



GE kV™ Switchboard Vector Electricity Meter

*Product Description
Option Board Installation Procedures,
Operating Instructions,
Maintenance Instructions
and
Site Analysis Guides*

Price: \$ 30.00

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Document Edition - First 12/98

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Contents

- 1. Product Description 1-1
- 1.1 General Information 1-3
 - 1.1.1 Physical Description 1-3
 - 1.1.2 Switchboard Forms 1-4
 - 1.1.3 Meter Features 1-6
- 1.2 Technical Information 1-7
 - 1.2.1 Theory of Operation 1-7
 - 1.2.2 Methods of Calculation 1-10
 - 1.2.3 Selecting a Method of Measurement 1-17
 - 1.2.4 Transformer-Rated Meter Calculations 1-20
- 2. Option Board Installation Procedures 2-1
 - 2.1.1 Removing the Switchboard Cover (Figure 2-1 shows exploded view) 2-2
 - 2.1.2 Removing the Bezel 2-2
 - 2.1.3 Removing an Option Board 2-3
 - 2.2 Installation Instructions 2-4
 - 2.2.1 Installing Option Boards 2-5
 - 2.2.2 Converting to *Time of Use* Metering 2-18
- 3. Operating Instructions 3-1
 - 3.1.1 Upper Nameplate Information 3-2
 - 3.1.2 Lower Nameplate Information 3-3
 - 3.1.3 Fitzall™ Lower Nameplate Information 3-4
 - 3.2 Display Information 3-4
 - 3.2.1 Display Modes 3-8
 - 3.2.2 Liquid Crystal Display Information 3-11
 - 3.2.3 Display Examples 3-12
 - 3.3 Site Genie Monitoring System 3-14
 - 3.3.1 Service Display 3-14
 - 3.3.2 Display of Phasor Information 3-17
 - 3.3.3 Diagnostic Displays 3-21
 - 3.4 Event Log 3-27
 - 3.5 Power Guard System 3-30
 - 3.5.1 Distortion Measurement 3-31
 - 3.5.2 Low Power Factor Alert 3-31
 - 3.5.3 High Demand Alert 3-32
 - 3.5.4 Average Power Factor 3-32
 - 3.5.5 Instantaneous Measurements 3-32
 - 3.5.6 Cumulative Measurements 3-33
 - 3.6 Errors and Cautions 3-34
 - 3.6.1 Error Reporting 3-34
 - 3.6.2 Caution Reporting 3-34
- 4. Maintenance Instructions 4-1
 - 4.1 Recommended Procedures 4-2

4.1.1	Meter Testing Tools.....	4-2
4.2	Test Mode.....	4-3
4.2.1	Starting the Test Mode.....	4-3
4.2.2	While in Test Mode.....	4-4
4.3	Field Test.....	4-6
4.3.1	Field Testing With Test Mode.....	4-6
4.3.2	Maximum Demand Reading Testing.....	4-6
4.4	Disk Analog Testing.....	4-7
4.5	Shop Test.....	4-8
4.5.1	Meter Shop Equipment.....	4-8
4.5.2	Test Constant.....	4-8
4.5.3	Watt-hour Test Procedure.....	4-9
4.5.4	VAR-hour Testing.....	4-10
4.6	Service.....	4-11
4.7	Repair.....	4-11
4.8	Returning a Meter.....	4-11
4.9	Cleaning.....	4-12
4.10	Storage.....	4-12
4.11	Troubleshooting Guide.....	4-13
5.	Regular Site Analysis Guides.....	5-1
6.	Fitzall TM Site Analysis Guides.....	6-1
7.	Display Multipliers.....	7-1
8.	Pulse Initiator Value Selections.....	8-2
9.	Index.....	9-1
10.	Special Information.....	10-0

Figures

- Figure 1-1. The kV Switchboard Meter 1-1
- Figure 1-2. kV Meter Block Diagram 1-7
- Figure 1-3. Conceptual Diagram of Four Function Meter..... 1-11
- Figure 1-4. Vector Power Diagram..... 1-13
- Figure 2-1. Exploded View of kV Switchboard Meter..... 2-3
- Figure 2-2. Installing an Option Board..... 2-5
- Figure 2-3. I/O and LP Labels 2-6
- Figure 2-6. Load Profile & I/O Option Boards..... 2-8
- Figure 2-7. FCC Label 2-10
- Figure 2-8. RS 232/485 Cable Installation..... 2-13
- Figure 2-9. Installation of Revenue Guard Option Board..... 2-15
- Figure 3-1. Meter Nameplate 3-2
- Figure 3-2. Upper Nameplate Information 3-3
- Figure 3-3. Lower Nameplate..... 3-3
- Figure 3-4. Fitzall Nameplate..... 3-4
- Figure 3-5. Alternate Display Mode Switch..... 3-9
- Figure 3-6. Liquid Crystal Display Information..... 3-11
- Figure 3-7. kWh Display 3-13
- Figure 3-8. Alternate Mode Display..... 3-13
- Figure 3-9. Test Mode Display 3-14
- Figure 3-10. Typical Service Display..... 3-15
- Figure 3-11. Service Error Display 3-16
- Figure 3-12. Phase Notation 3-19
- Figure 3-13. Phase Angle Conventions..... 3-20
- Figure 3-14. Phasor Display Examples 3-20
- Figure 3-15. Phasor Diagram..... 3-21
- Figure 4-1. OPTOCOM Port 4-2
- Figure 4-2. Liquid Crystal Display 4-3
- Figure 6-1. kV Site Genie™ Worksheet..... 6-13
- Figure 10-1. Outline Drawings 10-0

Tables

Table 1-1. kV Switchboard Meters.....	1-5
Table 1-2. Digital Signal Processor Output Quantities	1-8
Table 1-3 . Energy Detent Settings.....	1-12
Table 1-4. Quadergy Detent Settings	1-12
Table 1-5. Supported Demand Intervals	1-16
Table 1-6. Displays for Demand Values.....	1-17
Table 3-1. Expected Service Types.....	3-16
Table 3-2. Service Displays.....	3-16
Table 3-3. Site Genie Monitoring System Display Scroll.....	3-18
Table 3-4. kV Meter Phase Notation.....	3-19
Table 3-5. Site Genie Diagnostics	3-22
Table 3-6. Problem Detection with Diagnostic Tests.....	3-23
Table 4-1. Default Test Mode Values	4-4
Table 4-2. Test Mode Default Display.....	4-4
Table 4-3 Divisor Number	4-7
Table 4-4 Allowable Kt Range of Values.....	4-9
Table 4-5. Caution Code Display	4-13
Table 4-6. Error Code Display	4-14
Table 4-7. Fault Symptoms Without Codes	4-15
Table 5-1 Regular Site Analyses	5-1
Table 6-1 Fitzall™ Site Analyses	6-1

Equations

- Equation 1-1 Calculating Distortion Power per Phase, 1-13
- Equation 1-2 Apparent Power 1-13
- Equation 1-3. Arithmetic Apparent Power 1-14
- Equation 1-4. Calculating Q -hours 1-14
- Equation 1-5. Total Distortion kVAh 1-20
- Equation 1-6. Distortion Power Factor..... 1-20
- Equation 1-7. Transformer Rated Meter Calculations..... 1-20
- Equation 1-8. Displayed Value..... 1-21
- Equation 1-9. Pulse Output Value 1-22
- Equation 1-10. Pulse Value for Energy Pulses 1-22
- Equation 3-1. Power factor Relationships..... 3-26
- Equation 3-2. Apparent Power Definition 3-26
- Equation 3-3. Distortion Power..... 3-31
- Equation 4-1. Accumulated Watthours Calculation 4-7

1. Product Description

GE's kV Switchboard Vector Electricity Meter is the first of a new generation of electronic meters that extend functionality well beyond the bounds of traditional metering. The kV Meter adds automatic installation verification (Site Genie™) plus power quality (Power Guard™) and cost of service measurements.

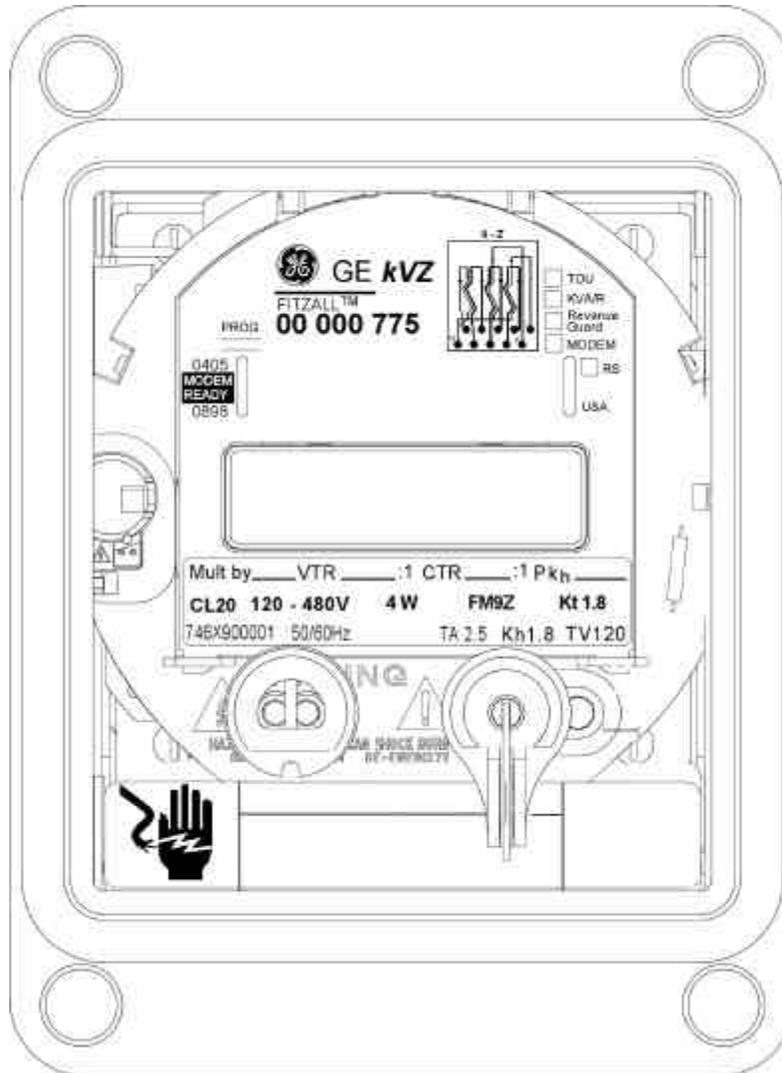


Figure 1-1. The kV Switchboard Meter

The kV Meter also improves traditional meter tasks by adding consolidated forms, 57 to 120, or 120 to 480 Volt measurement capability, improved billing protection (Revenue Guard™) and standardized meter reading (ANSI C12.18) and programming (ANSI C12.19).

1.1 General Information

The kV Meter offers functions and options not found in conventional meters. Some of the innovations are:

- Dependable apparent power measurements with unbalanced loads and asymmetrical services
- *Fundamental only* or *fundamental plus harmonics* measurements
- Distortion power and distortion power factor measurements
- Elimination of P/I ratios and meter measurement constants
- Demand meter with Load Profile recording
- All nonvolatile data storage including Load Profile data
- Support for new ANSI Reading and Programming Standards C12.18 and C12.19
- Fitzall™ capability

1.1.1 Physical Description

The clear Lexan™ cover serves several functions. Besides the protection offered to the meter, the cover limits access to the test switch located next to the demand reset switch.

The nameplate is removable and contains information not found on conventional meters. All the markings on the meter face are identified in Chapter 3.

The liquid crystal display indicates energy consumption and various other data. The display is covered in detail in Chapter 3.

The alternate display switch is located on the right side of the meter face slightly below the 3 o'clock position and is activated by a magnet. The switch and its use is described in detail in Chapter 3.

The demand reset and test switches are located at the 5 o'clock position of the meter face. The test switch has no external access. The cover must be removed to operate the switch.

An optical (OPTOCOM™) port is located in the 7 o'clock position of the meter face. The optical port allows a computer to communicate with the meter for reading and programming using Standard Tables (ANSI C12.19) and PSEM (Protocol Specification for Electricity Meters [ANSI C12.18])

The battery for the time-of-use option is visible at the 9 o'clock position. It is the industry-standard battery.

1.1.2 Switchboard Forms

The ANSI S-Base equivalent Switchboard meters are shown in Table 1-1. Also, all of the following forms may be created from one Fitzall™ Switchboard meter using MeterMate™. (The singlephase meter requires two jumpers to be compatible with previous installations.)

kV Fitzall™ meters minimize inventory costs: one form per voltage range satisfies all electrical services needing three, or fewer, meter elements. Meters are rated 120 to 480 Volts, and 57 to 120 Volts CL-20.

MeterMate™ software adapts kV 3-element meters to an electrical service's circuit topology. Calibration-retained meter is ready to install after a simple interactive MeterMate™ session, selecting service type and number of elements. Then, just mark the Fitzall™ nameplate. Site analyses and diagnostics are simultaneously adapted.

One of six connection arrangements satisfying Blondel's theorem for all new and many existing installations. The appendix explains connections for other existing installations.

Traditional metering schemes not satisfying Blondel's theorem have demonstrated acceptable commercial accuracy. *To fully realize the superior accuracy of electronic electricity meters, use Blondel metering solutions everywhere practical.* **Keep electrical energy the most accurately measured common commodity.**

Table 1-1. kV Switchboard Meters

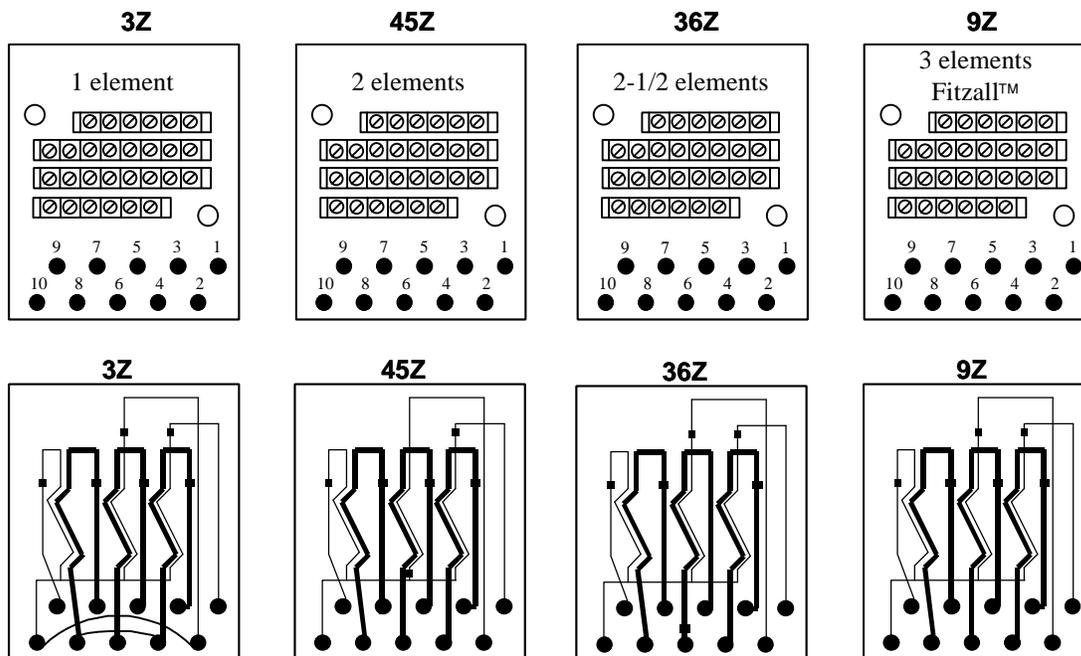
kV Switchboard Meter, 0.1 - 20 Amperes, TA 2.5

Service	Meter Elements	Meter Form	Voltage Range	K _t	DEMAND	IO,LP,MOD,RG
2-Wire, 1φ	1	3Z	120 - 480	0.60	746X300001	¹ 746X313001
3-Wire, 1, 2, or, 3φ	2	45Z	120 - 480	1.20	746X500001	746X517001
4-Wire, 3 φ, Y	2-1/2	³ 36Z	² 120 - 277	1.80	746X600001	746X617001
4-Wire, 3 φ, Y	2-1/2	³ 36Z	² 57 - 120	1.08	746X600002	746X617002
4-Wire, Y or Δ	3	9Z	² 120 - 480	1.80	746X900001	746X917001
4-Wire, Y or Δ	3	9Z	² 57 - 120	1.08	746X900002	746X917002
4-Wire, Fitzall™	3	9Z	² 120 - 277	1.80	746X900003	746X917003
4-Wire, Fitzall™	3	9Z	² 57 - 120	1.08	746X900004	746X917004

Notes

1. No Revenue Guard on 1φ.
2. When a 480/277 Volt Y Service is metered with VTs, the usual VT ratio is either 2.4, or 2.5:1, and the meter is rated for 120 Volts. If a 4:1 VT is connected line-to-neutral a meter rated for 69 Volts must be specified.
3. 36Z meters have two voltage sensing circuits connected line-to-neutral and three current sensing circuits. Three CTs are required.

kV Switchboard Meters
(back views)



1.1.3 Meter Features

The following paragraphs describe the features of the kV Meter.

1.1.3.1 *Automatic On site Monitoring*

Site Genie technology provides a simple, automatic way to identify wiring errors and/or changes before billing problems occur. It also provides the phasor information and diagnostics needed to fix the problems it finds.

The meter is easily upgraded to satisfy changing requirements.

- “T” soft switch enables TOU capability
- “K” soft switch enables kVA, kVARh or Q-hour measurement plus power factor.
- Three option board slots are available for adding recording, I/O, and communications functions.

1.1.3.2 *Improved Revenue Protection*

GE's new Revenue Guard option board improves metering reliability at critical installations. The Revenue Guard option allows the meter to operate from any available phase voltage. Unlike other electric meters, this feature prevents revenue loss due to a power outage on the phase that operates the meter. The meter can be ordered with this option board installed; or it can easily be added later.

1.1.3.3 *Better Cost of Service Measurement*

The kV Meter offers a selection of power measurements. Phasor power, apparent power, or arithmetic apparent power are available. Phasor and Apparent Power measurements are made using *fundamental only* or *fundamental plus harmonics*.

1.1.3.4 *Power Quality Monitoring*

Every kV Meter contains the Power Guard feature. Power Guard provides information about site conditions needed to improve power quality for your customers. This feature uses instantaneous measurements to trigger six different alerts and six counters. Working with your customer, you can use this data to identify service and load power quality problems before they become complaints.

1.1.3.5 *Rational Power Measurements*

The kV Meter provides IEEE-defined vector calculations of polyphase quantities. Vector calculation of apparent power provides dependable power factor and apparent power measurements even with unbalanced loads and asymmetrical services.

1.1.3.6 *Standardization*

The kV Meter is the first meter to use the new utility Reading and Programming standards, ANSI C12.18 and C12.19. ANSI C12.18 defines the Protocol Specification for ANSI Type II Optical Ports (PSEM). ANSI C12.19 defines Utility Industry End Device Data Tables.

1.1.3.7 Additional Features

Additional features offered in the kV Meter are:

- Distortion and Distortion Power Factor measurement
- DOS-based software compatible with existing handheld and laptop computers
- Elimination of pulse initiator (PI) ratios and meter constants
- MeterMate—a Windows-based PC program to simplify in program development
- Nonvolatile memory for data storage including load profile data
- Six months of previous billing information on the load profile option board
- A 200 entry Event Log (Firmware Revision 4.0)

1.2 Technical Information

This section contains theory of operation plus measurement techniques and calculations used by the GE kV Meter. It also contains a measurement selection guide.

1.2.1 Theory of Operation

The theory of operation of the kV Vector Electricity Meter is described in conjunction with the block diagram shown in Figure 1-2.

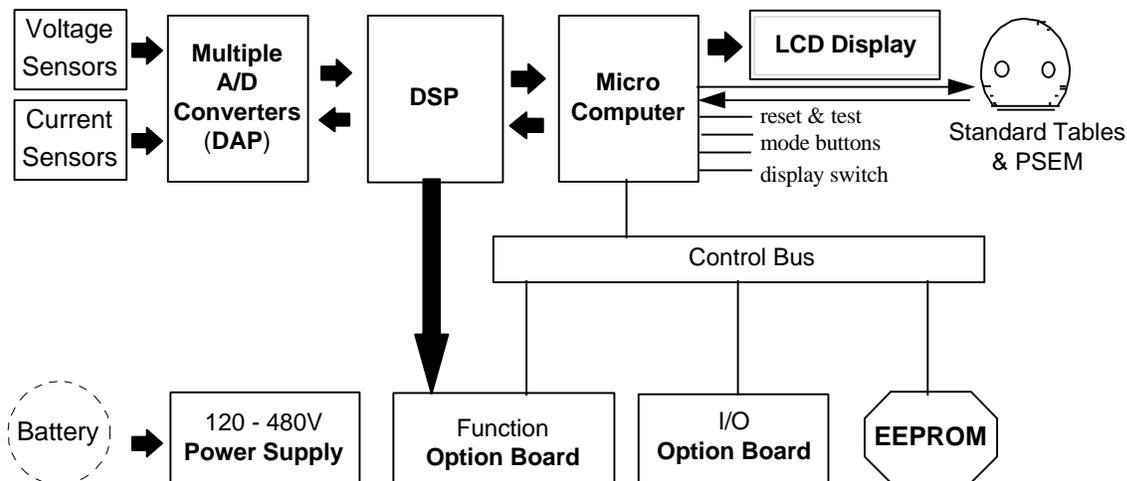


Figure 1-2. kV Meter Block Diagram

1.2.1.1 Sensing Devices

Voltages are sensed by up to three separate resistive dividers. Currents are sensed by up to three separate resistive dividers, each feeding an electronic comparator. These comparators will tolerate half wave rectification with root-mean-square current greater than 50% of class current. The sensors provide scaled signals to the Data Acquisition Platform (DAP) chip.

1.2.1.2 Data Acquisition

Up to six separate, simultaneous, continuous time delta-sigma analog to digital converters digitize each voltage and each current nearly 2,000,000 times per second. This

oversampling rate of 512 provides 3900 complete sets of decimated samples per second. For a full three element meter, 23,400 individual 16-bit samples are processed each second. Each voltage and current is measured over the whole sample interval. These are not spot samples.

1.2.1.3 Digital Signal Processor

The DSP operates on sets of voltage and current values, calculating and accumulating the quantities shown in Table 1-2 for each of the phases over a momentary interval of time. The length of the momentary interval is 60 cycles of the fundamental voltage signal for 60 Hz services, 50 cycles for 50 Hz services, or about 1 second.

At the end of each momentary interval the accumulated numeric data is transmitted to the microprocessor. The DSP applies the gain and phase angle calibration constants to the inputs so that the outputs are correctly scaled and phased.

The DSP also provides a test pulse output to the OPTOCOM port. The pulse is proportional to energy (K_t Watthours) or, optionally, quadergy (K_t VARh). Test constant K_t is set at the factory and marked on the nameplate. It can be changed by reprogramming the meter.

Table 1-2. Digital Signal Processor Output Quantities

Digital Signal Processor Output	
Current phase angle	For each phase (A,B,C)
Distortion power factor	For each element (A,B,C)
Distortion VA-hours	All phases
I^2 - hours, fundamental and harmonics	For each phase (A,B,C)
I^2n -hours, Imputed neutral current squared hours	
Number of samples in the momentary interval	
V^2 - hours, fundamental and harmonics	For each phase (A,B,C)
VA-hours	All phases
VARhours	All phases
VARhours, fundamental only	For each phase (A,B,C)
VARhours, fundamental and harmonics	For each phase (A,B,C)
Volts, line to neutral, fundamental only	For each phase (A,B,C)
Voltage phase angle	For each phase (A,B,C)
Watthours	All phases
Watthours, fundamental only	For each phase (A,B,C)
Watthours, fundamental and harmonics	For each phase (A,B,C)

1.2.1.4 Microcomputer

The microcomputer is an 8-bit Hitachi processor. It provides the register and display functions of the meter. It receives, accumulates, and operates on the values from the DSP. These values are sent over the control bus to the EEPROM for storage.

The microcomputer communicates through the OPTOCOM port for reading and programming. Its user programming controls the behavior of the meter.

1.2.1.5 Nonvolatile Memory

The kV meter is equipped with nonvolatile memory (EEPROM) that stores programmed information, billing quantities and calibration data. The billing quantities in the EEPROM are updated during each power fail event.

1.2.1.6 Power Supply

The kV meter is available with one, of two, wide range solid-state switching type power supplies: 120V to 480V, or 57 to 120V, +10% –20%.

Warning: do not exceed 144 Volts between any two voltage terminals for the 57-120V, or 575 Volts for the 120-480V supply.

1.2.1.7 Time Keeping Battery

A standard 3.6V, half-size AA, lithium battery maintains the meter clock when the meter is programmed as a time-of-use meter or demand meter with Load Profile recorder. Since all billing and programming information is stored in nonvolatile memory, the battery is only used for maintaining date and time information during a power outage.

1.2.2 Methods of Calculation

This section discusses the methods of calculation used to determine the momentary interval quantities shown in Table 1-2 and their subsequent processing by the microcomputer.

The DSP receives current and voltage inputs for each phase from the DAP chip at rate of 3900 samples per second. The processor filters each of these signals for DC. Then it applies the gain and phase adjustments that were determined during the meter calibration.

1.2.2.1 Power Selections Available

The microprocessor continuously receives the momentary interval data and accumulates it based on its programming. The energy data is accumulated directly; however, the microprocessor can display and record one type of reactive measurement only. A choice of one of the following five reactive measures must be made during the programming of the meter:

- kVA_{rh}, kVA_r
- phasor kVA_h, phasor kVA
- apparent kVA_h, apparent kVA
- arithmetic apparent kVA_h, arithmetic apparent kVA
- kQ-hour, kQ-hour demand

1.2.2.2 Momentary Interval Determination

The DSP applies an algorithm to the voltage signals to detect zero crossings. The count of positive-going zero crossings is used to determine the length of a momentary interval. Sixty crossings for a 60-Hz service and fifty zero crossings for a 50-Hz service is used for the

length of the momentary interval. This assures that each momentary interval of information contains data for 50 or 60 full cycles.

The kV Meter can display and output quantities based on the content of the fundamental through the 23 harmonic frequencies. Alternatively it can use the content of the fundamental frequency only. The choice of fundamental only or fundamental plus harmonics must be made during programming of the meter.

The DSP narrow-band filter clarifies the conditioned current and voltage inputs to create a separate set of currents and voltages. The set represents the content of the fundamental frequency only. The narrow band filter excludes all frequency content not near the service frequency (50 or 60 Hz). These fundamental currents and voltages are used to compute the *fundamental only* values shown in Table 1-2. If fundamental only is chosen during the programming of the microprocessor, the DSP computes the total quantities (Watt-hours, VAR-hours) on that basis.

1.2.2.3 Reactive Power

The DSP uses a unique reactive power filter that determines the reactive power for each phase. Potential squared, current squared, power, and reactive power for each element is known for fundamental only and fundamental plus harmonics and the current in the neutral conductor is determined.

The current in the neutral conductor is not measured directly but inferred from the current in each phase. These values are added to their respective accumulation registers.

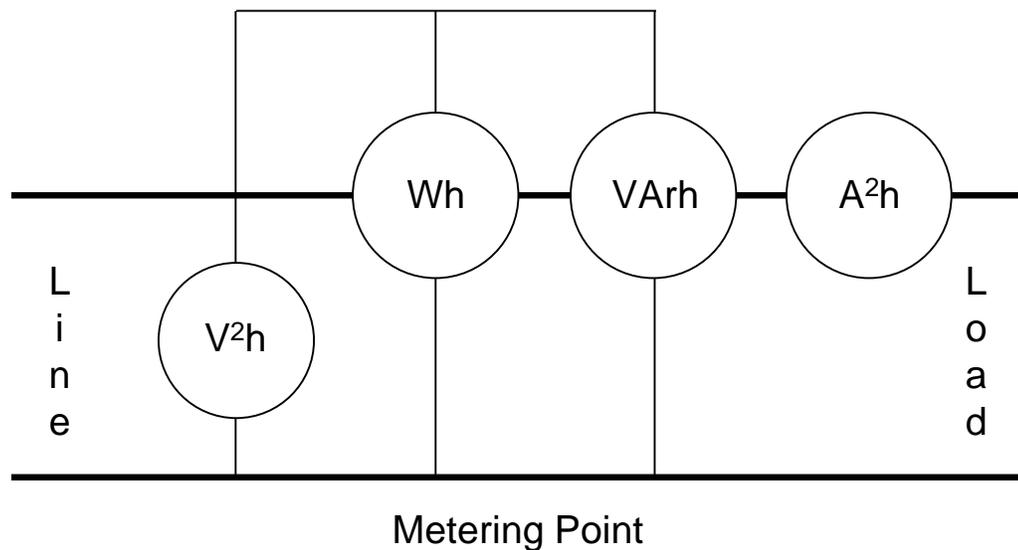


Figure 1-3. Conceptual Diagram of Four Function Meter

Another way to think of the accumulation registers is as a metering element with a Volt-squared, a current-squared, a Watthour and a VARhour meter for each phase for the fundamental frequency only and the fundamental plus harmonic frequencies. This is a total of 8 elements (four for fundamental only and four for fundamental plus harmonics) for each phase. A diagram of such a 4-function vector electricity meter is shown in Figure 1-3. At the end of each momentary interval, the DSP operates on the accumulation registers. The processor computes the balance of the items shown in Table 1-2 based on its:

- Settings for fundamental or fundamental plus harmonics
- Detent settings for energy and quadergy
- Selected method for VA-hours.

This momentary interval data is transmitted to the microprocessor. The DSP computes the total Watthours by adding up the Watthours for each element. It then applies the energy detent. There are four settings of the energy detent shown in Table 1-3.

The total Watthour accumulation also depends on the choice made for fundamental frequency only or fundamental plus harmonics. The DSP uses the accumulation registers of the chosen set only.

Table 1-3 . Energy Detent Settings

Energy (Wh) Detent Settings	Comments
Delivered	Typical Watthour meter
Received	Reversed Watthour meter
Sum of Absolutes Delivered + Received	Both increase accumulation “unidirectional”
Net Sum Delivered – Received	Delivered increases, received decreases

The DSP computes the total VARh by adding up the VARh for each element. It then applies the quadergy detent. There are four settings of the quadergy detent as shown in Table 1-4 . The total VARhour accumulation also depends on the choice made for fundamental frequency only or fundamental plus harmonics. The DSP uses the accumulation registers of the chosen set only.

Table 1-4. Quadergy Detent Settings

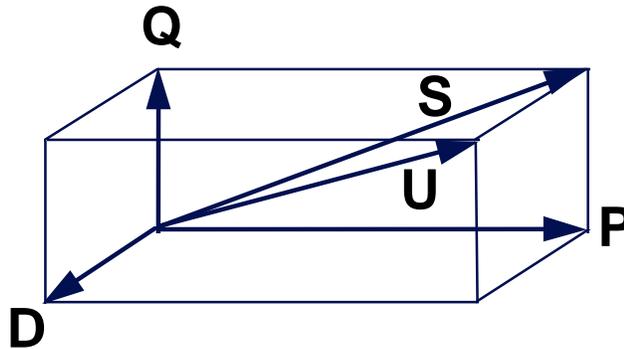
Quadergy (VARh) Detent Settings	Comments
Lagging	Typical VARhour meter
Leading	Reversed VARhour meter
Sum of Absolutes Lagging + Leading	Both increase Accumulation “Unidirectional”
Net Sum Lagging – Leading	Lagging increases, leading decreases

1.2.2.4 Calculation Choices for kVAh

The kV Meter offers choices of VAh accumulation: apparent VAh, arithmetic apparent VAh, and phasor VAh (Qhours may also be selected). The following are different methods of computing kVAh in a polyphase service.

1.2.2.5 Apparent Power

The kV Meter performs full vector processing of the power quantities. The active power, reactive power and distortion power for each phase are computed based on the ANSI/IEEE Standard 100 definitions as depicted in Figure 1-4. These quantities are treated as orthogonal vectors. The apparent power of each phase, U_x , is computed by taking the square root of the product of Volts-squared and the current-squared of that phase. Q_x (reactive power) and P_x (active power) are computed from their appropriate accumulation



registers. With these ingredients, the distortion power of that phase can be computed.

Figure 1-4. Vector Power Diagram

Where:

D = Distortion Power

P = Active Power

Q = Reactive Power

S = Phasor Power

U = Apparent Power

Equation 1-1 Calculating Distortion Power per Phase,

$$D_x = \pm \sqrt{U_x^2 - P_x^2 - Q_x^2} \quad \text{where, } x = \text{any of one of the phases of power (A, B, C).}$$

Equation 1-2 Apparent Power

$$U_{TOTAL} = +\sqrt{P_T^2 + Q_T^2 + D_T^2},$$

where, $P_T = \sum P_x$, $Q_T = \sum Q_x$, and $D_T = \sum D_x$

The total apparent power is the vector sum of the active power, the reactive power and the distortion power over the phases. Apparent VA is always computed without regard to the detent settings for energy or quadergy and always includes the harmonic components regardless of the setting of the fundamental flag.

1.2.2.6 Arithmetic Apparent Power

The arithmetic apparent power is the scalar treatment of apparent power. It is computed by arithmetically adding the apparent power of each phase. The arithmetic apparent VAh is integral of arithmetic apparent power over the momentary interval. Arithmetic apparent VAh is always computed without regard to the detent settings for energy or quadergy and always includes the harmonic components regardless of the setting of the fundamental flag.

$$U_{\text{arithmetic}} = +\sqrt{U_A^2} + \sqrt{U_B^2} + \sqrt{U_C^2}$$

Equation 1-3. Arithmetic Apparent Power

1.2.2.7 Phasor Power

Total phasor VA and phasor VAh is computed the same as total apparent power and total apparent VAh except that the distortion term is ignored. Phasor VAh can be computed with or without detents. If **with detents** are chosen, the detented quadergy (VARh) and energy (Wh) are used in the computation. If **without detents** is chosen, net quadergy (VARh) and energy (Wh) are used in the computation. The setting of the fundamental flag affects phasor VAh computation.

1.2.2.8 Q-hour Calculation

Note that Q-hours are computed by the meter as shown in Equation 1-4.

$$Q_h = \frac{1}{2} \left[\sum_k Wh_k \right] + \frac{\sqrt{3}}{2} \left[\sum_k varh_k \right]$$

Equation 1-4. Calculating Q -hours

Q-hours are calculated based on Wh and VARh at the end of each momentary interval. If positive, Q-hours are accumulated for that momentary interval. If negative, Q-hours are not accumulated for that momentary interval.

The kV Meter can be programmed to be either a demand meter or a time- of-use meter. The meter calculates the demand for a momentary interval and either block interval, rolling interval, or thermal demand meter emulation.

1.2.2.9 Demand Intervals

Rolling demand allows the intervals used for calculating demand to be subdivided into even subintervals. The demand calculation is performed at the end of each subinterval. An interval is composed of N subintervals ($1 \leq N \leq 10$). The data collected during the previous N subintervals is used in the demand calculation. An interval composed of one subinterval is by definition a block demand interval. Table 1-5 summarizes the allowable demand intervals.

