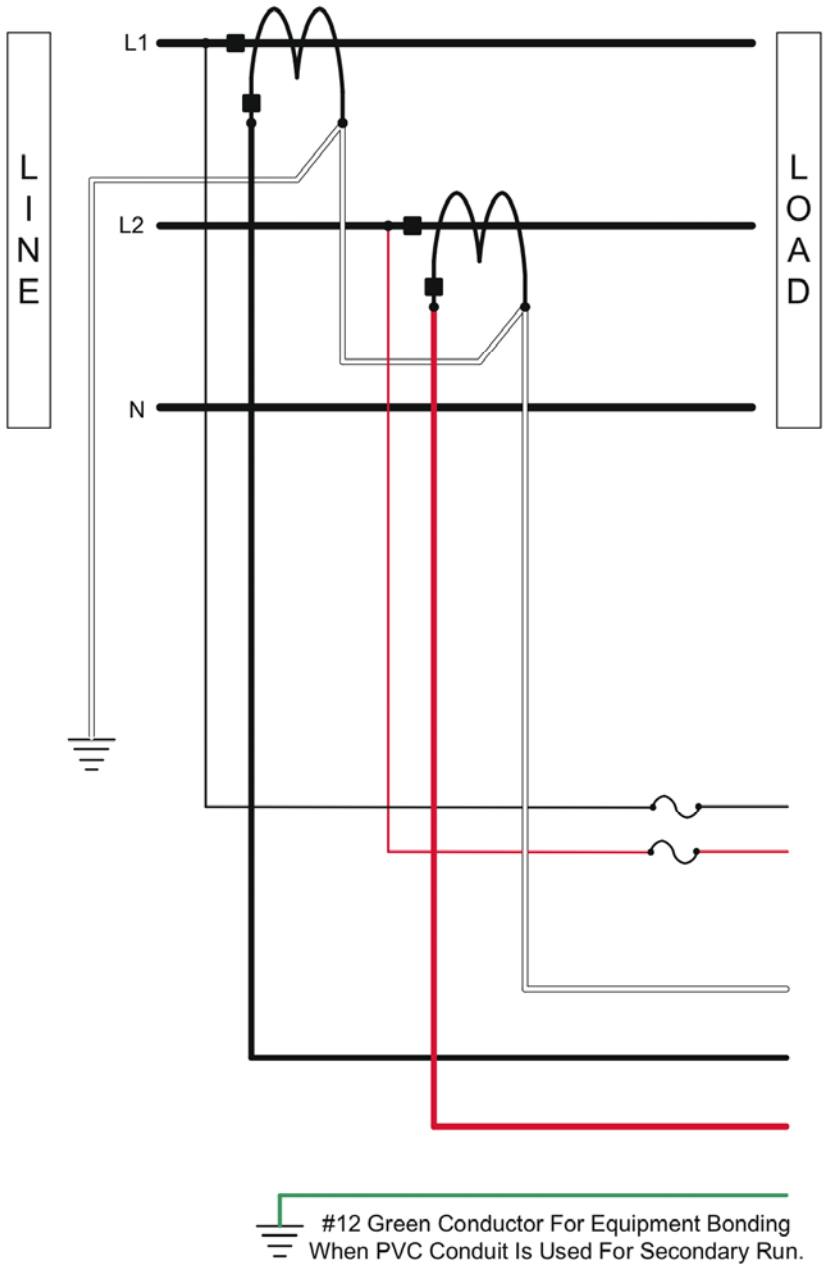
1 Phase 3 Wire Service Using 3 Wire CT

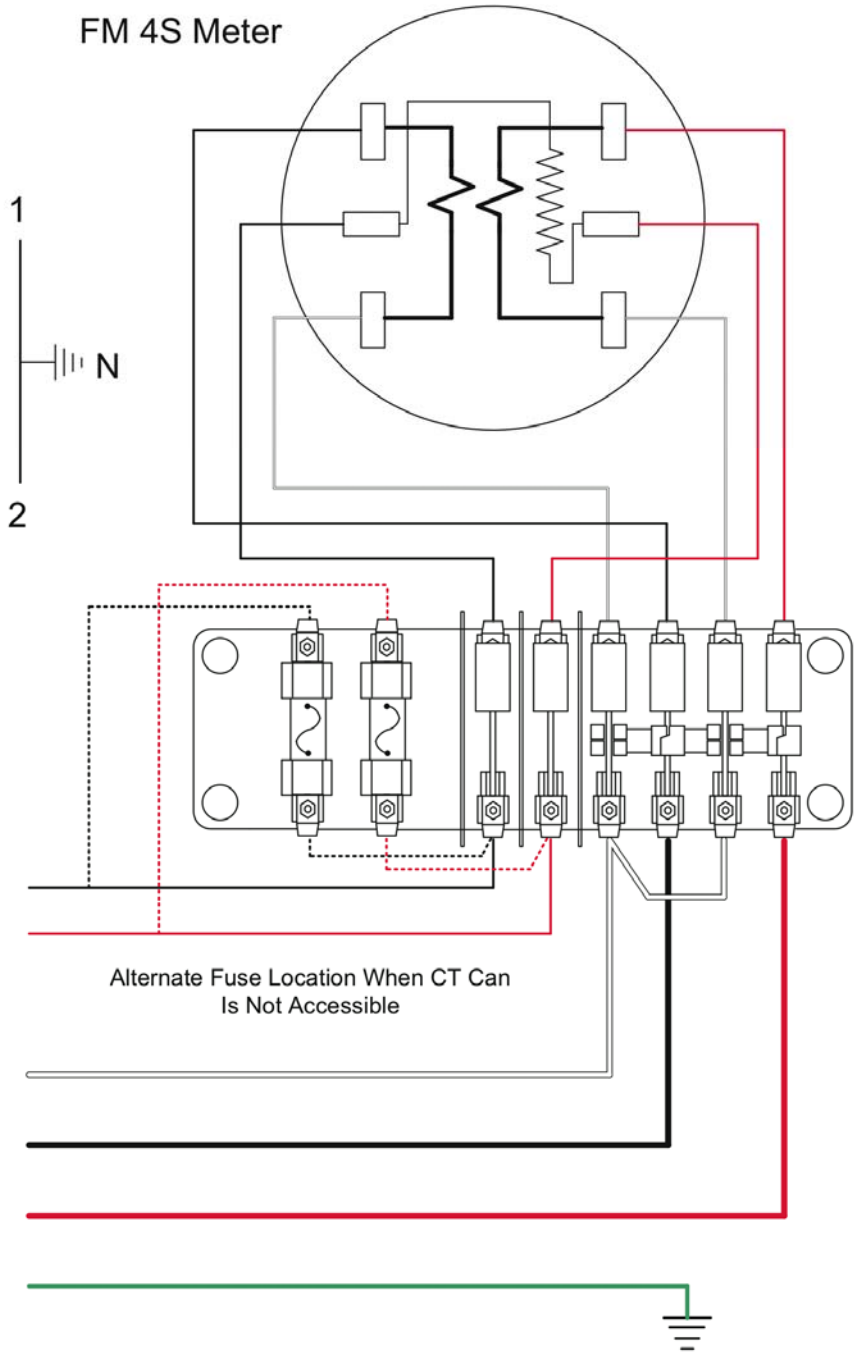


#12 Green Conductor For Equipment Bonding
When PVC Conduit Is Used For Secondary Run.

