kV2c® Gen 5 Electronic Meter

Features and Applications Guide

132272-TUM
Revision 2
www.Aclara.com

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FCC COMPLIANCE

This product generates and uses radio frequency energy. It has been tested and verified that it complies with the limits for the Code of Federal Regulations (CFR) 47, Part 15 - Radio Frequency Devices, Subparts A - General and B -Unintentional Radiators issued by the Federal Communications Commission for Class B digital devices. If, however, the product causes radio or television interference, notify:

Manager - Technology
Aclara Technologies
130 Main Street
Somersworth, NH 03878-3194

Class A equipment is intended for use in an industrial environment. The equipment generates, uses, and can radiate radio frequency energy, and, if not installed and used in accordance with these instructions, may cause interference to other devices in the vicinity. If this equipment does cause interference with other devices, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving device.
- Increase the separation between the equipment.
- Connect the equipment into an outlet on a circuit different from the impacted device(s).
- Consult the manufacturer or field service technician for help.

Class B equipment is intended for use in a residential environment. The equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interferences to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from the receiver.
- Consult the dealer or an experienced ration/TV technician for help.

NOTE All meters mentioned in this manual meet requirements for FCC Class B devices.

This Class B digital apparatus complies with Canadian ICES-003.

NOTE All meters mentioned in this manual meet requirements for ICES-003 Class B devices.

WARNINGS AND CAUTIONS

Electrical equipment contains hazardous voltages and may cause death, serious personal injury, or equipment damage.

Always de-energize and ground the equipment before maintenance. Maintenance should be performed only by qualified personnel. The use of unauthorized parts in the repair of the equipment or tampering by unqualified personnel will result in dangerous conditions which will cause severe personal injury or equipment damage. Follow all safety instructions contained herein.

IMPORTANT

The information contained herein is general and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased. Aclara reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligations. Should a conflict arise between the general information contained in this publication and the contents of drawing or supplementary material or both, the latter shall take precedence.

The equipment in this manual must be operated only from the power source specified.

The successful operation of this equipment depends upon proper handling, installation, and operation. Neglecting fundamental installation requirements may lead to personal injury as well as damage to electrical equipment or other property.

All electronic components within the meter are susceptible to damage from electrostatic discharge. To prevent damage when handling this product, use approved static control procedures.

Hazardous voltages can cause shock, burns, or death. To prevent exposure to hazardous voltages, disconnect and lock out all power sources before servicing and removing components.

If the meter is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

Unauthorized changes or modifications made to the unit could void the warranty.

QUALIFIED PERSON

For the purpose of this manual, a qualified person is one who is familiar with the installation, configuration, or operation of the equipment and the hazards involved. In addition, the person is:

- trained and authorized to de-energize, clear, ground, and tag circuits and equipment in accordance with established safety procedures;
- trained in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc. in accordance with established safety practices; and
- trained in rendering first aid.

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 procedures.

Before You Start

Read and thoroughly understand this guide before installing and operating the unit. Save these instructions for later use and reference.

The procedures in this document must be strictly adhered to. Any deviation from these could cause irreversible damages to the meter and could lead to property damage, personal injury, and/or death. Installation of the meter must be carried out by qualified personnel only.

Safety Precautions

Follow all safety precautions and instructions in this guide.

Only qualified personnel should work on the meter. Maintenance personnel should be familiar with the technology and the hazards associated with electrical equipment.

- Never work alone.
- Before performing visual inspections, tests, or maintenance on this equipment, isolate or disconnect all hazardous live circuits and sources of electric power. Assume that all circuits are live until they have been completely de-energized, tested, and tagged. Pay particular attention to the design of the power system. Consider all sources of power, including the possibility of back feed.
- Turn off all power supplying the equipment in which the meter is to be installed before installing and wiring the meter.

- Operate only from the power source specified on the installed power supply module.
- Beware of potential hazards and wear personal protective equipment.
- The successful operation of this equipment depends upon proper handling, installation, and operation. Neglecting fundamental installation requirements may lead to personal injury as well as damage to electrical equipment or other property.
- All electronic components within the meter are susceptible to damage from electrostatic discharge. To prevent damage when handling this product use approved static control procedures.
- Hazardous voltages can cause shock, burns or death. To prevent exposure to hazardous voltages, disconnect and lock out all power sources before servicing and removing components.
- If the meter is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.
- Changes or modifications made to the unit not authorized by Aclara could void the warranty.

Table of Contents

CHAPTER 1

INTRODUCTION

The features of the kV2c Gen 5 meter are explained in this document. The firmware supports current transformers, five thermal demand calculations, unsealed passwords, and self-reads without a H, R, or X softswitch. It also supports the previous five self-read display items.

This document 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 procedures.

Intended Audience

This document is intended for extensively trained and qualified metering personnel, industrial electricians, and metering specialists only.

Related Documentation

The following publications are referenced in this manual.

132271-TUM kV2c Gen 5 Electronic Meter User Manual

This user manual provides operating, maintenance, and upgrading instructions along with site analysis guides and diagrams for the kV2c Gen 5 meter family. This document plus the latest version of all other Aclara technical publications are available on Aclara Connect.

Handbook for Electricity Metering, 9th Edition (Edison Electronic Institute)

ANSI C12.18 Protocol Specification for ANSI Type 2 Optical Port

ANSI C12.19 Utility Industry End Device Data Tables

Support

If you have a question, an issue, or would like to speak with Aclara Support personnel, please contact Aclara using one of the following methods.

Technical Support

Email support@aclara.com or call 1-800-892-9008 to speak with an Aclara representative.

Returning Product

To return product, email rma@aclara.com or call 1-800-892-9008.

CHAPTER

2

MEASUREMENT AND MEASUREMENT PROFILE

This chapter defines the various quantities that may be calculated by the kV2c Gen 5 meter family. The kV2c Gen 5 meter can calculate a wide range of quantities, which will be defined in this section. This section will also explain the concept of the measurement profile, which is a list of up to 20 quantities the meter will accumulate.

NOTE The MeterMate programming software provides default measurement profiles, which contain the standard selections. One of the measurement profiles provided, for example, duplicates the measurement choices available in the kV meter. This enables a user who is only interested in the more typical billing measurements to create programs without having to search through all of the selections the meter provides.

Terms

The following terms used in this document are defined as:

momentary interval

A momentary interval is 60 cycles of the fundamental frequency of the voltage signal for 60 Hz applications and 50 cycles for 50 Hz applications.

fundamental only

A fundamental only quantity uses the fundamental frequency component of the voltage and/or current to compute the quantity.

fundamental plus harmonics

A fundamental plus harmonics quantity has the fundamental component and the harmonic components in it.

per element

The kV2c Gen 5 meter internally converts all services into a 4-wire wye. Per element quantities are calculated after this conversion has taken place. Therefore, for example, Element A watt-hours in a 3-wire delta is calculated from a voltage with respect to an imputed neutral.

The kV2c Gen 5 meter calculates a set of various quantities (watt-hour, var-hour, volt-ampere-hour, voltages, currents, etc.) and determines a quadrant for every momentary interval. The quadrant is based on the sign of the total watt-hours and var-hours (both fundamental plus harmonics data) for all elements over that momentary interval. The decision whether to add data to a selected

quadrant-specific quantity is made every momentary interval based on the quadrant number for that momentary interval. Quadrant numbers for per-element quantities are still based on the total watt-hours and var-hours. The quadrant numbers are not determined for each element individually.

Operation in Demand, Demand/Load Profile, and Time-of-Use Mode

The following measurements may be calculated.

Watt-Hour

The kV2c Gen 5 meter provides the following Wh measurement choices:

- Wh sum of elements delivered only
- Wh sum of elements received only
- Wh sum of elements |delivered| - |received|
- Wh sum of elements |delivered| + |received|
- Wh per quadrant
- Wh per element delivered
- Wh per element received
- Wh per element |delivered| - |received|
- Wh per element |delivered| + |received|
- Wh per element per quadrant

Each of these quantities can be specified to be fundamental only or fundamental plus harmonics. Some quantities require a softswitch; see *Measurement Restrictions* on page 13.

Var-Hour

The kV2c Gen 5 meter provides the following varh measurement choices:

- varh sum of elements lagging only
- varh sum of elements leading only
- varh sum of elements |lagging| - |leading|
- varh sum of elements |lagging| + |leading|
- varh per element lagging

- varh per element leading
- varh per element |lagging| - |leading|
- varh per element |lagging| + |leading|
- varh per element per quadrant

Each of the above quantities can be specified to be fundamental only or fundamental plus harmonics. Fundamental plus harmonics varh quantities can be calculated according to the IEEE definition, or as fuzzy varh. Per element fuzzy varh is calculated as:

$$\text{fuzzy varh}_x = \sqrt{(\text{varh}_x)^2 + (\text{distortion VAh}_x)^2}$$

x = element A, B, C; and *varh* is a fundamental plus harmonics value.

The vector sum is done each momentary interval. The sum of all elements fuzzy varh is the arithmetic sum of the per element fuzzy varh quantities. Note that in the case of fundamental only varh, there is no difference between fuzzy varh and IEEE varh, since the distortion VAh component is zero. Refer to *Distortion Volt-Ampere-Hours* on page 8 for information on calculating distortion VAh. All varh quantities require a softswitch.

Volt-Ampere-Hour

The kV2c Gen 5 meter provides the following VAh measurement choices. Refer to *Measurement Restrictions* on page 13 for the softswitches required for the VAh quantities described below:

- Apparent VAh
- Arithmetic apparent VAh
- Phasor VAh
- Apparent VAh per quadrant
- Arithmetic apparent VAh per quadrant
- Phasor apparent VAh per quadrant
- Apparent VAh per element
- Apparent VAh per element per quadrant

Apparent VAh

Apparent VAh is calculated each momentary interval as:

$$\text{Apparent VAh} = \sqrt{\left(\sum \text{Wh}_x\right)^2 + \left(\sum \text{varh}_x\right)^2 + \left(\sum \text{distortion VAh}_x\right)^2}$$

x = element A, B, C; and *Wh* and *varh* are fundamental plus harmonics values.

Arithmetic Apparent VAh

Arithmetic apparent VAh is the arithmetic sum of the per element VAh quantities. Each per element apparent VAh quantity is calculated each momentary interval as follows:

$$\text{Apparent VAh}_x = \sqrt{(V^2h_x) \times (I^2h_x)}$$

x = element A, B, C; and V^2h_x and I^2h_x are fundamental plus harmonics values.

Phasor VAh

Phasor VAh can be measured three different ways in the kV2c Gen 5 meter:

1. Phasor VAh fundamental plus harmonics, calculated with IEEE varh;
2. Phasor VAh fundamental plus harmonics, calculated using fuzzy varh; and
3. Phasor VAh fundamental only.

Phasor VAh is calculated each momentary interval as follows:

$$\text{Phasor VAh} = \sqrt{(\text{Wh})^2 + (\text{varh})^2}$$

x = element A, B, C.

Whether the Wh and varh values are fundamental plus harmonics or fundamental only and whether the varh quantity is IEEE varh or fuzzy varh determines the type of Phasor VAh quantity that is calculated.

Q-Hour

Q-hours are calculated each momentary interval as follows:

$$\text{Qh} = \frac{1}{2}\left[\sum_x \text{Wh}_x\right] + \frac{\sqrt{3}}{2}\left[\sum_x \text{varh}_x\right]$$

x = element A, B, C, and Wh and varh are fundamental plus harmonics values.

If the result of the calculation is negative, Qh for the momentary interval is set to zero. The K softswitch is required for Qh.

Volt-Squared-Hour

The kV2c Gen 5 meter provides the following volt-squared-hour measurement choices:

- V^2h line-to-neutral
- V^2h line-to-line

Both fundamental plus harmonics and fundamental only line-to-neutral and line-to-line quantities are available.

The Q softswitch is required for these quantities

Ampere-Squared-Hour

The kV2c Gen 5 meter provides the following ampere-squared-hour measurement choices:

- I^2h
- I_n^2h (neutral current-squared-hours)

Neutral current-squared-hours is an imputed quantity; it is not measured directly. It is only available as a fundamental plus harmonics quantity. The element current-squared-hour quantities are available as fundamental only and fundamental plus harmonics values.

The Q softswitch is required for these quantities

Voltage

The kV2c Gen 5 meter provides the following voltage measurement choices:

- Voltage line-to-neutral
- Voltage line-to-line

Both line-to-neutral and line-to-line quantities are available as fundamental only and fundamental plus harmonics values. Voltages are calculated every momentary interval and are the average RMS values for that momentary interval.

The kV2c Gen 5 meter internally converts all services into 4-wire wyes. The voltage selections in the measurement profile (see *Measurement Profile* on page 11) are based on this conversion. The user must be careful to choose the appropriate voltage based on the meter form and service.

NOTE This is not the case for Site Genie voltages (see *Site Genie*® on page 55).

The Q softswitch is required if voltage measures are to be used in data accumulations, summations, demand calculations, or load profile. The Q softswitch is not required to display the most recent momentary interval voltages or for Site Genie functions.

Current

The kV2c Gen 5 meter provides the following current measurement choices:

- I_n (neutral current)
- Current

Neutral current is an imputed quantity; it is not measured directly. It is only available as a fundamental plus harmonics quantity. Element current quantities are available as fundamental only and fundamental plus harmonics values.

The Q softswitch is required if voltage measures are to be used in data accumulations, summations, demand calculations, or load profile. The Q softswitch is not required to display the most recent momentary interval voltages or for Site Genie functions.

Distortion Volt-Ampere-Hours

The kV2c Gen 5 meter calculates distortion volt-ampere-hours (VAh) per element each momentary interval as follows:

$$\text{Distortion VAh}_x = \sqrt{(V^2h_x) \times (I^2h_x) - (Wh_x)^2 - (varh_x)^2}$$

x = element A, B, C and V^2h_x, I^2h_x, Wh_x, and $varh_x$ are fundamental plus harmonics quantities.

Total distortion VAh is the sum of the per element values. Calculating total distortion VAh requires that a sign is given to each per-element value. For meter and service combinations that satisfy Blondel's theorem, each element distortion VAh is given the same sign as the corresponding element fundamental plus harmonics varh. For combinations that do not, each element distortion VAh is given the same sign as the sum of elements fundamental plus harmonics Wh.

The Q softswitch is required if voltage measures are to be used in data accumulations, summations, demand calculations, or load profile. The Q softswitch is not required to display the most recent momentary interval voltages or for Site Genie functions.

Distortion Power Factor

The kV2c Gen 5 meter calculates distortion power factor each momentary interval as follows:

$$\text{Distortion PF}_x = \frac{\text{Distortion VAh}_x}{\text{Apparent VAh}_x}$$

x = element A, B, C, and sum of all elements.

Distortion power factor is not given a sign; it is always positive. The sum of all elements apparent VAh in the calculation is not the arithmetic sum of the per element apparent VAh quantities. It is the result of the apparent VAh calculation described by the *Arithmetic Apparent VAh* equation on page 6.

The Q softswitch is required if voltage measures are to be used in data accumulations, summations, demand calculations, or load profile. The Q softswitch is not required to display the most recent momentary interval voltages or for Site Genie functions.

Total Demand Distortion

The kV2c Gen 5 meter calculates total demand distortion (TDD) each momentary interval as follows:

$$\text{Total Demand Distortion}_x = \frac{\text{RMS of Harmonic Content of Current}_x}{\text{Max Installation Current}}$$

x = element A, B, C, and maximum installation current is a programmed value (typically set to the class amperage).

The Q softswitch is required if voltage measures are to be used in data accumulations, summations, demand calculations, or load profile. The Q softswitch is not required to display the most recent momentary interval voltages or for Site Genie functions.

Total Harmonic Distortion

The kV2c Gen 5 meter calculates voltage total harmonic distortion (VTHD) and current total harmonic distortion (ITHD). These are calculated each momentary interval as follows:

$$VTHD_x = \frac{\text{RMS of Harmonic Content of Voltage}_x}{\text{RMS of Fundamental Component of Voltage}_x}$$

$$ITHD_x = \frac{\text{RMS of Harmonic Content of Current}_x}{\text{RMS of Fundamental Component of Current}_x}$$

x = element A, B, C.

Although it is possible in some cases for the denominators to be larger than the numerators in these calculations, the kV2c Gen 5 meter does not allow the values to exceed 100%.

The Q softswitch is required if voltage measures are to be used in data accumulations, summations, demand calculations, or load profile. The Q softswitch is not required to display the most recent momentary interval voltages or for Site Genie functions.

Average Voltage

The kV2c Gen 5 meter calculates average voltage for load profile recording only. The following average voltages are available:

- V_A
- V_B
- V_C
- V_{AC}
- V_{CB}
- V_{BA}

Each of these quantities can be specified as fundamental only or fundamental plus harmonics. Average voltage is calculated as follows:

$$V_{average} = \frac{1}{N} \sum_{k=1}^{N} Vrms_i$$

N = number of momentary intervals over which the average is taken, and $Vrms_i$ = RMS voltage over momentary interval i.

Average Current

The kV2c Gen 5 meter calculates average current for load profile recording only. The following average voltages are available:

- I_A
- I_B
- I_C

Each of these quantities can be specified as fundamental only or fundamental plus harmonics.

The kV2c Gen 5 meter calculates average voltage as follows:

$$I_{average} = \frac{1}{N} \sum_{k=1}^{N} Irms_i$$

N = number of momentary intervals over which the average is taken, and $Vrms_i$ = RMS current over momentary interval i.

Temperature

The kV2c Gen 5 meter provides temperature in degrees Celsius, updated every momentary interval.

The Q softswitch is required if temperature is to be used in data accumulations, summations, demand calculations, or load profile. The Q softswitch is not required to display the most recent momentary interval temperature or for Site Genie functions.

The meter also provides average temperature for load profile recording only. It calculates average temperature as follows:

$$T_{average} = \frac{1}{N} \sum_{k=1}^{N} T_i$$

N = number of momentary intervals over which the average is taken, and T_i = temperature during momentary interval i.

Measurement Profile

The measurement profile serves two basic purposes: it specifies the quantities that will be calculated for the *Data Accumulations* (see page 17); and it specifies the

quantities from which the summations, demand calculations, and load profile quantities may be selected.

Any quantity the meter can calculate can be included in the measurement profile. Quantities such as voltage, which are not integrated but rather represent an average over a momentary interval, also require an operation to be specified in the profile. The possible operations are minimum, maximum, and store. Minimum means capture the smallest magnitude value over a given interval of time (e.g., load profile interval, time since last Master Reset procedure); maximum means capture the largest magnitude value over a given interval of time; and store means capture the most recent value.

In addition to the quantities defined above, external pulse inputs can be defined in the measurement profile. Refer to *Option Boards* on page 119 for more information.

Other Available Momentary Interval Quantities

In the kV2c Gen 5 meter, there is a set of pre-defined quantities that are available regardless of what has been selected in the measurement profile. These predefined quantities are updated every momentary interval. There is no operation (sum, maximum, minimum, or store) associated with any of the quantities in this set, and they are present regardless of what softswitches are enabled. They may be displayed on the meter's LCD. The following are available:

- kW per element, fundamental plus harmonics
- kW per element, fundamental only
- kvar per element, fundamental plus harmonics
- kvar per element, fundamental only
- Distortion kVA per element
- Apparent kVA per element
- Line-to-neutral voltages, fundamental plus harmonics
- Line-to-neutral voltages, fundamental only
- Line-to-line voltages, fundamental plus harmonics
- Line-to-line voltages, fundamental only
- Currents, fundamental only
- Currents, fundamental plus harmonics
- Imputed neutral current

- Power factor (calculated as net Wh divided by Apparent VAh, where net Wh = |delivered Wh| - |received Wh|)
- Frequency (of fundamental voltage signal)
- Total demand distortion per element
- Current total harmonic distortion per element
- Voltage total harmonic distortion per element
- Distortion power factor, per element and total
- Temperature in degrees Celsius

Measurement Restrictions

Four softswitches control what measurement profile quantities the meter will calculate for data accumulations, summations, demands, load profile data, and power factor data.

Quantities available with no measurement upgrades

- Wh sum of elements delivered only
- Wh sum of elements received only
- Wh sum of elements |delivered| - |received|
- Wh sum of elements |delivered| + |received|

•Frequency

Quantities available with the kVA/kvar/kQ upgrade (K softswitch)

- varh sum of elements lagging only
- varh sum of elements leading only
- varh sum of elements |lagging| - |leading|
- varh sum of elements |lagging| + |leading|
- Qh
- Apparent VAh
- Arithmetic apparent VAh
- Phasor apparent VAh

Quantities available with By Quadrant Measurements upgrade (B softswitch)

- Wh per quadrant
- varh per quadrant
- Apparent VAh per quadrant
- Arithmetic apparent VAh per quadrant
- Phasor apparent VAh per quadrant

Quantities available with Expanded Measurements upgrade (M softswitch)

- Wh per element delivered
- Wh per element received
- Wh per element |delivered| - |received|
- Wh per element |delivered| + |received|
- Wh per element per quadrant
- varh per element lagging
- varh per element leading
- varh per element |lagging| - |leading|
- varh per element |lagging| + |leading|
- varh per element per quadrant
- Apparent VAh per element
- Apparent VAh per element per quadrant

Quantities available with Power Quality Measure upgrade (Q softswitch)

- V_2h line-to-neutral
- V_2h line-to-line
- I_2h
- I_n^2h (neutral current-squared-hours)
- I_n (neutral current)
- Voltage line-to-neutral

- Voltage line-to-line
- Current
- Distortion VAh per element
- Distortion VAh
- Distortion power factor per element
- Distortion power factor
- VTHD
- ITHD
- TDD
- Average voltage (available for load profile recording only)
- Average current (available for load profile recording only)
- Temperature (average available for load profile recording only)

If a quantity is specified in the measurement profile in a meter without the appropriate softswitch, the quantity will not accumulate or be recorded, regardless of where it is used (e.g., data accumulations, summations, load profile).

CHAPTER

3

DATA ACCUMULATIONS

The purpose of the data accumulations feature is to take advantage of the measurement capability of the kV2c Gen 5 meter without the need to store large quantities of data by TOU rate or in demand reset/season change/self-read areas or the need to require users to purchase load profile softswitches.

Operation in Demand, Demand/Load Profile, and Time-of-Use Mode

The quantities stored in data accumulations are specified by the Measurement Profile. Each minute, the selected quantities are updated with the data that has accumulated over that minute. One-minute accumulations of integrated quantities, such as Wh, varh, VAh, Qh, I_2h, and V_2h, are added to the overall values. Data accumulations are displayable on the meter's LCD and available in the MeterMate MMCOMM Site Status report. They are also available in a MeterMate report.Non-integrated quantities (those that represent an average over one momentary interval) are not added. Measurement profile entries for non-integrated quantities, include an operation: maximum, minimum, or store. These operations are defined in *Measurement Profile* on page 11. For maximum quantities, the one-minute accumulation contains the maximum momentary interval value collected during that minute. For minimum quantities, it contains the minimum momentary interval value. For store quantities, it contains the most recent momentary interval value. Updating the overall values that are maximum or minimum consists of comparing the current overall value to the new minute value and replacing the overall value if needed. Updating store operation values consists of always replacing the overall value with the new minute value.

Data Accumulation Restrictions

Unlike billing measurements such as demands and summations, data accumulations are not saved as part of demand reset, season change, or self-read data. Nor are they saved by TOU rate.

If a given data accumulations quantity requires a softswitch which is not present in the meter, the quantity will be set to zero. Descriptions of measurement quantity options available by softswitch are outlined in *Measurement Restrictions* on page 13.

CHAPTER
4

SUMMATIONS

Summations are similar to data accumulations in that they may be integrated quantities as well as momentary interval averages with a defined operation. Like data accumulations, summations are updated each minute with the data collected over that minute.

Up to five summations can be specified in the kV2c Gen 5 meter. The five summations are a subset of the quantities defined in the *Measurement Profile* on page 11. The selection is made when creating a program with MeterMate Program Manager (Basic Meter Configuration Support Table). If a given summations quantity requires a softswitch which is not present in the meter, the quantity will be set to zero. Descriptions of measurement quantity options available by softswitch are outlined in *Measurement Restrictions* on page 13.

Operation in Demand and Demand/Load Profile Mode

In Demand only and Demand/Load Profile meters, there are two sets of summations: one set is updated only when the meter is in Real-time Pricing (RTP) mode, and the other set is updated both when the meter is in Normal mode and in RTP mode. Summations are saved as part of the previous demand reset data as well as the self-read data.

Summations (current revenue and previous demand reset) may be viewed on the meter's LCD and may be read and viewed using MeterMate.

Operation in Time-of-Use Mode

In a TOU meter, there are five sets of summations. There are the overall summations, which accumulate regardless of the TOU rate in effect, and one set each for TOU rates A through D. Summations are saved as part of the previous demand reset data, previous season data, and self-read data.

Summations (current revenue, previous demand reset, and previous season) are viewable on the meter display and may be read using MeterMate.

Data that is collected in one TOU rate is never added to summations for a different TOU rate.

If the meter loses its date and time, it will update the summations for its programmed default TOU rate in addition to its overall summations.

CHAPTER

5

DEMAND CALCULATIONS

The kV2c Gen 5 meter can compute demands using rolling demand, block demand, or thermal demand emulation algorithms.

NOTE The term *maximum demand* is used throughout this section. Its meaning is more general than it has been in previous meters. The kV2c Gen 5 meter does not restrict values treated as demands to kW/kvar/kVA/kQ.

For example, maximum element A line-to-neutral voltage fundamental plus harmonics may be computed as a demand value. In the case of thermal demand, only one demand value may be specified.

There are a number of programmable parameters that control how the demand calculations feature operates. These parameters are selectable when creating programs with MeterMate Program Manager (Basic Meter Configuration Support Table for all parameters except End of Interval Duration, which is available in the I/O and Alerts Support Table) and are described below. The number and length of subintervals are shown in *Subinterval Selections* on page 22.

Type of Demand

The type of demand to be calculated (block, rolling, or thermal).

Selection of Demands

The selection of demands to be calculated by the meter is specified by selecting five of the twenty available measures in the *Measurement Profile* on page 11 for meters programmed for block and rolling demand or one of the twenty for meters programmed for thermal demand. Quantities in the Measurement Profile defined as min or store quantities can't be selected as demands.

Selection of Coincident Values

This parameter involves the selection of two coincident values for each of the five selected demand values (block and rolling demand only; there are no coincident demands available with thermal emulation demands). Each coincident value for a demand may be either one of the other four demands or a power factor value. The power factor value is defined as a quotient of two of the selected demands. Up to two different coincident power factors can be defined.

Power fail exclusion time

The length of time, in minutes, after power up, during which the meter will not compute demands.

Subinterval multiplier

Number of subintervals per interval (rolling demand only).

Subinterval length

Length, in minutes, of a demand subinterval (rolling demand only).

Interval length

Length, in minutes, of a demand interval (block demand only).

End of interval duration

Amount of time, in seconds, the end of interval indicator is lit at the end of a demand calculation and an end of interval output is asserted (if the meter is programmed to do so).

Subinterval Selections

	Subinterval Length (in minutes)										
# of Subintervals	1	2	3	4	5	6	10	15	20	30	60
1 (block demand)	X	X	X	X	X	X	X	X	X	X	X
2	X	X	X		X	X	X	X		X	
3	X	X		X	X		X		X		
4	X		X		X						
5	X		X	X		X					
6	X	X			X		X				
10	X	X	X			X					
12	X				X						
15	X	X		X							

Operation in Demand Mode

In a Demand meter, there are two sets of demands. The first is the *Normal mode* set of maximum demands, which is calculated when the meter is operating in Normal mode (i.e., not in Real-time Pricing mode). The second is the real-time pricing set, which is only calculated when the meter is operating in Real-time Pricing mode. For a meter programmed for block or rolling demand, each set of demands contains of up to five quantities. For a meter programmed for thermal emulation, each set contains only one demand.

Maximum and cumulative demands (current revenue, previous demand reset, and previous season) are displayable on the meter's LCD. Demands may also be read with MeterMate.

Previous interval demands (for block and rolling demand calculations) or current thermal demands, as well as momentary interval averages for the selected demands, are displayable on the meter's LCD.

Block and Rolling Demands

The following sections provide calculation and interval information for block and rolling demands in Demand mode.

Demand Calculations

If the power fail exclusion is in effect, the meter does not calculate demands. If the power fail exclusion is not in effect, demands are calculated at the end of each demand interval.

