GEH-7285A

Encompass Electronic Meter Family

Features and Applications

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FCC COMPLIANCE STATEMENT

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 Regualtions (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:

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1 Measurements and the Measurement Profile

1.1 Introduction

The New Encompass Electronic Meter family comprises of KV2C ,KV2C+ and KV2n Meter's . Features of all the three meters are explained in this document . The Encompass Electronic Meter family Firmware is enhanced to support New Current transformers , Five thermal demand calculations , Unsealed Passwords, Self Reads without R or X or H Softswitch , Previous 5 self read display items incase of KV2C and KV2C+.
kV2n Meter is an energy only meter with specifically designed for 120 VAC service. The KV2n meter cannot be functionally upgraded and doesnot have any option boards . The kV2n meter doesnot support load profile recording and therefore does not have memory. KV2C+ support Huge Load Profile Memory (8 MB) when a 'H' softswitch is upgraded.

The KV2C/KV2C+ has the capability to calculate a wide range of quantities. In this section, those quantities will be defined. This section will also explain the concept of the measurement profile, which is a list of up to 20 quantities that the meter will accumulate.

Note: The Meter Mate programming software provides default Measurement Profiles, which contain the more common selections. One of the Measurement Profiles provided, for example, duplicates the measurement choices available in the kV meter. This allows a user who is only interested in the more typical billing measurements to create programs without having to search through all of the selections that the KV2/KV2C/KV2C+ provides.

Throughout this document, the term "momentary interval" is used. The definition of momentary interval, for the purposes of this document, is 60 cycles of the fundamental frequency of the voltage signal for 60 Hz applications, 50 cycles for 50 Hz applications. The terms "fundamental only" and "fundamental plus harmonics" are also used in this document. A "fundamental only" quantity is one in which only the fundamental frequency component of the voltage and/or the current is used to compute it. A "fundamental plus harmonics" quantity has the fundamental component and the harmonic components in it.

Every momentary interval, the KV2C meter calculates a set of Watt-hour quantities, varhour quantities, volt-ampere-hour quantities, voltages, currents, etc. It also determines a quadrant for that momentary interval. The quadrant is based on the sign of the total (i.e. sum of all elements) Watt-hours and varhours (both fundamental plus harmonics data) over that momentary interval. The decision whether to add data to a selected quadrant-specific quantity (e.g. Quadrant 1 Apparent VAh) is made every momentary interval based on the quadrant number for that momentary interval. The quadrant numbers for per-element quantities are still based on the total Watt-hours and varhous; i.e. the quadrant numbers are not determined for each element individually.

Another possible source of confusion is the term "per element". The KV2CC meter internally converts all services into 4-wire wyes. 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.

1.2 Operation in Demand Mode

1.2.1 Watt-hour Measurements

The KV2C 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 the above quantities can be specified to be fundamental only or fundamental plus harmonics. Some quantities require a soft switch; see section 1.5.

1.2.2 Varhour Measurements

The KV2C 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 specified to be calculated according to the IEEE definition, or as “fuzzy” varh. Per element fuzzy varh is calculated as follows:

$$\text{fuzzy varh}_x = \sqrt{(\text{varh}_x)^2 + (\text{distortion VAh}_x)^2}$$
$$\text{where x} = \text{element A, B, C}$$
$$\text{varh is a fundamental plus harmonics value}$$

Equation 1-1

The calculation for distortion VAh is given in section 1.2.9. The vector sum is done each momentary interval. 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.

All varh quantities require a soft switch. Refer to section 1.5.

1.2.3 Q-hour Measurements

Q-hours are calculated each momentary interval as follows:

$$\text{Qh} = \frac{1}{2}\left(\sum_x \text{Wh}_x\right) + \frac{\sqrt{3}}{2}\left(\sum_x \text{varh}_x\right)$$
$$\text{x} = \text{element A, B, C}$$
$$\text{Wh and varh are fundamental plus harmonics values}$$

Equation 1-2

If the result of the calculation is negative, Qh for that momentary interval is set to zero.

Qh requires the K switch (refer to section 1.5 below).

1.2.4 Volt-ampere-hour Measurements

The KV2C meter provides the following VAh measurement choices:

- 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 is calculated each momentary interval as follows:

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

where x = element A, B, C

Wh and varh are fundamental plus harmonics values

Equation 1-3

The calculation for distortion VAh is given in section 1.2.9.

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:

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

where x = element A, B, C

V^2h_x and I^2h_x are fundamental plus harmonics quantities

Equation 1-4

There are three different types of Phasor VAh available in the KV2C: 1. Phasor VAh fundamental plus harmonics, calculated with IEEE varh; 2. Phasor VAh fundamental plus harmonics calculated with fuzzy varh; and 3. Phasor VAh fundamental only. Phasor VAh is calculated each momentary interval as follows:

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

Equation 1-5

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.

Refer to section 1.5 for the soft switches that are required for the VAh quantities described above.

1.2.5 Volt-squared-hour Measurements

The KV2C 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 switch is required for these quantities (see section 1.5).

1.2.6 Ampere-squared-hour Measurements

The KV2C 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 also 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 switch is required for these quantities (see section 1.5).

1.2.7 Voltage Measurements

The KV2C 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.

As noted in section 1.1, the KV2C meter internally converts all services into 4-wire wyes. The voltage selections in the measurement profile (see section 1.2.10) 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 section 10).

The Q switch (see section 1.5) is required if voltage measures are to be used in Data Accumulations (section 2), Summations (section 3), Demand Calculations (section 4), or Load Profile (section 9). The Q switch is not required to display the most recent momentary interval voltages (see section 1.2.11) or for Site Genie functions.

1.2.8 Current Measurements

The KV2C provides the following current measurement choices:

- I_n (neutral current)
- Current

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

The Q switch (see section 1.5) is required if current measures are to be used in Data Accumulations (section 2), Summations (section 3), Demand Calculations (section 4), or Load Profile (section 9). The Q switch is not required to display the most recent momentary interval currents (see section 1.2.11) or for Site Genie functions.

1.2.9 Distortion Measurements

1.2.9.1 Distortion Volt-ampere-hours

The KV2C calculates distortion VAh per element each momentary interval as follows:

$$\text{Distortion VAh}_x = \sqrt{\left(V^2h_x\right)\times\left(I^2h_x\right)-\left(Wh_x\right)^2-\left(varh_x\right)^2}$$
$$\text{where } x = \text{element A, B, C}$$
$$V^2h_x, I^2h_x, Wh_x, \text{and } varh_x \text{ are fundamental plus harmonics quantities}$$

Equation 1-6

To calculate the total distortion VAh, which is the sum of the per element values, a sign must be 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 switch (see section 1.5) is required if distortion VAh measures are to be used in Data Accumulations (section 2), Summations (section 3), Demand Calculations (section 4), or Load Profile (section 9). The Q switch is not required to display the most recent momentary interval distortion VA measures (see section 1.2.11).

1.2.9.2 Distortion Power Factor

The KV2C calculates distortion power factor each momentary as follows:

$$\text{Distortion PF}_x = \frac{\text{Distortion VAh}_x}{\text{Apparent VAh}_x}$$
$$\text{where } x = \text{element A, B, C, and sum of all elements}$$

Equation 1-7

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 Equation 1-4.

The Q switch (see section 1.5) is required if distortion power factors are to be used in Data Accumulations (section 2), Summations (section 3), Demand Calculations (section 4), or Load Profile (section 9). The Q switch is not required to display the most recent momentary interval distortion power factors (see section 1.2.11) or for Site Genie functions.

1.2.9.3 Total Demand Distortion

The KV2C calculates total demand distortion (TDD) each momentary interval as follows:

$$\text{TDD}_x = \frac{\text{RMS of harmonic content of current}_x}{\text{Max Installation Current}}$$
$$\text{where } x = \text{element A, B, C}$$

Equation 1-8

Max installation current is a programmed value. Typically it is set to the class amps.

The Q switch (see section 1.5) is required if total demand distortion measures are to be used in Data Accumulations (section 2), Summations (section 3), Demand Calculations (section 4), or Load Profile (section 9). The Q switch is not required to display the most recent momentary interval total demand distortion measures (see section 1.2.11) or for Site Genie functions.

1.2.9.4 Total Harmonic Distortion

The KV2C calculates two types of total harmonic distortion: voltage total harmonic distortion (VTHD) and current total harmonic distortion (ITHD). They are calculated each momentary interval as follows:

$$\mathrm{VTHD_x} = \frac{\text{RMS of harmonic content of voltage}_x}{\text{RMS of fundamental component of voltage}_x}$$

$$\mathrm{ITHD_x} = \frac{\text{RMS of harmonic content of current}_x}{\text{RMS of fundamental component of current}_x}$$

$$\text{where x} = \text{element A, B, C}$$

Equation 1-9

Although it is possible in some cases for the denominators to be larger than the numerators in these calculations, the KV2C does not allow the values to exceed 100%.

The Q switch (see section 1.5) is required if THD measures are to be used in Data Accumulations (section 2), Summations (section 3), Demand Calculations (section 4), or Load Profile (section 9). The Q switch is not required to display the most recent momentary interval THD measures (see section 1.2.11) or for Site Genie functions.

1.2.10 Measurement Profile

The measurement profile serves two basic purposes: it specifies the quantities that will be calculated for the Data Accumulations (see section 2); and it specifies the quantities from which the Summations, Demand Calculations, and Load Profile quantities may be selected.

Any quantity that 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 in section 1.2, external pulse inputs can be defined in the measurement profile. Refer to section 22 for more information.

1.2.11 Other Available Momentary Interval Quantities

In the KV2C there is a set of pre-defined quantities (i.e. quantities available regardless of what has been selected in the measurement profile) that are updated every momentary interval. There is no operation (sum, maximum, minimum, store) associated with any of the quantities in this set, and they are present regardless of what soft switches 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 divide 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

1.3 Operation in Demand/Load Profile Mode

The measurements available and the function of the measurement profile in Demand/Load Profile mode are identical to Demand mode.

1.4 Operation in Time of Use Mode

The measurements available and the function of the measurement profile in TOU mode are identical to Demand mode.

1.5 Restrictions

Four soft switches 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 switch)

- 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 switch)

- 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 switch)

- 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 switch)

- 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

If a quantity is specified in the measurement profile in a meter without the appropriate soft switch, that quantity will not accumulate or be recorded, regardless of where it is used (e.g. Data Accumulations, Summations, Load Profile).

2 Data Accumulations

2.1 Introduction

The purpose of the Data Accumulations feature is to take advantage of the measurement capability of the KV2C 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 soft-switches.

2.2 Operation in Demand Mode

The quantities accumulated in the Data Accumulations are specified by the Measurement Profile (see section 1.2.10). 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. Non integrated quantities, i.e. those that represent an average over one momentary interval, are not added. Rather, as part of the measurement profile entries for each of these quantities, there must be an operation: max, min, or store. The definitions for these operations are given in section 1.2.10. For max quantities, the one-minute accumulation contains the maximum momentary interval value collected during that minute. For min 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 max or mins consists of comparing the current overall value to the new minute value and replacing the overall value if needed. Updating values that have the store operation associated with them consists of always replacing the overall value with the new minute value.

Data Accumulations are displayable on the meter's LCD. They are also available in the MeterMate DOS or MeterMate COMM Site Status report.

2.3 Operation in Demand/Load Profile Mode

The Data Accumulations feature in Demand/Load Profile mode operates identically to the way it does in Demand mode.

2.4 Operation in Time of Use Mode

The Data Accumulations feature in TOU mode operates identically to the way it does in Demand mode.

2.5 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 soft switch, and that soft switch is not present in the meter, the quantity will be set to zero. The soft switches that control what quantities are available are described in section 1.5.

3 Summations

3.1 Introduction

Summations are similar to Data Accumulations. Like Data Accumulations, Summations can be integrated quantities (e.g. Wh, varh, VAh) as well as momentary interval averages with a defined operation (e.g. element A voltage, max). Also like Data Accumulations, Summations are updated each minute with the data collected over that minute. Refer to section 2.2 for more details.

Up to five Summations can be specified in the KV2C meter. This five is a subset of the quantities defined in the Measurement Profile. The selection is made when creating a program with MeterMate Program Manager (Basic Meter Configuration Support Table).

3.2 Operation in Demand Mode

In a demand only meter, there are two sets of Summations. One set is updated only when the meter is in Real Time Pricing (RTP) mode, the other set is updated 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) are displayable on the meter's LCD and may be read and viewed using MeterMate DOS or MeterMate COMM.

3.3 Operation in Demand/Load Profile Mode

The Summations feature in Demand/Load Profile mode operates identically to the way it does in Demand mode.

3.4 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 displayable on the meter's LCD and may be read and viewed using MeterMate DOS or MeterMate COMM.

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

3.5 Restrictions

If a given Summations quantity requires a soft switch, and that soft switch is not present in the meter, the quantity will be set to zero. The soft switches that control what quantities are available are described in section 1.5.

4 Demand Calculations

4.1 Introduction

The KV2C 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 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 which 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 & Alerts Support Table):

- Type of demand to be calculated (block, rolling, or thermal).
- The selection of demands to be computed by the meter. This is specified by selecting five of the twenty available measures in the Measurement Profile for meters programmed for block and rolling demand, or one of the twenty for meters programmed for thermal demand. Quantities in the Measurement Profile that are defined as min or store quantities may not be selected as demands.
- 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, see Table 4-1 below).
- Subinterval length – length, in minutes, of a demand subinterval (rolling demand only, see Table 4-1 below).
- Interval length – length, in minutes, of a demand interval (block demand only, see Table 4-1 below).
- End of interval duration – amount of time, in seconds, for which the EOI annunciator is lit at the end of a demand calculation and an EOI output (if the meter is programmed to do that) is asserted.

(sub) interval length Subintervals per interval	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			X			
5	X		X	X		X					
6	X	X			X		X				
10	X	X	X			X					
12	X				X						
15	X	X		X							

Table 4-1 Interval/Subinterval Selections Available in the KV2C Meter

4.2 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. See section 4.1 for more information.

Maximum and cumulative (see section 4.2.4) 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 DOS or MeterMate COMM.

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.

4.2.1 Block and Rolling Demands

4.2.1.1 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 (see Data Accumulations section above), 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 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.
4. If real-time pricing is active, the KV2C 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 EOI annunciator on the LCD is lit for the programmed number of seconds. Also, if programmed to do so, the KV2C asserts an output for the EOI duration time.

4.2.1.2 Partial Demand Intervals

In a KV2C 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 calculates demands as described in section 4.2.1.1. When computing demands, the data is treated as though it had accumulated over a complete demand interval. For example, if a KV2C meter was metering a 5 kW load and test mode was initiated half way 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 meter allow a long demand interval.