Table 1-5. Supported Demand Intervals

Demand Interval Length	Number of Subintervals per Interval						
	01	02	03	04	05	06	10
	Subinterval Length in Minutes						
5	05	–	–	–	01	–	–
6	06	03	02	–	–	01	–
10	10	05	–	–	02	–	01
12	12	06	04	03	–	02	–
15	15	–	05	–	03	–	–
20	20	10	–	05	04	–	02
30	30	15	10	–	06	05	03
60	60	30	20	15	12	10	06

1.2.2.10 Thermal Demand

The kV Meter can emulate a thermal demand meter with a time characteristic of 15 minutes.

1.2.2.11 Cumulative Demand

The kV Meter computes cumulative demand, continuous cumulative demand and real-time pricing demand. These demand values are computed based on which demand mode is selected (for example, thermal , block). Cumulative demand is the cumulative total of the maximum demand values that existed at each demand reset. The cumulative demand is calculated by adding the maximum demand to the cumulative demand each time a demand reset occurs. Continuous cumulative demand is the sum of cumulative demand and the current maximum demand.

1.2.2.12 Real-time Pricing

Real-time pricing (RTP) demands are calculated only when real-time pricing input is active. The manner in which the data is calculated is identical to that for non-RTP demands. Table 1-6 shows all of the possible displays for demand values in both demand and time-of-use meters.

Table 1-6. Displays for Demand Values

Basic Meter	Basic Meter with K Switch, ADD:
Max. kW	Max kvar/kQ/kVA
Cum. kW	Cum. kvar/kQ/kVA
Cont. Cum. kW	Cont. Cum. kvar/kQ/kVA
Instantaneous kW	Instantaneous kvar/kQ/kVA
Previous Interval kW	Previous Interval kvar/kQ/kVA
RTP Max. kW	RTP Max. kvar/kQ/kVA
RTP Cum. kW	RTP Cum. kvar/kQ/kVA
RTP Cont. Cum. kW	RTP Cont. Cum. kvar/kQ/kVA
Last Reset Max. kW	Last Reset Max. kvar/kQ/kVA
Last Reset Cum. kW	Last Reset Cum. kvar/kQ/kVA
Last Reset RTP Max. kW	Last Reset RTP Max. kvar/kQ/kVA
Last Reset RTP Cum. kW	Last Reset RTP Cum. kvar/kQ/kVA

TOU Meter — needs T Switch	TOU Meter with K Switch, ADD:
Max kW & for Rate A,B,C,D (& Date/Time)	Max kvar/kQ/kVA & for Rate A,B,C,D (& Date/Time)
Cum. kW & for Rate A,B,C,D	Cum. kvar/kQ/kVA & for Rate A,B,C,D
Cont. Cum. kW & for Rate A,B,C,D	Cont. Cum. kvar/kQ/kVA & for Rate A,B,C,D
Instantaneous kW	Instantaneous kvar/kQ/kVA
Previous Interval kW	Previous Interval kvar/kQ/kVA
Last Season Max. kW (& Date/Time)	Last Season Max. kvar/kQ/kVA (& Date/Time)
Last Season Max. kW for Rate A,B,C,D	Last Season Max. kvar/kQ/kVA for Rate A,B,C,D
Last Season Cum. kW & for Rate A,B,C,D	Last Season Cum. kvar/kQ/kVA & for Rate A,B,C,D
Last Reset Max. kW (& Date/Time)	Last Reset Max. kvar/kQ/kVA (& Date/Time)
Last Reset Max. kW for Rate A,B,C,D	Last Reset Max. kvar/kQ/kVA for Rate A,B,C,D
Last Reset Cum. kW & for Rate A,B,C,D	Last Reset Cum. kvar/kQ/kVA & for Rate A,B,C,D

1.2.2.13 Per Phase Measurements

The kV Meter can display the per phase V_{rms} and I_{rms} in both demand and TOU meters. These have a resolution to the nearest tenth of Volt and tenth of an Ampere.

1.2.3 Selecting a Method of Measurement

The kV meter offers a number of measurement options to meter any rate devised for a particular service. This section discusses selecting a method of measurement.

1.2.3.1 First Factor—What to Measure?

The first choice to be made is whether to meter one of the following:

- Energy content near the service frequency only (Fundamental only)
- All the energy content (fundamental plus harmonics)

Depending on this factor and the nature of the load, the energy registration of the meter can be either larger or smaller. Fundamental only may yield a larger Watthour registration because the harmonics can have negative effect on total accumulation.

NOTE *It is important to keep in mind that the breakup of voltage waveforms and current waveforms into Fourier series is a mathematical convenience. A utility cannot deliver energy from line to load at the service frequency while the customer delivers energy in the harmonics from load to line. Energy flow can be in one direction only at a given point in time.*

The general trend today, when using electronic meters, is to measure the fundamental plus harmonics. However, there are several reasons why you might consider fundamental only measurement.

The following are reasons to use fundamental only measurements:

1. **Fairness**—Some utilities argue that measuring all harmonics rewards customers for having bad loads by decreasing their energy costs and penalizes customers with good loads by increasing their energy costs.
2. **Historical Precedent**—Fundamental only measurement simulates the response of electromechanical meters to loads with harmonic content.
3. **Incremental Generation Costs**—Fundamental only measurement is an accurate representation of incremental generation costs for a utility that is selling energy to a customer not in its service area.

The following are reasons not to use fundamental only measurements:

1. **Distributions Costs**—Fundamental only measurements neglect the Distortion Power components of *Cost of Service*. Vector Apparent Power that includes Distortion Power and works with unbalanced loads and asymmetrical services is the best single measurement of Cost of Service for a Distribution Utility.
2. **Equipment Sizing**—Again, vector power is the best measurement for equipment sizing because it includes all power components and does not lead to over estimation of equipment requirements with unbalanced loads or asymmetrical services.

The kV Meter is the first meter to give you the option of measuring the fundamental only or fundamental plus harmonics

1.2.3.2 *Second Factor—Detent Settings*

The second factor is the energy and quadergy detent settings. The settings are shown in Table 1-3 and Table 1-4. Typical commercial metering installations would be configured with delivered only Watthours and lagging only VARhours. The unidirectional energy detent, the sum of delivered and received energy, increases accumulation, and is often chosen as a deterrent to tampering. When metering an intertie point where energy is expected to flow in both directions, net sum of energy would be the natural choice. The settings of the quadergy detent are driven by the policies of the utility and the rate metered.

1.2.3.3 *Third Factor—Choice of Reactive Measure*

There are five choices for the reactive measure:

1. kVArh, kVAr
2. Phasor kVAh, phasor kVA
3. Apparent kVAh, apparent kVA
4. Arithmetic apparent kVAh, arithmetic apparent kVA
5. kQh, kQ

If the meter is being installed in an existing installation where kVAr or kQ were being metered, the choice is simple—duplicate what was there.

In an installation where a kVA rate is in place, apparent kVA (3D-vector power) is the choice that will meter per the definition in IEEE Standard 100. Phasor kVA is defined by the standard but it ignores the distortion power effects. This may be the correct choice if the rate in place was based on the definition of kVA in IEEE Standard 100.

Arithmetic apparent kVA should be chosen only when required by definition of the rate or to emulate a meter incapable of computing apparent kVA. Arithmetic apparent power should not be used with unbalanced loads or asymmetrical service.

Active power, reactive power, and distortion power are orthogonal vectors. Adding them in a scalar fashion, as shown in Equation 1-1, is technically incorrect.

1.2.3.4 *Distortion Measurement*

The kV Meter measures and displays total distortion kVAh and the instantaneous distortion power factor. Total distortion kVAh is computed as shown in Equation 1-5. Distortion power factor is computed as shown in Equation 1-6.

$$\text{Total Distortion VAh} = \sqrt{U^2 - P^2 - Q^2}$$

Equation 1-5. Total Distortion kVAh

$$\text{Distortion Power Factor} = \frac{\text{Distortion Power}}{\text{Apparent Power}}$$

Equation 1-6. Distortion Power Factor

Distortion power factor measurement may be used to determine which utility customer sites need attention. Excessive waveshape distortion can lead to early failure of transformers,

induction motors, and other equipment on the line. Distortion power factors in excess of 10 to 15 percent should be cause for concern.

1.2.4 Transformer-Rated Meter Calculations

The GE kV Meter has two ways of displaying metered data: secondary reading and primary reading.

A secondary reading is what you typically see when you view a meter display. The meter displays the values in the metered circuit. This is acceptable for self-contained meters. The values measured in the metered circuit are usually exactly what you want to see. The currents and voltage seen by the meter are the same currents and voltages seen by the load.

1.2.4.1 Primary and Secondary Displays

When meters are used with instrument transformers, the measurements of most interest are those on the primary side of the instrument transformers. Instrument transformers reduce the voltages and currents seen by the load to values that can be handled by the meter (currents less than 20A and voltages less than 480V). The metering circuit on the secondary side of the instrument transformers is measuring currents that are equal to the primary current divided by the current transformer ratio (CTR) and voltages that are equal to the primary voltage divided by the voltage transformer ratio (VTR). Refer to Equation 1-7. The product of CTR and VTR is called the transformer factor (TF). Primary energy and power values equal the secondary values multiplied by the transformer factor.

$$\text{Load Voltage} = \text{Metered Voltage} \times \text{VTR}$$

$$\text{Load Current} = \text{Metered Current} \times \text{CTR}$$

$$\text{TF} = \text{VTR} \times \text{CTR}$$

$$\text{Primary Reading (energy)} = \text{Secondary Reading} \times \text{TF}$$

$$\text{Energy Delivered to Load} = \text{Metered Energy} \times \text{TF}$$

Equation 1-7. Transformer Rated Meter Calculations

Refer to the current edition of the *EEI Handbook for Electricity Metering* for a more detailed discussion that includes corrections factors.

1.2.4.2 Multiply By Constants

Multiply by constants are often used to add simple scaling between the value displayed by the meter and the primary load. Often the *multiply by* is a multiple of 10. For example if the meter has a *multiply by* tab showing the *multiply by* is 100 then the meter reading should be multiplied by 100 to determine the primary value. The meter does not restrict the *multiply by* constant to multiples of 10. Any value between 0.001 and 9999.99 can be used.

1.2.4.3 Display Scaling (Primary Displays)

The kV Meter provides a simple method of scaling its display. Using MeterMate programming software, you can choose to display primary or secondary values.

If primary values are selected, the displayed values are multiplied by the voltage and current transformer ratios as shown in Equation 1-8. A *multiply by* constant may also be selected.

$$\text{Displayed Value} = \frac{\text{Metered Value} \times \text{VTR} \times \text{CTR}}{\text{Multiply By}}$$

Equation 1-8. Displayed Value

This scaling affects how all displayed cumulative and demand measurements are displayed; that is, all kW, kWh, kVA, kVAh, kVA, and kVAh measurements.

TIP Only displayed values are affected by display scaling. Data stored within the meter is not affected. Values read from the meter by the OPTOCOM port or other communications approaches are also not affected by display scaling.

1.2.4.3.1 Display Overflow

Display overflow occurs when the value to be displayed has more places to the left of the decimal point than the selected display format. For example, if the value to be displayed is 12345.6 kW and the display format is **XXXX**, a display overflow occurs because the meter can not display all numbers to the left of the decimal point. Two solutions are available. One—change the display format to allow more digits to the left. Two—if your system cannot handle numbers with more digits, use a *multiply by* constant.

CAUTION When displaying scaled values, care must be used to not create a display overflow condition.

When a display overflow occurs, the value is displayed as all **F**'s. Display overflow does not affect the values stored within the meter. It affects only how the values are displayed. The value can still be read using the OPTOCOM port or other communications.

If there are no transformers being used and display scaling is desired, VTR and CTR values should be set to 1:1 & 5:5, respectively.

1.2.4.3.2 Voltage and Current Displays

MeterMate programming software also allows the meter user to independently scale voltage and current displays to primary values. If this option is selected, voltage is scaled by the VTR and current by the CTR. Like other display scaling, only the displayed values are affected. Data stored within the meter is not affected by display scaling.

1.2.4.4 Other Uses for Display Scaling

Display scaling is sometimes used to obtain additional demand resolution or when *universal register ratios* are used.

1.2.4.5 Pulse Output Values

The meter does not use pulse initiator ratios. Pulse output values are specified directly in Wh. For example, energy pulses are specified directly in Wh per pulse. If you want 1 Wh pulses, enter 1 Wh as the pulse value.

Pulse output values are not affected by display scaling. The pulse output rate is a measurement of what is happening in the metered circuit only.

If you are replacing an existing meter and do not know the pulse output value, that value can be calculated using Equation 1-9 and the information on the nameplate.

$$PulseValue = K_h \times \frac{R}{P} \text{ (Wh / pulse)}$$

Equation 1-9. Pulse Output Value

R/P is the pulse initiator ratio expressed in revolutions per pulse. The pulse value for energy pulses is often referred to as K_e . And, K_e is usually expressed in kWh/pulse. Use Equation 1-10 to calculate the pulse value in kWh. But remember: the pulse value expressed in MeterMate software will be expressed in Wh/pulse.

$$PulseValue = \frac{k_h}{1000} \times \frac{R}{P} \text{ (kWh / pulse)}$$

Equation 1-10. Pulse Value for Energy Pulses

The kV meter outputs the following types of pulses:

- Apparent kVAh
- Arithmetic Apparent kVAh
- Energy, kWh
- I²h per phase
- Phasor kVAh
- Q-hour, kQh
- Quadergy, kVArh
- V2h per phase

2. Option Board Installation Procedures

WARNING: When energized, the GE kV meter contains lethal voltages. The meter must be completely disconnected from any external circuits before disassembly is attempted. Failure to observe this practice can result in serious injury or death.

Switchboard disassembly.

2.1.1 Removing the Switchboard Cover (Figure 2-1 shows exploded view)

1. Remove the seals from the four thumbscrews in each corner
2. Turn thumbscrews counterclockwise to release cover. Remove cover.
3. Remove paddle at bottom of cradle by grasping handle and pulling straight out. This disconnects the meter from the power line.
4. Lift cradle release levers at top and bottom of cradle.
5. Holding release levers, pull cradle out of case.
6. A stop strap at top of cradle will restrain the cradle from being removed completely.
7. Depress the strap and remove cradle completely.

2.1.2 Removing the Bezel

1. If a battery is present in the left side of the bezel, remove battery to disclose a screw located in the bottom center of battery holder.
2. Remove screw, nut, and lockwasher by turning counterclockwise.
3. On right side, remove four white/color stripe leads from two retaining grooves in upper right corner of sensor board.
4. Lift bezel from left side and disengage from holding tab on right side. Take care not to put any strain on wires.
5. Disconnect the white leads by squeezing the latches on the connector, and pull gently straight out.
6. Disconnect the gray or black leads by grasping the middle of the connector and pulling straight up.

CAUTION: Do not pull on the wires to disengage the connectors. Pull only on the connectors.

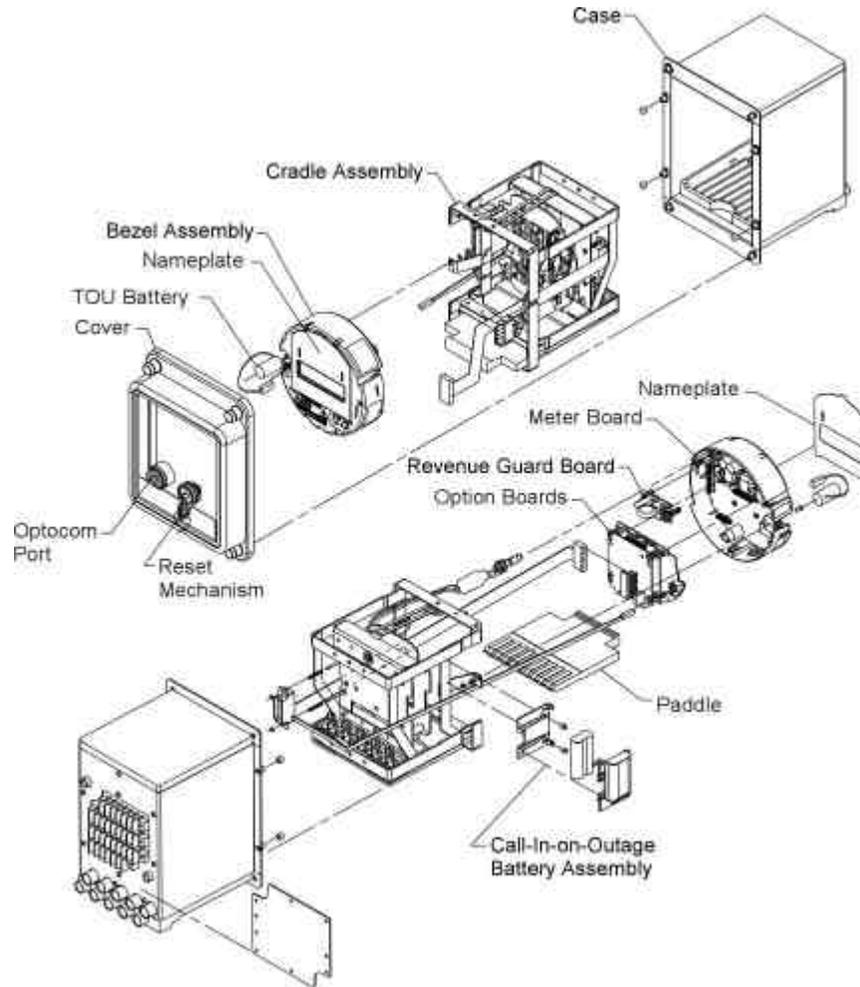


Figure 2-1. Exploded View of kV Switchboard Meter

2.1.3 Removing an Option Board

The following procedure is performed if you are:

- Adding a function-enhancing option board and an I/O board is installed
- Replacing an option board

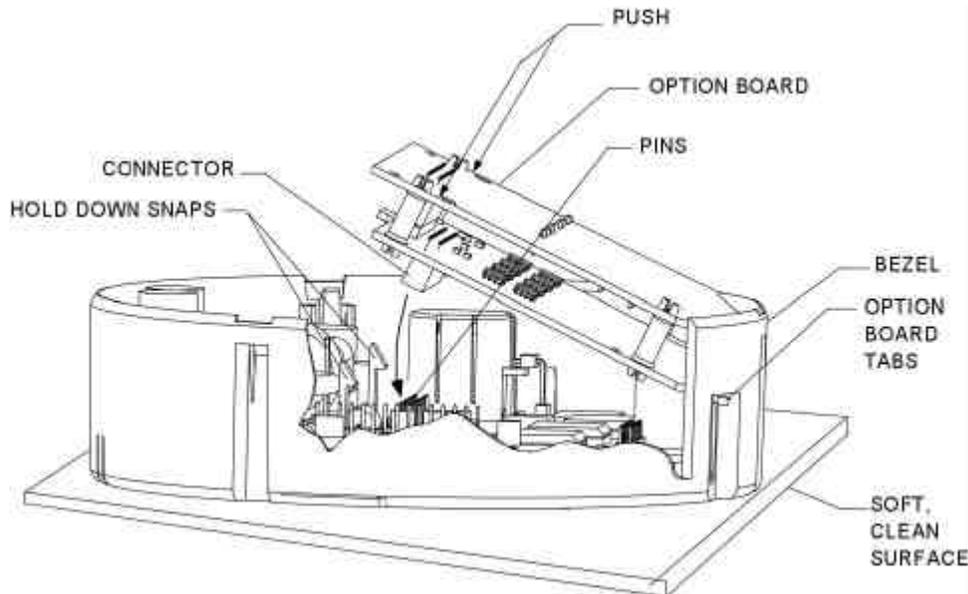
To remove the option board, refer to Figure 2-2 and proceed as follows:

1. Place the bezel on a flat, clean, cloth-covered surface with the meter face down.
2. Orient the bezel so that the connector is at the top of the option board and away from you.
3. Hold the option board with the thumb and index finger of each hand near the two board latches. Using your thumbs to push the latches away from the board, tilt the board upwards toward yourself.
4. Continue tilting the board until the tabs on the bezel and the tabs on the board are disengaged.
5. Lift the board out of the bezel.

2.2.1 Installing Option Boards

The inner position is referred to as the function slot. See Figure 2-2 for a graphic description of board installation.

Figure 2-2. Installing an Option Board



2.2.1.1 Installing the I/O-2 Board

Installation of any or all option boards is facilitated by disconnecting the voltage (white) and current (black or gray) wires after separating the bezel from the cradle.

I/O-2 Option Board Characteristics

The I/O-2 option board has solid state switches which provide two Form C and a Form A output. It also provides for optically isolated real time pricing input.

Contact Type:

- Solid State Contacts
- KYZ Outputs — Form C
- Programmable Switch — Form A

Maximum Ratings:

- 170 Vdc or 120 Vac
- 0.1 Adc or 12 VA ac
- 17 VA dc

Contact Protection:

- MOV suppressors for each output to common (K).

Notes: Typical RC arc-suppression circuits not required.

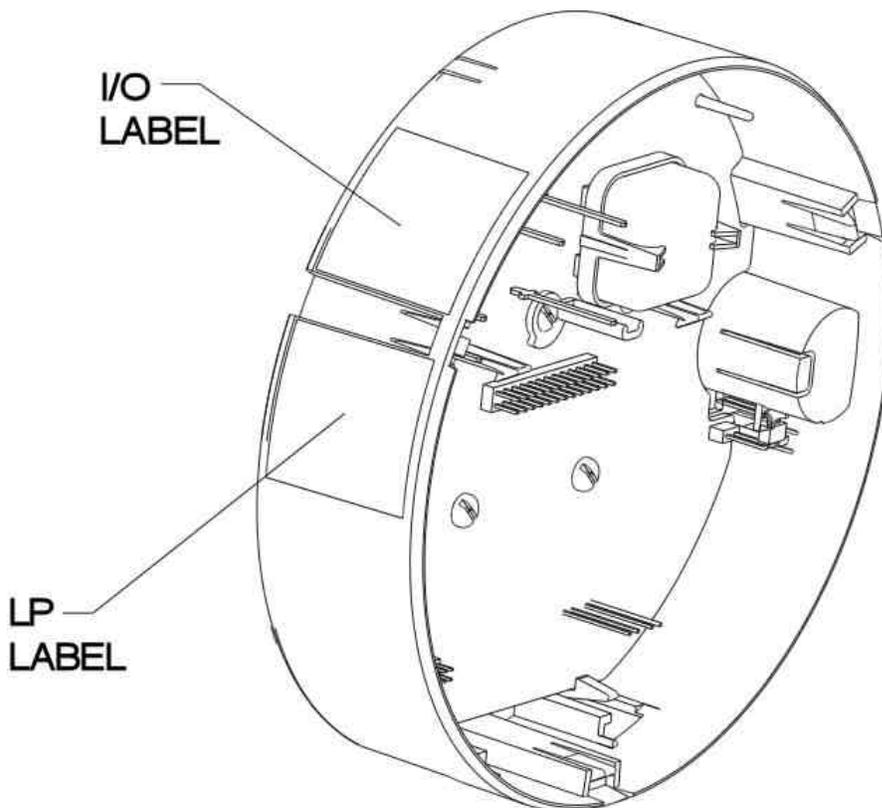
- No physical orientation restrictions.

NOTE: The I/O board is always the outer option board. This position provides adequate clearance around the board to connect the I/O cable to the board.

The I/O board is installed as follows:

1. If the switchboard meter is not disassembled, follow the disassembly instructions described earlier in this chapter.
2. Place the bezel face down on a soft, clean surface to protect the nameplate and the liquid crystal display
3. Check the pins on the meter board. Make sure no pin is bent or out of position. Align any pin that is out of alignment.
4. With the 26-pin connector on the underside of the board, insert the tabs on the board into the slots on the bezel.
5. Gently move the board until the board connector engages the meter board pins.
6. Push straight down on the option board near the standoffs. Push gently until the standoffs snap firmly on the edge of the option board.
7. Remove backing from I/O label and place on module as shown in Figure 2-3.
8. Module is now ready to be connected to I/O output cable. See *Installing Option Board Cables*.

Figure 2-3. I/O and LP Labels



1.

2.2.1.2 Installing a Load Profile Option Board

Load Profile Recorder Option Board Characteristics

- Features
 - up to two channels
 - ANSI C12.19 Standard Tables
 - 32.767 pulses / interval
 - 64 kB of memory
 - Six sets of self read data
- Software
 - MeterMate™ DOS for reading
 - MV-90 for Load Profile
 - ASCII Data Export
- Recorder quantities
 - kWh
 - or
 - kVArh
- Interval Lengths
 - 1,2,3,5,10,15,30,60
- Memory Size
 - 64 k of nonvolatile memory
- Available Recording per Channel

Load Profile Interval Length (minutes)	Storage per Channel Memory Configuration*	
	1 Channel	2 Channel
5	71 Days	36 Days
10	142	72
15	214	108
20	285	144
30	428	216
60	856	432
* Also includes 6 sets of self read data		

1. If switchboard meter is not disassembled, follow the instructions for removing switchboard cover and bezel described earlier in this chapter.
2. Place meter module face down on a soft surface to protect the nameplate and display with the top away from you.
3. With Load Profile board components on top, insert the two tabs of the board into the slots of the bezel. See Figure 2-2.
4. Lower board gently until header on the bottom of the board engages the connector pins. Check for alignment to be sure all pins are engaged.
5. Press down on the upper board corners until holding posts snap over edge of board.
6. Reconnect voltage and current sensor leads to module and reassemble to cradle.

7. Remove backing from label and place on module as shown in Figure 2-3.
8. Cradle assembly is now ready to be put in case.
9. Power up meter.

Note: If MeterMate is being used to program, the meter must have a "T" switch enabled and a battery installed in order to allow LP recording on "Demand Only" meters.

2.2.1.2.1 Installing a Load Profile and I/O Board

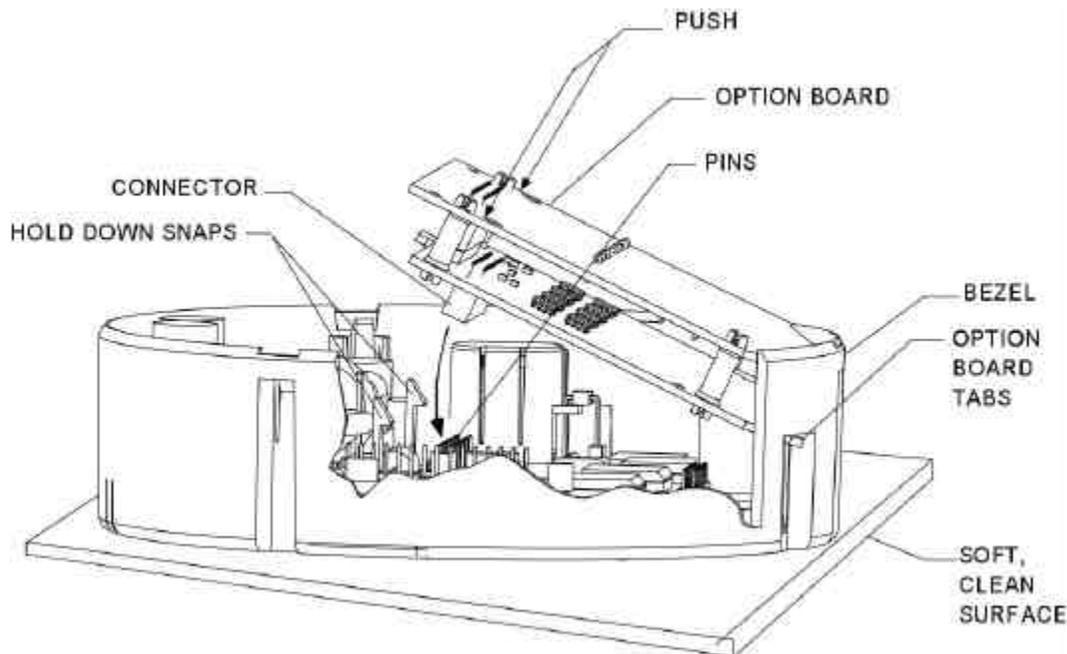


Figure 2-6. Load Profile & I/O Option Boards

1. If switchboard meter is not disassembled, follow the instructions for removing switchboard cover and bezel described earlier in this chapter.
2. Because the KYZ and output cable connectors are located on the I/O option board, it must be on top.
3. On bottom of I/O board, insert the four PC board spacer posts into the four holes shown in figure 2-6.
4. Place I/O board on top of Load Profile board and align 26-pin connector to 26-pin header.
5. Gently press connector and header together until the four posts are aligned with the four holes in the Load Profile board.
6. Press boards together until all four posts have snapped securely in place. Test by trying to pull boards apart with moderate force.
7. With I/O board on top, place tabs on Load Profile board into slot in bezel and lower boards until header on Load Profile board engages connector pins on module board.
8. Press down on upper board corners until holding posts snap over edge of board.
9. Remove backing from labels and place on bezel as shown in Figure 2-3.

10. See *Installing Option Board Cables* for connecting I/O – 2 output cable and reassembly of Module.

2.2.1.3 *Installing Modem Option Board*

The kV™ Modem Option Board is used to provide two-way communication to the kV™ Meter and may be used on S-base, A-base, or switchboard meters. It is available on both TOU and demand versions of the kV™ Meter.

The kV™ Modem Option Board uses a 2400 baud Rockwell modem and has the following basic features:

- 300, 1200, 2400 baud support
- Supports industry standard PSEM protocol and ANSI Tables
- Originate call on an event
- Originate call on a scheduled basis
- Other phone detect circuitry
- Phone line sharing (up to 5 meters per phone line)
- Originate call on power outage (optional)

All kV™ Meters, including those with modems, are programmed using GE's MeterMate software program.

See Instruction Manual GEH-7269 kV™ Meter Modem Option Board for detailed operating instructions.

Note: *The Modem Option Board must always be installed as the inner most option board (the board closest to the kV™ Meter's main board).*

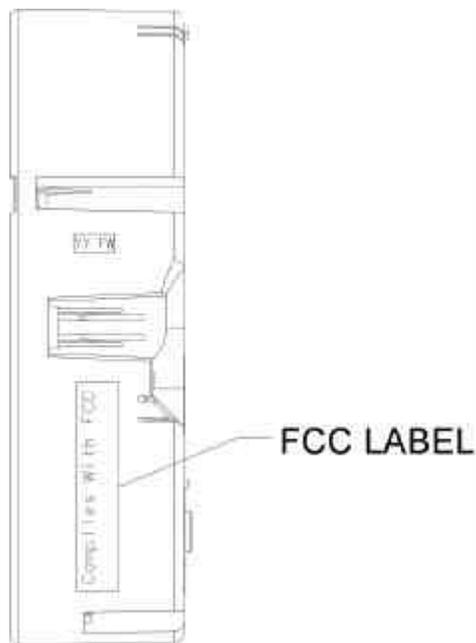
The modem board is installed as follows:

1. If the switchboard meter is not disassembled, follow the disassembly instructions earlier in this chapter.
2. Place the bezel face down on a soft, clean surface to protect the nameplate and liquid crystal display.
3. Remove the I/O and LP option boards if they are present.
4. ***The I/O-1 and LP-1 option boards must not be used with the Modem Option Board due to clearance issues.***
5. If the Modem Option Board will not be combined with either the I/O or LP option boards proceed to step 9. If the Modem Option Board will be installed with the I/O-2 and/or LP-2 option boards proceed to the next step.
6. Place the Modem Option Board on a soft clean surface, component side up, and install the four (4) nylon spacers by gently pushing them into the four (4) holes on the board.
7. If both the LP-2 and I/O-2 option boards are to be installed, the LP-2 option board must be installed next. Install it by engaging the 26 pin connector pins between the Modem Option Board and the LP-2 option board. Then, after lining up the nylon spacers on the Modem Option Board with the four (4) holes on the LP-2 board, snap the option board into place.

GEH-7271, kV Switchboard Vector Electricity Meter

8. -2 option board may be installed directly to the Modem Option Board if the LP-
Either way, the I/O-2 option board is installed in a similar manner to the LP-2 option board described in step 6 above.
Check the 30 pin header on the meter board to make sure that the pins are not bent or
10. Board into the slots in the bezel.
11. Gently lower the board until the 30 pin connector on the meter and the Modem Option Board are engaged. Make sure that the two snaps engage the board.
Place FCC label on bezel in the location shown in 2- .
13. On upper right side of the upper nameplate, place an "X" in the box marked "Modem."
14. See section on installing Option Board Cables and reassembly.

Figure -7



2.2.1.4

kV RSX Communications Board Characteristics

The kV RSX Option Board is used to provide two-way communication to the kV™ Meter. It

The kV RSX Option Board has 3 modes of operation: External Modem mode, RS232 Simple Serial mode and RS485 Simple Serial mode.

When operating in **External Modem Mode**, the kV RSX provides an RS232 interface to an external telephone or wireless modem to facilitate remote kV Meter reading and programming. In this mode the kV RSX contains AMRA tables which can be programmed to provide the following basic features:

- 300, 1200, 2400, 4800, 9600 baud support.
- Supports industry standard PSEM protocol and AMRA Tables
- Originate call on an event
- Originate call on a scheduled basis
- Originate call on power outage (optional)

In **RS232 Simple Serial Mode**, the kV RSX provides a 3-wire, RS-232 interface. This interface allows the kV Meter to be read by a computer using a null modem cable. It also serves as an RS-232 interface to third party communications devices. The baud rate for this mode is fixed at 9600 bps.

RS-485 Simple Serial Mode provides a half-duplex, 2 -wire, RS-485 interface for remote reading of the kV Meter. The baud rate is fixed at 9600 bps. No multidrop capability is supported.

All kV™ Meters, including those with kV RSX boards, are programmed using GE's MeterMate software program.

1. If switchboard meter is not disassembled, follow the instructions for removing switchboard cover and bezel described earlier in this chapter.
2. Go to section on *Installing Option Board Cables*.

2.2.1.5 Installing Option Board Cables

At rear of cradle, two brass posts on the left side hold the 24-position connector which mates with the 24-position receptacle on the rear inside of case. These two must mate correctly or the cradle will not seat properly in the case.

2.2.1.6 Installing 24-Position Connector and Cables

1. Place a supplied spring on each brass post.
2. Hold 24-position connector with open connector toward you and cables to the right. The cable at the top is the I/O 9-conductor flat cable with a 9-position connector. If there is a lower cable, it is either a Modem 4-conductor telephone cable or a 9-conductor RS 232/485 cable.
3. Fold the top cable (I/O) back underneath the 24-position connector and feed it under the left cradle leg while placing the 24-position connector onto the posts. If there is a lower cable, feed it under the cradle leg on the right side.
4. Secure 24-position connector to posts with e-rings provided, while compressing the springs. *Connector should now move freely on the posts.*
5. Turn cradle around and tip backwards so the connector block is in front.
6. If the RS 232/485 option board cable is present skip to Item 23.
7. While holding module in right hand, (be careful not to touch display panel) with left hand connect 15-position connector (black and gray leads) to 15-pin header on main kV board. Check to see that all 15 pins are aligned correctly.
8. Connect 4-position white connector to main board.

- 9.
10. battery cavity is over holding bracket on left side.
11. Secure with screw, washer, and nut
12. If no other cable is present, unit is ready to install in case.

2.2.1.7 Installing Telephone Modem Cable

13. If telephone modem cable is present, turn unit face down on a soft, clean surface to protect the nameplate and liquid crystal display.
Lay the telephone modem cable in the notches of the rear plate and sensor plate connection and should not be forced.
15. Use cable tie to secure cable to cross bar so to act as a strain relief for the cable connector. Excess cable should be at back of cradle assembly, pushed up into module. See 2- .
16. Unit is now ready to be installed in case.