NOTE In the case of rolling demand, a demand interval ends when a subinterval ends.

For block demand, the demand values are calculated based on the data collected over the most recent demand interval. For rolling demand, the demand values are calculated based on the data collected over the N most recent subintervals, where N is the programmed number of subintervals per interval. A demand calculation consists of the following steps:

1. For summed quantities, the average demand over the demand interval is calculated. For quantities defined as max values, the maximum value of the quantity that occurred during the demand interval is determined.
2. The previous interval demands for the five selected demand quantities are set to the newly computed demand quantities.
3. If real-time pricing is not active, the kV2c Gen 5 meter does the following:
   - The newly computed demand values are compared to the overall maximum demand values.
   - If a newly computed demand value is larger than its corresponding overall maximum demand, the overall maximum demand is set to the newly computed value and the corresponding coincident values are updated.

   If real-time pricing is active, the kV2c Gen 5 meter does the following:
   - The newly computed demand values are compared to the real-time pricing maximum demand values.
   - If a newly computed demand value is larger than its corresponding real-time pricing maximum demand, the real-time pricing maximum demand is set to the newly computed value and the corresponding coincident values are updated.

At the end of a demand interval, the end of interval indicator on the LCD is lit for the programmed number of seconds. Also, if programmed to do so, the kV2c Gen 5 meter asserts an output for the end of interval duration time.

Partial Demand Intervals

In a kV2c Gen 5 meter programmed operating in Demand mode, the following events will cause a demand calculation to be performed before the normal end of an interval or subinterval:

- Power failure
- Entering Test mode
- Entering or exiting Real-time Pricing mode

When one of these events occurs, the kV2c Gen 5 meter calculates demands as described in the section above. When computing demands, the data is treated as though it had accumulated over a complete demand interval. For example, if a kV2c Gen 5 meter was metering a 5 kW load and Test mode was initiated halfway through a demand interval, the calculated demand would be 2.5 kW.

The first demand interval or subinterval after a power failure or exiting Test mode is also a partial interval. Under no circumstances does the kV2c Gen 5 meter allow a long demand interval.

Thermal Emulation Demand

If the power fail exclusion is in effect, the meter does not calculate demands. If the power fail exclusion is not in effect, thermal demand values are updated every momentary interval. As required by ANSI C12.5-1978, the time constant of the kV2c Gen 5 meter is not less than 15 minutes. The exponential function that characterizes a thermal demand meter is approximated in the kV2c Gen 5 meter as follows:

$$I_n = I_{n-1} + (P_n - I_{n-1})\frac{1}{392.4}$$

I_n = the current thermal demand reading, I_{n-1} is the previous thermal demand reading, and P_n is the current momentary interval demand.

Each momentary interval, a new thermal demand, referred to as the current demand reading (I_n in the equation above), is calculated.

If real-time pricing is not active, the current thermal demand reading is compared to the overall maximum demand. If it is larger than the current overall maximum demand, then the current overall max demand is set to the current demand reading.

If real-time pricing is active, the current thermal demand reading is compared to the real-time pricing maximum demand. If it is larger than the real-time pricing maximum demand, then the real-time pricing max demand is set to the current demand reading.

Coincident demands are not available in a kV2c Gen 5 meter programmed for thermal demand calculations.

Cumulative Demand

Cumulative demand is computed when a demand reset is performed and is the sum of the cumulative demand prior to demand reset and the maximum demand prior to demand reset. For a meter programmed for block or rolling demand, there are five cumulative demands computed for Normal mode and five for Real-time Pricing mode. For a meter programmed for thermal demand, there is one cumulative demand for Normal mode and one for Real-time Pricing mode. Demand reset operation is described in more detail in *Demand Reset* on page 29.

Continuously Cumulative Demand

Continuously cumulative demand is the sum of the cumulative demand and the current maximum demand. This value is not stored in the meter. It is computed when it is to be displayed on the meter's LCD. For a meter programmed for block or rolling demand, there are five continuously cumulative demands computed for Normal mode and five for Real-time Pricing mode. For a meter programmed for thermal demand, there is one continuously cumulative demand for Normal mode and one for Real-time Pricing mode. Continuously cumulative demands for the previous reset data can also be displayed on the meter's LCD or computed by a reading device from data read from the meter.

Operation in Demand/Load Profile Mode

The same demands and demand calculations described in Demand mode are also available in Demand/Load Profile meter.

Partial Demand Intervals

The same events which cause a partial demand interval to occur in a kV2c Gen 5 meter in Demand mode will also cause a partial demand interval in a kV2c Gen 5 meter in Demand/Load Profile mode. In addition, setting the time in a kV2c Gen 5 meter will cause a partial demand interval.

The difference in calculations between Demand mode and Demand/Load Profile mode is that in Demand/Load Profile mode the demand intervals are synchronized to midnight. If a kV2c Gen 5 meter operating in Demand/Load Profile mode is programmed for 15 minute block intervals, the intervals will end at the hour boundary and at 15, 30, and 45 minutes past the hour. On power up, after exiting Test mode and after a time change, the time remaining in the demand interval is set so that demand intervals continue to be synchronized to midnight.

Thermal Demand Emulation, Cumulative Demand, and Continuously Cumulative Demand

Thermal demand emulation, cumulative demands, and continuously cumulative demands operate the same way in Demand/Load Profile mode as they do in Demand mode.

Operation in Time-of-Use Mode

In a TOU meter, there are five sets of demands. There are the overall maximum demands, which are calculated regardless of the TOU rate in effect, and one set each for TOU rates A through D. For a meter programmed for block or rolling demand, each set of demands contains of up to five quantities. For a meter programmed for thermal emulation, each set contains only one demand. Demands (maximums and cumulatives), are saved as part of the previous demand reset data, previous season data, and self-read data.

Maximum and cumulative demands (current revenue, previous demand reset, and previous season) are displayable on the meter's LCD. Demands may also be read and viewed with MeterMate.

Previous interval demands (for block and rolling demand calculations) or current thermal demands, as well as momentary interval averages for the selected demands, are displayable on the meter's LCD.

NOTE Data that is collected in one TOU rate is never used to calculate demands in a different TOU rate.

If the meter loses its date and time, it will update the demand data for its programmed default TOU rate in addition to its overall demand data.

Block and Rolling Demands

The following sections detail calculation and interval information for Block and Rolling Demands during TOU mode.

Demand Calculations

In a TOU meter, demands the average demand over the demand interval is calculated. For quantities defined as max values, the maximum value of the quantity that occurred during the demand interval is determined.

The previous interval demands for the five selected demand quantities are set to the newly computed demand quantities.

The results of the demand calculations are compared to the overall maximum demands, and if a newly calculated demand is greater than its corresponding overall maximum demand, the overall maximum demand is set to the new value. If the meter is operating in one of the four TOU rates (A-D), the newly calculated demands are compared to the maximum demands for that TOU rate. The maximum demands for that rate are then updated in the same manner as the overall maximum demands.

As with meters operating in Demand/Load Profile mode, meters operating in TOU mode have their demand intervals synchronized with midnight.

Partial Demand Intervals

A power failure, entering Test mode, and changing the meter's time will cause a demand calculation to be performed before the normal end of an interval. A time-of-use rate change can also cause a partial demand interval since rate changes can occur on 15 minute boundaries and demand intervals can be 30 or 60 minutes long.

Thermal Emulation Demand

In TOU mode, as in Demand mode, a kV2c Gen 5 meter programmed for thermal emulation calculates a demand as shown in *Thermal Emulation Demand* on page 24 every momentary interval. That demand is then compared to the overall maximum demand, and if the newly calculated demand is greater than the overall maximum, the overall maximum is set to the new value. If the meter is operating in one of the four TOU rates (A-D), the newly calculated demand is compared to the maximum for that TOU rate. The maximum demand for that rate is then updated in the same manner as the overall maximum demand. Whenever the TOU rate changes, the thermal demand value (I_{n-1}) is set to zero.

Cumulative Demand

In a TOU meter, there is a cumulative demand for each of the overall maximum demands and a cumulative demand for each of the TOU rate specific maximum demands. Cumulative demands are calculated when a demand reset is performed and is the sum of the cumulative demand prior to demand reset and the maximum demand prior to demand reset.

Continuously Cumulative Demand

In a TOU meter, there is a continuously cumulative demand available for each of the overall maximum demands and a continuously cumulative demand available for each of the TOU rate specific maximum demands.

Continuously cumulative demand is the sum of the cumulative demand and the current maximum demand. The meter does not store it. It is computed when it is to be displayed on the meter’s LCD. It may also be computed by a reading device from data read from the meter. Continuously cumulative demands may also be displayed on the meter’s LCD or computed by a reading device from data read from the meter for the previous reset and previous season data.

Demand Calculations Restrictions

No softswitches are required to compute block, rolling, or thermal demands. However, if a selected demand quantity requires a softswitch which is not present, the demand quantity will be set to zero.

CHAPTER

6

DEMAND RESET

A demand reset causes two general actions to take place:

1. Billing data at the time of the demand reset is saved as *previous reset data*.
2. Maximum demands are reset and cumulative demands are updated.

Other actions also occur depending on the operating mode of the meter and the type of demand reset that occurred.

Operation in Demand and Demand/Load Profile Mode

In a kV2c Gen 5 meter, operating in Demand mode, there are three methods of performing a demand reset:

- Activating the reset switch
- Sending the appropriate PSEM command during a communication session
- After a programmable number of hours since the last demand reset

When a demand reset is initiated, the following operations will occur:

- If the reset was initiated by a button press, the meter will check the demand reset inhibit flag. The demand reset inhibit flag may be set to true or false when programming a meter with MeterMate (Configure menu). If the flag is set to true, the demand reset will not be performed (i.e., none of the other steps listed are performed). If the flag is set to false, the meter will check the demand reset exclusion timer. If this timer has not expired, the demand reset will not be performed. The demand reset exclusion time is the time, in minutes, that must elapse before an additional demand reset is allowed.
- The display shows all segments for one scroll period.
- The demand reset exclusion timer is set to the programmed reset exclusion time. The demand reset exclusion time is selectable when creating programs with MeterMate Program Manager (Basic Configuration Support Table).
- The following data, which is available as the last reset data, is saved to nonvolatile memory.
  - Summations values
  - 5 real-time pricing summation values
  - 2 power factor accumulators

- For block and rolling demand meters:

  5 max demand values (each with 2 coincident values), 5 real-time pricing max demand values (each with 2 coincident values), 5 cumulative demands, and 5 real-time pricing cumulative demands

- For thermal demand:

  1 max demand (no coincident values), 1 real-time pricing max demand, 1 cumulative demand, and 1 real-time pricing cumulative demand

NOTE Last reset continuously cumulative demand for each demand listed above is available for display only. It is calculated as the sum of the last reset max demand and the last reset cumulative demand.

- For each of the ten demands (block and rolling demand meters) or two demands (thermal demand meters), the max demands are added to the cumulative demands to generate the new cumulative demands.
- For a meter programmed for block or rolling demand, all maximum demands and their coincident values are zeroed.
- For a meter programmed for rolling demand, the data accumulated in all demand subintervals except for the current one are zeroed.
- For a meter programmed for thermal demand, if real-time pricing is not active, the non-real-time pricing max demand is set to the current thermal demand reading and the real-time pricing max demand is zeroed. If real-time pricing is active, the non-real-time pricing max demand is zeroed and the real-time pricing max demand is set to the current thermal demand reading.
- The average power factor accumulators are zeroed.
- If the demand reset was performed by a reset switch press or a PSEM command, then the demand overload, received kWh, and leading kvarh cautions are cleared.
- The number of demand resets is incremented. If the current number of demand resets is 255, it rolls over to zero when incremented. The number of demand resets is displayable on the meter's LCD and may be read from the meter by a reading device.
- The demand reset timeout timer is set to the programmed number of hours.

NOTE The demand reset timeout function can be disabled by setting the timer to zero.

- If the meter is programmed to do so, it will perform a self-read.

- If the meter is programmed to do so, it will log the demand reset in the event log.

Operation in Time-of-Use Mode

In a kV2c Gen 5 meter programmed for TOU operation, there are two types of demand resets: manual and automatic.

A manual demand reset may be initiated:

- by activating the reset switch,
- by sending the appropriate PSEM command during a communication session, or
- after a programmable number of hours since the last demand reset.

An automatic demand reset may be initiated:

- as an action specified as a calendar event,
- as part of an automatic season change, or
- when a pending table takes effect.

When a demand reset is initiated, the following operations will occur:

- If the reset was initiated by a button press, the meter checks the demand reset inhibit flag. If the flag is set to true, the demand reset will not be performed (i.e., none of the other steps listed are performed). If the flag is set to false, the meter checks the demand reset exclusion timer. If this timer has not expired, the demand reset will not be performed. The demand reset exclusion time is the time, in minutes, that must elapse before an additional demand reset is allowed.
- The display shows all segments for one scroll period.
- The demand reset exclusion timer is set to the programmed reset exclusion time (manual demand reset only).
- The following data, which is available as the last reset data, is saved to non-volatile memory:
  - Overall summations values
  - 5 summations for each TOU rate
  - 2 power factor accumulators
  - For block and rolling demand meters:

    5 overall max demand values (each with 2 coincident values), 5 max demand values for each TOU rate (each with coincident values), 5 overall cumulative demands, and 5 cumulative demands for each TOU rate

- For thermal demand:

  1 overall max demand (no coincident values), 1 max demand for each TOU rate (no coincident values), 1 overall cumulative demand, and 1 cumulative demand for each TOU rate

NOTE Last reset continuously cumulative demand for each demand listed above is available for display only. It is calculated as the sum of the last reset max demand and the last reset cumulative demand.

- For each of the demands listed above, the max demands are added to the cumulative demands to generate the new cumulative demands.
- For a meter programmed for block or rolling demand, all maximum demands and their coincident values are zeroed.
- For a meter programmed for rolling demand, the data accumulated in all demand subintervals except for the current one are zeroed.
- For a meter programmed for thermal demand, the overall max demand and the max demand for the current TOU rate are set to the current thermal demand reading. The max demands for the other TOU rates are set to zero.
- The average power factor accumulators are zeroed.
- The demand overload, received kWh, leading kvarh, and low potential cautions are cleared (demand resets initiated by a button press or PSEM procedure only).
- The number of demand resets is incremented. If the current number of demand resets is 255, it rolls over to zero when incremented. The number of demand resets is displayable on the meter's LCVD and may be read from the meter and viewed with MeterMate.
- The time and date of the demand reset are saved. This information is displayable on the meter's LCD and may be read from the meter and viewed with MeterMate.
- The demand reset timeout timer is set to the programmed number of hours.
- If the meter is programmed to do so, it will perform a self-read.
- If the meter is programmed to do so, it will log the demand reset in the event log.
- If the meter is programmed to do so, it will perform a season change.

CHAPTER 7

POWER FACTOR

The kV2c Gen 5 meter calculates an average power factor value. Both the numerator and denominator are selected from the quantities defined in the Measurement Profile. The two quantities selected must both be summed quantities (minimum, maximum, and store quantities must not be selected).

A typical numerator selection would be fundamental plus harmonics watt-hours, |delivered| - |received|. A typical denominator selection would be apparent VAh. There is a current billing period average power factor and a previous demand reset average power factor.

The average power factor values are not stored in the meter. The meter calculates them when it displays an average power factor. The data can also be read, and the result of the power factor calculation displayed, with MeterMate. If a selected average power factor quantity requires a softswitch and that softswitch is not present in the meter, the quantity will be set to zero.

Operation in Demand and Demand/Load Profile Mode

Each minute the meter updates accumulators. The average power factor is calculated with the data accumulated during that minute. The power factor accumulators are updated whether or not real-time pricing is in effect. The average power factor accumulators are zeroed when a demand reset is performed.

Operation in Time-of-Use Mode

In TOU mode, the kV2c Gen 5 meter can be programmed to accumulate average power factor data continuously (regardless of the current TOU rate) or only during a specific TOU rate. This information can be specified when creating programs with MeterMate Program Manager (Basic Meter Configuration Support Table).

If the meter is programmed to accumulate power factor continuously or the meter is currently operating in the specified TOU rate, it updates the average power factor accumulators as described in *Operation in Demand and Demand/Load Profile Mode* . Otherwise, it does not update the accumulators.

The average power factor accumulators are saved when a season change occurs in a TOU meter. The previous season average power factor may be displayed on the meter's LCD. The data can also be read and the result of the power factor calculation displayed with MeterMate.

CHAPTER 8

EVENT LOG

The Event Log, which requires the E softswitch (MeterMate Upgrade), captures information about alerts, diagnostics, cautions, communication, and meter operations. The Event Log is useful for checking for application errors, equipment malfunctions, evidence of tampering, and proper operation of the meter. The meter maintains up to 500 of the most recent events. Each event type can be enabled or disabled. Event Log highlights include:

- Stores up to 500 events (MeterMate Program Manager Recorder Options Editor)
- Records 9 Standard Events and 28 Manufacturer Events (MeterMate Program Manager)
- Diagnostics Editor Site Genie (Site Diagnostics and Event Log Tabs)
- Records the date and time (TOU and Demand/Load Profile only), unique sequence number, operator, event, and any additional data for each event

NOTE Use the MeterMate Reset Unprogram command to clear the Event Log; Master Reset will not clear the Event Log.

Events Supported

All of the events can be recorded in Demand, Demand/Load Profile, and Time-of-Use mode. The event time stamp will contain the date and time the event was recorded.

Event	Argument
Primary Power Down	None
Primary Power Up	None
End Device Accessed for Read	None
End Device Accessed for Write	None
End Device Programmed	None
Demand Reset Occurred	None
Self-Read Occurred	None
Test Mode Enter	None
Test Mode Exit	None

Event	Argument
Diagnostic 1: Polarity, Cross Phase, Reverse Energy Flow	Angle out of tolerance $\angle V_B \angle V_C \quad \angle I_A \angle I_B \angle I_C$
Diagnostic 1: Condition Cleared	None
Diagnostic 2: Voltage Imbalance	Voltage out of tolerance $\angle V_A \angle V_B \angle V_C$
Diagnostic 2: Condition Cleared	None
Diagnostic 3: Inactive Phase Current	Current out of tolerance $\angle I_A \angle I_B \angle I_C$
Diagnostic 3: Condition Cleared	None
Diagnostic 4: Phase Angle Alert	Angle out of tolerance $\angle V_B \angle V_C \quad \angle I_A \angle I_B \angle I_C$
Diagnostic 4: Condition Cleared	None
Diagnostic 5: High Distortion	Element out of tolerance A, B, C, or Total
Diagnostic 5: Condition Cleared	None
Diagnostic 6: Under Voltage	Phase A, B, or C voltage
Diagnostic 6: Condition Cleared	None
Diagnostic 7: Over Voltage	Phase A, B, or C voltage
Diagnostic 7: Condition Cleared	None
Diagnostic 8: High Neutral Current	None
Diagnostic 8: Condition Cleared	None
Caution 000400: Under Voltage	Voltage out of tolerance $\angle V_A \angle V_B \angle V_C$
Caution 000400: Condition Cleared	None
Caution 004000: Demand Overload	None
Caution 004000: Condition Cleared	None
Caution 040000: Leading Quadergy	None
Caution 040000: Condition Cleared[1]	None
Caution 400000: Received Energy	None
Caution 400000: Condition Cleared[1]	None
Real-Time Pricing Activated	None
Real-Time Pricing Deactivated	None
Calibration Mode Activated[2]	None

1 The event is logged when the condition clears; however, the caution will remain on the display until cleared by a demand reset.

2 The meter only records when it enters Calibration mode. It is not necessary to record when the meter exits Calibration mode since the meter does not keep time during Calibration mode.

Primary Power Down/Up

A Primary Power Down event is logged when the meter loses power, and a Primary Power Up event is logged when power is restored. If the meter keeps time, the date and time of the outage and restoration are recorded. The Primary Power Down/Up events can be used to track quality of service by indicating the frequency and duration of outages. It can also be used for tamper detection. Unexpected Primary Power Down/Up events may indicate that the meter has been tampered with.

The meter will not record power up and power down events for power restoration durations shorter than a programmable duration. This duration has a range of 0 to 255 seconds in increments of 1 second. A value of 0 will disable the feature, meaning power up and down events will be logged regardless of how long the meter is powered up (if those events are enabled).

End Device Accessed for Read/Write/Program

The meter records the purpose of each communication session. If tables were read, the End Device Accessed for Read is recorded. If tables were written (including the execution of procedures), the End Device Accessed for Write is recorded. The End Device Accessed for Program is recorded after a successful programming session. These events can be used to gather evidence of tampering through unexpected communication with the meter.

Demand Reset Occurred

A Demand Reset Occurred event is recorded whenever a Demand Reset is initiated. The only exception to this is when the Demand Reset button is pressed during Test mode. The Demand Reset Occurred event may be used for tamper detection. Unexpected Demand Resets, intended to reduce the Max Demand used for billing, may be detected. The following actions initiate a Demand Reset Occurred event:

- Reset button not in Test mode
- Standard Procedure 4 Remote Reset
- Demand Reset Timer expiration
- Demand Reset TOU Calendar Event
- Season Change with Demand Reset TOU Calendar Event
- Activation of a Pending TOU Table with Demand Reset

Self-Read Occurred

A Self-Read Occurred event is recorded whenever a self-read is initiated. The following actions initiate a Self-Read Occurred event:

- Manual Demand Reset configured for Self-Read on Demand Reset
- Automatic Demand Reset configured for Self-Read on Demand Reset
- Automatic Self-Read

NOTE In the kV2c Gen 5, Meter Self-Read does not require either the Basic Recording (R softswitch), or Extended Recording (X softswitch). See *Self-Read* on page 83 for more information.

Test Mode Enter/Exit

Test Mode Enter/Exit events are logged whenever the meter enters or exits Test mode. Since the meter does not collect revenue data while it is in Test mode, such unexpected Test Mode Enter/Exit events may indicate tampering in an attempt to avoid billable electricity usage.

Diagnostic 1 - Polarity, Cross Phase, Reverse Energy Flow Set/Cleared

A Diagnostic 1 event is logged along with the angle out of tolerance (element B or C voltage, element A, B, or C current) when Diagnostic 1 is set. Likewise, a Diagnostic 1 Condition Cleared event is logged when the diagnostic is cleared. See *Site Genie*® on page 55 for more information on Diagnostic 1.

Diagnostic 2 - Voltage Imbalance Set/Cleared

A Diagnostic 2 event is logged along with the voltage out of tolerance when Diagnostic 2 is set. Likewise, a Diagnostic 2 Condition Cleared event is logged when the diagnostic is cleared. See *Site Genie*® on page 55 for more information on Diagnostic 2.

Diagnostic 3 - Inactive Phase Current Set/Cleared

A Diagnostic 3 event is logged along with the current out of tolerance (element A, B, or C) when Diagnostic 3 is set. Likewise, a Diagnostic 3 Condition Cleared event is logged when the diagnostic is cleared. See *Site Genie*® on page 55 for more information on Diagnostic 3.

Diagnostic 4 - Phase Angle Alert Set/Cleared

A Diagnostic 4 event is logged along with the angle out of tolerance (element B or C voltage, element A, B, or C current) when Diagnostic 4 is set. Likewise, a Diagnostic 4 Condition Cleared event is logged when the diagnostic is cleared. See *Site Genie*® on page 55 for more information on Diagnostic 4.

Diagnostic 5 - High Distortion Set/Cleared

A Diagnostic 5 event is logged along with the element on which the high distortion occurred (A, B, C or total) when Diagnostic 5 is set. Likewise, a Diagnostic 5 Condition Cleared event is logged when the diagnostic is cleared. See *Site Genie*® on page 55 for more information on Diagnostic 5.

Diagnostic 6 - Under Voltage Set/Cleared

A Diagnostic 6 event is logged along with the element on which the under voltage occurred when Diagnostic 6 is set. Likewise, a Diagnostic 6 Condition Cleared event is logged when the diagnostic is cleared. See *Site Genie*® on page 55 for more information on Diagnostic 6.

Diagnostic 7 - Over Voltage Set/Cleared

A Diagnostic 7 event is logged along with the element on which the over voltage occurred when Diagnostic 7 is set. Likewise, a Diagnostic 7 Condition Cleared event is logged when the diagnostic is cleared. See *Site Genie*® on page 55 for more information on Diagnostic 7.

Diagnostic 8 - High Neutral Current Set/Cleared

A Diagnostic 8 event is logged when Diagnostic 8 is set. Likewise, a Diagnostic 8 Condition Cleared event is logged when the diagnostic is cleared. See *Site Genie*® on page 55 for more information on Diagnostic 8.

Caution 000400 - Under Voltage Set/Cleared

A Low Potential (Caution 000400) event is logged along with the element with the low potential (A, B, or C) when Caution 000400 is set. Likewise, a Low Potential Condition Cleared event is logged when the caution is cleared. See *Self-Test Errors and Cautions* on page 85 for more information on the Under Voltage Caution.

Caution 004000 - Demand Overload Set/Cleared

A Demand Overload (Caution 004000) event is logged when Caution 004000 is set. Likewise, a Demand Overload Condition Cleared event is logged when the condition is cleared. See *Self-Test Errors and Cautions* on page 85 for more information on the Demand Overload Caution.

Caution 400000 - Received Energy Set/Cleared

A Received Energy (Caution 400000) event is logged when Caution 400000 is set. Likewise, a Received Energy (Caution 400000) Condition Cleared event is logged when the condition is cleared. See *Self-Test Errors and Cautions* on page 85 for more information on the Received Energy Caution.

Caution 040000 - Leading Quadergy Set/Cleared

A Leading Quadergy (Caution 040000) event is logged when Caution 040000 is set. Likewise, a Leading Quadergy (Caution 040000) Condition Cleared event is logged when the condition is cleared. See *Self-Test Errors and Cautions* on page 85 for more information on the Leading Quadergy Caution.

NOTE The Demand Overload, Leading Quadergy, and Received Energy cautions remain set in the meter even after the condition clears. They must be cleared by a manual demand reset. However, the event log entry is made when the condition clears.

Real-Time Pricing Activated/Deactivated

A Real-Time Pricing Activated event is logged when Real-Time Pricing is activated (includes the wait time). Likewise, a Real-Time Pricing Deactivated event is logged when Real-Time Pricing is deactivated.

The Real-Time Pricing events can be used to verify the correct operation of the meter during a real-time pricing instance. See *Real-Time Pricing* on page 81 for more information on real-time pricing.

Calibration Mode Activated

A Calibration Mode Activated event is logged when Calibration mode is activated. There is no equivalent Calibration Mode Deactivated event since the meter does not advance time while in Calibration mode.

CHAPTER 9

ALERTS AND PULSE OUTPUTS

The kV2c Gen 5 meter supports two I/O boards: a simple board and a complex board. The complex board supports up to four Form A or Form C inputs; two Form C outputs; six Form A only outputs; and an real-time pricing input. The simple board is a subset of the complex board supporting only two Form C outputs, one Form A output, and an real-time pricing input. Any of the outputs can be configured for any of the output functions. The table below summarizes the operation of the outputs and alerts in each mode.

	Demand	Demand/LP	TOU	Comm	Test
Pulse Outputs	Y	Y	Y	Y	Y
Demand Threshold Alert	Y	Y	Y	N	Y
Load Control	N	N	Y	Y	Y
End of Interval	Y	Y	Y	Y	Y
Power Factor Alert	Y	Y	Y	N	Y
TOU Rate Alert	N	N	Y	Y	Y
real-time pricing Alert	Y	Y	Y	Y	Y
Diagnostic Alert	Y	Y	Y	N	N
Caution Alert	Y	Y	Y	N	N

Operation in Demand and Demand/Load Profile Mode

The following describes the outputs and alerts when the meter is in either Demand or Demand/Load Profile mode.

Pulse Outputs

The kV2c Gen 5 meter can output any integrated quantity (Wh, varh, VAh, Qh, I_2h, and V_2h) that has been selected in the measurement profile. Each momentary interval, the meter calculates the rate it must output pulses during the next momentary interval based on the amount of the selected quantity accumulated during the previous momentary interval and programmed value of each pulse (e.g., 0.6 Wh/pulse). This is calculated using the equation below.

$$\text{number of pulses to output over next momentary interval} = \frac{\text{data accumulated during previous momentary interval}}{\text{programmed value of each pulse}}$$

The meter sets the timing between each pulse so the rate remains constant over the momentary interval. Any remainder left after the calculation is performed is added to the accumulation from the next momentary interval.

