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ELECTRIC REVENUE HIGH-VOLTAGE METERING

063436

Asset Type: Electric Metering

Function: Design

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Rev. #06: This document replaces Document 063436 Rev. #05. For a description of the changes, see Page 16.

Purpose and Scope

This document describes PG&E's electric metering requirements for electric revenue metering applications for load and generation customers interconnecting to PG&E's power system using wye-connected, revenue metering class, instrument transformers on three-phase, 3-wire transmission services.

General Information

1. The requirements in this document apply to three-phase, 3-wire transmission services (34.5 kV or above) with wye-connected, metering transformer installations. These requirements include:
 - A. Grounding the neutral conductors of the wye-connected, metering transformer.
 - B. One ground point on the secondary neutral conductors – Because different ground–potential rises within a substation can cause ground current to flow through the electric meter (which is a safety hazard and cause significant billing errors), there must not be more than one ground point for the current transformer (CT) and potential transformer (PT) secondary neutral conductors.
 - C. The maximum distance from the metering transformers to the meter enclosure.
2. PG&E electric metering personnel are responsible for the technical specifications, evaluation, and availability of PG&E owned metering products.
3. PG&E electric metering personnel may use customer installed safety grounds when performing metering work at the metering transformers.
4. Customers (load and generation) being served and metered by PG&E are as follows:
 - A. Net Sale/Surplus Sale - Meter(s) will be installed to measure surplus power delivered to PG&E's system.
 - B. No Sale or Stand by Service Only - Meter will be installed to measure power delivered to customer. If the customer sells power to the California Independent System Operator (CAISO) grid, additional metering to satisfy CAISO's revenue metering requirements shall be the responsibility of the customer.
5. Generators selling all their surplus energy to PG&E may require additional metering to measure the generator output when multiple types of generators are interconnected. Final determination of the additional metering shall be made by the metering group.

Metering Requirements

6. Metering requirements fall under PG&E's approved tariffs. The electric revenue metering requirements depend on the type of service provided to the customer. This requires installing different types of meters to accurately measure/record energy provided to the customer.
7. PG&E's revenue meters are equipped with a cellular modem to communicate to the revenue meter remotely, for billing purposes, using Verizon's cellular coverage. The customer will be responsible for ensuring adequate cellular coverage at the site. Minimum allowable RF conditions is "Good" in Table 1.

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Metering Requirements (continued)

Table 1 Revenue Meter Signal Strength

		RSSI (dBm)	RSRP (dBm)	RSRQ (dB)
	Technology	LTE & 3G	LTE Only	LTE Only
RF Conditions	Excellent	> - 65	> - 84	> -5
	Good	-65 to - 75	-85 to - 102	-9 to -5

8. The grounding source must be on or very close to the ground level and must be the effective ground as specified in the CPUC [General Order \(G.O.\) 95](#). For PG&E–built substations, the ground source is the ground grid, and the ground source inside the meter enclosure is Cadweld or compression connected to the substation ground grid.
9. The potential–transformer (PT) neutral conductors must be grounded as follows:
 - A. Ground the primary, PT neutral conductor at the base of the metering substructures.
 - B. Ground the secondary, PT neutral conductor at the meter enclosure near the meter panel.
10. The PT and current transformer (CT) secondary neutral conductors shall be grounded to the grounding source and have only one ground point inside the meter enclosure (see Note 1 in General Information).
11. During testing or maintenance, **never** disconnect the neutral conductors from the ground source. During in–service testing, do not lift the neutral conductor for the potential.
12. Stranded conductors can be used for the outdoor installation and into the meter cabinet and solid conductors from the test switch to the meter sockets.
13. Maintain a maximum distance of 100 feet from the CT/PT junction box at the metering unit structure to the meter cabinet to keep the burden within the accuracy limit of the CT.

PG&E and Customer Provided Equipment

14. PG&E owns, installs, maintains, operates, and reads its meters. These are PG&E–approved meters that are fully compatible with PG&E's Meter Data Acquisition System (MDAS).
15. For load–only customers, PG&E will procure and own the combination CT/PT metering units. The customer will mount the metering units on the structure.
16. For generation customers, the customer shall provide and install the CT/PT metering units and is responsible for testing them after they are mounted on the structure.
17. The customer (load and generation) is responsible for providing and maintaining the mounting structures for the CT/PT units. Conduits, meter cabinet, meter socket(s), and other devices required for PG&E's revenue meter installation are the responsibility of the customer.
18. The customer (load and generation) is responsible for providing the meter/control room and provide working space clearance in front of the meter cabinet. The meter/control room shall be sized according if other equipment such as protective relays, telecommunications, and/or EMS/SCADA equipment will be installed.
19. When the generation customer requests non–PG&E owned metering (i.e., CAISO and/or customer owned meter), PG&E will perform the wiring work and charge the customer accordingly. However, PG&E will not set and program non–PG&E meter.

CT/PT Combination Units, Junction Box and Conduits

20. The use of capacitor coupling voltage transformers (CCVTs) for revenue metering applications is limited to 500 kV and above. Revenue metering installations served from 34.5 kV through 230 kV require the use of combined metering CT/PT units.
21. For load customers, PG&E meter engineering personnel will order the units. For generation customers, PG&E meter engineering personnel must approve before they are ordered by the customer.
22. The H1 terminal, typically the CT polarity, shall be facing PG&E for load and generation customers.
23. The H1 and H2 terminals must be on the same side as the secondary terminal box as shown in Figure 3.
24. Use rigid steel conduit above ground and PVC for underground. Flex conduits are **not** permitted to be used for above ground conduits.

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CT/PT Combination Units, Junction Box and Conduits (continued)

25. CT and PT secondary wires must be in a dedicated underground conduit from the junction box on the metering cabinet. Underground conduit shall have a maximum of three bends and enter directly below the meter cabinet.
26. Refer to PG&E Drawing [376489](#) for an alternative metering unit structure for 60 kV and 115 kV only.

Meter Wiring

27. The revenue meter wiring diagram shall be submitted to PG&E during the design phase of the project for review and approval.
28. All meters connected on the same CT circuit shall be in the same meter cabinet.
29. The PG&E meter shall be first in the meter circuit, followed by non-PG&E owned meters wired on the same meter circuit.
30. PG&E will wire the CT and PT secondary connections to terminate in the J-box and pull wire to the meter cabinet and wire the test switches and meter sockets for the PG&E, CAISO and owner meters. If the CAISO and owner meters are switchboard style meters, then PG&E will only wire the PG&E test switch and meter socket. See Figure 14 on the PG&E wiring diagram.
31. When additional meters are required for generation customers on the low voltage side (34.5 kV and below), PG&E will wire the test switch and meter sockets in the cabinet. The customer will wire the low voltage side (34.5 kV to 600 V) CT and PT secondary and terminate in a junction box with shorting and terminal blocks. The customer can pull the wire into the meter cabinet if requested by PG&E.
32. When PG&E wires non-PG&E owned metering (i.e., CAISO and/or customer owned meter), PG&E will not install and program the non-PG&E meter. If the non-PG&E meters are in a separate cabinet, on the same meter circuit but not in the same cabinet with the PG&E meter, PG&E will not wire the non-PG&E meters.
33. The following are color codes of metering wires in Figures 11 - 14.
 - B = Black
 - LB = Light Blue
 - O = Orange
 - P = Purple
 - R = Red
 - W = White
 - G = Green
 - Y = Yellow