4.2.2 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 meter is not less than 15 minutes. The exponential function that characterizes a thermal demand meter is approximated in the KV2C meter as follow:

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

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

Equation 4-1

Each momentary interval a new thermal demand, referred to as the current demand reading (I_n in Equation 4-1), 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 meter programmed for thermal demand calculations.

4.2.3 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 section 5.

4.2.4 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. It may also be computed by a reading device from data read from the meter. 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 are also available (i.e. can be displayed on the meter's LCD or computed by a reading device from data read from the meter) for the previous reset data.

4.3 Operation in Demand/Load Profile Mode

The same demands available in a Demand meter are also available in a Demand/Load Profile meter. See section 4.2.

4.3.1 Block and Rolling Demands

4.3.1.1 Demand Calculations

The same calculations described for a KV2C meter in Demand mode in section 4.2.1.1 are also performed in a KV2C in Demand/Load Profile mode.

4.3.1.2 Partial Demand Intervals

The same events that cause a partial demand interval to occur in a KV2C in Demand mode will also cause a partial demand interval in a KV2C in Demand/Load Profile mode (see section 4.3.1.1). In addition, setting the time in a KV2C in Demand/Load Profile mode will cause a partial demand interval.

The difference between Demand mode and Demand/Load Profile mode with respect to demand calculations is that, in Demand/Load Profile mode, the demand intervals are synchronized to midnight. For example, if a KV2C operating in Demand/Load Profile mode is programmed for 15 minute block intervals, the intervals will end at the hour boundary and at 15 minutes past, 30 minutes past, 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 such that demand intervals continue to be synchronized to midnight.

4.3.2 Thermal Demand Emulation

Thermal demand emulation in Demand/Load Profile mode operates identically to the way it does in Demand mode (see section 4.2.2).

4.3.3 Cumulative Demands

Cumulative demand in Demand/Load Profile mode operates identically to the way it does in Demand mode (see section 4.2.3).

4.3.4 Continuously Cumulative Demands

Continuously cumulative demand in Demand/Load Profile mode operates identically to the way it does in Demand mode (see section 4.2.4).

4.4 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. See section 4.1 for more information. Demands (maximums and cumulatives, see section 4.4.3) are saved as part of the previous demand reset data, previous season data, and self read data.

Maximum and cumulative (see section 4.4.4) 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 DOS or MeterMate COMM.

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.

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

4.4.1 Block and Rolling Demands

4.4.1.1 Demand Calculations

In a TOU meter, demands are calculated as described in step 1 in section 4.2.1.1, and the previous interval demands are updated as described in step 2 of that section. 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 (see section 4.3.1.1).

4.4.1.2 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.

4.4.2 Thermal Emulation Demand

In TOU mode, as in Demand mode, a KV2C programmed for thermal emulation calculates a demand as shown Equation 4-1 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 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} in Equation 4-1) is set to zero.

4.4.3 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.

4.4.4 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 are also available (i.e. can 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.

4.5 Restrictions

No soft switches are required to compute block, rolling, or thermal demands. However, if a selected demand quantity requires a soft switch, and that soft switch is not present, that demand will be set to zero. The soft switches that control what quantities are available are described in section 1.5.

5 Demand Reset

5.1 Introduction

A demand reset causes two general actions to take place: 1. Billing data at the time of the demand rest is saved as “previous reset data”; and 2. Maximum demands are reset and cumulative demands are updated. Other actions occur depending on the operating mode of the meter and the type of demand reset that occurred.

5.2 Operation in Demand Mode

In a KV2C 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 demand reset inhibit flag is checked. The demand reset inhibit flag is may be set to true or false when programming a meter with MeterMate DOS or MeterMate COMM (Configure menu). If the flag is true, the demand reset will not be performed (i.e. none of the other steps listed are performed). Otherwise, the demand reset exclusion timer is checked. 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 non-volatile memory.
    - summations values (see section 3)
    - 5 real-time pricing summations values (see section 3)
    - For block and rolling demand meters: 5 max demand values, each with 2 coincident values; for thermal demand: 1 max demand (no coincident values) (see section 4)
    - For block and rolling demand meters: 5 real-time pricing max demand values, each with 2 coincident values; for thermal demand: 1 real-time pricing max demand (see section 4)
    - For block and rolling demand meters: 5 cumulative demands; for thermal demand: 1 cumulative demand (see section 4) (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 block and rolling demand meters: 5 real-time pricing cumulative demands; for thermal demand: 1 real-time pricing cumulative demand (see section 4)
    - 2 power factor accumulators (see section 6)
- 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 (see section 4.3.2).
- 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 (see section 6).
- 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 (see section 18).
- 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 demand reset timeout to zero.
- If the meter is programmed to do so, it will perform a Self-read (see section 17)
- If the meter is programmed to do so, it will log the demand reset in the event log (see section 7).

5.3 Operation in Demand/Load Profile Mode

The demand reset function in Demand/Load Profile Mode is identical to the demand reset function in Demand Mode.

5.4 Operation in Time of Use Mode

In a KV2C meter programmed for TOU operation, there are two types of demand resets: manual and automatic. A manual demand reset can be initiated by the following actions:
- Activating the reset switch
- Sending the appropriate PSEM command during a communication session
- After a programmable number of hours since the last demand reset

An automatic demand reset can be initiated by the following actions (see section 21 for more information):
- Action specified as a calendar event
- As part of an automatic season change
- 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 demand reset inhibit flag is checked. If the flag is true, the demand reset will not be performed (i.e. none of the other steps listed are performed). Otherwise, the demand reset exclusion timer is checked. 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 (see section 3).
    - 5 summations for each TOU rate (see section 3).
    - 2 power factor accumulators (see section 6).
    - For block and rolling demand meters: 5 overall max demand values, each with 2 coincident values; for thermal demand: 1 overall max demand (no coincident values) (see section 4).
    - For block and rolling demand meters: 5 max demand values for each TOU rate, each with 2 coincident values; for thermal demand: 1 max demand for each TOU rate (no coincident values) (see section 4).
    - For block and rolling demand meters: 5 overall cumulative demands; for thermal demand: 1 overall cumulative demand (see section 4).
    - For block and rolling demand meters: 5 cumulative demands for each TOU rate; for thermal demand: 1 cumulative demand for each TOU rate (see section 4).

Note: last reset continuously cumulative demand for each demand listed above shall be available for display only. It shall be 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 (see section 4.4.3).
- 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 be set to the current thermal demand reading. The max demands for the other TOU rates are set to zero (see section 4).
- The average power factor accumulators are zeroed. (see section 6).
- The demand overload, received kWh, leading kvarh, and low potential cautions are cleared (demand resets initiated by a button press or PSEM procedure only) (see section 18).
- 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 and viewed with MeterMate DOS or MeterMate COMM.
- 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 DOS or MeterMate COMM.
- 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 (see section 17)
- If the meter is programmed to do so, it will log the demand reset in the event log (see section 7).
- If the meter is programmed to do so, it will perform a season change (see section 21).

5.5 Restrictions

None.

6 Power Factor

6.1 Introduction

The KV2C calculates an average power factor value. Both the numerator and denominator are selected from the quantities defined in the Measurement Profile (see section 1). The two quantities selected must both be "summed" quantities; i.e. minimum, maximum, and store quantities must not be selected. For example, a typical numerator selection would be fundamental plus harmonics watthours, |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 DOS or MeterMate COMM.

6.2 Operation in Demand Mode

Each minute the meter updates accumulators from which 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 (see section 5).

6.3 Operation in Demand/Load Profile Mode

The power factor function in Demand/Load Profile Mode is identical to the power factor function in Demand Mode.

6.4 Operation in Time of Use Mode

In TOU mode, the KV2C can be programmed to accumulate average power factor data continuously (i.e. 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 section 6.2. 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 DOS or MeterMate COMM.

6.5 Restrictions

If a selected average power factor quantity requires a soft switch, and that soft switch is not present in the meter, the quantity will be set to zero. The soft switches that control what quantities are available are described in section 1.5.

7 Event log

7.1 Introduction

The Event Log, which requires the E soft switch, 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:

- Requires the E soft switch (MeterMate DOS or MeterMate COMM Upgrade).
- Stores up to 500 events (MeterMate Program Manager Recorder Options Editor).
- Records 9 Standard Events and 28 Manufacturer Events (MeterMate Program Manager Meter Diagnostics Editor Site Genie Site Diagnostics and Event Log Tabs).
- Records the date & time (TOU and Demand/LP only), unique sequence #, operator, event and any additional data for each event.
- Use MeterMate DOS or MeterMate COMM Reset Unprogram command to clear the Event Log (Master Reset will not clear the Event Log).

7.2 Operation in Demand Mode

7.2.1 Events Supported

The Event Log supports 37 events (see Table 7-1).

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

Event	Argument
Self-Read Occurred	None
Test Mode Enter	None
Test Mode Exit	None
Diagnostic 1 – Polarity, Cross Phase, Reverse Energy Flow	Angle out of tolerance (∠ V_B, ∠ V_C, ∠ I_A, ∠ I_B, ∠ I_C)
Diagnostic 1 Condition Cleared	***None***
Diagnostic 2 – Voltage Imbalance	Voltage out of tolerance (V_A, V_B, V_C)
Diagnostic 2 –Condition Cleared	None
Diagnostic 3 – Inactive Phase Current	Current out of tolerance (I_A, I_B, I_C)
Diagnostic 3 Condition Cleared	None
Diagnostic 4 – Phase Angle Alert	Angle out of tolerance (∠ V_B, ∠ V_C, ∠ I_A, ∠ I_B, ∠ 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, Element A	Element A voltage
Diagnostic 6 Condition Cleared	None
Diagnostic 7 - Over Voltage, Element A	Element A 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 (V_A, V_B, V_C)
Caution 000400 Condition Cleared	None
Caution 004000 – Demand Overload	None
Caution 004000 Condition Cleared [1]	None
Caution 400000 – Received Energy	None
Caution 400000 Condition Cleared [1]	None
Caution 040000 – Leading Quadergy	None
Caution 040000 Condition Cleared [1]	None
Real Time Pricing Activated	None
Real Time Pricing Deactivated	None
Calibration Mode Activated [2]	None
Revenue Guard+	Element lost [3]

Table 7-1 Events Logged

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.***

3. ***See Table 7-2 for a description of the Revenue Guard+ arguments.***

Description	Value
Event End (see note)	0
Phase A low	***1***
Phase B low	2
Phase C low	3

Table 7-2 Arguments for Revenue Guard+ Events

Note: "Event End" indicates that the meter has detected that all three elements are present and has switched out of Revenue Guard+ mode. This feature is available only on a KV2C+ Meter .

7.2.1.1 Primary Power Down/Up

As its name implies, a Primary Power Down event is logged when the meter loses power. The Primary Power Up event is logged when power is restored. If the meter keeps time, the date and time of the outage and subsequent 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.

7.2.1.2 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.

7.2.1.3 Demand Reset Occurred

A Demand Reset Occurred event is recorded whenever a Demand Reset is initiated. 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

See section 5 for more information about demand resets.

7.2.1.4 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 kV2C Meter Self-Reads doesnot require either the Basic Recording, R, or Extended Recording, X, soft switch. See section 17 for more information.

7.2.1.5 Test Mode Enter/Exit

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

7.2.1.6 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 Section 10 for more information on Diagnostic 1.

7.2.1.7 Diagnostic 2 – Voltage Imbalance Set/Cleared

A Diagnostic 2 event is logged along with the voltage out of tolerance (element B or C) when Diagnostic 2 is set. Likewise, a Diagnostic 2 Condition Cleared event is logged when the diagnostic is cleared. See Section 10 for more information on Diagnostic 2.

7.2.1.8 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 Section 10 for more information on Diagnostic 3.

7.2.1.9 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 Section 10 for more information on Diagnostic 4.

7.2.1.10 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 Section 10 for more information on Diagnostic 5.

7.2.1.11 Diagnostic 6 - Under Voltage, Element A Set/Cleared

A Diagnostic 6 event is logged along with the element on which the under voltage occurred (element A only) when Diagnostic 6 is set. Likewise, a Diagnostic 6 Condition Cleared event is logged when the diagnostic is cleared. See Section 10 for more information on Diagnostic 6.

7.2.1.12 Diagnostic 7 - Over Voltage, Element A Set/Cleared

A Diagnostic 7 event is logged along with the element on which the over voltage occurred (element A only) when Diagnostic 7 is set. Likewise, a Diagnostic 7 Condition Cleared event is logged when the diagnostic is cleared. See Section 10 for more information on Diagnostic 7.

7.2.1.13 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 Section 10 for more information on Diagnostic 8.

7.2.1.14 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 Section 18 for more information on the Under Voltage Caution.

7.2.1.15 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 Section 18 for more information on the Demand Overload Caution.

7.2.1.16 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 Section 18 for more information on the Received Energy Caution.

7.2.1.17 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 Section 18 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.

7.2.1.18 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 Section 16 for more information on Real Time Pricing.

7.2.1.19 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.

7.2.1.20 Revenue Guard+

A Revenue Guard+ event is logged when the meter switches into or out of 2-½-element operation along with the missing element. See Section 30.1 for more information on Revenue Guard+.

7.3 Operation in Demand/Load Profile Mode

All of the events can be recorded in Demand/Load Profile Mode. The event time stamp will contain the date and time the event was recorded.

7.4 Operation in Time of Use Mode

All of the events can be recorded in Demand/Load Profile Mode. The event time stamp will contain the date and time the event was recorded.

7.5 Restrictions

The Event Log requires the E soft switch to operate.

8 Alerts and Pulse Outputs

8.1 Introduction

The KV2C 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 RTP input. The simple board is a subset of the complex board supporting only two Form C outputs; one Form A output and an RTP input. Any of the outputs can be configured for any of the output functions.

Table 8-1 summarizes the operation of the outputs and alerts. See section 22 for a description of the operation of the pulse inputs.

Function	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
RTP Alert	Y	Y	Y	Y	Y
Diagnostic Alert	Y	Y	Y	N	N
Caution Alert	Y	Y	Y	N	N

Table 8-1 Operation of Outputs and Alerts in Each Mode

8.2 Operation in Demand Mode

8.2.1 Pulse Outputs

The KV2C can output any integrated quantity (Wh, varh, VAh, Qh, I^2h, and V^2h) that has been selected in the Measurement Profile (see section 0). 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 that has accumulated during the previous momentary interval and programmed value of each pulse (e.g. 0.6 Wh/pulse). This is done as shown in Equation 8-1.

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

Equation 8-1

The meter sets the time between each pulse for a momentary interval such that the rate remains constant over that momentary interval. Any remainder left after the calculation described in Equation 8-1 is performed is added to the accumulation from the next momentary interval.