It is recommended the meter be programmed so the maximum output pulse rate is no higher than 30 pulses per second for the expected load conditions.

The measurement profile quantities to be output and the value of each pulse are selectable when creating programs with MeterMate.

Demand Threshold Alert

An output programmed for Demand Threshold Alert will activate whenever the selected demand exceeds a programmed threshold for three consecutive tests taken five seconds apart. The selected demand is one of the (up to) five demands the meter has been programmed to calculate. Every five seconds, the meter compares the magnitude of the selected demand over the most recent momentary interval to the programmed threshold. If the demand is larger than the programmed threshold for three consecutive tests, the Demand Threshold Alert is activated. If the demand is smaller than the programmed threshold for two consecutive tests, the alert is deactivated.

The Demand Threshold Alert does not operate during demand delay.

The demand value and threshold are selectable when creating programs with MeterMate Program Manager (I/O and Alerts Support Table).

Load Control

This feature is not applicable in a kV2c Gen 5 meter operating in Demand mode.

End of Interval

Whenever a demand interval ends, any output configured for end of interval is asserted for the programmed end of interval duration. This duration is selectable when creating programs with MeterMate software. Refer to *Demand Calculations* on page 21 for a description of when demand intervals end.

Power Factor Alert

An output programmed for Power Factor will activate whenever the power factor drops below the programmed threshold and the selected demand exceeds the programmed threshold for three consecutive tests taken five seconds apart. The power factor is calculated by taking the momentary interval accumulations of the quantities specified for the numerator and denominator of the average power factor and dividing them. The selected demand is one of the (up to) five demands that the meter has been programmed to calculate.

NOTE The demand need not be the same one that is selected for the Demand Threshold Alert. The threshold is separately programmable as well.

If the calculated power factor is above the threshold or the demand is below the threshold for two consecutive tests, the output is deactivated. The Power Factor Alert does not operate during demand delay. The power factor threshold, the demand value, and the demand threshold are selectable when creating programs with MeterMate Program Manager (I/O and Alerts Support Table).

TOU Rate Alert

This feature is not applicable in a meter operating in Demand mode.

Real-Time Pricing Alert

An output programmed for real-time pricing alert will activate whenever the meter is in real-time pricing and deactivate whenever the meter exits real-time pricing. More information is given in *Real-Time Pricing* on page 81.

Diagnostic Alert

The kV2c Gen 5 meter can be programmed to activate an alert whenever one or more of the *Site Genie® Diagnostics* (see page 56) occur. More than one output can be configured as a Diagnostic Alert, and each can be programmed with a different set of diagnostics that will activate the alert. The output will deactivate when all of the diagnostic conditions that control that output clear. Which diagnostics will cause a given output to activate is selectable when creating programs with MeterMate Program Manager (I/O and Alerts Support Table).

NOTE A diagnostic must be enabled for it to activate an alert.

Caution Alert

The kV2c Gen 5 meter can be programmed to activate an alert whenever one or more of the meter caution events occur. More than one output can be configured as a Caution Alert, and each can be programmed with a different set of cautions that will activate the alert. The output will deactivate when all of the caution conditions that control that output are cleared. In some cases (e.g., leading kvar), this will not occur until a demand reset is performed. Which cautions will cause a given output to activate is selectable when creating programs with MeterMate Program Manager (I/O and Alerts Support Table).

NOTE A caution must be enabled for it to activate an alert.

Operation in Time-of-Use Mode

The pulse outputs, end of interval alert, real-time pricing alert, diagnostic alert, and caution alert operate identically in meters programmed for Demand mode and meters programmed for TOU mode. The operation of the others is described below.

Demand Threshold Alert

In a TOU meter, the Demand Threshold Alert can be programmed to operate continuously or only during one of the TOU rates. This is selectable when creating programs with MeterMate. Other than that, the alert operates identically to the way it does in Demand mode.

Load Control

An output programmed for Load Control will activate whenever Load Control is active. Refer to *Operation in Time-of-Use Mode* on page 82 and *Operation in Time-of-Use Mode* on page 101 for more information.

Power Factor Alert

In a TOU meter, the Power Factor Alert can be programmed to operate continuously or only during one of the TOU rates. This is selectable when creating programs with MeterMate Program Manager (I/O and Alerts Support Table). Other than that, the alert operates identically to the way it does in Demand mode.

TOU Rate Alert

An output programmed for TOU Rate Alert will activate whenever the specified TOU rate becomes active. The TOU rate that will activate the alert is selectable when creating programs with MeterMate Program Manager (I/O and Alerts Support Table).

CHAPTER
10

LOAD PROFILE RECORDING

The kV2c Gen 5 meter has built-in support for up to 20 channels of Load Profile recording without any additional hardware. In addition to the traditional energy quantities, the kV2c Gen 5 meter can record power quality data such as frequency, maximum or minimum voltages, or currents. Load Profile Recording is only supported in Demand/Load Profile and TOU modes.

Operation in Demand/Load Profile and TOU Mode

Load Profile recording requires either an H, R, or X softswitch and a battery for timekeeping during outages if the battery-free feature is not used. The quantities available for recording depend on the softswitch installed in the meter. Descriptions of measurement quantity options available by softswitch are outlined in *Measurement Restrictions* on page 13. The table below outlines the channel and storage specifications of each softswitch:

Softswitch	Channels	Storage
R	1-8	128 KB
X	1-20	192 KB
H	1-20	384 KB

Load Profile data is organized into blocks. Each block consists of a Block End Time (the date and time of the last interval recorded in that block), Block End Reading (readings for each channel), and interval data. Blocks are stored in a circular queue. When all of load profile memory is filled with blocks, the next block will overwrite the oldest block. Interval times represent the end time for the interval. All interval times are synchronized with midnight (i.e., the last interval of the day ends at midnight). The number of blocks of interval data stored in the meter can be limited.

H Softswitch Days of Load Profile Data per Channel

	Interval Length in Minutes					
Channels	1	5	10	15	30	60
1	86	434	868	1302	2604	5208
2	43	219	439	659	1318	2636
3	33	165	330	495	990	1980
4	24	120	240	361	722	1444

	Interval Length in Minutes					
Channels	**1**	**5**	**10**	**15**	**30**	**60**
5	20	101	203	305	610	1220
6	16	82	165	248	496	992
7	14	73	147	221	442	884
8	12	63	126	189	378	756
9	11	57	115	173	346	692
10	10	51	102	153	306	612
11	9	47	94	142	284	568
12	8	42	85	128	256	512
13	8	40	80	120	240	480
14	7	36	73	110	220	440
15	6	34	69	104	208	416
16	6	32	64	97	194	388
17	6	30	61	92	184	368
18	5	28	57	86	172	344
19	5	27	55	83	166	332
20	5	26	52	78	156	312

R Softswitch (128KB) Days of Load Profile Data per Channel

	Interval Length in Minutes					
Channels	**1**	**5**	**10**	**15**	**30**	**60**
1	28	144	289	434	868	1736
2	14	73	146	219	438	876
3	11	55	110	165	330	660
4	8	40	80	120	240	480
5	6	33	67	101	202	404
6	5	27	54	82	164	328
7	4	24	48	73	146	292
8	4	21	42	63	126	252

X Softswitch Days of Load Profile Data per Channel

	Interval Length in Minutes					
Channels	**1**	**5**	**10**	**15**	**30**	**60**
1	43	217	434	651	1302	2604
2	22	109	219	329	658	1316

	Interval Length in Minutes					
Channels	**1**	**5**	**10**	**15**	**30**	**60**
3	16	82	164	247	494	988
4	12	60	120	180	360	720
5	10	50	101	152	304	608
6	8	41	82	124	248	496
7	7	36	73	110	220	440
8	6	31	62	94	188	376
9	5	28	57	86	172	344
10	5	25	50	76	152	304
11	4	23	47	71	142	284
12	4	21	42	64	128	256
13	4	20	40	60	120	240
14	3	18	36	55	110	220
15	3	17	34	52	104	208
16	3	16	32	48	96	192
17	3	15	30	46	92	184
18	2	14	28	43	86	172
19	2	13	27	41	82	164
20	2	13	26	39	78	156

Load Profile Data

At the end of an interval the following processing occurs:

1. Block End Time is updated with the current date and time.
2. Block End Reading(s) are updated for each channel. The value stored for the Block End Reading is taken from the appropriate value in the 20 accumulators.

   Summation

   Running total since the last Master Reset

   Maximum

   Maximum absolute value (magnitude) since the last Master Reset

   Minimum

   Minimum absolute value (magnitude) since the last Master Reset

   End of Interval

   The current value at the end of the Load Profile interval

3. The Common Status, Extended Status and data for each channel is written to the current block as a new interval.

   Summation

   At the end of each minute, the data accumulated during the previous minute is added to the load profile accumulator. At the end of the load profile interval, the data is scaled and stored.

   Maximum

   At the end of each minute, the maximum absolute value (magnitude) for the previous minute's data is compared to the current maximum for the load profile interval. If the value for the previous minute exceeds the current maximum, the current maximum is updated. At the end of the load profile interval, the unscaled maximum is stored.

   Minimum

   At the end of each minute, the minimum absolute value (magnitude) for the previous minute's data is compared to the current minimum for the load profile interval. If the value for the previous minute is less than the current minimum, the current minimum is updated. At the end of the load profile interval, the unscaled minimum is stored.

   End of Interval

   At the end of the load profile interval, the unscaled value from the previous momentary interval is stored.

4. A new block is started when the current block is filled. When a block is filled, the data is fixed and will not change. For example, changing the date and time in the meter will not affect the Block End Time on completed blocks.

   The meter can accumulate up to 32,767 units/interval. Under some combinations of service connection, voltage, and interval length, pulse counts greater than this may be generated. The raw units accumulated during a load profile interval may need to be scaled to fit in 32,767. MeterMate can program a scale factor from 1 to 10 to reduce the number of units stored.

The table below shows maximum unit counts for a 15-minute interval with a scale factor of 1.

	15 Amps for 15 Minutes				320 Amps for 15 Minutes			
Service	**120**	**240**	**277**	**480**	**120**	**240**	**277**	**480**
1Φ 2W	9,000	18,000		36,000	12,800	25,600		51,200
1Φ 3W		18,000		36,000		25,600		51,200
PΦ Network	18,000				25,600			
PΦ 3W Δ	15,588	37,177		62,354	22,170	44,341		88,681

	15 Amps for 15 Minutes				320 Amps for 15 Minutes			
Service	**120**	**240**	**277**	**480**	**120**	**240**	**277**	**480**
PΦ 4W Wye	27,000		62,354		38,400		88,681	
PΦ 4W Δ		31,177		62,354		42,466		84,933

Interval Status

Each Load Profile interval contains a common status, which applies to all channels, and an extended status, which is specific to a channel. The common and extended statuses provide information about events that took place during an interval. If no status is present, nothing unusual occurred during that interval.

Common Status

The Common Status flags apply to all channels in an interval. Common Status flags are not mutually exclusive. Multiple Common Status flags may be set based on conditions in the meter. For example, if an outage occurs during Daylight Savings, both the Power Outage and Daylight Savings flags will be set.

Flag	Description
0	Daylight savings
1	Power outage
2	Clock reset Forward
3	Clock reset Backwards

Daylight Savings

The meter sets the Daylight Savings flag in the Common Status if the interval was recorded during Daylight Savings. The meter automatically adjusts its clock in the spring for Daylight Savings time (spring forward) and in the fall for Standard time (fall back) based on the Programmable Dates.

Power Outage

The meter sets the Power Outage flag in the Common Status if a power outage, which exceeded the Load Profile Outage duration, occurred during any portion of the Load Profile interval. The length of the outage necessary to mark a power outage can be set in the MeterMate Recorder Option Editor from 0 seconds (any outage) to over 18 hours in one-second increments. If the outage did not exceed the Load Profile Outage duration, the interval will not be marked.

Clock Reset

Changing the time of the meter clock may result in a partial or long interval.

Forward

The meter sets the Clock Reset Forward flag in the common status if the meter's clock was advanced during the interval. The clock may have been

changed automatically by a spring daylight savings programmable date or by MeterMate because the meter's clock was slow by more than the allowed tolerance.

Backwards

The meter sets the Clock Reset Backward flag in the common status if the meter's clock was changed backwards during the interval. The clock may have been changed automatically by a Fall Daylight Savings programmable date or by MeterMate because the meter's clock was fast by more than the allowed tolerance.

Extended Status

The extended status flags apply to a particular channel in an interval. The common statuses are mutually exclusive. Only one value will be recorded per channel. The extended status are listed in the table below in increasing precedence. For example, if the value to be recorded exceeds 32,767 during a long interval, only the long interval status will be recorded.

Status Flag	Description
0	No status
1	Overflow
2	Partial interval
3	Long interval
4	Not used
5	Test mode

Overflow/Underflow

The meter sets the Overflow/Underflow Extended Status when the scaled value for a channel exceeds the range of values that can be stored (-32,768 to 32,767). To prevent Overflow/Underflow, increase the scale factor in the MeterMate Recorder Option Editor.

Partial Interval

The meter sets the Partial Interval Extended Status for a channel when the actual duration of the interval is less than the interval length. A partial interval could be caused by the following conditions:

- First interval recorded
- Restarting Load Profile recording (i.e., MeterMate Master Reset)
- Clock Reset Forward/Backwards

For example, a meter is programmed with a 15-minute load profile interval. At 08:02, the meter’s time is advanced 8 minutes to 08:10. Prior to the time change, there were 13 minutes remaining in the interval. After the time change, there were

only 5 minutes remaining in the interval. The current interval is marked as a partial interval.

- Interval Length: 15 minutes.
- Current Time: 08:02. Time Remaining in Interval: 13 minutes.
- New Time:08:10. Time Remaining in Interval: 05 minutes Partial.

Long Interval

The meter sets the Long Interval Extended Status for a channel when the actual duration of the interval is longer than the interval length. A long interval can only be caused by a Clock Reset Forward/Backwards. For example, a meter is programmed with a 15-minute load profile interval. At 13:44, the meter's time is moved back 8 minutes to 13:37. Prior to the time change, there was 1 minute remaining in the interval. After the time change, there were 8 minutes remaining in the interval. The current interval is marked as a Long interval.

- Interval Length: 15 minutes.
- Current Time: 13:44. Time Remaining in Interval: 1 minute.
- New Time: 3:37. Time Remaining in Interval: 8 minutes Long.

Test Mode

The meter sets the Test Mode Extended Status for a channel if the meter was in Test mode for any part of the interval. The meter does not accumulate data collecting during Test mode. The first and last Test mode intervals will contain data from the portion of the interval not in Test mode.

Operation During Loss of Time

The meter has three options for handing Load Profile data after the loss of date and time. The first option is to stop recording Load Profile. The other two, recover Load Profile data and resume Load Profile recording, are used for battery-free operation.

Stop Load Profile Recording

If the meter stops keeping time (i.e., it loses its battery during a power outage) and the Load Profile outage recovery is disabled, the meter does the following:

1. The meter stops Load Profile recording.
2. Load Profile data recorded before the outage is available for reading.

To resume Load Profile recording after the battery is replaced, the date and time must be set and the Start Load Profile procedure must be executed as part of a programming session.

Recover Load Profile Data

If the meter stops keeping time and Load Profile outage recovery feature is enabled, the meter does the following:

1. The meter records temporary blocks of Load Profile data. The duration of these blocks is equal to the duration of the programmed Load Profile interval if the Load Profile interval is 10 minutes or less. Otherwise, the duration of the temporary Load Profile interval blocks is 10 minutes.
2. The meter continues to record these blocks until its time and date are set.
3. Once the time and date are set, the meter, to the extent possible, restores the Load Profile data collected during the period when it did not have date and time information. As an example, consider the following scenario:
    - 15 minute Load Profile intervals
    - At 9:55 the power fails
    - At 11:18 power returns, the battery failed, and the meter has lost time
    - At 12:22 the meter's time is set

Because the Load Profile interval length is programmed to be 15 minutes, the meter will store temporary Load Profile blocks every 10 minutes. The temporary Load Profile intervals will end at the following times:

Load Profile Block 1	Load Profile Block 2	Load Profile Block 3	Load Profile Block 4	Load Profile Block 5	Load Profile Block 6
11:28	11:38	11:48	11:58	12:08	12:18

Once the meter's time is set, it can calculate how long the power was out (it stores the power fail time before shutting down, and it knows how long the power has been up). It uses this information to record outage intervals. In this case, the following intervals will be marked as outage intervals:

Interval 1	Interval 2	Interval 3	Interval 4	Interval 5	Interval 6
10:00[1]	10:15	10:30	10:45	11:00	11:15[2]

1 Interval 1 is a partial interval, since power failed at 9:55.
2 Interval 6 is a partial interval, since power came back at 11:08.

The meter then allocates the data from the 10-minute temporary Load Profile blocks to actual 15-minute Load Profile blocks as follows:

- 70% of Load Profile block 11:18 is allocated to the 11:15 Load Profile block
- 30% of the 11:18 temporary block is allocated to the 11:30 Load Profile block
- 100% of the 11:28 temporary block is allocated to the 11:30 Load Profile block
- 20% of the 11:38 temporary block is allocated to the 11:30 Load Profile block
- 80% of the 11:38 temporary block is allocated to the 11:45 Load Profile block

- 70% of the 11:48 temporary block is allocated to the 11:45 Load Profile block

This process continues until all of the temporary Load Profile block data has been processed. The last step is 30% of the 12:18 temporary Load Profile block will be allocated to the current Load Profile interval, which will end at 12:30.

If one or more power fails occur before the date and time are set, the meter will continue to record temporary Load Profile intervals. When its date and time are set, it will treat all temporary intervals as though they had occurred just prior to the meter's date and time being set.

Resume Load Profile Data

If the meter loses its date and time during a power outage and Load Profile outage resume function is enabled, it does the following:

1. When the meter's date and time is set, the meter will account for the time that the power was out and the time during which the meter did not have date/time by recording outage intervals with zero data.
2. The meter will continue to record load profile data as usual after the date and time is set. Note that the meter shall mark both the interval during which the power failed and the interval during which the time and date was set as partial intervals.

CHAPTER
11

SITE GENIE®

This section will describe service detection (automatic and manual), Fitzall® support, and the operation of the Site Genie diagnostics. Site Genie operates in the same manner in Demand mode, Demand/Load Profile mode, and TOU mode.

Automatic Service Detection

At various times, the meter automatically determines the metered service by examining the element voltages and the phase angles between the voltages. This occurs immediately after power up, ten minutes after power up, daily (optional), after a demand reset (optional), and after a programming session.

Form 1, 2, 3, 4, and 36 meters are used with a specific service and do not require automatic service determination at power up. Form 9, 10, 12, 13, 16, 25, 45, 48, and 56 meters can be used with more than one service and require automatic service determination at power up. In this case, the meter uses three sets of phase angle data gathered over 3 seconds to check the service as defined below. If the three checks give inconsistent results, the meter will keep checking until three consecutive checks give the same result or until 60 seconds have been elapsed. If 60 seconds pass without three consecutive checks giving the same result, a service error is set. Diagnostics are disabled while the service is being determined. They remain disabled if the meter cannot successfully detect a service.

The phase C voltage angle is checked to determine if the angle is 60, 90, 120, or 180 degrees (±10 degrees) in respect to the phase A voltage angle. When three valid angles are determined, the service is determined based on the angle and the ANSI form. In forms 45 and 56, if the angle is ±90, then the phase A and C voltage magnitudes must be checked to differentiate between a 4-wire delta and a 2-phase 5-wire service. If Vc ≅ Va, within ±5%, the service is 2-phase, 5-wire, otherwise the meter assumes Vc ≅ Va / 2 * √3 and the service is 4-wire delta.

Forms	Service	Expected V_c Angle
9, 10, 16, 45, 48, 56	4-Wire Wye	± 120°
9, 10, 16, 45, 48, 56	4-Wire Delta	± 90°
12, 13, 25, 45, 56	Single Phase, 3-Wire	± 180°
12, 13, 25	Network	± 120°
12, 13, 45, 56	3-Wire Delta	± 60°
45, 56	2-Phase, 5-Wire	± 90°

The meter will re-determine the electrical service on a manually initiated demand reset if programmed to do so.

Manual Service Detection

The meter provides a means to program the electrical service under which it will operate. Programming the electrical service disables Automatic Service Detection.

Fitzall® Support

Three element Fitzall meters are capable of being configured to functionally replace 1, 2, 2½, or 3 element meters by means of programming the ANSI Form and DSP Case (a value that tells the meter how to process voltage and current samples for a given form and service) to that of the form and case of the meter being replaced. The table below lists the supported Fitzall meters and the ANSI Form to be programmed depending on the electrical service.

Form	Elements	5W 2Φ	4W Y	4W Δ	3W Δ	3W Net	3W 1Φ	2W 1Φ
9S, 10A, 48A	3		9	9				
9S, 10A, 48A	2½		36					
9S, 10A, 48A	2	45	45	45	45	45	45	
9S, 16S, 10A, 16A, 48A	1						2	3
16S, 16A	2				12	12	12	
16S, 16A	3		16	16				

Site Genie® Diagnostics

Site Genie provides eight diagnostic tests. The diagnostic and the display of the diagnostic may be toggled on or off in the program. The meter may also be programmed to add the diagnostic to the scroll or to freeze the display. The following diagnostic tests are performed when metering functions are operating normally:

- d1 Polarity, Cross Phase, Rev energy flow
- d2 Phase Voltage Alert
- d3 Inactive Phase Current
- d4 Phase Angle Alert
- d5 Distortion Alert
- d6 Undervoltage
- d7 Overvoltage
- d8 High Imputed Neutral Current

NOTE The meter does not perform Site Genie diagnostic error checking during Test mode or when a service error is present.

All diagnostics (except d6 Undervoltage and d7 Overvoltage) are checked every 5 seconds using one second of data. Diagnostics 6 and 7 are checked every second. If a diagnostic fails each check performed during a programmed duration that begins with the first failed check, the diagnostic error is set and the diagnostic counter is incremented.

There are two programmable diagnostic fail durations: one for diagnostics 6 and 7 and one for the remaining diagnostics. The fail duration for diagnostics 6 and 7 is programmable from 3 seconds to 30 minutes in 1 second increments. The fail duration for the remaining diagnostics is programmable from 15 seconds to 30 minutes in 5 second increments. It takes 2 consecutive error free checks to clear a diagnostic error condition.

NOTE Because diagnostics other than 6 and 7 are checked every 5 seconds, there is a tolerance of -5/+0 seconds for the pass and fail durations. For example, if the fail duration for diagnostic 1 is programmed for 30 seconds, the diagnostic may be set after the fail condition has occurred for anywhere between 25 and 30 seconds. Similarly, the condition may be cleared after the pass condition has occurred for anywhere between 5 and 10 seconds.

The range for all diagnostic counters is 0 to 255. When a diagnostic counter reaches 255, it rolls over to 0 on the next count. Diagnostic errors and counters may be reset via communication procedures.

The table below shows the expected voltages and currents based on the listed ANSI forms.

	Element / Sensor Present					
ANSI Form	V_A	V_B	V_C	I_A	I_B	I_C
1, 3	✓			✓		
2, 4	✓			✓		✓
12, 13, 25	✓		✓	✓		✓
45, 56	✓	✓*	✓	✓		✓
35	✓		✓	✓	✓	✓
9, 10, 16, 48	✓	✓	✓	✓	✓	✓

* Form 45 and 56 meters have a V_B element used for 4WΔ only, but the meter zeroes V_B data.

Diagnostics Expected Phase Angles

Site Genie diagnostics expect certain voltage and current phase angles as appropriate for the actual ANSI form, electrical service, and phase sequence. In the following table, lagging phase angles are given positive values. The angle is based on the ANSI form, the electrical service, and the observed phase sequence.

ANSI Form	Electrical Service	Phase Sequence	Expected Angles				
			V_B	V_C	I_A	I_B	I_C
2, 4	1P3W				0		180
1, 3	1P2W				0		
36	4WY	abc		240	0	120	240
36	4WY	cba		120	0	240	120
9,10,16,48	4WY	abc	120	240	0	120	240
9,10,16,48	4WY	cba	240	120	0	240	120
9,10,16,48	4WD	abc	180	270	30	150	270
9,10,16,48	4WD	cba	180	90	330	210	90
12, 13, 25	1P3W			180	0		180
12, 13, 25	NET	abc		240	0		240
12, 13, 25	NET	cba		120	0		120
45, 56	1P3W			180	0		180
45, 56	2P5W	ac'a'c		270	0		270
45, 56	2P5W	aca'c'		90	0		90
45, 56	4WY	abc		240	330		270
45, 56	4WY	cba		120	30		90
45, 56	4WD	abc		270	0		270
45, 56	4WD	cba		90	0		90
12, 13, 25, 45, 56	3WD	abc		300	30		270
12, 13, 25, 45, 56	3WD	cba		60	330		90

The values for the parameters which control the operation of Site Genie diagnostics are selectable when creating programs with MeterMate Program Manager (Meter Diagnostics Support Table).

Diagnostic 1: Polarity, Cross Phase, Reverse Energy Flow

Diagnostic 1 verifies all meter elements are sensing the correct voltage and current for the electrical service. This is accomplished by comparing each voltage and current phase angle with expected values. Voltage phase angles must be within ±10° of the expected value and current phase angles must be within ±120° of the expected value to prevent a diagnostic 1 error.

Diagnostic 2: Voltage Imbalance

This diagnostic verifies the voltage at each phase is maintained at an acceptable level with respect to the other phases.

The average phase voltage is combined with the user programmed percentage tolerance to determine the acceptable range for the individual phase voltages as appropriate for the ANSI form and service type.

$$\text{Calculate } V_{average} = \frac{1}{3}(V_A + V_B + V_C)$$

$$\begin{aligned}\text{Pass} = {} & [V_{average}(1 - T\%) < V_A < V_{average}(1 + T\%)] \\ \text{and } & [V_{average}(1 - T\%) < V_B < V_{average}(1 + T\%)] \\ \text{and } & [V_{average}(1 - T\%) < V_C < V_{average}(1 + T\%)]\end{aligned}$$

$$\begin{aligned}\text{Fail} = {} & [V_{average}(1 - T\%) \geq V_A \geq V_{average}(1 + T\%)] \\ \text{or } & [V_{average}(1 - T\%) \geq V_B \geq V_{average}(1 + T\%)] \\ \text{or } & [V_{average}(1 - T\%) \geq V_C \geq V_{average}(1 + T\%)]\end{aligned}$$

T is the programmed tolerance with a range of 0 to 100% in increments of 1%.

Diagnostic 3: Inactive Phase Current

Diagnostic 3 verifies the current of each phase is maintained at an acceptable level. A diagnostic 3 error condition is triggered if the current of one or more phases falls below a user programmed low current value and at least one phase current remains above this value.

Diagnostic 4: Phase Angle Imbalance

Diagnostic 4 verifies the current phase angles fall within a user specified range. This diagnostic can be enabled only if diagnostic 1 is enabled and is checked only if diagnostic 1 passes. The user programmed current phase angle tolerance value for diagnostic 4 has a range of 0°to 120° in increments of 1°.

Diagnostic 5: Phase Distortion

Diagnostic 5 verifies the user-selected form of distortion measured is not excessive. This diagnostic may be set to monitor one of the following:

- Distortion Power Factor, per element and summed
- Total Demand Distortion, per element
- Total Harmonic Current Distortion, per element
- Total Harmonic Voltage Distortion, per element

- DC Detection

A diagnostic 5 error condition is triggered if any of the distortion calculations exceed a user-specified threshold. There shall be four counters associated with diagnostic 5, one for each element and one for the total of all elements (used only for Distortion Power Factor measurements).

Phase Distorition is checked only when the momentary interval demand exceeds a user programmed threshold. This is the same demand threshold used for the power factor threshold output. The user programmed distortion tolerance value for diagnostic 5 has a range of 0 to 100% in increments of 1%.

DC presence is sensed by measurement of the second harmonic content in the measured current waveform. A D5 is set when the total current level and second harmonic level are high enough for saturation to be possible and the ratio of second harmonic current to total current exceeds the programmed tolerance.

Diagnostic 6: Under Voltage

Diagnostic 6 verifies the phase voltages are maintained above an acceptable level. The user programs an tolerance percentage for under voltage that has a range of 0 to 100%. A diagnostic 6 error condition is triggered for a given phase if the voltage at that phase falls below the reference voltage minus the under voltage percentage tolerance ($V_{ref} - T$).