References	Location	Document
Accessory Equipment for Revenue Metering Installations	Substation Design Standard Drawings ..	026237
Diagram of Connections for Metering Polyphase Loads Using Self-Contained Meters	OH: Meters/UG-1: Services	028162
Diagram of Connections for Metering Polyphase Loads Using Transformer-Rated Meters	OH: Meters/UG-1: Services	028163
Revenue-Class Instrument Transformers 0–500 kV ..	Electric Metering	054340
Electric Revenue Meters	OH: Meters	062208
Outdoor Electrical Clearance Distances for Transmission and Distribution Substations	Electrical Design Standard	067908
60kV & 115kV Metering Transformer Support Structure	Civil Design Standard	376489

Electric Revenue High-Voltage Metering

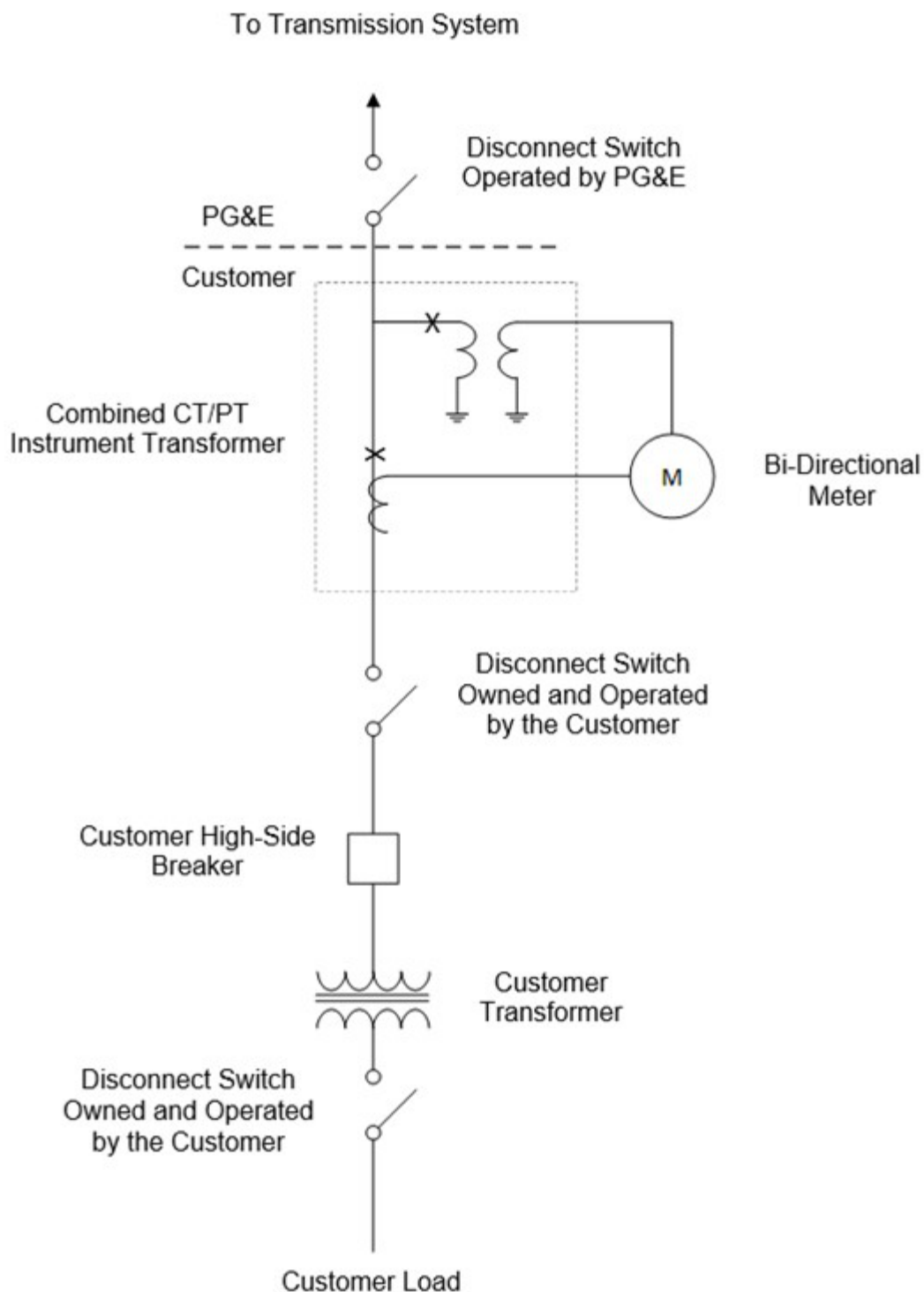
Single Line Diagram – Transmission Voltages 34.5 kV Through 230 kV

Figure 1
Typical Connection for Load-Only Customer

Electric Revenue High-Voltage Metering

Single Line Diagram – Transmission Voltages 34.5 kV Through 230 kV (continued)