2.2.1.8 Installing Call-In-Outage Battery

17. If Call-In-Outage battery is to be installed, proceed as follows:
18. With large notch down, install retainer battery holder with two #4-48 ¼ inch screws onto cross bar located on left side of cradle. See Figure 2-1.
19. Place battery into battery holder with leads extending through the slot in the battery holder and pointing up.
20. Insert top of battery holder under two top snaps and press bottom of battery holder until the two bottom snaps engage.
21. Connect battery to Modem option board next to telephone line. This is a keyed connection and should not be forced.
22. Unit is now ready to be installed in case.

2.2.1.9 Installing RS 232/485 Option Board Cable

23. With the RS 232/485 cable installed, place 4- & 6-position connectors into connector holder as shown in Figure 2-8. Make sure white polarizing keys are in proper location to match missing pins on option boards.
24. To the RS 232/485 Option Board by itself, carefully place the 4- & 6-pin connectors in connector holder on the RS 232/485 option board pins (Figure 1-1) and gently push until holder snaps into holes on option board. If other option boards are required, add the remaining option boards according to the proper stacking order.
25. Snap option board, or stack of option boards, into module according to instructions and figure 2-2 being careful of connected cable.
26. Turn cradle assembly onto its left side toward module. If I/O option board and cables are installed, while holding module upright, bring I/O cable up outside of cradle assembly under top cross bar and plug into I/O option board.
27. Plug in current sensor leads (15-position connector) to 15-position header pins on main kV board. Check to be sure all 15 pins are properly connected and that the three leads are over the I/O cable if present.

28. Plug in the 4–position white connector to main kV board.
29. Holding module, gently stand cradle assembly upright, being careful not to unplug any cables.
30. Place slot on right side of module bezel over holding angle and lower until hole in battery cavity is over holding bracket on left side of cradle.
31. Secure module to holding bracket with screw, lockwasher, and nut.
32. Secure cable to crossbar with cable tie so as to act as a strain relief for cable connectors. Excess cable should be at back of cradle assembly, *not* pushed up into module.
33. On upper right side of upper nameplate, place “X” in box marked “RS.”
34. Cradle assembly is now ready to install in case.

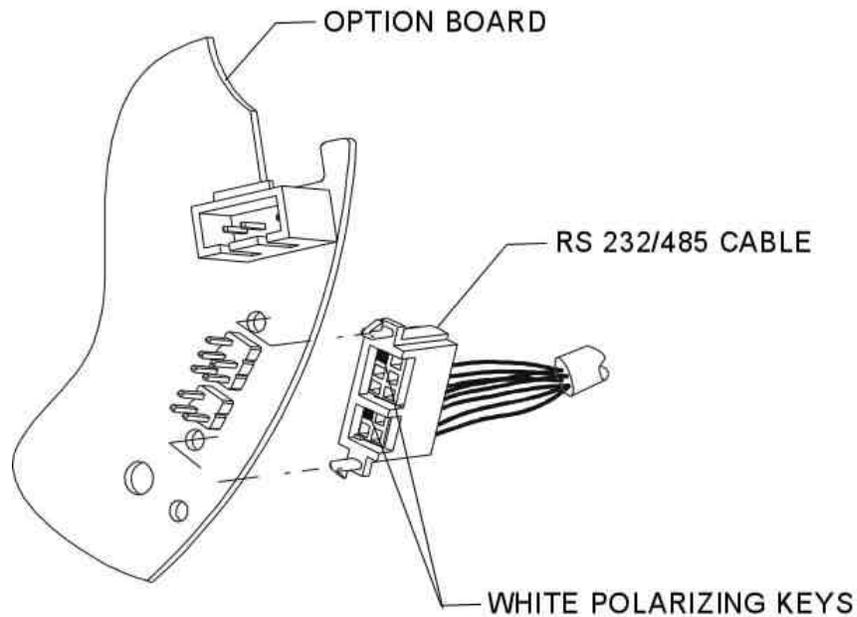
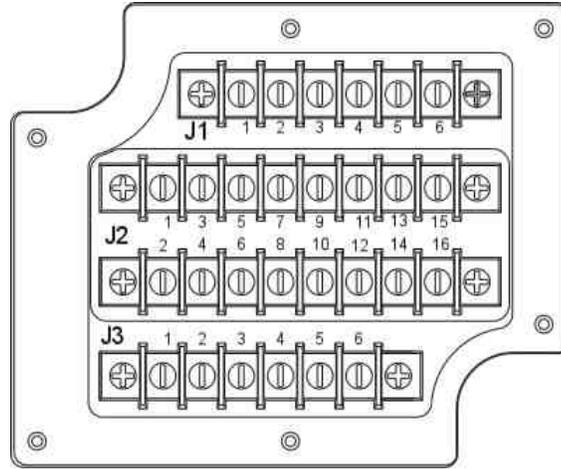


Figure 2-8. RS 232/485 Cable Installation

2.2.1.10 Option Board Outputs

Shown below is the Output Option Panel located on the rear of the kVZ Switchboard case. Below that is a table of outputs for each option board.

For details regarding the outputs available see: Instruction Book GEH-7269 For Telephone Modem or Instruction Book GEH-7275 For RS-232/485.



Terminal No.	I/O Function	MODEM Function	RS 232 Function	RS 485 Function
J2 - 1	RTP+			
-	RTP-			
- 3				
- 4	K3			
5	Z2			
-	K1 K2			
- 7	Z1			
8	Y2			
-	Y1			
- 15			DTR	
- 16				
J3 - 1			DCD	
- 2			COM	
- 3			RI	RX +
- 4		X	RX	RX -
- 5		X	TX	TX -
- 6			RTS	TX +

2.2.1.11 Installing a Revenue Guard Board

The Revenue Guard Option Retrofit Kit can be ordered as GE Part Number 9938280001. To install the Revenue Guard board, proceed as follows:

CAUTION **De-energize the meter. All work must be done with no power applied to the meter.**

1. Remove the meter from service.
2. Remove the cover and bezel from the meter.

TIP *If the meter has an I/O or Function option board, remove the other option boards before installing the Revenue Guard board.*

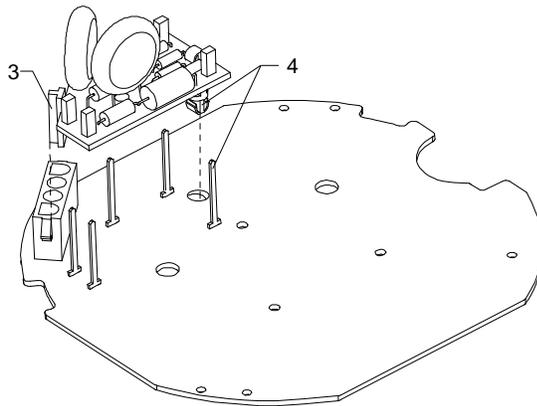


Figure 2-9. Installation of Revenue Guard Option Board

3. Install press fit standoff onto Revenue Guard Option Board, located on the angled portion of board between the MOV and the receptacle of the Revenue Guard Board shown above.
4. With the components of the Revenue Guard option board facing away from the face of the bezel, slide the option board onto the five standoffs on the meter board. Make certain that the option board is firmly seated on the posts of the meter board. and that the locking spacer snaps in the meter board as shown above.
5. Reinstall any other option boards which were removed.
6. Reconnect the current sensor and voltage connectors. Adjust press fit standoff so that it is locked in place by voltage connector.
7. Reassemble the bezel to the meter cradle.
8. On the upper right corner of the meter label, place an X in the box next to Revenue Guard.
9. Reinstall Lexan cover and test.

Test the Revenue Guard board for proper functioning. Use an appropriate test panel or socket. The meter should continue to function with the voltage removed from one or two phases.

CAUTION: *Do not interchange base and bezel assemblies between meters. Calibration data stored in the meter is particular to a set of current sensors. and electronics module. Interchanging these components causes the meter to lose calibration.*

Caution POLYPHASE TESTING

Do not polyphase test kV meters using Wye test conditions at voltages higher than 277 Volts line-to-neutral for 120-480V rating; no higher than 144 Volts for 57-120V rating.

The kV meter is designed to meter conventional services with line-to-neutral voltages up to 277 Volts and line-to-line voltages up to 480 Volts, or 69 Volts and 120 Volts respectively for 57-120V rating. Operation at voltages more than 10% above this rating will lead to shortened life or failure.

For example, polyphase testing of 120-480V rated 9S, 10A, 48A, 16S, or 16A meters at 480 Volt “Wye” line to neutral conditions will result in voltages in excess of 800 Volts being applied to the meter. Stresses of this magnitude will result in immediate failure of the Revenue Guard Board if it is present or shorten meter life.

2.2.2 Converting to *Time of Use* Metering

Register conversion provides the capability to change metering modes (demand, TOU and demand load profile). TOU mode conversion is described in paragraph 2.2.2.1.

2.2.2.1 *Enabling the Time-of-Use Option*

The following items are required to enable this option:

- Computer with MeterMate Software
- Soft switch holder with T switch
- SMARTCOUPLER device
- Time Keeping Battery

If at any time you are unsure if the meter has been upgraded, select **Check Meter** on the MeterMate **Upgrade** screen. The screen will display the capabilities of the meter. To enable the TOU function, proceed as follows:

CAUTION - Battery installation must be done with NO power applied to the meter.

1. Plug the soft switch holder into the parallel port of the computer.
2. Install the battery.
3. Apply power to the meter.
4. Connect the SMARTCOUPLER device to the serial port of the computer and the OPTOCOM port on the kV Meter.
5. Using MeterMate software, go to the **Main Menu**.
6. On the **Main Menu**, select **Program**.
7. On the **Program** menu, select **Upgrade**.
8. On the **Upgrade** menu, select **TOU**.
9. This enables the TOU function in the meter. When completed, the screen reverts to the **Upgrade** menu.
10. Mark the TOU box on the nameplate.

TIP: If you are not ready to install the TOU program, the meter may still be used as a demand meter after the TOU switch is enabled and the battery installed. However the battery is not used until the meter is programmed as a TOU meter.

2.2.2.2 *Replacing the Battery*

CAUTION - Battery installation must be done with NO power applied to the meter.

1. Remove power from the meter.
2. Remove the meter cover.
3. Remove the old battery and disconnect its wire from the bezel.
4. Place the new battery in the battery compartment.

NOTE *When changing the battery, you have at least 2 minutes to remove the old battery and install a new battery. After 2 minutes, data may be lost.*

5. Connect the battery wire to the connector in the battery compartment.
6. Replace the meter cover.
7. Energize the meter.
8. Program the meter as described in the MeterMate documentation.

Lithium Inorganic 3.6 Volt Battery (Safety Precautions)

- Do not expose battery to temperatures above 100 degrees C. Do not incinerate, puncture, crush, recharge, overdischarge or short circuit battery.
- The contents are water reactive and the battery contents can form HCL (hydrochloric acid), SO₂ (sulfur dioxide) and H₂ (hydrogen), upon contact with water (only when forced open). Do not expose contents of battery to water. Do not expose contents to high humidity for extended periods of time.
- Dispose of batteries in accordance with local, state and federal hazardous waste regulations.

To obtain an MSDS, contact S. Allan Bucar, Manager - Quality and EHS, GE Meter, 130 Main Street, Somersworth, NH 03878 - 3194, Tel 603-749-8550.

3. Operating Instructions

Nameplate Information

See Figure 3-1 for a graphic representation of the meter nameplate.

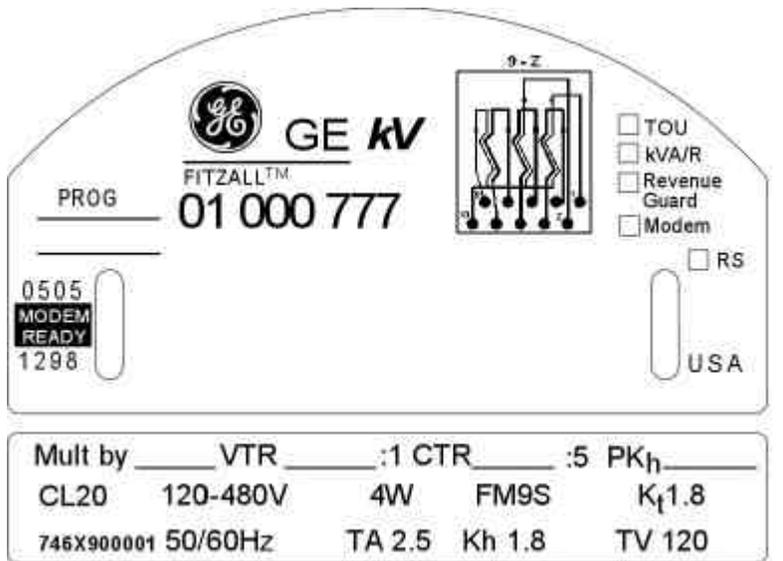


Figure 3-1. Meter Nameplate

3.1.1 Upper Nameplate Information

The upper nameplate information is shown in Figure 3-2. The following numbered list coincides with the numbers in the figure.

1. Meter type
2. ANSI C12.10 diagram of meter wiring
3. A check or X in a box means that the T-Switch or K-Switch is enabled or the Revenue Guard option board has been installed.
4. Utility's information and bar code area
5. Month and Year of manufacture
6. Communication ready
7. Hardware revision
8. Firmware revision
9. Program identification
10. Meter Serial number

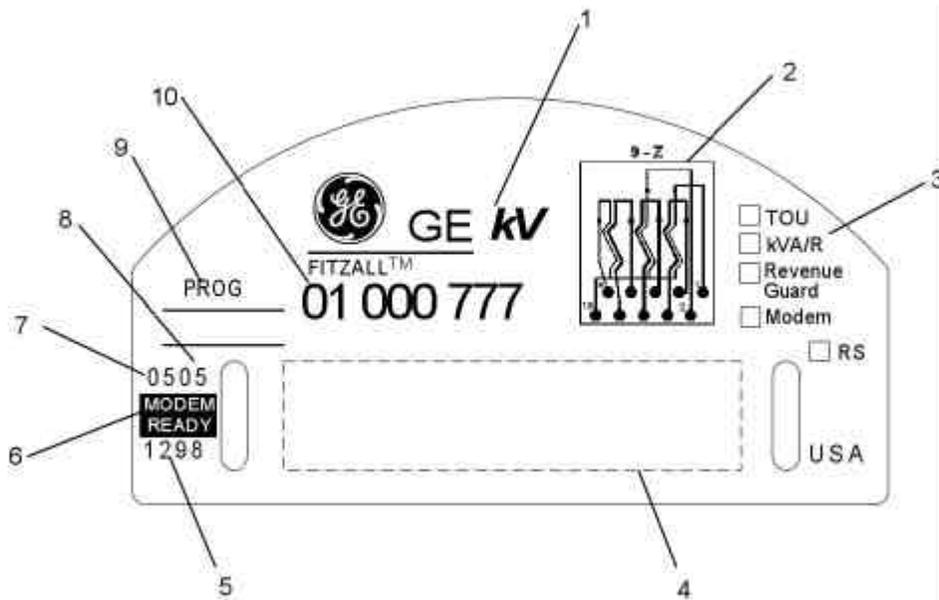


Figure 3-2. Upper Nameplate Information

3.1.2 Lower Nameplate Information

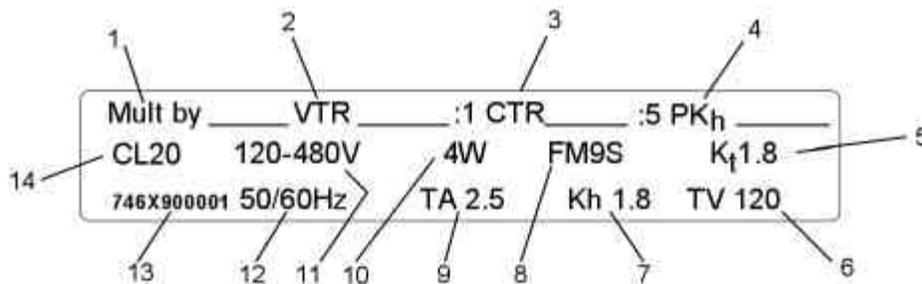


Figure 3-3. Lower Nameplate

The numbered list below coincides with the numbers in Figure 3-3.

1. Multiply by constant
2. Voltage transformer ratio
3. Current transformer ratio
4. Primary Watthour constant
5. Test constant
6. Test voltage
7. Watthour meter constant
8. Form Number
9. Test Amperes
10. Number of wires for the metered service
11. Nominal Voltage operating range
12. Nominal Frequencies
13. Catalog number
14. Meter Class

3.1.3 Fitzall™ Lower Nameplate Information

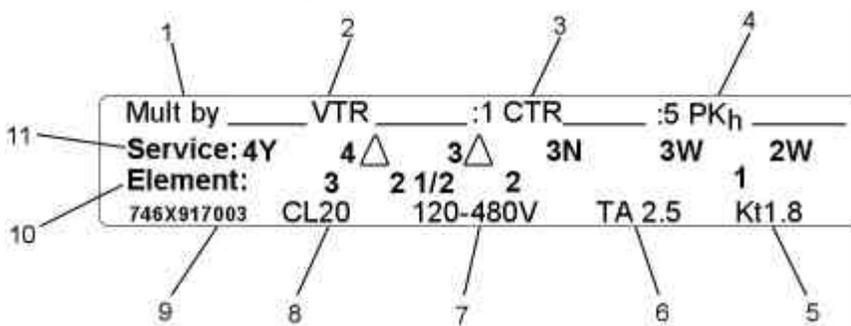


Figure 3-4. Fitzall Nameplate

The numbered list below coincides with the numbers in Figure 3-4.

1. Multiply by constant
2. Voltage transformer ratio
3. Current transformer ratio
4. Primary Watthour constant
5. Test constant
6. Test Amperes
7. Nominal voltage operating range
8. Meter Class
9. Catalog number
10. Number of elements
11. Service type

3.2 Display Information

	Display Item	Operational Modes Available
DEMAND		
Current Season		
Maximum		
	Maximum kW	All
	Maximum kW Date	TOU
	Maximum kW Time	TOU
	Maximum kW Rate A,B,C,D	TOU
	Maximum kW Rate A,B,C,D Date	TOU
	Maximum kW Rate A,B,C,D Time	TOU
	Maximum kvar/kVA/kQ	All
	Maximum kvar/kVA/kQ Date	TOU
	Maximum kvar/kVA/kQ Time	TOU
	Maximum kvar/kVA/kQ Rate A,B,C,D	TOU
	Maximum kvar/kVA/kQ Rate A,B,C,D Date	TOU
	Maximum kvar/kVA/kQ Rate A,B,C,D Time	TOU
Cumulative		
	Cumulative kW	All
	Cumulative kW Rate A,B,C,D	TOU
	Cumulative kvar/kVA/kQ	All
	Cumulative kvar/kVA/kQ Rate A,B,C,D	TOU

Display Item	Operational Modes Available
Continuously Cumulative:	
Continuously Cumulative kW	All
Continuously Cumulative kW Rate A,B,C,D	TOU
Continuously Cumulative kvar/kVA/kQ	All
Continuously Cumulative kvar/kVA/kQ Rate A,B,C,D	TOU
Instantaneous	
Momentary Interval kW	All
Momentary Interval kvar/kVA/kQ	All
Previous Interval	
Previous Interval kW	All
Previous Interval kvar/kVA/kQ	All
<u>Last Season</u>	
Maximum	
Maximum kW	TOU
Maximum kW Date	TOU
Maximum kW Time	TOU
Maximum kW Rate A,B,C,D	TOU
Maximum kvar/kVA/kQ	TOU
Maximum kvar/kVA/kQ Date	TOU
Maximum kvar/kVA/kQ Time	TOU
Maximum kvar/kVA/kQ Rate A,B,C,D	TOU
Cumulative	
Cumulative kW	TOU
Cumulative kW Rate A,B,C,D	TOU
Cumulative kvar/kVA/kQ	TOU
Cumulative kvar/kVA/kQ Rate A,B,C,D	TOU
<u>Last Reset</u>	
Maximum	
Maximum kW	All
Maximum kW Date	TOU
Maximum kW Time	TOU
Maximum kW Rate A,B,C,D	TOU
Maximum kvar/kVA/kQ	All
Maximum kvar/kVA/kQ Date	TOU
Maximum kvar/kVA/kQ Time	TOU
Maximum kvar/kVA/kQ Rate A,B,C,D	TOU
Cumulative	
Cumulative kW	All
Cumulative kW Rate A,B,C,D	TOU
Cumulative kvar/kVA/kQ	All
Cumulative kvar/kVA/kQ Rate A,B,C,D	TOU
ENERGY	
Current Season	
Total	
Total kWh	All
Total kvarh/kVAh/kQh	All
TOU	
kWh Rate A,B,C,D	TOU
kvarh/kVAh/kQh Rate A,B,C,D	TOU
Last Season	
Total	
Total kWh	TOU
Total kvarh/kVAh/kQh	TOU
TOU	
kWh Rate A,B,C,D	TOU
kvarh/kVAh/kQh Rate A,B,C,D	TOU
Last Reset	
Total	

GEH-7271, kV Switchboard Vector Electricity Meter

Display Item	Operational Modes Available
Total kWh	All
Total kvarh/kVAh/kQh	All
TOU	
Last Reset kWh Rate A,B,C,D	TOU
Last Reset kvarh/kVAh/kQh Rate A,B,C,D	TOU
POWER FACTOR	
Average Power Factor	All
Instantaneous Power Factor	All
REAL-TIME PRICING (RTP)	
RTP Total kWh	Dmd/ DmdLP
RTP Total kvarh/kVAh/kQh	Dmd/ DmdLP
RTP Maximum kW	Dmd/ DmdLP
RTP Cumulative kW	Dmd/ DmdLP
RTP Continuously Cumulative kW	Dmd/ DmdLP
RTP Maximum kvar/kVA/kQ	Dmd/ DmdLP
RTP Cumulative kvar/kVA/kQ	Dmd/ DmdLP
RTP Continuously Cumulative kvar/kVA/kQ	Dmd/ DmdLP
Last Reset	
Last Reset RTP Total kWh	Dmd/DmdLP
Last Reset RTP Total kvarh/kVAh/kQh	Dmd/DmdLP
Last Reset RTP Maximum kW	Dmd/DmdLP
Last Reset RTP Maximum kvar/kVA/kQ	Dmd/DmdLP
Last Reset RTP Cumulative kW	Dmd/DmdLP
Last Reset RTP Cumulative kvar/kVA/kQ	Dmd/DmdLP
SECURITY LOG	
Number of Bad Passwords	All
Number of Demand Resets	All
Number of EEPROM Writes	All
Number of OPTOCOM Communications	All
Number of Power Outages	All
Number of Times Programmed	All
Number of Times for Real-Time Pricing Entries	All
Cumulative Power Outage Duration in seconds	TOU/DmdLP
Date of Last Calibration	All
Time of Last Calibration	All
Date of Last Demand Reset	TOU
Time of Last Demand Reset	TOU
Date of Last OPTOCOM Comm.	TOU
Time of Last OPTOCOM Comm.	TOU
Date of Last Power Outage	TOU/ DmdLP
Time of Last Power Outage	TOU/DmdLP
Date of Last Programming	All
Time of Last Programming	All
Date of Last Real-Time Pricing Entry	TOU
Time of Last Real-Time Pricing Entry	TOU
DIAGNOSTIC TOOLS	
Distortion	
Distortion Power Factor (D/U)	All
Total Distortion kVAh	All
Voltage	
RMS Volts (fundamental frequency), Phases A,B,C	All
Voltage Phase Angle (degrees), Phases A,B,C	All
Current	
RMS Amps (fundamental frequency), Phases A,B,C	All
Current Phase Angle (degrees), Phases A,B,C	All
Diagnostic Counters (number of occurrences)	
d1 [Polarity, etc.]	All
d2 [Voltage Imbalance]	All
d3 [Inactive Current]	All

Display Item	Operational Modes Available
d4 [Current Imbalance]	All
d5-A [Distortion]	All
d5-B [Distortion]	All
d5-C [Distortion]	All
d5 Total [Distortion]	All
d6 [Under Voltage]	All
d7 [Over Voltage]	All
d8 [High Neutral]	All
TEST MODE	
Test Mode Demand Interval length in minutes (block)	All
Test Mode Demand No of Subintervals. (rolling only)	All
Test Mode Demand Subint. length in minutes (rolling)	All
Test Mode Maximum kW	All
Test Mode Maximum kvar/kVA/kQ	All
Test Mode Time Out Length in minutes	All
Test Mode Wh	All
Test Mode varh/VAh/Qh	All
Test Mode Thermal Interval Type: "0"=15 min., "1"=1 min.	All
Test Mode Accumulating Demand kvar/kVA/kQ	All
Test Mode Accumulating Demand kW	All
CONSTANTS	
Demand Interval Length in minutes (block only)	All
Demand No. of Subintervals (rolling only)	All
Demand Subinterval Length in minutes (rolling only)	All
Demand Alert Threshold in W, or kW per "Display Demand Units" below	All
Demand Delay Length in minutes	All
Minimum Outage for Demand Delay in seconds	All
Display Demand Units: "0"= kW, "1"= W	All
Display Scalar: (for GE internal use)	All
Display Primary Volts/Amps Flag: "0"= Sec, "1"= Pri.	All
Display Multiplier (Scaled): (for GE internal use)	All
Electrical Service	All
Meter ID 1	All
Meter ID 2	All
Program ID	All
Transformer Ratio - Current: X:5	All
Transformer Ratio - Voltage: X:1	All
EOI Duration in seconds: contact closure and annunciator	All
Power Factor Threshold	All
Power Factor kW Demand Threshold	All
Load Profile # Channels	TOU/ DmdLP
Load Profile Interval Length in minutes	TOU/ DmdLP
Real-Time Pricing State: "0"= Disabled, "1"= Enabled	All
Seal Flag State: "0"= Unsealed, "1"= Sealed	All
Official Government Metrology Control	
Blank Data Display	All
All Segments	All
Firmware Version No. = 1, 2,...	All
Hardware Version No. = 1, 2,...	All
VARIABLES	
Current Season	TOU/ DmdLP
Current Date	TOU/ DmdLP
Current Day Of Week (1-7 means Sun-Sat)	TOU/DmdLP
Current Time	TOU/ DmdLP

Display Item	Operational Modes Available
Time Remaining in Demand (Sub)interval in minutes (Not valid for thermal demands)	All
Load Control ON ("0"= OFF, "1"= ON)	TOU
Real-Time Pricing time remaining until activation in min.	All
Time Remaining in Test Mode (Sub)interval in min. & sec. (Not valid for thermal demands)	All

3.2.1 Display Modes

There are four modes of display:

- Normal Mode
- Alternate Mode
- Site Genie Mode
- Test Mode

The user can switch between these display modes using the Display Switch and the Test Switch.

3.2.1.1 Display Switch Actions

The display switch is activated using a magnet as shown in Figure 3-5. Holding a magnet next to the display switch for a given time causes the meter to change display mode.

- A momentary hold produces one normal scroll if an error or caution is frozen on the display.
- A 3-second hold produces one alternate scroll then returns to the normal display mode.
- A 6-second hold changes the mode to Site Genie display mode.

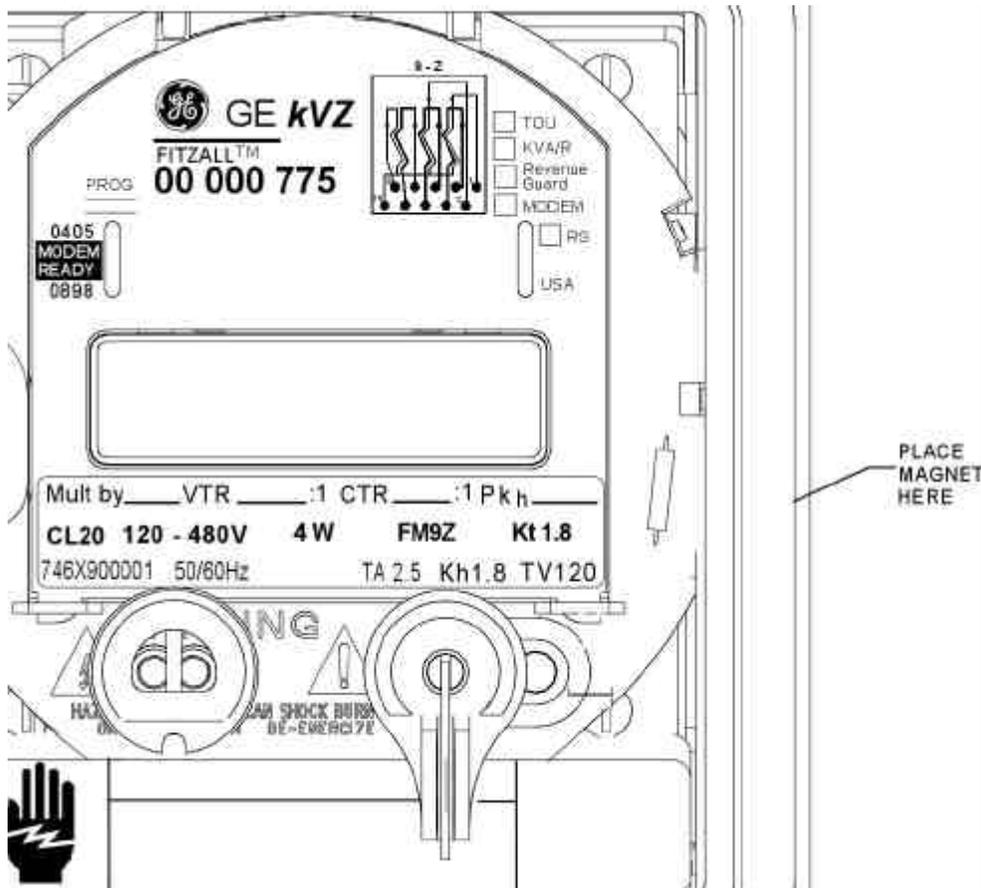


Figure 3-5. Alternate Display Mode Switch

3.2.1.2 Normal Display Mode

In normal mode, the meter display scrolls continually until one of the following occurs:

- Demand reset is invoked.
- Display switch is actuated.
- OPTOCOM communication is initialized.
- Test mode is invoked.
- A frozen error, caution, or diagnostic message is triggered.

This is the default display mode. The meter returns to the normal Display mode when other display actions have been completed or have timed-out.

TIP While the meter is communicating, the annunciators are off and the LCD displays BUSY.

3.2.1.3 Alternate Mode

The Alternate Display Mode is used to display information for the meter technician that is not contained in the Normal Display. Alternate mode display items are selected during program development using MeterMate software.

The Alternate display mode is invoked by magnetically activating the Display Switch. After completing one scroll of the alternate display items the meter returns to the normal display mode.

3.2.1.4 Site Genie Display Mode

The Site Genie display mode will display Service type, phasor information, and the status of the diagnostic counters.

After the Site Genie display mode has been activated, the meter scrolls through the Site Genie information. The following display controls are available in Site Genie mode:

- *Initiate Site Genie Display* - A 6-second hold of the magnet by the display switch changes the mode to Site Genie display mode
- *Change to test mode* – Push T (test) button for 1 second.
- *Repeat Site Genie scroll* – Keep magnet at display switch.
- *Revert to normal display mode* – Remove magnet from display switch. At the end of the Site Genie scroll, the meter reverts back to normal mode.

3.2.1.5 Test Mode Display Controls

The following display controls are available in test mode:

- *Activate test mode*—A 1-second push of the T (test) button causes the meter to change to the test mode.
- *Advance the display one item at a time*—Momentarily place a magnet at the display switch.
- *Display all segments and reset test accumulators*—Push the R (demand reset) switch. This action does not affect billing data.
- *Change to normal mode scrolling*— A 1-second push of the T (test) switch.

3.2.1.6 Frozen Error and Caution Displays

If an error, caution, or diagnostic is programmed to freeze the display, the meter will constantly display the error, caution or diagnostic. The display controls functions available are:

- **Display Switch**—Use a magnet to activate the display switch. The meter will perform one normal scroll and then return to the frozen display.
- **Reset Switch**—A momentary push of the reset button causes the meter to display all segments. The meter then performs a demand reset.
- **Test Switch**—A 1 second push of the test button changes the display to test mode.

13. When displayed, this arrow indicates energy is being delivered to the load.
14. When displayed, this arrow indicates VARh are leading.
15. When displayed, this arrow indicates VARh are lagging.
16. The four blocks are a disk analog and are used to display energy flow. Each complete cycle indicates K_t Watthours.
17. When displayed, this arrow indicates energy is being received from the load.
18. – 21. The letters A through D indicate the time-of-use (TOU) rate that is in effect. Only one letter is displayed at a time when operating in a TOU Mode.

3.2.3 Display Examples

The following three figures show examples of possible kV Meter displays.

3.2.3.1 kWh Display

Figure 3-7. kWh Display shows the following conditions.

1. The Display Label is "01".
2. Five digit display of energy (kWh).
3. All phases (A, B, C) are present and voltage is at expected levels.
4. End of demand interval indication. This indicator is lit at the end of each demand subinterval.
5. Displayed quantity is measured in kilowatthours.
6. Energy is being delivered to the load.
7. Moving block shows and rate and direction (forward to the right and reverse to the left) of energy flow (Disk analog).
8. Quadergy (kVARh) is lagging.
9. Time-of-use rate B is in effect.

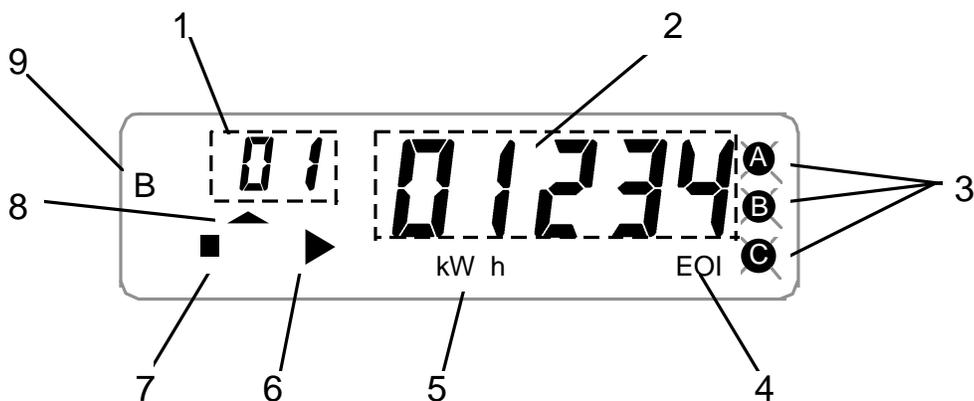


Figure 3-7. kWh Display

3.2.3.2 Alternate Display Mode

Figure 3-8. Alternate Mode Display shows the following conditions.

1. Meter is in alternate display mode.
2. Display label "108" is displayed
3. Six digit previous billing period or season kvarh
4. Phase B voltage is not expected.
5. Displayed quantity is measured in kVARh.
6. Meter is displaying previous billing period or season data.
7. Quadergy (kVARh) is leading.
8. Moving block shows rate and direction (forward to the right and reverse to the left) of energy flow (disk analog).
9. Energy is being received from the load.
10. Time-of-use metering rate A is in effect.