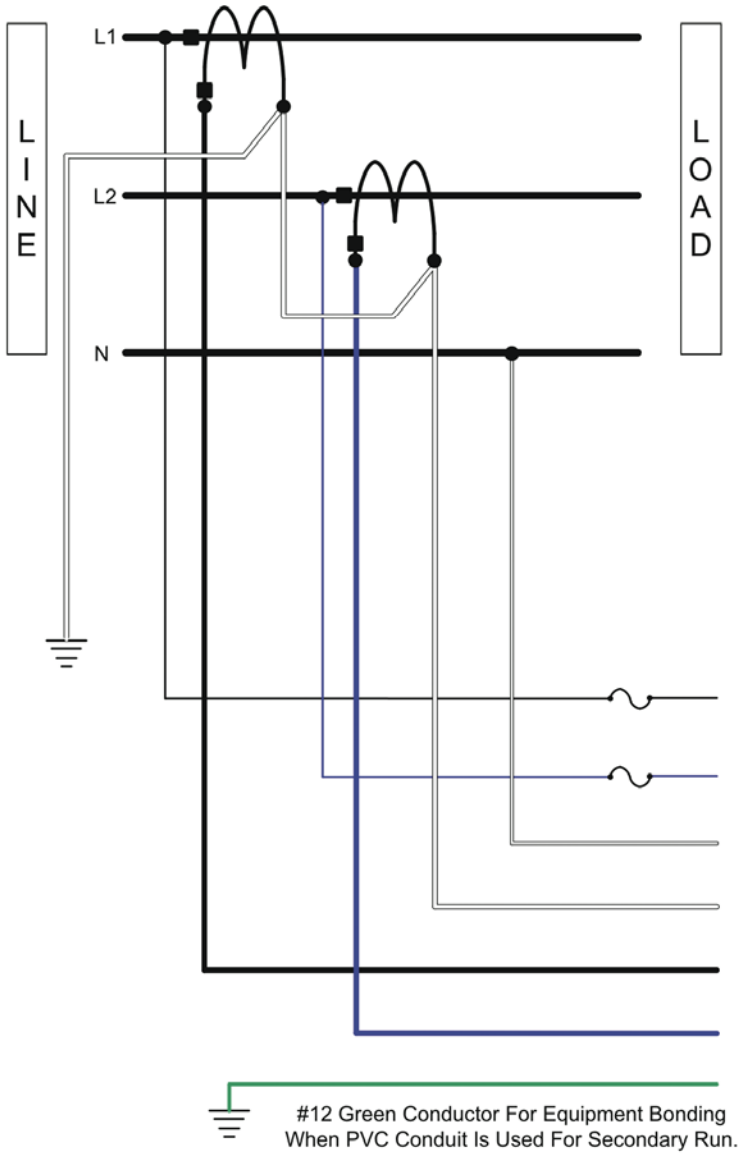

FM 3S Meter
1
N
2
Alternate Fuse Location When CT Can
Is Not Accessible

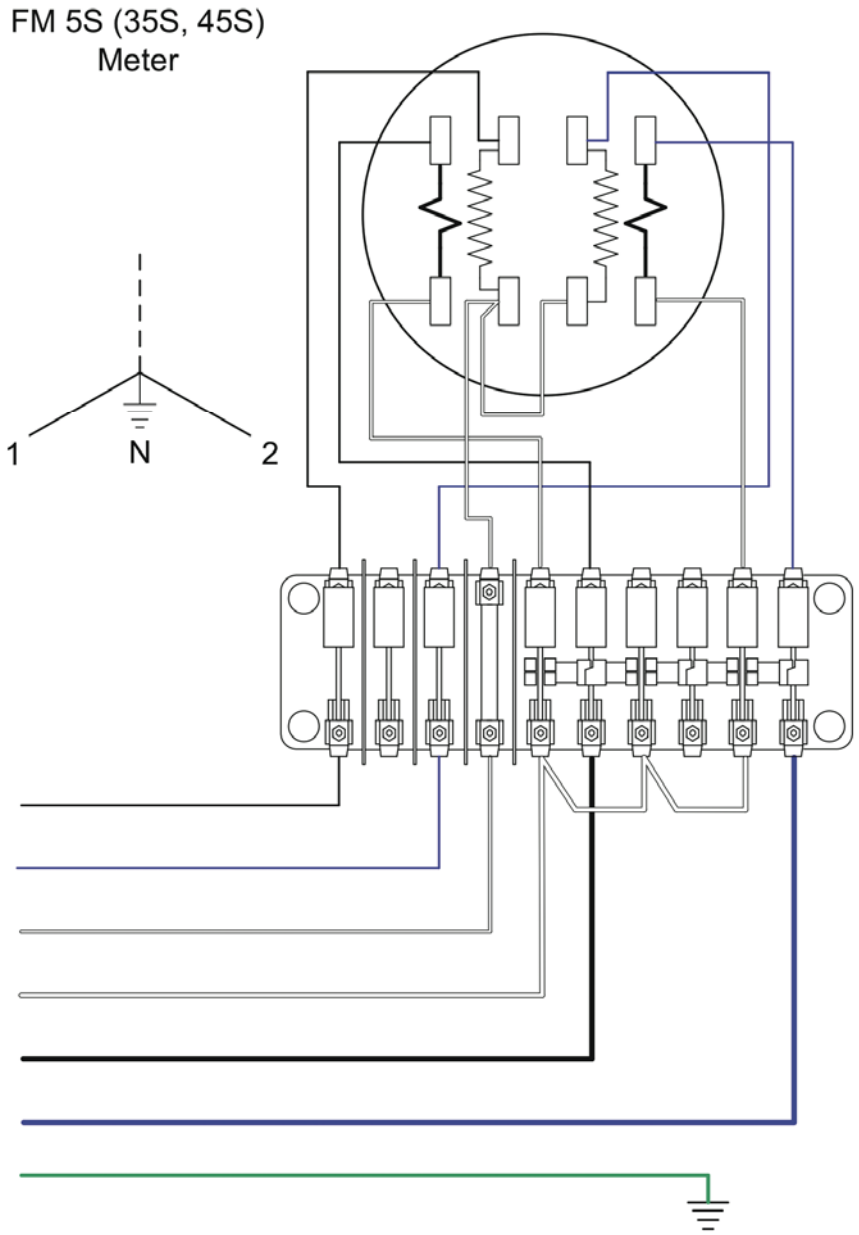
1 Phase 3 Wire Service



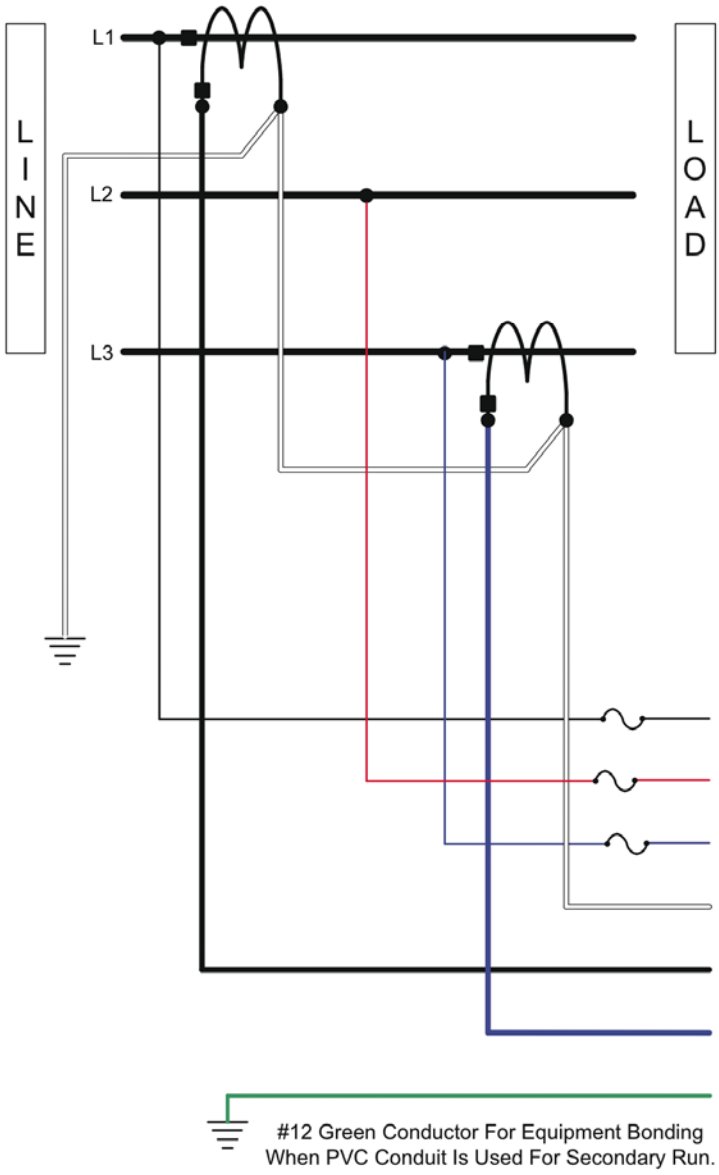

FM 4S Meter
1
N
2
Alternate Fuse Location When CT Can
Is Not Accessible

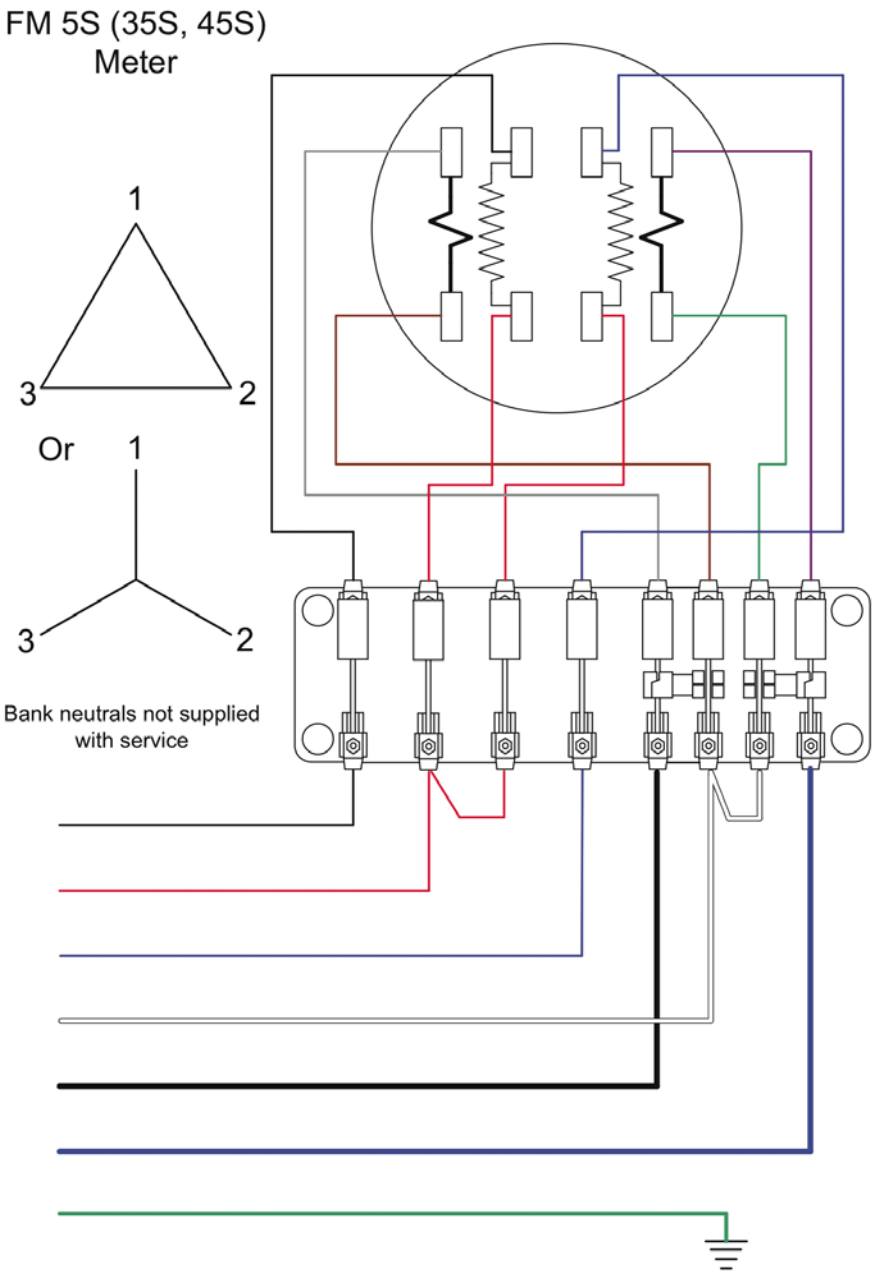