The meter should be programmed such that the maximum output pulse rate is no higher than 30 pulses per second for the load conditions it is expected to see.

The Measurement Profile quantities to be output and the value of each pulse are selectable when creating programs with MeterMate Program Manager (I/O & Alerts Support Table).

8.2.2 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 (see section 4). Every five seconds, the meter compares the magnitude of the selected demand over the most recent momentary interval (see section 0 for the definition of 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 (see section 4).

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

8.2.3 Load Control

This feature is not applicable in a KV2C operating in Demand mode.

8.2.4 End of Interval

Whenever a demand interval ends, the any output configured for EOI is asserted for the programmed EOI duration. This duration is selectable when creating programs with MeterMate Program Manager (I/O & Alerts Support Table). See section 4 for a description of when demand intervals end.

8.2.5 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 (see section 6) and dividing them. The selected demand is one of the (up to) five demands that the meter has been programmed to calculate (see section 4). 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 (see section 4).

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

8.2.6 TOU Rate Alert

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

8.2.7 Real Time Pricing Alert

An output programmed for Real Time Pricing Alert will activate whenever the meter is in Real Time Pricing (RTP) mode and deactivate whenever the meter exits RTP mode. Section 16 describes the operation of the RTP feature.

8.2.8 Diagnostic Alert

The KV2C can be programmed to activate an alert whenever one or more of the Site Genie diagnostics occur (see section 10). 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 & Alerts Support Table). Note: a diagnostic must be enabled for it to activate an output.

8.2.9 Caution Alert

The KV2C can be programmed to activate an alert whenever one or more of the meter caution events occur (see section 18). 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. Note that 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 & Alerts Support Table). Note: a caution must be enabled for it to activate an output.

8.3 Operation in Demand/Load Profile Mode

All of the pulse outputs and alerts in a Demand/Load Profile meter operate identically to the way they do in Demand mode.

8.4 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.

8.4.1 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 Program Manager (I/O & Alerts Support Table). Other than that, the alert operates identically to the way it does in Demand mode.

8.4.2 Load Control

An output programmed for Load Control will activate whenever Load Control is active. Refer to sections 16.4 (Real Time Pricing mode) and 21.4 (normal mode) for more information about the operation of Load Control

8.4.3 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 & Alerts Support Table). Other than that, the alert operates identically to the way it does in Demand mode.

8.4.4 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 & Alerts Support Table).

8.5 Restrictions

The meter must have a simple or complex I/O board to output pulses or set alerts. The meter will not output pulses unless the P (Pulse Output) soft switch is enabled. Note: this soft switch is enabled in all KV2C meters at the factory.

9 Load Profile Recording

9.1 Introduction

The KV2C 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 can record power quality data such as frequency, maximum or minimum voltages or currents.

9.2 Operation in Demand Mode

Load Profile Recording is only supported in a Demand/Load Profile and TOU meters.

9.3 Operation in Demand/Load Profile Mode

Load Profile recording requires either an R (4-channel recording) or X (20-channel recording) and a battery.

Soft Switch	Channels	Storage
R	1 – 4	64KB

Soft Switch	Channels	Storage
X	1 – 20	192KB

Table 9-1 Load Profile Soft Switches

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(s) (a "meter 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 over write 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

	Interval Length (minutes)					
Channels	**1**	**5**	**10**	**15**	**30**	**60**
1	14.6	73.0	146.0	219.0	438.0	876.0
2	7.3	36.7	73.3	110.0	220.0	440.0
3	5.5	27.3	54.7	82.0	164.0	328.0
4	4.0	20.0	40.0	60.0	120.0	240.0

Table 9-2 R Soft Switch Days of LP Data per Channel

	Interval Length (minutes)					
Channels	**1**	**5**	**10**	**15**	**30**	**60**
1	43.8	219.0	438.0	657.0	1314.0	2628.0
2	22.1	110.3	220.7	331.0	662.0	1324.0
3	16.5	82.7	165.3	248.0	496.0	992.0
4	12.1	60.3	120.7	181.0	362.0	724.0
5	10.2	51.0	102.0	153.0	306.0	612.0
6	8.3	41.3	82.7	124.0	148.0	496.0
7	7.3	36.7	73.3	110.0	220.0	440.0
8	6.3	31.7	63.3	95.0	190.0	380.0
9	5.7	28.7	57.3	86.0	172.0	344.0
10	5.1	25.3	50.7	76.0	152.0	304.0
11	4.7	23.7	47.3	71.0	142.0	284.0
12	4.3	21.3	42.7	64.0	128.0	256.0
13	4.0	20.0	40.0	60.0	120.0	240.0
14	3.7	18.3	36.7	55.0	110.0	220.0
15	3.5	17.3	34.7	52.0	104.0	208.0
16	3.2	16.0	32.0	48.0	96.0	192.0
17	3.1	15.3	30.7	46.0	92.0	184.0
18	2.9	14.3	28.7	43.0	86.0	172.0
19	2.7	13.7	27.3	41.0	82.0	164.0
20	2.6	13.0	26.0	39.0	78.0	156.0

Table 9-3 X Soft Switch Days of LP Data per Channel

9.3.1 Load Profile Data

At the end of an interval the following processing occurs:

1. Block End Time is updated
   The date and time is updated with the current date and time.

2. Block End Reading(s) are updated
   For each channel, the Block End Reading is updated. 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. A new interval is recorded
   The Common Status, Extended Status for each channel and data for each channel is written to the current block.
   - 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 (SF) from 1 to 10 to reduce the number of units stored.

The example below shows a maximum unit counts for a 15-minute interval with a SF of 1.

		Voltage		
Service	**120**	**240**	**277**	**480**
1ϕ 2W	12,800	25,600		***51,200***
1ϕ 3W		25,600		51,200
Pϕ Network	25,600			
Pϕ 3W Δ	22,170	44,341		88,681
Pϕ 4W Wye	38,400		88,681	
Pϕ 4W Δ		42,466		84,933

Table 9-4 Unit Counts for a Class 320 KV2C with 320 amps applied for 15 minutes

		Voltage		
Service	**120**	**240**	**277**	**480**
1ϕ 2W	9,000	18,000		***36,000***
1ϕ 3W		18,000		36,000
Pϕ Network	18,000			
Pϕ 3W Δ	15,588	31,177		62,354

		Voltage		
Service	**120**	**240**	**277**	**480**
Pϕ 4W Wye	27,000		62,354	
Pϕ 4W Δ		31,177		62,354

Table 9-5 Unit Counts for a Class 20 KV2C with 15 amps applied for 15 minutes

9.3.2 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.

9.3.2.1 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

Table 9-6 Load Profile Interval Common Status Flags

9.3.2.1.1 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. See Section 21 for more information on Daylight Savings Programmable Dates.

9.3.2.1.2 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 a power 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 1-second increments. If the outage did not exceed the Load Profile Outage duration, the interval will not be marked.

9.3.2.1.3 Clock Reset 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. Advancing the clock in the meter may result in a partial or long interval. See the descriptions of the Partial and Long Extended Status below.

9.3.2.1.4 Clock Reset 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. Changing the clock in the meter backwards may result in a partial or long interval. See the descriptions of the Partial and Long Extended Status below.

9.3.2.2 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 Statuses are listed in Table 9-7 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	Description (increasing precedence)
0	***No Status***
1	Overflow
2	Partial Interval
3	Long Interval
4	Not used
5	Test Mode

Table 9-7 Load Profile Interval Extended Status

9.3.2.2.1 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 (SF) in the MeterMate Recorder Option Editor.

9.3.2.2.2 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 (e.g. MeterMate Master Reset)
- Clock Reset Forward/Backward

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 mintues			
Current Time:	08:02	Time Remaining in Interval:	13 minutes	
New Time:	08:10	Time Remaining in Interval	05 minutes	Partial

9.3.2.2.3 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/Backward.

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 mintues			
Current Time:	13:44	Time Remaining in Interval:	01 minute	
New Time:	13:37	Time Remaining in Interval	08 minutes	Long

9.3.2.2.4 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.

9.4 Operation in Time of Use Mode

The operation of Load Profile Recording in TOU Mode is identical to Demand/Load Profile operation.

9.5 Restrictions

Load Profile recording requires either the R (4-channel recording) or X (20-channel recording) soft switch and a battery for timekeeping during outages. The quantities available for recording depend on the soft switches installed in the meter. See section 1.5 for a list of what soft switch is required for each quantity.

10 Site Genie

10.1 Introduction

This section will describe service detection (automatic and manual), Fitzall™ support, and the operation of the Site Genie diagnostics.

10.2 Operation in Demand Mode

10.2.1 Service Detection

10.2.1.1 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 if programmed to do so, after a demand reset if programmed to do so, and after a programming session.

The 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 therefore 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, with respect to the phase A voltage angle, ±60, ±90, ±120, ±180 degrees within ±10 degrees. 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 4WD and a 2P5W service. If $Vc \cong Va$, within +-5%, the service is 2P5W, otherwise the meter assumes that $Vc \cong Va / 2 * \sqrt{3}$ and the service is 4WD.

Form	Vc Angle	Service
9, 10, 16, 48	±120	4WY
9, 10, 16, 48	±90	4WD
12, 13, 25	±180	1P3W
12, 13, 25	±120	NET
12, 13	±60	3WD
45, 56	±180	1P3W
45, 56	±120	4WY
45, 56	±90	4WD
45, 56	±90	2P5W
45, 56	±60	3WD

Table 10-1 Expected Phase C Voltage Angles

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

10.2.1.2 Manual Service Detection

The meter provides a means to program the electrical service under which it will operate. Programming the electrical service disables the automatic electrical service determination.

10.2.2 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.

FITZALL™ METHODS OF OPERATION (PROGRAMMED FORM)								
FORM	**ELE**	**5W-2ϕ**	**4W-Y**	**4W-Δ**	**3W-Δ**	**3W-Net**	**3W-1ϕ**	**2W-1ϕ**
9S,10A,48A	3	–	9	9	–	–	–	–
9S,10A,48A	2-1/2	–	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	–	–	–	–

Table 10-2 Fitzall™ Combinations

10.2.3 Site Genie Diagnostics

The following diagnostic tests are continuously checked whenever 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

The meter does not perform Site Genie diagnostic error checking during Test Mode or in the presence of a service error.

Each Site Genie diagnostic has the following programmable characteristics:
- Enable / Disable
- Display / Do not Display
- Freeze Display / Add to the Scroll

All diagnostics except 6 and 7 (undervoltage and overvoltage) are checked every 5 seconds using one second's worth 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 remains there until reset by the user. Diagnostic errors and counters may be reset via communication procedures.

Table 10-3 shows the expected voltages and currents based on the ANSI form. Y means a voltage element or a current sensor is present. Voltage element Va and current sensor Ia are present in all ANSI forms.

ANSI Form	Element/Sensor:			
	Vb	**Vc**	**Ib**	**Ic**
1,3	N	N	N	N
2,4	N	N	N	Y
12,13,25	N	Y	N	Y
45,56	Y*	Y	N	Y
36	N	Y	Y	Y
9,10,16,48	Y	Y	Y	Y

Table 10-3 Expected Voltage and Current Elements

*Note: Form 45 and 56 meters have a Vb element which is used for 4WD only but the meter zeroes Vb data

Site Genie diagnostics expect certain voltage and current phase angles as appropriate for the actual ANSI form, electrical service, and phase sequence (refer to Table 10-4 for expected angles). Note: In the table of expected angles, 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	Elec. Ser.	Phase Seq.	Expected Angles				
			Vb	Vc	Ia	Ib	Ic
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
12,13,45,56	3WD	Abc	-	300	30	-	270
12,13,45,56	3WD	Cba	-	60	330	-	90

Table 10-4 Expected Phase Angles

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

10.2.3.1 Diagnostic #1 – Polarity, Cross Phase, Reverse Energy Flow

This diagnostic verifies that 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.

10.2.3.2 Diagnostic #2 – Phase Voltage Alert

This diagnostic verifies that the voltage at each phase is maintained at an acceptable level with respect to the other phases. For diagnostic 2 tests, the A phase voltage is combined with the user programmed percentage tolerance to determine the acceptable range for the B and C phase voltages as appropriate for the ANSI form and service type. For the 4 wire delta services, the meter scales Vc before comparing it to Va. Pass Conditions for diagnostic 2:

$$V_a(100\% - T\%) < [V_B] < V_a(100\% + T\%) \text{ and}$$
$$V_a(100\% - T\%) < [V_C] < V_a(100\% + T\%)$$

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

10.2.3.3 Diagnostic #3 – Inactive Phase Current

This diagnostic verifies that 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, as appropriate for the ANSI form and service type, falls below a user programmed low current value and at least one phase current remains above this value.

10.2.3.4 Diagnostic #4 – Phase Angle Alert

This diagnostic verifies that the current phase angles fall within a user specified range around expected values. Diagnostic 4 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°.

10.2.3.5 Diagnostic #5 – Distortion Alert

This diagnostic verifies that the user-selected form of distortion measured on each individual element and, in the case of DPF, across all elements, is not excessive.

Diagnostic 5 shall be selectable to monitor one of the following distortion measures:

- Distortion Power Factor (DPF), per element and summed.
- Total Demand Distortion (TDD), per element only.
- Total Harmonic Current Distortion (ITHD), per element only.
- Total Harmonic Voltage Distortion (VTHD), per element only
- 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, for DPF only, one for the total of all elements. Diagnostic 5 is checked only when the momentary interval demand (kW, kvar, or kVA depending on how the meter is programmed) 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. Detection of this condition causes the meter diagnostic condition, d5, distortion, to be set. 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 programmed tolerance

10.2.3.6 Diagnostic #6 – Undervoltage Phase A

This diagnostic verifies that the phase A voltage is maintained above an acceptable level. The user programs an undervoltage percentage tolerance for diagnostic 6 that has a range of 0 to 100 % in increments of 1%. A diagnostic 6 error condition is triggered if the voltage at phase A falls below the reference voltage (V_{ref}) minus the undervoltage percentage tolerance (T).

The threshold used for diagnostic 6 is also used for the potential annunciators and the low potential caution (see section 18.4.5).

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

10.2.3.7 Diagnostic #7 – Overvoltage Phase A

This diagnostic verifies that the phase A voltage is maintained below an acceptable level. The user programs an overvoltage percentage tolerance for diagnostic 7 that has a range of 0 to 100 % in increments of 1%. A diagnostic 7 error condition is triggered if the voltage at phase A rises above the reference voltage (V_{ref}) plus the overvoltage percentage tolerance (T).

10.2.3.8 Diagnostic #8 – High Imputed Neutral Current

This diagnostic verifies that the imputed neutral current is maintained below an acceptable level. A diagnostic 8 error condition is triggered if the imputed neutral current exceeds a user-programmed threshold. Form 45 and 56 as 4WD or 4WY 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.