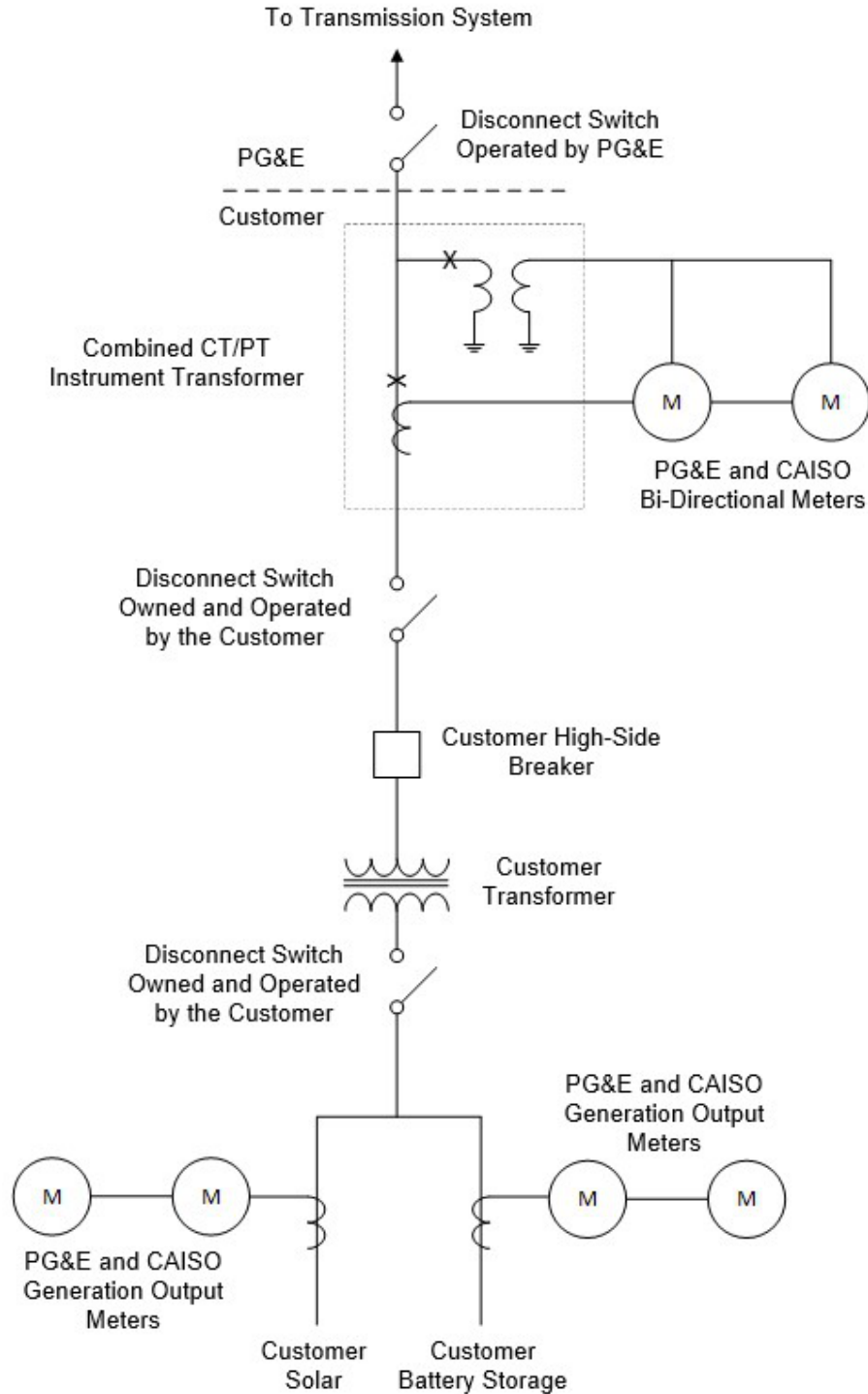


Figure 2
Typical Connection for a Generating Customer
with a CAISO and PG&E Meter

Electric Revenue High-Voltage Metering

Physical Connections at PT/CT Substructure for Three-Phase, 3-Wire, Transmission, Y-Connected, High Voltage Metering

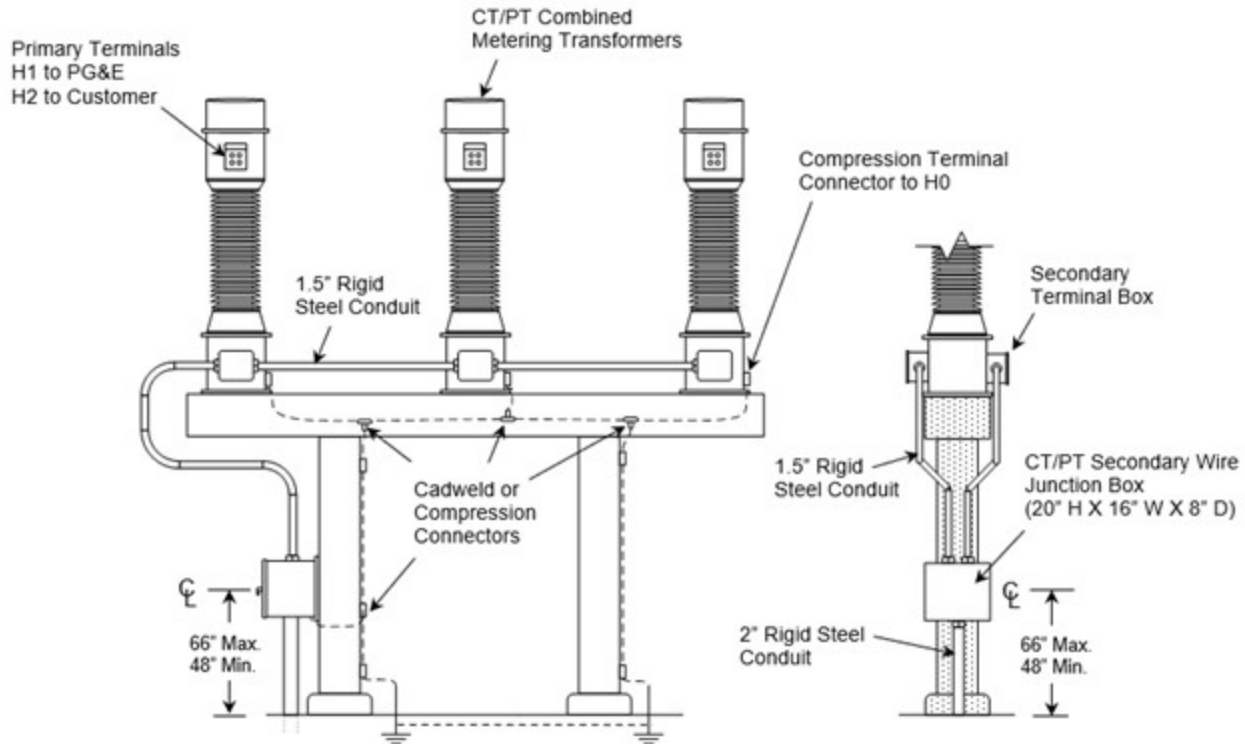


Figure 3
Conduit and Grounding Construction

Notes

1. **Do not use** flex conduit.
2. For proper spacing and clearances of PT/CTs, please consult PG&E.
3. The secondary terminals of current transformers are short-circuited at the factory prior to shipment. These short circuits should remain in place until the secondary connections are made. If connections are not made to one or more secondary windings at the time the transformer is placed in service, keep the short circuits on unused secondaries since they will have no effect on the accuracy of the other independent secondary windings. When not connected into a circuit, it is a good practice to ground the current transformer secondary windings. This applies only where separate secondary windings are on separate cores and does not apply to tapped portions of windings on a single secondary core.
4. On voltage transformers, the secondary should never be short-circuited. It is a good practice to ground one side of each secondary winding whether that winding is used or not. Make sure the neutral bushing is securely connected to the base ground. These units are designed to be installed on systems having a solidly grounded neutral. The ground connection of the neutral (H0) bushing must be in place when the transformer is energized.
5. Junction box must be tied to the substation ground grid with exothermic welding or compression connectors.