The threshold used for under voltage is also used for the displayed potential and the low potential caution (see *Low Potential - CA 000400* on page 89).

The reference voltage used for the under voltage and over voltage diagnostics and for the displayed potential annunciator thresholds is determined at power up by measuring the phase A voltage and classifying the service as 120 V, 240 V, 277 V wye, 347 V wye, or 480V delta. This may be overridden with a user programmed reference voltage, which has a range of 0-999 V in increments of 1 V.

Diagnostic 7: Over Voltage

Diagnostic 7 verifies the phase voltages are below an acceptable level. The user programs an over voltage percentage tolerance that has a range of 0 to 100%. A diagnostic 7 error condition is triggered for a given phase if the voltage at that phase rises above the reference voltage plus the over voltage percentage tolerance (Vref + T).

Diagnostic 8: High Imputed Neutral Current

Diagnostic 8 verifies the imputed neutral current is maintained below an acceptable level. This condition is triggered if the imputed neutral current exceeds a user-programmed threshold. Form 45 and 56 as 4-wire delta or 4-wire wye applications are not valid services for calculating the imputed neutral values. In

these cases, the imputed neutral will be zeroed after the service type has been determined.

Site Genie Display Scroll		
ID	**Display**	**Quantity**
SER	See the Electrical Service Displays table below.	Electrical Service
PhA	XXX.X°	Element A Voltage Angle
PhA	XXX.X	Element A Volts RMS
PhA	XXX.X°	Element A Current Angle
PhA	XXX.X	Element A Amps RMS
PhB	XXX.X°	Element B Voltage Angle
PhB	XXX.X°	Element B Volts RMS
PhB	XXX.X°	Element B Current Angle
PhB	XXX.X	Element B Amps RMS
PhC	XXX.X°	Element C Voltage Angle
PhC	XXX.X°	Element C Volts RMS
PhC	XXX.X°	Element C Current Angle
PhC	XXX.X°	Element C Amps RMS
PF	X.XX.X	Power Factor
dPF	X.XX	Distortion Power Factor
d 1 _	XXX	Diagnostic counter 1
d 2 _	XXX	Diagnostic counter 2
d 3 _	XXX	Diagnostic counter 3
d 4 _	XXX	Diagnostic counter 4
d 5 _	XXX	Diagnostic counter 5 total
d 5 A _	XXX	Diagnostic counter 5 phase A
d 5 b _	XXX	Diagnostic counter 5 phase B
d 5 C	XXX	Diagnostic counter 5 phase C
d 6 A	XXX	Diagnostic counter 6 phase A
d 6 B	XXX	Diagnostic counter 6 phase B
d 6 C	XXX	Diagnostic counter 6 phase C
d 7 A	XXX	Diagnostic counter 7 phase A
d 7 B	XXX	Diagnostic counter 7 phase B
d 7 C	XXX	Diagnostic counter 7 phase C
d 8 _	XXX	Diagnostic counter 8

Electrical Service Displays	
Display	**Electrical Service**
_2-1PH	Single phase, 2 wire
_3-1PH	Single phase, 3 wire

Electrical Service Displays	
Display	**Electrical Service**
_5-2PH	Two phase, 5 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

When the presence of diagnostic conditions are displayed as part of the normal display scroll or the frozen condition display, they have the format shown in the table below:

Diagnostic Error Displays		
ID	**Display**	**Quantity**
CA	DIAG 1	Diagnostic error 1
CA	DIAG 2	Diagnostic error 2
CA	DIAG 3	Diagnostic error 3
CA	DIAG 4	Diagnostic error 4
CA	DIAG 5	Diagnostic error 5
CA	DIAG 6	Diagnostic error 6
CA	DIAG 7	Diagnostic error 7
CA	DIAG 8	Diagnostic error 8

The A, B, and C potential annunciators are either on or blinking for each voltage element present based on the ANSI form. If a voltage element is not present, the annunciator is turned off. A potential annunciator will blink if the measured voltage for the corresponding phase falls below the tolerance programmed for use by the undervoltage diagnostic (#6). The annunciators are updated every 5 seconds.

CHAPTER
12

PROGRAMMING SEAL

In addition to the physical hardware seals, the kV2c Gen 5 meter also provides a software seal which protects meter data and configuration parameters from unauthorized changes. When the meter is sealed, critical meter parameters cannot be written except for Passwords in Security file.

Operation

Operation of the programming seal is identical for Demand, Demand/Load Profile, and Time-of-Use modes. The programming seal may be enabled with MeterMate COMM.

To disable the programming seal:

1. Switch the meter into Test mode
2. Hold the Test and Reset buttons for at least 15 seconds
3. Take the meter out of Test mode.

When the meter is programmed with MeterMate MMCOMM after this operation has been performed, MeterMate will alert the user that the meter is in Password Recovery mode. MeterMate will then prompt the user whether to reprogram the security codes. Selecting yes will cause MeterMate to program the meter with the security codes present in the MeterMate security file. This does not cause the meter to be re-sealed. The following tables are protected from writing by the programming seal:

- Standard Table 11: Actual Sources Limiting Table
- Standard Table 12: Unit of Measure Table
- Standard Table 13: Demand Control Table
- Standard Table 14: Data Control Table
- Standard Table 15: Constants Table
- Standard Table 16: Source Definition Table
- Standard Table 21: Actual Register Table
- Standard Table 22: Data Selection Table
- Standard Table 23: Present Data Table

- Standard Table 24: Previous Season Data Table
- Standard Table 25: Previous Reset Data Table
- Manufacturer Table 43: Firmware Upgrade Control Table
- Manufacturer Table 66: Meter Program Constants 1 Table
- Manufacturer Table 70: Display Configuration Table
- Manufacturer Table 76: Input/Output Board Configuration Table
- Manufacturer Table 79: Alternate Calibration Correction Factors Table (requires softswitch)
- Manufacturer Table 86: Electrical Service Configuration Table
- Manufacturer Table 89: Transformer Loss Compensation Table (requires softswitch)
- Manufacturer Table 91: Dimension Totalization Limiting Table (requires softswitch)
- Manufacturer Table 92: Totalization Selection Table (requires softswitch)
- Manufacturer Table 93: Data Accumulators Selection Table
- Manufacturer Table 94: Data Accumulators Present Values Table
- Manufacturer Table 101: Actual Input/Output Table
- Manufacturer Table 102: Input/Output Configuration Table
- Manufacturer Table 110: Present Register Data Table

The following procedures are protected from execution by the programming seal:

- Standard Procedure 0: Cold Start (Unprogram)
- Standard Procedure 3: Clear Data (Master Reset)
- Manufacturer Procedure 2: Direct Execute
- Manufacturer Procedure 66: Change Configuration Status
- Manufacturer Procedure 67: Convert Meter Mode
- Manufacturer Procedure 68: Upgrade Meter
- Manufacturer Procedure 73: Flash Calibration Mode Control
- Manufacturer Procedure 76: Remove Softswitch

Unsealed Password

The passwords in Manufacturer Table 84: Security Table may be programmed when the meter is sealed in a kV2c Gen 5 meter.

CHAPTER
13

PASSWORD RECOVERY

The password recovery feature allows a meter's passwords to be programmed without first having to send the meter a valid password.

To switch the meter into Password Recovery mode:

1. Put the meter into Test mode.
2. Hold the Test and Reset buttons for at least 15 seconds
3. Take the meter out of Test mode.

When the meter is programmed with MeterMate after this operation has been performed, MeterMate will alert the user that the meter is in Password Recovery mode. MeterMate will then prompt the user whether to reprogram the security codes. Selecting yes will cause MeterMate to program the meter’s passwords for optical communication and AMI communication with the security codes present in the MeterMate security file. This does not cause the meter to be re-sealed.

CHAPTER
14

READING AND PROGRAMMING

The parameters that control operation of the kV2c Gen 5 meter may be set by the user through a process called programming. Program parameters are written to the kV2c Gen 5 meter using tables as defined in ANSI C12.19, Utility End Device Data Tables. Likewise, accumulated metering data can be retrieved from the meter by reading the appropriate data tables. Standard Table 0 contains bitfields that specify the Standard and Manufacturer Tables which are present in the meter, as well as bitfields that indicate the tables which may be written. These bitfields will be updated any time the meter operating mode is changed in a way which causes additional tables to become available or removes support for previously available tables. Standard Table 0 should be used by reading and programming software to determine which tables are present in the meter.

Security access to the tables is controlled using three levels of password protection. The highest access level, Master, is normally required for programming the meter. Read access is controlled on a table-by-table basis, depending upon the sensitivity of the data contained in each table.

When a kV2c Gen 5 meter is first received from the factory, it does not have any passwords and is unprogrammed. When it is powered up for the first time, an Unprogrammed caution, CA 000010, will appear on the display. Although the meter will operate as a demand meter out of the box, it is not considered programmed until passwords are written. At the same time that passwords are written, the desired operating parameters may be programmed into the meter. The first time the meter is programmed, no password is required. Once programming has been successfully accomplished, the unprogrammed caution will no longer be displayed and all subsequent access to the meter will be restricted based on the password used during communication.

Programmed parameters are not saved to non-volatile memory in the kV2c Gen 5 meter until the programming session is complete. If a programming session is terminated prematurely due to communications problems, a power outage or some similar cause, the meter will discard all newly written parameters and continue to operate with the program that was in effect prior to the most recent programming session. This protects against leaving the meter in an inconsistent, partially updated state.

Operation in Demand Mode

The kV2c Gen 5 meter provides a set of tables containing parameters to control basic demand metering operation. Additional functionality is available in Demand mode with optional softswitches, which provide features such as reactive metering, event logging, and power quality monitoring.

The kV2c Gen 5 meter communicates with programming software using the PSEM protocol and either an optical port or an optional modem communication board.

NOTE The kV2c Gen 5 with Enhanced Power Supply meter does not have the optional RSX communication board or an optional modem communication board.

Programmable Tables

The following sections provide lists of programmable tables for the kV2c Gen 5 meters.

Minimum Tables for Demand Mode

The following is a list of the minimum set of tables which must be programmed in Demand mode.

- Standard Table 11: Actual Sources Limiting Table
- Standard Table 13: Demand Control Table
- Standard Table 16: Source Definition Table
- Standard Table 22: Data Selection Table
- Standard Table 32: Display Source Table
- Standard Table 33: Primary Display List Table
- Manufacturer Table 66: Meter Program Constants 1
- Manufacturer Table 67: Meter Program Constants 2
- Manufacturer Table 68: Error Caution Configuration
- Manufacturer Table 70: Display Configuration
- Manufacturer Table 71: Line-side Diagnostics Configuration
- Manufacturer Table 74: Test Mode Configuration
- Manufacturer Table 84: Security Table

Optional

- Standard Table 5: Device Identification Table
- Standard Table 12: Unit of Measure Table*
- Standard Table 14: Data Control Table*

- Standard Table 15: Constants Table*

*These tables need additional softswitch(es) enabled in order to access the data.

Optional Softswitch-Enabled Programmable Tables

The following tables should be programmed or may require additional programming, if the corresponding softswitch has been enabled. The tables may or may not be present in the meter if the related softswitch is not enabled. See the following list for details.

If Expanded Measurements, By Quadrant Measurements, kVA/kvar/kQ Measurements, or Power Quality Measurements are enabled:

- Standard Table 12: Unit of Measure Table*
- Standard Table 14: Data Control Table*
- Standard Table 15: Constants Table

If Demand/LP or TOU is enabled:

- Standard Table 51: Actual Time and TOU Table (this table must be written before ST54)
- Standard Table 53: Time Offset Table
- Standard Table 54: Calendar Table
- Manufacturer Table 77: Load Control Switch Configuration (optional)
- Manufacturer Table 82: TOU Day Type Map

If I/O Board is present and/or Pulse Initiator Output is enabled:

- Manufacturer Table 76: I/O and Alerts Configuration (not needed for Pulse Initiator)*
- Manufacturer Table 101: Actual Input/Output Table*
- Manufacturer Table 102: Input/Output Configuration Table*

If Load Profile Recording (Basic or 20-Channel) is enabled:

- Standard Table 21: Actual Register Table*
- Standard Table 61: Actual Load Profile Table
- Standard Table 62: Load Profile Control Table

If Event Logging is enabled:

- Standard Table 71: Actual Log Table
- Standard Table 75: Event Log Control Table

If Totalization is enabled:

- Manufacturer Table 91: Actual Totalization Limiting Table
- Manufacturer Table 92: Totalization Selection Table

If Transformer Loss Compensation is enabled:

- Manufacturer Table 89: Transformer Loss Compensation Table

If Transformer Accuracy Adjustments are enabled:

- Manufacturer Table 79: Alternate Calibration Correction Factors

If Voltage Event Monitor is enabled:

- Manufacturer Table 71: Diagnostics Configuration
- Manufacturer Table 111: Voltage Event Monitor Configuration Table

* These tables need additional softswitch(es) enabled in order to access the data.

Readable Tables

The following tables are available for reading in Demand mode.

- Standard Table 0: General Configuration Table
- Standard Table 1: Manufacturer Identification Table
- Standard Table 3: End Device Mode and Status Table
- Standard Table 5: Device Identification Table
- Standard Table 8: Procedure Response Table
- Standard Table 11: Actual Sources Limiting Table
- Standard Table 12: Unit of Measure Table
- Standard Table 13: Demand Control Table
- Standard Table 14: Data Control Table
- Standard Table 15: Constants Table
- Standard Table 16: Source Definition Table

- Standard Table 21: Actual Register Table
- Standard Table 22: Data Selection Table
- Standard Table 23: Present Data Table
- Standard Table 25: Previous Demand Reset Table
- Standard Table 31: Actual Display Table
- Standard Table 32: Display Source Table
- Standard Table 33: Primary Display List Table
- Manufacturer Table 0: Aclara Device Table
- Manufacturer Table 42: Firmware Download Event Log
- Manufacturer Table 43: Firmware Download Control Table
- Manufacturer Table 66: Meter Program Constants 1 Table
- Manufacturer Table 67: Meter Program Constants 2 Table
- Manufacturer Table 68: Error/Caution Configuration Table
- Manufacturer Table 69: Error/Caution History Table
- Manufacturer Table 70: Display Configuration Table
- Manufacturer Table 71: Line-side Diagnostics Configuration Table
- Manufacturer Table 72: Line-side Diagnostics Data Table
- Manufacturer Table 73: Power Factor Configuration Table
- Manufacturer Table 74: Test Mode Configuration Table
- Manufacturer Table 75: Scale Factors Table
- Manufacturer Table 76: Input/Output Configuration Table
- Manufacturer Table 78: Security Log Table
- Manufacturer Table 81: Average Power Factor Table
- Manufacturer Table 84: Security Table*
- Manufacturer Table 85: Meter State Table
- Manufacturer Table 86: Electrical Service Configuration Table
- Manufacturer Table 87: Electric Service Status Table

- Manufacturer Table 93: Data Accumulators Sources Table
- Manufacturer Table 94: Data Accumulators Present Values Table
- Manufacturer Table 95: User-defined Calculations Mapping Table
- Manufacturer Table 96: User-defined Calculations Descriptor Table
- Manufacturer Table 101: Actual Input/Output Table
- Manufacturer Table 102: Input/Output Configuration Table
- Manufacturer Table 107: Security Table for AMI Port Communications*
- Manufacturer Table 110: Present Register Data Table

*Password fields will be populated with FF.

Optional, Softswitch-Enabled Readable Tables

The following tables may be accessed if the related softswitch(es) are enabled.

If Demand/LP or TOU is enabled:

- Standard Table 51: Actual Time and TOU Table
- Standard Table 52: Clock Table
- Standard Table 53: Time Offset Table
- Standard Table 54: Calendar Table

If TOU is enabled:

- Standard Table 4: Pending Status Table
- Standard Table 55: Clock State Table
- Manufacturer Table 82: TOU Day Type Map

If Load Profile Recording (Basic or 20-Channel) is enabled:

- Standard Table 61: Actual Load Profile Table
- Standard Table 62: Load Profile Control Table
- Standard Table 63: Load Profile Status Table
- Standard Table 64: Load Profile Data Set 1 Table

If Event Logging is enabled:

- Standard Table 71: Actual Log Table

- Standard Table 72: Events Identification Table
- Standard Table 75: Event Log Control Table
- Standard Table 76: Event Log Data Table

If Totalization is enabled:

- Manufacturer Table 91: Actual Totalization Limiting Table
- Manufacturer Table 92: Totalization Selection Table

If Transformer Loss Compensation is enabled:

- Manufacturer Table 89: Transformer Loss Compensation Table

If Transformer Accuracy Adjustments are enabled:

- Manufacturer Table 79: Alternate Calibration Correction Factors

If Voltage Event Monitor is enabled:

- Manufacturer Table 111: Voltage Event Monitor Configuration Table
- Manufacturer Table 112: Voltage Event Monitor Log Table

Operation in Demand/Load Profile Mode

In Demand/Load Profile mode, reading and programming are accomplished in the same way as in Demand mode, except that additional tables are available. Perform the following to enable the kV2c Gen 5 meter for load profile recording:

1. Enable one of the load profile recording (H, R, or X) softswitches.
2. Convert meter mode to Demand/LP mode.
3. Set the date and time.
4. Program the load profile tables (Standard Table 61 first, and then Standard Table 62) and Standard Table 21: Actual Register Table.
5. Execute the Start LP Recording procedure (Standard Procedure 16).

Decade 60 Standard Tables will not be visible unless at least one of the load profile softswitches is enabled and the meter has been converted to either Demand/LP mode or TOU mode.

Operation in Time-of-Use Mode

In Time-of-Use mode, reading and programming are accomplished in the same way as in Demand mode, except that additional tables, including pending tables,

are available. To enable the kV2c Gen 5 meter for TOU operation, perform the following steps:

1. Enable the TOU (T) softswitch.
2. Convert meter mode to TOU mode.
3. Set the date and time.
4. Program the TOU tables: Standard Tables 51, 53, 54, and Manufacturing Tables 77 (optional) and 82.

Pending Tables

Pending tables are defined by ANSI C12.19 and provide a means to program tables that are to take effect at a future date and time. In the kV2c Gen 5 meter, pending tables are only supported in TOU mode.

The tables which may be written as pending are:

- Standard Table 7 (Manufacturer Procedure 78: RTP Control, only)
- Standard Table 51
- Standard Table 54
- Manufacturer Table 77
- Manufacturer Table 82

Standard Table 4, the Pending Status Table, reports on the status of pending events. In the kV2c Gen 5 meter, this table provides room for 5 entries, which is enough to hold one pending event for each of the pending tables. When this table is full, additional requests to write a new pending table will be rejected, until a currently pending table either becomes active or is cleared by the user.

The kV2c Gen 5 meter supports Standard Procedure 14, Clear All pending tables, which may be used to remove previously programmed pending tables, and Standard Procedure 15, Clear Selected pending table(s). The tables may then be reprogrammed.

NOTE When Standard Procedure 14 is executed, Standard Table 4 will not be empty, but the NBR_PENDING_ACTIVATION field will be zeroed and the pending bit will be cleared in each of the current entries. When a pending table is activated, NBR_PENDING_ACTIVATION will be decremented and the pending bit in the TABLE_SELECTOR field will be cleared.

CHAPTER
15

COMMUNICATIONS

The kV2c Gen 5 meter provides an optical communications interface that complies with ANSI C12.18, Protocol Specification for ANSI Type 2 Optical Port. In addition, the kV2c Gen 5 meter implements the interface defined for the kV Meter to support communication option boards, which provide remote communication over various media. Option boards will communicate with the kV2c Gen 5 meter over the optical connection. For telephone communication, the kV2c Gen 5 meter supports ANSI C12.21, PSEM Protocol for Telephone Communications. All data is transported in AMRA Table format (see ANSI C12.19, Utility Industry End Device Data Tables).

CHAPTER 16

SECURITY LOG

The kV2c Gen 5 meter maintains a count of certain events in the meter along with, in some cases, the date and time the last one occurred and an identifier. This log is referred to as the Security Log since it can be helpful for a utility trying to detect tampering.

The following information is stored in the Security Log:

- Date and time meter was last calibrated
- Name of person who last calibrated the meter
- Date and time meter was last programmed
- ID of person who last programmed the meter
- Number of programming sessions
- Number of demand resets
- Number of communication sessions (does not include sessions initiated by option boards)
- Date and time of last communication session (not available in Demand mode)
- Number of passwords received which did not match any of the programmed passwords
- Number of times meter entered real-time pricing
- Date and time meter last entered real-time pricing (not available in Demand mode)
- Amount of time, in seconds, meter has been without power (not available in Demand mode)
- Number of power outages
- Date and time of last power outage (not available in Demand mode)
- Number of times meter has written data to EEPROM
- Date and time the transformer loss compensation parameters were last updated (not available in Demand mode)

- ID of person who last updated transformer loss compensation parameters
- Date and time of last time change (not available in Demand mode)
- Number of AMI communication sessions
- Date and time of last AMI communication session

CHAPTER
17

REAL-TIME PRICING

The real-time pricing feature provides a mechanism for signaling the meter to compute a second, separate set of summations and demands for as long as real-time pricing is active. The meter is put into real-time pricing by executing a procedure with MeterMate or by the activation of a dedicated two-wire input (5-24 V DC) from the internal modem board or an I/O board (simple or multiple).

Operation in Demand Mode and Demand/Load Profile Mode

During normal operation, the kV2c Gen 5 meter checks the status of the real-time pricing input. The real-time pricing input is debounced; the input must remain in the same state for 1.5 seconds before the change in state is acknowledged. When the kV2c Gen 5 meter detects that the input has changed state from inactive to active, it checks the programmed activation delay time. The activation delay time is the time, in minutes, the meter waits after detecting that the real-time pricing input has activated before switching to real-time pricing. This value is selectable when creating programs with MeterMate Program Manager (I/O and Alerts Support Table). If the delay time is zero, the kV2c Gen 5 meter enters real-time pricing immediately; otherwise, it remains in Normal mode until the timer activation delay time has passed.

Real-time Pricing mode can also be entered and exited via a procedure executed from MeterMate. Executing this procedure is identical to activating/deactivating the real-time pricing input. The meter keeps a status flag that indicates whether or not the meter has been put into real-time pricing via this procedure. This flag is logically ORed with the state of the real-time pricing input. Either method can therefore be used to put the meter into real-time pricing. If the meter has been put into real-time pricing with one method and while the meter is in real-time pricing the second method is used to activate real-time pricing, the meter will remain in real-time pricing. The activation delay is not restarted. In this case, however, the meter will remain in real-time pricing until the real-time pricing input has been deactivated and the exit real-time pricing procedure has been sent.

When the meter enters real-time pricing, it processes any unprocessed summations and demand data (i.e., for block and rolling demand meters, the demand interval ends). No data accumulated by the meter while not in real-time pricing will be processed as real-time pricing data.

During real-time pricing, the meter continues to calculate the data accumulations, average power factor, and non-real-time pricing summations. The meter does not calculate non-real-time pricing demands during real-time pricing. During real-time

pricing, the meter calculates real-time pricing summations and real-time pricing demands.

When the meter exits real-time pricing, it processes any unprocessed summations and demand data (i.e., for block and rolling demand meters, the demand interval ends).

Operation in Time-of-Use Mode

As in Demand mode, a meter in Time-of-Use mode may be put into real-time pricing by activating the input or executing a procedure with MeterMate. Rather than entering a separate real-time pricing, the meter enters one of the four TOU rates when real-time pricing has been activated. This TOU rate is selectable when creating programs with MeterMate Program Manager (I/O and Alerts Support Table). There is also a load control state, selectable with MeterMate Program Manager, associated with the real-time pricing TOU rate. If an I/O board is present in the meter and one of the outputs is programmed for Load Control, the meter will set the output to the specified real-time pricing Load Control state.

A meter in Time-of-Use mode may also be put into or taken out of real-time pricing via a pending procedure. A pending procedure is one that takes effect at a specified time and date in the future. The activation time must be on a 15 minute boundary (i.e., on the hour boundary or 15, 30, or 45 minutes past the hour). The activation delay does not apply to a pending enter real-time pricing procedure. In that case, as soon as the specified time is reached, the meter enters real-time pricing. Note that there is never a delay associated with exiting real-time pricing.

When the meter enters the real-time pricing TOU rate, it process any unprocessed summations and demand data (i.e., for block and rolling demand meters, the demand interval ends). This occurs even if the programmed real-time pricing TOU rate is the same rate that was in effect when real-time pricing was initiated. During real-time pricing, the meter continues to calculate the data accumulations. During real-time pricing, average power factor, summations, and demands are calculated as they would for a TOU meter operating in the rate programmed to take effect during real-time pricing.

CHAPTER
18

SELF-READ

The meter can store up to twelve self-reads. Each self-read captures a snapshot of the current billing data (summations and demands). Pressing the demand reset switch to zero demand values will trigger a self-read, ensuring demand data is not lost.

Operation in Demand and Demand/Load Profile Mode

A Demand meter must be configured to perform a self-read on a demand reset. When a demand reset occurs, the current billing data is copied before the demand values are reset. When self-read memory is full, the oldest self-read is over written.

Events that cause a self-read in a Demand meter configured for self-read on a demand reset are:

- Pressing the demand reset switch
- Using MeterMate to initiate a demand reset
- Expiration of the demand reset timer

Operation in Time-of-Use Mode

Operation in a Time-of-Use meter is similar to Demand mode. The billing data contains demands and summations for TOU rates and maximum demands are time-stamped. Events that initiate a self-read in a TOU meter configured for self-read on a demand reset are:

- Pressing the demand reset switch
- Using MeterMate to initiate a demand reset
- Expiration of the demand reset timer
- Activation of a self-read calendar action
- Activation of a demand reset calendar action
- Activation of a season change with demand reset calendar action
- Activation of a pending table with demand reset

CHAPTER
19

SELF-TEST ERRORS AND CAUTIONS

The purpose of the self-tests is to monitor the well-being of the major subsystems in the meter. Any problems are reported. As a general philosophy, problems are only reported while they are active and are cleared after they go away. The kV2c Gen 5 meter maintains a history flag to indicate a problem that became active and then went away.

Self-tests are divided into two major sections: errors and cautions. Errors represent one or more failure(s) in the basic subsystem of the meter, which directly affect the ability of the meter to register electrical usage. Cautions, on the other hand, represent conditions that may be of concern to the operator but do not directly affect the ability of the meter to register electrical usage. All of the kV2c Gen 5 meter self-tests errors and cautions are built into the meter and no softswitch upgrades are required. An Unprogram command executed with MeterMate software will clear all errors and cautions including their history flags.

Supported Operating Modes

The table below shows the meter's operating modes in which self-tests are supported. While in any one of the meter's basic operating modes (Demand, Demand/LP, TOU, Test, etc.), the meter can enter the Communications mode. When self-tests are being performed in one of the meter's basic operating modes, the self-test continues to be active during the communications session. And conversely, if no self-tests are being performed during the meter's basic operating modes, then self-tests are not active during the communications session.

		Mode			
Error or Caution	Code	Demand	Demand/LP	TOU	Test
Battery failure & power loss	Er 000002		✓	✓	
System error	Er 000020	✓	✓	✓	✓
RAM	Er 000100		✓		
Non-volatile RAM	Er 000200	✓	✓	✓	
ROM	Er 001000	✓	✓	✓	
Measurement	Er 100000	✓	✓	✓	
DAP	Er 200000	✓	✓	✓	
Low battery	CA 000001		✓	✓	
Meter not programmed	CA 000010	✓	✓	✓	
Loss of program	CA 000040	✓	✓	✓	
Programming interrupted	CA 000050	✓	✓	✓	
Low potential	CA 000400	✓	✓	✓	

Error or Caution	Code	Mode			
		Demand	Demand/LP	TOU	Test
Demand overload	CA 004000	✓	✓	✓	
Leading kvarh	CA 040000	✓	✓	✓	
Received kWh	CA 400000	✓	✓	✓	

Self-Test Errors

Self-test errors represent one or more failures in the basic subsystem of the meter that directly affect the ability of the meter to register electrical usage.

Error Highlights

- They are always enabled. (They cannot be programmed to be disabled.)
- They are always displayed.
- They can be programmed to freeze or not freeze the display. This is selectable when creating programs with MeterMate Program Manager (Meter Diagnostics Support Table).
- They cannot be configured to set an output.
- Errors are not cleared when a demand reset is performed.