Network Service



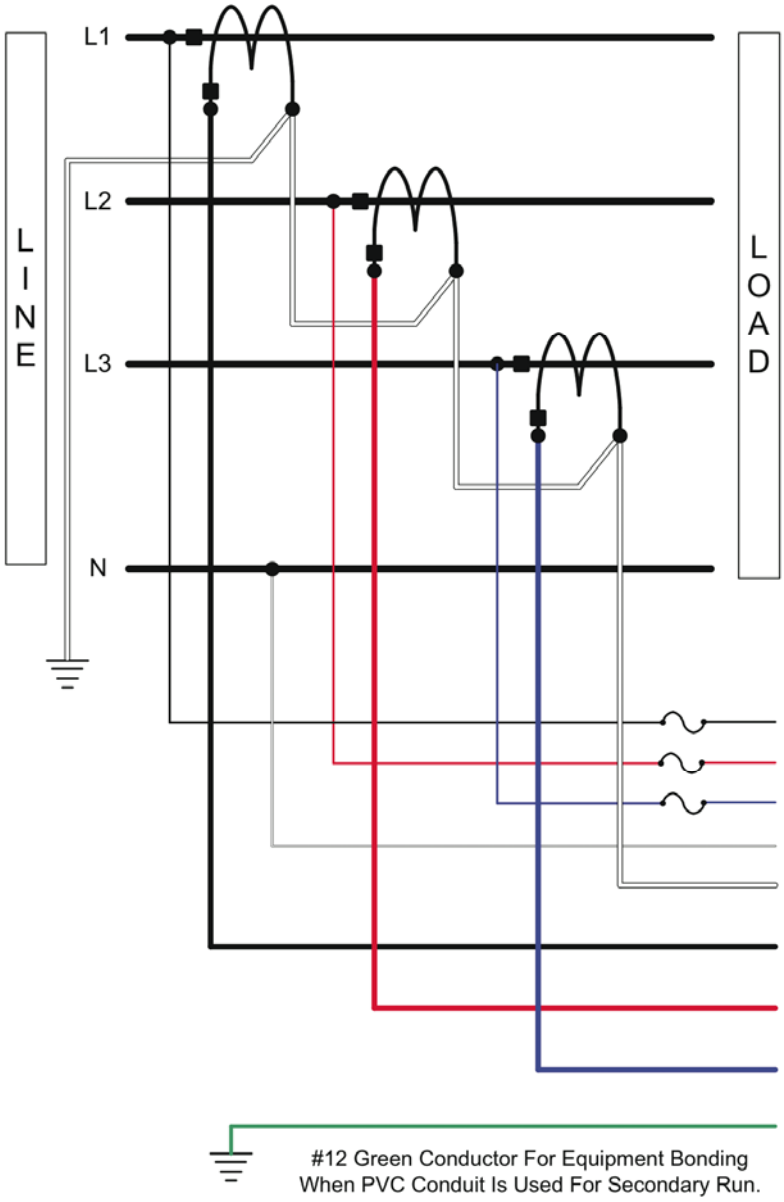

FM 5S (35S, 45S)
Meter
1
N
2

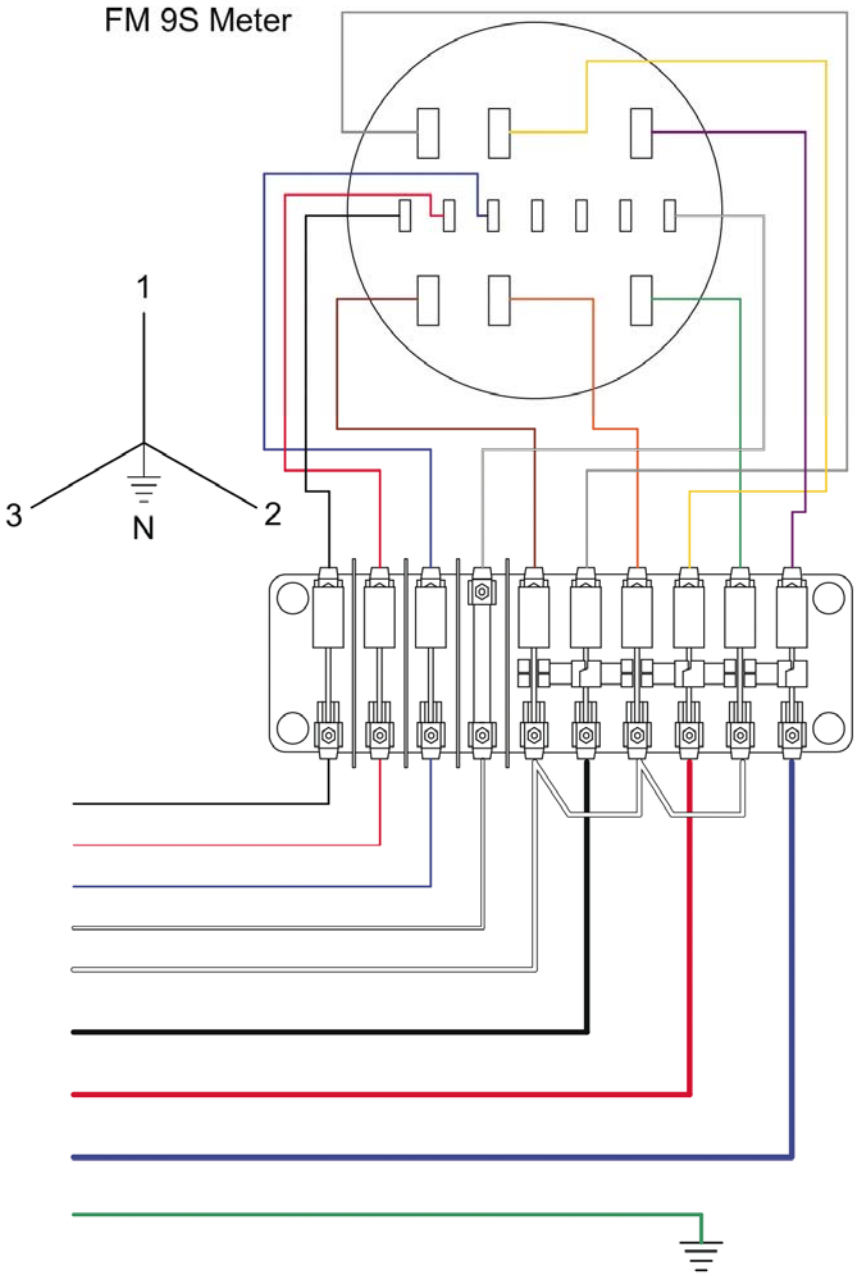
3 Phase 3 Wire Service



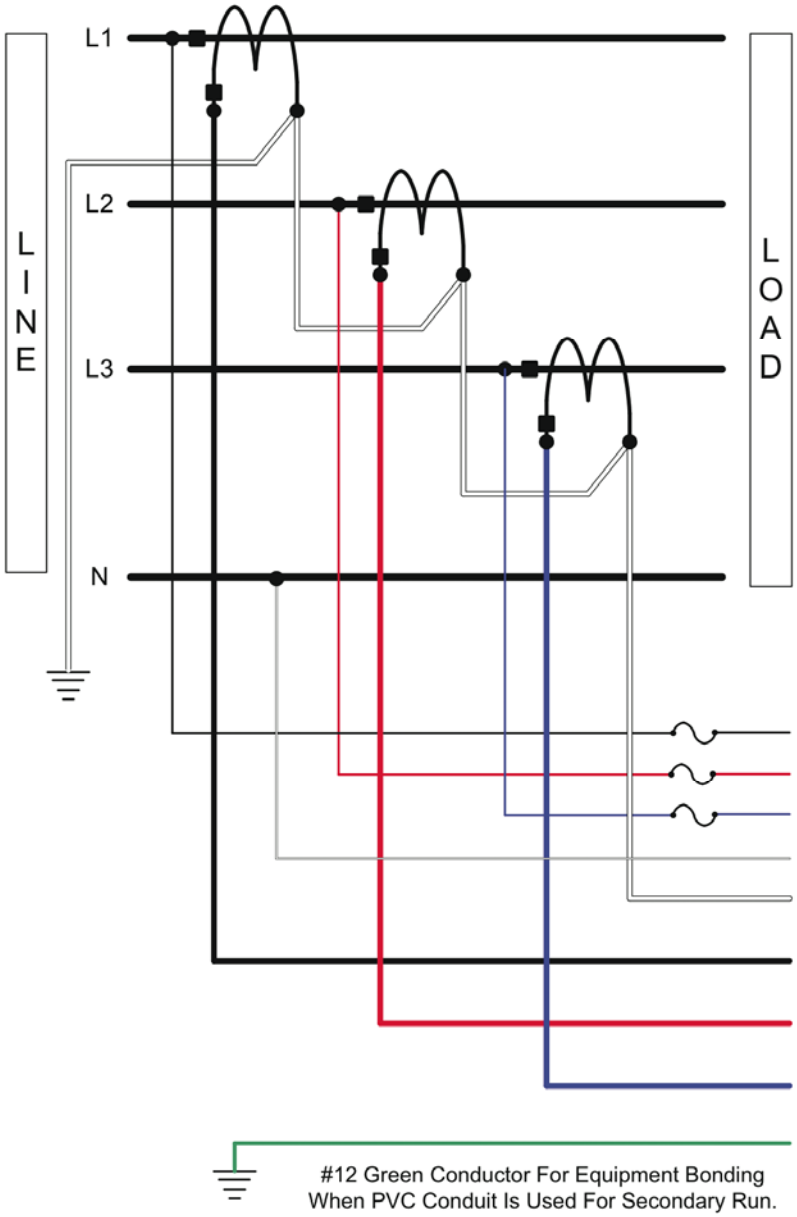

FM 5S (35S, 45S)
Meter
1
3
2
Or
1
3
2
Bank neutrals not supplied
with service

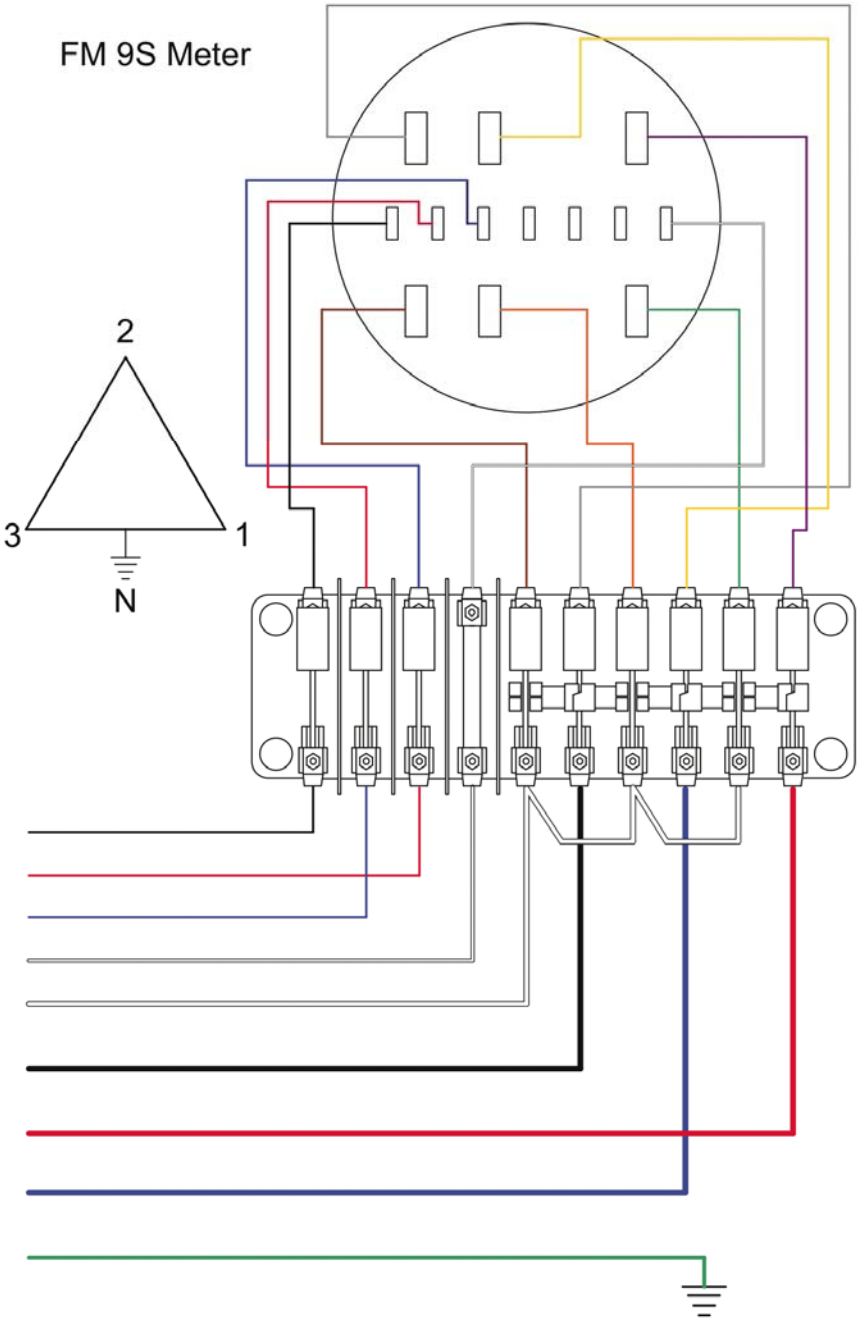
3 Phase 4 Wire Wye Service