Electric Revenue High-Voltage Metering

Physical Connections at PT/CT Substructure for Three-Phase, 3-Wire, Transmission, Y-Connected, High Voltage Metering (continued)

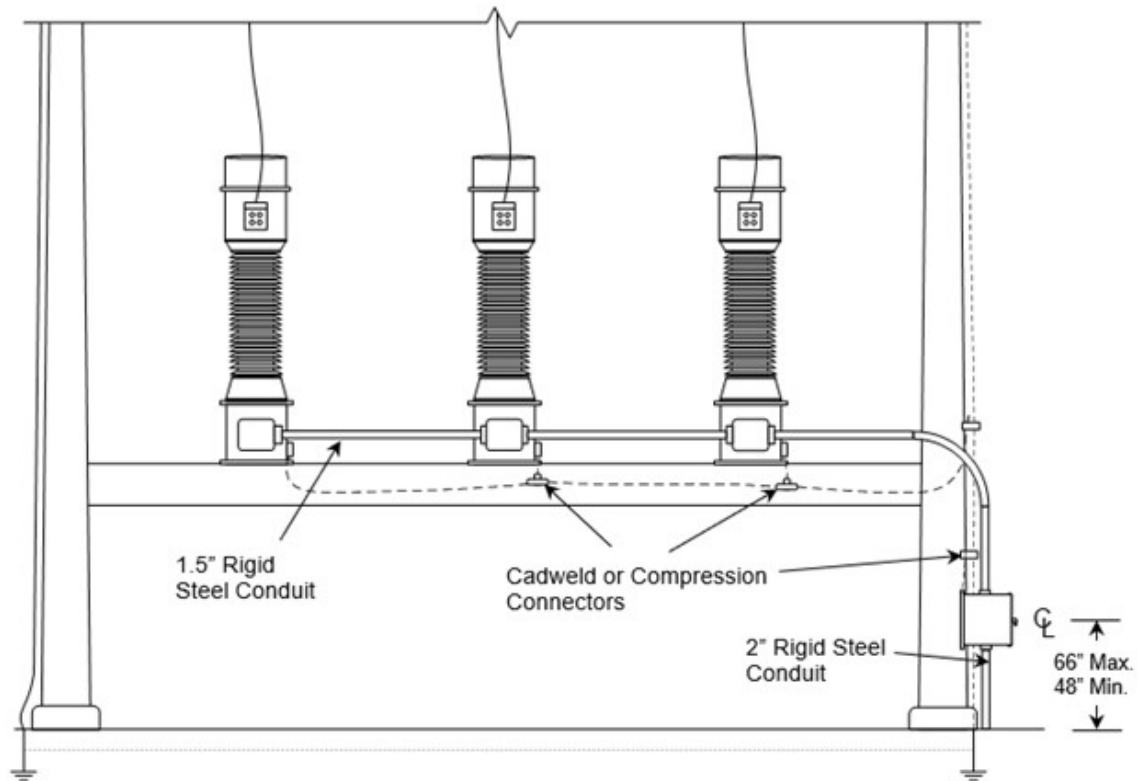


Figure 4
Wiring and Construction on a Dead-End Structure

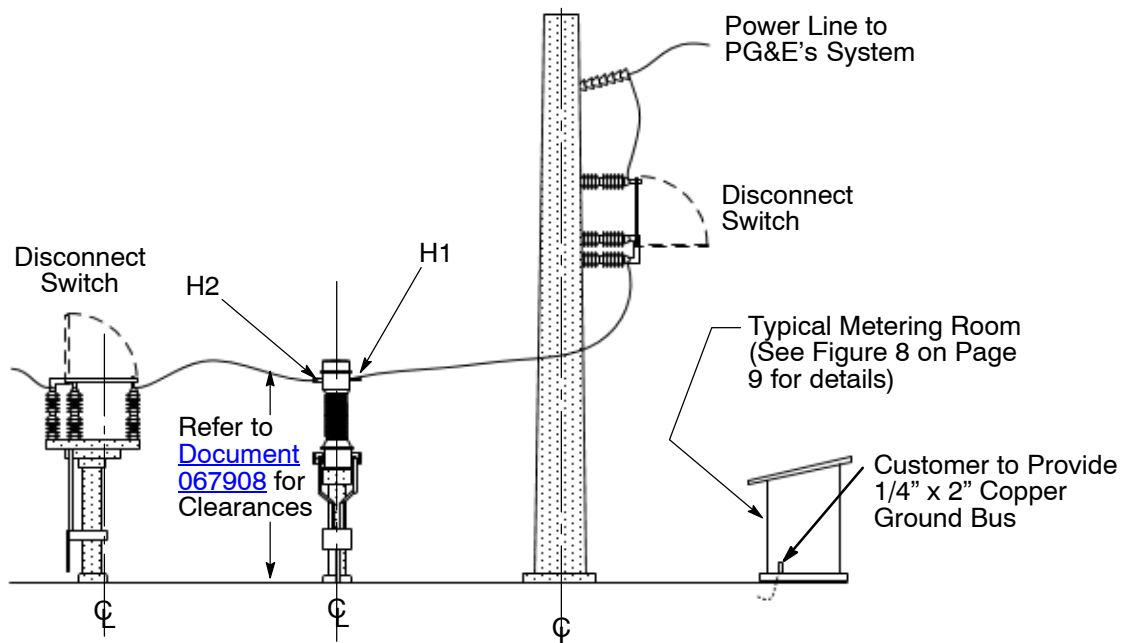


Figure 5
Typical Arrangement of Metering Transformer and Meter Enclosure

Electric Revenue High-Voltage Metering

Physical Connections at PT/CT Substructure for Three-Phase, 3-Wire, Transmission, Y-Connected, High Voltage Metering (continued)