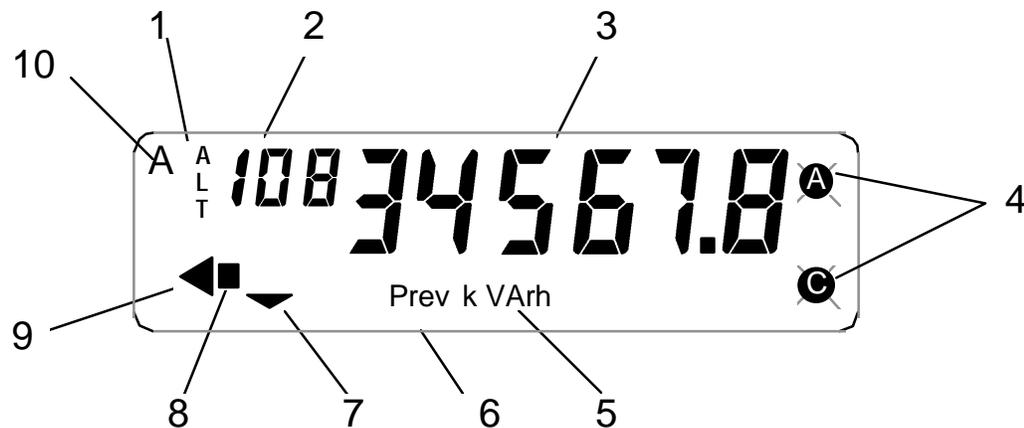


Figure 3-8. Alternate Mode Display

3.2.3.3 Test Mode Display

Figure 3-9. Test Mode Display shows the following conditions:

1. Meter is in TEST mode.
2. Display label is "905".
3. Meter display is a six digit energy display (Wh) with one digit to the right of the decimal point.
4. A and B phase voltages are present. When a voltage indicator is blinking (C in the figure), it indicates that voltage is low or missing.
5. Meter display is in Watthours.
6. Energy is being delivered to the load.
7. Moving block shows rate and direction (forward to the right and reverse to the left) of energy flow (disk analog).
8. Time-of-use metering rate D is in effect.
9. Quadergy (kVARh) is lagging.

Figure 3-9. Test Mode Display



3.3 Site Genie Monitoring System

The Site Genie Monitor checks the installation, monitors the service after installation, and displays information to alert and diagnose problems.

At power-up, the kV meter automatically determines the metered service by examining the phase voltages and the phase angles between the voltages. Each determination takes approximately 5 seconds. The meter must obtain the same service result from three consecutive tests before selecting the service.

Tip *The service type must be one that can be metered by this meter form for the meter to call it a valid service type. For example, a 36S meter will not consider a four wire delta service a valid service because it is not capable of metering that service. See for valid service types.*

After the service is determined, it becomes part of the Site Genie display scroll. If the meter does not get three consecutive service results during the first 12 attempts (approximately one minute of operation), a service error diagnostic is added to the Site Genie scroll.

The Site Genie Monitoring System automatically identifies the metered service after every power outage. Table 3.1 shows the allowed services for each switchboard meter form.

3.3.1 Service Display

As soon as the Site Genie System determines the service, the metered service can be displayed.

Tip *If the meter has not yet determined the service type, it will display “in progress” (InPrOg). If the service type display has not been added to the display scrolls, a service error at installation is seen in the Site Genie Display scroll only. If the meter cannot determine the service type, diagnostic errors are disabled.*

Table 3-2 lists the meter’s service displays.

Any attempt to read the service from the meter before the Site Genie Monitor has determined the service causes **InPrOg** to be displayed. A service display for a 4-wire Wye service is shown.

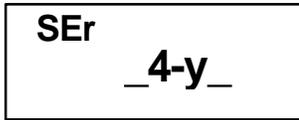


Figure 3-10. Typical Service Display

Table 3-1. Expected Service Types

If the service type display has not been added to the display scrolls, a service error at installation is seen in the Site Genie Display scroll only. If the meter cannot determine the

Meter Form	Meter Elements	Service	Symmetrical Service	Blondel Solution
3Z	1	1 phase, 2 wire		Yes
9Z	3	3 phase, 4 wire (Wye)	Yes	Yes
		3 phase, 4 wire (Delta)	No	Yes
36Z	2½	3 phase, 4 wire (Wye)	Yes	No
45Z	2	3 phase, 3 wire (Delta)	Yes	Yes
		2 phase, 5 wire	Yes	No
		3 phase, 4 wire (Wye)	No	No
		3 phase, 4 wire (Delta)	No	No
		1 phase, 3 wire	Yes	Yes

service type, diagnostic errors are disabled.

Table 3-2. Service Displays

Display	Electrical Service
_2-1PH	Single phase, 2 wire
_3-1PH	Single phase, 3 wire
3-d	Polyphase, 3 wire(delta)
4-d	Polyphase, 4 wire(delta)
4-y	Polyphase, 4 wire(Wye)
3-n	Network
InPrOg	In Progress
SEr_Er	Service Error

A service error display, shown in Figure 3-10 indicates that the meter did not find a stable set of phase voltages that matched any of expected voltage set for that meter form. A review of the Site Genie Monitor display of phasor information should explain why the service error occurred.



Figure 3-11. Service Error Display

WARNING *Before leaving the installation, always verify that the service identified by the meter is the type of service desired and that a service error has not occurred. It is possible for the wired service to be an allowed service for that meter form but not the intended service type.*

3.3.2 Display of Phasor Information

The Site Genie Monitoring System displays all circuit information used by the kV Meter for individual phase measurements and to determine service type. This information is also the source of the diagnostic displays and counters. The information in the Site Genie display scroll can be used to determine why an installation error or diagnostic error has occurred.

The 25 displays that make up the Site Genie display scroll can be grouped as follows:

- Service type
- Voltage phase angles, A, B, C
- Voltages, A, B, C
- Current phase angles A, B, C
- Currents, A, B, C
- Distortion Power Factor
- Diagnostic counters 1 – 8

3.3.2.1 Starting the Site Genie Display Scroll

The Site Genie display scroll is started by holding a magnet to the right of the alternate display switch indicator on the bezel of the meter. Holding the magnet to the bezel for 3 seconds causes the meter to enter the alternate display mode. Holding the magnet to the bezel for 6 seconds causes the meter to enter the Site Genie display scroll. See Figure 3-2 for a diagram of the task.

3.3.2.2 Site Genie Display Scroll

Table 3-3 lists the items displayed in the Site Genie display scroll. The table shows the order of the displayed items and the label used with each display. Table 3-4 lists the displayed service labels.

Table 3-3. Site Genie Monitoring System Display Scroll

Label	Value
SER	Service Label
PhA	Voltage Angle A
PhA	Voltage Magnitude A
PhA	Current Angle Phase A
PhA	Current Magnitude Phase A
PhB	Voltage Angle Phase B
PhB	Voltage Magnitude Phase B
PhB	Current Angle Phase B
PhB	Current Magnitude Phase B
PhC	Voltage Angle Phase C
PhC	Voltage Magnitude Phase C
PhC	Current Angle Phase C
PhC	Current Magnitude Phase C
dPF	Distortion Power Factor
d1_	Diagnostic Counter 1
d2_	Diagnostic Counter 2
d3_	Diagnostic Counter 3
d4_	Diagnostic Counter 4
d5_	Diagnostic Counter 5
d5A	Diagnostic Counter 5 Phase A
d5B	Diagnostic Counter 5 Phase B
d5C	Diagnostic Counter 5 Phase C
d6_	Diagnostic Counter 6
d7_	Diagnostic Counter 7
d8_	Diagnostic Counter 8

3.3.2.3 Phase Voltage and Current Conventions

The per-phase information displayed by the Site Genie Monitor is referenced to the internal voltage and current sensors of the meter. The meter defines each phase in terms of meter elements.

3.3.2.3.1 Phase Notation

Table 3-4. kV Meter Phase Notation shows the convention used by the Site Genie Monitoring System and within this book to describe service phases and meter elements.

Table 3-4. kV Meter Phase Notation

Display Label	Defined Phase	Meter Element
PhA	Phase A	Left-hand element
PhB	Phase B	Center element
PhC	Phase C	Right-hand element

Figure shows two typical examples of how the phase labeling convention is used. The drawings assume that you are looking at the back of the meter case: schematic on the left and pictorial diagram on the right.

9Z Back View

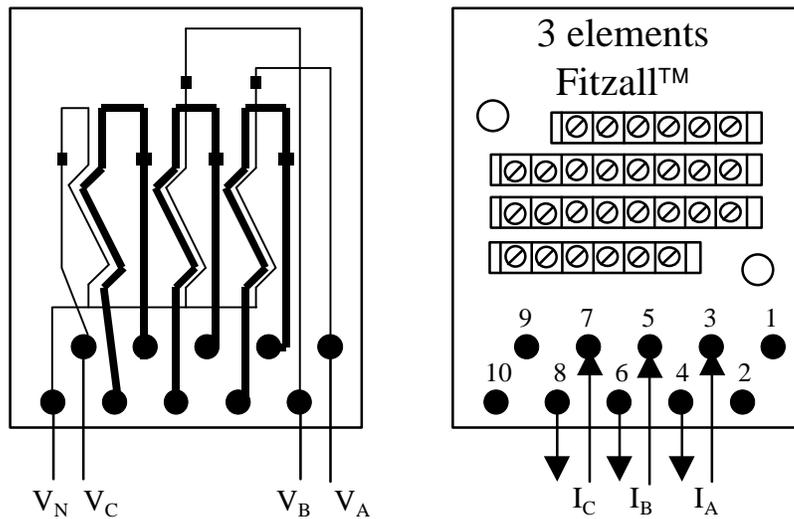


Figure 3-12. Phase Notation

3.3.2.3.2 Angle and Rotation Conventions

The location of the Phase A voltage is the reference for angular measurements. All angles are measured as lagging from the Phase A voltage. Unless shown otherwise, phase rotation is counterclockwise. Therefore, positive angles measure the amount of lag from the Phase A voltage. Figure illustrates these conventions.

TIP

The Site Genie Monitor uses the A phase voltage as a reference point. Therefore, the A phase voltage angle is always 0.0 degrees.

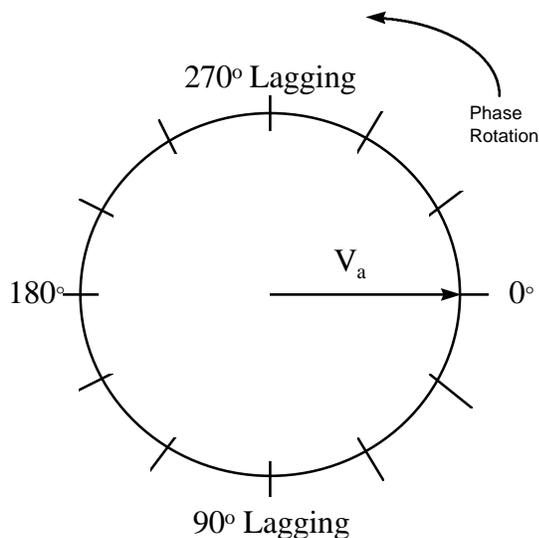


Figure 3-13. Phase Angle Conventions

3.3.2.4 Phase Voltage and Current Displays

Figure shows typical Site Genie Phasor information for a 9Z form meter, on a 3 phase 4 wire Y installation as it appears on the display of a kV Meter.

	Phase A, Left Element	Phase B, Center Element	Phase C Right Element
Voltage Phase Angle	PhA 0.0° V	Phb 121.2° V	PhC 240.1° V
Phase Voltage	PhA 120.8 V	Phb 120.1 V	PhC 121.2 V
Current Phase Angle	PhA 9.8° A	Phb 126.0° A	PhC 243.8° A
Phase Current	PhA 36.7 A	Phb 42.2 A	PhC 29.2 A

Figure 3-14. Phasor Display Examples

The phasor information is most easily analyzed by plotting on a phasor diagram. Comparing the actual phasor diagram with the expected diagram for the service shows phase

sequence and the sources of service wiring errors. Typical errors, such as polarity errors on transformers or mismatching currents and voltages, are easily diagnosed using the phasor diagram.

Phase sequence is determined by rotating the phasors counterclockwise and observing the order they would rotate through zero. In Figure , if the phasors are stationary, A is at zero. Rotating E_{NB} and E_{NC} counterclockwise, phase B next moves through zero followed by C. This indicates ABC phase sequence.

TIP For CBA sequence, A is at zero, but when the phasors are rotated counterclockwise, A is followed by C and then B. (Cs and Bs would be swapped from diagram below.)

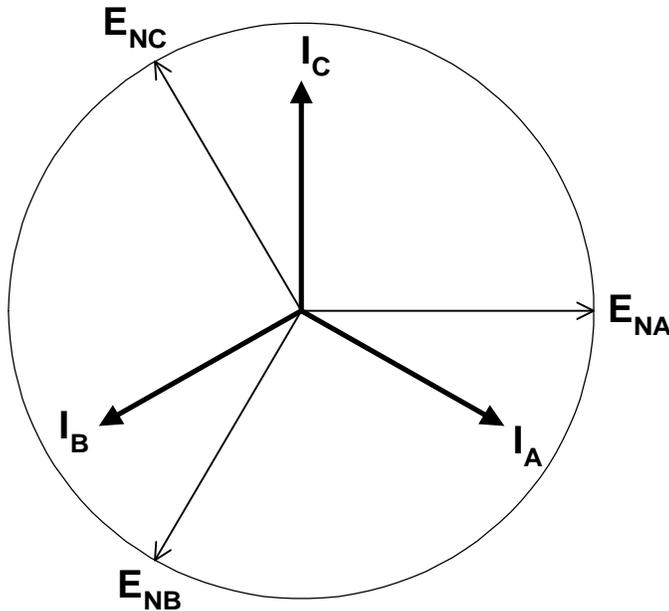


Figure 3-15. Phasor Diagram

Looking at the Figure , we can make the following observations about the circuit and installation:

- All phase currents are lagging.
- Phase voltage, current magnitudes, and angles are as expected for a Wye installation. Therefore, there appears to be no wiring errors.

3.3.3 Diagnostic Displays

Site Genie diagnostics provide continuous monitoring of the meter installation. They report on, and keep a count of, unexpected operating conditions (unless inhibited in the meter's program). Diagnostic checks are performed every five seconds. If a diagnostic check fails, the diagnostic display is added to the normal display scroll and the counter in the Site Genie scroll is increased. Refer to Table 3-5 for a list of diagnostic displays and the meaning of the display.

Table 3-5. Site Genie Diagnostics

Diagnostic Test	Display
Polarity, Cross-Phase & Energy Flow Phasors must agree with service type.	dIAg 1
Voltage Imbalance (%) Phase voltages must maintain acceptable agreement.	dIAg 2
Inactive Phase Current (current less than limit) All phase currents must be active or inactive.	dIAg 3
Imbalance (degrees) Phase angles between phase voltages and currents must not exceed limit.	dIAg 4
Distortion (Total and per phase) (max. %) Max limit for distortion power factor.	dIAg 5,A,B,C
Under voltage (1 Second) (% below nominal)	dIAg 6
Over voltage (1 second) (% above nominal)	dIAg 7
High Neutral Current (current greater than limit)	dIAg 8

MeterMate software provides several options for handling diagnostic errors. Each diagnostic may be enabled or disabled. If the diagnostic is enabled, then it may be added to the normal display scroll or suppressed. When added to the display scroll, the diagnostic may or may not freeze the display. Freezing the display depends on what options have been selected in the program.

3.3.3.1 Diagnostic Limits

The limits for the diagnostic tests are set as part of the meter program. Specific voltage levels and services need not be set in the program. The Site Genie Monitor senses the service type and voltage. Diagnostic limits are set as variances (usually in percentages) from the nominal values.

TIP *Diagnostic tests are disabled during series testing and test mode operation. This is done to allow normal testing of the meter without generating diagnostic displays and counts.*

3.3.3.2 Setting and Clearing of Diagnostics

Diagnostic conditions are checked every 5 seconds except for over- and under- voltage diagnostics which are checked every second. Three consecutive out-of-limits conditions must occur before a diagnostic condition is set in the meter. After the diagnostic condition is set, the meter displays the diagnostic and increments the diagnostic counter. The diagnostic is not armed again until two consecutive tests indicate conditions are within limits. The diagnostic is not cleared from the display until a demand reset is performed.

The range for the counters is from 0 to 255. After 255 is reached, the counter rolls back to zero when the next diagnostic is set. Diagnostic counters may be reset using the Master Reset command in MeterMate DOS (answer *NO* to the first prompt, respond appropriately to subsequent prompts).

Extended diagnostic conditions are counted only once. For example, at an industrial plant, the voltage drops below limits at 8 a.m. and stays low until 3 p.m.. Later the voltage goes above limit from 7 p.m. until 6 a.m.. Only one overvoltage and one undervoltage diagnostic count is recorded.

3.3.3.3 Problem Detection

Table 3-6 lists the typical problems detected by each of the diagnostic tests. A detailed description of each test follows immediately after the table.

Table 3-6. Problem Detection with Diagnostic Tests

Test	Test Description	Typical Problems Detected
1	Polarity, Cross-phase, and Energy Flow Check	<ul style="list-style-type: none"> • Cross-phasing of a voltage or current circuit • Incorrect polarity of voltage or current circuit • Reverse energy flow • Wiring error
2	Voltage Imbalance	<ul style="list-style-type: none"> • Loss of a phase voltage • Incorrect voltage transformer ratio • Shorted voltage transformer • Incorrect phase voltage • Wiring error
3	Inactive Phase Current	<ul style="list-style-type: none"> • Open or shorted current transformer • Wiring error • Tampering or current diversion • Shorting bar or by-pass closed in socket
4	Current Imbalance or Displacement	<ul style="list-style-type: none"> • Poor power factor • Imbalanced load
5	Distortion	<ul style="list-style-type: none"> • DC current • Non-linear load created distortion • SCR and TRIAC motor controls • Switching power supplies • Reciprocating pumps
6	Under Voltage	<ul style="list-style-type: none"> • High load • Voltage regulation • High system impedance • Blown fuse
7	Over Voltage	<ul style="list-style-type: none"> • Capacitor banks • Voltage regulation • Blown fuse
8	High Neutral Current	<ul style="list-style-type: none"> • Third harmonic distortion adding in neutral • Switching power supplies in PCs, copiers, fax machines

3.3.3.4 Description of Diagnostic Tests

There are eight diagnostic tests performed by the Site Genie Monitor. Each is described in the following paragraphs.

3.3.3.4.1 Automatically Determined Reference Voltage

The reference voltage used for the under- and overvoltage diagnostics and the voltage annunciators in the display is determined at power-up. This is accomplished by measuring the Phase A voltage and classifying the service as 120V, 240V, 277V Wye, or 480V Delta. The reference voltage may be overridden by programming a reference voltage.

3.3.3.4.2 Diagnostic Test 1 - Polarity, Cross-phase, and Energy flow

This test verifies that all meter elements are sensing the correct voltage and current. This is accomplished by comparing each voltage and current phase angle with the expected

GEH-7271, kV Switchboard Vector Electricity Meter

values. Voltage phase angles must be within plus or minus 10 degrees of expected value and current phase angles must be within ± 90 degrees of the expected values.

3.3.3.4.3 Diagnostic Test 2 - Voltage Imbalance

Test 2 verifies that the B phase voltage magnitude (if present) and the C phase voltage magnitude are within a specified range of the A phase voltage. The expected value depends on the type of service being metered. For example, in a 4-wire Δ service using a form 45Z meter: V_C is expected to be 0.866 times V_A .

TIP *The high and low voltage diagnostics (D6 and D7) monitor movement of the service voltage. D2 monitors voltage imbalance. D2 tells you if phase B and phase C are following changes in phase A. If V_B or V_C are changing and move more than $T\%$ (T = tolerance) away from the phase A voltage then a Diagnostic 2 alert occurs.*

3.3.3.4.4 Diagnostic Test 3 - Inactive Phase Current

This test verifies that the current of each phase is active. If any phase current falls below this minimum value while the current on another phase is above the minimum value, then a test 3 diagnostic occurs.

This test is intended to catch open current circuits or blown fuses. The limit can be programmed as a value from 0 to test amperes for the meter class ($TA = 2.5A$ for transformer rated meters).

TIP *The minimum operating current for a transformer rated meter is 5 milliAmperes. Any value below 5 mA for a transformer rated meter is considered zero. For dIAG 3 to be active, the limit must be set above the minimum operating current for the meter.*

This test should be used only for situations where continuous polyphase currents are expected. Circuits with only single phase loads may generate diagnostics.

TIP *The smallest current value a kV meter will display is 100 milliAmperes. Currents below this threshold will be displayed as all dashes. Diagnostic limits below the minimum displayed value should be considered approximate.*

3.3.3.4.5 Diagnostic Test 4 Current Phase Angle

Diagnostic 4 is enabled only if diagnostic 1 is enabled. It is checked only if diagnostic 1 passes. Diagnostic 4 is used to apply tighter tolerances on current phase angles than the limits used in diagnostic 1.

This diagnostic verifies that the current phase angles fall within the specified range of the expected value for the service. The range is specified in degrees from the expected locations (plus or minus). The user-programmed range for this test is 0 degrees to 90 degrees in increments of 1 degree.

If the measured current is less than 0.5 percent of class, the phase current displays appear as dashes, Diagnostic Test 4 is disabled.

3.3.3.4.6 Diagnostic Test 5 Total, A, B, C - Distortion

This test identifies loads that generate excessive distortion or DC currents. This diagnostic is done in total and separately on each metered phase. Four diagnostic counters and displays are used with this test. Performing this test on each phase sensitizes the test to single-phase distortion sources and allows the user to more easily identify the distortion source.

The Distortion Power Factor (DPF) is used as the indicator in this test. Distortion Power Factor is very good at identifying distortion sources and avoids penalizing others because distortion power is usually a result of non-linear loads. Linear loads typically do not have any distortion power even when harmonics are present.

Distortion Power Factor is the ratio of distortion power to apparent power. Distortion Power Factor tells us how much of the apparent power is explained by distortion power. *Active Power Factor (PF) plus Reactive Power Factor (RF) and Distortion Power Factor (DPF) completely explain apparent power. Because these power factors are vector quantities, they add as shown in Equation 3-1.*

$$\sqrt{PF^2 + RF^2 + DPF^2} = 1$$

Equation 3-1. Power factor Relationships

This is true because of the way the power vectors are defined. By definition, the square of apparent power is equal to the sum of the squares of active power, reactive power, and distortion power as shown in Equation 3-2. In the equation, U = Apparent Power, P = Active Power, Q = Reactive Power and D = Distortion Power.

$$U^2 \equiv P^2 + Q^2 + D^2$$

Equation 3-2. Apparent Power Definition

This test is active only when the kW demand for the last momentary interval is greater than a user-programmed limit (the same limit is used for power factor checks). The limits for this test can be programmed as any Distortion Power Factor value from 0 to 100 percent in 1 percent increments. Typically, the limit used for this test is the same limit used by your power quality group for current THD. Typical limits are between 15 and 30 percent. Distortion Power Factor usually closely follows current THD through the usable part of current THD's range (5% to 80%). This is because current distortion is usually much larger than voltage distortion and overwhelms out the effects of voltage distortion.

3.3.3.4.7 Diagnostic Test 6 - Undervoltage Test

The undervoltage and overvoltage diagnostics use phase A voltage as their reference. A Diagnostic is generated if the phase A voltage falls to a value less than the nominal voltage for the service minus the programmed voltage tolerance. The under voltage tolerance is programmed in a range from 0 to 100 percent in steps of 1 percent.

Undervoltage and overvoltage tests are performed every second. An undervoltage or overvoltage condition must exist for at least 3 seconds for a diagnostic to be generated. The diagnostic is set until the phase A voltage comes back within limits for at least 2 seconds. However, the diagnostic remains in the display until a demand rest occurs.

3.3.3.4.8 Diagnostic Test 7 - Overvoltage Test

The undervoltage and overvoltage diagnostics use the phase A voltage as their reference. A diagnostic is generated if the phase A voltage rises to a value greater than the nominal voltage for the service plus the programmed voltage tolerance. The overvoltage tolerance is programmed in a range from 0 to 100 percent in steps of 1 percent.

Undervoltage and overvoltage tests are performed every second. An undervoltage or overvoltage condition must exist for at least 3 seconds for a diagnostic to be generated. The diagnostic is set until the phase A voltage comes back within limits for at least 2 seconds. However, the diagnostic remains in the display until a demand rest occurs.

3.3.3.4.9 Diagnostic Test 8 - High Imputed Neutral Current

This diagnostic verifies that the imputed neutral current is below a user programmed limit. The kV meter does not measure the actual neutral current. It calculates what the neutral current should be from the measured currents.

TIP *Triplen currents add in the neutral. The triplens are the harmonics that are simply multiples of three times the fundamental. The third, sixth, and ninth harmonics are examples of triplens. For example, if there are large third harmonic currents in the phases, the neutral current can be higher than the individual phase currents.*

TIP *It is often difficult to verify neutral current magnitude because the neutral wire may not be brought to the meter or the socket and measuring in any one wire may not measure total neutral current if faults are present.*

3.3.3.5 Diagnostic Output

The Site Genie diagnostic can also be used to control a switch on a meter's I/O board. All diagnostic are supported and drive a single solid- state relay (SSR) on the I/O board. This output may be a Form A or Form C output. (See the I/O board specifications for ratings.)

MeterMate programming software allows the user to select which diagnostic will generate a closure of the SSR. Any or all of the diagnostics can be selected to activate the SSR. If any of the selected diagnostic conditions occur, the SSR is activated.

TIP *This output can be tied to an event recorder or other similar devices to determine the actual time when diagnostics occur.*

3.4 Event Log

A 200 entry event log is available in kV meters with firmware version 4.0, or greater, and the event log upgrade enabled. The meter will record events in all operating modes (Demand, Demand with Load Profile, and TOU). The most recent 200 events are kept.

The kV meter records two categories of events: Standard Events and Manufacturer Defined Events. Standard Events are those defined in ANSI C12.19, UTILITY INDUSTRY END DEVICE DATA TABLES; Manufacturer Defined Events are those defined by GE.

The following Standard Events are recorded by the kV meter:

Code	Event	Argument
01	Primary Power Down	None
02	Primary Power Up	None
07	End Device Accessed for Read	None
08	End Device Accessed for Write	None
11	End Device Programmed	None
20	Demand Reset Occurred	None

The following Manufacturer Defined Events may be recorded by the kV meter:

Code	Event	Argument
00	Diagnostic 1 - Polarity, Cross Phase, Reverse Energy Flow	Angle out of tolerance (phase B or C voltage, phase A, B, or C current)
01	Diagnostic 1 Condition Cleared	none
02	Diagnostic 2 - Voltage Imbalance	Voltage out of tolerance (phase B or C)
03	Diagnostic 2 - Cleared	none
04	Diagnostic 3 - Inactive Phase Current	Current out of tolerance (phase A, B, or C)
05	Diagnostic 3 Condition Cleared	none
06	Diagnostic 4 - Phase Angle Alert	Angle out of tolerance (phase A, B, or C current)
07	Diagnostic 4 Condition Cleared	none
08	Diagnostic 5 - High Distortion	Phase with high distortion (phase A, B, C, or total)
09	Diagnostic 5 - Cleared	none
10	Diagnostic 6 - Under Voltage, Phase A	none
11	Diagnostic 6 Condition Cleared	none
12	Diagnostic 7 - Over Voltage, Phase A	none
13	Diagnostic 7 Condition Cleared	none
14	Diagnostic 8 - High Neutral Current	none
15	Diagnostic 8 - Cleared	none
16	Caution 000400 - Under Voltage	Voltage out of tolerance (phase A, B, or C)
17	Caution 000400 Condition Cleared	none
18	Caution 004000 - Demand Overload	none
19	Caution 004000 Condition Cleared (see note below)	none
20	Caution 400000 - Received kWh	none
21	Caution 400000 Condition Cleared (see note below)	none
22	Caution 040000 - Leading kVArh	none
23	Caution 040000 Condition Cleared (see note below)	none
24	Real Time Pricing Activation	none
25	Real Time Pricing Deactivation	none
26	Test Mode Activation	none
27	Test Mode Deactivation	none
28	Calibration Mode Activated	none
29	Self Read Performed	none

Note: The Demand Overload, Leading kVArh, and Received kWh cautions remain set in the meter until cleared by a manual demand reset or a PSEM command. However, when the condition that causes the caution ceases, that will be recorded in the event logger.

Manufacturer Defined Events 24 - 29, and all of the Standard Events, are always recorded. The remaining manufacturer defined events are logged if the corresponding caution or diagnostic is enabled.

In addition to the event number and the argument (where applicable), the meter records the date and time when the event occurred (TOU & Demand LP meters only) and an ID (defined below).

The ID recorded with each event has the following meaning:

- 0 - event was initiated by the device (e.g. high distortion current detected)
- 1 - event was manually initiated (e.g. demand reset by a button press)
- 2 - 65,535 - ID number sent with the logon request that started the communication session during which the event was generated (e.g. end device programmed)

The event log may be read with MeterMate versions 1.30 and later. A master reset will not clear the event log.

3.5 Power Guard System

The Power Guard System adds power quality measurement to the kV Meter features by extending the capabilities of the Site Genie Monitor. The Power Guard System adds the following power quality measurements and alerts to the kV Meter:

- Average power factor (enabled with K switch)
- Cumulative measurement of:
 - * Distortion kiloVolt-Ampere-hours
 - * Number of outages
 - * Power outage duration (with TOU recording)
 - * Date and time of last power outage (with TOU or recording)
 - * High demand alert
- Instantaneous measurements of:
 - * Active power
 - * Distortion power factor
 - * Power factor (enabled with K switch)
 - * Reactive power (enabled with K switch)
 - * Low power factor alert (enabled with K switch)

Power Guard also makes the following Site Genie power quality measurements available in the normal and alternate mode display scrolls. (See the Site Genie Monitor section for a detailed description of these features.)

- Distortion measurement, alert, counter and output
- High neutral current alert, counter and output
- Per-phase voltage
- Per-phase current
- voltage and current phase angles

3.5.1 Distortion Measurement

The kV is the first meter to measure IEEE defined 3D vector apparent power. Other meters measure 2D phasor power or the scalar quantity arithmetic apparent power.

The ability of the kV meter to measure distortion power (D) and the integral of distortion power, Distortion kiloVolt-Ampere-hours, make it the first meter to directly measure the third dimension of power. This approach allows direct measurement of the three components of *cost of service*, active power, reactive power, and distortion.

TIP Normally meters that measure the scalar quantity arithmetic apparent power forget to add the qualifier “arithmetic” that would warn you that the vector quantity apparent power is being added arithmetically not vectorially. Before the kV meter, GE electronic meters measured the two dimensional quantity phasor power. Phasor power is the vector sum of active power (P) and reactive power (Q).

The components of 3-dimensional vector apparent power are active power (P), reactive power (Q), and distortion power (D). These three quadrature components are added vectorially to obtain apparent power. The kV Meter calculates distortion power using Equation 3-3.

$$D = \sqrt{U^2 - (P^2 + Q^2)}$$

Equation 3-3. Distortion Power

In Equation 3-3:

- U is product of RMS voltage and current, EI .
- P is the product of instantaneous voltage and current, vi .
- Q is voltage, shifted -90 degrees at all frequencies, and current product.

3.5.2 Low Power Factor Alert

The low power factor alert is used to signal a customer or control equipment of undesirable low power factor conditions.

The power factor alert is an output that can be programmed to become active if the power factor drops below a programmed limit and the kW demand is above a programmed threshold. Every 5 seconds, the instantaneous power factor and kW demand are calculated and compared to the limits. If the conditions described above are met in three consecutive tests, the alert is set. If the alert is set and the diagnostic conditions are not met in two consecutive tests, the alert is cleared.

In TOU meters, this output can be programmed to occur at any time or only during a specific TOU rate.

The power factor alert uses the Form A solid-state relay on the I/O option board for its output (see specifications of the I/O board for rating information).

3.5.3 High Demand Alert

The high demand alert is used to alert a user or control equipment about excessively high current or demand conditions.

The output is activated when the demand exceeds the programmed limit. The output is activated as long as the indication from the demand calculation is set, provided the output is enabled.

The high demand alert uses the Form A solid-state relay on the I/O option board for its output (see specifications of the I/O board for rating information).

3.5.4 Average Power Factor

The kV Meter calculates the average power factor since the last demand reset. In a TOU meter, the user can select whether the calculation is done for all time periods or only during one TOU period (A, B, C, D). The meter also calculates a power factor for the power factor alert and instantaneous power factor display.

Power factors are available after the K switch has been enabled. Power factors are read and displayed as zeros until this upgrade is performed.

Average power factor is calculated by dividing the net kWh by the kVAh. If kVAh is calculated using Phasor power methodology, electronic detenting (selected via programming) may affect this calculation. Both values, net kWh and kVAh, must be the value since last demand reset. The average power factor will have a value between -1.00 and 1.00. The sign is determined by the sign of the net kWh.

Average power factor is a *display only* value. A reading device must read the average power factor accumulators (kWh and kVAh) to obtain the average power factor.

3.5.5 Instantaneous Measurements

When the term *instantaneous* is used in this section and throughout this document, it refers to the momentary interval during which data is accumulated by the digital signal processor before it is transmitted to the meter. In the kV meter the momentary interval is 60 cycles of the fundamental voltage signal for 60 Hz services, 50 cycles for 50 Hz services.

The following instantaneous measurements are available in the normal or alternate display scrolls:

- Active power
- Distortion power factor
- Power factor
- Reactive power
- IRMS per phase
- VRMS per phase

TIP *The reactive power and power factor displays usually are all zeros unless the K switch is activated.*

3.5.6 Cumulative Measurements

The following cumulative displays may be added to the normal or alternate display scrolls:

- Distortion kiloVolt-Ampere-hours
- Number of outages
- Power outage duration (with TOU or recording)

3.5.6.1 Distortion KiloVolt-Ampere-hours

The distortion kiloVolt-Ampere-hours measurement is the accumulation of distortion power over time just as kWh is accumulation of active power (kW) with time. It provides a time-based measurement of distortion. This allows you to determine if high-distortion power factor measurements are brief and sporadic or if a significant level of distortion is occurring.

NOTE *Little accumulation of distortion kiloVolt-Ampere-hours is expected. Any significant accumulation of this value indicates a continuing and significant level of load-created distortion.*

3.5.6.2 Power Outage Duration (TOU or Recording modes only)

The kV Meter measures duration of power outages. A power outage is any loss of voltage that causes the kV Meter to go into power-down mode.

The total cumulative power outages, length of all power outages, is maintained. The accumulated battery carryover time to the nearest second is available for reading. The maximum display value is 999,999, after which it is set back to zero.

TIP: *If a battery failure occurs during a power outage, and the meter is operating as a TOU meter or recorder, the date and time of the outage is saved and the current meter time will be the time that the meter has operated since the last outage occurred.*

3.5.6.3 Number of Outages

A record of the total number of power outages is maintained in nonvolatile memory, the range is 0 to 65535. This value rolls back to zero on overflow.

3.5.6.4 Last Power Outage

If the meter is operating as a TOU meter or load profile recording demand meter, the date and time of the last power outage is maintained in nonvolatile memory.

3.6 Errors and Cautions

The GE kV Meter continually tests itself for internal errors, hardware failures, and cautions. These events are reported in coded form on the liquid crystal display. Error and caution codes are listed in Chapter 4.