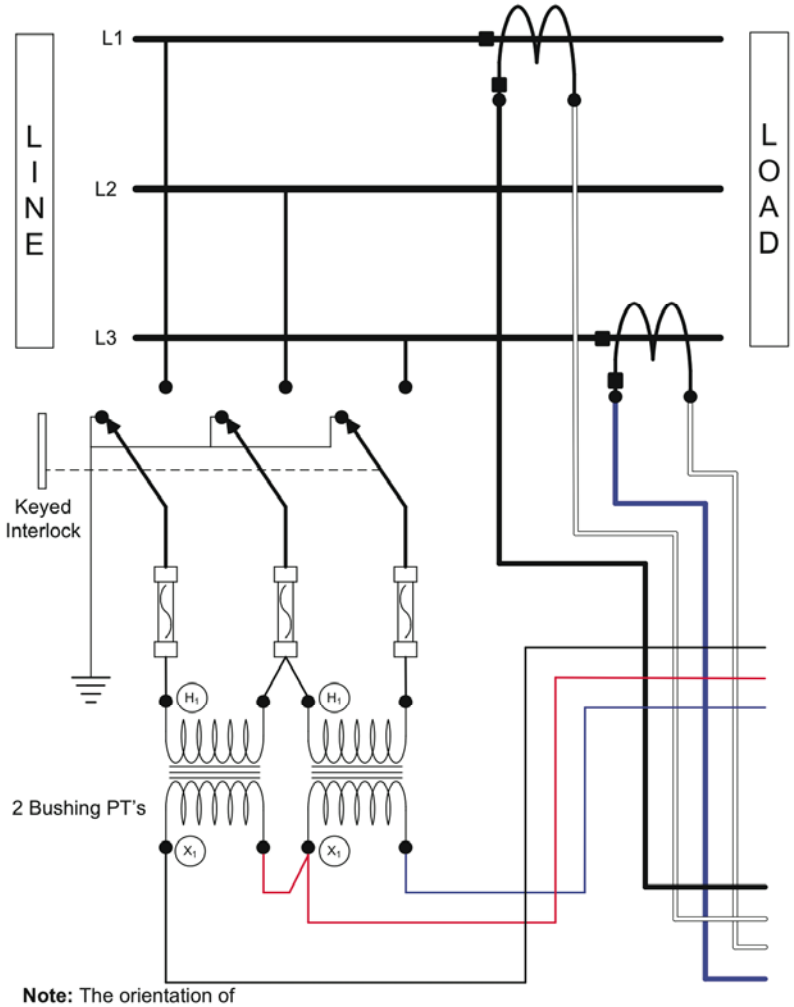

FM 9S Meter
1
3
N
2

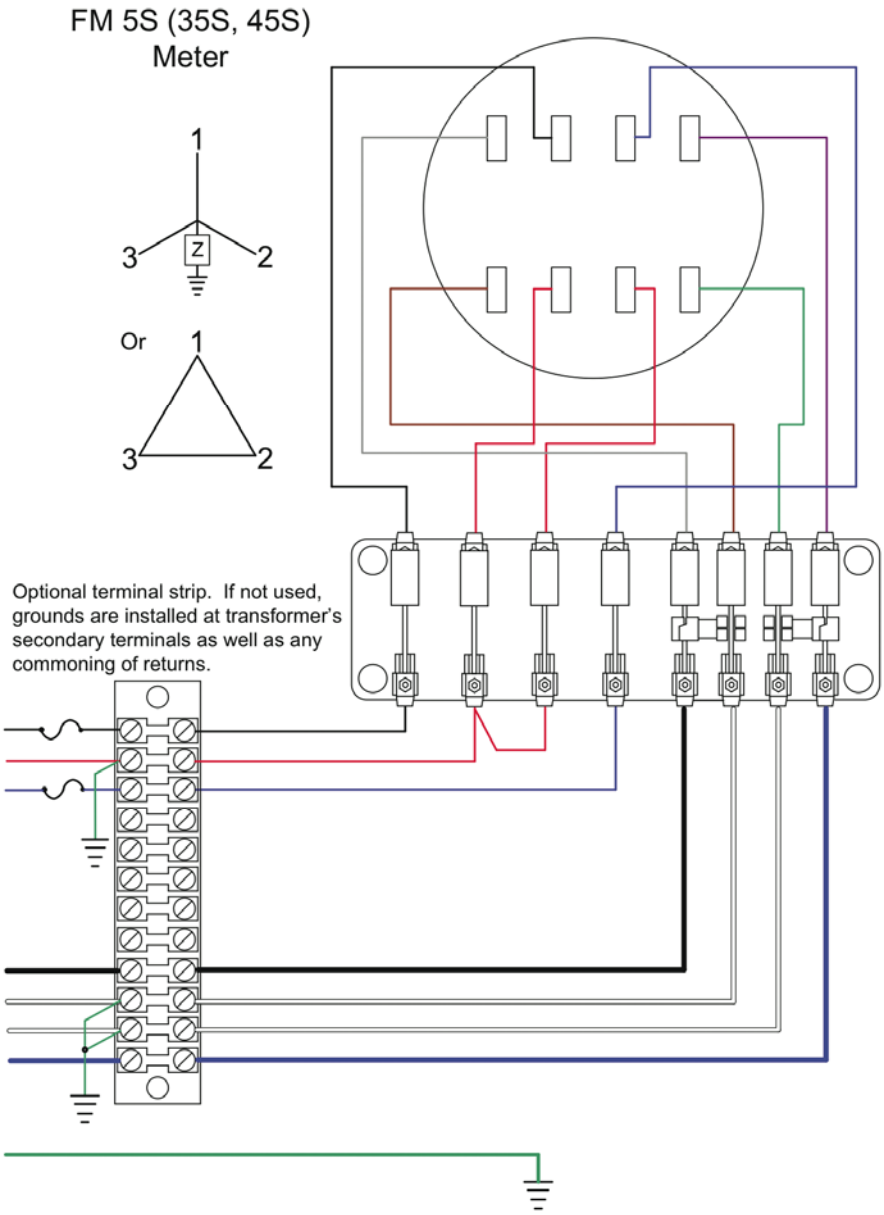
3 Phase 4 Wire Delta Service



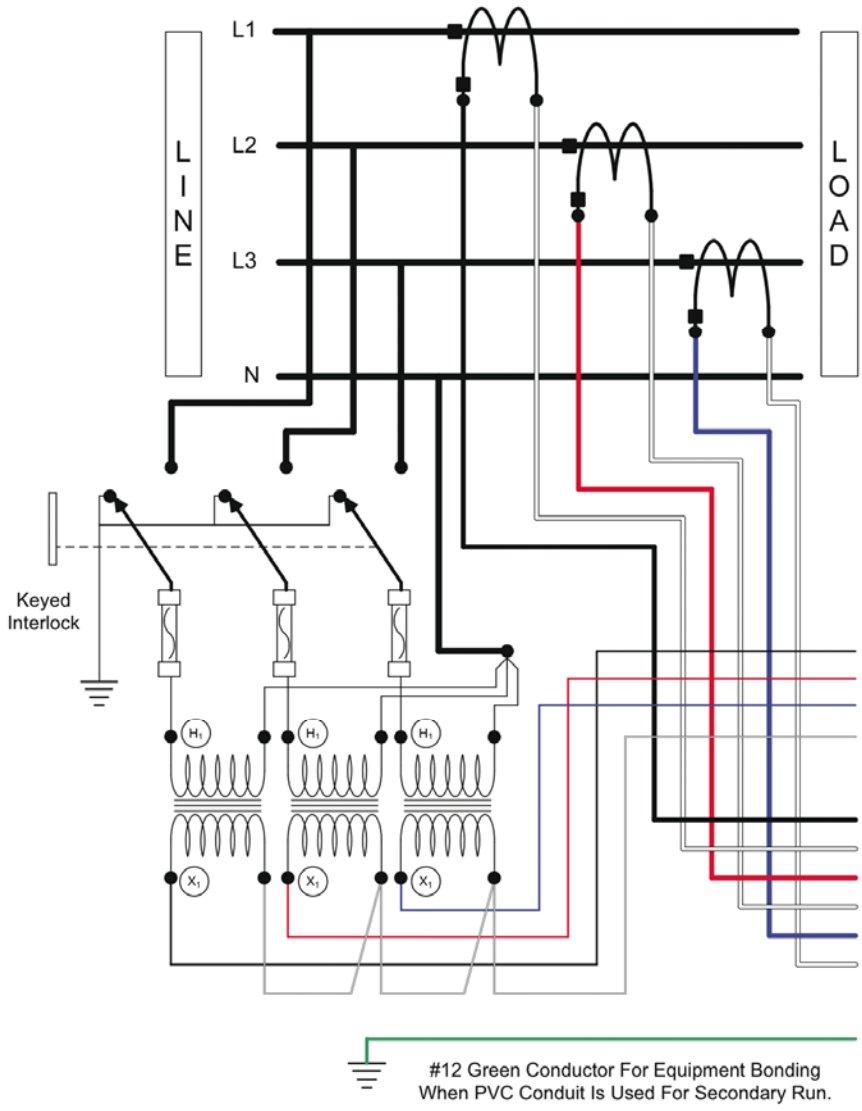

FM 9S Meter
2
3
1
N

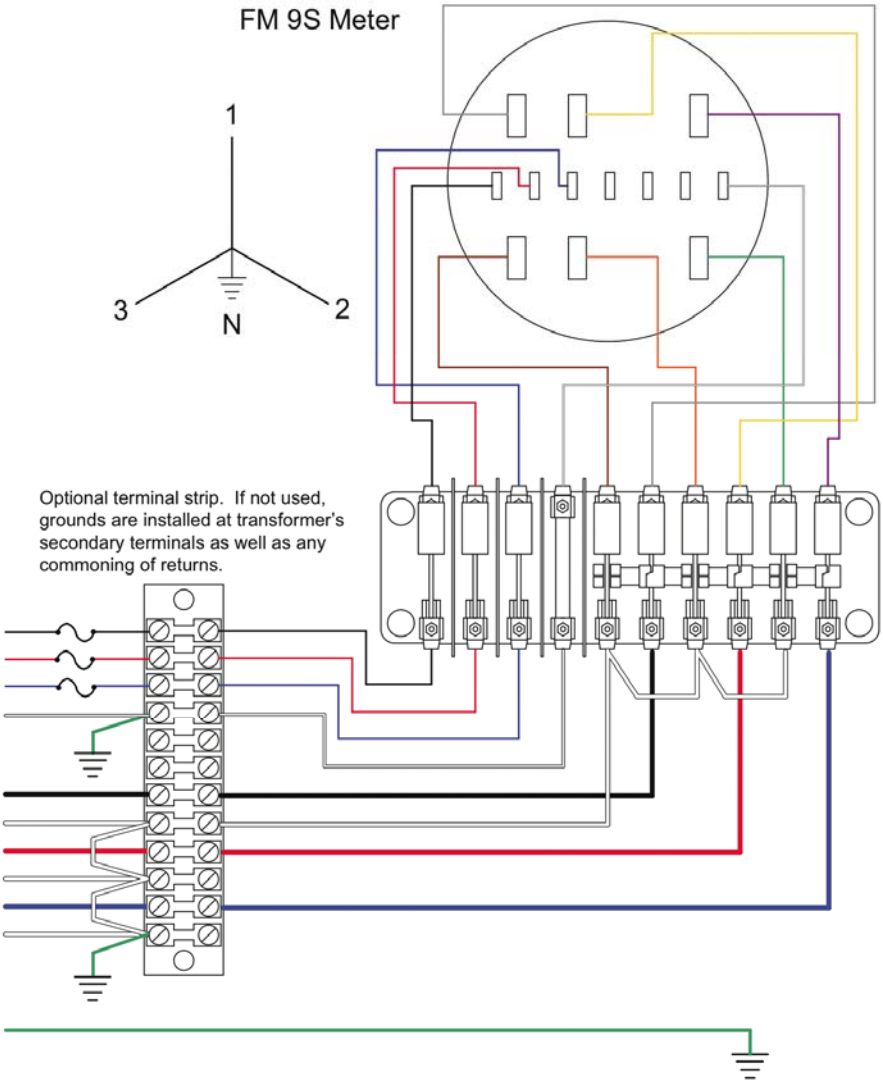
Primary 3 Phase 3 Wire Service




FM 5S (35S, 45S)
Meter
1
3
Z
2
Or
1
3
2