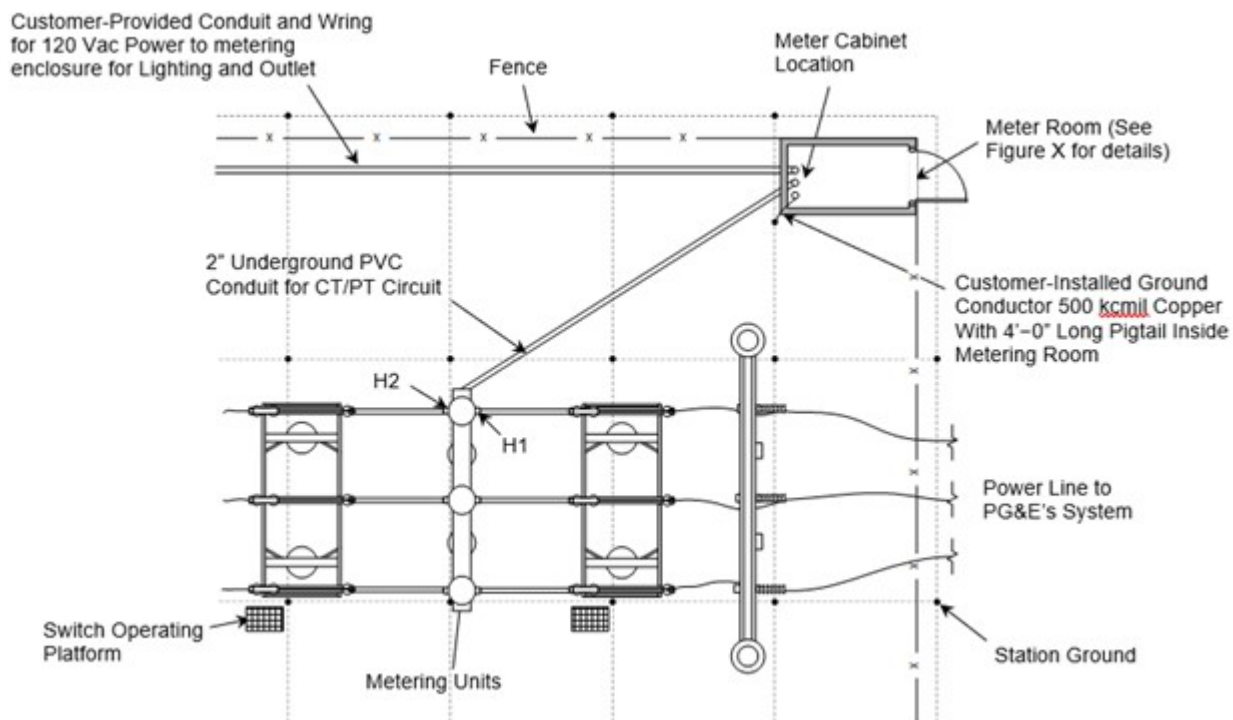


Figure 6
Substation Layout of Metering Transformer and Meter Room

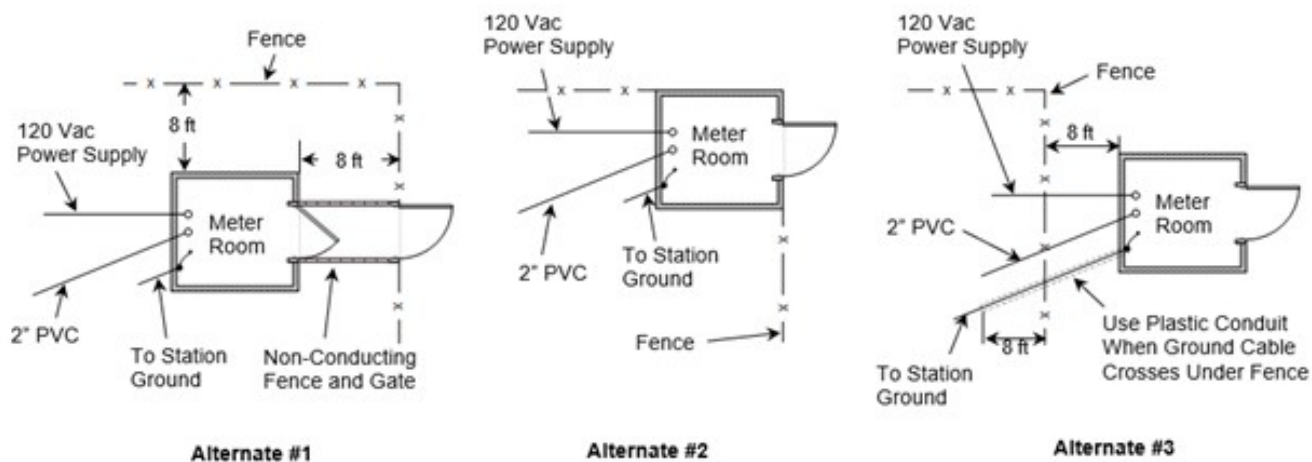
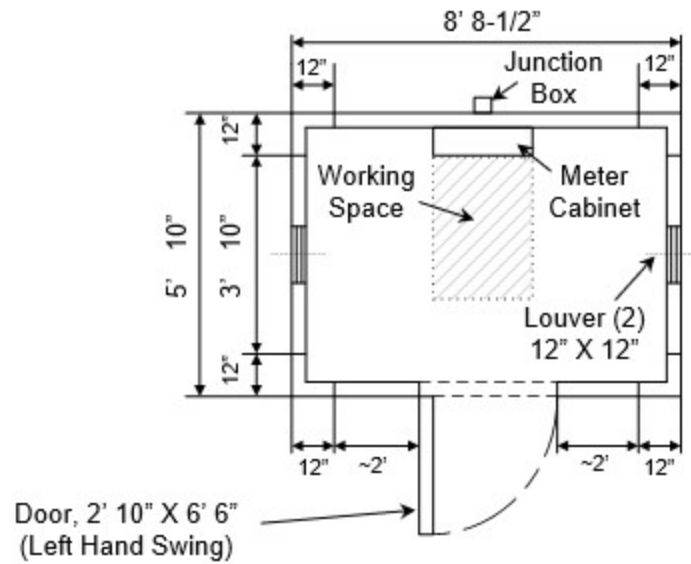


Figure 7
Alternate Conduits Stub-Outs Configurations

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Metering Enclosure and Cabinet Specifications



Metering Enclosure #2, Model #102
(Bally "Prefab" Modular Building)

Figure 8
Metering Enclosure Details

Notes

1. Meter cabinet and junction box not included with the enclosure.
2. Use minimum 6" X 6" junction box for meter antenna, 8' to 10' from grade.
3. Maintain minimum working space clearance of 30" wide and 36" deep from the front of the meter cabinet.
4. Provide a key to the meter room for PG&E field metering personnel. PG&E will install a lock box on the outside to place the key in.

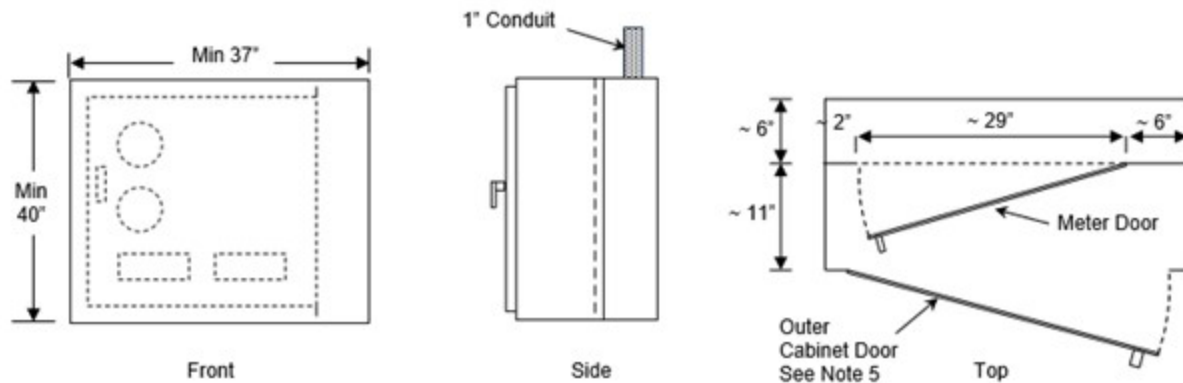
Metering Enclosure and Cabinet Specifications (continued)

Figure 9
Wall-Mounted Meter Cabinet (1 – 2 Meter Configuration)

Notes

1. Purchased and installed by the customer and must be a 15-jaw socket, ring-type.
2. Install a placard with the site name and address, service voltage, and load/generation output.
3. Meter door must have a mounting plate for the test switch on the test switch cutout. See Greenbook Figure 10-30.
4. A Brooks test switch part # 110-54580 or States equivalent, will be provided and installed by the customer. A clear and slotted cover is required for the test switch.
5. Outer door not required if installed indoor to increase space in the meter room.
6. The PG&E meter height must be 48" minimum, 72" maximum from centerline of the meter to ground level.
7. Cabinet must come with a ground bus bar installed by the customer in the back of the cabinet and bonded to station ground.
8. Customer will install a 1" conduit from the top of the cabinet to a 6" x 6" junction box on the outside wall for a meter antenna. PG&E will install the meter antenna.