3.6.1 Error Reporting

Error detection is permanently enabled and error codes are displayed as soon as errors are detected. You can program the meter to freeze error codes in the display when an error is detected. Refer to the Troubleshooting Guide section of Chapter 4 for a list of errors.

Self-test errors are serious events and usually indicate a condition has occurred that may have compromised the meter data. Unless GE has issued a service advisory indicating that other actions should be taken, *you should remove the meter from service and contact your GE sales representative.* The only exception to this rule is the error display Er 000 002. **Do not return meters displaying Er 000 002.**

The Er 000 002 display indicates that the meter lost time because of a weak or defective battery. The battery power was inadequate to maintain time during a power outage. Replace the battery and reprogram the meter to eliminate the problem.

TIP: *When the meter is read through the OPTOCOM port, error and caution conditions are returned with the meter data regardless of what display options are chosen in the meter program.*

3.6.2 Caution Reporting

Cautions identify meter conditions of concern but are not a problem with the meter itself. You may enable or disable each caution code and program it to be displayed or not. You can program the meter to freeze the caution code in the display when a caution is detected.

Low battery and unprogrammed cautions are used to remind the user of actions that are required. Any meter with a low battery caution may lose time if the battery is not replaced before the next power outage.

Other caution codes report unusual operation such as receiving energy from the load, leading power factor, very high current flow, or low voltage. Refer to the Troubleshooting Guide section of Chapter 4.

TIP: When multiples errors or cautions occur they are combined . For example, CA040400 indicates leading quadergy low potential.

4. Maintenance Instructions

WARNING: The information contained within this document is intended to be an aid to qualified metering personnel. It is not intended to replace the extensive training necessary to install or remove meters from service. Any work on or near energized meters, meter sockets, or other metering equipment presents the danger of electrical shock. All work on these products must be performed by qualified industrial electricians and metering specialists only. All work must be done in accordance with local utility safety practices and the procedures outlined in the current edition of the Handbook for Electricity Metering. The handbook is available from the Edison Electric Institute, 701 Pennsylvania Avenue N.W., Washington D.C. 20004-2696.

4.1 Recommended Procedures

The procedures described on the following pages are those recommended by the General Electric Company. Any procedures not described herein or referenced herein are not recommended.

4.1.1 Meter Testing Tools

The meter is equipped with a light-emitting diode (LED) for calibration and a liquid crystal display with disk analog and test displays. The calibration LED is part of the OPTOCOM port as shown in Figure 4-1.

4.1.1.1 Calibration LED

The OPTOCOM LED emits calibration pulses until the meter detects the presence of OPTOCOM communications. This LED is the source of Watthour and VARhour calibration pulses. Each calibration pulse is equal to the value assigned to K_t (Watthours or VARhours).

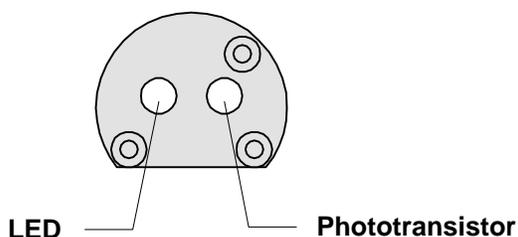


Figure 4-1. OPTOCOM Port

The default unit for the calibration pulses is Watthours. The meter may be switched to VARh calibration pulses using MeterMate version 1.2 software.

4.1.1.2 LCD Display

The *meter* display has annunciators for quadrant, phase voltage, and energy flow indication as shown Figure . The annunciators provide valuable information during the testing process.

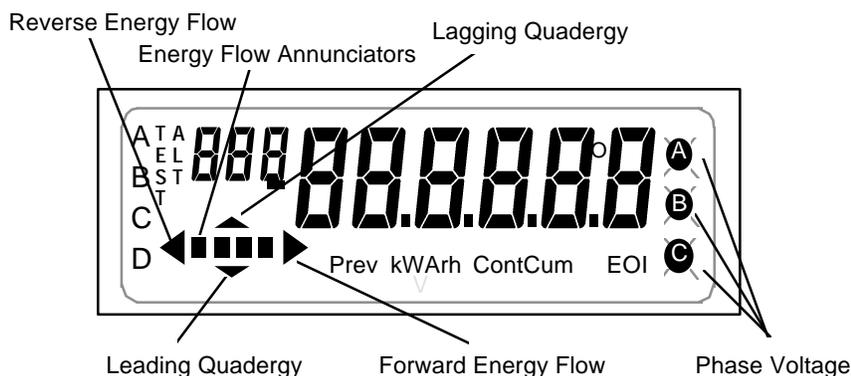


Figure 4-2. Liquid Crystal Display

Quadrant annunciators—The left and right arrows indicate reverse and forward energy flow, respectively. An up arrow indicates lagging quadergy, and a down arrow indicates leading quadergy. These arrows can be used to determine the quadrant in which the meter is currently operating.

Phase voltage—Three annunciators labeled A, B, and C are used to indicate the presence of voltage on their respective phases. If the annunciator is not displayed, there is no meter element in that phase or no phase voltage is expected for the metered service. For example, a 2 or 2½ element meter will show only A and C phases. If an expected voltage is low (below the value programmed into the meter [see Diagnostic Test 6 and Diagnostic Test 2]), the phase indicator blinks.

Energy flow annunciators—A series of four display segments are used to indicate the direction and relative quantity of energy flow (Disk analog). As energy flows from the line to the load, the segments will be energized, sequentially, from left to right. Conversely, as energy flows from the load to the line, they will be sequenced from right to left. The rate at which the segments are energized is inversely proportional to K_t . One complete cycle of four segments indicates that K_t Watthours of energy have been measured.

4.2 Test Mode

Test mode allows the meter to be tested without disturbing billing data or setting a new maximum demand. The Test Mode performs the same function as setting the pointers back on an electromechanical meter after testing.

The Test mode may be entered by pressing the test switch for 1 second. The test mode switch is operated by removing the Lexan cover and pushing the test switch (switch marked T on the bezel).

4.2.1 Starting the Test Mode

To enter the test mode: use the test switch on the face of the meter.

Upon entering the test mode, several actions occur:

- The current demand interval is terminated.
- All outputs programmed to be active remain active.
- All test accumulators are set to zero.
- The subinterval countdown timer starts.
- LP recording is suspended, and LP interval status bits reflect test mode was in effect during affected interval.

When the test mode begins, the test annunciator is lit and the first item programmed for display is displayed.

4.2.2 While in Test Mode

The same energy, quadergy, and Volt-Ampere-hour values that are calculated during normal operation are calculated in test mode. However, the data is displayed in Wh, VARh, and VAh rather than kWh, kVARh, and kVAh. Demand values remain in units of kW, kVA, or kVA.

4.2.2.1 Energy Calculations

If the metering constants are not programmed, default values are used. Table contains the default test mode values.

Table 4-1. Default Test Mode Values

Constant	Default Value
Demand decimal position	Same as nontest mode
Demand interval length	15 minutes
Demand subinterval length	5 minutes
Energy display format	Firmware Rev < 4.0, XXXXX.X Firmware Rev >= 4.0, XXX.XXX
Number of demand subintervals	3
Power line frequency	60

The display does not scroll while in test mode. Each item remains displayed until the display switch is activated with a magnet. At that time, the next item in the display program is shown. The quantity displayed is updated every 5 seconds.

The test mode display is fully programmable. Table 4-2 lists the default test mode display items for an unprogrammed meter. Items can be added or deleted using MeterMate software.

Table 4-2. Test Mode Default Display

Display ID	Display Quantity
91	Time remaining in subinterval (MM SS)
92	Momentary interval demand
93	Maximum test kW demand
94	Accumulating Wh
95	Previous interval kW demand

4.2.2.1.1 Displays Available in Test Mode Only

The following display items are available for display only in the test mode:

- Test mode demand maximums for kW, kVAr/ Q-hour demand/ kVA
- Time remaining in test demand interval in block demand only
- Time remaining in test demand subinterval in rolling demand only
- Test mode Wh, VArh/Qh/VAh.
- Test mode accumulating kW, kVAr/kQ/kVA

4.2.2.2 *Test Reset*

A test reset is initiated by pressing the reset switch while in the test mode. A test mode reset causes all test quantities to be reset to zero and a new subinterval to be started. An all-segments display is shown until the reset switch is released. The item displayed when the reset occurred remains in the display, but the value will be initialized.

In the event of a power outage, data on test mode energy, demand, and power factor are not saved. These data are reset when power returns. Upon power up, the meter remains in test mode and the item displayed when the reset occurred remains unchanged. In a TOU meter or demand meter with load profiling, there may be a slight delay before re-entering test mode on power up. During the delay, the meter is performing its catch-up tasks.

4.2.2.3 *Exiting Test Mode*

Test mode is exited in one of two ways:

1. By pressing and holding the test switch for more than 1 second

2. By the test mode time-out timer

All test mode data is lost when test mode is exited. Upon exiting test mode in a meter programmed for rolling demand, a new, possibly partial, subinterval is started. The past subinterval as well as the current subinterval are zeroed. Upon returning to the normal operating mode, a TOU meter or demand meter with load profiling will complete the time remaining in the current partial subinterval such that subsequent subintervals will be synchronized with the midnight boundary. The new subinterval in the demand only mode is the number of minutes that was remaining in the subinterval prior to entering test mode.

For meters that are programmed for thermal emulation, the thermal demand reading is set to zero immediately after test mode is exited.

The meter will automatically exit the Test Mode when the time in the Test Mode Time has exceeded its programmed limit. This Test Mode time limit prevents accidentally leaving the meter in the test mode and losing billing information. The test mode time-out function is programmable from 1 minute to 99 hours.

4.3 Field Test

The test mode allows the meter to be field-tested without disturbing any billing data.

4.3.1 Field Testing With Test Mode

Testing the meter in the field can be accomplished three ways in the test mode by using the:

1. Maximum demand reading in the display
2. Disk analog
3. Instantaneous demand feature of the kV

4.3.2 Maximum Demand Reading Testing

This is the most accurate of the three test methods. For this test, you need a portable standard with a start/stop switch and a phantom load.

1. Make sure that the voltage coils are in parallel and the current coils are in series.
2. Connect the phantom load and the portable standard to the meter to be tested.
3. Apply voltage to the meter and the standard.
4. Put the meter into test mode.
5. Change the display to maximum demand (display ID 93 using the default display items).
6. Switch on the desired current.
7. Check the flow indicator on the meter to make sure that the polarity is correct.
8. Reset the standard.
9. Simultaneously reset the meter and start the standard. The test reset takes effect when switch is released.
10. Turn the current off when the end-of-interval (EOI) annunciator comes on.
11. Compare the meter readings with the standard's readings. EOI comes at the end of every subinterval; numbers won't match before interval is completed and display is updated.

4.4 Disk Analog Testing

The disk analog provides a precise means of checking the calibration of the meter, for certain K_t values. Use K_t values that are divisible, without remainder, by the number for your meter from Table 4-3 .

Table 4-3 Divisor Number

Firmware Revision Number (Item 5, Figure 3-2)		
4.0 or greater		
	57-120V	120-480V
CL 20	0.0008	0.0020

Example : CL 20, 120-480V, Rev 4.0

Will K_t = 1.0 be ok?

$1.0 / .0200 = 50$ with no remainder — *a good choice.*

There are some practical limits to this method of testing. For example, if the load on the meter is very low, the test may take a long time. Conversely, if the load is high, it may be difficult to accurately time the switching of the standard

For this test you need a portable standard with a start/stop switch. Field testing using the disk analog allows you to check the calibration of the meter without having to install a phantom load.

1. Make sure the voltage coils are in parallel and the current coils are in series.
2. Connect the portable standard to the meter.
3. Reset the standard.
4. Observe the disk analog. Each cycle of the disk analog represents K_t Watt hours of accumulation (The K_t value is printed on the meter nameplate).
5. When the first annunciator comes on, start the standard.
6. Let the disk analog scroll through a predetermined number of times (10, for example).
7. Stop the standard when the first annunciator comes on for the tenth time.
8. Calculate the accumulated Watthours as shown in Equation 4-1.

Accumulated Energy = K_t × the number of complete disk analog scrolls

Equation 4-1. Accumulated Watthours Calculation

For example: if K_t equals 3 and 10 complete scrolls were counted, then:

3 Wh x 10 complete scrolls = 30 Wh.

Compare the above reading to the reading on the standard.

4.5 Shop Test

Shop testing consists of verifying the meter's accuracy.

Caution POLYPHASE TESTING

Do not polyphase test kV meters using Wye test conditions at voltages higher than 277 Volts line-to-neutral for 120-480V rating; no higher than 144 Volts for 57-120V rating.

The kV meter is designed to meter conventional services with line-to-neutral voltages up to 277 Volts and line-to-line voltages up to 480 Volts, or 69 Volts and 120 Volts respectively for 57-120V rating. Operation at voltages more than 10% above this rating will lead to shortened life or failure.

For example, polyphase testing of 120-480V rated 9Z, 36Z, or 45Z meters at 480 Volt "Wye" line to neutral conditions will result in voltages in excess of 800 Volts being applied to the meter. Stresses of this magnitude will result in immediate failure of the Revenue Guard Board if it is present or shorten meter life.

4.5.1 Meter Shop Equipment

The meter loading equipment must be capable of maintaining accuracy while supplying energy to the meter's broad range switching power supply. Otherwise, meters may be tested in any shop that meets the requirements outlined in the current editions of the *Handbook for Electricity Metering* published by the Edison Electric Institute and the American National Standard Code for Electricity Metering.

4.5.1.1 Equipment Setup

The meter mounting equipment and its electrical connections must be used as required for the meter form number on the meter nameplate.

4.5.1.2 Testing

The Watthour constant (K_h) of a meter is defined as *Watthours per disk revolution*. Because electronic meters do not rely on disk revolutions to measure energy, K_h is not a meaningful unit of measure in the GE kV Meter. K_h is printed on the meter label as a reference to an equivalent electromechanical meter as required by applicable meter standards. *It has no practical application in the operation of the kV Meter.*

4.5.2 Test Constant

The meter test constant (K_t) is the number of Watthours per calibration pulse. Typically the kV Meter is tested like an electromechanical meter, using a K_t value equal to a standard K_h value as printed on the meter label.

To simplify and speed up testing, you may want to use K_t values different from the traditional K_h values used with electromechanical meters. For example, a K_t of 0.3 for transformer-rated meters would significantly speed up testing and dramatically reduce the number of test constants used. This value, 0.3 is the smallest value that tests the complete operating range of the meter (up to 480V and class load). However, smaller values are possible if you are willing to restrict the test range. The test pulse duration of 25 milliseconds limits the minimum K_t value to a value large enough that the Test LED is not lit continuously at the maximum test load.

NOTE: *Changing the value of K_t does not affect meter readings or measurements. Changing K_t affects only the speed at which test pulses are generated. Smaller K_t values produce more test pulses and reduce test time.*

The wide voltage range capability of the kV meter let's you replace several ratings of traditional electromechanical meters with one 120 Volt to 480 Volt meter. Each of these traditional voltage rating had a separate K_h . This means that we have several choices for K_t when testing a kV meter like a traditional electromechanical meter. The following recommendations should be kept in mind when selecting K_t .

1. . Select the smallest practical K_t . Larger K_t values only slow down testing and do not increase test accuracy or change the test range.
2. . If testing like an electromechanical meter use a K_t that matches the 120 Volt K_h for that meter. The meter can still be tested over the complete voltage range and will test faster than if the 480 Volt K_h is chosen.

Table 4-4 Allowable K_t Range of Values

		Firmware Revision Number (Item 5, Figure 3-2) greater than or equal to 4.0	
		57-120V	120-480V
CL 20		0.15 — 1.6	0.3 — 4.0

Note: The maximum K_t values shown in Table 4-4 should not be exceeded. Exceeding these values may produce testing errors.

4.5.3 Watthour Test Procedure

To test the meter, proceed as follows:

1. Note the meter K_t value listed on the nameplate.
2. Select the desired voltage and current level(s) on the test equipment. (Test voltage of 120V is assumed.)
3. Install the meter in the test socket, making certain that the socket is wired and/or configured for the appropriate meter form.
4. Align the optical pickup of the test equipment with the calibration LED.
5. Begin testing according to standard test procedures. Allow 15 seconds of settling time after applying voltage before making accuracy measurements.
6. Check the meter calibration under three load conditions: full load, light load, and full load with lagging power factor. A minimum test time of 30 seconds is needed to reduce test uncertainty to a level compatible with the accuracy of the kV meter. (Check the instruction book for your test board or standard to determine the actual minimum test time. Standards with heavily filtered inputs may require longer test times.)

4.5.4 VArhour Testing

GE kV meters are digital sampling meters. All quantities are derived mathematically from the same set of voltage and current sampled data used to compute Watthours. Therefore, it is necessary to check Watthour calibration only to ensure that all revenue quantities are accurate. However, some utilities are required by their Public Utilities Commissions to verify the accuracy of VArhour data as well as Watthour data.

GEH-7271, kV Switchboard Vector Electricity Meter

1. Use MeterMate version 1.2, or greater, software to put the meter calibration LED into VARhour pulse output mode.
2. Set up the meter for testing as described above in Watthour Test Procedure. The test pulse value is now K_t VARhours per pulse.
3. Begin testing according to your standard VARhour test procedures. Allow 15 seconds of settling time after applying voltage before making accuracy measurements.

NOTE: Test conditions with high power factors require very long VARh test times. Typically VARh testing is done at 120V and 0.5 PF.

4.6 Service

The GE kV Meter is factory calibrated and requires no routine or scheduled service by the user.

4.7 Repair

Factory repair or replacement service is offered when you cannot fix a problem. Because of the high density and integrated design, the repair of on-board components is not recommended. Instead, return the whole meter to General Electric as described in the following paragraph.

4.8 Returning a Meter

If you wish to return a meter, call the General Electric district sales office for a Return Apparatus Tag. The district sales office will send you the tag. The complete meter should be returned with a description of the problem, the messages displayed at the time of failure, any and all actions taken, and the installation parameters.

The meter should be packed the same as in the original packaging. Return the package with the shipping prepaid to:

**Product Service
Repair and Return Service
General Electric Company
130 Main Street
Somersworth, NH 03878-3194**

4.9 Cleaning

CAUTION *Care must be taken during cleaning not to damage or contaminate any gold-plated contacts of the connectors.*

Any of the meter assemblies may be cleaned by dusting with clean, dry, low-pressure, compressed air. Circuit boards may be cleaned with a soft, lint-free cloth dampened with water or alcohol.

CAUTION *Do not immerse the meter in any liquid.
Do not use abrasive cleaners on the Lexan covers.
Do not use chlorinated hydrocarbon or ketone solvents on the covers.*

4.10 Storage

The kV Meter is a durable device; however, it should be handled and stored with care. The temperature and humidity levels in storage are not critical; but, extremes of either factor should be avoided.

4.11 Troubleshooting Guide

The meter displays two types of code.

- One code begins with CA and is the caution code as shown in Table 4-5.
- The other code begins with Er and is the error code. See Table 4-6 for error codes.
- Problems that do not display any codes are listed in Table 4-7.

Table 4-5. Caution Code Display

Caution Display	Probable Cause	Remedy
CA 000 001	Low battery. Battery failed test.	Replace battery.
CA 000 010	Meter unprogrammed. Using default values.	Program the meter.
CA 000 400	Low potential on indicated phase.	Check circuit voltages.
CA 004 000	Demand overload warning has exceeded programmed threshold.	Check for service overload conditions. Check programming threshold value.
CA 040 000	Leading kVArh warning.	a. Disable the warning. b. Check system operating parameters if leading kVArh is unexpected.
CA 400 000	a. CT polarity is incorrect. b. Energy is flowing from load to line. c. Meter's internal wiring defective	a. Check meter and CT wiring. b. Disable caution. Check system operating parameters if reverse energy flow is unexpected. c. Check that sensor connector is properly seated.

Table 4-6. Error Code Display

Error Display	Probable Cause	Remedy
Er 000 002	Power outage occurred, and: a. Battery disconnected. b. Battery defective.	Reprogram meter, and: a. Connect battery. b. Replace battery.
Er 000 020	Hardware failure.	Replace meter.
Er 000 200	EEPROM checksum error.	Replace meter.
Er 001 000	a. Microprocessor error. b. ROM checksum error.	Replace meter.
Er 010 000	Load profile checksum error due to data memory failure, or internal communication failure.	Replace LP-1 option board.
Er 100 000	A-to-D converter failed status test.	Replace meter.
Er 200 000	DSP configuration failed.	Replace meter.
Er 300 000	Both A/D converter and DSP failed.	Replace meter.

Table 4-7. Fault Symptoms Without Codes

Symptom	Probable Cause	Remedy
High/low demand registration	<ul style="list-style-type: none"> a. Socket wiring error. b. Meter internal wiring defective. c. Defective sensor. 	<ul style="list-style-type: none"> a. Rewire according to applicable diagram. b. Check that voltage and current connectors are coupled. Check the leads for damage. c. Replace meter.
Meter creeps with only voltage or current applied	Defective measurement circuit.	Replace meter.
Meter overheats	Meter is overloaded.	Check current transformer ratios
Meter runs slow	<ul style="list-style-type: none"> a. Wiring error. b. Meter internal wiring defective. c. Defective sensor. 	<ul style="list-style-type: none"> a. Rewire according to applicable diagram. b. Check that voltage and current wiring is connected. Check the leads for damage. c. Replace meter.
No display	<ul style="list-style-type: none"> a. Circuit de-energized. b. Meter internal wiring defective. 	<ul style="list-style-type: none"> a. Check circuit voltages. b. Check that the voltage and current sensors are properly connected. Also check the wires for damage.
Option board malfunctioning	<ul style="list-style-type: none"> a. Option board improperly installed. b. Output cables defective. c. Defective option board. 	<ul style="list-style-type: none"> a. Check option board installation. b. Check output cables for loose or damaged leads. c. Replace option board.

5. Regular Site Analysis Guides

NOTICE:

These site analyses include rudimentary connection diagrams for identification of metering installation. *These diagrams are not metering installation guides.*

Table 5-1 Regular Site Analyses

Site Analyses pages to see **(Blondel solutions are in *bold type*)**

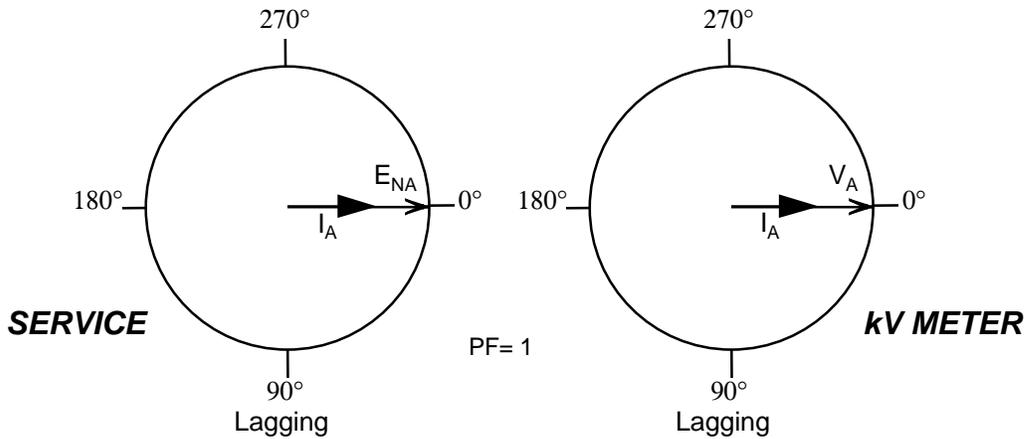
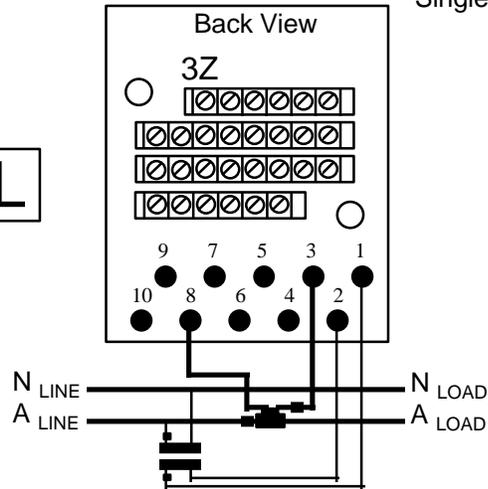
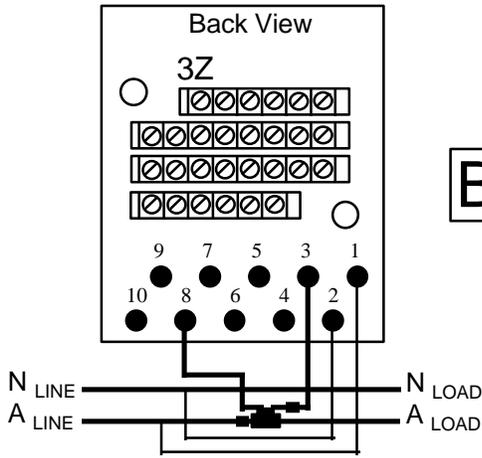
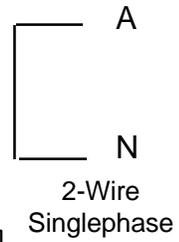
Form	Elements	2W-1 ϕ	3W-1 ϕ	3W-Network	3W- Δ	4W- Δ	4W-Y
3Z	1	5-2					
9Z	3					5-3	5-4
36Z	2-1/2						5-5
45Z	2		5-6	5-7	5-8	5-9, 5-10	5-11,5-12

Traditional metering schemes not satisfying Blondel's theorem have demonstrated acceptable commercial accuracy. *To fully realize the superior accuracy of electronic electricity meters, use Blondel metering solutions everywhere practical. **Keep electrical energy the most accurately measured common commodity.***

See Figure 6-1. kV Site Genie™ Worksheet on page 6-13.

kV Site Analysis

Form 3Z (Transformer Rated)



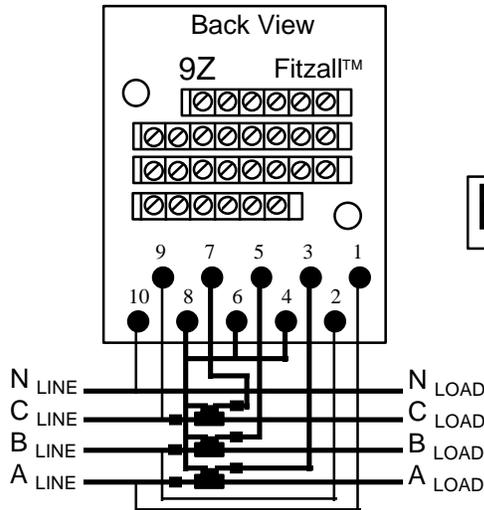
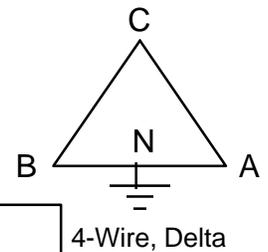
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

2-wire, 1-phase, 1-element

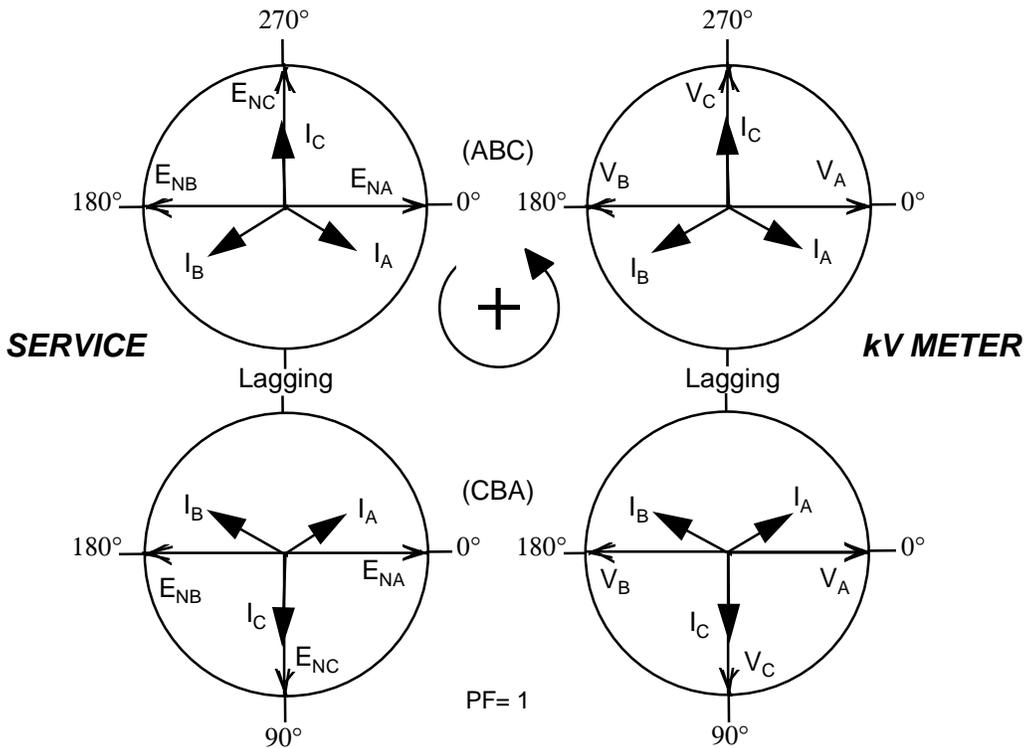
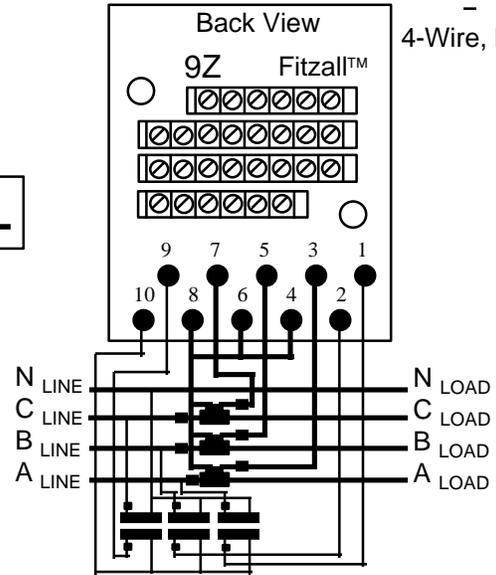
MO 3-5

kV Site Analysis

Form 9Z (Transformer Rated)



B LONDEL
solution



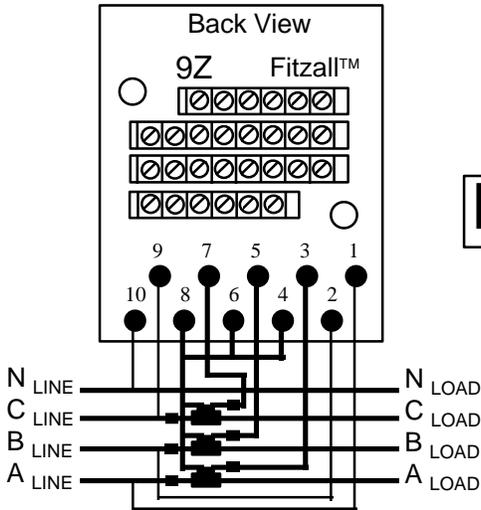
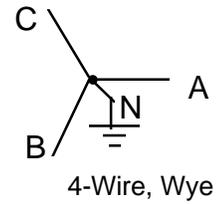
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

4-wire, 3-Element

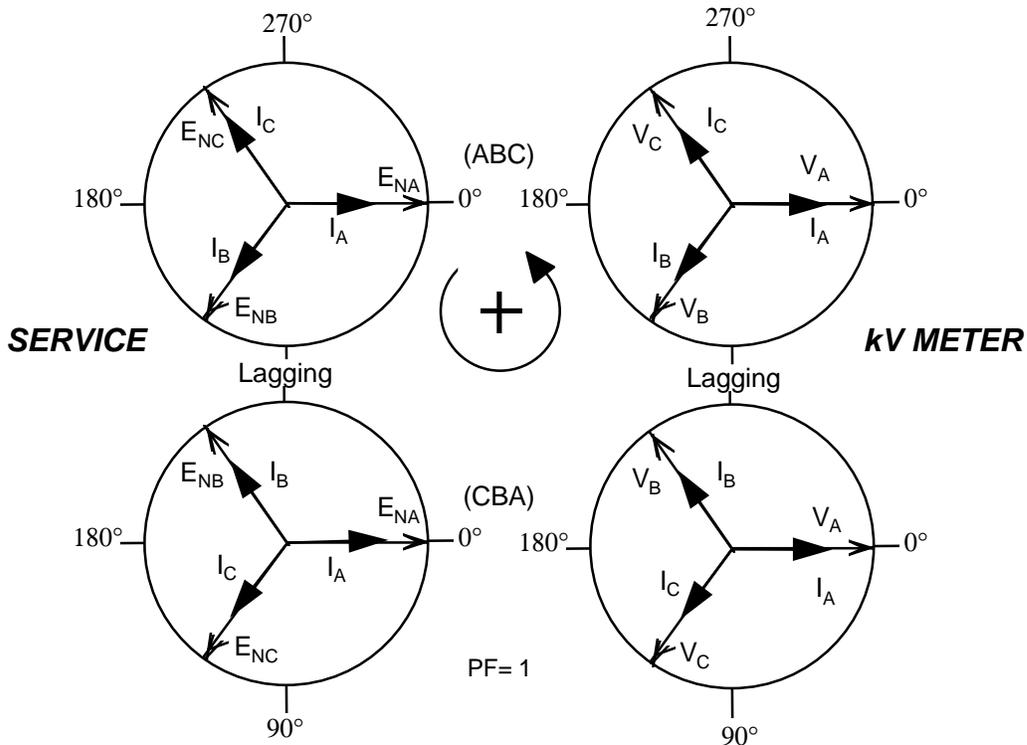
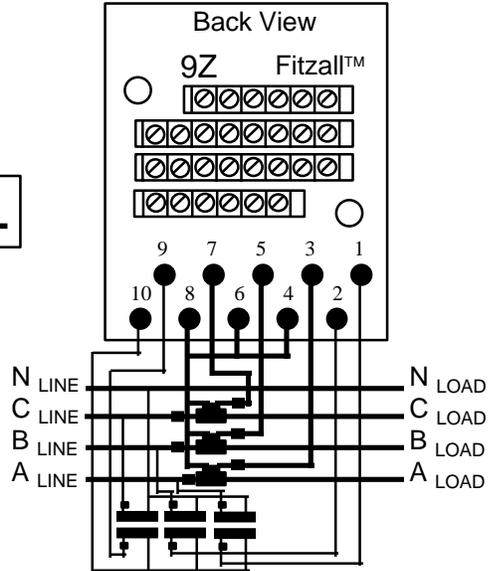
MO 9-6

kV Site Analysis

Form 9Z (Transformer Rated)



BLONDEL
solution L



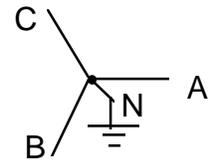
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

4-wire, 3-Element

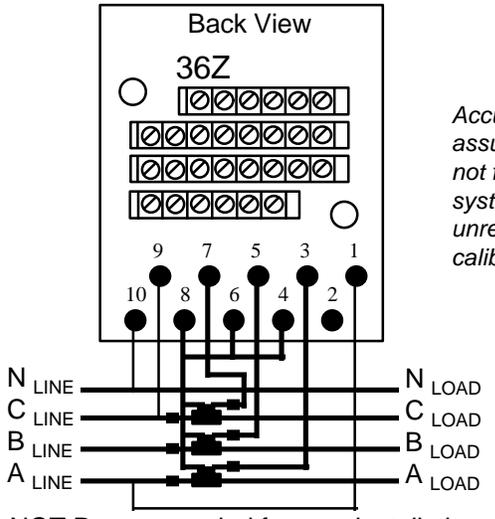
MO 9-6

kV Site Analysis

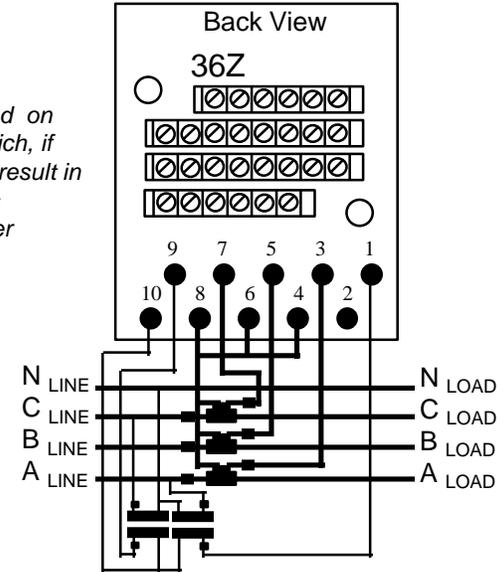
Form 36Z (Transformer Rated)



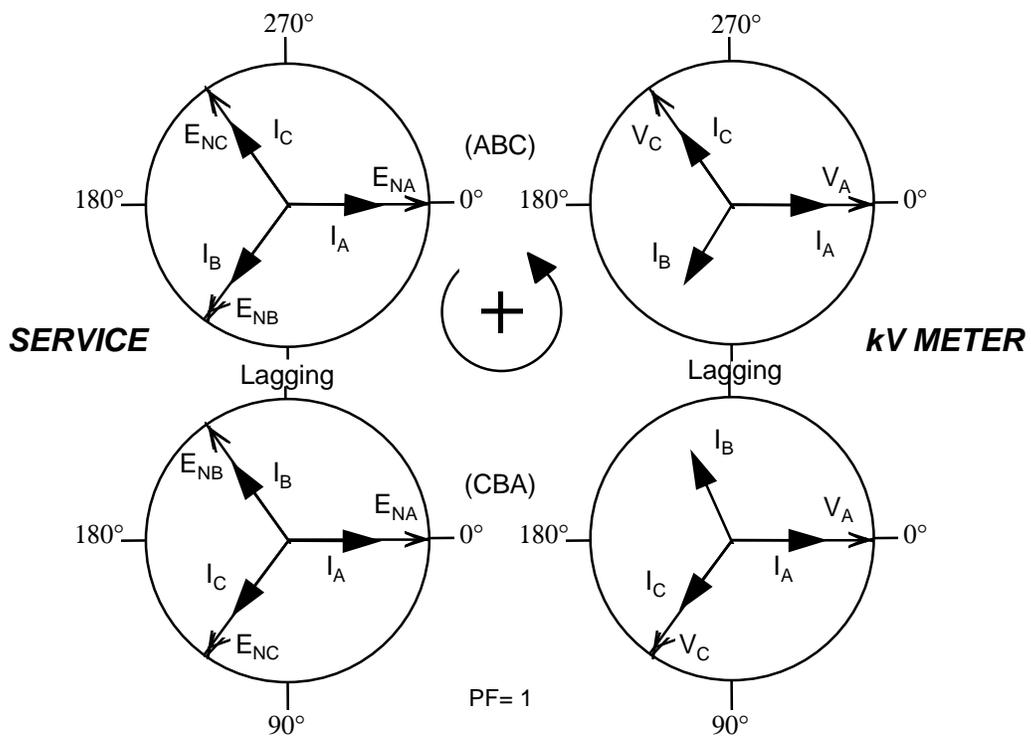
4-Wire, Wye



Accuracy is based on assumptions which, if not fulfilled, may result in systematic errors unrelated to meter calibration.