10.2.4 Site Genie Display

Table 10-5 shows the data displayed in the Site Genie display scroll.

ID	Display	Quantity
SER	See Table 10-6	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	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 _	XXX	Diagnostic counter 6
d 7 _	XXX	Diagnostic counter 7
d 8 _	XXX	Diagnostic counter 8

Table 10-5 Site Genie Display Scroll

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

Table 10-6 Electrical Service Displays

When the presence of diagnostic conditions are displayed as part of the normal display scroll or the frozen condition display, they have the format show in Table 10-7.

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

Table 10-7 Diagnostic Error Displays

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.

10.3 Operation in Demand/Load Profile Mode

The operation of Site Genie in Demand/Load Profile mode is identical to its operation in Demand mode.

10.4 Operation in Time of Use Mode

The operation of Site Genie in TOU mode is identical to its operation in Demand mode.

10.5 Restrictions

None.

11 Programming Seal

11.1 Introduction

The programming seal is a software seal that protects meter data and configuration parameters from unauthorized changes. When the meter is sealed, critical meter parameters cannot be written expect for Passwords in Security file

11.2 Operation

Operation of the programming seal is identical for all metering modes (Demand-only, Demand/LP and TOU).

The programming seal may be enabled with MeterMate DOS or MeterMate COMM. To disable the programming seal, the user must put the meter into Test Mode, hold the ***Test*** and ***Reset*** buttons for at least 15 seconds, and take the meter out of test mode. Note that this is the same process that is used for password recovery; therefore, once this procedure is complete the meter's security codes may be written without having to first send it a valid security code (see section 12). When the meter is programmed with MeterMate DOS or MeterMate COMM 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:
Std. Table 11, Actual Sources Limiting Table

Std. Table 12, Unit of Measure Table
Std. Table 13, Demand Control Table
Std. Table 14, Data Control Table
Std. Table 15, Constants Table
Std. Table 16, Source Definition Table
Std. Table 21, Actual Register Table
Std. Table 22, Data Selection Table
Std. Table 23, Present Data Table
Std. Table 24, Previous Season Data Table
Std. Table 25, Previous Reset Data Table

Mfg. Table 66, Meter Program Constants 1 Table
Mfg. Table 70, Display Configuration Table
Mfg. Table 76, Input/Output Board Configuration Table
Mfg. Table 79, Alternate Calibration Correction Factors Table (requires optional soft switch)
Mfg. Table 86, Electrical Service Configuration Table
Mfg. Table 89, Transformer Loss Compensation Table (requires optional soft switch)
Mfg. Table 91, Dimension Totalization Limiting Table (requires optional soft switch)
Mfg. Table 92, Totalization Selection Table (requires optional soft switch)
Mfg. Table 93, Data Accumulators Selection Table
Mfg. Table 94, Data Accumulators Present Values Table
Mfg. Table 101, Actual Input/Output Table
Mfg. Table 102, Input/Output Configuration Table
Mfg. Table 110, Present Register Data Table

The following procedures are protected from execution by the programming seal:
Std. Procedure 0, Cold Start (Unprogram)
Std. Procedure 3, Clear Data (Master Reset)

Mfg. Procedure 2, Direct Execute
Mfg. Procedure 66, Change Configuration Status
Mfg. Procedure 67, Convert Meter Mode
Mfg. Procedure 68, Upgrade Meter
Mfg. Procedure 73, Flash Calibration Mode Control
Mfg. Procedure 76, Remove Soft Switch

Unsealed Password :

Mfg. Table 84, Security Table.
The Passwords in Security Table (MT84) may be programmed when the meter is sealed in an Encompass kV2C Meter.

12 Password Recovery

12.1 Introduction

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

12.2 Operation

The procedure to put the meter into password recovery mode is identical to the procedure to unseal a meter (see section 11): Put the meter into Test Mode, hold the ***Test*** and ***Reset*** buttons for at least 15 seconds, and take the meter out of test mode. When the meter is programmed with MeterMate DOS or MeterMate COMM or MeterMate COMM 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.

13 Reading and Programming

13.1 Introduction

The parameters that control operation of the KV2C may be set by the user through a process called programming. Program parameters are written to the KV2C 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 which specify the Standard and Manufacturer Tables which are present in the meter, as well as bitfields which 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 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 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.

13.2 Operation in Demand Mode

The KV2C provides a set of tables containing parameters to control basic demand metering operation. Additional functionality is available in demand mode with optional soft switches, which provide features such as reactive metering, event logging, and power quality monitoring. See Section 19, Soft Switches, as well as the individual feature sections for more information.

The KV2C meter communicates with programming software using the PSEM protocol and either an optical coupler, an optional RSX (RS-232, RS-485, or external modem) communication board, or an optional modem communication board (see ANSI C12.18, Protocol Specification for ANSI Type 2 Optical Port and ANSI C12.21, Protocol Specification for Telephone Modem Communication).

13.2.1 Programmable Tables

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

Optionally,

- 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 are always present, and may be programmed, but any values related to soft-switched features will be ignored, unless the related soft-switch(es) is/are enabled.

13.2.1.1 Optional, Soft-switched Programmable Tables

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

If Expanded Measurements, By Quadrant Measurements, kVA/kvar/kQ Measurements, or Power Quality Measurements is 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 Standard Table 54)
- 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 are/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 enabled:

- Manufacturer Table 79, Alternate Calibration Correction Factors

If Voltage Event Monitor enabled:

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

If Demand Soft Switch (N) is enabled:

- Standard Table 23, Current Register Data Table

* These tables are always present, and may be programmed, but any values related to soft-switched features will be ignored, unless the related soft-switch(es) is/are enabled.

13.2.2 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, GE Device 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 110, Present Register Data Table

13.2.2.1 Optional, Soft-switched Readable Tables

The following tables may be read only if the related soft-switch(es) has/have been 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 enabled:

- Manufacturer Table 79, Alternate Calibration Correction Factors

If Voltage Event Monitor enabled:

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

13.3 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. See Operation in Demand Mode for more information.

To enable the KV2C for LP recording the following steps must be followed:

- Enable one of the LP recording soft-switches, either 4-Channel (R switch) or 20-Channel (X switch);
- Convert Meter Mode to Demand/LP Mode;
- Set the Date and Time;
- Program the LP tables (Std. Table 61**first**, and then Std. Table 62) and Std Table 21, Actual Register Table;
- Execute the Start LP Recording procedure (Std. Procedure 16);

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

13.4 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. See Operation in Demand Mode and the following section for more information.

To enable the KV2C for TOU operation, the following steps must be followed:

- Enable the TOU (T) soft-switch;
- Convert Meter Mode to TOU Mode;
- Set the Date and Time;
- Program the TOU tables: Std. Tables 51, 53, 54, and Mfg. Tables 77 (optional) and 82.

13.4.1 Pending Tables

Pending tables are defined by ANSI C12.19 and provide a means for programming tables which are to take effect at some future date and time. In the KV2C, pending tables are supported in TOU mode only.

The tables which may be written as pending are: Std. Table 7 (Manufacturer Procedure 78, RTP Control, only), Std. Table 51, Std. Table 54, Mfg. Table 77 and Mfg. Table 82. Standard Table 4, Pending Status Table, reports on the status of pending events. In the KV2C, this table provides room for 5 entries, just enough to hold one pending event for each of the aforementioned tables. When this table fills, subsequent 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 supports Std. Procedure 14, Clear All Pending Tables, which may be used to remove previously programmed pending tables and Std. Procedure 15, Clear Selected Pending Table(s). The tables may then be reprogrammed. Note: when the former procedure is executed, Std. 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.

14 Communications

The KV2C provides an optical communications interface that complies with ANSI C12.18, ***Protocol Specification for ANSI Type 2 Optical Port***. In addition, the KV2C 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 over the optical connection. For telephone communication, the KV2C 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***).

A complete description of the KV2C communications interface is available in GEI-101423 ***Reading and Programming for the KV2C Meter Technical Development Reference.***

15 Security Log

15.1 Introduction

The KV2C 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.

15.2 Operation

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 RTP mode
- Date and time meter last entered RTP mode (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)

16 Real Time Pricing

16.1 Introduction

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 (RTP) is active. The meter is put into real-time pricing mode by executing a procedure with MeterMate DOS or MeterMate COMM or MeterMate COMM, or by the activation of a dedicated two-wire input (5-24V DC) from the kV modem board or an I/O board (simple or multiple).

16.2 Operation in Demand Mode

During normal operation, the KV2C meter checks the status of the RTP input. The RTP 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 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 RTP input has activated, before switching to RTP mode. This value is selectable when creating programs with MeterMate Program Manager (I/O & Alerts Support Table). If the delay time is zero, the KV2C enters RTP mode immediately; otherwise, it remains in normal mode until the timer activation delay time has passed.

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

When the meter enters RTP mode 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 RTP mode will be processed as real-time pricing data.

During RTP mode, the meter continues to calculate the data accumulations (section 2), average power factor (section 6), and non-RTP summations (section 3)**.** The meter does not calculate non-RTP demands during RTP mode. During RTP mode, the meter calculates RTP summations and RTP demands.

When the meter exits RTP mode, it processes any unprocessed summations and demand data; i.e. for block and rolling demand meters, the demand interval ends.

16.3 Operation in Demand/Load Profile Mode

The operation of real-time pricing in Demand/Load Profile Mode is identical to its operation in Demand Mode.

16.4 Operation in Time of Use Mode

As in Demand Mode, a meter in Time of Use mode may be put into Real Time Pricing mode by activating the RTP input or executing a procedure with MeterMate DOS or MeterMate COMM or MeterMate COMM. Rather than entering a separate RTP mode, however, the meter enters one of the four TOU rates when RTP has been activated. This TOU rate is selectable when creating programs with MeterMate Program Manager (I/O & Alerts Support Table). There is also a load control state, also selectable with MeterMate Program Manager, associated with the RTP 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 RTP Load Control state.

A meter in Time of Use mode may also be put into or taken out of RTP mode 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 RTP mode procedure. In that case, as soon as the specified time is reached, the meter enters RTP mode. Note that there is never a delay associated with exiting RTP mode.

When the meter enters the RTP 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 RTP TOU rate is the same rate that was in effect when RTP was initiated. During RTP mode, the meter continues to calculate the data accumulations (section 2). During RTP mode, average power factor (section 6), summations (section 3) and demands (section 4) are calculated as they would for a TOU meter operating in the rate programmed to take effect during RTP.

17 Self Read

17.1 Introduction

The meter can store up to 12 Self-Reads. Each Self-Read captures a snapshot of the current billing data (summations and demands). Self-Reads can be used to detect tampering. Pressing the Demand Reset switch to zero demand values can trigger a Self-Read, ensuring that demand data will not be lost.

17.2 Operation in Demand Mode

A Demand meter must be configured to perform a Self-Read on a Demand Reset (See MeterMate Basic Meter Configuration Editor). 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 (This assumes that the meter is configured for Self-Read on a Demand Reset):

- Pressing the Demand Reset switch
- Using MeterMate to initiate a Demand Reset
- Expiration of the Demand Reset Timer

17.3 Operation in Demand/Load Profile Mode

Operation in Demand/Load Profile Mode is identical to Demand Mode.

17.4 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 max demands are time-stamped. There are several more events which initiate a Self-Read in a TOU meter.

Events that cause a Self-Read in a TOU meter:

- Pressing the Demand Reset switch (configured for Self-Read on a Demand Reset)
- Using MeterMate to initiate a Demand Reset (configured for Self-Read on a Demand Reset)
- Expiration of the Demand Reset Timer (configured for Self-Read on a Demand Reset)
- Activation of a Self-Read Calendar action
- Activation of a Demand Reset Calendar action (configured for Self-Read on a Demand Reset)
- Activation of a Season Change with Demand Reset Calendar action (configured for Self-Read on a Demand Reset)
- Activation of a Pending Table with Demand Reset (configured for Self-Read on a Demand Reset)

17.5 Restrictions

The KV2 Firmware will require an R or X SoftSwitch to perform Self Reads but KV2C Firmware will not require an R or X SoftSwitch to perform Self Reads.

18 Self Test Errors and Cautions

18.1 Introduction

The purpose of the Self-Tests is to monitor the well being of the major sub-systems 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 maintains a history flag to indicate a problem that became active and then went away.

The Self-Tests are divided into two major sections: Errors and Cautions. Errors represent one or more failure(s) in the basic sub-system 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 Self-Tests Errors and Cautions are built into the meter and no Soft Switch upgrades are required.

18.2 Supported Operating Modes

Table 18-1 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-Test are being performed during the meter's basic operating modes, then Self-Tests are not active during the communications session.

	Code	**Demand**	**Demand/LP**	**TOU**	**Test**
Errors					
Battery Fail & Power Loss	Er 000002		X	X	
System Error	Er 000020	X	X	X	X
RAM	Er 000100				
NVRAM	Er 000200	X	X	X	
ROM	Er 001000	X	X	X	
Measurement	Er 100000	X	X	X	
DAP	Er 200000	X	X	X	
Cautions					
Low Battery	CA 000001		X	X	
Meter Unprogrammed	CA 000010	X	X	X	
Loss of Program	CA 000040	X	X	X	
Unprogrammed and Loss of Program (programming operation of default demand meter interrupted)	CA 000050	X	X	X	
Low Potential	CA 000400	X	X	X	
Demand Overload	CA 004000	X	X	X	
Leading kvarh	CA 040000	X	X	X	
Received kWh	CA 400000	X	X	X	

Table 18-1 Supported Errors and Cautions

18.3 Self-Test Errors

Self-Test Errors represent one or more failures in the basic sub-system of the meter that directly affect the ability of the meter to register electrical usage.

Error Highlights

- Are always enabled (i.e. They can not be programmed to be disabled).
- Are always displayed.

- Can be programmed to freeze or not freeze the display. This is selectable when creating programs with MeterMate Program Manager (Meter Diagnostics Support Table).
- Can not be configured to set an output
- An Unprogram command executed with MeterMate DOS or MeterMate COMM or MeterMate COMM clears all Errors and Cautions including their history flags.
- Errors are not cleared when a Demand Reset is performed.

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

A brief description of each Self-Test Error follows.

18.3.1 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. Note that this error can not occur in a meter programmed in the Demand Only mode of operation. To correct this error condition, replace the battery and reprogram the meter.

18.3.2 System Error – Er 000020

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

18.3.3 Non-Volatile RAM – Er 000200

The KV2C 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, 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.

18.3.4 ROM – Er 001000

The KV2C meter continually performs checksum tests on its ROM, which consists of its masked ROM and the external flash memory used for downloadable code and user-defined calculations. If a checksum error occurs in any one of these sections, the meter records a ROM checksum error.