Optional terminal strip. If not used, grounds are installed at transformer's secondary terminals as well as any commoning of returns.

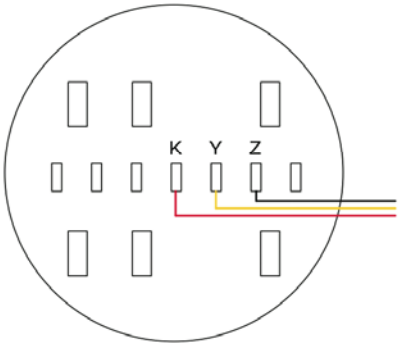
Primary 3 Phase 4 Wire Wye Service




FM 9S Meter
1
3
2
N
Optional terminal strip. If not used, grounds are installed at transformer's secondary terminals as well as any commoning of returns.

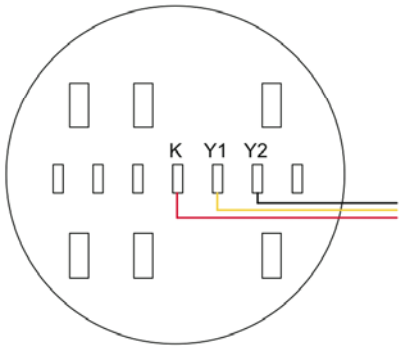
Pulse Outputs

Output values expressed as kWH/C (kilowatthours per Count)
As shown below, outputs are on terminal numbers 14 (K), 15 (Y or Y1), and 16 (Z or Y2) on form 9 meters or by using ambilcals on other meter forms. Whether using Form A or Form C, kWH/C values are calculated as Form C values.