NOT Recommended for new installations
--Use 3-element Blondel Solution.



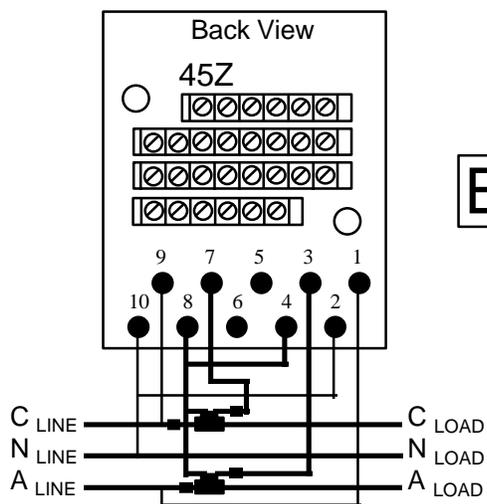
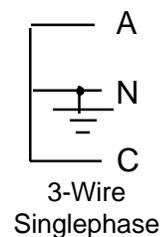
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

4-wire, wye, 2-1/2-element

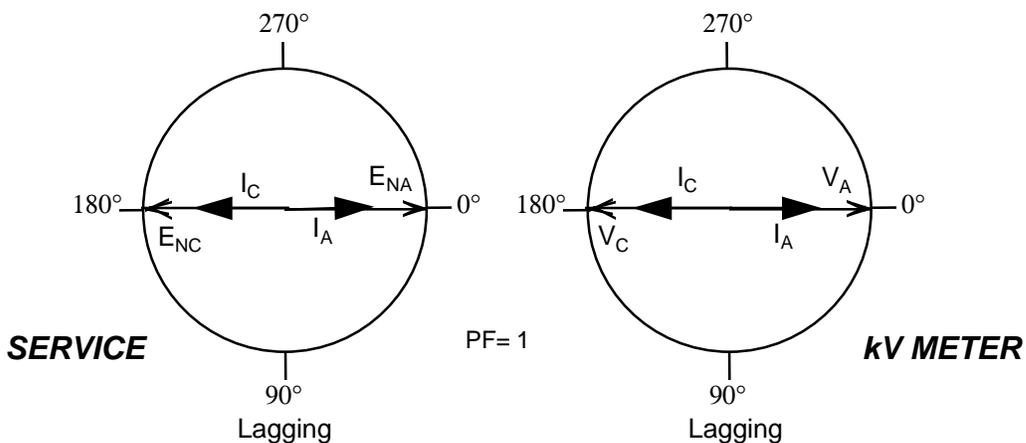
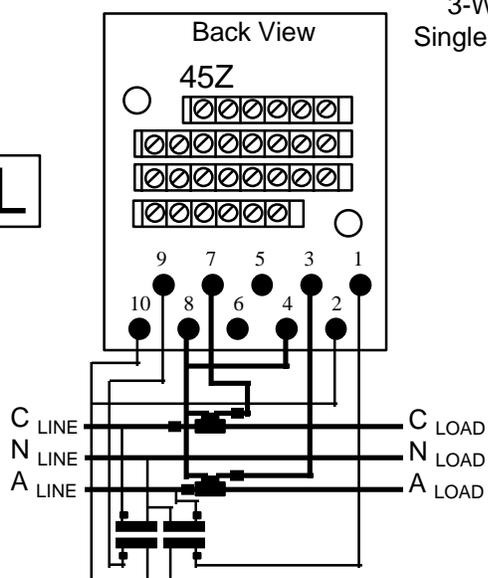
MO 36-2

kV Site Analysis

Form 45Z (Transformer Rated)



BLONDEL
solution



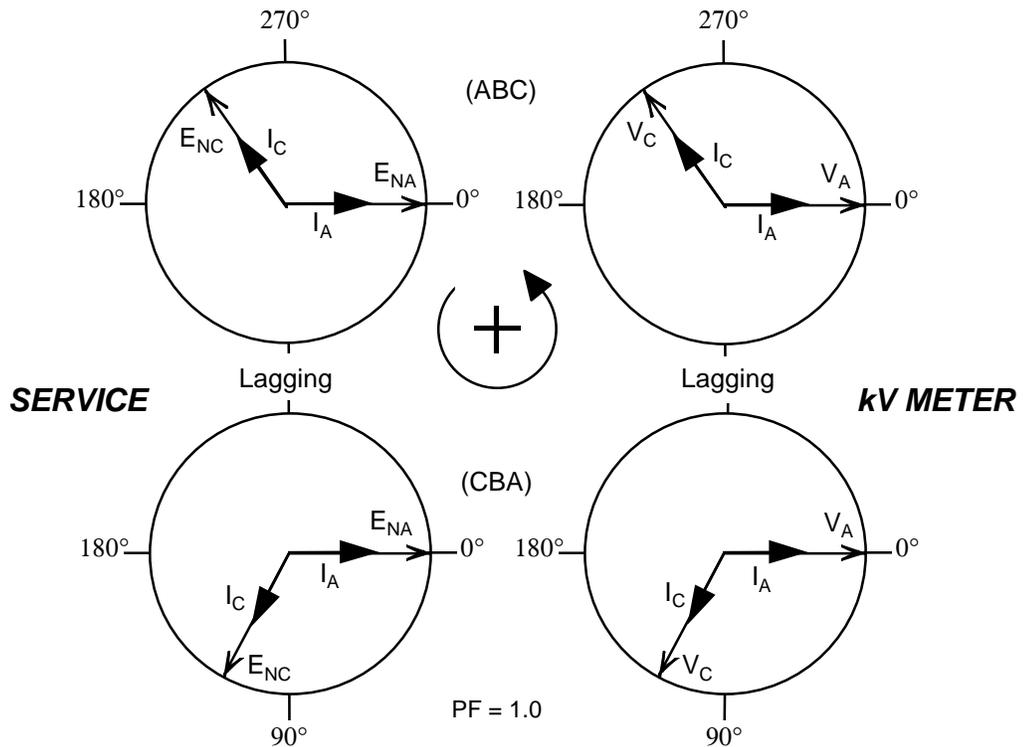
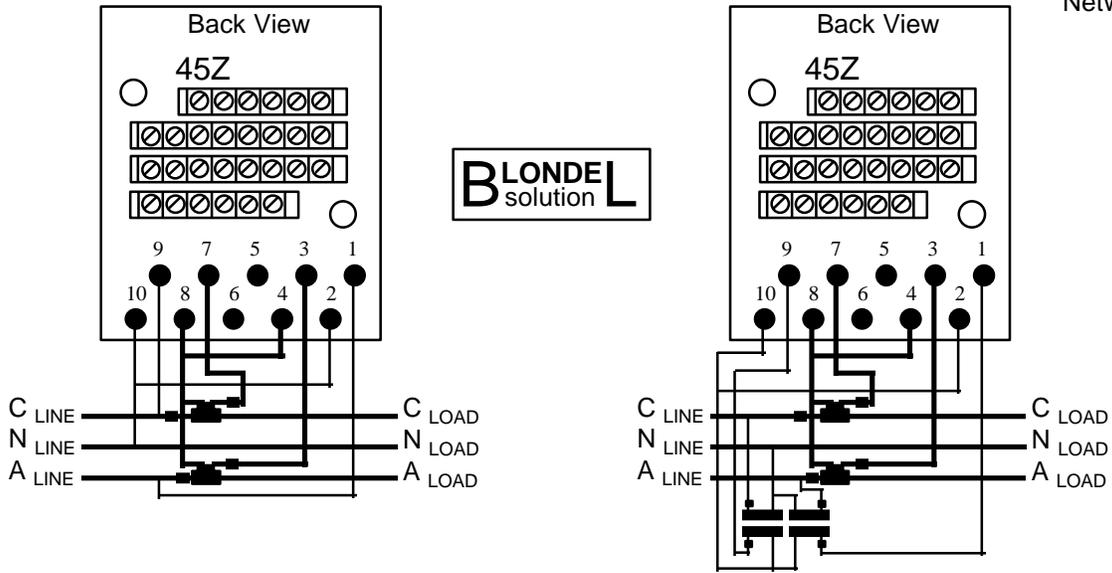
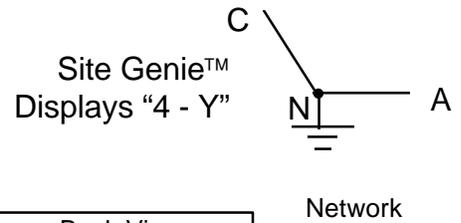
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

3-wire, 1-phase, 2-element

MO 45-3

kV Site Analysis

Form 45Z (Self-Contained)



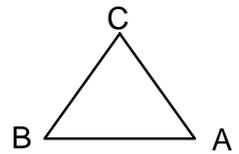
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

3-wire, Network, 2-element

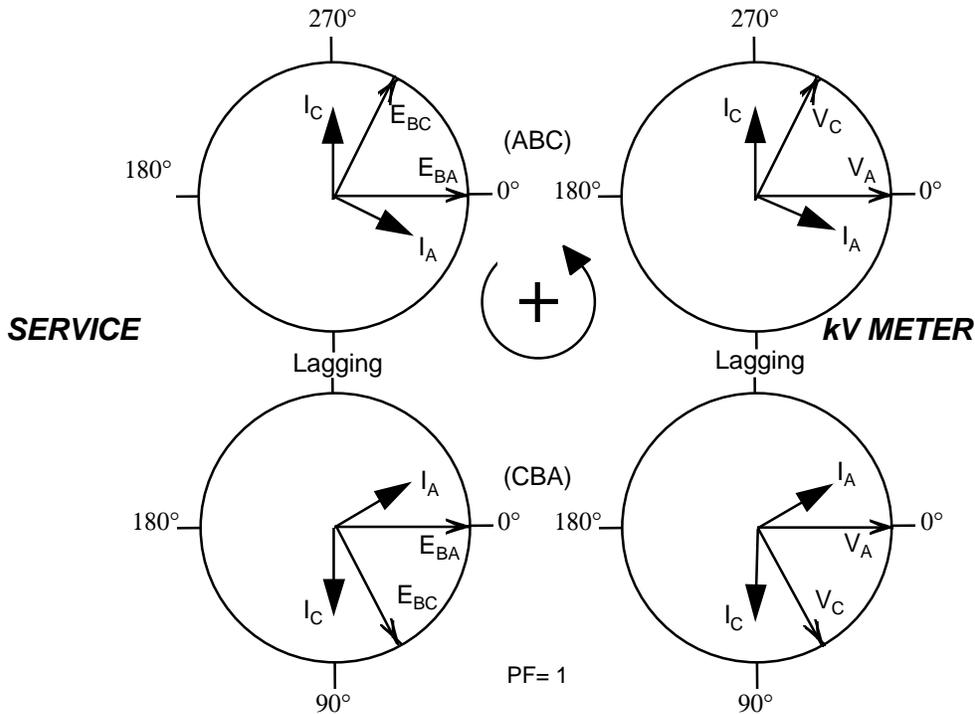
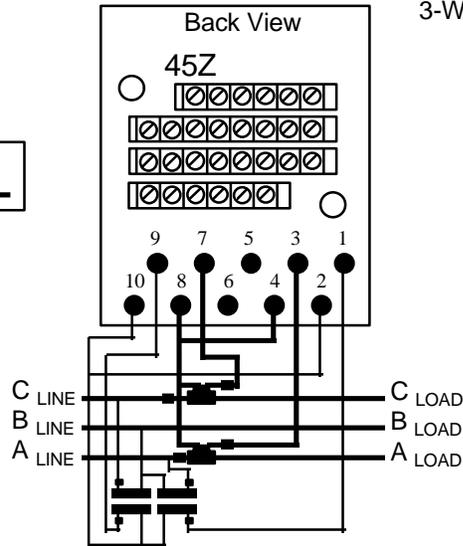
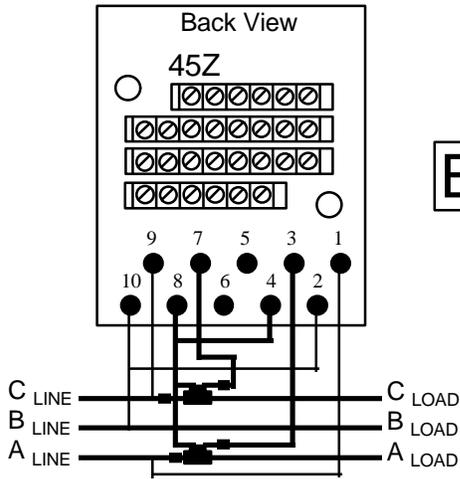
MO 45-3

kV Site Analysis

Form 45Z (Transformer Rated)



3-Wire, Delta



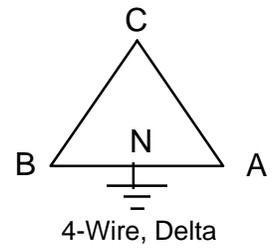
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

3-wire, 3-phase, 2-element

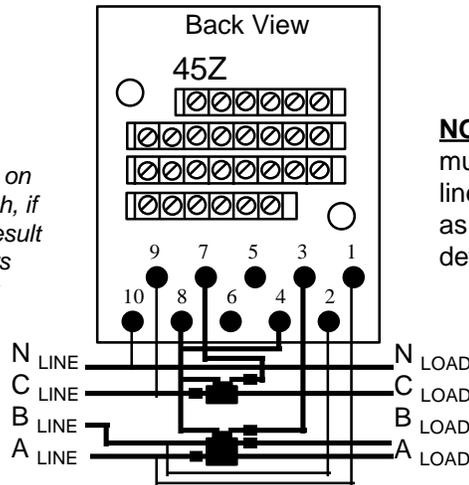
MO 45-0

kV Site Analysis

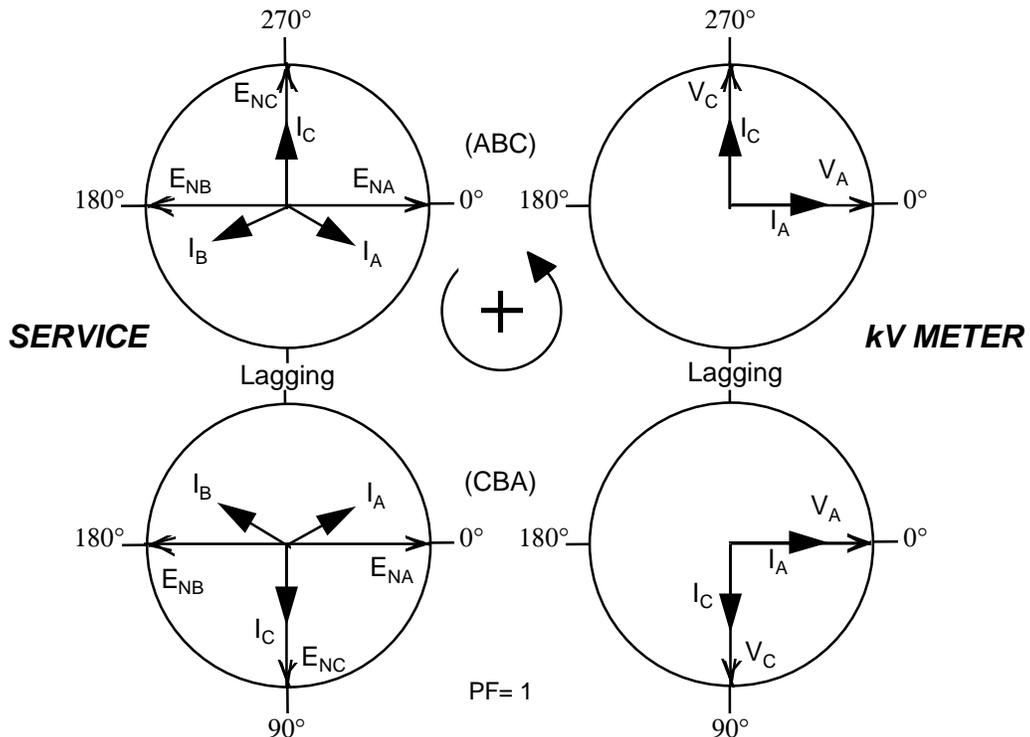
Form 45Z (Transformer Rated)



Accuracy is based on assumptions which, if not fulfilled, may result in systematic errors unrelated to meter calibration.



NOTE: A window CT in lines A & B must be twice the ratio of the CT in line C. Use the ratio of CT in line C as the transformer factor in determining the multiplier.



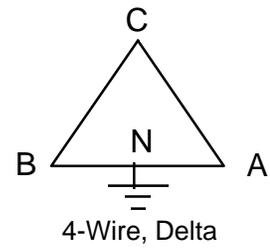
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

4-wire, delta, 2-element

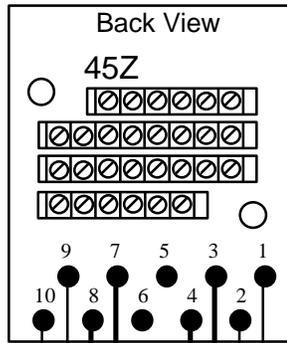
MO 45-3

kV Site Analysis

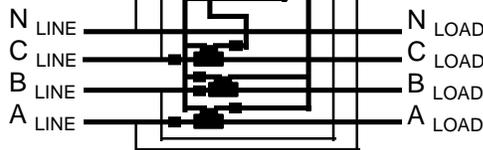
Form 45Z (Transformer Rated)



Accuracy is based on assumptions which, if not fulfilled, may result in systematic errors unrelated to meter calibration.

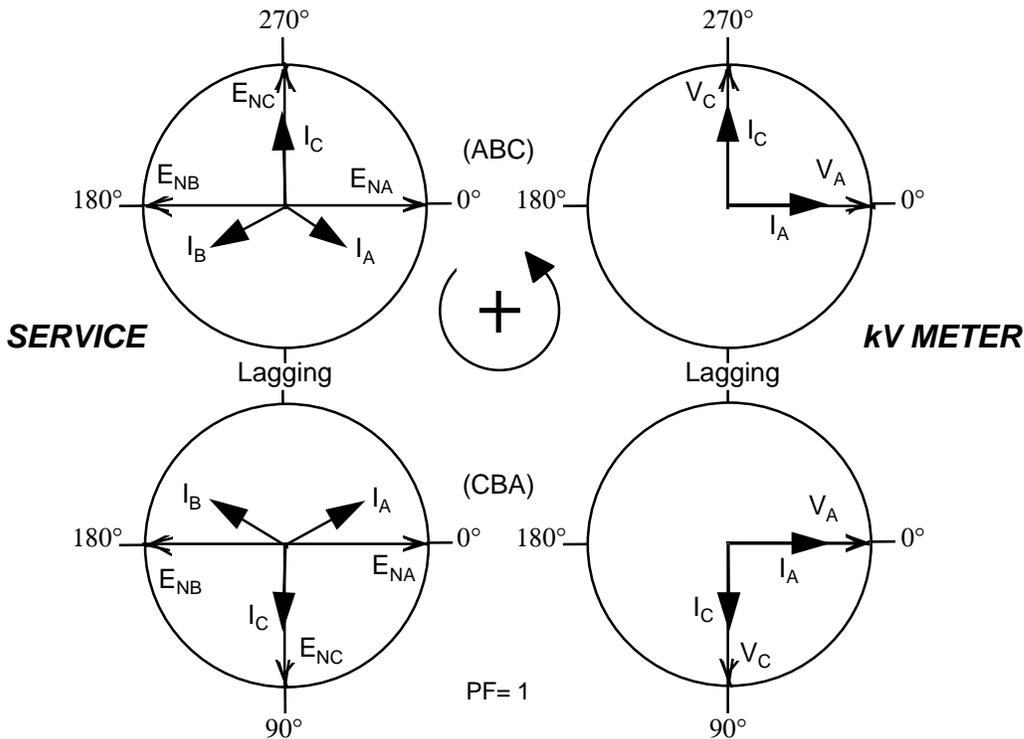


NOTE: The CTs in lines A & B must be twice the ratio of the CT in line C. Use the ratio of CT in line C as the transformer factor in determining the multiplier.



NOT Recommended for new installations

--Use 3-element Blondel Solution.



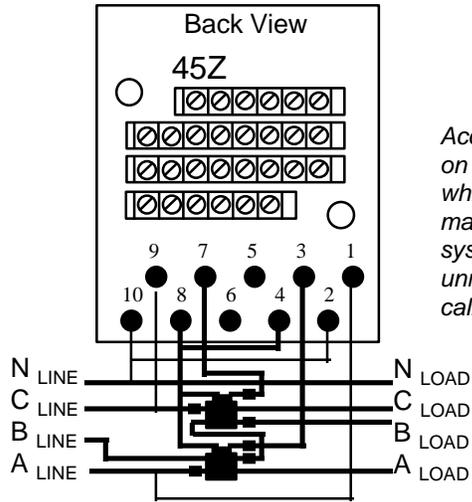
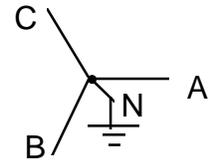
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

4-wire, delta, 2-element

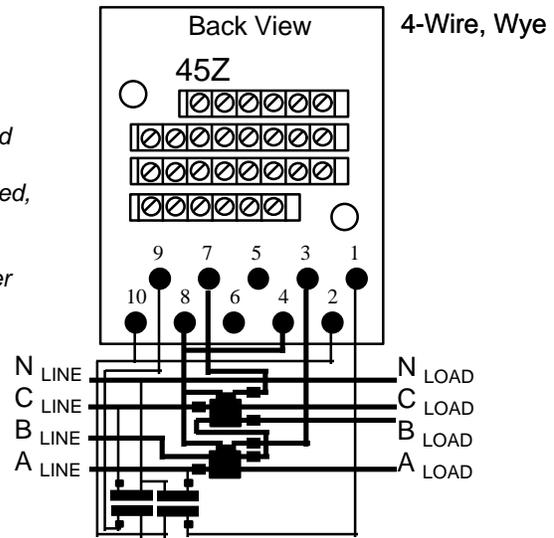
MO 45-3

kV Site Analysis

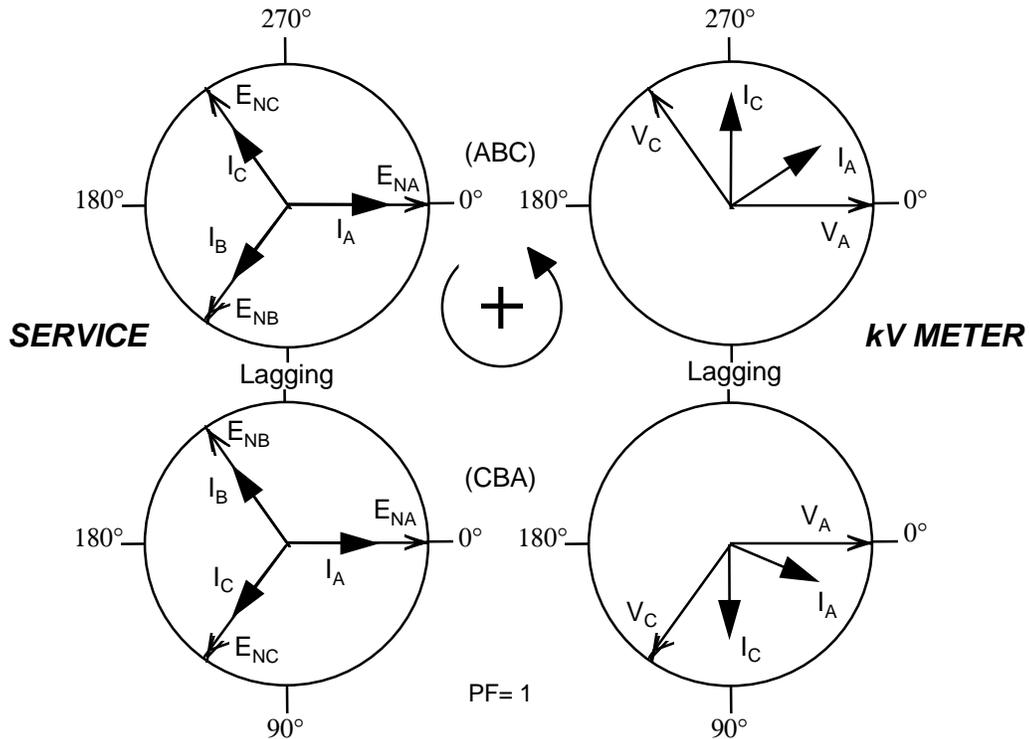
Form 45Z (Transformer Rated)



Accuracy is based on assumptions which, if not fulfilled, may result in systematic errors unrelated to meter calibration.



NOTE: For 3-wire CTs rated x&x:5, use 2x:5 when determining the TF.



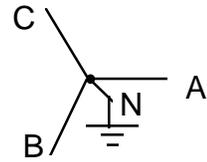
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

4-wire, wye, 2-element

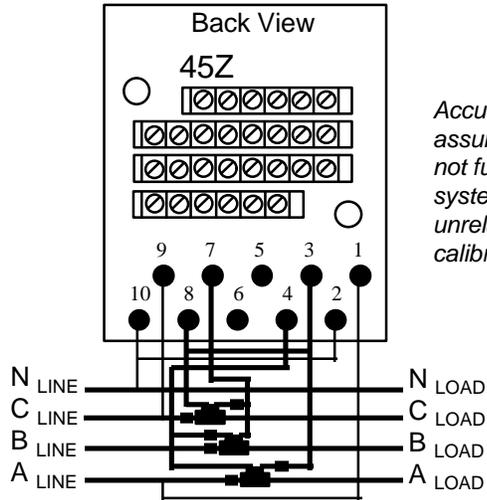
MO 45-3

kV Site Analysis

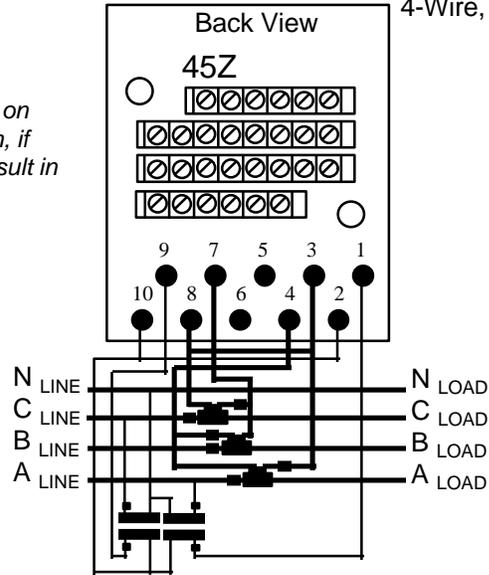
Form 45Z (Transformer Rated)



4-Wire, Wye

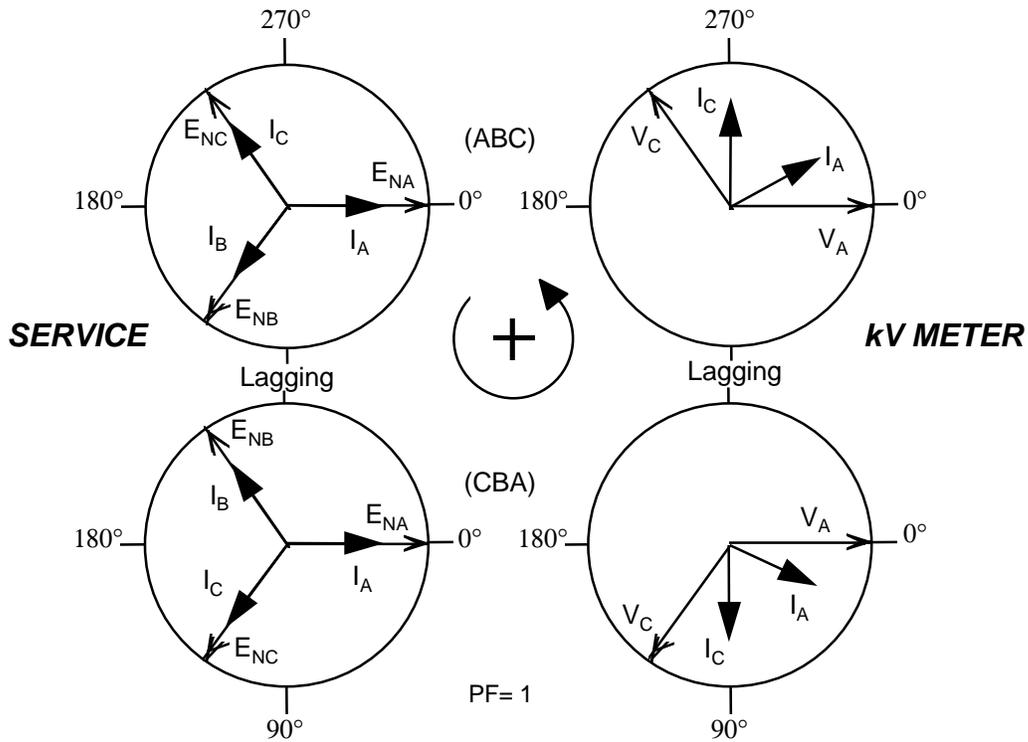


Accuracy is based on assumptions which, if not fulfilled, may result in systematic errors unrelated to meter calibration.



NOT Recommended for new installations

--Use 3-element Blondel Solution.



Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards

4-wire, wye, 2-element

MO 45-3

6. Fitzall™ Site Analysis Guides

NOTICE:

These site analyses include rudimentary connection diagrams for identification of metering installation. *These diagrams are not metering installation guides.*

Table 6-1 Fitzall™ Site Analyses

Site Analyses pages to see **(Blondel solutions are in bold type)**

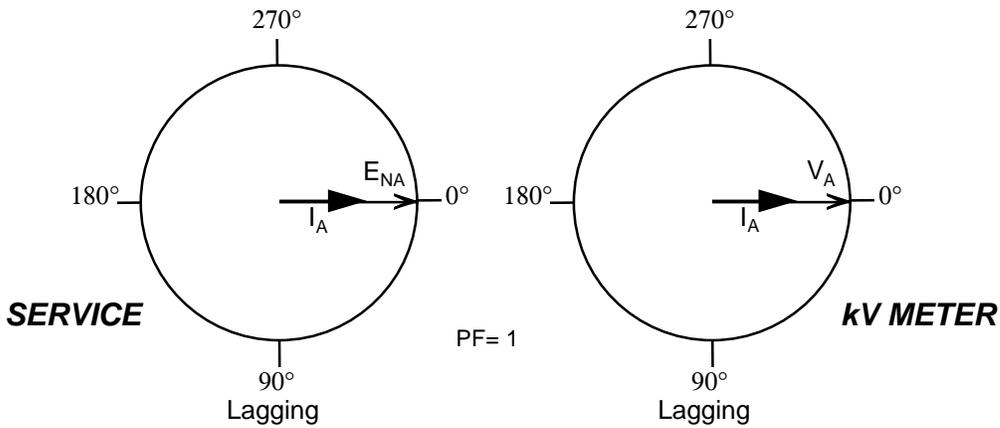
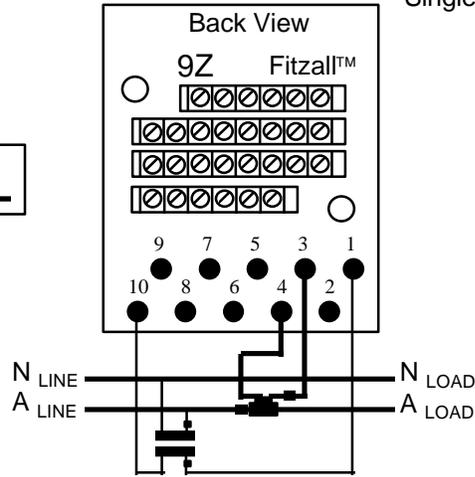
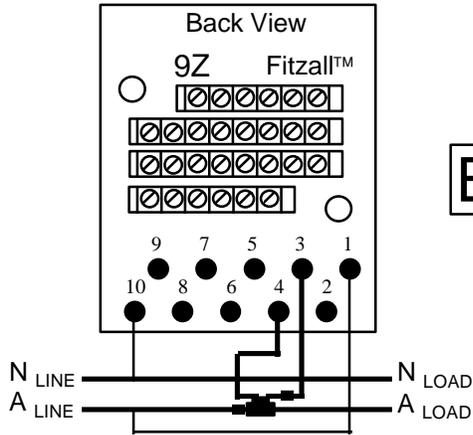
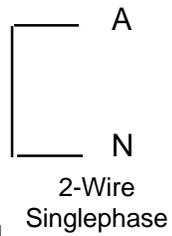
Form	Element	2W-1 ϕ	3W-1 ϕ	3W-Network	3W- Δ	4W- Δ	4W-Y
9Z	3					6-6	6-9
9Z	2-1/2						6-10
9Z	2		6-3	6-4	6-5	6-7, 6-8	6-11, 6-12
9Z	1	6-2					

Traditional metering schemes not satisfying Blondel's theorem have demonstrated acceptable commercial accuracy. *To fully realize the superior accuracy of electronic electricity meters, use Blondel metering solutions everywhere practical. **Keep electrical energy the most accurately measured common commodity.***

See Figure 6-1. kV Site Genie™ Worksheet on page 6-13.

kV Site Analysis
 Form 9Z (Transformer Rated)
 Fitzall™ Application

Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



Meter Nameplate marking

Mult by _____	VTR _____	:1	CTR _____	:5
SERVICE: 4Y	4Δ	3Δ	3N	3W (2W)
ELEMENTS: 3	2 1/2	2	(1)	(2)
746x9 _____	CL 20	120-480V	TA 2.5	Kt 1.8

MeterMate™ serVice Selection:

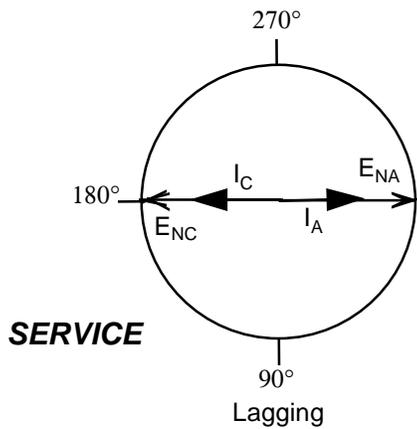
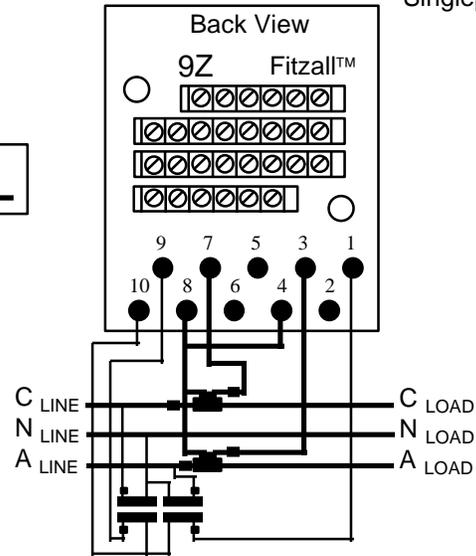
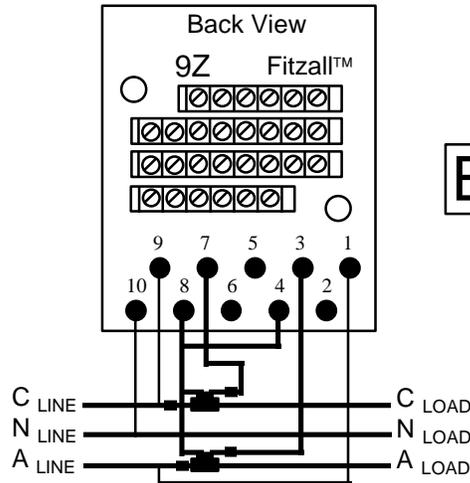
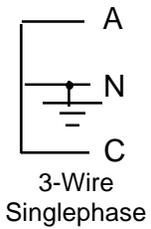
2-wire, 1-phase, 1-element

MO 3-5

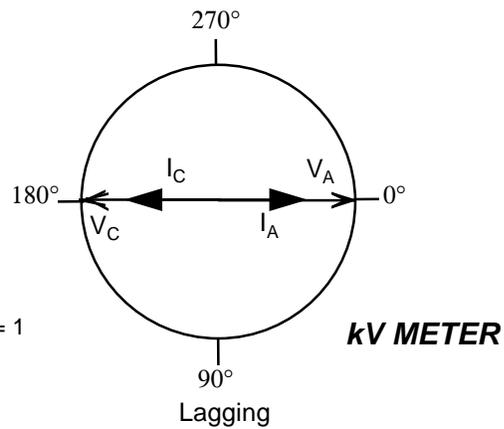
kV Site Analysis

Form 9Z (Transformer Rated)
Fitzall™ Application

Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



PF= 1



Meter Nameplate marking

Mult by _____	VTR _____	:1	CTR _____	:5
SERVICE: 4Y	4Δ	3Δ	3N	(3W) 2W
ELEMENTS: 3	2 1/2	(2)	1	
746x9 _____	CL 20	120-480V	TA 2.5	Kt 1.8

MeterMate™ service Selection:

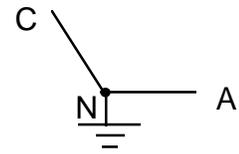
3-wire, 1-phase, 2-element

MO 45-4

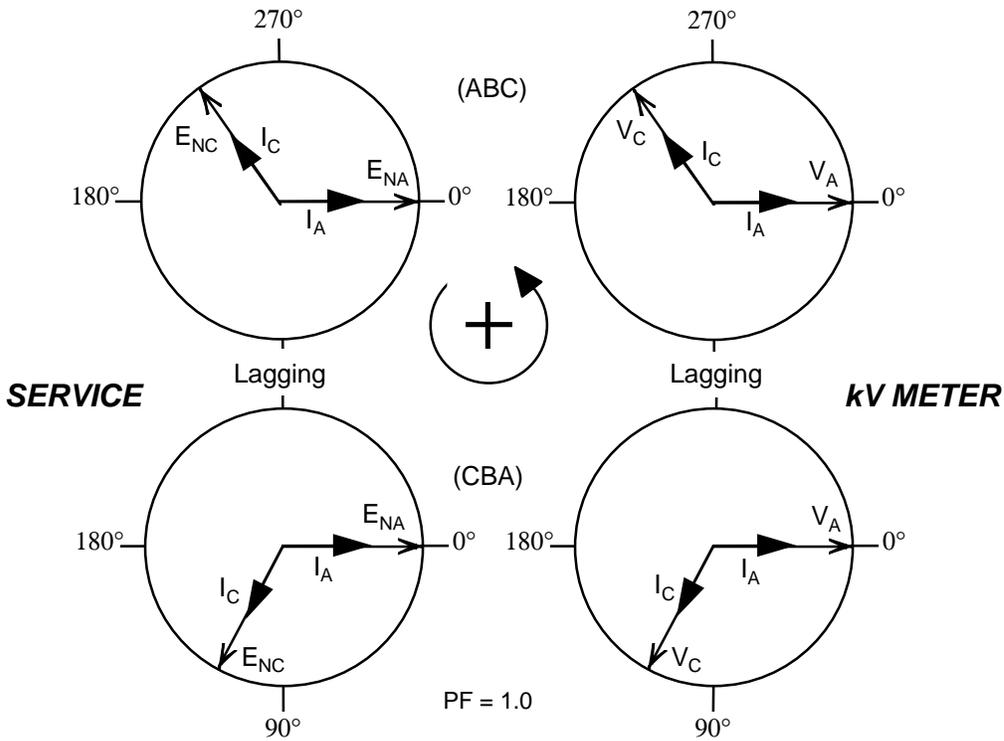
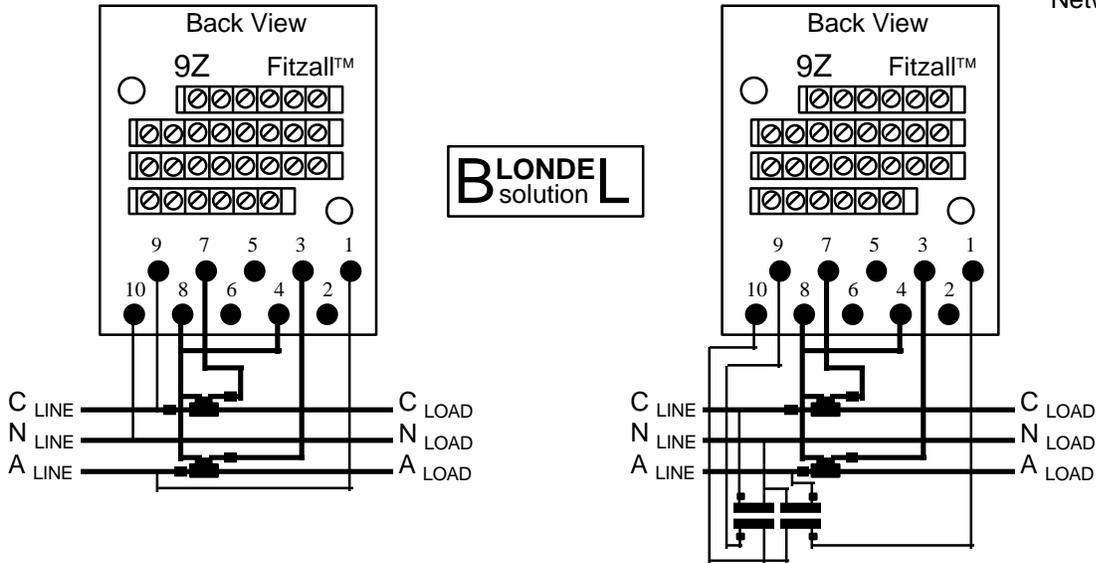
kV Site Analysis

Form 9Z (Transformer Rated)
Fitzall™ Application

Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



Network



Meter Nameplate marking

Mult by _____	VTR _____:1	CTR _____:5
SERVICE: 4Y	4Δ	3Δ
ELEMENTS: 3	2 1/2	②
746x9 _____	CL 20	120-480V
	TA 2.5	Kt 1.8

MeterMate™ serVice Selection:

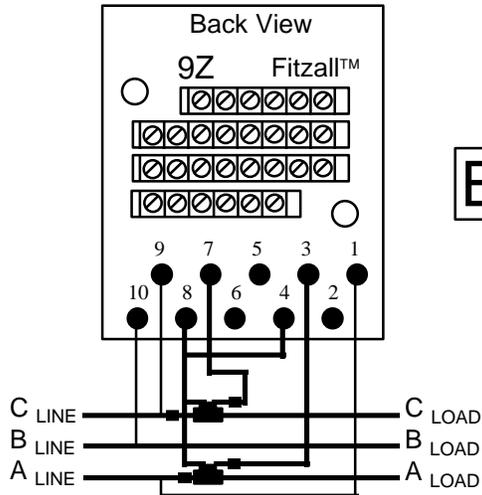
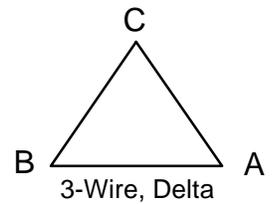
3-wire, Network, 2-element

MO 12-4

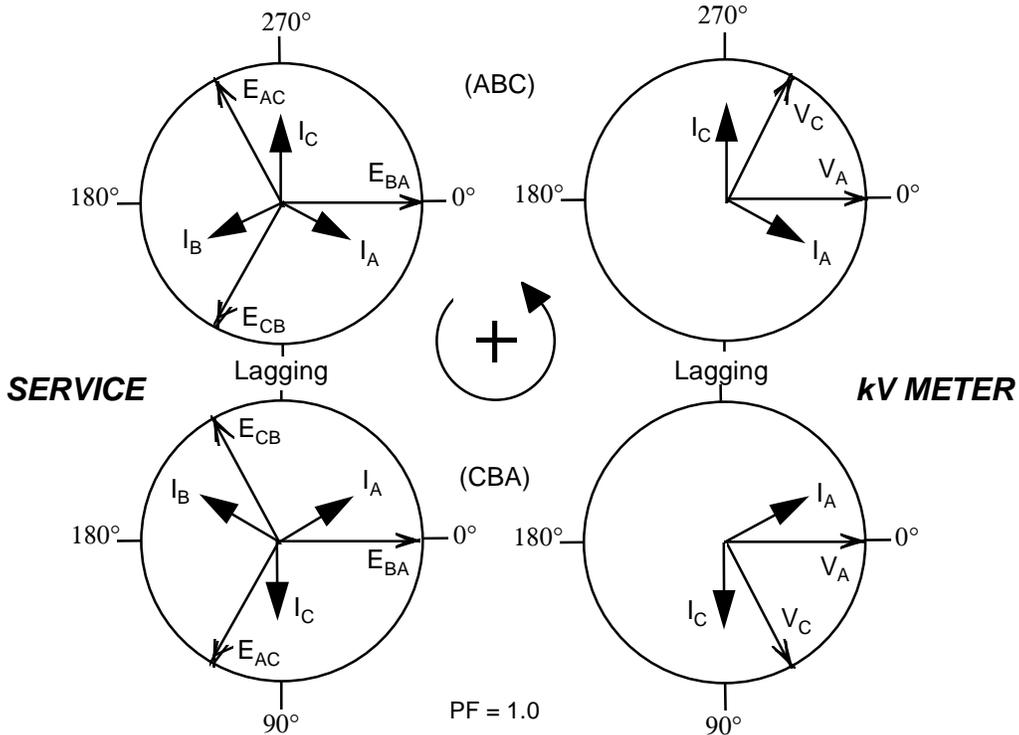
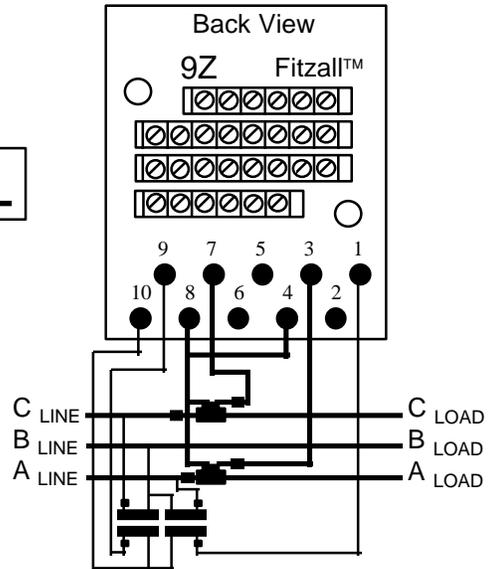
kV Site Analysis

Form 9Z (Transformer Rated)
Fitzall™ Application

Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



BLONDEL
solution



Meter Nameplate marking

Mult by _____	VTR _____	:1	CTR _____	:5
SERVICE: 4Y	4Δ	3Δ	3N	(3W) 2W
ELEMENTS: 3	2 1/2	(2)		1
746x9 _____	CL 20	120-480V	TA 2.5	Kt 1.8

MeterMate™ *serVice* Selection:

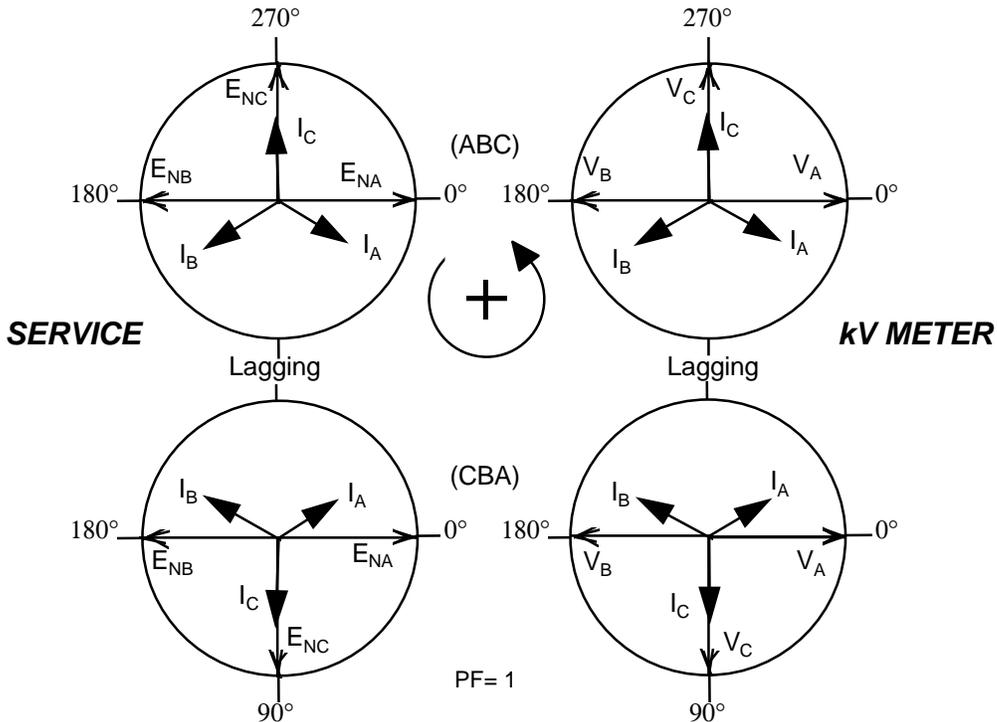
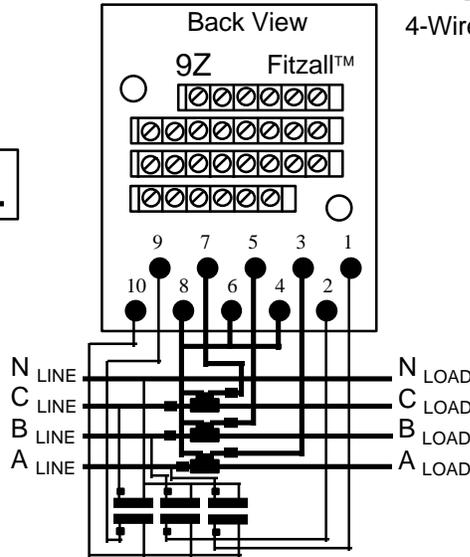
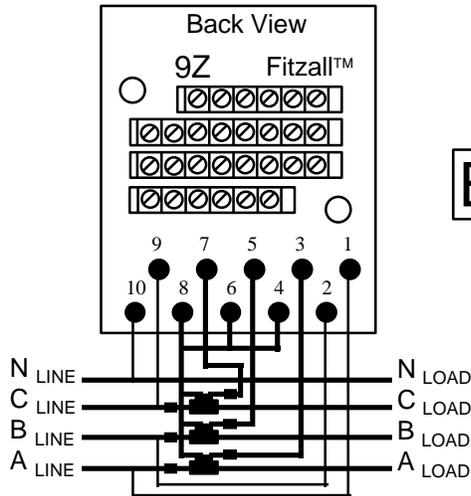
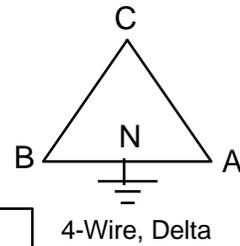
3-wire, 3-phase, 2-element

MO 45-0

kV Site Analysis

Form 9Z (Transformer Rated)
Fitzall™ Application

Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



Meter Nameplate marking

Mult by _____	VTR _____:1	CTR _____:5
SERVICE: 4Y	(4Δ)	3Δ 3N 3W 2W
ELEMENTS: (3)	2 1/2	2 1
746x9 _____	CL 20	120-480V TA 2.5 Kt 1.8

MeterMate™ serVice Selection:

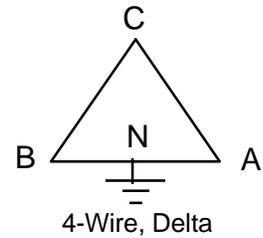
3-Element Automatic

MO 9-6

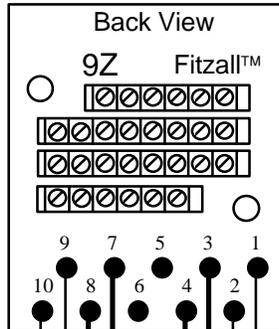
kV Site Analysis

Form 9Z (Transformer Rated)
Fitzall™ Application

Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



Accuracy is based on assumptions which, if not fulfilled, may result in systematic errors unrelated to meter calibration.

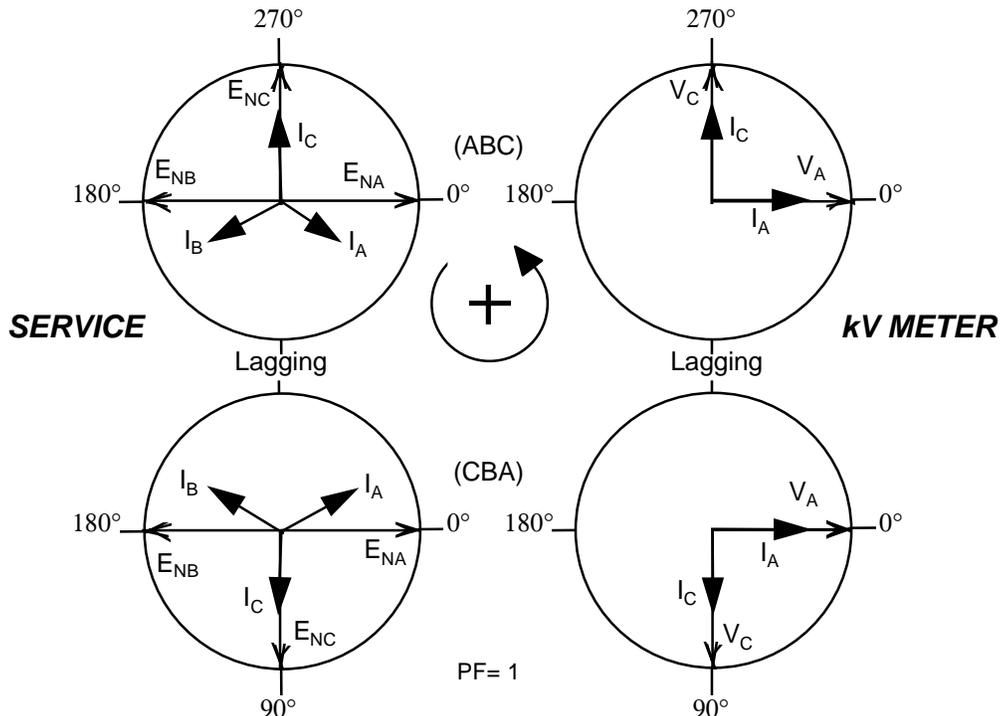


NOTE: The CTs in lines A & B must be twice the ratio of the CT in line C. Use the ratio of CT in line C as the transformer factor in determining the multiplier.



NOT Recommended for new installations

--Use 3-element Blondel Solution.



Meter Nameplate marking

Mult by _____	VTR _____:1	CTR _____:5
SERVICE: 4Y	(4Δ)	3Δ 3N 3W 2W
ELEMENTS: 3	21/2	(2) 1
746x9 _____	CL 20	120-480V TA 2.5 Kt 1.8

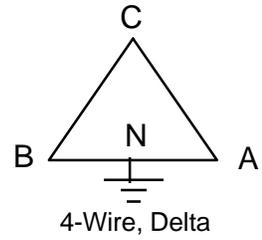
MeterMate™ serVice Selection:

4-wire, delta, 2-element

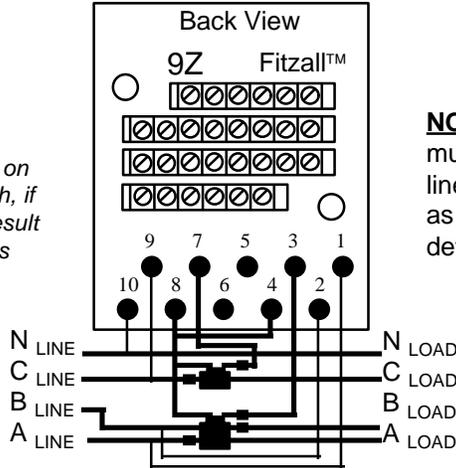
MO 45-3

kV Site Analysis
 Form 9Z (Transformer Rated)
 Fitzall™ Application

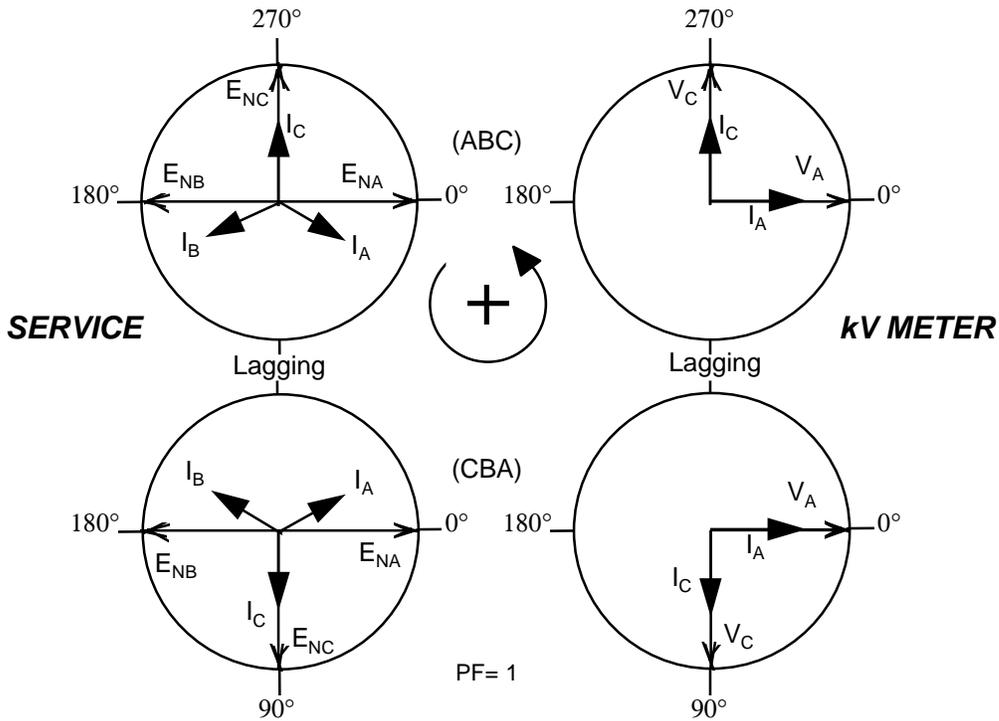
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



Accuracy is based on assumptions which, if not fulfilled, may result in systematic errors unrelated to meter calibration.



NOTE: A window CT in lines A & B must be twice the ratio of the CT in line C. Use the ratio of CT in line C as the transformer factor in determining the multiplier.



Meter Nameplate marking

Mult by _____	VTR _____:1	CTR _____:5
SERVICE: 4Y	4Δ	3Δ 3N 3W 2W
ELEMENTS: 3	2 1/2	2 1
746x9 _____	CL 20	120-480V TA 2.5 Kt 1.8

MeterMate™ serVice Selection:

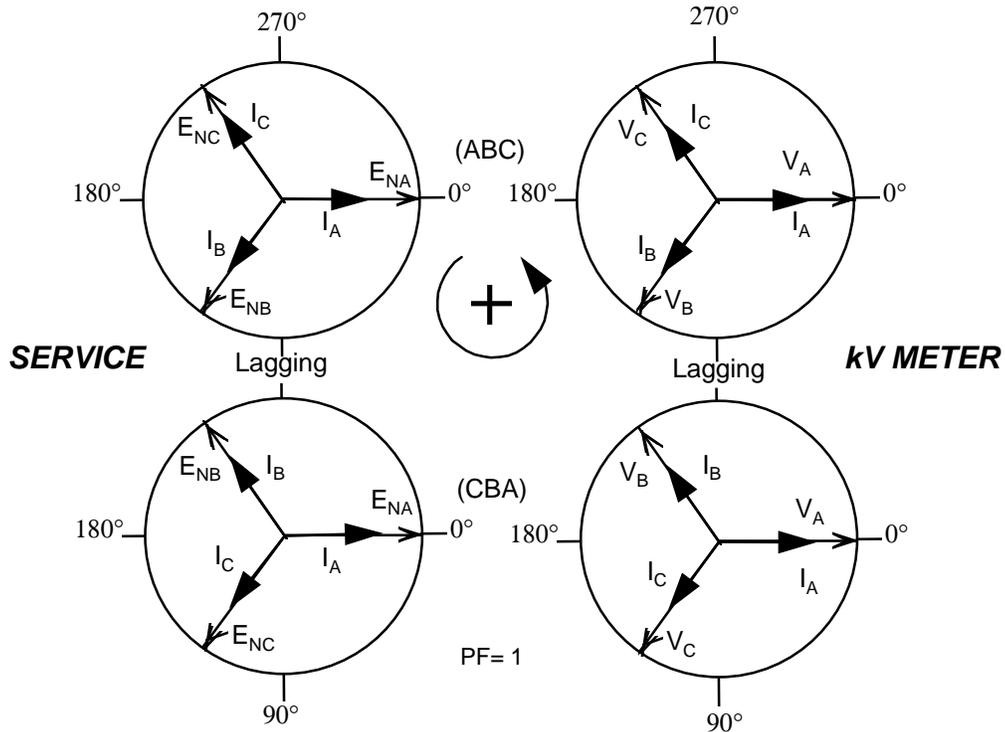
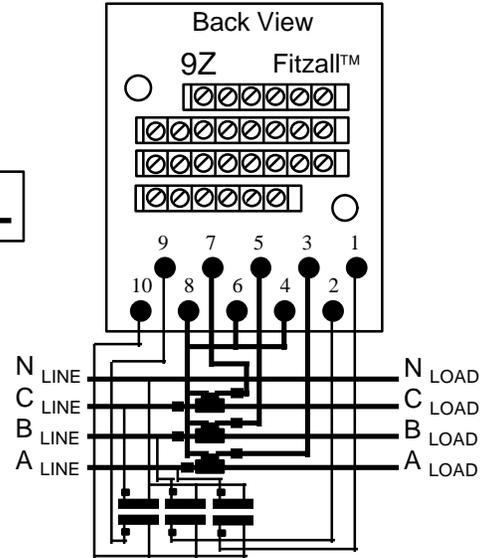
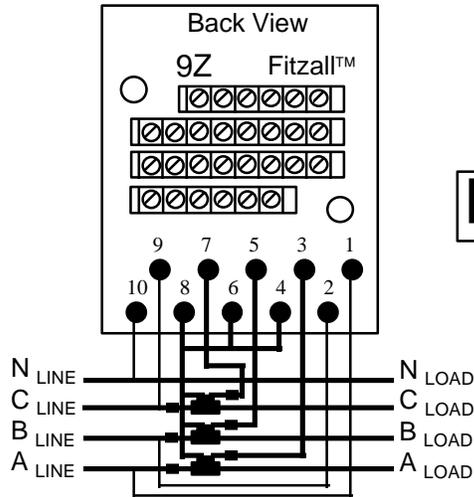
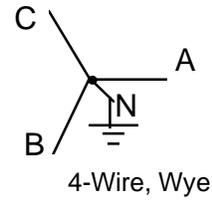
4-wire, delta, 2-element

MO 45-3

kV Site Analysis

Form 9Z (Transformer Rated)
Fitzall™ Application

Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



Meter Nameplate marking

Mult by	VTR	:1	CTR	:5
SERVICE:	(4Y)	4Δ	3Δ	3N 3W 2W
ELEMENTS:	(3)	2 1/2	2	1
746x9	CL 20	120-480V	TA 2.5	Kt 1.8

MeterMate™ service Selection:

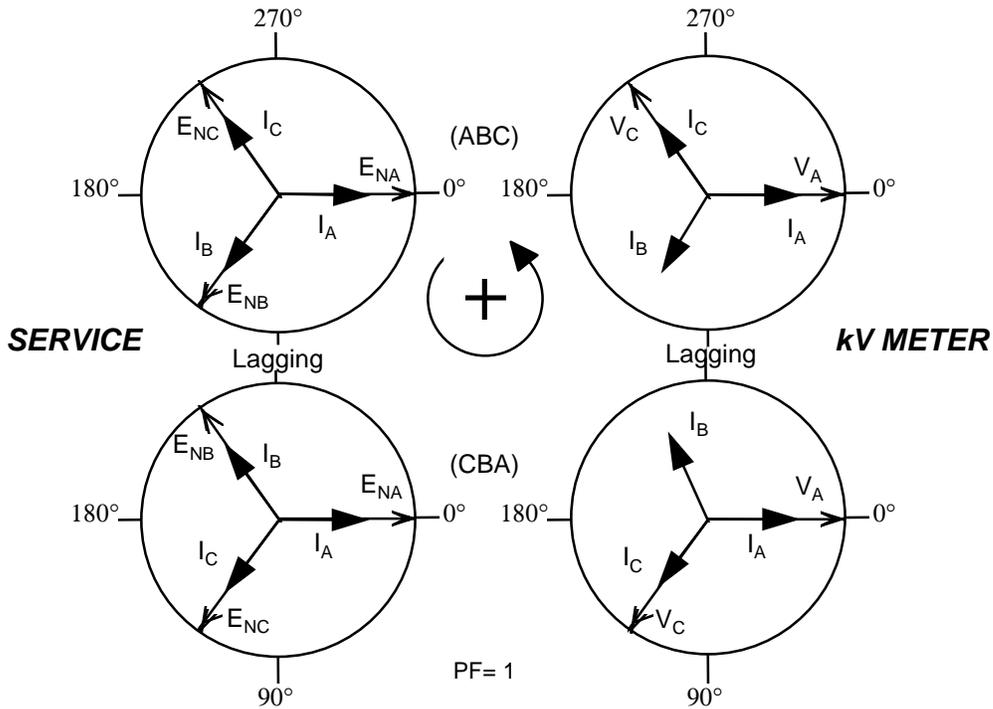
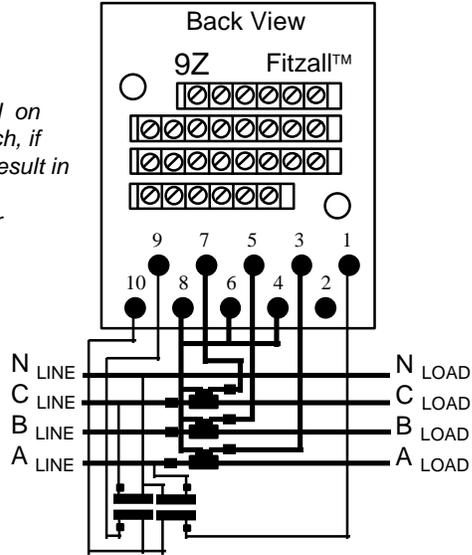
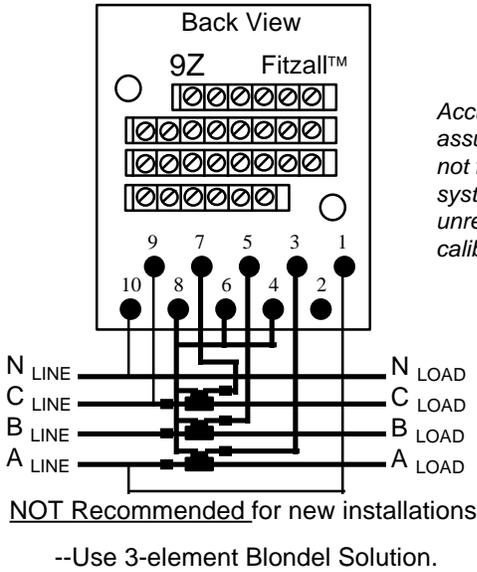
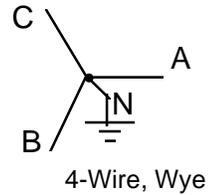
3-Element Automatic