Electric Revenue High-Voltage Metering

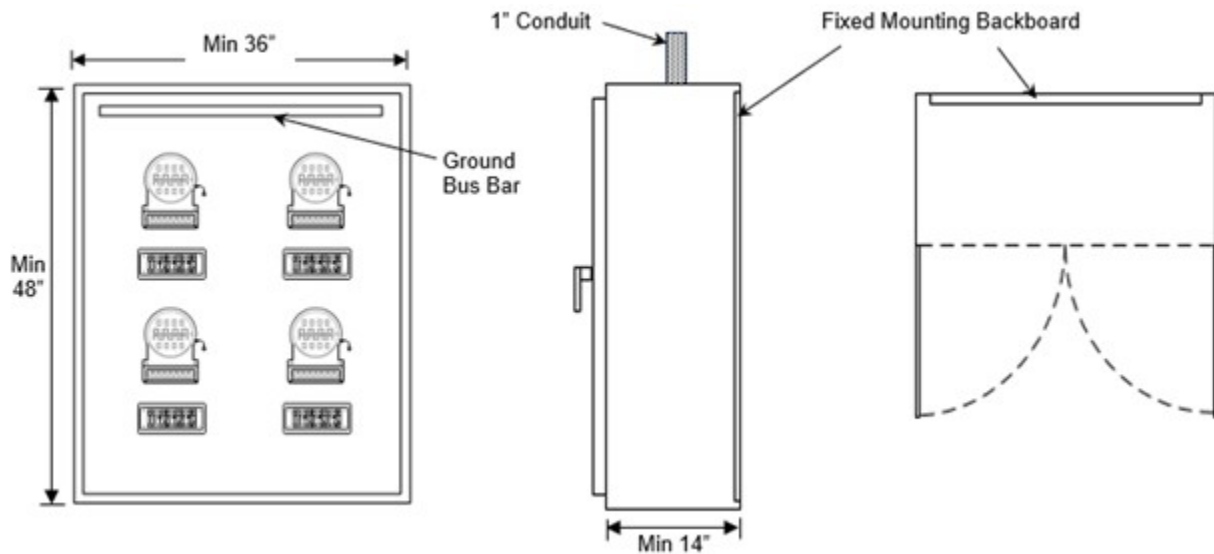


Figure 10
Wall-Mounted Meter Cabinet (3 – 4 Meter Configuration)

Notes

1. The enclosure must be:
 - A. Equipped with a device to secure the door in the open position at 90 degrees or more.
 - B. Secured in the closed position with a handle-operated latching mechanism, and lockable with a padlock.
 - C. Door can be a single or double door.
2. Install a placard with the site name and address, service voltage, and load/generation output.
3. The customer will provide and install a Marwell A-base adapter, part # 220-N SP -2885-6, with a 1" width notch at the 6 O'clock position.
4. A Brooks test switch part # 110-54580 or States equivalent, will be provided and installed by the customer. A clear and slotted cover is required for the test switch.
5. The PG&E meter height must be 48" minimum, 72" maximum from centerline of the meter to ground level.
6. Customer will install a 1" conduit from the top of the cabinet to a 6" x 6" junction box on the outside wall for a meter antenna. PG&E will install the meter antenna.
7. For floor standing metering cabinets or rack is allowed, consult with PG&E metering personnel.

Electric Revenue High-Voltage Metering

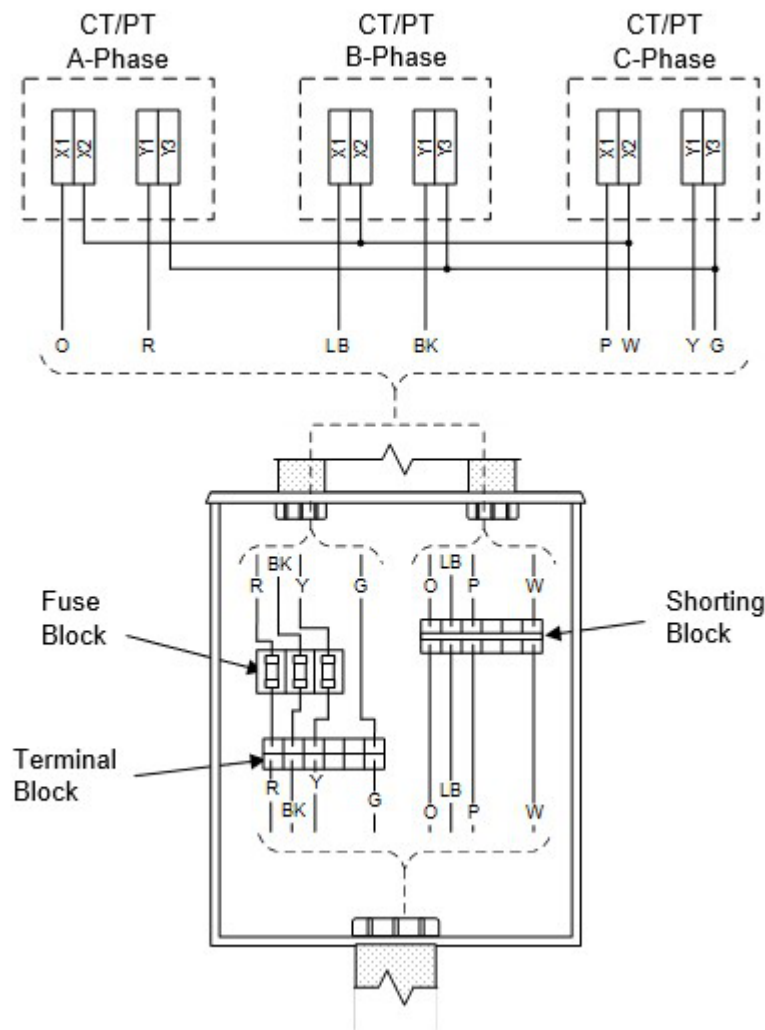
Wiring for Three-Phase, 3-Wire, Transmission, Y-Connected, High Voltage Metering

Figure 11
Meter and Test Switch Wiring

Notes

1. Customer to provide and install one 6-point terminal and one 6-point shorting block, GE EB25A06W and EB27A06S or equivalent, #10 AWG maximum wire size. See [DWG 057384](#).
2. Customer to provide and install fuse block and size and install fuses. Use fuse block Eaton Bussmann CHM3DIU or equivalent with 5 A fuses.
3. X1 on the CT/PT diagram is polarity facing PG&E.
4. PT tap will be 120 V to the PG&E meter, generally the Y1 and Y3 tap.
5. PTs may have a second winding (Z tap) and will be grounded at the CT/PT secondary box.