NOTE Any meter with an error other than error 000002 should be replaced.

Below is a brief description of each self-test error.

Battery Fail and Power Loss - Er 000002

The Battery Fail and Power Loss Error occurs when there is low voltage on the battery's terminals and the meter has experienced a power loss. If the meter is not intended to operate in Battery-free mode, replace the battery and reprogram the meter.

NOTE This error cannot occur in a meter programmed in the Demand Only operation mode. The meter will display an Er 000 002 even if it is operating in Battery-free mode. The error will be cleared when the meter date and time are successfully set (see *Operation During Loss of Time* on page 51).

System Error - Er 000020

The System Error is triggered when the meter detects a problem with its internal hardware, most likely the microprocessor.

Non-Volatile RAM - Er 000200

The kV2c Gen 5 meter continually performs checksum tests on its non-volatile RAM (NVRAM), which consists of EEPROM and flash memory. Each memory type is further segmented according to its use (e.g., Load Profile, revenue data, or programming data), and each segment has its own checksum. If a checksum error occurs in any one of the segments, the meter records an NVRAM checksum error.

Code Flash Error - Er 001000

The kV2c Gen 5 meter continually performs checksum tests on its firmware image in flash memory. If a checksum error occurs, the meter records a Code Flash checksum error.

Measurement Error - Er 100000

The kV2c Gen 5 meter reports a measurement error whenever it detects a problem with its voltage reference.

Metering Error - Er 200000

The meter continually monitors the operation of its metrology function. If the meter detects that metrology function has stopped, data is out of range or configuration parameters are incorrect, it will set a Metering Error.

Self-Test Cautions

Self-test cautions represent conditions that may be of concern to the operator but do not directly affect the ability of the meter to register electrical usage.

Caution Highlights

- Cautions can be either enabled or disabled.
- With the exception of the bad password, time change, and high temperature cautions, which are not displayable, cautions can be programmed to appear on the display (default selection) or to not appear on the display. The caution must be enabled to be displayed.
- Displayable cautions can be programmed to freeze or not freeze the display.
- Cautions can be configured to set an output.

A demand reset will clear the Received kWh, Leading kvarh, and Demand Overload cautions. The remaining cautions are not affected by a demand reset.

Parameters which control the operation of cautions are selectable when creating programs with MeterMate Program Manager (Meter Diagnostics Support Table).

Below is a brief description for each of the self-test cautions.

Low Battery - CA 000001

The Low Battery Caution and its history flag are set when the voltage at the battery's connector falls below a predetermined voltage. After powering up with the battery replaced, the Low Battery Caution will be cleared.

While the battery is low, if the meter experiences an extended power outage, the Battery Fail and Power Loss Error will occur.

The battery is tested (in Demand/LP and TOU modes only) at the following times:

- At power up
- Daily at 00:16:00
- When the display switch is activated, except during Test mode
- When the meter is programmed
- When the meter receives a test battery procedure (available in MeterMate)

This caution should be disabled if the meter is being used in Battery-free mode.

Unprogrammed Meter - CA 000010

The Unprogrammed Caution is set when the meter is converted to the Default Demand mode or an Unprogram command (available in MeterMate) is executed. This caution is cleared when passwords are successfully written to the meter.

Loss of Program - CA 000040

The Loss of Program Caution and its history flag are set when the kV2c Gen 5 meter programming session terminates prematurely. The meter will then revert to using the program that was in place before the terminated programming session began. This Caution is cleared when a programming session terminates successfully.

Note that setting the meter's date and time, which is required to restart load profile operation in a meter operating in Battery-free mode, needs to be done through a programming session. If this operation is interrupted (by a power outage, for example), the meter will flag this caution (if it is programmed to do so). This caution does not indicate that the meter has lost its program, only that the operation was interrupted. The meter does not require a reprogramming in this case, only the caution flag needs to be cleared.

For meters integrated with communication modules that will be performing operations such as setting date/time or changing meter programs, it is recommended this caution be disabled.

Unprogrammed and Loss of Program - CA 000050

The Unprogrammed and Loss of Program Caution occurs when programming of a meter operating in the default Demand mode is interrupted.

Low Potential - CA 000400

The Low Potential Caution is set when any one of the potentials that are expected to be present drop below a programmed threshold for three consecutive tests (a test is performed every five seconds). This threshold is the same one that is used for Site Genie *Diagnostic 6: Under Voltage* (see page 60). The caution clears when all of the potentials expected to be present are above the programmed threshold for two consecutive tests.

Demand Overload - CA 004000

The Demand Overload Caution check is performed on the interval demand selected for this caution at the end of each demand interval. The selected demand must be one of the (up to) five demands the meter has been programmed to calculate (see *Demand Calculations* on page 21). If the magnitude of the demand exceeds the programmed demand overload threshold, the Demand Overload Caution and its history flags are set. When the magnitude of the demand does not exceed the programmed overload threshold, this caution is not cleared. However, this condition is reflected in the Event Log. This caution is cleared when a manual demand reset is performed.

Leading kvarh - CA 040000

The Leading kvarh Caution test is performed every 5 seconds. If the direction of the quadergy is leading and the magnitude is greater than the programmed threshold for three consecutive tests, this caution and its history flag are set. When these conditions are not both true for two consecutive tests, this caution is not cleared. However, this condition (two consecutive tests of lagging quadergy) is reflected in the Event Log. This caution is cleared when a manual demand reset is performed.

Received kWh - CA 400000

The Received kWh Caution test is performed every 5 seconds. If the direction of the measured energy is received and the magnitude is greater than the programmed threshold for three consecutive tests, this caution and its history flag are set. When these conditions are not both true for two consecutive tests, this caution is not cleared. However, this condition (two consecutive tests of measured energy delivered) is reflected in the Event Log. This caution is cleared when a manual demand reset is performed.

Bad Password

This caution is not displayable. The bad password caution flag and history flag are set when the meter receives more than the programmed number of invalid passwords without receiving a valid password. This caution is cleared when a manual demand reset is performed.

Time Change

This caution is not displayable. The time change caution flag and history flag are set when the meter's time is changed. This caution is cleared when a manual demand reset is performed.

High Temperature Caution

The threshold for this caution is programmable from 0 to 100° Celsius in increments of 1° Celsius. The default value is 95° Celsius. The high temperature caution is always enabled.

The high temperature caution is set when the temperature reading by the meter reaches or exceeds the programmed threshold for 60 seconds. The caution is cleared when the temperature drops below the programmed threshold for 60 seconds.

The meter will perform the high temperature check at least once every five seconds. When the meter detects a high temperature caution condition, it sets a caution flag indicating an event occurred, and it sets the caution history flag. When the condition clears, the meter clears the caution flag. The meter will also clear the high temperature caution on power up.

A High Temperature Caution Flag is indicative of environmental changes detrimental to the reliability and accuracy of meter functions. While this caution flag does not appear on the display, you may poll the meter using reading software to check the latest high temperature cautions or the current environment temperature.

NOTE These values are not definitive enough to determine if a meter is functioning properly and should not be used in place of regular inspection. The temperature reading in the meter can be affected by external influences. This can cause temporary erroneous spikes in the temperature reading. Typically the impact will be five degrees Celsius or less, but under some extreme conditions the impact can be 10 degrees Celsius or more. It is therefore recommended that multiple readings be taken and averaged, or anomalous readings (those that differ by more than five degrees from other readings) be removed, to more accurately determine the temperature.

CHAPTER
20

SOFTSWITCHES

The kV2c Gen 5 meter allows certain features to be enabled and disabled through softswitches.

Measurement Softswitches (B, K, M, or Q Switches)

There are four measurement softswitches available for the kV2c Gen 5 meter:

- By quadrant (B)
- kVA/kvar/kQ (K)
- Expanded Measures (M)
- Power Quality (Q)

Descriptions of measurement quantity options available by softswitch are outlined in *Measurement Restrictions* on page 13.

When a measurement softswitch is added, the meter is capable of accumulating data for quantities that are controlled by that softswitch. This includes data accumulations, summations, and demand calculations quantities.

When a measurement softswitch is removed, the meter will no longer accumulate data for quantities that are controlled by that softswitch. However, any data accumulated in quantities controlled by that softswitch while it was enabled will remain until cleared by, for example, a Clear Data procedure or demand Reset.

For example, suppose a meter without a B switch is programmed with a Measurement Profile (see *Measurement Profile* on page 11) that includes quadrant 1 watt hours, fundamental plus harmonics (this is one of the quantities that is controlled by the B switch). Further suppose that this quantity is selected as a summation and one of the demands (e.g., max quadrant 1 kW fundamental plus harmonics). These quantities will remain zero until the B switch is added. Once the B switch is added, these quantities will begin to accumulate. If the switch is subsequently removed, these values will stop accumulating. They will not, however, be set to zero by the action of removing the softswitch. They will stay at whatever value they had when the switch was removed.

Event Log (E Softswitch)

The Event Log softswitch allows the meter to track the most recent 500 events. Use MeterMate to select which event types should be logged and how many occurrences should be tracked-up to 500 occurrences max. Date and time stamps are included on logged events for Demand/LP or TOU meters.

Logged Events:

- Diagnostics 1-8: When set and when cleared (d5 by phase and total, d6 and d7 by phase)
- Cautions: Under voltage, demand overload, leading kvarh, reverse energy flow-when set and when cleared
- Real-time pricing activation and deactivation
- Test mode activation and deactivation
- Externally initiated meter reading (local or remote)
- Programming sessions
- Power up, power down
- Demand resets
- Self-reads

Transformer Inaccuracy Correction (I Softswitch)

When the I switch is added, the meter will be able to perform the Transformer Inaccuracy Correction function (see *Transformer Inaccuracy Correction* on page 131). If the meter has never been programmed for this function or has not been programmed for it since the last time it had received a MeterMate Unprogram command, the function will be disabled when the switch is added. The table that controls this function will be programmable when the switch is added. If the meter had been programmed for this feature and no subsequent Unprogram command had been performed, then adding the softswitch will cause the meter to begin performing the function. It will use the coefficients previously programmed into the meter.

When the I switch is disabled, the meter will no longer perform the Transformer Inaccuracy Correction function.

Transformer Loss Compensation (L Softswitch)

When the L switch is added, the meter will be able to perform the Transformer Loss Compensation function (see *Transformer (and Line) Loss Compensation* on page 111). If the meter has never been programmed for this function, or has not

been programmed for it since the last time it had received a MeterMate Unprogram command, the function will be disabled when the switch is added. The table that controls this function will be programmable when the switch is added. If the meter had been programmed for this feature and no subsequent Unprogram command had been performed, then adding the softswitch will cause the meter to begin performing the function. It will use the coefficients previously programmed into the meter.

When the L switch is removed, the meter will no longer perform the Transformer Loss Compensation function.

Load Profile Recording (R or X Softswitch)

When the Basic Load Profile Recording (R) switch is added, the meter may be programmed to record up to eight channels and 128 kilobytes (kB) of on-board memory. When the Expanded Load Profile Recording (X) switch is added, the meter may be programmed to record up to twenty channels and 192 kB of load profile data.

When both the R and X switches are removed, the meter will continue to perform the self-read but will no longer perform load profile functions and load profile data previously recorded will not be readable. However, the self-read data can be readable. If either the R or the X switch is removed while the meter is actively recording load profile data, the meter will stop recording load profile data even if the other Load Profile switch is present. If the other switch is present, load profile recording may be restarted by reprogramming the meter for load profile operation.

Huge Load Profile (H Softswitch)

When the Huge Load Profile Recording softswitch is added, the meter may be programmed to record up to twenty channels and 384 kB of load profile data.

Time-of-Use (T Softswitch)

When the T softswitch is added, the meter may be programmed for Time-of-Use operation.

How the meter operates after the T softswitch is removed depends on how it was operating prior to the T softswitch being removed. If the meter was operating as a TOU meter, it will softswitch to the Demand/Load Profile mode if Load Profile Recording was active or Demand mode if it was not. Otherwise, the function of the meter will not change.

Voltage Event Monitor (V Softswitch)

When the V switch is added, the meter will be able to perform the Voltage Event Monitor function (see *Voltage Monitor* on page 115). If the meter has never been programmed for this function or has not been programmed for it since the last time

it had received a MeterMate Unprogram command, the function will be disabled when the switch is added. The table that controls this function will be programmable when the switch is added. If the meter had been programmed for this feature and no subsequent Unprogram command had been performed, then adding the softswitch will cause the meter to begin performing the function. It will use the parameters previously programmed into the meter.

When the V switch is removed, the meter will no longer perform the Voltage Event Monitor function

Waveform Capture (W Softswitch)

When the W switch is added, the meter will, during subsequent communication sessions, capture voltage and current samples for (at least) one cycle when it receives a capture waveform procedure (available in MeterMate software as part of its harmonic analysis option). See *Waveform Capture* on page 117 for more information.

When the W switch is removed, the meter will no longer capture voltage and current samples when it receives a capture waveform procedure.

Totalization (Z Softswitch)

When the Z switch is added, the meter will be able to perform the Totalization function (see *Pulse Inputs and Totalization* on page 107). If the meter has never been programmed for this function or has not been programmed for it since the last time it had received a MeterMate Unprogram command, the function will be disabled when the switch is added. The parameters which control this function will be programmable after the switch has been added. If the meter had been programmed for this feature and no subsequent Unprogram command had been performed, then adding the softswitch will cause the meter to begin performing the function. It will use the coefficients previously programmed into the meter.

When the Z switch is removed, the meter will no longer perform the Totalization function.

CHAPTER
21

TEST MODE

Test mode allows the meter to be tested without disturbing billing data or setting a new maximum demand.

The kV2c Gen 5 meter will enter Test mode if the test switch is pressed for at least one second or the meter receives a procedure to enter Test mode (available in MeterMate Test menu).

Metering in Test Mode

The same selected measurement profile quantities calculated during normal operation are calculated in Test mode. In Test mode, data accumulations are updated every momentary interval instead of every minute, as is the case in Normal mode (see *Data Accumulations* on page 17). Data accumulated during Test mode is not added to the Normal mode billing data.

Test mode data accumulations are only available as displayable items; they may not be read from the meter.

Summations

In Test mode, there is no distinction between data accumulations and summations.

Demand Calculations

The same demand values calculated during normal operation are also calculated in Test mode. The type of demand calculation (rolling, block, thermal) is also used for Test mode demand calculations. The interval time (block), subinterval time, and subinterval multiplier (rolling), or time constant (thermal) may be different for Test mode demand calculations.

In Test mode, there are no coincident, cumulative, or continuously cumulative demands. Test mode demands are only available as displayable items, and may not be read from the meter.

Block and Rolling Demand Calculations

The meter calculates test demands (block or rolling) whether or not the power fail exclusion is in effect. In Test mode, block and rolling demands are updated every momentary interval. For block demand, the demand values are calculated based on the data collected over the most recent demand interval. For rolling demand, the demand values are calculated based on the data collected over the N most recent subintervals, where N is the programmed subinterval multiplier. Even though

demand calculations are performed every momentary interval, the data accumulated is still treated as though it was accumulated over an entire demand interval. The results of the demand calculations performed every momentary interval are referred to as accumulating demands.

A demand calculation for block and rolling demand in Test mode consists of the following steps:

- For summed quantities, the average demand over the demand interval is calculated. For quantities defined as max values, the maximum value of the quantity that occurred during the demand interval is determined.
- The newly computed demand values are compared to the test maximum demand values. If a newly computed demand value is larger than its corresponding test maximum demand, the test maximum demand is set to the newly computed.
- At the end of a test demand interval, the previous interval demands for the five selected demand quantities are set to the newly computed demand quantities.

NOTE In Test mode, demand intervals and subintervals begin when Test mode is entered or a test reset is performed. They are not synchronized to minute boundaries (or, where applicable, midnight boundaries) in the meter.

Thermal Demand Calculations

The meter calculates thermal demands in Test mode whether or not the power fail exclusion is in effect. Thermal demand values are updated every momentary interval. The time constant for thermal demand in Test mode is programmable to be (not less than) fifteen minutes or (not less than) one minute. The exponential functions that characterize a thermal demand meter are approximated in the kV2c Gen 5 meter with a two-term series expansion. The thermal demand equation for a one-minute time constant is:

$$I_n = I_{n-1} + (P_n - I_{n-1}) \frac{1}{26.58}$$

I_n is the current thermal demand reading.

I_{n-1} is the previous thermal demand reading.

P_n is the current momentary interval demand

Each momentary interval, a new thermal demand, referred to as the current demand reading, is computed.

This demand is compared to the test maximum demand. If it is larger than the current test maximum demand, then the current test max demand is set to the current thermal demand reading.

Demand Reset

There are two demand reset actions that must be handled by the meter in Test mode. The first is a test demand reset that is initiated by a press of the reset button. The operation of this function is described in this section. The second is a demand reset initiated by either the demand reset timer timing out (Demand, Demand/load profile, and Time-of-Use meters) or a calendar action (Time-of-Use meters). The main differences in demand reset in Test mode is that the all-segment display does not show on the scroll for one scroll period, and, if the meter is programmed for thermal demands, all the thermal readings are zeroed (i.e., the current rate and overall max demands are not set to the current thermal reading).

When the reset switch is pressed, the display shows an all segments display, which remains until the reset switch is released. When the reset switch is released, all of the Test mode data is initialized and the display returns to the item that was shown when the switch was pressed. The following data is initialized:

- Test mode data accumulations are set to zero.
- Test mode demands are set to zero.
- The time remaining in the test demand interval is set to the test interval length (block demand) or the test subinterval length (rolling demand).

The demand reset inhibit and reset lockout features do not apply to test demand reset. The number of demand resets is not incremented, the date and time of last demand reset is not updated, and a test demand reset is not recorded in the event log.

Power Factor

The kV2c Gen 5 meter calculates momentary interval power factor while in Test mode. The selection of the two quantities, one for the numerator and one for the denominator, from which the power factor is calculated, are not separately selectable for Test mode power factor. They are the same as those selected for average power factor. Test mode power factor is only available as a displayable item. It cannot be read from the meter.

Other Functions

This section provides if and how the remaining functions operate when the meter is in Test mode.

Event Log

The meter, if programmed to do so, will log Test mode enter and exit events. The following events may be logged while the meter is in Test mode:

- Primary Power Up/Down
- Real-Time Pricing
- Demand reset (timer or TOU calendar Event)

- Self-read (TOU calendar Event)

All other events are disabled during Test mode.

Alert Outputs

Programmed alert outputs for features that run in Test mode continue to operate in Test mode.

Pulse Initiator Outputs

Pulse initiator outputs continue to function as programmed in Test mode.

Load Profile Recording

The meter continues to record load profile intervals in Test mode, but data accumulated in Test mode is not recorded in those intervals.

Site Genie

The potential indicators operate in Test mode. The Site Genie diagnostics are disabled.

Programming Seal, Reading, and Programming

These features do not apply to Test mode since communication with the meter is limited to exiting Test mode when the meter is in Test mode.

Real-Time Pricing

The meter can be put into or taken out of real-time pricing during Test mode by activating or deactivating the input. Billing data for real-time pricing (Demand and Demand/Load Profile meters) or the programmed real-time pricing TOU rate (TOU meters) is not updated as long as the meter is in Test mode.

Self-Read

Only self-reads scheduled as calendar actions will be performed during Test mode.

Self-Test

Only system errors are detected during Test mode.

Softswitches

Softswitches cannot be enabled or disabled during Test mode.

Time-of-Use Schedules and Programmable Dates

Rate changes and calendar actions continue to occur in Test mode.

Pulse Inputs and Totalization

The meter will collect input pulses and perform totalizations in Test mode. The data is not added to Normal mode billing data.

Transformer and Line Loss Compensation

The meter will apply transformer loss compensation to data in Test mode.

Voltage Monitor

The voltage event monitor does not operate in Test mode.

Waveform Capture

Waveform capture cannot be performed during Test mode.

Timekeeping

Timekeeping operates in Test mode just as it does in Normal mode.

Display

During Test mode, an item remains on the display until the display switch is activated. When the switch is activated, the next item in the display program is shown. Displayed items are updated every second in Test mode. Normal, Alternate, and Site Genie display modes are not available while the meter is in Test mode.

Exiting Test Mode

The kV2c Gen 5 meter exits Test mode if:

- the test switch is pressed for at least one second,
- the meter receives a procedure to exit Test mode (available in MeterMate Test Menu), or
- the Test mode timeout timer expires.

CHAPTER
22

TIME-OF-USE (TOU) SCHEDULES AND PROGRAMMABLE DATES

Adding a T (Time-of-Use) softswitch to the meter adds a real-time clock, calendar, and a TOU Tier Schedule. The meter supports a 150-entry calendar and an 80-setpoint TOU Tier Schedule with 4 Seasons, 4 Tiers (A - D) and 4 day types (3 regular day types and a holiday). In addition to the active calendar and TOU Tier Schedule, the meter supports a pending calendar and TOU Tier Schedule that will take effect at a set date and time in the future. Time-of-Use features are not supported in a Demand meter.

Operation in Demand/Load Profile Mode

A Demand/Load Profile meter supports a limited set of TOU calendar actions. Only Spring and Fall Daylight Savings calendar actions are supported.

Operation in Time-of-Use Mode

Each midnight, the meter searches through its calendar and compiles a list of the actions (holiday, season change, DST, self-read, or demand reset) that must performed. After the actions for the day are performed, the meter determines the day type and TOU Tier for the new day.

After a power outage, the meter processes the calendar similar to midnight to determine what calendar actions were not processed because of the outage. Each type of action will only be processed once based on the order of precedence listed on page 102 and the last calendar action of each type processed. The one exception is DST actions. All DST actions are processed first to ensure that the real-time clock is properly adjusted to reflect the true time before the rest of the calendar is processed.

Calendar

The calendar supports up to 150 entries which tells the meter when actions such as holidays, season changes, Daylight Savings, demand resets, and self-reads occur. Each calendar entry has a date, qualifier, and action associated with it. Dates can be Nonrecurring (happen only once) or Recurring (happen repeatedly).

Each day at midnight, the calendar is scanned for all actions that must be processed, and then the actions are processed. The calendar is scanned first to ensure an action is only performed once at midnight. Recurring Dates are scanned before Nonrecurring Dates. This gives Nonrecurring Dates precedence over

Recurring Dates when the same action is scheduled more than once for the same day. Recurring Dates must be sorted from the most general (Weekly) to the most specific (Fixed). The precedence for calendar entries are:

1. Recurring Dates
2. Floating Dates
3. Weekly
4. Monthly
5. Nth Occurrence
6. Fixed Dates
7. Non-recurring Dates

If there is more than one instance of an action type scheduled for the same day, only the last action processed will be performed. For example, if a season change with a demand reset and a demand reset are scheduled for the same day, only one demand reset will be performed. So, if one entry is Season 1 on the 2nd Monday in July, and another entry is Season 2 every July 9th, the meter will change into Season 2. If two Season Changes are scheduled for the same day, the last Season Change processed based on the precedence in the numbered list above will take effect.

Nonrecurring Dates

A Nonrecurring Date is used to define an event which only occurs once on a specific date. Nonrecurring dates are processed last and take precedence over all other dates.

Recurring Dates

The calendar events may be scheduled as fixed or floating recurring dates.

Fixed Recurring Dates

Fixed Recurring Dates are events which occur on the same month and day every year (e.g., New Year's Day (January 1st), Independence Day (July 4th), Christmas (December 25th), etc.).

Floating Recurring Dates

Floating Recurring Dates are used to define events that occur weekly (e.g., every Monday), monthly (e.g., 1st of every month), or on a specific occurrence of a day every year (e.g., the 4th Thursday of November).

Examples of Floating Recurring Dates				
Date	**Week**	**Day of Week**	**Month**	**Action**
Presidents' Day	3rd	Monday	February	Holiday
Memorial Day	Last	Monday	May	Holiday
Labor Day	1st	Monday	September	Holiday

Examples of Floating Recurring Dates				
Date	**Week**	**Day of Week**	**Month**	**Action**
Columbus Day	2nd	Monday	October	Holiday
Thanksgiving	4th	Thursday	November	Holiday

Qualifiers

Each date may have an additional qualifier. The meter supports the following date qualifiers:

- This Day Only: Only the date specified (default)
- Next Day Also: The date specified *and* the following day
- Next Day Only: The day following the date specified
- Sunday to Monday: On Monday whenever it falls on Sunday
- Saturday to Friday: On Friday whenever it falls on Saturday
- Non-Weekend: switch to Friday or Monday when if falls on Saturday or Sunday

Actions

The following calendar events are supported:

- holiday
- season change
- self-read
- demand reset
- Spring Daylight Savings
- Fall Daylight Savings

Holiday

The most common calendar entry is a holiday action. At midnight, the meter searches its calendar for any holidays matching the current date. When the date in the meter matches the date for a holiday, the meter switches to the holiday day type for the current season.

Season Change

The meter supports up to 4 seasons. The meter changes seasons through scheduled season changes in the calendar. A season change can be scheduled to happen automatically on the specified date or to be armed to happen at the next demand reset. Automatic season changes take place immediately. Manual season changes are armed when the season change action is processed but not implemented until the next demand reset (i.e., demand reset switch, MeterMate demand reset, or a demand reset initiated by a calendar action). MeterMate sets the current season in the meter during programming. A demand reset and/or a self-read may accompany a season change.

Self-Read/Demand Reset

In addition to self-reads and demand reset that can be scheduled in conjunction with a season change, a self-read and/or demand reset calendar action can be scheduled.

Daylight Saving Time

The meter can be configured to automatically adjust its real-time clock to daylight savings through Spring/Fall Daylight Saving calendar actions. During the processing of calendar at midnight, the meter looks for Daylight Saving actions. If a Daylight Saving action is scheduled, it will not take effect until 2:00 a.m. At 2:00 a.m., the meter will adjust the clock forward to 3:00 a.m. in the spring for a Spring Daylight Savings action. In the Fall, at 2:00 a.m., it will adjust the clock backwards to 01:00 a.m. for a Fall Daylight Savings action.

Tier Schedule

The meter supports a TOU tier schedule made up of 80 tier switches. The tier switches determine the TOU Tier based on the current season, day type, and time of day and the state of the Load Control output. The meter supports up to 4 day types (3 regular day types and 1 holiday day type) for each of the 4 Seasons (16 day types maximum). Each day type must have at least one tier switch associated with it that defines the tier schedule for that day type. Below is an example of a TOU tier schedule with 2 seasons, 2 regular day types, and a holiday day type.

	Day Type 1	Day Type 2	Day Type 3 (Holiday)
Season 1	00:00 Rate C, load on 07:00 Rate B, load on 09:00 Rate A, load on 17:00 Rate B, load on 21:00 Rate C, load on	07:00 Rate B, load on 21:00 Rate C, load on	00:00 Rate C, load on
Season 2	00:00 Rate C, load on 09:00 Rate A, load on 17:00 Rate C, load on	07:00 Rate B, load on 21:00 Rate C, load on	00:00 Rate C, load on

The day type table in the MeterMate software defines which of the 3 regular day types are in effect for each day of the week. The calendar determines which days the holiday day type is in effect. Day types take effect at midnight. Below is an example of a day type table.

Day of Week	Day Type
Monday	Type 1
Tuesday	Type 1
Wednesday	Type 1
Thursday	Type 1
Friday	Type 1
Saturday	Type 2
Sunday	Type 2

At midnight, the meter determines the day type and TOU tier for the upcoming day. If the current day is not a holiday, the day type is determined by the entry from the day type table for the day of week (e.g., Monday, Tuesday, etc.). If the day type selected does not have a tier switch at midnight, the current tier remains in effect until the first tier switch is reached (all day types must have at least one tier switch).

Every quarter hour the meter checks the day type to see if a new tier switch should be activated. When the current time matches the time of a tier switch, the data for the current tier is saved to non-volatile memory, and the data for the new tier is loaded into memory.

NOTE Activation of real-time pricing overrides the operation of tier switches in the day type.

CHAPTER
23

PULSE INPUTS AND TOTALIZATION

Pulse Input requires a Multi-Function I/O (MIO) board. Raw pulses can be accumulated with the MIO Board and no other softswitches. However, scaled pulses and/or totalization requires a Z softswitch, and the profile used for the MeterMate program must contain at least one Totalization channel. A 5 to 24 V DC power supply is also required to energize the pulse initiator circuits of the external pulse inputs.