18.3.5 Measurement Error – Er 100000

The KV2C meter reports a measurement error whenever it detects a problem with its voltage reference.

18.3.6 DAP – Er 200000

The DAP (Data Acquisition Platform) is the meter’s analog-to-digital converter. Two events will cause a DAP error: a timeout error (the DAP does not communicate with the meter’s microprocessor quickly enough) and an overrun error (the meter is unable to correctly process data from the DAP). If either of these errors occur, the meter sets the DAP error.

18.4 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

- They can be either enabled or disabled.
- Can be programmed to not be displayed or to be displayed. The caution must be enabled to be displayed.
- Can be programmed to freeze or not freeze the display.
- Can be configured to set an output.

- An Unprogram command executed with MeterMate DOS or MeterMate COMM or MeterMate COMM clears all Errors and Cautions including their history flags.
- The following Cautions are cleared when a Demand Reset is performed.
    1. Received kWh
    2. Leading kvarh
    3. Demand Overload

  The remaining cautions are not affected by a Demand Reset.

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

A brief description for each of the Self-Test Caution follows.

18.4.1 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 (see section 18.3.1).

The battery is tested (in Demand/LP and TOU modes only):

- At power up
- At 00:16:00 on the first day of each month
- 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 DOS or MeterMate COMM or MeterMate COMM)

18.4.2 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 DOS or MeterMate COMM or MeterMate COMM) is executed. This Caution is cleared when passwords are successfully written to the meter.

18.4.3 Loss of Program – CA 000040

The Loss of Program Caution and its history flag are set when the KV2C 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.

18.4.4 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.

18.4.5 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 (see section 10.2.3.6). The caution clears when all of the potentials that are expected to be present are above the programmed threshold for two consecutive tests.

18.4.6 Demand Overload – CA 004000

The Demand Overload Caution check is performed on the momentary interval demand selected for this caution. The selected demand must be one of the (up to) five demands the meter has been programmed to calculate (see section 4). If the magnitude of the momentary interval demand exceeds the programmed demand overload threshold for three consecutive tests (a test is done every five seconds), the Demand Overload Caution and its history flags are set. When the magnitude of the momentary interval demand does not exceed the programmed overload threshold for two consecutive tests, this caution is **not** cleared. However, this condition (two consecutive tests under the threshold) is reflected in the Event Log (see section 7). This caution is cleared when a manual Demand Reset is performed.

18.4.7 Leading kvarh – CA 040000

The Leading kvarh Caution test is performed every 5 seconds. If the direction of the quadergy is leading for three consecutive tests, this caution and its history flag are set. When the direction of the quadergy is lagging for two consecutive tests, this caution is **not** cleared. However, this condition (two consecutive tests of lagging quadergy) is reflected in the Event Log (see section 7). This caution is cleared when a manual Demand Reset is performed (see section 5).

18.4.8 Received kWh – CA 400000

The Received kWh Caution test is performed every 5 seconds. If the direction of the measured energy is received for three consecutive tests, this caution and its history flag are set. When the direction of the measured energy is delivered 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 (see section 7). This caution is cleared when a manual Demand Reset is performed (see section 5).

19 Soft Switches

19.1 Introduction

The KV2C allows certain features to be enabled and disabled through soft switches.

19.2 Operation

Sections 19.2.1 through 19.2.11 describe the soft switches that are available, and what impact adding and removing each of them has on the operation of the meter.

19.2.1 Alternate Communications (A Switch)

Upgrade: When the A switch is added, the meter will communicate with installed communications option boards

Downgrade: When the A switch is removed, the meter will no longer communicate with installed communications option boards.

Note: this soft switch is enabled in all KV2C meters at the factory.

See section 26 for more information about communications option boards.

19.2.2 Measurement Switches (B, K, M and Q)

There are four measurement switches in the KV2C: By quadrant (B switch), kVA/kvar/kQ (K switch), Expanded Measures (M switch), and Power Quality (Q switch) measures. The quantities that each of these switches control are given in section 1.5.

Upgrade: When a measurement switch is added, the meter is capable of accumulating data for quantities that are controlled by that switch (see section 1.5). This includes Data Accumulations (section 2), Summations (section 3) and Demand Calculations (section 4) quantities.

Downgrade: When a measurement switch is removed, the meter will no longer accumulate data for quantities that are controlled by that switch. However, any data that accumulated in quantities controlled by that switch 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 section 1.2.10) that includes Quadrant 1 watthours, 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 (i.e. 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 soft switch. They will stay at whatever value they had when the switch was removed.

19.2.3 DSP Sample Output (D Switch)

Upgrade: When the D switch is added, the meter will output voltage and current samples over a synchronous serial channel. See section 25 for more information.

Downgrade: When the D switch is removed, the meter will no longer output voltage and current samples.

Note: this soft switch is enabled in all KV2C meters at the factory.
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19.2.4 Transformer Inaccuracy Correction (I Switch)

Upgrade: When the I switch is added, the meter will be able to perform the Transformer Inaccuracy Correction function (see section 29). 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 soft switch will cause the meter to begin performing the function. It will use the coefficients previously programmed into the meter.

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

19.2.5 Transformer Loss Compensation (L Switch)

Upgrade: When the L switch is added, the meter will be able to perform the Transformer Loss Compensation function (see section 23). 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 soft switch will cause the meter to begin performing the function. It will use the coefficients previously programmed into the meter.

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

19.2.6 Pulse Initiator Outputs (P Switch)

Upgrade: When the P switch is added, the meter will output pulses if an I/O option board is present and it is programmed to do so. See section 8 for more information.

Downgrade: When the P switch is removed, the meter will no longer output pulses.

Note: this soft switch is enabled in all KV2C meters at the factory.

19.2.7 Load Profile Recording Switches (R and X)

Upgrade: When the Basic Load Profile Recording (R) switch is added, the meter may be programmed record up to four channels and 64K bytes of load profile data.

When the Expanded Load Profile Recording switch is added, the meter may be programmed to record up to twenty channels and 192K bytes of load profile data.

Downgrade: 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.

19.2.8 Time of Use (T Switch)

Upgrade: When the T switch is added, the meter may be programmed for Time of Use operation (see sections describing TOU operation of the various features).

Downgrade: How the meter operates after the T switch is removed depends on how it was operating prior to the T switch being removed. If the meter was operating as a TOU meter, it will switch 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.

19.2.9 Voltage Event Monitor (V Switch)

Upgrade: When the V switch is added, the meter will be able to perform the Voltage Event Monitor function (see section 24). 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 soft switch will cause the meter to begin performing the function. It will use the parameters previously programmed into the meter.

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

19.2.10 Waveform Capture (W Switch)

Upgrade: 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 DOS or MeterMate COMM or MeterMate COMM software as part of its harmonic analysis option). See section 25 for more information.

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

19.2.11 Totalization (Z Switch)

Upgrade: When the Z switch is added, the meter will be able to perform the Totalization function (see section 22). 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 that 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 soft switch will cause the meter to begin performing the function. It will use the coefficients previously programmed into the meter.

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

19.2.12 Demand (N Switch)

Upgrade : When N Switch is added , the meter will be able to Calculate Billing Demand . Without N Switch a KV2C meter will not calculate billing demands. However, the Meter will calculate non Billing Demands for Cautions, Errors,etc . The KV2C Meter shall set Billing demands to Zero if N Switch is not present.

20 Test Mode

20.1 Introduction

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

20.2 Entering Test Mode

The KV2C 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 DOS or MeterMate COMM or MeterMate COMM Test menu).

20.3 Metering in Test Mode

20.3.1 Data Accumulations

The same selected measurement profile quantities (see section 2) that are 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 section 2). 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.

20.3.2 Summations

In test mode there is no distinction between data accumulations and summations. See Data Accumulations section above.

20.3.3 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; they may not be read from the meter.

20.3.3.1 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 (see section 2), 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.

20.3.3.2 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 meter with a two-term series expansion. The equation for a 15-minute time constant is given in Equation 4-1. Theequation 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

Equation 20-1

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.

20.3.4 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 operation of these functions is described in section 5. There are two differences when test mode is active, however:

1. The all-segment display does not show on the scroll for one scroll period; and
2. 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 LCD 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 item on the LCD when the switch was pressed is displayed. 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 resets. The number of demand resets is not incremented, and the date and time of last demand reset is not updated after a test demand reset. A test demand reset is not logged in the event log.

20.3.5 Power Factor

The KV2C 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 (see section 6).

Test mode power factor is only available as a displayable item; it may not be read from the meter.

20.4 Other Functions 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 only)
- Self-read (TOU Calendar Event only

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. See section 9 for more information.

Site Genie – The potential annunciators 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 RTP mode during test mode by activating or deactivating the input. Billing data for RTP mode (Demand and Demand/Load Profile meters) or the programmed RTP TOU rate (TOU meters) is not updated as long as the meter is in test mode.

Self Read – Self Reads scheduled as calendar actions only will be performed during test mode (see section 17).

Self Test – Only System Errors (see section 18) are detected during test mode.

Soft Switches – Soft switches 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 done 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 LCD until the display switch is activated, at which time 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.

20.5 Exiting Test Mode

The KV2C 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 DOS or MeterMate COMM or MeterMate COMM Test menu); or
- The test mode timeout timer expires.

20.6 Restrictions

None.

21 Time of Use Schedules and Programmable Dates

21.1 Introduction

Adding a T (Time Of Use) soft switch 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.

21.2 Operation in Demand Mode

Time Of Use features are not supported in a Demand meter.

21.3 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. See Section 21.4.1.3.4 for more information on the Spring and Fall Daylight Savings Calendar actions.

21.4 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 in Table 21-1 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.

21.4.1 Calendar

The Calendar supports up to 150 entries that are used to tell 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 that 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) (see Table 21-1).

Recurring Dates
Floating Dates
Weekly
Monthly
Nth Occurrence
Fixed Dates
Nonrecurring Dates

Table 21-1 Date Processing

If there is more than one instance of a type of an action scheduled for a day, only the last action processed will be performed. For instance, if both a Season Change with a Demand Reset and a Demand Reset are scheduled for the same day, only one Demand Reset will be performed. For example, 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 Table 21-1 will take effect.

21.4.1.1 Dates

21.4.1.1.1 Nonrecurring Dates

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

21.4.1.1.2 Recurring Dates

21.4.1.1.2.1 Fixed Recurring Dates

Fixed Recurring Dates are used to define events that occur on the same month and day every year. Examples of Fixed Recurring Dates are New Year's Day (January 1st), Independence Day (July 4th) and Christmas (December 25th).

21.4.1.1.2.2 Floating Recurring Dates

Floating Recurring Dates are used to define events that occur every week, every month or on a specific occurrence of a day every year.

- Weekly – the same day of the week every week (e.g. every Monday)
- Monthly – the same day of the month every month (e.g. 1st of every month)

- Nth occurrence in a month (see Table 21-2)

	Week	Day of Week	Month	Action
Presidents Day	3rd	Monday	February	Holiday
Spring DST	1st	Sunday	April	Spring DST
Memorial Day	Last	Monday	May	Holiday
Labor Day	1st	Monday	September	Holiday
Columbus Day	2nd	Monday	October	Holiday
Fall DST	Last	Sunday	October	Spring DST
Thanksgiving	4th	Thursday	November	Holiday

Table 21-2 Examples of Floating Recurring Dates

21.4.1.2 Qualifiers

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

- This Day Only — On the date specified only (default)
- Next Day Also — On both the date specified and the following day
- Next Day Only — On 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 — On Friday or Monday when if falls on Saturday or Sunday

21.4.1.3 Actions

The following Calendar events are supported:

- Holiday
- Season Change
- Self-Read
- Demand Reset
- Spring Daylight Savings
- Fall Daylight Savings

21.4.1.3.1 Holiday

The most common calendar entry is a Holiday action. At midnight, the meter searches its Calendar for any Holidays that match 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.

21.4.1.3.2 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.

21.4.1.3.3 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.

21.4.1.3.4 Spring/Fall Daylight Savings

The meter can be configured to automatically adjust its real-time clock to daylight savings through Spring/Fall Daylight Savings calendar actions. During the processing of calendar at midnight, the meter looks for Daylight Savings actions. If a Daylight Savings action is scheduled, it will not take affect until 2:00 a.m. The meter will adjust the clock forward to 03:00 at 02:00 a.m. for a Spring Daylight Savings action. It will adjust the clock backward to 01:00 at 02:00 a.m. for a Fall Daylight Savings action.

21.4.2 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	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 Off	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 Off	07:00 Rate B Load On 21:00 Rate C Load On	00:00 Rate C Load On

Table 21-3 Example Day Type Tier Switches

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

Table 21-4 Example Day Type Table

The Day Type Table in the MeterMate TOU Schedule Editor 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.

At midnight, the meter determines the Day Type and TOU Tier for the up coming 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.) (See the MeterMate TOU Schedule Editor). 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 (e.g. 00, 15, 30, and 45) 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.

22 Pulse Inputs and Totalization

22.1 Introduction

The meter can perform totalization under glass on up to 4 inputs and internal quantities.

22.2 Operation

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 (i.e. ON→OFF or OFF→ON for Form A; or 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) soft switch is enabled, the meter performs two additional steps: scaling and totalization.

22.2.1 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	120-480V
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

$$\frac{\text{Primary Pulse Value}\ \frac{\mu Wh}{pulse}}{\text{Transformer Factor} \times \text{VAh Scale Factor}\ \frac{\mu Wh}{unit}} = \frac{1{,}000{,}000{,}000\ \frac{\mu Wh}{pulse}}{24000 \times 250\ \frac{\mu Wh}{unit}} = \frac{500\ units}{3\ pulses}$$

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 x 500 = 120,000) with a remainder of 2 pulses. The remainder is carried over into the next minute.

22.2.2 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.

Example:

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 equipped with an MIO option board and Z soft switch. 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. User 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 & Alerts Support Table from step 2 above.

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

Table 22-1 Example Totalization Mappings

22.3 Restrictions

Pulse Input requires a Multi-Function I/O (MIO) Board. Raw pulses can be accumulated with the MIO Board and no other soft switches; however, scaled pulses and/or totalization requires a Z soft switch. The Profile used for the MeterMate program must contain at least one Totalization Channel

A 5 to 24V DC power supply is 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.

23 Transformer (and Line) Loss Compensation

23.1 Introduction

The KV2C meter is capable of adjusting metered values to compensate for the losses of a transformer and any line losses between the metering point and the billing point. The compensation may be added or subtracted from the metered values as needed.

In a typical application, electrical service is provided to a customer such that the billing point is on the high voltage side of a transformer but the meter is located on the low voltage side of the transformer. This may be done for a variety of reasons, but often economic and safety concerns are the driving factors. Allowing the use of lower voltage, less expensive instrument transformers addresses those concerns.