Electric Revenue High-Voltage Metering

Wiring for Three-Phase, 3-Wire, Transmission, Y-Connected, High-Voltage Metering (continued)

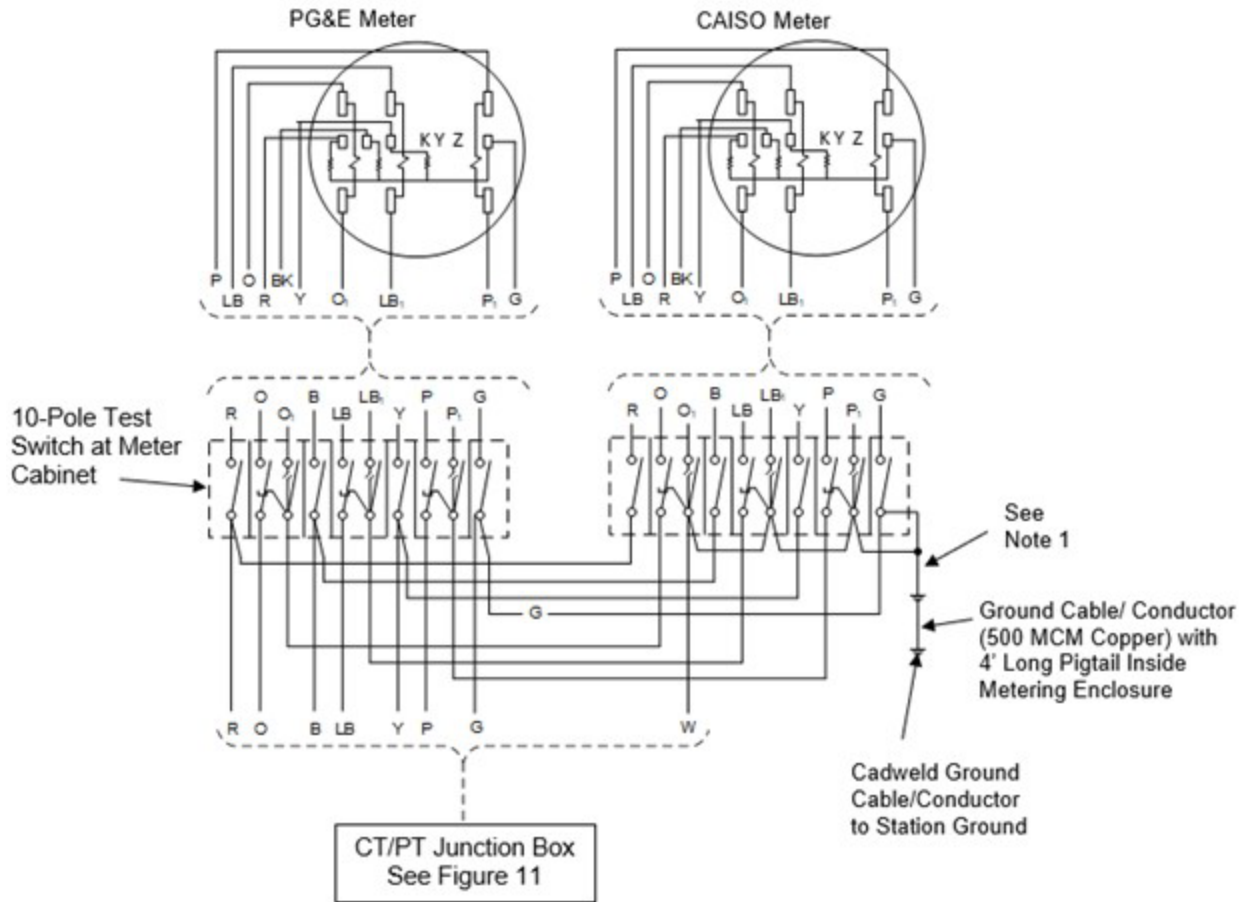


Figure 12
Meter and Test Switch Wiring for a PG&E and CAISO Meter

Notes

1. Two (2) neutrals (1 PT-neutral [G] and 1 CT-neutral [W]) grounded at the ground bus the meter cabinet. Installer to provide dual lugs on the ground bus.
2. CT circuit goes to the PG&E meter is first when CAISO and customer meter is on the same meter circuit.
3. All meters on the CT and PT circuit will be in the same meter cabinet.

Electric Revenue High-Voltage Metering

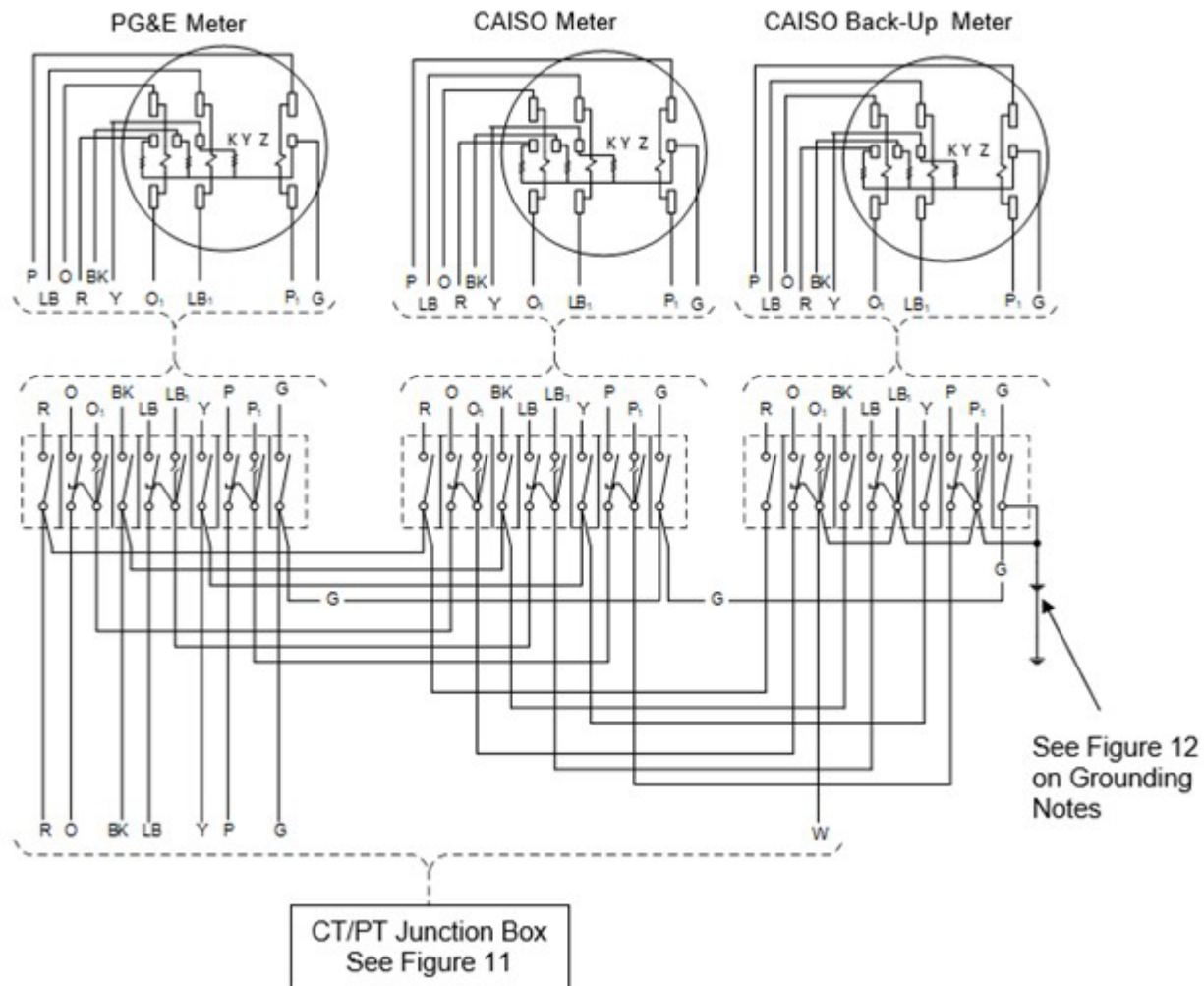
Wiring for Three-Phase, 3-Wire, Transmission, Y-Connected, High-Voltage Metering (continued)