NOTE If a two-wire input is provided, it must be connected to the K and Z inputs.

The meter can perform totalization under glass on up to 4 inputs and internal quantities. The Multi-Function I/O (MIO) Board has 4 inputs that can be configured for either Form A or Form C. The meter is capable of counting up to 30 pulses per second. The meter samples the state of all 4 pulse inputs 60 times per second. Each state change in a pulse input (e.g., ON→OFF or OFF→ON for Form A; KY→KZ or KZ→KY for Form C) increments the respective pulse counter. Pulses are accumulated for one minute. At the end of each minute, pulses are added to their respective accumulator(s). If the Totalization (Z) softswitch is enabled, the meter performs two additional steps: scaling and totalization.

Input Pulse Scaling

Pulses may be scaled to obtain a common unit of measure. Once pulses are converted into equivalent internal units, they can be treated the same as quantities calculated by the meter. Scaled pulses can have demands calculated and be displayed in engineering units (e.g., kWh, kvarh, or kVAh). At the end of each minute, raw pulses are scaled based on the ratio of input pulses (1-65,535) to internal units (1-65,535). It is necessary to scale the input pulses before totalizing to ensure that all values are in the same units. Any remainder from scaling the input pulses is carried forward to the next minute.

Form	9S
Class	20
Voltage Range	120-480 V
Current Transformer Ratio	1200:5
Potential Transformer Ratio	100:1
VAh Scale Factor	250 µWH/unit

Transformer Factor	24000
Primary Pulse Value	1 kWH/pulse

$$\frac{\text{Primary Pulse Value}}{\text{Transformer Factor X VAh Scale Factor}} \quad \frac{\frac{\mu Wh}{pulse}}{\frac{\mu Wh}{unit}} =$$

$$\frac{1{,}000{,}000 \ \frac{\mu Wh}{pulse}}{24000 \times 250 \ \frac{\mu Wh}{unit}} = \frac{500 \text{ units}}{3 \text{ pulses}}$$

In the example above, another device is feeding pulses with a primary value of 1 kWh/pulse into the meter. Each input pulse must be scaled into internal units on the secondary side of the transformer in order to be manipulated and displayed as kWh by the meter. The input scaling must be set to store 500 units for every 3 input pulses. If the meter collects 722 pulses in one minute, that is equivalent to 120,000 units (722/3 = 240 2/3; 240 · 500 = 120,000) with a remainder of 2 pulses. The remainder is carried over into the next minute.

Totalization

Scaled input pulses may be combined with other scaled input pulses and/or values calculated by the meter through a process called totalization. The meter updates totalized values each minute after all pulses have been collected and scaled. The meter uses totalization mapping to define what quantities are to be combined and how.

For example, suppose an industrial complex is serviced by five feeders, each with its own meter. The goal is to obtain a single Total kWh value for the entire industrial complex. Four meters output kWh pulses to a kV2c Gen 5 meter equipped with an MIO option board and Z softswitch. The input pulses from each meter are scaled appropriately into internal kWh units. Totalization mappings are used to combine the kWh from all five meters into a single quantity. The resulting Totalization Channel 1 can be displayed, recorded, etc. the same as any internal kWh value.

1. Use the MeterMate Profile Editor to create a profile with scaled pulse inputs (Pulse Input 5-8) and at least one Totalization Channel.
2. Use the MeterMate I/O Alerts Editor to set up the 4 scaled pulse inputs (Pulse Input 5-8).
3. Use the MeterMate Totalization Editor to define the totalization mappings.

Be sure to select the I/O and Alerts Support Table from step 2 above.

Example Totalization Mappings	
	Profile
1	kWh Total Del Only
2	Pulse Input 5 (Scaled) Wh
3	Pulse Input 6 (Scaled) Wh
4	Pulse Input 7 (Scaled) Wh
5	Pulse Input 8 (Scaled) Wh
6	Totalization Channel 1
...	...
20	

Source	Operation	Destination
kWh Total Del Only	Add	Totalization Channel 1
Pulse Input 5 (Scaled) Wh	Add	Totalization Channel 1
Pulse Input 6 (Scaled) Wh	Add	Totalization Channel 1
Pulse Input 7 (Scaled) Wh	Add	Totalization Channel 1
Pulse Input 8 (Scaled) Wh	Add	Totalization Channel 1

CHAPTER
24

TRANSFORMER (AND LINE) LOSS COMPENSATION

The kV2c Gen 5 meter is capable of adjusting metered values to compensate for any transformer or line losses between the metering point and the billing point. The compensation may be added or subtracted from the metered values as needed.

NOTE Transformer Loss Compensation will not operate and the coefficients cannot be programmed unless the Transformer Loss Compensation softswitch is enabled. Transformer Loss Compensation can also be turned on and off through MeterMate.

Electrical service is typically provided to a customer with the billing point on the high voltage side of a transformer and the meter located on the low voltage side of the transformer. This may be done for a variety of reasons, but economic and safety concerns are often the driving factors. By allowing for the use of lower voltage, less expensive instrument transformers can address economic and safety concerns. If the billing point is on the high voltage side of the transformer but the meter is on the low voltage side, the meter needs to be programmed to add no-load and load loss values to the quantities measured by the meter. If for some reason the metering point is on the high voltage side of the transformer but the billing point is on the low voltage load side, the meter needs to be programmed to subtract no-load and load loss values from the quantities measured by the meter.

MeterMate software (MeterMate Meter COMM, a.k.a. MMCOMM) is used to calculate the transformer loss compensation factors and program them into the kV2c Gen 5 meter during an interactive programming session (locally or remotely). Users are prompted for the required information during a programming session with a kV2c Gen 5 meter. The following information will be required as input to the MMCOMM prompts:

$kVA_{Elem\ rated}$

The per element kVA rating for the power transformer (total rating divided by 3 if the manufacturer provided data represents the total kVA rating for a three phase transformer)-An equal per element rating is assumed by MMCOMM.

$Volts_{L-N}$

The line-to-neutral voltage of the power transformer on the metered side of the transformer-Even if the power transformer is connected in delta at the metering point, and the metering VTs are connected line-to-line, calculate the line-to-neutral voltage value (divide V_{L-L} by the square root of 3) to serve as

the input value to MMCOMM. This requirement has to do with how the kV2c Gen 5 meter internally processes the input voltage and current signals.

$Amps_{line}$

The line current of the power transformer on the metered side of the transformer at maximum rating (i.e., the current in the primary of the current transformer).

VTR

The voltage transformer ratio for the instrument transformers supplying voltage inputs to the meter.

CTR

The current transformer ratio for the instrument transformers supplying current inputs to the meter.

LFE Elem watts

The per element power transformer no-load loss watts (a.k.a. iron or core loss).

LCU Elem watts

The per element power transformer load loss watts (a.k.a. copper or winding losses).

EC%

Percent excitation current of the power transformer.

IMP%

Percent impedance of the power transformer.

$LL_{Elem\ watts}$

The per element line loss watts (optional input) at full load current of wiring and/or bus bars between the metering point and the billing point.

MMCOMM will use the input values outlined above to calculate appropriate compensation values so the following is true:

- No-load loss watts are proportional to V^2.
- Load loss watts are proportional to I^2.
- No-load loss vars are proportional to V^4.
- Load loss vars are proportional to I^2.

The specific values calculated by MMCOMM and the formulas used are shown below.

Value	Description	Equation
$LFE_{Elem\ VA}$	Per element power transformer **no load loss VA** (iron or core loss VA)	$LFE_{ElemVA} = \frac{EC\%}{100} \times VA_{rated}$
$LFE_{Elem\ vars}$	Per element power transformer **no load loss vars** (iron or core loss vars)	$LFE_{Elemvars} = \sqrt{(LFE_{ElemVA})^2 - (LFE_{Elemwatts})^2}$
$LCU_{Elem\ VA}$	Per element power transformer **load loss VA** (copper or winding loss VA)	$LCU_{ElemVA} = \frac{IMP\%}{100} \times VA_{rated}$
$LCU_{Elem\ vars}$	Per element power transformer **load loss vars** (copper or winding loss vars)	$LCU_{Elemvars} = \sqrt{(LCU_{ElemVA})^2 - (LCU_{Elemwatts})^2}$
G_{Elem}	Per element secondary **Conductance**	$G_{Elem} = \frac{LFE_{Elemwatts} \times \frac{VTR}{CTR}}{Volts^2_{L-N}}$
R_{Elem}	Per element secondary **Resistance**	$R_{Elem} = \frac{(LCU_{Elemwatts} + LL_{Elemwatts}) \times \frac{CTR}{VTR}}{Amps^2_{Line}}$
B_{Elem}	Per element secondary **Susceptance**	$B_{Elem} = \frac{LFE_{Elemvars} \times \frac{VTR^3}{CTR}}{Volts^4_{L-N}}$
X_{Elem}	Per element secondary **Reactance**	$X_{Elem} = \frac{LCU_{Elemwatts} \times \frac{CTR}{VTR}}{Amps^2_{Line}}$

Operation in Demand, Demand/Load Profile, and Time-of-Use Mode

Transformer loss compensation operates the same in Demand, Demand/Load Profile, and Time-of-Use modes. The kV2c Gen 5 meter computes secondary per element compensation values every momentary interval and adds or subtracts from the normally measured energy (wh) and quadergy (varh) values as follows:

$LFE_{Elem\ wh} = G_{Elem} \times (V_{L-N})^2 h$	where $V_{L\text{-}N}{}^2h$ is the L-N Volt2 hours measured[1] by the kV2c Gen 5 meter.
$LCU_{Elem\ wh} = R_{Elem} \times (I_{Line})^2 h$	where $I_{Line}{}^2h$ is the L-N Ampere2 hours measured by the kV2c Gen 5 meter.

$LFE_{Elem\ varh} = B_{Elem} \times (V_{L-N})^4 h$	where $V_{L\text{-}N}{}^4h$ is the L-N Volt4 hours measured[1] by the kV2c Gen 5 meter.
$LCU_{Elem\ varh} = X_{Elem} \times (I_{Line})^2 h$	where $I_{Line}{}^2h$ is the L-N Ampere2 hours measured by the kV2c Gen 5 meter.

[1] For 3-wire delta services, the line-to-neutral voltage is computed by the meter from the input line to line voltages. For 4-wire wye services, the line to neutral input voltage is used directly. $(V_{L-N})^2 h$ and $I_{Line}{}^2h$ are fundamental plus harmonics quantities.

G_{Elem}, R_{Elem}, B_{Elem}, and X_{Elem} are calculated by MeterMate and programmed into the meter.

The calibration LED of the kV2c Gen 5 meter is affected by TLC settings. It will blink proportional to compensated Wh or varh values. Accumulated and displayed values in either the Normal operating mode or the Test mode will reflect the effects of any TLC factors programmed and enabled.

Both fundamental only and fundamental plus harmonics Wh and varh are compensated. Only the fundamental plus harmonics $(V_{L-N})^2 h$ and $I_{Line}{}^2h$ are used to calculate the compensation values, however. For example, $LFE_{Elem\ A\ Wh}$ is added to both fundamental plus harmonics Wh and fundamental only Wh, even though it was calculated from fundamental plus harmonics $V_A{}^2h$.

The various volt-ampere-hour quantities available in the kV2c Gen 5 meter (apparent, phasor, arithmetic) are calculated from the compensated Wh and varh quantities. The distortion VAh component is not compensated. See *Site Genie*® on page 55 for more information about how VAh quantities are calculated in the kV2c Gen 5 meter. Examples of Transformer Loss Compensation calculations are given in *Loss Compensation Examples* on page 153.

CHAPTER
25

VOLTAGE MONITOR

The voltage monitor detects and records sags and swells as short as one cycle in the metered voltages. It operates the same in Demand, Demand/Load Profile, and Time-of-Use modes. The only exception is that in Demand/Load Profile mode, the date and time of each event is also recorded in the voltage event log. The Voltage Monitor requires that the Voltage Monitor softswitch be enabled prior to programming.

Operation in Demand, Demand/Load Profile, and Time-of-Use Mode

A voltage event begins when a user-programmed level threshold is passed on any element for a time exceeding a user-programmed duration threshold. A voltage event ends when the voltages on all elements cease to be under-voltages for a sag event or over-voltages for a swell event, as defined by the level thresholds. Only one cycle is needed for the event to be considered complete.

There are two programmed level thresholds: one for sags and another for swells. The thresholds are expressed as a percentage of the reference voltage (see *Site Genie*® on page 55), 1% to 100% in increments of 1%. There is one programmed duration threshold used to monitor both sags and swells, expressed in cycles, from 1 to 65,535 cycles. Each of the two event types (i.e., sags and swells) have an associated 16-bit event counter, which is incremented once per event. Event counters do not wrap but freeze at 65,535. The voltage event monitor can be reset with the MeterMate Master Reset function. MeterMate lets the user reset the voltage event monitor without clearing the billing data.

All of the parameters that control the operation of the voltage event monitor may be set with MeterMate Program Manager (Meter Diagnostics).

The voltage event log is maintained separately from the standard event log. The voltage event log supports up to 200 entries. The meter creates only one log entry per voltage event, which is done at the end of the event. The reason for this is that most of the information in the entries at the beginning and end is redundant.

If a voltage event is in progress when power fails, then this defines the end of the event and a log entry is created. An event of the same type (sag/swell) will not be recognized until the current event ends and has been recorded. The current event ends when all voltages are back within tolerances.

The following information is recorded in the voltage event log when an event ends:

- Event sequence number 0-65,535
- Event type (sag or swell)
- The number of cycles that the event lasted up to 65,535 (18.2 minutes)-An event that lasts longer than that will be recorded as lasting 65,535 cycles.
- The minimum (for sags) or the maximum (for swells) per cycle RMS voltage measured on each element from the first cycle of the event to the end of the event
- The RMS current per element coincident with the minimum (for sags) or maximum (for swells) per cycle RMS voltage recorded-For example, the RMS current in the A phase during the cycle when the A phase had a minimum voltage will be recorded.

The voltage event monitor may be read and then displayed with MeterMate.

CHAPTER
26

WAVEFORM CAPTURE

The kV2c Gen 5 meter can provide voltage and current sample data via its Waveform Capture function. The Waveform Capture function requires that the Waveform Capture softswitch is enabled.

Introduction

The kV2c Gen 5 meter provides a procedure to capture and store 1 cycle of current and voltage samples from each element. The data consists of the actual voltage and current samples by element over at least one cycle (85 sets of 6, 32-bit samples are captured, which covers a complete cycle at the lowest line frequency of 47.5 Hz). This feature is used by MeterMate software as part of its harmonic analysis option.

CHAPTER
27

OPTION BOARDS

The kV2c Gen 5 meter supports various add-on boards that will provide enhanced functionality. Two option boards, typically a communication board and one other, may be installed together. The kV2c Gen 5 meter will test for the presence of installed option boards at power up. Any boards detected will be recorded by the meter.

The kV2c Gen 5 meter supports AMI communication boards as well as the Simple and Multiple I/O boards.

The kV2c Gen 5 meter will not communicate with communication option boards unless the A (Alternate Communication) softswitch has been installed. Some of the I/O functions require softswitches to operate as well. These are described in *Alerts and Pulse Outputs* on page 41 and *Pulse Inputs and Totalization* on page 107.

CHAPTER
28

TIMEKEEPING

The meter may be programmed to always use either the line frequency (primary time base) or the 32.768 kHz crystal oscillator (secondary time base) for timekeeping. Line frequency is defined as the fundamental frequency of the voltage signal. Timekeeping will operate correctly at 50 or 60 Hz line frequencies with only a programming change. Both the time base and the frequency are selectable when creating programs with MeterMate Program Manager (Site Support Table).

Operation in Demand Mode

In a kV2c Gen 5 meter operating in Demand mode, the timekeeping function is only used to time the length of demand (sub)intervals.

Operation in Demand/Load Profile and Time-of-Use Mode

In a kV2c Gen 5 meter operating in either one of these modes, the timekeeping function is used to time the length of demand (sub)intervals and load profile intervals. It is also used to maintain real date and time, consisting of the year, month, day, hours, minutes, and seconds.

The meter accommodates Leap Years by automatically inserting an additional calendar day, February 29th, in years exactly divisible by four (accurate until the year 2100). The meter's time may be changed without a complete reprogramming via Standard Procedure 10. The meter's date may also be changed, but that does require a reprogramming operation. Automatic daylight savings time shifts occur on programmable dates (see *Time-of-Use (TOU) Schedules and Programmable Dates* on page 101). In the event of a power outage, time and date is maintained using the secondary time base. The maximum loss of time during a power outage is 0.1 second per power outage plus the gain or loss due to the inaccuracy of the 32.768 kHz crystal oscillator as specified above.

Timekeeping Accuracy

Timekeeping based on line frequency will be 100% accurate in the presence of line voltage harmonics when:

- The magnitude of a single harmonic is less $\leq$ 30% of the applied voltage for harmonics up through the 12th.

- The magnitudes of harmonics 22 and higher do not exceed 10% of the applied voltage.

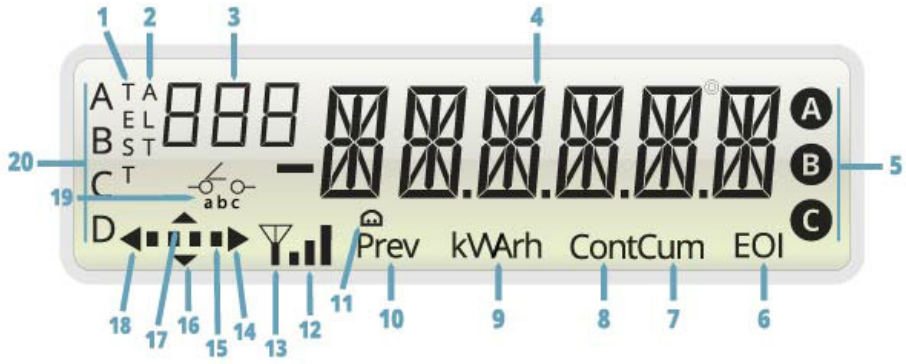
The standard 32.768 kHz crystal oscillator used for the secondary time base is accurate to within 50 PPM (which equals approximately 2 minutes per month) at 25°C.

CHAPTER
29

DISPLAY

kV2c® Gen 5 Meter Liquid Crystal Display (LCD)

The image below depicts the layout of the kV2c Gen 5 meter's LCD.



1 TEST: Lit when the meter is in Test mode

2 ALT: Lit when the alternate display scroll is in effect

3 The three small digits are used to display the current display label or code. **CA** or **Er** appearing in this location indicates a Caution or Error message in the display.

4 These characters display alphanumeric quantities.

- The open O between the rightmost character and the character to its left is a degree symbol for fundamental frequency lagging phase angles.
- The short bar to the left of the first large digit indicates a minus sign.
- There are four possible decimal point positions located between the five rightmost digits.

5 When displayed, the annunciator (A,B,C, respectively) indicates the voltage (A,B,C, respectively) is present at the meter. If blinking, the voltage is low. If an annunciator is not displayed, the voltage is not present for this combination of service and meter form.

6 This display indicates an end of interval (EOI) condition.

7 **CUM** is displayed when the meter is displaying cumulative demand measurements.

8 When **CONT** and **CUM** are displayed, it indicates that the meter is displaying continuously cumulative demand measurements.

9 These letters are used to display the units of measure for the quantity currently being displayed. For example, energy displays will have a "kWh" annunciator, and Apparent Power will have a "kVA" annunciator. Q-hour displays will have no annunciators.

10	This part of the display indicates the previous season or billing period data is being shown.
11	Optical communication indicator
12	Signal strength indicator (not currently used)
13	AMI device communicating with meter indicator
14	When displayed, this arrow indicates energy is being delivered to the load.
15	The four blocks simulate a disk revolution and are used to display energy flow.
16	When displayed, this arrow indicates varh are leading.
17	When displayed, this arrow indicates varh are lagging.
18	When displayed, this arrow indicates energy is being received from the load.
19	Service disconnect switch state indicator
20	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. If no letters are lit, the meter is in a non-TOU rate

Displayable Quantities

Display Quantities on page 157 outlines all displayable quantities and available modes and how they are formatted.

Display Modes

The following display modes are used in the kV2c Gen 5 meter:

- Normal mode
- Alternate mode
- Test mode
- Site Genie mode
- Frozen Condition display mode
- Communication mode
- All Segments mode

These modes are described in more detail below.

Programmable Display Configuration Inputs

Display configuration data are programmable inputs that specify how metering data is displayed on the meter's LCD. These parameters are selectable when creating programs with MeterMate Program Manager (Display Tables Support Table). The following display configuration data is programmable:

- **Suppress leading zeroes flag**: Indicates whether meter measurements are displayed with or without leading zeroes-One bit specifies whether to suppress leading zeroes for energy, and one bit specifies whether to suppress leading zeroes for demands.
- **Display multiplier**: Scalar applied to meter measurements before being displayed-This value may be 1, 0.1, 0.01, or 0.001.
- **Display scalar and multiplier**: Scaling data applied to meter measurements before they are displayed-The range is 1 to 9999999.

NOTE These parameters are not directly selectable with MeterMate Program Manager. Rather, MeterMate Program Manager calculates the appropriate multiplier and scalar based on the Display Multiplier selected when creating a program.

- **Demand display units**: The units in which volt-ampere demand measurements are displayed. The value may be 0 for kilo-units (e.g., kilowatts), and 1 for units (e.g., watts).

NOTE This format applies to volt-ampere quantities (kW, kvar, kQ, kVA) only.

- **Cumulative demand digits format**: The number of data digits to the right and left of the decimal that will be shown when cumulative and continuously cumulative volt-ampere demand values are displayed-Digits to the left can be 2-6; digits to the right can be 0-4. There may be no more than 6 digits total.

NOTE This format applies to cumulative volt-ampere quantities (kW, kvar, kQ, kVA) quantities only.

- **Demand digits format**: The number of data digits to the right and left of the decimal that will be shown when demand values are displayed-Digits to the left can be 2-6; digits to the right can be 0-4. There can be no more than 6 digits total.

NOTE This format applies to volt-ampere quantities (kW, kvar, kQ, kVA) quantities only.

- **Summations digits format**: The number of data digits to the right and left of the decimal that will be shown when summations are displayed-Digits to the left can be 2-6; digits to the right can be 0-4. There can be no more than 6 digits total.

NOTE This format applies to volt-ampere-hour quantities (kWh, kvarh, kQh, kVAh) quantities only.

- **Primary volts/amps display flag**: Specifies whether volts and amps should have their respective transformer ratios applied before they are displayed-This value may be 0 (False) or 1 (True).
- **Date format**: Indicates whether dates are to be displayed as DD-MM-YY, MM-DD-YY, or YY-MMDD (used in Demand/Load Profile and TOU meters only).

Programmable Display Sequence Inputs

The display sequence data are programmable inputs that specify what data is to be displayed in the Normal, Alternate, and Test mode displays; in what order the data is displayed; and what three-digit identifiers are to be displayed with each item. For Normal and Alternate display modes, the number of seconds an item remains on the scroll is also programmable.

Operation in Demand, Demand/Load Profile, and Time-of-Use Mode

When the kV2c Gen 5 meter powers up, it shows all segments on the display until it has completed its initialization tasks. It then starts the normal display scroll, unless a frozen condition is present in the meter.

NOTE In TOU mode, the meter displays the active TOU rate on the LCD. Otherwise, the operation of the display in TOU mode is identical to its operation in Demand and Demand/LP mode.

Normal Display Mode

In Normal display mode, the display continuously cycles through the list of programmed normal display items. Each display item in Normal display mode shall be accompanied by its programmed 3-digit code identifier and associated annunciators. At the beginning of the normal display scroll, all the quantities that could change during a pass through the display scroll are retrieved or calculated to represent a snapshot in time. Activating the display switch for less than three seconds will cause the normal display scroll to restart at the beginning. The normal display scroll may be interrupted by a demand reset, a communication session,

initiation of Test mode, or display switch activation. This is summarized in the table below.

Display Switch	< 3 seconds	Resets to beginning of Normal mode scroll
	≥ 3 seconds	Changes to Alternate mode scroll
	≥ 6 seconds	Changes to Site Genie mode scroll
Reset Button	> debounce	Demand Reset Performed All segments displayed, returns to beginning of Normal mode scroll when complete
Test Button	> 1 second	Changes to Test mode
Communication Session Initiated		BUSY displayed on LCD

Alternate Display Mode

The alternate display scroll is initiated by activating the display switch for more than 3 seconds but less than 6 seconds. When the alternate display scroll is initiated, the ALT annunciator is lit. The quantities that could change during a pass through the alternate display scroll are retrieved or calculated to represent a snapshot in time. The meter will show the alternate display scroll once. When the scroll is finished, the meter returns to the normal display scroll if there is no frozen condition present. If there is a frozen condition present, the meter shows the frozen condition display. The Alternate display mode may be interrupted by a demand reset, a communication session, initiation of Test mode, initiation of Site Genie display mode, or an additional press of the display switch. This is summarized in the table below.

Display Switch		
- new press	< 3 seconds	Changes to Normal mode or Frozen Condition mode If frozen condition present, one pass through Normal mode scroll will be displayed before freezing the display.
- continuous press	≥ 6 seconds	Change to Site Genie mode
Reset Button	> debounce	Demand Reset Performed All segments displayed, returns to beginning of Normal mode scroll when complete
Test Button	> 1 second	Changes to Test mode
Communication Session Initiated		BUSY displayed on LCD

Site Genie® Display Mode

Site Genie display mode is initiated when the display switch is activated for more than 6 seconds. The quantities that could change during a pass through the Site Genie display scroll are retrieved or calculated to represent a snapshot in time. Site Genie display mode is not available while the automatic service detect function is in progress. **INPROG** is displayed for one scroll period to denote this. If Site Genie mode is available, the meter scrolls through the preset (i.e., non-programmable) display items. See *Site Genie*® on page 55 for details of the Site Genie display scroll. If the display switch is activated when the end of the Site Genie display scroll is reached, the meter will scroll through the Site Genie display items again. If the display switch is not activated when the end of the Site Genie scroll is reached, the display will revert to normal or frozen condition display mode. There is no method to prematurely terminate this display mode with the display switch. The operation of the display in Site Genie mode is summarized in the table below.

Display Switch		
end of scroll	Deactivated	Changes to Normal mode scroll
	Activated	Display another pass through the Site Genie scroll
Reset Button	> debounce	Demand Reset Performed All segments displayed, returns to beginning of Normal mode scroll when complete
Test Button	> 1 second	Changes to Test mode
Communication Session Initiated		BUSY displayed on LCD

Frozen Condition Display Mode

The Frozen Condition display mode is entered whenever an error, caution, or diagnostic that is programmed to freeze the display exists in the meter. Non-freezing errors and displayable but non-freezing cautions and diagnostics are added to the normal display scroll. If both freezing errors and freezing cautions or diagnostics exist, the error is displayed and the cautions and diagnostics are added to the normal display scroll. If both freezing cautions and freezing diagnostics exist, the cautions are displayed and the diagnostics are added to the display scroll. The operation of the display in Frozen Condition mode is summarized in the table below.

Display Switch	< 3 seconds	Displays one complete pass through Normal mode scroll (known as Temp Normal mode), returns to frozen display when complete-If display switch is activated while scrolling through Normal mode scroll, scroll will automatically return to frozen display.

	≥ 3 seconds	Displays one complete pass through Alt mode scroll and one complete pass through Normal mode scroll. If display switch activated again while scrolling through Alt mode or Normal mode, scroll will automatically return to frozen display.
	≥ 6 seconds	Changes to Site Genie mode scroll
Reset Button	> debounce	Demand Reset Performed, all segments lit while performing reset Scroll returns to frozen display when complete
Test Button	> 1 second	Changes to Test mode
Communication Session Initiated		BUSY displayed on LCD

CHAPTER
30

TRANSFORMER INACCURACY CORRECTION

The kV2c Gen 5 meter has a set of factory-programmed calibration coefficients that compensate for inaccuracies in various components in the meter (e.g., current sensors). The meter also provides a set of alternate coefficients which it can use in place of the factory-programmed coefficients. This alternate set can be used to compensate for inaccuracies in the instrument transformers used in an installation. Transformer Inaccuracy Correction will not operate and the coefficients cannot be programmed unless the Transformer Inaccuracy Correction softswitch has been enabled.

If the Transformer Inaccuracy Correction (I) softswitch is enabled, the meter can be programmed with an alternate set of calibration coefficients. The set of coefficients the meter uses can be selected via MeterMate.