If the billing point is on the high voltage side of the transformer, but the meter is on the low voltage side, then the meter needs to be programmed to ***add*** no-load and load loss values to the quantities measured directly 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, then the meter needs to be programmed to ***subtract*** no-load and load loss values to the quantities measured directly by the meter.

MeterMate 5.0 software (MeterMate Meter Comm, a.k.a. MMDOS) is used to calculate the Transformer Loss Compensation (TLC) factors and program them into the KV2C meter during an interactive programming session (locally or remotely). Users are prompted for the required information during a programming session with a KV2C meter. The following information will be required as input to the MMDOS/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 MMDOS or MMCOMM incase of MM5.00.

$Volts_{L-N}$........ 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 $\sqrt{3}$) to serve as the input value to MMDOS or MMCOMM incase of MM5.00.. This requirement has to do with how the KV2C 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.

MMDOS or MMCOMM incase of MM5.00 will take the input values and calculate appropriate compensation values such that:

- 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 MMDOS/MMCOMM, and the formulae used, are shown below:

$LFE_{Elem\ VA}$.... The per element power transformer no-load loss VA (iron or core loss VA).

$LFE_{Elem\ vars}$...... The per element power transformer no-load loss vars (iron or core loss vars).

$LCU_{Elem\ VA}$...... The per element power transformer load loss VA (copper or winding loss VA).

$LCU_{Elem\ vars}$..... The per element power transformer load loss vars (copper or winding loss vars).

G_{Elem}.................... The per element secondary Conductance.

R_{Elem}.................... The per element secondary Resistance.

B_{Elem}.................... The per element secondary Susceptance.

X_{Elem}.................... The per element secondary Reactance.

$$\text{LFE}_{\text{Elem VA}} = (\text{EC\%}/100) \times \text{VA}_{\text{rated}}$$

$$\text{LFE}_{\text{Elem vars}} = \sqrt{(\text{LFE}_{\text{Elem VA}})^2 - (\text{LFE}_{\text{Elem watts}})^2}$$

$$\text{LCU}_{\text{Elem VA}} = (\text{IMP\%}/100) \times \text{VA}_{\text{rated}}$$

$$\text{LCU}_{\text{Elem vars}} = \sqrt{(\text{LCU}_{\text{Elem VA}})^2 - (\text{LCU}_{\text{Elem watts}})^2}$$

$$\text{G}_{\text{Elem}} = \frac{\text{LFE}_{\text{Elem watts}} \times \text{VTR}/\text{CTR}}{\text{Volts}^2_{\text{L-N}}}$$

$$\text{R}_{\text{Elem}} = \frac{(\text{LCU}_{\text{Elem watts}} + \text{LL}_{\text{Elem watts}}) \times \text{CTR}/\text{VTR}}{\text{Amps}^2_{\text{Line}}}$$

$$\text{B}_{\text{Elem}} = \frac{\text{LFE}_{\text{Elem vars}} \times \text{VTR}^3/\text{CTR}}{\text{Volts}^4_{\text{L-N}}}$$

$$\text{X}_{\text{Elem}} = \frac{\text{LCU}_{\text{Elem watts}} \times \text{CTR}/\text{VTR}}{\text{Amps}^2_{\text{Line}}}$$

23.2 Operation in Demand Mode

The KV2C 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:

$\text{LFE}_{\text{Elem wh}} = \text{G}_{\text{Elem}} * \text{V}_{\text{L-N}}{}^2\text{h}$	Where $\text{V}_{\text{L-N}}{}^2\text{h}$ is the L-N Volt^2 hours measured** by the KV2C.
$\text{LCU}_{\text{Elem wh}} = \text{R}_{\text{Elem}} * \text{I}_{\text{Line}}{}^2\text{h}$	Where $\text{I}_{\text{Line}}{}^2\text{h}$ is the Ampere^2 hours measured by the KV2C.
$\text{LFE}_{\text{Elem varh}} = \text{B}_{\text{Elem}} * \text{V}_{\text{L-N}}{}^4\text{h}$	Where $\text{V}_{\text{L-N}}{}^4\text{h}$ is the L-N Volt^4 hours measured** by the KV2C.
$\text{LCU}_{\text{Elem varh}} = \text{X}_{\text{Elem}} * \text{I}_{\text{Line}}{}^2\text{h}$	Where $\text{I}_{\text{Line}}{}^2\text{h}$ is the Ampere^2 hours measured by the KV2C.

**For 3-wire delta services the line-to-neutral voltage is computed by the KV2C from the input line-to-line voltages. For 4-wire wye services the L-N input voltage is used directly. $\text{V}_{\text{L-N}}{}^2\text{h}$ and $\text{I}_{\text{Line}}{}^2\text{h}$ are fundamental plus harmonics quantities.

G_{Elem}, R_{Elem}, B_{Elem}, and X_{Elem} are calculated by MeterMate as shown in section 23.1 and are programmed in the meter.

The calibration LED of the KV2C meter is unaffected by TLC settings. It will blink proportional to measured values only (watthour or varhour), not compensated 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 $\text{V}_{\text{L-N}}{}^2\text{h}$ and $\text{I}_{\text{Line}}{}^2\text{h}$ are used to calculate the compensation values, however. For example, $\text{LFE}_{\text{Elem A wh}}$ is added to both fundamental plus harmonics Wh and fundamental only Wh, even though it was calculated from fundamental plus harmonics $\text{V}_{\text{A}}{}^2\text{h}$.

The various volt-ampere-hour quantities available in the KV2C meter (apparent, phasor, arithmetic) are calculated from the compensated Wh and varh quantities. The distortion VAh component is not compensated. See section 0 for more information about how VAh quantities are calculated in the KV2C.

Examples of Transformer Loss Compensation calculations for the KV2C are given in Appendix A.

23.3 Operation in Demand/Load Profile Mode

The operation of Transformer Loss Compensation in Demand/Load Profile Mode is identical to its operation in Demand Mode.

23.4 Operation in Time of Use Mode

The operation of Transformer Loss Compensation in Time of Use Mode is identical to its operation in Demand Mode.

23.5 Restrictions

Transformer Loss Compensation will not operate, and the coefficients can not be programmed, unless the Transformer Loss Compensation soft switch is enabled. Transformer Loss Compensation can also be turned on and off through MeterMate DOS or MeterMate COMM or MeterMate COMM.

24 Voltage Monitor

24.1 Introduction

The voltage monitor detects and records sags and swells as short as one cycle in the metered voltages.

24.2 Operation in Demand 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. NOTE: This need be only for 1 cycle for the event to be considered completed.

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 section 10), 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 65535 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 65535. The voltage event monitor can be reset with the MeterMate Master Reset function (note: MeterMate lets the user do this 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 (section 7). 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 – 65535
- Event type (sag or swell).
- The number of cycles that the event lasted up to 65535 (18.2 minutes). An event that lasts longer than that will be recorded as lasting 65535 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 the displayed with MeterMate DOS or MeterMate COMM.

24.3 Operation in Demand/Load Profile Mode

The operation of the voltage event monitor in Demand/Load Profile mode is identical to its operation in Demand mode, except that the date and time of each event is also recorded in the voltage event log.

24.4 Operation in Time of Use Mode

The operation of the voltage event monitor in TOU mode is identical to its operation in Demand/Load Profile mode.

24.5 Restrictions

The Voltage Monitor will not operate, and the parameters that control it can not be programmed, unless the Voltage Monitor soft switch has been enabled.

25 Waveform Capture and Sample Output

25.1 Introduction

The KV2C can provide voltage and current sample data to another device via two mechanisms: Waveform Capture and Sample Output. Each is described below.

25.2 Waveform Capture

The KV2C 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 (70 sets of 6, 16-bit samples are captured, which covers a complete cycle at the lowest line frequency of 47.5 Hz). This feature is used by MeterMate DOS or MeterMate COMM software as part of its harmonic analysis option

25.3 Sample Output

The KV2C meter can be set up to output voltage and current samples every sample period over a synchronous serial channel available on a connector on the meter's PCB. The meter always outputs three of each, even if there are fewer voltage or current elements present. The samples are gain and phase corrected; i.e. they are not the raw samples read from the analog-to-digital converter. Each sample is a signed 16-bit quantity.

25.4 Restrictions

The Waveform Capture function will not operate unless the Waveform Capture soft switch has been enabled. The meter will not output samples unless the DSP Sample Output soft switch has been enabled.

26 Option Boards

26.1 Introduction

The KV2C supports various add-on boards that will provide enhanced functionality. Two option boards, typically a communication board and one other, may be installed together.

26.2 Operation

The KV2C currently supports the following option boards:

- Modem
- RSX
- Simple I/O
- Multiple I/O

More information about the communication option boards can be found in ***GEH-7269 kV™ Meter - Modem Option Board*** and ***GEH-7275 kV RSX - RS232/RS485 Communications Option***. The I/O functions available for the simple and multiple I/O boards are described in sections 8 (Alerts and Outputs) and 22 (Pulse Inputs and Totalization).

At power-up, the KV2C tests for the presence of installed option boards. Any boards that are detected will be recorded by the meter.

26.3 Restrictions

The KV2C meter will not communicate with communication option boards unless the A (Alternate Communication) switch has been installed. Some of the I/O functions require soft switches to operate as well. These are described in sections 8 (Alerts and Outputs) and 22 (Pulse Inputs and Totalization).

27 Timekeeping

27.1 Introduction

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).

27.1.1 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 than or equal to 30% of the applied voltage for harmonics up through the 12^{th}.
- 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 (approximately 2 minutes per month) at 25°C. KV2C meters may be purchased with a crystal that is accurate to within 5 PPM (13 seconds per month) at 25°C.

27.2 Operation in Demand Mode

In a KV2C operating in Demand mode, the timekeeping function is only used to time the length of demand (sub)intervals.

27.3 Operation in Demand/Load Profile Mode

In a KV2C operating in Demand/Load Profile mode, 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 29^{th}, in years exactly divisible by four (this is correct 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 section 21).

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.

27.4 Operation in Time of Use Mode

The operation of the timekeeping function in TOU mode is identical to its operation in Demand/Load Profile Mode.

28 Display

28.1 Introduction

28.1.1 KV2C Meter LCD

Figure 28.1 shows the layout of the KV2C's LCD.

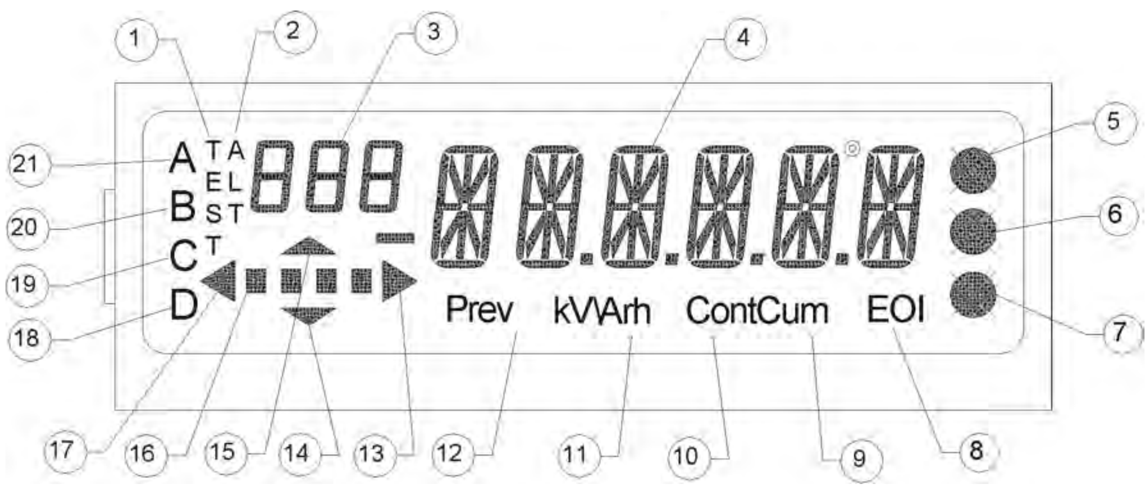

Figure 28-1

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 "A" annunciator indicates the "A" voltage is present at the meter. If blinking, "A" voltage is low.
6. When displayed, the "B" annunciator indicates the "B" voltage is present at the meter. If blinking, "B" voltage is low.
7. When displayed, the "C" annunciator indicates the "C" voltage is present at the meter. If blinking, "C" voltage is low.

8. This display indicates an end of interval (EOI) condition.
9. CUM is displayed when the meter is displaying cumulative demand measurements.
10. When CONT and CUM are displayed, it indicates that the meter is displaying continuously cumulative demand measurements.
11. 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. Qhour displays will have no annunciators.
12. This part of the display indicates the previous season or billing period data is being shown.
13. When displayed, this arrow indicates energy is being delivered to the load.
14. When displayed, this arrow indicates Varh are leading.
15. When displayed, this arrow indicates Varh are lagging.
16. The four blocks simulate a disk revolution and are used to display energy flow. One through four blocks indicates 60, 70, 80 and 90% of K_t Watthours respectively. When all four blocks go blank, it indicates a complete cycle (i.e. K_t Watthours).
17. When displayed, this arrow indicates energy is being received from the load.

18-21. The letters A through D indicate the Time-Of-Use (TOU) rate that is in effect. Only one letter is displayed at a time when operating in a TOU Mode. If no letters are lit, the meter is in a non-TOU rate.

28.1.2 Displayable Quantities

The list of displayable quantities, in what modes they are available, and how they are formatted, is given in Appendix B.

28.1.3 Display Modes

The following display modes are used in the KV2C 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.

28.1.4 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, 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 parameter 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), 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-MM-DD (used in Demand/Load Profile and TOU meters only).

28.1.5 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.

28.2 Operation in Demand Mode

When the meter powers up in Demand mode, 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. The next sections describe the operation of the display modes that can occur in a KV2C in Demand mode.

28.2.1 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 shall 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 secs	Resets to beginning of Normal Mode scroll.
	>= 3 secs	Changes to Alternate Mode scroll.
	>= 6 secs	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 sec	Changes to Test Mode.
Communication Session Initiated		BUSY displayed on the LCD

28.2.2 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 shall 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, or the frozen condition display if there is. 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 continuous press	 < 3 secs > 6secs total	 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. Change to Site Genie mode.
Reset Button	> debounce	Demand Reset performed, “All Segments” displayed, returns to Normal Mode or Frozen Condition Mode.
Test Button	> 1 sec	Changes to Test Mode.
Communication Session Initiated		BUSY displayed on the LCD

28.2.3 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 section 10 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 Activated	 Changes to Normal Mode scroll. Display another pass through the Site Genie scroll.
Reset Button	> debounce	Demand Reset performed, “All Segments” are lighted, returns to beginning of Normal Mode or Frozen Condition Mode when complete.
Test Button	> 1 sec	Changes to Test Mode.
Communication Session Initiated		BUSY displayed on the LCD

28.2.4 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 secs	Displays one complete pass through the 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 secs	Displays one complete pass through Alt Mode scroll and one complete pass through Normal Mode scroll. Returns to frozen display when complete. If display switch activated again while scrolling through Alt Mode or Normal Mode, scroll will automatically return to frozen display.
	>= 6 secs	Changes to Site Genie Mode.
Reset Button	> debounce	Demand reset performed, all segments lit while performing reset. Scroll returns to frozen display when complete.
Test Button	> 1 sec	Changes to Test Mode.
Communication Session Initiated		BUSY displayed on the LCD

28.3 Operation in Demand/Load Profile Mode

The operation of the display in Demand/Load Profile mode is identical to its operation in Demand mode.