MO 9-6

kV Site Analysis

Form 9Z (Transformer Rated)
Fitzall™ Application

Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



Meter Nameplate marking

Mult by	VTR	:1	CTR	:5
SERVICE: (4Y)	4Δ	3Δ	3N	3W 2W
ELEMENTS: 3	(21/2)	2		1
746x9	CL 20	120-480V	TA 2.5	Kt 1.8

MeterMate™ serVice Selection:

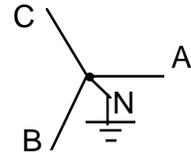
4-wire, wye, 2-1/2-element

MO 36-2

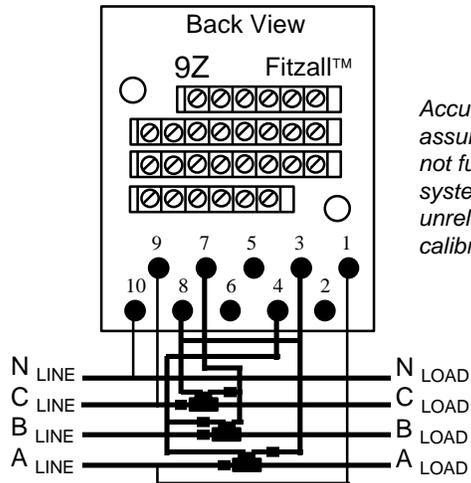
kV Site Analysis

Form 9Z (Transformer Rated)
Fitzall™ Application

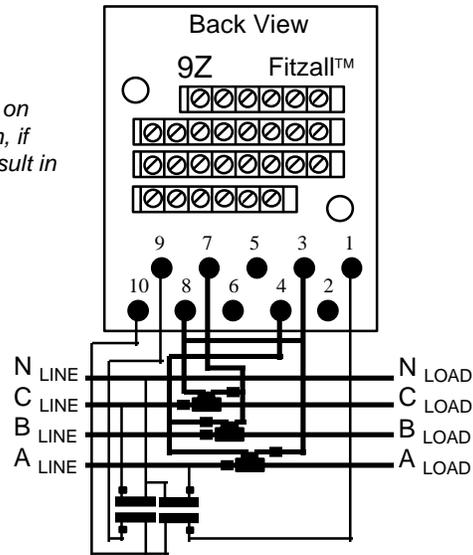
Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



4-Wire, Wye

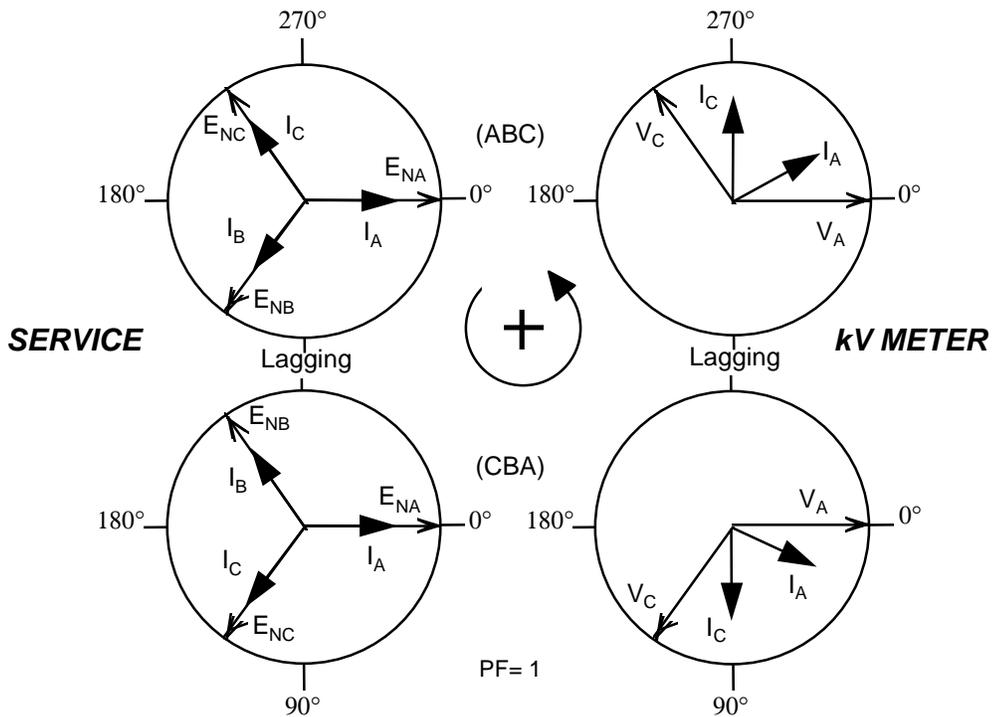


Accuracy is based on assumptions which, if not fulfilled, may result in systematic errors unrelated to meter calibration.



NOT Recommended for new installations

--Use 3-element Blondel Solution.



Meter Nameplate marking

Mult by _____	VTR _____:1	CTR _____:5
SERVICE: (4)Y	4Δ	3Δ
ELEMENTS: 3	21/2	(2)
746x9 _____	CL 20	120-480V
	TA 2.5	Kt 1.8

MeterMate™ serVice Selection:

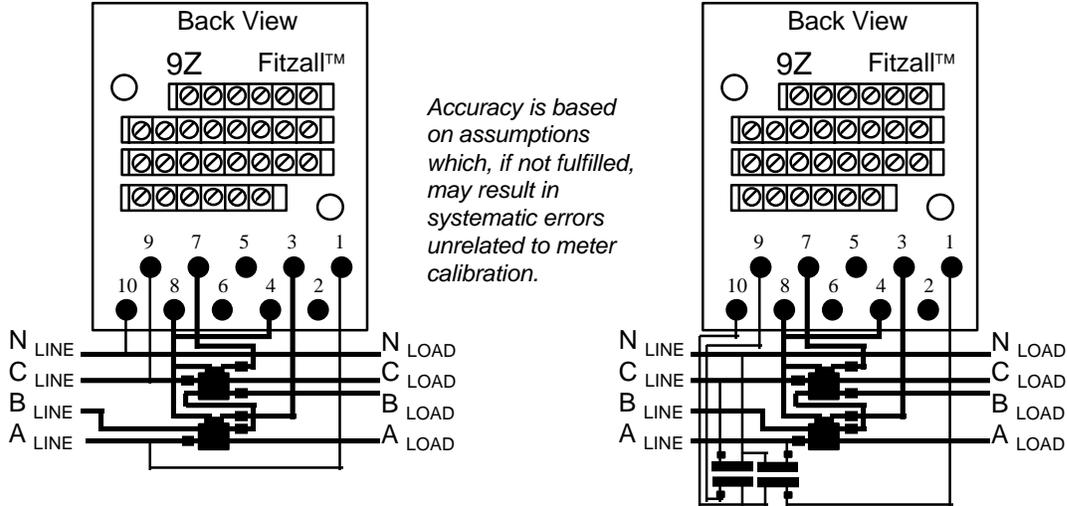
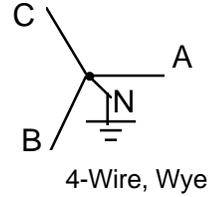
4-wire, wye, 2-element

MO 45-4

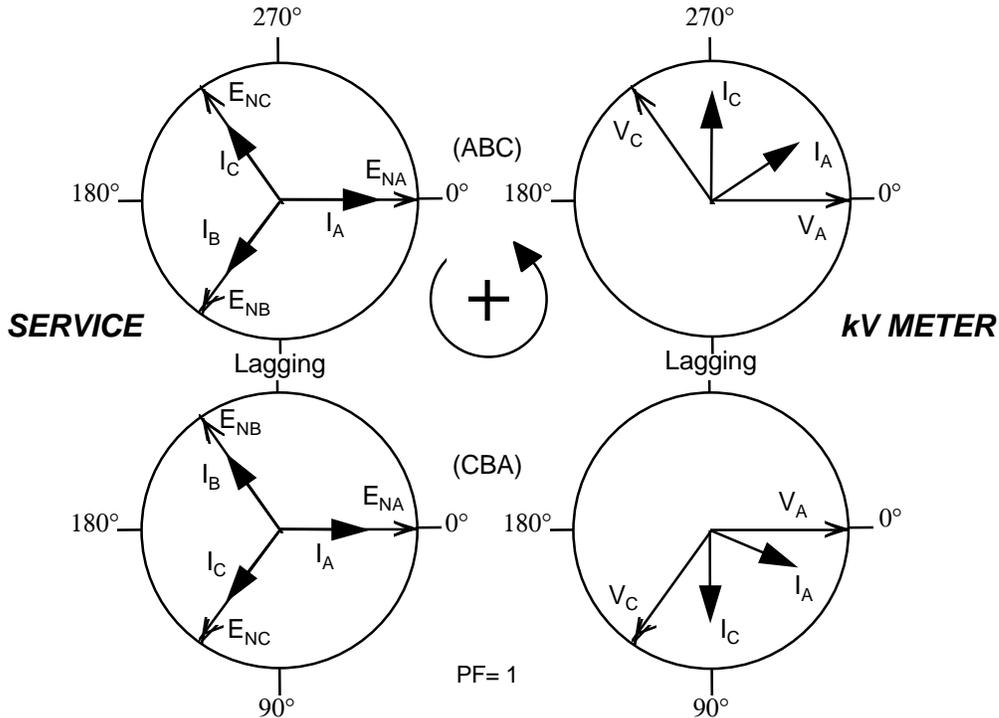
kV Site Analysis

Form 9Z (Transformer Rated)
Fitzall™ Application

Actual installation procedures, materials, equipment, and connections must conform to applicable codes and standards



NOTE: For 3-wire CTs rated x&x:5, use 2x:5 when determining the TF.



Meter Nameplate marking

Mult by	VTR	:1	CTR	:5		
SERVICE:	4Y	4Δ	3Δ	3N	3W	2W
ELEMENTS:	3	21/2	2	1		
746x9	CL 20	120-480V	TA 2.5	Kt 1.8		

MeterMate™ serVice Selection:

4-wire, wye, 2-element

MO 45-4

Figure 6-1. kV Site Genie™ Worksheet



GE Meter

kV Site Genie™ Worksheet

Data File Name: _____
 Complete Path: _____

Meter #: _____

Site: _____

Service: _____

Service Display: _____

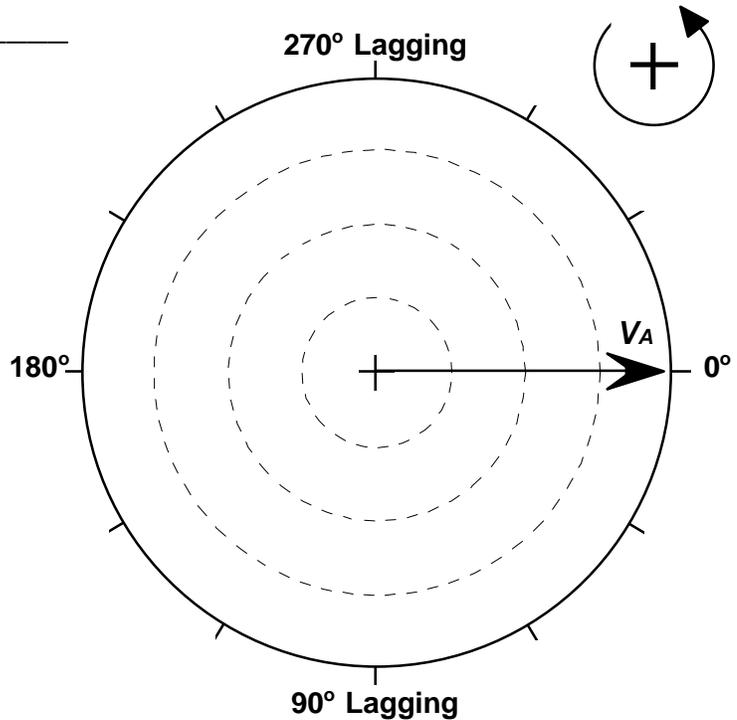
FUNDAMENTAL PHASORS

	A	B	C	
Voltage Angle	0.0			° Lagging
Voltage				Volts
Current Angle				° Lagging
Current				Amperes

Distortion Power Factor: _____

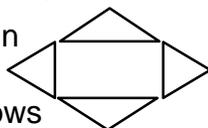
Diagnostic Counts

D1	
D2	
D3	
D4	
D5T	
D5A	
D5B	
D5C	
D6	
D7	
D8	



Meter Display Status

Fill-in Lit Arrows



- (A) Blinking
- (B) Off - Blinking
- (C) Off - Blinking

Ca _____

Er _____

7. Display Multipliers

MeterMate™ software is able to accept a user input display multiplier of any value between 0.001 and 9999.999, however certain selections will cause undesirable display characteristics on the kV meter. Most common display multipliers (10, 100, 1000) will provide operation as expected.

The kV meter calculates energy and related values based on what it sees at the meter input terminals. This raw data is always what you obtain via OPTOCOM communication, and is correct. However, the meter is designed to enable use of a Display Multiplier, commonly used for many applications.

The Display Multiplier in the MeterMate™ program file essentially causes the meter to divide the raw data by that amount prior to display. Anyone reading the display would normally multiply the displayed value by the programmed Display Multiplier. In practice, the meter and software accomplish the display manipulation in a unique fashion. Specifically, the Display Multiplier, Current Transformer Ratio (CTR), and Voltage Transformer Ratio (VTR) chosen by the user are converted to an internal Display Multiplier value and Display Scalar value. (Note: CTR x VTR are used *only* if Primary Display Scaling is selected.) The relationship between these values is as follows:

$$\text{Programmed DM} = \frac{\text{CTR} \times \text{VTR}}{\text{Internal DM} \times 10^{-\text{Display Scalar}}}$$

$$\text{Displayed Value} = \text{Raw Data} \times \text{Internal DM} \times 10^{-\text{Display Scalar}}$$

To calculate the Internal Display Multiplier and Display Scalar values, MeterMate™ software takes the reciprocal of the Programmed Display Multiplier and shifts the decimal point to the right until the Internal Display Multiplier is represented as an integer value. The number of decimal places shifted becomes the Display Scalar. If the Internal Display Multiplier cannot be made into a complete integer value in 6 decimal point shifts or less, the value is truncated. (Number of shifts allowed depends on the energy and demand display format selected — greatest number of digits to the left of decimal point.) This truncation may lead to display errors as illustrated in the following example: (Assume CTR = VTR = 1)

User Input DM	Digits left of Decimal Point	Internal DM	Display Scalar	Error in Displayed Value
1	—	1	0	0.00%
9	3	111,111	6	0.0001%
	4	11,111	5	0.001%
10	—	1	1	0.00%
12	3	83,333	6	0.0004%
	4	8,333	5	0.004%
18	3	55,556	6	0.0008%
	4	5,556	5	0.008%
20	—	5	2	0.00%
24	3	41,667	6	0.0008%
	4	4,167	5	0.008%
36	3	27,778	6	0.0008%
	4	2,778	5	0.008%

Note that any error resulting from truncation of the Internal Display Multiplier only affects the displayed quantities. Data read via the OPTOCOM port is correct. Most common display multipliers (10, 100, 1000) result in no display errors.

Also note that when the Display Multiplier is shown as a display item, it is the internally derived Display Multiplier that is provided, not the Display Multiplier entered by the user in the MeterMate™ program file. The Display Multiplier in the program file is the value that should be applied to the displayed quantities. If desired, use the formula shown above to relate the displayed Display Multiplier and Display Scalar values to the Display Multiplier that should be applied to the displayed quantities.

Application Example #1:

A kV meter is to be installed in a transformer rated installation, CTR = 200:5, and there is no VT (i.e. use a VTR = 1:1). The meter display is to be multiplied by the Transformer Factor (TF = CTR x VTR). How should the kV meter be programmed?

Solution:

This is a classic “secondary reading” register application. The displayed value should represent the energy and demand based on the secondary output of the instrument transformers. In MeterMate’s **Display Table** editor, **Display Format** tab; set **Display Scaling** to *Secondary*, and **Display Multiplier** to 1. The nameplate of the meter should be marked to indicate displayed values must be multiplied by 40 to obtain primary values since, in this example, $TF = 40 \times 1 = 40$. Note that while it isn’t necessary to input CTR or VTR values into the meter in this example (the values do not affect displayed energy or demand values), it may be desirable to input them for record keeping purposes or if primary current display values are desired.

Note: A common error is to input a Display Multiplier of 40. This will cause the meter to divide the secondary values by 40 before displaying them, and would require users to multiply by 40, twice, to obtain the proper primary values.

Application Example #2:

A Form 9S kV meter is installed on a 480Y/277 V installation, with CTR = 200:5, VTR = 2.4:1. For convenience, a display multiplier of 1 is desired instead of the TF of 96 (TF = 40 x 2.4 = 96).

Solution:

This is a classic “primary reading” register application. The displayed value should represent the energy and demand based on the primary side of the instrument transformers. In MeterMate’s **Display Table** editor, **Display Format** tab; set **Display Scaling** to *Primary*, and **Display Multiplier** to 1. The nameplate of the meter should be marked to indicate displayed values must be multiplied by 1 to obtain primary values since, in this example, the meter takes care of multiplying the secondary values by the TF prior to displaying them. Note that it is necessary to input the correct CTR & VTR values into the meter since they affect displayed energy and demand values. CTR and VTR values may be input at time of programming (prompt for input during programming process), or they may be set as part of the program information in MeterMate’s Site editor, in the **Transformer Ratios** section.

Application Example #3:

A kV meter is to be used at a large account where the CTR = 1500:5, VTR = 4:1. For convenience, and to prevent premature rollover of the displayed values, a display multiplier of 1000 is desired instead of the TF of 1200 (TF = 300 x 4 = 1200).

Solution:

As in Application Example #2, go to MeterMate’s **Display Table** editor, **Display Format** tab; set **Display Scaling** to *Primary*, and **Display Multiplier** to 1000. The nameplate of the meter should be marked to indicate displayed values must be multiplied by 1000 to obtain primary values. Again, it is necessary to input the correct CTR & VTR values into the meter since they affect displayed energy and demand values. CTR and VTR values may be input at time of programming (prompt for input during programming process), or they may be set as part of the program information in MeterMate’s **Site** editor, in the **Transformer Ratios** section.

8. Pulse Initiator Value Selections

The kV meter offers a great deal of flexibility in specifying Pulse Initiator (PI) output values. For watt-hour, var-hour, volt-ampere-hour, and Q-hour selections you may enter any value within the range of 0.100 to 288000 Wh/varh/VAh/Qh per pulse. To obtain the best performance, the value selected should be evenly divisible by a number that depends on the meter Class rating, power supply, and kV meter firmware revision, as follows:

Meter Class	Rev 03 & below, kV Divisor: (Power Supply Range)		Rev 04 and above, kV Divisor: (Power Supply Range)	
	120~480V	57~120V	120~480V	57~120V
20	0.0006	0.0003	0.0005	0.0002
200	0.006	0.003	0.005	0.002
320	0.009	0.0045	0.0075	0.003

Use of PI values that are evenly divisible by these numbers will prevent errors from occurring due to truncation of repeating or long decimal values.

Most traditional PI value selections provide error free operation, or contain insignificant errors.

To calculate the magnitude of any possible errors, use the following formula:

$$Percent\ Error = \left[1 - \frac{Integer\left(\frac{desired\ Wh / pulse}{kV\ Divisor}\right)}{\frac{desired\ Wh / pulse}{kV\ Divisor}} \right] \times 100\%$$

Example #1: Using a PI value = 1.0 on a Class 20 kV Meter, Firmware Revision 03 or below:

$$Percent\ Error = \left[1 - \frac{Integer\left(\frac{1.0}{0.0006}\right)}{\frac{1.0}{0.0006}} \right] \times 100\% = \left[1 - \frac{1666}{1666.66667} \right] \times 100\% = 0.04\%$$

Example #2: Using a PI value = 1.0 on a Class 20 kV Meter, Firmware Revision 04:

$$Percent\ Error = \left[1 - \frac{Integer\left(\frac{1.0}{0.0005}\right)}{\frac{1.0}{0.0005}} \right] \times 100\% = \left[1 - \frac{2000}{2000} \right] \times 100\% = 0.00\%$$

Application of Pulse Initiator Values

It is important to remember that for transformer rated applications the PI value programmed into the kV meter must be expressed in secondary watt-hours per pulse. To clarify how this may impact your calculations, here are some examples:

Application Example #1:

An existing installation has an electromechanical meter and a gear driven pulse initiator with an R/P = 1/4. The meter Kh = 1.8 wh/rev. The CTR = 600:5, and there is no VT (i.e. use a VTR = 1:1). How do we program the kV meter to provide the same PI value, and what is the primary value of each pulse?

Solution:

First calculate the existing PI value, both on a secondary and primary basis.

$$\text{Secondary Wh / Pulse} = Kh \times \frac{R}{P} = 1.8 \times \frac{1}{4} = 0.45 \text{ Wh / Pulse}$$

$$\text{Primary kWh / Pulse} = \frac{Kh \times \frac{R}{P} \times CTR \times VTR}{1000} = \frac{1.8 \times \frac{1}{4} \times 120 \times 1}{1000} = 0.054 \text{ kWh / Pulse}$$

Knowing the existing values, simply program the kV meter with the secondary PI value (0.45 wh/pulse). To ensure proper translation of the pulse data, keep in mind that the secondary pulse value needs to be multiplied by the Transformer Factor (TF = CTR X VTR) to determine the pulse value on a primary basis. In this example, the primary pulse value is 0.45 X 120 = 54 Wh/Pulse or 0.054 kWh/Pulse.

Application Example #2

A pulse value equal to 1 kWh/pulse (on a primary basis) is desired from a kV meter. The installation CTR = 500:5, VTR = 4:1.

Solution:

Since the kV meter needs a secondary PI value for programming input, calculate it as follows:

$$\text{Secondary Wh / Pulse} = \frac{\text{Primary kWh / Pulse} \times 1000}{CTR \times VTR} = \frac{1 \times 1000}{100 \times 4} = 2.5 \text{ Wh / Pulse}$$

Program the kV meter with a value of 2.5 Wh/Pulse, and with the CTR and VTR specified in this example, the primary kWh/Pulse value will be as desired, 1 kWh/Pulse.

9. Index

- 3D-vector power, 1-17
- A-base meters, 2-9
- accumulation registers, 1-10, 1-11
- accuracy, 4-8, 4-9, 4-10
- active power, 1-11, 1-12, 3-25, 3-29, 3-30
- Active power, 1-17, 3-28, 3-30
- actual time, 3-26
- adjustments, 1-8
- all zeros, 3-30
- alternate display, 1-2, 3-9, 3-11, 3-13, 3-17, 3-30
- alternate display switch, 1-2
- annunciators, 4-2
- ANSI, 1-1, 1-2, 1-5, 1-11
- ANSI C12.10, 3-2
- ANSI C12.18, 1-1, 1-2, 1-5
- ANSI C12.19, 1-1
- ANSI/IEEE Standard 100
 - definitions, 1-11
- apparent power, 1-11, 1-12
- apparent power measurements, 1-2
- Arithmetic apparent kVA, 1-17
- arithmetic apparent power, 1-13
- average power factor, 3-30
- battery, 1-2, 1-8, 2-17, 2-18, 3-31, 3-32, 4-13, 4-14
 - safety and disposal, 2-18
- Battery, 1-8, 2-17, 4-13, 4-14
- battery carryover time, 3-31
- bezel, 2-3, 2-5, 2-6, 2-7, 2-9, 2-15, 2-17, 3-17, 4-3
- billing data, 4-6
- block demand interval., 1-13
- Blondel, 3-16
- cable, 2-6
- calibration, 1-7, 1-8, 2-15, 4-2, 4-7, 4-8, 4-9, 4-10
- calibration LED, 4-2
- calibration pulses, 4-2
- catch-up tasks, 4-4
- Caution Code Display, 4-13
- cautions, 3-31, 3-32
- Cautions, 3-31, 3-32
- Changing K_t , 4-9
- Circuit boards, 4-12
- cleaning, 4-12
- communications, 1-5, 1-19, 4-2
- connector, 2-2, 2-3, 2-6, 2-7, 2-8, 2-9, 2-18, 4-13
- Continuous cumulative demand, 1-14
- control bus, 1-7
- cover, 1-2, 2-8, 2-15, 2-17, 2-18, 4-3
- CTR, 1-19, 7-2
- cumulative demand, 1-14
- cumulative displays, 3-30
- cumulative power outages, 3-31
- current maximum demand, 1-14
- current sensor, 2-7, 2-15
- current transformer ratio, 1-18
- current waveforms, 1-16
- Data Acquisition Platform, 1-6
- default test mode, 4-4
 - display items, 4-4
- default test mode values, 4-3
- delay, 4-4
- Demand decimal position, 4-4
- demand interval, 4-3
- Demand interval length, 4-4
- demand meter, 1-8, 1-13, 1-14, 2-17, 3-31, 4-4, 4-5
- Demand subinterval length, 4-4
- demand subintervals, 4-4
- Detent settings, 1-10
- detenting, 3-30
- diagnostic, 3-9, 3-10, 3-14, 3-16, 3-17, 3-21, 3-22, 3-23, 3-24, 3-25, 3-26, 3-29
- digital signal processor, 3-30
- disassembly, 2-2, 2-6
- disk analog, 3-12, 3-13, 4-2, 4-7
- Disk analog, 3-12, 4-3, 4-6
- Disk Analog Testing, 4-7
- display format, 1-19, 4-4
- Display Format, 7-2
- display items, 3-9, 4-4, 4-6
- Display Multiplier, 3-7, 7-1, 7-2
- Display Scalar, 3-7, 7-1
- Display Scaling, 7-2
- display switch, 3-8, 3-10, 4-4
- displaying metered data, 1-18
- distortion, 1-2, 1-11, 1-12, 1-13, 1-17, 3-22, 3-23, 3-24, 3-25, 3-29, 3-30, 3-31
- Distortion kilovolt-ampere-hours, 3-28, 3-29, 3-30
- DOS-based software compatible, 1-6
- DSP, 1-7, 1-9, 1-10
- duration of power outages, 3-31
- EEPROM, 1-7
- electrical connections, 4-8
- end-of-interval, 4-6
- energy, ii, 1-2, 1-3, 1-7, 1-8, 1-10, 1-12, 1-13, 1-16, 1-17, 1-18, 1-19, 1-20, 3-11, 3-12, 3-13, 3-23, 3-32, 4-2, 4-3, 4-4, 4-8, 4-13, 5-1, 6-1, 7-1, 7-2
- Energy Calculations, 4-3
- Energy display format, 4-4
- energy flow, 3-12, 3-13, 3-23, 4-2, 4-3, 4-13
- Energy flow annunciators, 4-3
- Er 000 002, 3-31, 4-14
- Error Code Display, 4-14
- event recorder, 3-26
- failures, 3-31
- Fault Symptoms, 4-15
- Field Testing, 4-6
- flow indicator, 4-6
- Fourier series, 1-16
- freeze error codes, 3-31
- fundamental, 1-2, 1-5, 1-7, 1-9, 1-10, 1-12, 1-13, 1-16, 3-11, 3-26, 3-30
- fundamental plus harmonics, 1-10
- gain, 1-7, 1-8
- gain calibration constants, 1-7
- General Information, 1-2
- harmonic components, 1-12
- harmonics, 1-2, 1-5, 1-7, 1-9, 1-10, 1-16, 3-25, 3-26
- header, 2-7, 2-8, 2-9
- High Imputed Neutral Current, 3-26
- high power factors, 4-10
- Hitachi processor, 1-7
- I/O cable, 2-6
- I/O option board, 2-9, 2-10
- I/O-1 board, 2-6
- imputed neutral current, 3-26
- installation, 1-1, 1-17
- installation verification, 1-1

GEH-7271, kV Switchboard Vector Electricity Meter

installations, 1-5, 1-17
instantaneous, 1-5, 1-17, 3-29, 3-30
instantaneous power factor display, 3-30
instrument transformers, 1-18
interval demand, 4-4
IRMS per phase, 3-30
K switch, 3-28, 3-30
 K_t , 1-7
 K_t value, 4-7, 4-8, 4-9
kVAh, 4-3
kVArh, 4-3
kWh, 4-3
KYZ, 2-8
labels, 2-9, 3-17
laptop computers, 1-6
LCD, 3-9, 3-11, 4-2
LED, 4-2, 4-9, 4-10
light-emitting diode, 4-2
liquid crystal display, 1-2, 2-6, 3-11, 3-31, 4-2
load profile, 1-6
Load Profile, 1-2, 1-8
Load profile option board, 2-9, 2-10
load profiling, 4-4, 4-5
load-created distortion, 3-31
LP recording, 4-3
Main Menu, 2-17
Maximum demand, 4-6
meter constants, 1-6
meter cover, 2-8, 2-17, 2-18
meter loading equipment, 4-8
meter mounting equipment, 4-8
Meter Shop Equipment, 4-8
meter test constant, 4-8
metered circuit, 1-18, 1-20
metering constants, 4-3
metering modes
 demand, 2-17
 demand load profile, 2-17
 time-of-use, 2-17
MeterMate, 2-9, 2-11
microcomputer, 1-7
microprocessor, 1-10
midnight boundary, 4-5
momentary interval, 1-7, 1-8, 1-10, 1-13, 3-25, 3-30
multiples errors, 3-32
nameplate, 1-2, 1-7, 1-20, 2-6, 2-17, 3-2, 4-7, 4-8, 4-9
net sum of energy, 1-17
neutral conductor, 1-9
neutral current, 1-7, 3-26, 3-28
number of power outages, 3-31
option board, 1-5, 1-6, 2-3, 2-6, 2-8, 2-15, 3-2, 3-29, 4-14, 4-15
option boards, 2-9
options, 1-2, 1-15
OPTOCOM, 4-2
OPTOCOM, 2-17
OPTOCOM port, 1-7
original packaging, 4-11
orthogonal vectors, 1-11
outage duration, 3-28, 3-30
outages, 3-28, 3-30, 3-31
output cable, 2-8
partial subinterval, 4-5
phantom load, 4-6, 4-7
phase, 1-5, 1-7, 1-8, 1-9, 1-11, 1-13, 1-15, 1-20
phase angle calibration constants, 1-7
phase voltage, 3-19, 3-23, 3-24, 3-28, 4-2, 4-3
Phase voltage, 4-3
Phasor kVA, 1-17
Phasor power, 1-5, 3-29, 3-30
Phasor power methodology, 3-30
Physical Description, 1-2
PI values, 8-1
polyphase service, 1-10
portable standard, 4-6, 4-7
power factor, 1-2, 1-5, 1-7, 1-17, 3-22, 3-23, 3-25, 3-28, 3-29, 3-30, 3-32, 4-4, 4-9
Power factor, 3-25, 3-28, 3-30
power factor alert, 3-28, 3-29, 3-30
power outage, 2-9, 2-11, 4-4
power quality, 1-1, 1-5, 3-25, 3-28
power quality measurement, 3-28
power supply, 4-8
Power Supply, 1-8
Previous interval kW, 4-4
primary reading, 1-18
pulse, 1-7, 1-19, 1-20, 4-2, 4-8, 4-10
pulse initiator (PI) ratios, 1-6
pulse initiator ratios, 1-19
quadergy, 1-10, 4-3
quadergy detent, 1-17
quadrant, 4-2
reactive power, 1-9, 1-11, 1-12, 1-17, 3-25, 3-29, 3-30
Reactive power, 3-28, 3-30
reactive power filter, 1-9
reactive volt-ampere-hours (VArh)., 1-7
Real-time pricing, 1-14
Repair, 4-11
reprogram, 3-31
reset, 1-2, 1-14, 3-9, 3-10, 3-22, 3-30, 4-4, 4-6
Reset, 3-10, 3-22, 4-4, 4-6, 4-7
Reset command, 3-22
Returning a Meter, 4-11
Revenue Guard, 1-1, 1-5, 2-15, 2-16, 3-2, 4-8
Rolling demand, 1-13
S-base meters, 2-9
secondary reading, 1-18
Self-test, 3-31
settling time, 4-9, 4-10
Site Analysis Guides, i, 5-1, 6-1
Site editor, 7-2
SMARTCOUPLER device, 2-17
soft switch, 1-5
Storage, 4-12
subinterval countdown timer, 4-3
Switch holder, 2-17
television interference, ii
Test, 1-7, 2-8, 2-15, 3-3, 3-4, 3-8, 3-9, 3-10, 3-13, 3-14, 3-22, 3-23, 3-24, 3-25, 3-26, 3-27, 4-3, 4-4, 4-5, 4-6, 4-8, 4-9, 4-10
test accumulators, 3-10, 4-3
test annunciator, 4-3
Test constant, 1-7
test demand
 time remaining in interval, 4-4
 time remaining in subinterval, 4-4
test kW demand, 4-4
test mode, 3-10, 3-11, 3-22, 4-3, 4-4, 4-5, 4-6
Test mode, 4-4
 maximums for kQ, 4-4
 maximums for kVA, 4-4
 maximums per kVA, 4-4

Test Mode, 3-8, 3-10, 3-13, 3-14, 4-3, 4-4, 4-5, 4-6
 test mode switch, 4-3
 test mode values, 4-3
 Test Procedure, 4-9, 4-10
 test pulses, 4-9
 test switch, 1-2, 4-3, 4-5
 test time, 4-9
 testing, 3-22, 4-2, 4-3, 4-7, 4-8, 4-9, 4-10
 thermal demand meter, 1-14
 Time Keeping Battery, 1-8, 2-17
 Time remaining in subinterval, 4-4
 time-based measurement of distortion, 3-30
 TOU meter, 2-17, 3-30, 3-31, 4-4, 4-5
 transformer factor, 1-18
 Transformer Factor, 8-2
 Transformer Ratios, 7-2
 Triplen currents, 3-26
 triplens, 3-26
 Troubleshooting, 3-31, 3-32, 4-13

universal register ratios, 1-19
 unprogrammed, 3-32, 4-4, 4-13
 VAh, 4-3
 values, 1-7, 1-9, 1-14, 1-18, 1-19, 1-20, 3-22, 3-23, 3-30, 4-3, 4-8, 4-9, 4-13
 VARh, 4-3
 VARh test times, 4-10
 VARhour, 4-2
 VARhours, 1-7, 1-9, 1-17, 4-2, 4-10
 voltage transformer ratio, 1-18
 voltage waveforms, 1-16
 volt-ampere-hour, 4-3
 VRMS per phase, 3-30
 VTR, 1-19, 7-2
 Watthour, 4-2
 Watthour constant, 4-8
 Watthours, 1-7, 1-9, 1-10, 1-17, 3-12, 3-13, 4-2, 4-3, 4-7, 4-8, 4-10
 Wh, 4-3