Figure 13
Meter and Test Switch Wiring for a PG&E and CAISO Primary Back-Up Meter

Notes

1. Two (2) neutrals (1 PT-neutral [G] and 1 CT-neutral [W]) grounded at the ground bus the meter cabinet. Installer to provide dual lugs on the ground bus.
2. CT circuit goes to the PG&E meter is first when CAISO and customer meter is on the same meter circuit.
3. All meters on the CT and PT circuit will be in the same meter cabinet.

Electric Revenue High-Voltage Metering

Wiring for Three-Phase, 3-Wire, Transmission, Y-Connected, High-Voltage Metering (continued)

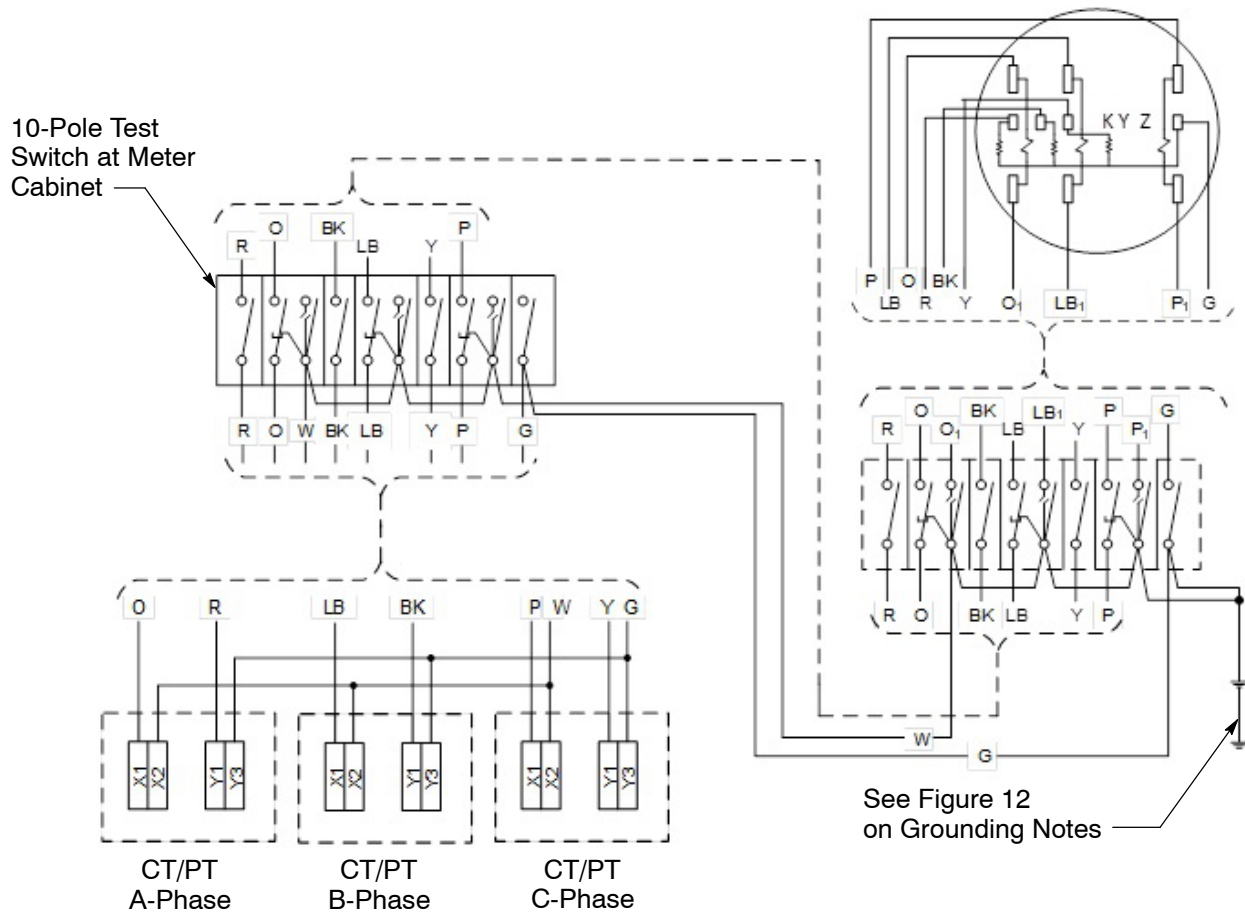


Figure 14
Meter and Test Switch Wiring (For Existing Sites)

Notes

1. Used as a reference on existing sites.
2. Not to be used when CAISO metering is on the same meter circuit as the PG&E meter.

Revision Notes

Revision 06 has the following changes:

1. Minor language change to Purpose and Scope and General Information on Page 1.
2. Minor edits in Metering Requirements. Remove POTS line requirements and added new #7 in Metering Requirements on page 1 for cellular requirements.
3. Removed Table 1, Distance “D” to Maintain 0.3% Accuracy of Current Transformer (or 0.5–ohm burden).
4. Removed Procedures, Wiring Diagram, PG&E–Provided Equipment, General Notes, and Ordering Meter Units and added new sections PG&E and Customer Provided Equipment, CT/PT Combination Units, Junction Box and Conduits, and Meter Wiring.
5. Minor edits to Figures 1 – 10.
6. Moved Figure 11 on rev #5 to Figure 14 and added new Figure 11.