28.4 Operation in Time of Use Mode

In TOU mode, the meter displays the active TOU rate on the LCD (see figure 28.1 above). Otherwise, the operation of the display in TOU mode is identical to its operation in Demand mode.

28.5 Restrictions

None.

29 Transformer Inaccuracy Correction

29.1 Introduction

The KV2C 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 that 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.

29.2 Operation

If the I switch 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 DOS or MeterMate COMM.

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.

29.3 Restrictions

Transformer Inaccuracy Correction will not operate, and the coefficients can not be programmed, unless the Transformer Inaccuracy Correction soft switch has been enabled.

30 KV2C+ Features

. In addition to all the KV2C features ,a KV2C+ Meter has an Option Revenue Guard board or a High Voltage board , Huge Load Profile Memory (8 MB) and a Huge Load Profile (H Soft Switch), G Soft Switch for upgrade and downgrade.

30.1 Revenue Guard Plus

30.1.1 Introduction

The Revenue Guard Plus feature allows a 3-element meter to revert to 2 1/2 element operation upon the loss of any (one) voltage input on a 4-wire wye service.

30.1.2 Operation in Demand Mode

If the Revenue Guard Plus is enabled, a 3-element meter metering a 4-wire Y service will switch to an appropriate 2-1/2 element algorithm when a line to neutral voltage sags below ½ the normal voltage for more than fifteen seconds. After the Revenue Guard Plus feature has taken effect (i.e. a meter has switched to the 2-1/2 element metering algorithm), once every programmable number of minutes the meter will switch back to the 3-element algorithm to check for the return of the voltage. The range for this programmable value is 1 to 255 minutes.

Note: If the Revenue Guard Plus is enabled, the automatic and manual service detection features are disabled and the service is be assumed to be 4WY on power up.

Revenue Guard Plus operation selectable when creating programs with MeterMate Program Manager (Site Support Table).

30.1.3 Operation in Demand/Load Profile Mode

The operation of the Revenue Guard Plus feature in Demand/Load Profile mode is identical to its operation in Demand mode.

30.1.4 Operation in Time of Use Mode

The operation of the Revenue Guard Plus feature in TOU mode is identical to its operation in Demand mode.

30.1.5 Restrictions

The Revenue Guard Plus soft switch must be enabled for this feature to function. A Revenue Guard board is not required, but without it the meter will not operate if element A voltage is lost, even if the other elements are present. It is therefore recommended that meters programmed for the Revenue Guard Plus feature have a Revenue Guard board installed.

31 Load Profile Recording

31.1 Introduction

The KV2C 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 can record power quality data such as frequency, maximum or minimum voltages or currents.

31.2 Operation in Demand Mode

Load Profile Recording is only supported in a Demand/Load Profile and TOU meters.

31.3 Operation in Demand/Load Profile Mode

Load Profile recording requires either an R (4-channel recording) or X (20-channel recording) or H (20-channel recording, 384 KB of Load Profile memory) and a battery.

Soft Switch	Channels	Storage
R	1 – 4	64KB
X	1 – 20	192KB
H	1-20	384 KB

Table 31-1 Load Profile Soft Switches

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(s) (a “meter 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 over write 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

	Interval Length (minutes)					
Channels	**1**	**5**	**10**	**15**	**30**	**60**
1	14.6	73.0	146.0	219.0	438.0	876.0
2	7.3	36.7	73.3	110.0	220.0	440.0
3	5.5	27.3	54.7	82.0	164.0	328.0
4	4.0	20.0	40.0	60.0	120.0	240.0

Table 31-2 R Soft Switch Days of LP Data per Channel

	Interval Length (minutes)					
Channels	**1**	**5**	**10**	**15**	**30**	**60**
1	43.8	219.0	438.0	657.0	1314.0	2628.0
2	22.1	110.3	220.7	331.0	662.0	1324.0
3	16.5	82.7	165.3	248.0	496.0	992.0
4	12.1	60.3	120.7	181.0	362.0	724.0
5	10.2	51.0	102.0	153.0	306.0	612.0
6	8.3	41.3	82.7	124.0	148.0	496.0
7	7.3	36.7	73.3	110.0	220.0	440.0
8	6.3	31.7	63.3	95.0	190.0	380.0
9	5.7	28.7	57.3	86.0	172.0	344.0
10	5.1	25.3	50.7	76.0	152.0	304.0
11	4.7	23.7	47.3	71.0	142.0	284.0
12	4.3	21.3	42.7	64.0	128.0	256.0
13	4.0	20.0	40.0	60.0	120.0	240.0
14	3.7	18.3	36.7	55.0	110.0	220.0
15	3.5	17.3	34.7	52.0	104.0	208.0
16	3.2	16.0	32.0	48.0	96.0	192.0
17	3.1	15.3	30.7	46.0	92.0	184.0
18	2.9	14.3	28.7	43.0	86.0	172.0
19	2.7	13.7	27.3	41.0	82.0	164.0

	Interval Length (minutes)					
Channels	1	5	10	15	30	60
20	2.6	13.0	26.0	39.0	78.0	156.0

Table 31-3 X Soft Switch Days of LP Data per Channel

	Interval Length (minutes)					
Channels	1	5	10	15	30	60
1	87.6	438.0	876.0	1314.0	2628.0	5256.0
2	44.1	220.6	441.4	662.0	1324.0	2648.0
3	33	165.4	330.6	496.0	992.0	1984.0
4	24.2	120.6	241.2	362.0	724.0	1448.0
5	20.4	102.0	204.0	306.0	612.0	1224.0
6	16.6	82.6	165.4	248.0	296.0	992.0
7	14.6	73.4	146.8	220.0	440.0	880.0
8	12.6	63.4	126.6	190.0	380.0	760.0
9	11.4	57.4	114.6	172.0	344.0	688.0
10	10.2	50.6	110.4	152.0	304.0	608.0
11	9.2	47.4	94.6	142.0	284.0	568.0
12	8.6	42.6	85.4	128.0	256.0	512.0
13	8.0	40.0	80.0	120.0	240.0	480.0
14	7.2	36.6	72.4	110.0	220.0	440.0
15	7.0	34.6	69.4	104.0	204.0	416.0
16	6.4	32.0	64.0	96.0	192.0	384.0
17	6.2	30.6	61.4	92.0	184.0	368.0
18	5.8	28.6	56.4	172.0	344.0	688.0
19	10.8	54.4	54.6	82.0	164.0	328.0
20	5.2	26.0	52.0	78.0	156.0	312.0

Table 31-4 H Soft Switch Days of LP Data per Channel

32 Soft Switches

32.1 Introduction

The KV2C+ allows certain features to be enabled and disabled through soft switches . In addition to all the above softswitches discussed under KV2C meter , a KV2C+ has additional two softswitches for upgrade and downgrade.

32.1.1 Revenue Guard Plus (G Switch)

Upgrade: When the G switch is added, the meter will be able to perform the Revenue Guard Plus function (see section 30.1). Just installing the switch will not automatically activate Revenue Guard Plus; the meter must also be programmed for this feature. If the meter had been programmed for it prior to the installation of the G switch, then Revenue Guard Plus will begin to operate as soon as the switch is added.

Downgrade: When the G switch is removed, the meter will no longer perform the Revenue Guard Plus function

32.1.2 Huge Load Profile (H Switch)

Upgrade: When the Basic Load Profile Recording (R) switch is added, the meter may be programmed record up to four channels and 64K bytes of load profile data.

When the Expanded Load Profile Recording switch is added, the meter may be programmed to record up to twenty channels and 192K bytes of load profile data.

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

32.1.3 Optional, Soft-switched Programmable Tables

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

If Revenue Guard Plus enabled:

- Manufacturer Table 86, Electrical Service Configuration*

33 KV2n – Energy only Meter

kV2n Meter is an energy only meter with specifically designed for 120 VAC network service; consequently, the kV2n has the characteristics of a Low Voltage kV2 (57 – 120VAC).
The US version of the kV2n will use the kV2 display and new CL200, non-DC immune, VAC CT type current sensors. The IUSA version will be identical with the exception of a special display and an ON indicator LED in the place of the OPTOCOM Rx photo LED.
The KV2n meter cannot be functionally upgraded and does not have any option boards .
The kV2n meters are built on kV2 Meter firmware. The measurement profile, diagnostics and displayable items are programmable at Factory to meet the different markets needs. .

kV2n Meter has a predefined profile already programmed in the Meter at Factory . The standard program has the following measurement parameters

33.1 Measurement Parameters

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

33.2 Display

kV2n Meter primarily being an Energy only meter has a 5 digit display for Energy Measurement. All other RATE, TEST, ALT , Prev, Cum ,Con Cum, Real Time Annunciators are not available in a kV2n Meter. Total kWh has a scroll duration of 6 seconds..

33.3 Soft Switches

The Primary function of kV2n Meter is Energy Measurement only and does not require any functionality to be upgraded hence it does not have any soft switches .

34 References

[1] ANSI C12.18 Protocol Specification for ANSI Type 2 Optical Port

[2] ANSI C12.19 Utility Industry End Device Data Tables

[3] ANSI C12.21 PSEM Protocol for Telephone Communications

[4] GEI-101423 Reading and Programming for the KV2 Meter Technical Development Reference
[5] GEH-7269 kV™ Meter - Modem Option Board
[6] GEH-7275 kV RSX - RS232/RS485 Communications Option.
[7] Handbook for Electricity Metering, 9th Edition

Appendix A – Example Transformer Loss Compensation Calculations

Example #1: A Delta-Delta transformer bank with low voltage side metering

To use a familiar set of numbers, this example will use the same scenario shown in the "Handbook for Electricity Metering", 9th Edition, starting on page 241.

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) GE KV2C 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 to be ignored.

From manufacturer supplied data we know the following about the transformer bank (at 75° C):

Unit Number	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	9,690	18,400	1.06	8.03
3	3,333	115,000/2,520	9,340	18,692	0.91	8.12

The necessary inputs to the MMDOS/MMCOMM prompts would therefore be:

MMDOS Prompt	Input Values			Comments
	Phase A	Phase B	Phase C	
kVA_{rated}	3333			From manufacturer data – same for all
$Volts_{L-N}$	1454.9			$= V_{L-L} / (3)^{1/2}$ – same for all
$Amps_{line}$	2290.8			$= (VA/V_{L-N})$ – same for all
VTR	20			x:1 – same for all
CTR	3000			x:5 – same for all
$LFE_{Elem\ watts}$	9650	9690	9340	From manufacturer data
$LCU_{Elem\ watts}$	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 that the KV2C meter converts 3-wire delta metering inputs into a virtual 4-wire wye service during processing of the data. That is why MMDOS requests V_{L-N} instead of V_{L-L}, and other inputs are expressed in terms of Phases A, B, & C even though it is a two element metering application. Using the formulae described earlier, MMDOS would compute:

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	9.493E-08	1.011E-07	8.587E-08
Reactance, X	1.551E+00	1.526E+00	1.543E+00

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
$LFE_{watts} = G * (V_{L-N}/VTR)^2 *TF$	9650	9690	9340
$LCU_{watts} = R * (I_L/CTR)^2 *TF$	18935	18400	18692
$LFE_{vars} = B * (V_{L-N}/VTR)^4 *TF$	34699	36635	31736
$LCU_{vars} = X * (I_L/CTR)^2 *TF$	271313	267007	269993

Example #2: 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 be done using a three stator (Form 9S) GE KV2C 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 to be ignored.

From manufacturer supplied data we know the following about the transformer (at 75° C):

Rated kVA	Rated Voltage	No-load (iron) loss watts at rated voltage	Load (copper) loss watts at rated kVA	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 MMDOS prompts as shown below.

MMDOS Prompt	Input Values			Comments
	Phase A	Phase B	Phase C	
KVA_{rated}	250			1/3 of manufacturer data – same for all
$Volts_{L-N}$	277			$= V_{L-L} / (3)^{1/2}$ – same for all
$Amps_{line}$	902.1			$= (VA/V_{L-N})$ – same for all
VTR	2.4			x:1 – same for all
CTR	600			x:5 – same for all

LFE $_{Elem\ watts}$	579	579	579	1/3 of manufacturer data
LCU $_{Elem\ watts}$	2619	2619	2619	1/3 of manufacturer data
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.

Note that if the power transformer was connected in delta on the low voltage side, the only MMDOS input number that would change would be the VT ratio (4:1 instead of 2.4:1). Using the formulae described earlier, MMDOS would compute:

Calculated Compensation Factors (per element)	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	1.313E-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
$LFE_{watts} = G * (V_{L-N}/VTR)^2 *TF$	579.33	579.33	579.33	1738
$LCU_{watts} = R * (I_L/CTR)^2 *TF$	2618.67	2618.67	2618.67	7856
$LFE_{vars} = B * (V_{L-N}/VTR)^4 *TF$	6725.09	6725.09	6725.09	20175.3
$LCU_{vars} = X * (I_L/CTR)^2 *TF$	14210.74	14210.74	14210.74	42632.2

Appendix B – Displayable Quantities

B.1 List of Displayable Quantities

Quantity	Modes Avail.	Test Mode?	ID format	Quantity Format
Data accumulations 1-20	All	N	XXX	UOM dependent (note 1)
Cont Cum demands 1-5	All	N	Y Y Y	UOM dependent (note 1)
RTP Cont Cum demands 1-5	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Cont Cum demands 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Cont Cum demands 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Cont Cum demands 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Cont Cum demands 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Cum demands 1-5	All	N	Y Y Y	UOM dependent (note 1)
RTP Cum demands 1-5	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Cum demands 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Cum demands 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Cum demands 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Cum demands 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Total summations 1-5	All	N	Y Y Y	UOM dependent (note 1)
RTP summations 1-5	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Summations 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Summations 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Summations 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Summations 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5	All	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Date	TOU	N	Y Y Y	Date
Max demands 1-5 Time	TOU	N	Y Y Y	H H M M
Max demands 1-5 coincident 1	All	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 coincident 2	All	N	Y Y Y	UOM dependent (note 1)
RTP max demands 1-5	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
RTP max demands 1-5 coincident 1	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
RTP max demands 1-5 coincident 2	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate A Date	TOU	N	Y Y Y	Date
Max demands 1-5 Rate A Time	TOU	N	Y Y Y	H H M M
Max demands 1-5 Rate A coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate A coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate B Date	TOU	N	Y Y Y	Date
Max demands 1-5 Rate B Time	TOU	N	Y Y Y	H H M M
Max demands 1-5 Rate B coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate B coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate C Date	TOU	N	Y Y Y	Date
Max demands 1-5 Rate C Time	TOU	N	Y Y Y	H H M M
Max demands 1-5 Rate C coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate C coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate D Date	TOU	N	Y Y Y	Date
Max demands 1-5 Rate D Time	TOU	N	Y Y Y	H H M M
Max demands 1-5 Rate D coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Max demands 1-5 Rate D coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Average power factor	All	N	Y Y Y	X.X X
Last reset Cont Cum demands 1-5	All	N	Y Y Y	UOM dependent (note 1)

Quantity	Modes Avail.	Test Mode?	ID format	Quantity Format
Last reset RTP Cont Cum demands 1-5	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Last reset Cont Cum demands 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Cont Cum demands 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Cont Cum demands 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Cont Cum demands 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Cum demands 1-5	All	N	Y Y Y	UOM dependent (note 1)
Last reset RTP Cum demands 1-5	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Last reset Cum demands 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Cum demands 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Cum demands 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Cum demands 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Total summations 1-5	All	N	Y Y Y	UOM dependent (note 1)
Last reset RTP summations 1-5	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Last reset Summations 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Summations 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Summations 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Summations 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5	All	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Date	TOU	N	Y Y Y	Date
Last reset Max demands 1-5 Time	TOU	N	Y Y Y	H H M M
Last reset Max demands 1-5 coincident 1	All	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 coincident 2	All	N	Y Y Y	UOM dependent (note 1)
Last reset RTP max demands 1-5	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Last reset RTP max demands 1-5 coincident 1	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Last reset RTP max demands 1-5 coincident 2	Dmd/DmdLP	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate A Date	TOU	N	Y Y Y	Date
Last reset Max demands 1-5 Rate A Time	TOU	N	Y Y Y	H H M M
Last reset Max demands 1-5 Rate A coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate A coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate B Date	TOU	N	Y Y Y	Date
Last reset Max demands 1-5 Rate B Time	TOU	N	Y Y Y	H H M M
Last reset Max demands 1-5 Rate B coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate B coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate C Date	TOU	N	Y Y Y	Date
Last reset Max demands 1-5 Rate C Time	TOU	N	Y Y Y	H H M M
Last reset Max demands 1-5 Rate C coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate C coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate D Date	TOU	N	Y Y Y	Date
Last reset Max demands 1-5 Rate D Time	TOU	N	Y Y Y	H H M M
Last reset Max demands 1-5 Rate D coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Max demands 1-5 Rate D coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Last reset Average power factor	All	N	Y Y Y	X.X X
Previous season Cont Cum demands 1-5	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Cont Cum demands 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Cont Cum demands 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Cont Cum demands 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Cont Cum demands 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Cum demands 1-5	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Cum demands 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Cum demands 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Cum demands 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)

Quantity	Modes Avail.	Test Mode?	ID format	Quantity Format
Previous season Cum demands 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Total summations 1-5	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Summations 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Summations 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Summations 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Summations 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Date	TOU	N	Y Y Y	Date
Previous season Max demands 1-5 Time	TOU	N	Y Y Y	H H M M
Previous season Max demands 1-5 coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate A	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate A Date	TOU	N	Y Y Y	Date
Previous season Max demands 1-5 Rate A Time	TOU	N	Y Y Y	H H M M
Previous season Max demands 1-5 Rate A coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate A coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate B	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate B Date	TOU	N	Y Y Y	Date
Previous season Max demands 1-5 Rate B Time	TOU	N	Y Y Y	H H M M
Previous season Max demands 1-5 Rate B coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate B coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate C	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate C Date	TOU	N	Y Y Y	Date
Previous season Max demands 1-5 Rate C Time	TOU	N	Y Y Y	H H M M
Previous season Max demands 1-5 Rate C coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate C coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate D	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate D Date	TOU	N	Y Y Y	Date
Previous season Max demands 1-5 Rate D Time	TOU	N	Y Y Y	H H M M
Previous season Max demands 1-5 Rate D coincident 1	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Max demands 1-5 Rate D coincident 2	TOU	N	Y Y Y	UOM dependent (note 1)
Previous season Average power factor	TOU	N	Y Y Y	X.X X
Momentary interval demands 1-5	All	Y	Y Y Y	UOM dependent (note 1)
Line-to-neutral voltages fundamental plus harmonics	All	Y	Y Y Y	Voltage
Line-to-neutral voltages fundamental only	All	Y	Y Y Y	Voltage
Line-to-line voltages fundamental plus harmonics	All	Y	Y Y Y	Voltage
Line-to-line voltages fundamental only	All	Y	Y Y Y	Voltage
Line currents fundamental plus harmonics	All	Y	Y Y Y	Current
Line currents fundamental only	All	Y	Y Y Y	Current
I_n (imputed neutral current)	All	Y	Y Y Y	Current
Site Genie Voltages	All	Y	Y Y Y	Voltage
Site Genie Currents	All	Y	Y Y Y	Current
Site Genie Voltage Angles	All	Y	Y Y Y	Angle
Site Genie Current Angles	All	Y	Y Y Y	Angle
Distortion PF per element (note 2)	All	Y	Y Y Y	X.X X
Distortion PF total (note 2)	All	Y	Y Y Y	X.X X
TDD per element (note 2)	All	Y	Y Y Y	X.X X
ITHD per element (note 2)	All	Y	Y Y Y	X.X X
VTHD per element (note 2)	All	Y	Y Y Y	X.X X
Momentary interval power factor	All	N	Y Y Y	X.X X
Momentary interval kW per element fundamental plus harmonics	All	Y	Y Y Y	Volt-ampere
Momentary interval kW per element fundamental only	All	Y	Y Y Y	Volt-ampere

Quantity	Modes Avail.	Test Mode?	ID format	Quantity Format
Momentary interval kvar per element fundamental plus harmonics	All	Y	Y Y Y	Volt-ampere
Momentary interval kvar per element fundamental only	All	Y	Y Y Y	Volt-ampere
Momentary interval distortion kVA per element	All	Y	Y Y Y	Volt-ampere
Momentary interval apparent kVA per element	All	Y	Y Y Y	Volt-ampere
Frequency	All	Y	Y Y Y	X X.X X
Canadian Seal State	All	Y	Y Y Y	Binary
Current Date	TOU/ DmdLP	Y	Y Y Y	Date
Current Day Of Week	TOU/ DmdLP	Y	Y Y Y	Numeric
Current Season	TOU	Y	Y Y Y	Numeric
Current Time	TOU/ DmdLP	Y	Y Y Y	H H M M
Demand Alert Theshold	All	Y	Y Y Y	UOM dependent (note 1)
Power fail exclusion time	All	Y	Y Y Y	Numeric
Demand Interval Size (block only)	All	Y	Y Y Y	Numeric
Demand Min Outage for power fail exclusion	All	Y	Y Y Y	Numeric
Demand Subint Mult (rolling only)	All	Y	Y Y Y	Numeric
Demand Subint Size (rolling only)	All	Y	Y Y Y	Numeric
Demand Time Remaining in Subint (Not valid for thermal demands)	All	N	Y Y Y	M M S S
Display Dmd Units	All	Y	Y Y Y	Numeric
Display Multiplier	All	Y	Y Y Y	Numeric
Display Scalar	All	Y	Y Y Y	Numeric
Display Primary Volts/Amps Flag	All	Y	Y Y Y	Numeric
EOI Duration	All	Y	Y Y Y	Numeric
Load Control ON	TOU	Y	Y Y Y	Numeric
Load Profile # Channels	TOU/ DmdLP	Y	Y Y Y	Numeric
Load Profile Interval Length	TOU/ DmdLP	Y	Y Y Y	Numeric
Diagnostic Counters 1-4, 5, 5a, 5b, 5c, 6-8 (note 3)	All	Y	Y Y Y	Numeric
Meter ID 1,2	All	Y	M M M	M M M M M M
Electrical Service	All	Y	Y Y Y	Special lables (text)
Power Factor demand threshold	All	Y	Y Y Y	UOM dependent (note 1)
Power Factor Threshold	All	Y	Y Y Y	Numeric
Prior interval demands 1-5	All	Y	Y Y Y	UOM dependent (note 1)
Program ID	All	Y	Y Y Y	X X X X
RTP Enabled	All	Y	Y Y Y	Binary
RTP time remaining until activation	All	Y	Y Y Y	Numeric
S Log # Bad Passwords	All	Y	Y Y Y	Numeric
S Log # Demand Resets	All	Y	Y Y Y	Numeric
S Log # NV memory writes	All	Y	Y Y Y	Numeric
S Log # OPTOCOM Communications	All	Y	Y Y Y	Numeric
S Log # Power Outages	All	Y	Y Y Y	Numeric
S Log # Times Programmed	All	Y	Y Y Y	Numeric
S Log # Times RTP Entries	All	Y	Y Y Y	Numeric
S Log Cum Power Outage Duration	TOU/DmdLP	Y	Y Y Y	Numeric
S Log Date Last Calibration	All	Y	Y Y Y	Date
S Log Date Last Demand Reset	TOU	Y	Y Y Y	Date
S Log Date Last OPTOCOM Comm	TOU	Y	Y Y Y	Date
S Log Date Last Power Outage	TOU/ DmdLP	Y	Y Y Y	Date
S Log Date Last Programming	TOU	Y	Y Y Y	Date
S Log Date Last RTP Entry	TOU	Y	Y Y Y	Date
S Log Date Last Time Change	TOU	Y	Y Y Y	Date
S Log Date Last TLC Update	TOU	Y	Y Y Y	Date
S Log Date Last Transformer Inaccuracy Adjustment	TOU	Y	Y Y Y	Date
S Log Time Last Calibration	All	Y	Y Y Y	H H M M
S Log Time Last Demand Reset	TOU	Y	Y Y Y	H H M M
S Log Time Last OPTOCOM Comm	TOU	Y	Y Y Y	H H M M
S Log Time Last Power Outage	TOU/DmdLP	Y	Y Y Y	H H M M
S Log Time Last Programming	All	Y	Y Y Y	H H M M

Quantity	Modes Avail.	Test Mode?	ID format	Quantity Format
S Log Time Last RTP Entry	TOU	Y	Y Y Y	H H M M
S Log Time Last Time Change	TOU	Y	Y Y Y	H H M M
S Log Time Last TLC Update	TOU	Y	Y Y Y	H H M M
S Log Time Last Transformer Inaccuracy Adjustment	TOU	Y	Y Y Y	H H M M
Test Dmd Interval size (block only)	All	Y	Y Y Y	Numeric
Test Dmd Subint mult (rolling only)	All	Y	Y Y Y	Numeric
Test Dmd Subint size (rolling only)	All	Y	Y Y Y	Numeric
Test Mode Max demands 1-5	All	Y	Y Y Y	UOM dependent (note 1)
Test Mode Time Out Length	All	Y	Y Y Y	Numeric
Test Mode data accumulations 1-20	All	Y	Y Y Y	UOM dependent (note 1)
Test Thermal Interval Type	All	Y	Y Y Y	Binary
Transformer Ratio – Current	All	Y	Y Y Y	Numeric
Transformer Ratio – Voltage	All	Y	Y Y Y	Numeric
Version Firmware	All	Y	Y Y Y	Numeric
Version Hardware	All	Y	Y Y Y	Numeric
Test Mode Time Remaing in Subint (Not valid for thermal demands)	All	Y	Y Y Y	M M S S
Test Mode Accumulating demands 1-5	All	Y	Y Y Y	UOM dependent (note 1)
Segment Check	All	Y	8 8 8	All segments lit
User-defined labels 1-5	All	Y	Y Y Y	Text
Test Mode Power Factor	All	Y	Y Y Y	X.X X
Transformer Factor	All	Y	YYY	UOM dependent (note 1)
Previous Self Read Total Summation 1-5	All	N	YYY	UOM dependent (note 1)
Previous Self Read Max Demand 1-5	All	N	YYY	UOM dependent (note 1)
Previous Self Read Max Demand 1-5 Date	TOU	N	YYY	Date
Previous Self Read Max Demand 1-5 Time	TOU	N	YYY	HH:MM

Key:
Binary = binary value (zero or one)
X = variable data
Y = ID code
Date = programmable date format
M = meter ID format (two sets of nine digits)
H H M M = time displayed as two-digit hour, two-digit minute
M M S S = time displayed as two-digit minute, two-digit second

Notes:

1. UOM (unit of measure) dependent quantities are displayed based on the quantity type.
   Data accumulations (see section 2) and summations (see section 3) 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 (including demand thresholds, see section 4) may have the following types:
   - Volt-ampere (e.g. kW, kvar, kVA)
   - Voltage
   - Current
   - Numeric (pulse counts)

   Cumulative and continuously cumulative demands (see section 4) 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. More detail about each display format type is given below.

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.

B.2 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.

B.2.1 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:

$$\text{displayed kilo volt - ampere - hour data} = \frac{(\text{raw data}) \times (\text{VAh scale factor}) \times (\text{display multipler})}{10^{3+(\text{display scalar})}}$$

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.

B.2.2 Formatting Test Mode Volt-Ampere-Hour Quantities

Test mode volt-ampere-hour data is converted from raw data stored in the meter to a displayable value as follows:

$$\text{displayed volt - ampere - hour data} = \frac{(\text{raw data}) \times (\text{VAh scale factor}) \times (\text{display multipler})}{10^{(\text{display scalar})}}$$

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.

B.3 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:

$$\text{displayed (kilo)volt-ampere-hour data} = \frac{(\text{raw data})\times(\text{VA scale factor})\times(\text{display multipler})}{10^{(\text{VA/kVA adjust})+(\text{display scalar})}}$$

The VA scale factor input is specified in either Manufacturer Table 75 or Standard Table15 (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, F's 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.

B.4 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 section B.3. 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).

B.5 Formatting Voltages

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 99999.9V, 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 99999.9V, 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 section 10), the meter will display dashes in all six alpha-numeric segments. Voltages always have positive signs.

B.6 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 99999.9A, 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 99999.9A, 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 section 100), the meter will display dashes in all six alpha-numeric segments. Currents always have positive signs.

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