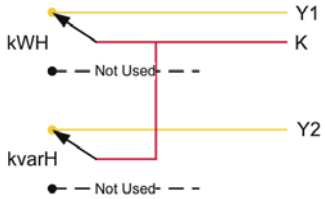
Front View

KYZ Form C Watthour Pulse Output
1 - 3 wire output
K (Red) – Common
Y (Yellow) – Watthour pulse contact
Z (Black) – Watthour pulse contact
(Compliment to Y)



Front View

K Y1 Y2 Independent Form A Watthour Pulse Output and varhour Pulse Output
2 - 2 wire outputs
K (Red) – Common(common to Y1 and Y2)
Y1 (Yellow) – Watthour pulse contact
Y2 (Black) – varhour pulse contact



Pulse Output Formulas

For GE kV / kV2C

$$kWH / C = \frac{K_e * TF}{1000}$$

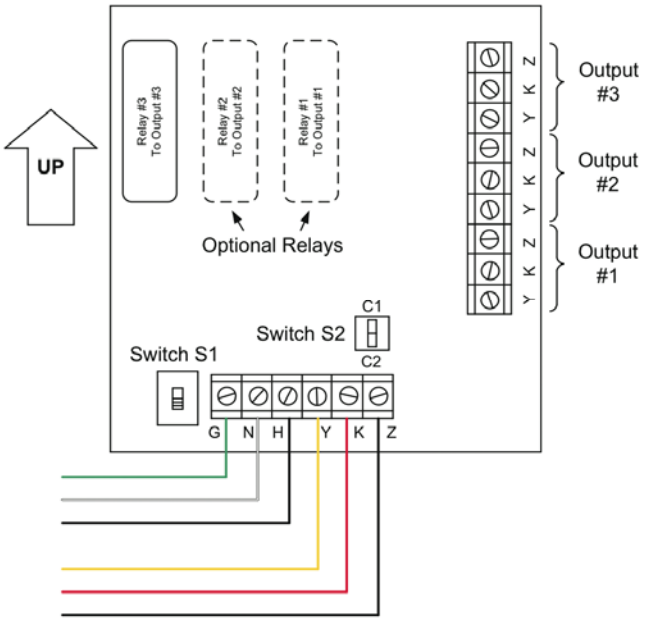
Where K_e=Programmed Value

For ABB A1R / A1D

$$kWH / C = \frac{R * K_h * TF}{K_p * 1000}$$

Where Kp=24
R=Programmed Value

Sumatron 1100 Isolation Relay



- ❑ Switch S1 Up for 90-160 Volt operation
  Down for 161-300 Volt operation

- ❑ Switch S2 C1 Position for Form C input
  C2 Position for Form A input
  Use K-Z Inputs for Form A input

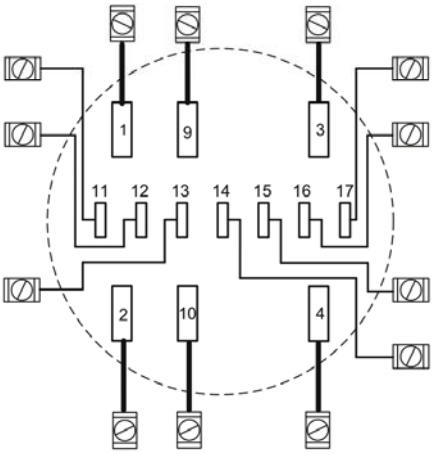
- ❑ Relays need to be installed in the correct orientation (Relays are position sensitive)

- ❑ If using multiple outputs to supply pulses to City Light and customer devices, City Light will connect to output #3.

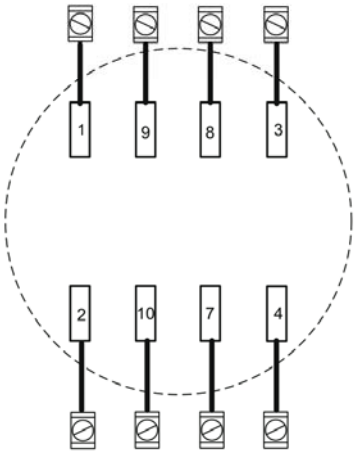
Meter Forms

Service Type	Self Contained Forms	Transformer Rated Forms
1Ø 2 Wire	1S	3S
1Ø 3 Wire	2S	4S
Network	12S, 25S	5S, 35S, 45S
3Ø 3 Wire	12S	5S, 35S, 45S
3Ø 4 Wire Wye	16S, 14S	9S, 6S, 36S
3Ø 4 Wire Delta	16S, 15S	9S, 8S

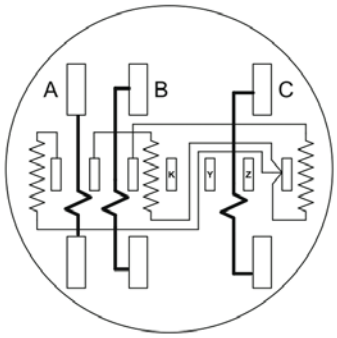
9S Socket Connections
Front View



5S Socket Connections
Front View

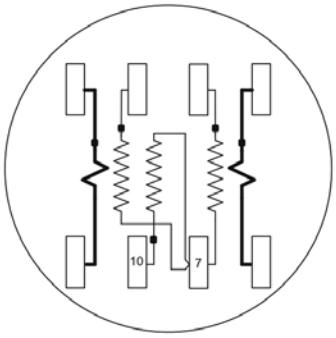


9S Meter



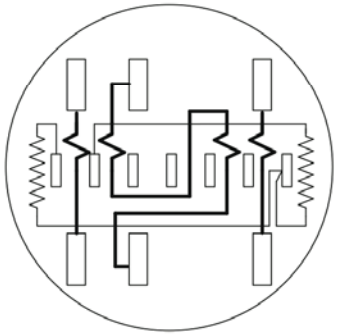
Form 9S meters are used on most of our 4 wire transformer rated services. When used on 4 wire Delta services, convention is to wire the high leg to C element. See page 21.

45S Meter



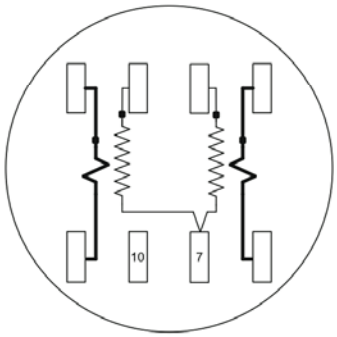
A Form 45S meter is a 2 element meter capable of 4 wire metering. When used on 3W installations, it is recommended that socket jaws 7 and 10 be jumpered at the socket or at the test switch. See pages 13, 15 and 21.
On 3 wire services, if the socket is wired with the potential return connected to only jaw 7, a form 45S and 35S meter will correctly meter a 3 wire service but a form 5S meter will not. Convention is to wire the socket as a typical 5S meter installation.
The use of Form 45S meters on 4 wire services is not currently a practice at City Light.