If the meter is programmed to do so, it will apply the programmed alternate gain and phase correction coefficients to the voltage and current samples every sample period. Therefore, all metering quantities (e.g., energy, voltage, current, distortion measures) are affected by these coefficients. The calibration LED is also affected.

CHAPTER
31

PASSWORD LOCKOUT AND OPTICAL PORT DISABLE

Password Lockout

The kV2c Gen 5 meter provides a password lockout function. This feature is intended to make it more difficult for an unauthorized user to determine a meter's password by trying a large number of different passwords. This function only applies to password attempts over the meter's optical port.

The password lockout feature is enabled when the Bad Password caution is enabled. The number of bad passwords required to trigger the caution also applies to the password lockout function.

The meter will enter Password Lockout mode if it receives the programmed number of invalid password attempts before one of the following occurs:

- The meter receives a valid password.
- A programmable number of minutes elapses since the meter received its last password attempt.

When the meter is in Password Lockout mode, it will respond to all security requests with an error response (ERR_RESP).

Optical Port Disable

The kV2c Gen 5 meter provides a means to disable the optical port. When enabled, the meter will not respond to any requests received over the optical port. The meter will continue to respond to communication requests over its AMI port. The optical port can be re-enabled through programming over the AMI port or by removing the meter’s cover and performing a password recovery operation.

CHAPTER
32

FIRMWARE UPGRADES

Introduction

The KV2c Gen 5 meter was designed so that it may be upgraded in the field by downloading code into flash. The KV2c Gen 5 meter firmware is upgraded using a full image download instead of a patch. The full image download method makes for more flexibility in adding features and fixing bugs while the meter remains in the field. The firmware upgrade process runs in the background while the meter is fully operational. However, the firmware upgrade will fail if the meter is in Test mode. All KV2c Gen 5 meter functionality is operational during the firmware upgrade process. Each new firmware image is independent of the running image. This allows firmware to be updated with either a newer image or an older image. The firmware versions maintain forward and backward compatibility by keeping space between all major data structures stored in EEPROM. This allows for future expansion of the existing data structures while maintaining compatibility between versions. This also allows a meter to maintain its current metering program while running a new version of firmware.

Download Process

The firmware upgrade process starts with receiving a firmware package file from Aclara. The file name contains the version number. This file is prepared at Aclara to provide a compressed, signature protected firmware image. Only an authentic firmware image will successfully load to the meter. A specific process must be followed in order to load a new firmware image to the meter. The Firmware Upgrade Control Table, Manufacturer Table 43, controls the meter's ability to perform upgrades. The Firmware Download Log provides feedback to the download process in real time. The general download process is described in the following steps:

1. **Start a Session using the Master Password**

   Start a communication session with the meter. The meter must be in Metering mode. It must not be in Password Recovery mode or Test mode. Use the standard session PSEM commands: PSEM Identify, Negotiate, Logon, and Security with the Master Password.

2. **Issue the Start Download procedure**

   To start a firmware upgrade, issue Manufacturer Procedure 83 with a parameter of 1. This starts the firmware download process in the meter. This procedure with this parameter will also cancel an in-progress firmware upgrade.

3. **Erase Sectors in the Area(s) to be Downloaded**

   The sectors to erase are 1 through 7; they must be erased in numerical order. For each sector to erase, do the following: Issue Manufacturer Procedure 82 to erase the sector. The first parameter = 1 (Erase Sector); the second parameter is the sector number to erase. Read Standard Table 8 to ensure the erase was initiated (RESULT_CODE = 0 = completed OR 1 = accepted but not completed). Repeat periodically until Table 8 returns a completed status (0 = No operation in progress) in the first byte of RESP_DATA_RCD indicating the erase has completed successfully. The algorithm must be able to wait for up to 3 seconds per sector erase.

4. **Download the Image**

   Chose segment length for the MT12 writes, typically between 32 and 128 bytes. The first image segment is written to address 0x0000. The following segments must be written in address order without gaps.

5. **Issue the Download Complete Procedure**

   Issue Manufacturer Procedure 83 with a parameter of 0. PSEM Terminate to exit Download mode. The meter will take several seconds to process and validate the downloaded code. Read Table 8 to ensure that Manufacturer Procedure 83 was initiated (RESULT_CODE = 0 = completed OR 1 = accepted but not completed). Periodically read Standard Table 8 until the RESULT_CODE returns 0. This can take up to 15 seconds.

6. **Verify Firmware Package has been Processed by the Meter**

   Once the Download Complete procedure has completed, it is good practice to verify the status of the firmware download. Read the first byte of Manufacturer Table 42 to get the firmware download status. The IMAGE_READY flag will be set if the download was successful. The ERROR flag will be set if there was a problem with processing the download. Further information is available by reading the entire MT42. The events in the log will give further details as to the firmware download status.

7. **Activate the Firmware Upgrade**

   The newly downloaded firmware image can remain dormant in the meter indefinitely. The image is stored in flash waiting to be activated. There are two methods to activate a downloaded image. The first is to automatically activate on download completion, and the second is to issue the Image Activate procedure, Manufacturer Procedure 40. For automatic activation, the IMMEDIATE_REBOOT bit must be set in Manufacturer Table 43, the Firmware Download Event Control Table. If this bit is not set, Manufacturer Procedure 40 must be issued to activate the new image. There is no time limit between when the firmware image is loaded to the meter and when it is activated.

Firmware Upgrade Control

The KV2c Gen 5 meter has several features that control firmware upgrade. Manufacturer Table 43 holds the control information for firmware upgrade. This

information can be read and written. Some control parameters are set at the factory and cannot be changed by the user, while others are programmable. These parameter values can be permanently fixed by sealing the meter. The control parameters are listed below:

- **Order** - Indicates whether the firmware upgrade log is transported in ascending or descending order. This is fixed at the factory to ascending in time.
- **Erasable** - Determines if the firmware upgrade log entries can be erased. This value is programmable. If this flag is set to zero, the firmware upgrade will operate normally until the firmware upgrade log has been filled. Then, firmware upgrade will be disabled.
- **Prohibit** - Prohibits firmware upgrades. This parameter will make the meter unreceptive to firmware upgrades.
- **Immediate Reboot** - A newly uploaded firmware image will activate immediately following the download completion if this parameter is set. Otherwise, the firmware image activate procedure must be executed.

Firmware Upgrade Log (Manufacturer Table 42)

The Firmware Upgrade Log captures information related to the process of Firmware Upgrade. The Firmware Upgrade Log is useful for checking for firmware upgrade errors, the upgrade history of the meter, or the status of an upgrade in progress. The meter maintains up to 1,000 of the most recent firmware upgrade events. Each recorded event describes the status of a significant event in the firmware upgrade process. This Log is necessary to keep track of the firmware history of the meter. The Firmware Upgrade Log is readable via Meter Mate. Once a set of events have been read, they can be cleared from the Log using the Firmware Upgrade Event Log Export Procedure (Manufacturer Procedure 41). Once an entry has been exported, it can no longer be read. Several entries can be exported with a single procedure call. If the log becomes full of entries, future firmware upgrades become disabled until events are **exported** from the firmware upgrade log.

Entry Structure

Each entry in the Firmware Upgrade Log contains the same basic information:

- **Time Stamp** - Each entry is stamped with the meter time at 1 second resolution. If the meter does not have a valid time, the time stamp contains 0s.
- **Event ID** - An ID identifying the firmware upgrade event type. The events are:
  - Start of Firmware Upgrade.

  - Firmware Package successfully loaded to the meter.
  - Firmware Image Ready. The firmware has been successfully extracted from the Firmware Package.
  - Request for Image Activation.
  - Image Successfully Activated.
  - Error in Firmware Upgrade. The Firmware Upgrade has failed.
  - Error in Firmware Activation. The new firmware image has failed to activate, and the original firmware is restored to the meter. This event is posted if the Request for Image Activation fails.
- **User ID** - PSEM user ID, defined in the ANSI C12.18 specification. This value will wrap without notice if the count exceeds its 16 bit limit (65535).
- **Event Sequence Number** - A unique number assigned to each log entry, each number is assigned sequentially starting at zero.
- **Firmware Signature** - An eight byte value that is unique to each version of firmware. It is used to positively identify a version of firmware.
- **Firmware Version** - A three byte value that represents the released version of the firmware.
- **Detailed Information** - Information that is specific to the log entry. This information is dependent on the **Event ID** and provides extra information about the specific event. The content of this field is flexible, and depends on the particular recorded event.

Firmware Upgrade Events (Event IDs)

The Firmware Upgrade Log is filled with upgrade events, and each type of event is identified using an **Event ID**. A successful Firmware upgrade will result in the event log adding five events in the following order:

1. Start of Firmware Upgrade
2. Firmware Package successfully loaded to the meter
3. Firmware Image successfully extracted from the Firmware Package
4. Request for Image Activation
5. Firmware Image Successfully Activated

The Error Event is written to the firmware upgrade log if an error occurs in any of the first four steps. If the Image Activation Request fails, the Activate Error will be written to the firmware upgrade log. Details for each firmware upgrade log event are below.

Start Firmware Upgrade

This event is written to the firmware upgrade log when the start firmware upgrade procedure is received by the meter. After this event, the meter is ready to receive firmware image data. Receiving this event will also reset a currently in-progress firmware upgrade.

Detailed Log Information:

- This field will be empty for this firmware upgrade log event.

Firmware Package Successfully Loaded

This event is logged when the firmware download process has completely uploaded the new firmware image to serial flash.

Detailed Log Information:

- Version Number - Version number of the packaged firmware image.
- Signature - Firmware signature of the packaged firmware image.

Firmware Image Ready

This firmware upgrade event is logged when the image has been successfully extracted from the package. At this time, the new firmware is ready to be activated.

Detailed Log Information:

- Version Number - Version number of the firmware image.
- Signature - Firmware signature of the firmware image.
- Size - Size in bytes of the firmware image.

Firmware Active Request

This event is logged when a request for firmware activate procedure (Manufacturer Procedure 40) is processed.

Detailed Log Information:

- This field will be empty for this firmware upgrade log event.

Firmware Successfully Activated

This event is logged when the new firmware image has been activated and has run successfully through the initialization portion of the code.

Detailed Log Information:

- Signature - Firmware signature of the previously running firmware image.

Firmware Activation Failed

This event is logged if the new firmware image fails to progress through the initialization code without a watchdog timeout. If the system is rebooted through a watchdog three times, the original firmware will be reload and this event will be entered into the firmware download event log.

Detailed Log Information:

- This field will be empty for this firmware upgrade log event.

Firmware Upgrade Failed

This event is logged when the firmware upgrade process has failed prior to the Firmware Activation Request. After this event is logged, the meter resets its firmware upgrade process and is ready to start a new upgrade. The Detailed Log Information contains more specific information about the failure. The top level of bullets in the Detailed Log Information specifies the ID of the failure cause. The failure ID is then followed by specific failure information which is shown in the sub-bullets below.

Detailed Log Information:

- Failure State ID - An identifier for the specific process that failed during upgrade.
  - Sector Erase - Failure during the memory erase process of the firmware upgrade.
    - Request Sector Erase number
    - Expected Sector Erase number
    - Hardware Error Flag - Experience a Hardware failure if this is set.
  - Data Download - Failure during the download of the firmware data.
    - Cause - Hardware Error, Address Error, Overflow Error
    - Number of bytes written prior to error
    - Current write address requested
    - Size of the firmware package
  - Verify - Failure to verify the integrity of the firmware image.
    - Signature Verify Cause
  - Inflate - Failure to decompress the firmware image from the downloaded firmware package.
    - Inflate Error Cause
    - Number of bytes processed before the failure
  - Verify Inflate - Failure to match the inflated firmware image calculated CRC16 to the expected CRC16.
    - Computed CRC16

  - Expected CRC16
- Image Header - Failure in the process to build the new firmware image header.
  - Failure Cause

CHAPTER
33

SERVICE DISCONNECT SWITCH AND LOAD CONTROL

The kV2c Gen 5 meter is available with a service disconnect switch for 16S forms. Note that in this configuration, the meter is a Class 100 meter (rather than a Class 200 meter). The service disconnect switch is applicable to both 50 and 60 Hz services. The service disconnect switch can be operated with direct load control commands (e.g., open and close service disconnect switch) or with the demand limiting period (DLP) load control feature.

All commands, programmable settings, and status information are handled through ANSI C12.19 procedures and tables. Please see the *kV2c® Gen 5 Electronic Meter Reading and Programming Guide (132273-TUM)* for the details of these procedures and tables.

Service Disconnect Operation

The service disconnect switch provides the means to disconnect and reconnect the load-side terminals from the line-side terminals for all three phases. Note that the meter does not provide the ability to operate the relay for each phase individually. Commands sent to the meter to operate the disconnect switch will apply to all three phases.

Operation on Initial Power-up

Power failure/restoration will not alter the state of the service disconnect switch.

Normal Operation

The service disconnect function can be in one of the following states:

- Open and locked
- Closed and locked
- Open and held open
- Open due to load control service disconnect
- Closed with service connected

Note that this state does not refer to the physical state of the relay. The state of the service disconnect function is determined by the last valid load control command

received by the meter. The applicable commands and status information are provided in subsequent sections. Also note that the term “locked” does not refer to a physical lockout. It refers to a state in which the meter will ignore subsequent commands until the locked state has been cleared.

Open and Locked State

When the service disconnect function is in the Locked Open state, the meter will keep trying to open the switch until it is successful and then freeze the switch in the Open state.

While in Locked Open state, the meter will ignore commands to open switch, close switch, and set lock. Commands to start and end DLP will be accepted and processed, although load control functions will have no effect on the switch while it is locked open.

The Clear Lock command ends the Locked Open state. If the switch had been commanded open prior to being locked, then the Open state is to be entered; otherwise, the DLP directive will determine whether service connect or service disconnect will be the next state.

Should power fail while the switch is locked open, the switch will remain in Locked Open state at power-up.

Locked Closed State

When the service disconnection function is in the Locked Closed state, the meter will freeze the switch in the Closed state. The Locked Closed state can only be entered through one command, Set Lock, which must be received by the meter while the switch is closed.

While in the Locked Closed state, the meter will ignore commands to open switch, close switch, and set switch lock. Commands to start and end demand limiting will be accepted and processed, though load control functions will have no effect on the switch while it is locked closed. The Clear Switch Lock command ends the Locked Closed state. In the case where the lockout is cleared while the switch is locked closed, the DLP directive will determine whether service connected or service disconnected will be the next state.

Open and Held Open

The Open and Held Open state is entered when the switch is commanded to be opened. When the meter receives an open switch command and it is not locked, then the Open and Held Open state is entered.

If the meter receives the Set Lockout command in this state, it will enter the Locked Open state.

Commands to start and end DLP will be accepted and processed while the meter is in the Open and Held Open state. However, if the service switch function is in the Open and Held Open state and the DLP function closes the switch, the meter will reopen it.

A Close Switch command will end this state.

Open Due to DLP

The meter enters this state when the DLP function opens the switch.

Closed with Service Connected State

This state will be entered in response to the receipt of a Close Switch command, provided the actual switch state is not Locked Open or Locked Closed and the meter does not detect load-side voltage on one or more of its phases (see *Load-side Voltage Detection* on page 146).

Switch Status Reporting

The kV2c Gen 5 meter with service disconnect provides the following status information for the load control operations of the meter:

- **Sensed level (state) of the service disconnect switch** – The meter sets this for each of the three phases. Note that the meter cannot directly determine the state of the contacts. It determines the state based on whether there is load-side voltage present.
- **Requested level of the service disconnect switch** – The desired state of the switch based on the last command received or load control directive. The meter provides this information for each phase, but since the relays are not individually controllable by the meter, all three will have the same value.
- **Output level of the service disconnect switch** – This will be identical to the requested level.
- **Actual switch state** –This flag will indicate that the service disconnect switch is closed if the meter determines that at least one of the relays is closed. If the meter detects that all relays are open, this flag will indicate that the service disconnect switch is open. Note that the individual switch states can be determined by the values of the sensed service state level.
- **Desired switch state** – This flag reflects the value of the requested service state level.
- **Switch controller communication error** – The meter sets this error if it is unable to communicate with the board that provides the interface to the service disconnect switch. If this flag is set, the meter will not be able to change the state of the switch or retrieve updated status information.
- **Switch controller error** – The meter sets this error if it detects that the data coming from the service disconnect controller board indicates that there is no load-side voltage present, but the meter detects current flowing.

- **Switch failed to close** – The meter sets this error if no load-side voltage is detected on one or more phases after the meter attempted to close the switch three times. The meter will continue to try to close the switch even after it sets this error.
- **Switch failed to open** – The meter sets this error if load-side voltage is present on at least one phase after the meter attempted to open the disconnect switch three times or it detects that current is still flowing through one or more phases after its initial attempt. The meter will continue to try to open the switch even after it sets this condition.
- **Load control memory error** – The meter sets this error if it detects invalid data in the memory that it uses to store load control status information. In this condition, the meter will only allow direct load control open and close procedures. This is to prevent the possible erroneous open or close of the disconnect switch due to invalid data.
- **Load control switch state mismatch (MT115)** – The meter sets this flag when it detects load-side voltage on at least one phase and no load-side voltage on at least one phase, indicating that the three switches are not in the same state.

Load-side Voltage Detection

The meter detects load-side voltage by sampling and calculating an RMS value for each load-side voltage. If the load-side voltage is above a user-programmed threshold, the meter will declare that the phase has load-side voltage present.

Direct Load Control Operation

The kV2c Gen 5 meter with service disconnect provides the following direct load control operations:

- **Open service disconnect switch** – When the meter receives an Open command, it will disconnect the line and load-side terminals for all three phases. Note that the meter will attempt to open the service disconnect switch when it receives this command even if it detects that the service disconnect switch is already open. The meter will also terminate DLP if it is active when the meter receives an Open command.
- **Close service disconnect switch** – When the meter receives a Close command, it will reconnect the line- and load-side terminals for all three phases unless it detects a voltage on the load-side of one or more of the phases (see *Load-side Voltage Detection* on page 146).

- **Set service disconnect lockout** – When the meter receives a command to set the disconnect lockout, it will reject any command to change the state of the switch.
- **Clear service disconnect lockout** – When the meter receives a command to clear the disconnect lockout, it will accept subsequent commands to change the state of the switch. Note that commands to operate the switch during lockout will not be executed once the lockout has been cleared.

Demand Limiting Switch Function

The demand limiting period (DLP) function is intended to allow a utility to enforce a minimum critical load support to customers who may have irregular or no payment history. The application allows utilities to program a meter to disconnect a switch if the actual demand is above the programmed threshold.

The meter provides the following procedures and programmable parameters to control the operation of DLP. Please see the *kV2c® Gen 5 Electronic Meter Reading and Programming Guide (132273-TUM)* for the details of these procedures and tables.

- **Initiate DLP mode procedure** – When the meter receives this command, it will initiate the DLP function.
- **Exit DLP mode procedure** – When the meter receives this command, it will terminate the DLP function. See below for details.
- **DLP demand threshold value** – This is the demand value above which the DLP function will disconnect the relay. The demand is averaged over the duration specified by the DLP demand interval length.
- **DLP demand delay** – This is the duration for which the meter will wait after reconnection or power failure before checking the DLP demand.
- **DLP duration period** – This is the number of minutes the meter will wait after disconnection before attempting to reconnect. If this value is zero, the meter will not attempt to reconnect the load.
- **DLP reconnection attempts** – This is the number of times that the meter will reconnect the load after being disconnected by the DLP function. A value of zero indicates that no attempt to reconnect should be made. When the value is set to 255, an unlimited number of attempts to reconnect will be made. Any other value from 1 to 254 will designate the actual number of reconnect attempts that will be made before the meter stops trying to reconnect service. If reconnection fails after the full number of attempts has been exhausted, service will remain disconnected until the end of DLP.

- **DLP demand interval length** – This is the block interval length, in minutes, over which DLP demands are calculated. This value can be any one of the following: 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, or 60 minutes. The default value is 5 minutes.
- **DLP demand source** – This specifies which of the billing demand quantities for which the meter is programmed should be used for the DLP demand calculation.
- **DLP softswitch** – The meter will not perform DLP functions unless the DLP softswitch is enabled.
- **Demand softswitch** – The meter will not calculate demand values for the DLP function unless the demand softswitch is enabled.

Operation During Power Up

When the meter powers up, it will determine whether DLP is active. If it is, the meter will do the following:

- Restore the number of DLP reconnection attempts that were available when power failed.
- Set the DLP reconnection period timer at its programmed value if a DLP Disconnect was in progress when power failed.
- Set the DLP demand delay time to its programmed value. If the programmed demand delay is zero, the meter will begin calculating demand as soon as its power up initialization is complete. In this case, the first demand interval will be short by up to one minute. More details are given in *Entering DLP Mode* below.

Normal Operation

Entering DLP Mode

When the meter receives a procedure request to enter DLP, it will determine whether DLP is currently active. If it is, the meter will return an error response. In this case, the DLP reconnection timer and reconnection attempts will not be reset and will maintain their current value. If the DLP softswitch has not been enabled, then the meter will generate an error response.

There are three general states of DLP operation: DLP Off, DLP On, and DLP On and Disconnected.

When the meter receives a request to enter DLP, if DLP is not currently active and the DLP softswitch is enabled, the meter will transition to the DLP On state and do the following:

- Log an event indicating that a DLP period has started, if programmed to do so.
- Start the timer for the DLP demand interval used to calculate the DLP demand value. Note that the timer will be updated on the meter's usual one-minute boundary; therefore, the first DLP demand calculated by the meter after DLP is initiated will be done on data taken over a period of N to N-1 minutes, where N is the demand interval length. When the meter calculates demand, however, it will divide the energy accumulated in the demand interval by the nominal interval length, not the actual length. Note that the DLP demand intervals are not synchronized to the hour boundary.
- Set the DLP reconnection attempt counter to its programmed value.

Operation During DLP Mode

During DLP On mode, the meter will do the following:

- Calculate the average demand for the DLP demand interval when a DLP demand interval ends.
- Open the service disconnect switch if the calculated DLP demand is above the programmed threshold and the switch is not currently locked or opened and held open.
- Start a new DLP demand interval when the previous DLP demand interval ends. Note that the meter does this regardless of whether DLP demand delay is in effect, as the demand delay prevents energy from being accumulated for the DLP demand calculation, but all other operations continue.
- Open the service disconnect switch on receipt of an Open command, thereby terminating DLP. Ending DLP mode causes the meter to clear the DLP On and DLP Disconnect flags.
- If the demand is below the programmed threshold, the meter will perform no additional DLP processing.

NOTE The meter will not calculate demand unless the demand softswitch is enabled. DLP will operate in a meter with demand softswitch disabled, but demand calculations are suppressed so the demand will never exceed the threshold and the DLP function is effectively disabled.

The meter will perform the following when the demand exceeds the DLP threshold:

- If programmed to do so, the meter will log an event indicating that it has opened the service disconnect switch because of a DLP event, unless the switch is already open. If the switch is already open, then no event will be logged.

- DLP Disconnect will result in the switch being opened, but only if the switch is not currently locked or commanded to hold switch open.
- If the DLP reconnection attempt count is greater than zero and the programmed DLP reconnection period is greater than zero, the meter shall set its DLP reconnection timer.

During DLP Disconnect mode, the meter shall perform the following:

- If the DLP reconnection attempt count is greater than zero, the programmed DLP reconnection period is greater than zero, and the DLP reconnection timer has expired, the meter will decrement the DLP reconnection attempt count and clear DLP Disconnect. This will result in the switch closing, provided no other higher priority switch directive exists that requires the switch be open. The meter shall also set the DLP demand delay timer.
- If the meter receives a Switch Close command and the service disconnect switch successfully closes, then it will decrement the LC reconnection attempt counter if it is greater than zero. The meter will start the DLP demand delay timer, zero the DLP demand accumulator, and start the DLP demand interval timer. The meter will enter DLP On mode. Note that this occurs when the command arrives, not when the switch actually closes.

If the meter receives a procedure to reset the DLP reconnection attempt counter, the meter will set its counter to the programmed number of LC reconnection attempts. The meter will not end DLP Disconnect.

A demand reset will not impact the calculation of the DLP demand.

If the meter receives a cold start procedure during DLP mode, it will set its DLP parameters to their default values and cease the DLP function.

If the meter receives a clear data procedure during DLP mode, it will cease the DLP function.

If the meter is programmed while DLP mode is active, it will restart the DLP demand interval timer and reset the data that has accumulated in the current DLP demand accumulator. This prevents the possibility of the meter calculating an artificially high DLP demand value if the DLP interval length is set to a shorter value during the programming session.

Exiting DLP Mode

The meter shall exit DLP mode when an End DLP or Open command is received. When DLP ends due to an End DLP command, the DLP Disconnect ends also. If no other reasons for keeping the switch open exist, such as Open and Locked Meter or Hold Switch Open service disconnect switch state, then the meter will close the service disconnect switch. The Open command requests the switch to open, ending DLP. The end of DLP should be logged as an event if the meter is programmed to log this type of event. Should an End DLP command be received while DLP is not active, an error response will be generated.

Display Operation

The meter shall provide a displayable item that indicates the status of DLP. This displayable item may be added to the normal and alternate display scrolls like the other displayable items. This displayable item will show one of the following:

- **NORMAL** – This indicates that DLP is not active.
- **DLP** – This is displayed in the three leftmost digits and indicates that DLP is active.
- **DLPDSC** – This indicates that the switch has been opened because of DLP.

In addition, the following ECP information shall be displayable:

- DLP demand threshold
- Load control (DLP) demand
- Minutes until next DLP reconnection attempt
- DLP reconnection attempts remaining

APPENDIX

A

LOSS COMPENSATION EXAMPLES

This appendix provides examples of calculations for transformer loss compensation.

Delta-Delta Transformer Bank

The first example is for a delta-delta transformer bank with low voltage side metering. A 9,999 kVA transformer bank, consisting of three 115,000:2520 volt, 3,333 kVA transformers, is connected delta-delta. Metering will be done using a two stator (Form 45S) kV2c Gen 5 meter on the low voltage side of the transformer bank. Two 3,000:5 CTs and two 2400:120 VTs will be used. Since the billing point is on the high side of the transformer, the metered values must be compensated to reflect the losses in the transformer bank, and the loss values computed will be added to the metered values. Line losses from the bus work and wiring are ignored.

The transformer manufacturer supplied data indicates that at 75 °C:

Unit #	Rated kVA	Rated Voltage	No-Load (iron) Loss Watts at Rated Voltage	Load (copper) Loss Watts at Rated kVA	Percent Excitation Current	Percent Impedance
1	3,333	115,000/2,520	9,650	18,935	1.00	8.16
2	3,333	115,000/2,520	9,650	18,400	1.06	8.03
3	3,333	115,000/2,520	9,650	18,692	0.91	8.12

The necessary MMCOMM inputs would be:

MMCOMM Prompt	Input values			Comments
	Phase A	Phase B	Phase C	
kVA_{rated}	3333	3333	3333	From manufacturer data
$Volts_{L-N}$	1454.9	1454.9	1454.9	$V_{L-L} \div 3^{½}$
$Amps_{Line}$	2290.8	2290.8	2290.8	$VA \div V_{L-N}$
VTR	20	20	20	x:1
CTR	3000	3000	3000	x:5

MMCOMM Prompt	Input values Phase A	Phase B	Phase C	Comments
$LFE_{Elemwatts}$	9650	9690	9340	From manufacturer data
$LCU_{Elemwatts}$	18935	18400	18692	From manufacturer data
EC%	1.00	1.06	0.91	From manufacturer data
IMP%	8.16	8.03	8.12	From manufacturer data
LL_{watts}	0	0	0	These losses ignored in this example

Note the kV2c Gen 5 meter converts 3-wire delta metering inputs into a virtual 4-wire wye service during processing of the data. That is why MMCOMM requests VL-N instead of VL-L, and other inputs are expressed in terms of Phases A, B, and C even though it is a two element metering application. Using the formulae described earlier, MMCOMM would compute the following:

Calculated Compensation Factors (per element)	Phase A	Phase B	Phase C
Conductance (G)	1.520E-04	1.526E-04	1.471E-04
Resistance (R)	1.082E-01	1.052E-01	1.069E-01
Susceptance (B)	9.943E-08	1.011E-07	8.587E-08
Reactance (X)	1.551E+00	1.526E+00	1.543E+00

To verify the compensation factors have been computed correctly, the loss watts and vars (primary) can be computed, assuming rated voltage and full load current have been applied and compared to the input transformer loss data.

Losses (primary)	Phase A	Phase B	Phase C
$LFE_{watts} = G \times \left(\frac{V_{L-N}}{VTR}\right)^2 \times TF$	9650	9690	9340
$LCU_{watts} = R \times \left(\frac{I_L}{CTR}\right)^2 \times TF$	18935	18400	18692
$LFE_{vars} = B \times \left(\frac{V_{L-N}}{VTR}\right)^4 \times TF$	34699	36635	31736
$LCU_{vars} = X \times \left(\frac{I_L}{CTR}\right)^2 \times TF$	271313	267007	269993

Wye-Wye 3-Phase Transformer

This example is for a wye-wye 3-phase transformer with low voltage side metering. A 750 kVA 3-phase transformer (12470/7200 to 480/277) is connected wye-wye. Metering will is performed using a three stator (Form 9S) meter on the low voltage side of the transformer bank. Three 600:5 CTs and three 2.4:1 VTs will be used. Since the billing point is on the high side of the transformer, the metered values must be compensated to reflect the losses in the transformer bank, and the loss values computed will be added to the metered values. Any additional line losses are ignored.

The transformer manufacturer supplied data indicates that at 75 °C:

Rated kVA	Rated Voltage	Core Loss	No-Load (iron) Loss Watts at Rated Voltage	Percent Excitation Current	Percent Impedance
750	12470:480	1738	7856	2.7	5.78

Since only aggregate values for rated kVA and losses are provided for the 3-phase transformer, they must be divided by 3 to compute the necessary inputs to the MMCOMM prompts as shown below:

MMCOMM Prompt	Input			Comments
	Phase A	Phase B	Phase C	
kVA_{rated}	250	250	250	From manufacturer data
$Volts_{L-N}$	277	277	277	$V_{L-L} \div 3^{½}$
$Amps_{Line}$	902.1	902.1	902.1	$VA \div V_{L-N}$
VTR	2.4	2.4	2.4	x:1
CTR	600	600	600	x:5
$LFE_{Elemwatts}$	579	579	579	manufacturer data / 3
$LCU_{Elemwatts}$	2619	2619	2619	manufacturer data / 3
EC%	2.7	2.7	2.7	From manufacturer data
IMP%	5.78	5.78	5.78	From manufacturer data
LL_{watts}	0	0	0	These losses ignored in this example

If the power transformer was connected in delta on the low voltage side, the only MMCOMM input that would change would be the VT ratio (4:1 instead of 2.4:1). MMCOMM would compute the following:

Calculated Compensation	Phase A	Phase B	Phase C
Conductance (G)	1.509E-04	1.509E-04	1.509E-04
Resistance (R)	1.609E-01	1.609E-01	1.609E-01
Susceptance (B)	1.313E-07	1.313-07	1.313E-07
Reactance (X)	8.731E-01	8.731E-01	8.731E-01

To check that the compensation factors have been computed correctly, the loss watts and vars (primary) can be computed, assuming rated voltage and full load current have been applied, and compared to the input transformer loss data.

Losses (primary)	Phase A	Phase B	Phase C	Total
$LFE_{watts} = G \times \left(\frac{V_{L-N}}{VTR}\right)^2 \times TF$	579.33	579.33	579.33	1738
$LCU_{watts} = R \times \left(\frac{I_L}{CTR}\right)^2 \times TF$	2618.67	2618.67	2618.67	7856
$LFE_{vars} = B \times \left(\frac{V_{L-N}}{VTR}\right)^4 \times TF$	6752.09	6752.09	6752.09	20175.3
$LCU_{vars} = X \times \left(\frac{I_L}{CTR}\right)^2 \times TF$	14210.74	14210.74	14210.74	42632.2

APPENDIX

B

DISPLAY QUANTITIES

This appendix provides a list of quantities that may programmed to appear on the display.

Quantity	Modes Available	Test Mode	ID Format	Quantity Format
Data accumulations 1-20	All		XXX	UoM dependent[1]
Cont cum demands 1-5	All		YYY	UoM dependent[1]
Real-time pricing cont cum demands 1-5	Dmd/DmdLP		YYY	UoM dependent[1]
Cont cum demands 1-5 rate A	TOU		YYY	UoM dependent[1]
Cont cum demands 1-5 rate B	TOU		YYY	UoM dependent[1]
Cont cum demands 1-5 rate C			YYY	UoM dependent[1]
Cont cum demands 1-5 rate D			YYY	UoM dependent[1]
Cum demands 1-5	All		YYY	UoM dependent[1]
Real-time pricing cum demands 1-5	Dmd/DmdLP		YYY	UoM dependent[1]
Cum demands 1-5 rate A			YYY	UoM dependent[1]
Cum demands 1-5 rate B			YYY	UoM dependent[1]
Cum demands 1-5 rate C			YYY	UoM dependent[1]
Cum demands 1-5 rate D			YYY	UoM dependent[1]
Total summations 1-5	All		YYY	UoM dependent[1]
Real-time pricing summations 1-5	Dmd/DmdLP		YYY	UoM dependent[1]
Summations 1-5 rate A			YYY	UoM dependent[1]
Summations 1-5 rate B			YYY	UoM dependent[1]
Summations 1-5 rate C			YYY	UoM dependent[1]
Summations 1-5 rate D			YYY	UoM dependent[1]
Max demands 1-5	All		YYY	UoM dependent[1]
Max demands 1-5 date			YYY	MMDDYY
Max demands 1-5 time			YYY	HHMM
Max demands 1-5 coincident 1	All		YYY	UoM dependent[1]
Max demands 1-5 coincident 2	All		YYY	UoM dependent[1]
Real-time pricing max demands 1-5	Dmd/DmdLP		YYY	UoM dependent[1]
Real-time pricing max demands 1-5 coincident 1	Dmd/DmdLP		YYY	UoM dependent[1]
Real-time pricing max demands 1-5 coincident 2	Dmd/DmdLP		YYY	UoM dependent[1]

Quantity	Modes Available	Test Mode	ID Format	Quantity Format
Max demands 1-5 rate A			YYY	UoM dependent[1]
Max demands 1-5 rate A date			YYY	MMDDYY
Max demands 1-5 rate A time			YYY	HHMM
Max demands 1-5 rate A coincident 1			YYY	UoM dependent[1]
Max demands 1-5 rate A coincident 2			YYY	UoM dependent[1]
Max demands 1-5 rate B			YYY	UoM dependent[1]
Max demands 1-5 rate B date			YYY	MMDDYY
Max demands 1-5 rate B time			YYY	HHMM
Max demands 1-5 rate B coincident 1			YYY	UoM dependent[1]
Max demands 1-5 rate B coincident 2			YYY	UoM dependent[1]
Max demands 1-5 rate C			YYY	UoM dependent[1]
Max demands 1-5 rate C date			YYY	MMDDYY
Max demands 1-5 rate C time			YYY	HHMM
Max demands 1-5 rate C coincident 1			YYY	UoM dependent[1]
Max demands 1-5 rate C coincident 2			YYY	UoM dependent[1]
Max demands 1-5 rate D			YYY	UoM dependent[1]
Max demands 1-5 rate D date			YYY	MMDDYY
Max demands 1-5 rate D time			YYY	HHMM
Max demands 1-5 rate D coincident 1			YYY	UoM dependent[1]
Max demands 1-5 rate D coincident 2			YYY	UoM dependent[1]
Average power factor	All		YYY	X.XX
Last reset cont cum demands 1-5	All		YYY	UoM dependent[1]
Last reset real-time pricing cont cum demands 1-5	Dmd/DmdLP		YYY	UoM dependent[1]
Last reset cont cum demands 1-5 rate A			YYY	UoM dependent[1]
Last reset cont cum demands 1-5 rate B			YYY	UoM dependent[1]
Last reset cont cum demands 1-5 rate C			YYY	UoM dependent[1]
Last reset cont cum demands 1-5 rate D			YYY	UoM dependent[1]
Last reset cum demands 1-5	All		YYY	UoM dependent[1]
Last reset real-time pricing cum demands 1-5	Dmd/DmdLP		YYY	UoM dependent[1]
Last reset cum demands 1-5 rate A			YYY	UoM dependent[1]
Last reset cum demands 1-5 rate B			YYY	UoM dependent[1]
Last reset cum demands 1-5 rate C			YYY	UoM dependent[1]
Last reset cum demands 1-5 rate D			YYY	UoM dependent[1]
Last reset total summations 1-5	All		YYY	UoM dependent[1]
Last reset real-time pricing summations 1-5	Dmd/DmdLP		YYY	UoM dependent[1]

Quantity	Modes Available	Test Mode	ID Format	Quantity Format
Last reset summations 1-5 rate A	TOU		YYY	UoM dependent[1]
Last reset summations 1-5 rate B			YYY	UoM dependent[1]
Last reset summations 1-5 rate C			YYY	UoM dependent[1]
Last reset summations 1-5 rate D			YYY	UoM dependent[1]
Last reset max demands 1-5	All		YYY	UoM dependent[1]
Last reset max demands 1-5 date			YYY	MMDDYY
Last reset max demands 1-5 time			YYY	HHMM
Last reset max demands 1-5 coincident 1	All		YYY	UoM dependent[1]
Last reset max demands 1-5 coincident 2	All		YYY	UoM dependent[1]
Last reset real-time pricing max demands 1-5	Dmd/DmdLP		YYY	UoM dependent[1]
Last reset real-time pricing max demands 1-5 coincident 1	Dmd/DmdLP		YYY	UoM dependent[1]
Last reset real-time pricing max demands 1-5 coincident 2	Dmd/DmdLP		YYY	UoM dependent[1]
Last reset max demands 1-5 rate A			YYY	UoM dependent[1]
Last reset max demands 1-5 rate A date			YYY	MMDDYY
Last reset max demands 1-5 rate A time			YYY	HHMM
Last reset max demands 1-5 rate A coincident 1			YYY	UoM dependent[1]
Last reset max demands 1-5 rate A coincident 2			YYY	UoM dependent[1]
Last reset max demands 1-5 rate B			YYY	UoM dependent[1]
Last reset max demands 1-5 rate B date			YYY	MMDDYY
Last reset max demands 1-5 rate B time			YYY	HHMM
Last reset max demands 1-5 rate B coincident 1			YYY	UoM dependent[1]
Last reset max demands 1-5 rate B coincident 2			YYY	UoM dependent[1]
Last reset max demands 1-5 rate C			YYY	UoM dependent[1]
Last reset max demands 1-5 rate C date			YYY	MMDDYY
Last reset max demands 1-5 rate C time			YYY	HHMM
Last reset max demands 1-5 rate C coincident 1			YYY	UoM dependent[1]
Last reset max demands 1-5 rate C coincident 2			YYY	UoM dependent[1]
Last reset max demands 1-5 rate D			YYY	UoM dependent[1]
Last reset max demands 1-5 rate D date			YYY	MMDDYY
Last reset max demands 1-5 rate D time			YYY	HHMM

Quantity	Modes Available	Test Mode	ID Format	Quantity Format
Last reset max demands 1-5 rate D coincident 1			YYY	UoM dependent[1]
Last reset max demands 1-5 rate D coincident 2			YYY	UoM dependent[1]
Last reset average power factor	All		YYY	X.XX
Previous season cont cum demands 1-5			YYY	UoM dependent[1]
Previous season cont cum demands 1-5 rate A			YYY	UoM dependent[1]
Previous season cont cum demands 1-5 rate B			YYY	UoM dependent[1]
Previous season cont cum demands 1-5 rate C			YYY	UoM dependent[1]
Previous season cont cum demands 1-5 rate D			YYY	UoM dependent[1]
Previous season cum demands 1-5			YYY	UoM dependent[1]
Previous season cum demands 1-5 rate A			YYY	UoM dependent[1]
Previous season cum demands 1-5 rate B			YYY	UoM dependent[1]
Previous season cum demands 1-5 rate C			YYY	UoM dependent[1]
Previous season cum demands 1-5 rate D			YYY	UoM dependent[1]
Previous season Total summations 1-5			YYY	UoM dependent[1]
Previous season summations 1-5 rate A			YYY	UoM dependent[1]
Previous season summations 1-5 rate B			YYY	UoM dependent[1]
Previous season summations 1-5 rate C			YYY	UoM dependent[1]
Previous season summations 1-5 rate D			YYY	UoM dependent[1]
Previous season max demands 1-5			YYY	UoM dependent[1]
Previous season max demands 1-5 date			YYY	MMDDYY
Previous season max demands 1-5 time			YYY	HHMM
Previous season max demands 1-5 coincident 1			YYY	UoM dependent[1]
Previous season max demands 1-5 coincident 2			YYY	UoM dependent[1]
Previous season max demands 1-5 rate A			YYY	UoM dependent[1]
Previous season max demands 1-5 rate A date			YYY	MMDDYY
Previous season max demands 1-5 rate A time			YYY	HHMM
Previous season max demands 1-5 rate A coincident 1			YYY	UoM dependent[1]
Previous season max demands 1-5 rate A coincident 2			YYY	UoM dependent[1]
Previous season max demands 1-5 rate B			YYY	UoM dependent[1]
Previous season max demands 1-5 rate B date			YYY	MMDDYY
Previous season max demands 1-5 rate B time			YYY	HHMM

Quantity	Modes Available	Test Mode	ID Format	Quantity Format
Previous season max demands 1-5 rate coincident 1			YYY	UoM dependent[1]
Previous season max demands 1-5 rate B coincident 2			YYY	UoM dependent[1]
Previous season max demands 1-5 rate C			YYY	UoM dependent[1]
Previous season max demands 1-5 rate C date			YYY	MMDDYY
Previous season max demands 1-5 rate C time			YYY	HHMM
Previous season max demands 1-5 rate C coincident 1			YYY	UoM dependent[1]
Previous season max demands 1-5 rate C coincident 2			YYY	UoM dependent[1]
Previous season max demands 1-5 rate D			YYY	UoM dependent[1]
Previous season max demands 1-5 rate D date			YYY	MMDDYY
Previous season max demands 1-5 rate D time			YYY	HHMM
Previous season max demands 1-5 rate D coincident 1			YYY	UoM dependent[1]
Previous season max demands 1-5 rate D coincident 2			YYY	UoM dependent[1]
Previous season average power factor			YYY	X.XX
Momentary interval demands 1-5	All	✓	YYY	UoM dependent[1]
Line-to-neutral voltages fundamental plus harmonics	All	✓	YYY	Voltage
Line-to-neutral voltages fundamental	All	✓	YYY	Voltage
Line-to-line voltages fundamental plus harmonics	All	✓	YYY	Voltage
Line-to-line voltages fundamental	All	✓	YYY	Voltage
Line currents fundamental plus harmonics	All	✓	YYY	Current
Line currents fundamental	All	✓	YYY	Current
In (imputed neutral current)	All	✓	YYY	Current
Site Genie voltages	All	✓	YYY	Voltage
Site Genie currents	All	✓	YYY	Current
Site Genie voltage angles	All	✓	YYY	Angle
Site Genie current angles	All	✓	YYY	Angle
Distortion PF per element [2]	All	✓	YYY	X.XX
Distortion PF total [2]	All	✓	YYY	X.XX
TDD per element [2]	All	✓	YYY	X.XX
ITHD per element [2]	All	✓	YYY	X.XX
VTHD per element [2]	All	✓	YYY	X.XX
Momentary interval power factor	All		YYY	X.XX

Quantity	Modes Available	Test Mode	ID Format	Quantity Format
Momentary interval kW per element fundamental plus harmonics	All	✓	YYY	Volt-ampere
Momentary interval kW per element fundamental	All	✓	YYY	Volt-ampere
Momentary interval kvar per element fundamental plus harmonics	All	✓	YYY	Volt-ampere
Momentary interval kvar per element fundamental	All	✓	YYY	Volt-ampere
Momentary interval distortion kVA per element	All	✓	YYY	Volt-ampere
Momentary interval apparent kVA per element	All	✓	YYY	Volt-ampere
Frequency	All	✓	YYY	XX.XX
Canadian seal state	All	✓	YYY	Binary
Current date	TOU/DmdLP	✓	YYY	MMDDYY
Current day of week	TOU/DmdLP	✓	YYY	Numeric
Current season		✓	YYY	Numeric
Current time	TOU/DmdLP	✓	YYY	HHMM
Demand alert threshold	All	✓	YYY	UoM dependent[1]
Power fail exclusion time	All	✓	YYY	Numeric
Demand interval size (block)	All	✓	YYY	Numeric
Demand min threshold for power fail exclusion	All	✓	YYY	Numeric
Demand subint mult (rolling)	All	✓	YYY	Numeric
Demand subint size (rolling)	All	✓	YYY	Numeric
Demand time remaining in subint (not valid for thermal demands)	All		YYY	MMSS
Display demand units	All	✓	YYY	Numeric
Display multiplier	All	✓	YYY	Numeric
Display scalar	All	✓	YYY	Numeric
Display primary volts/amps flag	All	✓	YYY	Numeric
EOI Duration	All	✓	YYY	Numeric
Load control on	TOU	✓	YYY	Numeric
Load profile # channels	TOU/DmdLP	✓	YYY	Numeric
Load profile interval length	TOU/DmdLP	✓	YYY	Numeric
Diagnostic counters 1-4, 5, 5a, 5b, 5c, 6a, 6b, 6c, 7a, 7b, 7c, 8[3]	All	✓	YYY	Numeric
Meter ID 1,2	All	✓	MMM	MMMMMM
Electrical service	All	✓	YYY	Text
Power factor demand threshold	All	✓	YYY	UoM dependent[1]

Quantity	Modes Available	Test Mode	ID Format	Quantity Format
Power factor threshold	All	✓	YYY	Numeric
Prior interval demands 1-5	All	✓	YYY	UoM dependent[1]
Program ID	All	✓	YYY	XXXX
Real-time pricing Enabled	All	✓	YYY	Binary
Real-time pricing time remaining until activation	All	✓	YYY	Numeric
S Log # bad passwords	All	✓	YYY	Numeric
S Log # demand resets	All	✓	YYY	Numeric
S Log # NV memory writes	All	✓	YYY	Numeric
S Log # OPTOCOM communications	All	✓	YYY	Numeric
S Log power outages	All	✓	YYY	Numeric
S Log # times programmed	All	✓	YYY	Numeric
S Log # times real-time pricing entries	All	✓	YYY	Numeric
S Log cum power outage duration	TOU/DmdLP	✓	YYY	Numeric
S Log date last calibration	All	✓	YYY	MMDDYY
S Log date last demand reset	TOU	✓	YYY	MMDDYY
S Log date last OPTOCOM communication	TOU	✓	YYY	MMDDYY
S Log date last power outage	TOU/DmdLP	✓	YYY	MMDDYY
S Log date last programming		✓	YYY	MMDDYY
S Log date last real-time pricing entry		✓	YYY	MMDDYY
S Log date last time change		✓	YYY	MMDDYY
S Log date last TLC change		✓	YYY	MMDDYY
S Log date last transformer inaccuracy adjustment		✓	YYY	MMDDYY
S Log time last calibration	All	✓	YYY	HHMM
S Log time last demand reset		✓	YYY	HHMM
S Log time last OPTOCOM communication		✓	YYY	HHMM
S Log time last power outage	TOU/DmdLP	✓	YYY	HHMM
S Log time last programming	All	✓	YYY	HHMM
S Log time last real-time pricing entry		✓	YYY	HHMM
S Log time last time change		✓	YYY	HHMM
S Log time last TLC update		✓	YYY	HHMM
S Log time last transformer inaccuracy adjustment		✓	YYY	HHMM
Test demand interval size (block)	All	✓	YYY	Numeric
Test demand subint mult (rolling)	All	✓	YYY	Numeric
Test demand subint size (rolling)	All	✓	YYY	Numeric
Test mode max demands 1-5	All	✓	YYY	UoM dependent[1]
Test mode time out length	All	✓	YYY	Numeric

Quantity	Modes Available	Test Mode	ID Format	Quantity Format
Test mode data accumulations 1-20	All	✓	YYY	UoM dependent[1]
Test thermal interval type	All	✓	YYY	Binary
Transformer ratio-current	All	✓	YYY	Numeric
Transformer ratio-voltage	All	✓	YYY	Numeric
Version firmware	All	✓	YYY	V V.R R.N N[4]
Version hardware	All	✓	YYY	Numeric
Test mode time remaining in subint (not valid for thermal demands)	All	✓	YYY	MMSS
Test mode accumulating demands 1-5	All	✓	YYY	UoM dependent[1]
Segment check	All	✓	888	All segments
User-defined labels 1-5	All	✓	YYY	Text
Test mode power factor	All	✓	YYY	X.XX
Transformer factor	All	✓	YYY	UoM dependent[1]
Previous self-read total summation 1-5	All		YYY	UoM dependent[1]
Previous self-read max demand 1-5	All		YYY	UoM dependent[1]
Previous self-read max demand 1-5 date			YYY	MMDDYY
Previous self-read max demand 1-5 time			YYY	HHMM
Daily max non-cycle sensitive demand 1-2 time			YYY	HHMM
Daily max non-cycle sensitive demand 1-2 rate A time			YYY	HHMM
Daily max non-cycle sensitive demand 1-2 rate B time			YYY	HHMM
Network status info 1-8		✓	YYY	Text

NOTES:

1 UOM (unit of measure) dependent quantities are displayed based on the quantity type. Data accumulations and summations may have the following types:
- Volt-ampere-hour (e.g., kWh, kvarh, kVAh)
- Test mode volt-ampere-hour (e.g., Test mode Wh, Test mode varh)
- Voltage
- Current
- Numeric (pulse counts)

Demands may have the following types:
- Volt-ampere (e.g., kW, kvar, kVA)
- Voltage
- Current
- Numeric (pulse counts)

Cumulative and continuously cumulative demands may have the following types:
- Cumulative/continuously cumulative volt-ampere
- Voltage
- Current
- Numeric

The meter will calculate cumulative and continuously cumulative values even when quantities such as voltages and currents are selected as demands. Since cumulative values have no meaning for some quantities, however, it is recommended that they not be displayed.

2 Distortion measurements (d/U, TDD, or THD) are displayed in the format X.X X, no leading zeroes, and are not converted into percentages. Distortion (d/U, VTHD, ITHD or TDD) calculations are not allowed to exceed 1.00.

3 In Site Genie display mode, the diagnostic numbers (e.g., d1, d2, d5A) are displayed in the three-digit

identifier field when the corresponding diagnostic counter is displayed. In the other display modes, the programmed three-digit identifier code is displayed.

4 V V = two-digit version, R R = two-digit revision, and N N = two-digit minor revision. For example, firmware 4.13.2 would be displayed as 04.13.02.

KEY:

Binary = Binary value (zero or one)

X = Variable data

Y = ID code

M = Meter ID format (two sets of nine digits)

Date = MMDDYY two digit month, two digit day, two digit year (programmable)

HHMM = two digit hour, two digit minute

MMSS = two digit minute, two digit second

Formatting Volt-Ampere-Hour (VAh) Quantities

The following are volt-ampere-hour quantities:

- kWh
- kvarh (IEEE or fuzzy)
- apparent kVAh
- phasor kVAh
- arithmetic apparent kVAh
- kQh
- distortion kVAh

Volt-ampere-hour quantities are accumulated as data accumulations and as summations.

Formatting Volt-Ampere-Hour Quantities in Normal Mode

Volt-ampere-hour data shall be converted from raw data stored in the meter to a displayable value as follows:

$$\text{displayed kilo volt-ampere-hour data} = \frac{(\text{raw data})\,(\text{VAhscale factor})\,(\text{display multiplier})}{10^{3+\text{display scalar}}}$$

The VAh scale factor input is specified in Standard Table 15. The display multiplier and display scalar are defined in Manufacturer Table 70. Once the volt-ampere-hour quantity to be displayed has been calculated, it is displayed on the LCD in kilo-units (e.g., kWh, kvarh) according to the summations digits format and the suppress leading zeroes flag (both in Manufacturer Table 70). Displayed volt-ampere-hour values are truncated, not rounded, to the nearest displayed digit. Volt-ampere-hour values are signed quantities. If a value has a negative sign, the meter will display its magnitude and light the minus sign annunciator.

Formatting Volt-Ampere-Hour Quantities in Test Mode

Test mode volt-ampere-hour data is converted from raw data stored in the meter to a displayable value as follows:

$$\text{displayed volt-ampere-hour data} = \frac{(\text{raw data})\,(\text{VAh scale factor})\,(\text{display multiplier})}{10^{\text{display scalar}}}$$

Once the Test mode volt-ampere-hour quantity to be displayed has been calculated, it is displayed on the LCD in units (e.g., Wh, varh) in the format X X X.X X X. Leading zeroes are displayed or not depending on how the meter is programmed.

Formatting Volt-Ampere Quantities

The following are volt-ampere quantities:

- kW
- kvar (IEEE or fuzzy)
- apparent kVA
- phasor kVA
- arithmetic apparent kVA
- kQ
- distortion kVA

Volt-ampere quantities may be maximum demands, momentary interval demands, previous interval demands, coincident demands, or accumulating demands (Test mode only). Volt-ampere data shall be converted from raw data stored in the meter to a displayable value as follows:

$$\text{displayed (kilo)volt-ampere-hour data} = \frac{\text{(raw data) (VAscale factor) (display multiplier)}}{10^{(\text{VA/kVA adjust}) + \text{display scalar}}}$$

The VA scale factor input is specified in either Manufacturer Table 75 or Standard Table 15 (the values will be the same; where the meter looks for the scale factor depends on what type of demand is being displayed). The display multiplier and display scalar are defined in Manufacturer Table 70. The VA/kVA adjust factor is 3 if volt-ampere demand display units (Manufacturer Table 70) is 0 (i.e., display kilo-units) or 0 if demand display units is 1 (i.e., display units).

Once the volt-ampere quantity to be displayed has been calculated, it is displayed on the LCD in units (e.g., W, var) or kilo-units (e.g., kW, kvar) according to the demand digits format and the suppress leading zeroes flag (both in Manufacturer Table 70). Displayed volt-ampere values are truncated, not rounded, to the nearest displayed digit. If the calculated volt-ampere quantity is too large to fit in the specified format, Fs are be displayed. For example, if the demand display format specifies 2 digits to the left and 3 digits to the right of the decimal point, and the calculated demand was 105.236 kW, the display would show F F.F F F along with the appropriate annunciators. Volt-ampere values are signed quantities. If a value has a negative sign, the meter will display its magnitude and light the minus sign annunciator.

Formatting Cumulative and Continuously Cumulative Volt-Ampere Quantities

Cumulative and continuously cumulative demands are converted from raw data to displayable with the same formula given in the previous section. Once the quantity to be displayed has been calculated, it is displayed on the LCD in units (e.g., W, var) or kilo-units (e.g., kW, kvar) according to the cumulative demand digits format and the suppress leading zeroes flag (both in Manufacturer Table 70).

All voltages are stored in the meter in tenth of volts and represent voltage at the metering point. When the meter displays a voltage on the LCD, it checks the primary volts/amps display flag (Manufacturer Table 70). If the flag is true, the meter will multiply the voltage by the voltage transformer ratio before it is displayed. If the voltage to be displayed is less than or equal to 99999.9 V, the meter will display the voltage in the format X X X X X.X with the V annunciator lit and no leading zeroes. If the voltage to be displayed is greater than 99999.9 V, the meter will display the voltage in kilovolts in the format X X X.X X X with the k and V annunciators lit and no leading zeroes. If a voltage is invalid (refer to *Site Genie*® on page 55), the meter will display dashes in all six alpha-numeric segments. Voltages always have positive signs.

Formatting Currents

All currents are stored in the meter in tenth of amps and represent current at the metering point. When the meter displays a current on the LCD, it checks the primary volts/amps display flag (Manufacturer Table 70). If the flag is true, the meter will multiply the voltage by the current transformer ratio before it is displayed. If the voltage to be displayed is less than or equal to 99999.9 A, the meter will display the current in the format X X X X X.X with the A annunciator lit and no leading zeroes. If the voltage to be displayed is greater than 99999.9 A, the meter will display the current in kilo-amps in the format X X X.X X X with the k and A annunciators lit and no leading zeroes. If a current is invalid (refer to *Site Genie*® on page 55), the meter will display dashes in all six alpha-numeric segments. Currents always have positive signs.

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