36S Meter

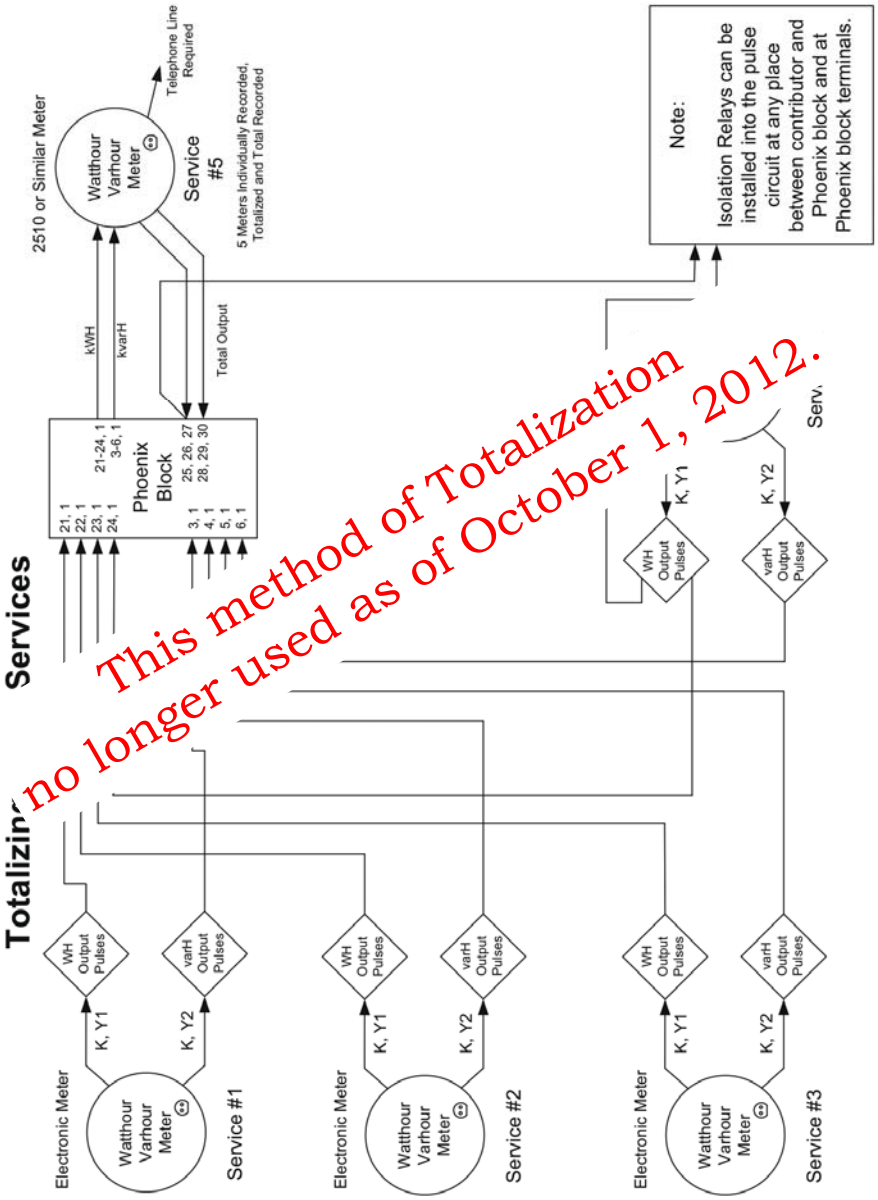


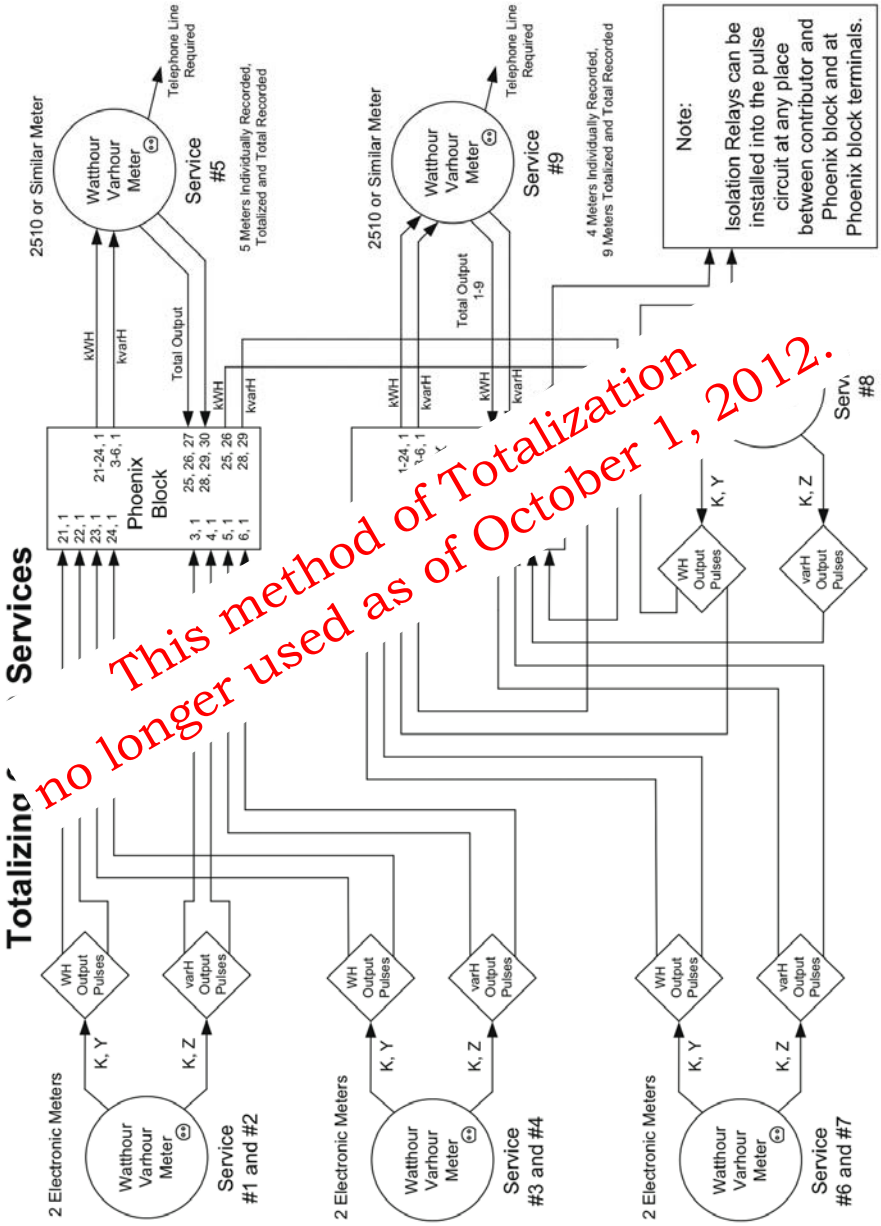
A Form 36S meter is a transformer rated 2 ½ element meter used on the 26kV Feeder Survey. Unlike the 6S with 2 separate neutral blades, the 36S neutrals are tied to a common blade.

35S Meter



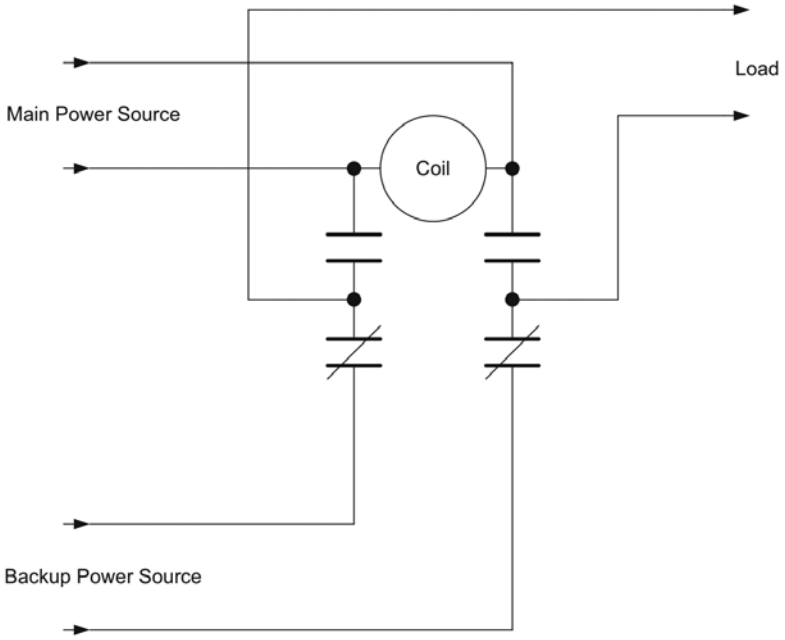
A Form 35S meter is a 2 element 3 wire transformer rated meter with a common potential return on blade 7.


Note:
Isolation Relays can be installed into the pulse circuit at any place between contributor and Phoenix block and at Phoenix block terminals.
2510 or Similar Meter
Watthour Varhour Meter
Telephone Line Required
Service #5
5 Meters Individually Recorded, Totalized and Total Recorded
kWH
kvarH
Total Output
Phoenix Block
21, 1
22, 1
23, 1
24, 1
21-24, 1
3-6, 1
25, 26, 27
28, 29, 30
3, 1
4, 1
5, 1
6, 1
Services
Totalizing
WH Output Pulses
varH Output Pulses
K, Y1
K, Y2
Electronic Meter
Service #1
Service #2
Service #3
This method of Totalization no longer used as of October 1, 2012.



This method of Totalization no longer used as of October 1, 2012.

Auxiliary Power
Cross-Over Relaying Scheme



NOTES: