Echelon

ANSI Electric Meter v3.1

User's Guide

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PRELIMINARY DRAFT

Echelon ANSI Electric Meter v3.1 User's Guide

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FCC Compliance

If the WAN Card will be integrated into an ANSI IP Meter and used within the United States of America, then the complete ANSI IP Meter (including the WAN Card) must comply with FCC regulations. In addition, the accompanying documentation for the complete product would need to include a notice such as the following:

> This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the FCC Rules per sections 15.107 and 15.109. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the manufacturer's instruction manual, may cause interference with radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, you are encouraged to try to correct the interference by one or more of the following measures:
>
> - Reorient or relocate the receiving antenna.
> - Increase the separation between the equipment and the receiver.
> - Connect the equipment into an outlet on a circuit different from that which the receiver is connected.
> - Consult the dealer or an experienced radio/television technician for help.
>
> Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

RF Statements

This equipment also complies with the limits for wireless devices per sections 15.203, 15.205, 15.207, 15.209 and 15.247. It uses frequency 2.4GHz per IEEE 802.15.4-2006, and uses a frequency bandwidth from 2400MHz to 2483.5MHz.

This equipment complies with the FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Table of Contents

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Introduction

This chapter provides a description of the content of this document, a list of related documentation, and an overview of the capabilities of the Echelon ANSI electric meter.

About This Guide

This document describes the installation and operation of the Echelon ANSI 83011-83301 electric meter, and is intended for use by metering administrators, installers, and meter technicians. ANSI electric meters are designed to be part of a utility metering system that is supervised by Echelon's Data Concentrator in conjunction with Networked Energy Services (NES) System Software.

The following chapters are included:

- Chapter 1: *Introduction*
- Chapter 2: *Meter Installation*
- Chapter 3: *Meter Operation*
- Chapter 4: *Demand Metering*
- Chapter 5: *MEP Devices*
- Appendix A: *Meter Troubleshooting*
- Appendix B: *Meter Specifications*
- Appendix C: *Glossary*
- Appendix D: *Model Changes*

Related Documentation

The following Echelon documentation provides operating instructions and descriptions of the various components of the Networked Energy Services (NES) metering system:

- *ANSI Electric Meter Quick Installation Guide*
- *DC-1000/SL Data Concentrator User's Guide*
- *NES Provisioning Tool User's Guide*
- *NES System Getting Started Guide*
- *NES System Software Installation Guide*
- *NES System Software Programmer's Guide*
- *NES System Software API Reference Guide*
- *NES System Software Version Compatibility Guide*

Meter Features

Echelon electric meters and the NES system that the meters operate within provide a comprehensive set of energy services. Some of these services are: automated two-way meter reading, Time-of-Use metering, remote electronic disconnect and local physical reconnect, distribution system asset optimization, outage detection and restoration management, blackout and brownout detection, comprehensive revenue protection, real-time direct load control, and more.

ANSI electric meters include the following features:

- Power line carrier (PLC) communication with an Echelon Data Concentrator, using Echelon's A-Band power line carrier technology
- Optical communication port provides an interface for direct communication with a computer or hand-held reader.

- Meter display provides a scrolling list of up to 30 items (with an ID code for each item) including energy data, time, date, remaining credit (if prepay metering is in effect), tariff-specific energy values, and more.
- Push button provides immediate advancement to next display item and is used to silence the audible prepay low credit alarm.
- Display characters and icons indicate various operating conditions, such as: when main cover is properly installed, that PLC communication has occurred, and the open/closed state of the load disconnect and control relay.
- Nameplate message indicators are illuminated on the display when a listed item or action is programmed into the meter.
- Load disconnect switch with prepay and remote disconnect capability. When remotely set to off state, cannot be turned on manually. 200 amps maximum.
- Data log intervals of 5, 15, 30, 60 minutes, or 1-day.
- Up to 180 days of single-channel load profile memory storage in meter at a 60-minute log interval and 2094 days at a 1-day interval. Up to 8 channels can be recorded on the same interval.
- Four Time-of-Use kWh and kvarh tariff registers. Perpetual calendar: 4 seasons, 15 holidays. 2 holiday day schedules per season, 3 separate day schedules per season, 10 tariff periods per day schedule.
- A second Time-of-Use calendar schedule can be programmed into the meter for activation at a preset future date.
- Daylight Saving Time changeover with perpetual calendar.
- Battery-backed Real Time Clock (RTC) to maintain time accuracy and tamper detection during power outages.
- Alarms for customer tamper and meter operating variances.
- Power quality measurements for: sag, swell, number of over-current occurrences, number of long power outages, duration and time of the last 10 long power outages, number of short power outages, maximum and minimum frequency, phase loss, and total harmonic distortion (THD) events.
- Prepay metering. Energy credit is loaded into the meter and customer power is automatically turned off when credit becomes zero. Emergency credit allows power to continue after standard credit is exhausted, with the option of a reduced power mode. A configurable audible alarm warns customer of low credit.
- Data transmission accuracy ensured using CRC for optical communication and authentication and handshaking for PLC communication.
- Security is provided by password protection for optical communication, encryption and authentication for PLC communication.
- Signal relay for control of external contactor or other devices, with activation linked to the currently active tariff period or controlled by remote command (optional feature).
- KYZ pulse output (optional feature).
- Demand metering. The meter optionally offers various types of demand calculations that can be performed to measure the peak active and reactive power being delivered to the system. Demand measurements are useful in that they provide information on peak usage as opposed to accumulation over time. Consult Chapter 4 for more information on demand metering.

- An optional MEP (Multipurpose Expansion Port) port that is capable of connecting to a smart device and allowing that device (referred to as a *MEP device*) to access meter data, run meter procedures, and have limited write access to the meter.

Figure 1.1: Echelon ANSI Electric Meter

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Meter Installation

This chapter includes safety warnings, meter installation instructions, and initial start-up procedures.

Safety Warnings

Before you install and operate your meters, you should be familiar with all regulatory agency, manufacturer, and utility industry safety precautions. Observe these safety precautions during all steps of meter installation, operation, and service. Failure to comply with these precautions, or with specific warnings or instructions elsewhere in this guide, violates safety standards of design, manufacture, and the intended use of the meter. Echelon assumes no liability for failure to comply with these requirements.

The information presented in this guide is intended to be an aid to qualified metering personnel. It does not replace the extensive training necessary to handle metering equipment in a safe manner.

Safety Warning: Any work on or near energized meters or other metering equipment presents the danger of electrical shock. Only qualified electricians and metering specialists should be authorized to work with the meters, in accordance with local utility safety practices, utility requirements, and other safety precautions as dictated by local code, regulations, or statutes.

Visual Meter Inspection

Before installing the meter, inspect the meter case, display, optical port, and blades to make sure they are not damaged.

Safety Warning: Return damaged meters and components to Echelon; do not attempt to repair the damage. The meter has no user-serviceable parts. Any attempt to remove or repair internal parts voids the meter warranty.

Provisioning the Meter

Before a meter can operate correctly in your system, it must be configured with specific operating parameters. This configuration is called "provisioning" and is performed by writing programs with preset values into the meter, either from NES System Software via the Data Concentrator, or directly to the meter optical port from a computer using the NES Provisioning Tool application. The parameters in the Provisioning Tool programs are set by administrative staff at the governing utility, and the programs can be distributed to technicians for meter provisioning operations.

The meter provisioning may be performed by Echelon prior to shipment, at a service depot before transportation to the meter installation site, or at the installation site.

After a meter is installed, updates to program settings are usually performed by sending the updated information from NES System Software to the Data Concentrator that is supervising the meter. The Data Concentrator writes the update to the meter and confirms the successful implementation back to NES System Software. For more information on the Data Concentrator, see the *DC-1000/SL and DC-1000/SLE Data Concentrator User's Guide.*

You can also use the Provisioning Tool to view meter data and diagnostic information. For instructions on provisioning meters, see the *NES Provisioning Tool User's Guide.*

Mounting the Meter

The form, current class and rated voltage of the ANSI meter are marked on the front of the meter, as shown in Figure 2.1. Before mounting the meter in its socket, you should make sure that these settings match the form, maximum current and rated voltage for the socket you are using.

Operating Environment

The meter is designed to operate in an indoor or outdoor (IP54 rating) location, in a non-hazardous environment. You should make sure to mount the meter in a well-ventilated enclosure that will prevent condensation from forming inside the meter.

Mounting Surface

The meter is designed to be installed in an upright position on a flat vertical surface.

Figure 2.1 Form, Current Class and Rated Voltage

Meter Test Links

The test links of the back of the ANSI meter must be in the closed position before you mount and begin using the ANSI meter, as shown in Figure 2.2.

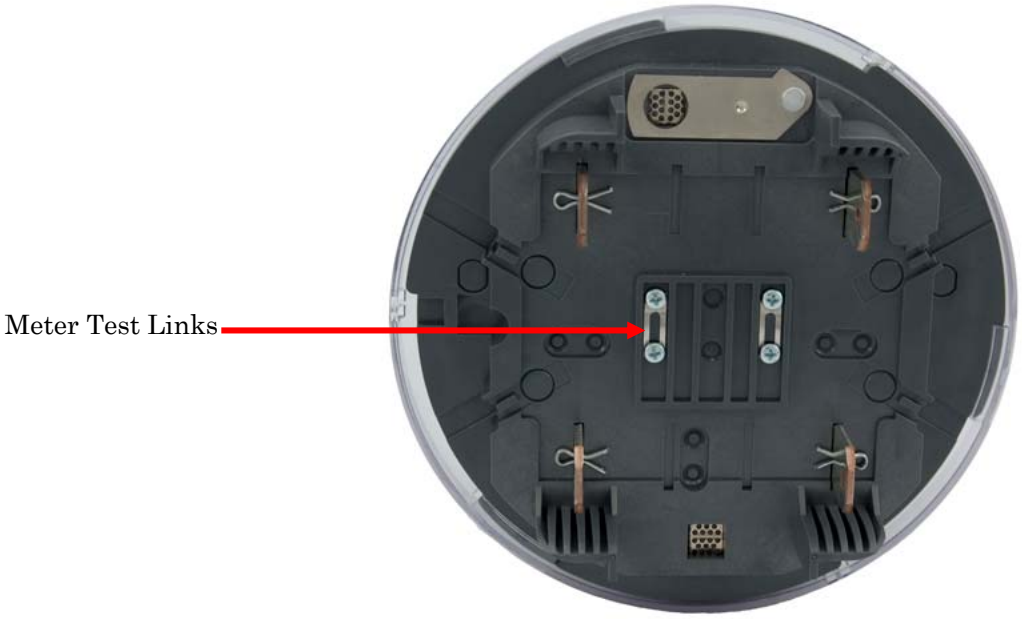

Figure 2.2 Meter Test Links

Determining Load Disconnect and Relay State without Line Power

The meter's load disconnect contactor and control relay open or closed state cannot be visually determined before line power is supplied to the meter. When in the closed state, power will be delivered to the load when line power is supplied to the meter.

Determining Load Disconnect State

To determine if the meter load disconnect contactor is in the open or closed state when power is **not** supplied to the meter, follow this procedure:

1. Set a multi-meter to continuity test mode or use a continuity tester.
2. Connect one continuity test probe to L1 line-in terminal and one probe to L1 load terminal.
3. If there is NO continuity in the signal path the disconnect is Open (Off). If there IS continuity in the signal path the disconnect is Closed (On).

Determining Control Relay State

To determine if the control relay is in the open or closed state when power is **not** supplied to the meter, follow this procedure:

1. Set a multi-meter to continuity test mode or use a continuity tester.
2. Connect the continuity test probes to the two control relay wires.
3. If there is NO continuity in the signal path the control relay is Open (Off). If there IS continuity in the signal path the control relay is Closed (On).

Testing for Correct Meter Operation

When power is applied to the meter, the following can be checked to determine if the meter is operating properly:

Function/Operation	Indicated By
Power to meter is On	The display is active (shows information).
Power to load is On (load disconnect contactor is in the On, or closed, position)	The "disconnect open" display indicator  is **Not** illuminated, indicating that the disconnect contactor is closed.
All necessary phases are connected to the meter and providing voltage	The **L1** and/or **L2** phase indicators are lit on the display, signifying the phases that have voltage present
Polyphase only: The phases are connected to the meter correctly (Does not detect reversed line and load wires or swapped line and neutral)	**L1, L2, L3** (**L1, L3** for 2s/12s) indicators are lit on the display (verification only available for 3-phase, 4-wire electrical service)
Polyphase only: The phases are not connected to the meter in the correct order (Does not detect every possible incorrect connection order such as L3L1L2, reversed line and load wires, or swapped line and neutral)	**L1, L2, L3 (L1, L3** for 2s/12s) indicators are lit on the display (verification only available for 3-phase, 4-wire electrical service)
The metered building is consuming active energy (forward active)	The **"→"** arrow is lit on the display
The metered building is generating active energy (reverse active)	The **"←"** arrow is lit on the display
A self-test failed, a tamper condition has been detected, or an alarm condition has occurred	An error code may lock the display or a caution code may be shown at the end of the scrolling display list, if these codes have been configured to be active. See "Self Tests and Diagnostic Messages" on page 1 for information on messages
The main cover has been properly installed and the cover tamper switch is closed	The "tamper switch open" display indicator  is **Not** illuminated, indicating that the cover is installed properly
PLC network communication is occurring	 This icon is lit when PLC communication on the network has been detected by the meter. This icon can be used during installation to see if network communication can be 'heard' by the meter before the meter is accepted by the system as an active device. See "Power Line Carrier Communication" on page 1 for detailed information.
PLC communication has occurred with the meter (See "Reading the Display" in Chapter 3 for more information)	 This icon indicates that PLC communication occurred with this specific meter within the last X minutes (X is configurable from 1 to 65535 minutes) and shows the quality of the most recent received PLC message. See "Power Line Carrier Communication" on page 1 for detailed information.

Test Mode

Test mode is an optional feature that is only supported by some NES version 3.1 ANSI meters. While in test mode, the meter will suspend standard energy accumulations, standard demand calculations, power quality analysis, tariff register calculations, automated control of the disconnect switch, and automated control of the control relay. In addition, all standard operation demand calculations that were interrupted by test mode activation will be considered completed and the values will be calculated as if the full time of the demand interval has elapsed (the non-elapsed time is considered to have had an energy accumulation of zero). You may find test mode useful if you want to test the meter's accuracy without disrupting its billing registers. The meter display includes an icon that will be enabled when the meter enters test mode.

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Meter Operation

This chapter describes the operation and features of the Echelon ANSI electric meters.

Meter Operation Overview

The Echelon ANSI electric meter provides a comprehensive set of energy services when operating within the NES system. The meter supplies automatic encrypted data transfer and diagnostic reporting to NES System Software by communicating with an Echelon Data Concentrator over local power lines using PLC technology. An optical port provides local communication for direct programming and data reading.

The meter measures active power and energy for both forward and reverse, reactive power and energy for import and export, voltage, current, power factor, and frequency. Data can be recorded in up to 4 perpetual-calendar Time-of-Use (TOU) registers. The data can be logged in intervals of 5, 15, 30, 60 minutes, or 1-day, with up to 8 channels per interval.

A programmable display presents comprehensive local information on meter operation and customer power consumption. Additional messaging features supply power quality information and tamper detection. LEDs are included for test functions. An optional KYZ output is also available.

Remote or local disconnect of customer power allows automatic prepay metering functions, power limiting, and service cancellation control. An optional control relay can turn an external device on or off based on tariff periods, or by command from NES System Software or the Provisioning Tool.

NES version 3.1 meters optionally support demand metering, which offer various types of calculations that can be performed to measure the peak active and reactive power being delivered to the system over a designated time period. For more information on demand metering, see Chapter 4, *Demand Metering*.

NES version 3.1 meters also include a Multipurpose Expansion Port (MEP) that allows external MEP devices to connect to the meter and access meter data and run meter procedures. For more information on MEP devices, see Chapter 6, *MEP Devices*.

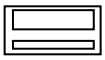
Reading the Display

The indicators on the meter display designate which value is being displayed and provide indication of various operating parameters. The format of the 8-digit value is configurable as to the number of digits, viewing of leading zeros, and the decimal point location. See the *NES Provisioning Tool User's Guide* for information on configuring display options. Refer to Figure 3.1 and the following table for a description of the display features:

Figure 3.1: Meter Display, All Segments Lit

Item Displayed	Value Format	Indicator	Function
All segments lit		All	Confirms proper operation of the display.
Value ID code	Any letter or number x.x.x.x.		Identification code for present displayed value. Maximum of 4 characters, letters or numbers.
Value	xxxxx.x.x.x		Number value. Maximum of 8 numbers and decimal point of 3 possible places.
Present tariff period		**T1, T2, T3, T4**	Indicates the present operating tariff period.
Forward active energy			Indicates that forward active energy is flowing. This is also displayed if there is no present active energy flow and the previous flow was in the forward direction.
Reverse active energy			Indicates that reverse active energy is flowing. This is also displayed if there is no present active energy flow and the previous flow was in the reverse direction.
Import reactive energy			Indicates that import reactive energy is flowing. This is also displayed if there is no present reactive energy flow and the previous flow was in the import direction.
Export reactive energy			Indicates that export reactive energy is flowing. This is also displayed if there is no present reactive energy flow and the previous flow was in the export direction.
Control relay 1 open			Indicates that control relay 1 is in the open position.
Control relay 2 open			Not used.
Load disconnect open			This display indicator can be configured by the user to either reflect the current state of the load disconnect contactor, or to indicate whether or not load side voltage has been detected by the meter. For more information on this, see “Display Indicator for Disconnect Position and Load Side Voltage” on page 1.
Dollar value	xxxxx.x.x.x	**$**	(Not used) Currency value of prepay credit remaining is displayed in Dollars.
Euro value	xxxxx.x.x.x	**€**	(Not used) Currency value of prepay credit remaining is displayed in Euros.
Correct 3-phase wiring		**L1L2L3**	Correct wiring configuration order for all 3 phases. (Does not detect reversed line and load wires or swapped line and neutral.)

Item Displayed	Value Format	Indicator	Function
Reverse 3-phase wiring		**L3L2L1**	Indicates that 3-phase wiring is installed in the wrong order. (Does not detect reversed line and load wires or swapped line and neutral.)
Tamper switch open			Indicates that the main cover tamper switch is open. The cover is not installed or not installed correctly.
PLC traffic detection			This icon is lit when PLC communication on the network has been detected by the meter. See “Power Line Carrier Communication” on page 1 for detailed information.
PLC received message occurrence and quality			This icon indicates that PLC communication occurred with this specific meter within the last X minutes (X is configurable from 1 to 65535 minutes) and shows the quality of the most recent received PLC message. – No bars = no message received for this meter – Smallest bar = a poor quality message – Both smallest and medium bar = a medium quality message – All three bars = a high quality message See “Power Line Carrier Communication” on page 1 for detailed information.
Line 1 voltage		**L1**	Indicates that voltage is present on line 1.
Line 2 voltage		**L2**	Indicates that voltage is present on line 2.
Line 3 voltage		**L3**	Indicates that voltage is present on line 3.
Meter date	dd:mm:20yy	**DATE**	Present local date in meter, or a self-read record date, is displayed.
Meter time	hh:mm:ss	**TIME**	Present local DST time in meter, or a self-read record time, is displayed.
Reactive energy	xxxxx.x.x.x	**kvarh**	Accumulated import or export reactive energy is displayed.
Active energy	xxxxx.x.x.x	**kWh**	Accumulated kilowatt-hours of forward, reverse, forward + reverse, or forward – reverse active energy is displayed.
Reactive power	xxxxx.x.x.x	**kvar**	Import or export reactive power is displayed.
Active power	xxxxx.x.x.x	**kW**	Kilowatts of forward or reverse active power is displayed.
End of Interval		**EOI**	(Not used) Indicates that a demand reset has occurred and that a new demand interval has started.

Item Displayed	Value Format	Indicator	Function
Disconnect status			This display indicator, can be configured by the user to either reflect the current state of the load disconnect contactor, or to indicate whether load side voltage has been detected by the meter. If it is configured to reflect the current state of the load disconnect contactor, it will be illuminated when the load disconnect contactor is in the open position. If it configured to indicate whether or not load side voltage has been detected by the meter, it will be illuminated when there is no load side voltage detected by the meter. For more information on this, see "Display Indicator for Disconnect Position and Load Side Voltage" on page 1.
Nameplate message active		**F0, F1, F2**	Indicates the nameplate messages that are presently active in the meter. See additional description following this table.
Load side voltage detected		**F4**	Depending on your meter's configuration, this icon may be used to indicate whether or not load side voltage has been detected by the meter. For more information on this, see "Display Indicator for Disconnect Position and Load Side Voltage" on page 1.
Prepay enabled			Prepay is enabled in the meter.
Self-read/One-time read error			Indicates that the current Self-read or One-time-read record that is being displayed has errors that may affect register accuracy.
Access lockout override in effect			The access lockout settings are deactivated by hardware screw.
Negative number indicator		**(-)**	The number displayed is negative
Test mode indicator		**TEST**	The meter is in test mode. This icon turns on when the meter enters test mode, and turns off when it exits test mode.
Tilt sensor indicator		**TILT**	The meter includes a sensor that will detect when the meter has been tilted. This icon indicates that the sensor has detected a tilt condition.
Simulated mechanical wheel			The simulated mechanical wheel will scroll through each of the six indicators at a rate that indicates the amount of energy consumed/produced as well as the direction of energy flow.

Item Displayed	Value Format	Indicator	Function
ANSI meter form indicator		**2S**	This icon will be used to display the present ANSI meter form being used. All ANSI v3.1 meters use form 2S.
Name plate message		**MP**	Indicates that the MEP device connected to the meter is registered.
MEP communication indicators			These icons can be configured to flash or remain on when communication with a MEP device is occurring.

Error and Caution Display Messages

Various error and caution message codes can be shown on the display. A diagnostic event can be configured by the user to be shown as either an error or caution message, or can be set to not appear on the display. The action of each type is:

- Caution message codes are shown at the end of the regular scroll list, when a caution is present. Scrolling continues for all display items.
- Error message codes override all regular display items and only the error message codes are displayed. Scrolling stops for regular display items when an error is displayed.

Once an error or caution occurs, the display continues to show the error or caution code until it is cleared. The codes persist across power outages and continue to display after the meter is powered down and back up. The error or caution codes are read and cleared by NES System Software via PLC communication with the Data Concentrator, or directly with the Provisioning Tool via the meter optical port.

All error and caution message codes can be read by the Data Concentrator and sent to NES System Software, even when not selected to appear on the display.

If more than one error or caution is active, the displayed characters are a combination of the error or caution values. See "Self Tests and Diagnostic Messages" on page 1 for a list of the diagnostic messages and an explanation of display codes.

Display Value ID Code

The display value ID code is the user configurable 1 to 4 character alpha/numeric identifying code for the value currently shown in the 8-digit value field of the meter display. Different codes are used for power values and error and caution diagnostic values. See the *NES Provisioning Tool User's Guide* for more information on creating value ID codes. Figure 3.2 shows the 4-character display value ID location.

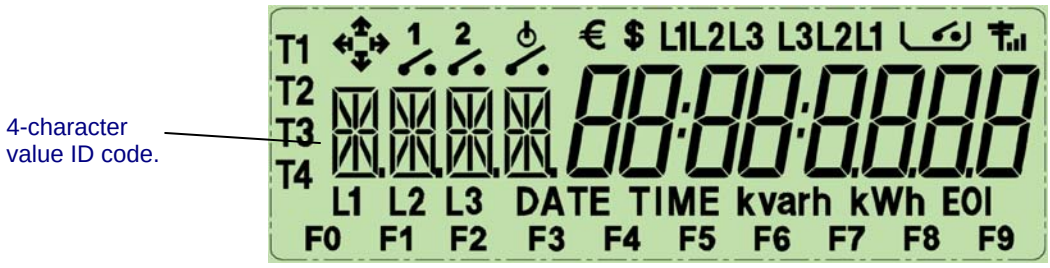


Figure 3.2: Display, 4-Character Value ID Code

Nameplate Message Identifiers

Various messages may be listed on the front of the meter in the nameplate area. These messages describe certain states, functions, or actions that could be operating in the meter. When any of the message states or functions are active in the meter, the corresponding identifier F0, F1, or F2 is illuminated on the display. The meter nameplate also includes an erasable strip that can be used to add more data to the meter display.

Low Voltage Display

During a brownout condition, the meter display will show **VOLT LO**. This will continue to be displayed until the meter is powered back up, or until it is completely powered off. The meter display will also briefly show **VOLT LO** when the meter is powered down normally, although the message will not persist in this case.

Display Value Items

The meter can display up to 30 numeric value items, which are chosen from the available total and tariff energy measurements, as well as time, date, and prepay energy credit remaining. The display scrolls through each item, with a programmable scroll-time for each item of 6 to 15 seconds. The scroll-time is the time that the value is shown on the display before scrolling to the next item. Each item has a unique programmable 4-character ID code that is displayed along with the value item.

You can use the meter push button to automatically advance to the next display value item, before the scroll-time expires. Alternatively, you can disable automatic scrolling, so that the push button must be used to advance the meter display to the next item at all times. For more information on the meter push button, see "Push Button Operation" on page 1.

The decimal point location for energy values is configurable, with an available range of 1 to 8 digits to the left and 0 to 3 digits to the right of the decimal point. The display of leading zeros can also be suppressed. The decimal point location and zero suppression apply only to register values and prepay totals. Other display items, such as date, time, firmware version, TOU calendar ID, and diagnostic codes are not affected by the decimal point location and zero suppression settings.

When an actual value is larger than the number of digits configured to the left of the decimal point, the most significant digits are not displayed. This allows the most frequently changing digits to display. The actual stored values are not affected.

The following are the choices of items that are available to be shown on the meter display. The summation and self-read items can be per-tariff or a total of all 4 tariffs, except for the power outage values, the error counter, which show only totals.

Value Type	Item Description
Summation / accumulators	Forward active kWh L1+L2+L3
Summation / accumulators	Reverse active kWh L1+L2+L3
Summation / accumulators	Forward + reverse active kWh L1+L2+L3
Summation / accumulators	Forward – reverse active kWh L1+L2+L3

Value Type	Item Description
Summation / accumulators	Import reactive kvarh L1+L2+L3
Summation / accumulators	Export reactive kvarh L1+L2+L3
Summation / accumulators	Power outage duration minutes (accumulation of all outages since last reset)
Summation / accumulators	Power outage count (number of outages since count was last reset to 0)
Summation / accumulators	Error Counter - A count of the number of alarms that have occurred for RAM Failure, Non-Volatile Memory Failure, Clock Error, Measurement Error, Cover Removed, and Save-All Aborted.
Present / instantaneous	Forward active kW L1+L2+L3
Present / instantaneous	Reverse active kW L1+L2+L3
Present / instantaneous	Import reactive kvar L1+L2+L3
Present / instantaneous	Export reactive kvar L1+L2+L3
Present / instantaneous	RMS current L1
Present / instantaneous	RMS current L2
Present / instantaneous	RMS current L3
Present / instantaneous	RMS voltage L1
Present / instantaneous	RMS voltage L2
Present / instantaneous	RMS voltage L3
Present / instantaneous	Power factor L1
Present / instantaneous	Power factor L2
Present / instantaneous	Power factor L3
Present / instantaneous	VA power L1+L2+L3
Present / instantaneous	Frequency
Present / instantaneous	Sine of phase angle L1 (angle between voltage and current on L1)
Present / instantaneous	Sine of phase angle L2 (angle between voltage and current on L2)
Present / instantaneous	Sine of phase angle L3 (angle between voltage and current on L3)
Demand	Date/time
Demand	Previous demand value
Demand	Present demand value
Demand	Cumulative demand value
Demand	Continuous cumulative demand value
Demand	Maximum demand value
Note: The demand values listed above are available to be displayed for any of the 8 configurable demand sources. The 8 demand sources are forward power, reverse power, forward + reverse power, and forward - reverse active power, as well as for reactive power for all 4 quadrants.	
Self-read/One-time-read/ Historical demand reset	Forward active kWh L1+L2+L3
Self-read/One-time-read/ Historical demand reset	Reverse active kWh L1+L2+L3
Self-read/One-time-read/ Historical demand reset	Forward + reverse active kWh L1+L2+L3

Value Type	Item Description
Self-read/One-time-read/ Historical demand reset	Forward – reverse active kWh L1+L2+L3
Self-read/One-time-read/ Historical demand reset	Import reactive kvarh L1+L2+L3
Self-read/One-time-read/ Historical demand reset	Export reactive kvarh L1+L2+L3
Self-read/One-time-read/ Historical demand reset	Power outage duration seconds (accumulation of all outages since last reset)
Self-read/One-time-read/ Historical demand reset	Power outage count (number of outages since count was last reset to 0)
Self-read/One-time-read/ Historical demand reset	Error Counter – A count of the number of alarms that have occurred for RAM Failure, Non-Volatile Memory Failure, Clock Error, Measurement Error, Cover Removed, and Save-All Aborted.
Self-read/Historical demand reset date and time	Date and time that a self-read occurred
Note: Self-read and One-time-read values can be configured to display from any of the 24 Self-read or One-time-read data sets stored in the meter, and for 12 of the historical demand reset data stored in the meter.	
Date	Local DST (Daylight Saving Time) date in meter
Time	Local DST (Daylight Saving Time) time in meter
Pre-pay, total	Prepay credit remaining, in Wh
Pre-pay, emergency	Prepay emergency credit remaining, in Wh
TOU calendar ID	Identifier of the Time-of-Use calendar that is presently operating
Firmware version	Firmware version currently running in the meter. You can configure the meter to display its firmware version for 1-15 seconds on power-up, if desired. When the firmware version is shown on the meter display, the alphabet character portion is shown as a numeric value. The letter “a” is shown as 01, “b” as 02, “c” as 03, and so on through the alphabet. For example, firmware version 1.00a is shown on the meter display as 01 00 01.
Disconnect Open	The meter can be configured to display the reason the load disconnect contactor has been opened as a user-specified text string. The following characters are not supported: K, M, Q, V, W, X. Note that the digit “2” is used to represent the letter “Z,” the digit “1” is used to represent the letter “I” and the digit “5” is used to represent the letter “S.”
Demand Resets	The number of demand resets that have occurred.
Load Side Voltage Detected	The meter can be configured to automatically reject remote closing of the load disconnect contactor when load side voltage is present, and to display the reason for this as a user-specified text string. The same character restrictions as described for the Disconnect Open display item above apply. For more information on this feature, see “Remote Disconnect” on page 1.

Push Button Operation

The push button on the front of the meter (next to the display and labeled **LCD**), performs various functions. The button functions are:

- **Display Advance:** When pushed and released in less than 3 seconds, the display immediately advances to the next item. After a change to a new item due to the activation of the push button, the display shows the item until either the button is pushed again or the regular scroll time (on time) expires, whichever occurs first. Once the regular scroll time expires, the display returns to its normal operation.
- **Prepay Credit Alarm Silencing:** When the audible prepay credit alarm is activated (due to a low or exhausted prepay credit level) the button can be pushed for any length of time to silence the alarm.
- **Push Button Hold Time:** When the button is pushed and held down for longer than 3 seconds, the display changes to show the number of seconds that the button has been held, and the ID code changes to "PTIM." This allows you to track how long the button has been held in order to activate a desired function.

Self Tests and Diagnostic Messages

The meter performs a comprehensive self-test at power-up and periodically performs additional diagnostics and self-tests, with messages created to indicate the occurrence of alarm or error conditions. Some self-tests are performed every second, minute, hour, daily, or weekly, and some self-tests are performed on power-up only.

Detected faults can be read by the Data Concentrator and transmitted to NES System Software, and can also be read directly from the meter via the optical port using the Provisioning Tool. Diagnostic or alarm flags are set for the specific condition and must be cleared either via the optical port (using the Provisioning Tool) or by NES System Software through the Data Concentrator. You can configure the meter to show selected message codes on the display as cautions or errors.

Understanding Display Diagnostic Codes

The diagnostic codes are hexadecimal values, which will allow all possible diagnostic events to be shown on the display simultaneously. If more than one error or caution is occurring, the displayed characters are a combination of the error or caution values.

Diagnostic Event Descriptions

The following table lists the diagnostic events that can generate error or caution messages. The Display Code column shows the value for each event, and is the value shown on the meter display when only one event in each digit position is being reported. When more than one event is being reported for the same digit position, the displayed value is the sum of the event codes. Message codes are displayed on 2 screens, with scrolling between them occurring at the standard scroll time set for the normal display sequence.

Error or Caution Item	Display Code	Description	Self-Test Schedule
Screen 1			
	Display Code Digit Position 8		
Configuration Error	00000002	PLC communications IC initialization failed	At power-up
System Reset	00000004	Watch-dog reset or event buffer overflow occurred. May be due to momentary voltage interruption.	Upon occurrence

Error or Caution Item	Display Code	Description	Self-Test Schedule
RAM Failure	00000008	Memory corruption occurred.	Upon occurrence
	Display Code Digit Position 7		
ROM Failure	00000010	Invalid CRC in Bootrom	
Non-Volatile Memory Failure	00000020	CRC verification failed. Memory may have been corrupted.	At power-up
Clock Error	00000040	Loss of clock memory data or clock functions have been suspended due to meter having been without AC power for an extended period of time.	At power-up
Measurement Error	00000080	Metering error occurred.	Once per second
	Display Code Digit Position 6		
Low Battery	00000100	Real Time Clock backup battery is below 2.5V.	Daily
Power Failure	00000800	Power failure occurred since this flag was last cleared. Detected upon occurrence at time of power-down.	Upon occurrence
	Display Code Digit Position 5		
Cover Removed	00001000	The meter main cover has been removed. Considered a tamper event.	Once per second
Reverse Energy	00002000	Meter has registered reverse power for 10 consecutive seconds. Considered a possible tamper event.	Once per second
Data Backup Incomplete	00004000	A data backup procedure did not complete.	At power-up
Disconnect Switch Error	00008000	Disconnect open/closed state may be incorrect. **Note:** This flag is also set when the voltage isolation link is removed for accuracy testing.	Upon occurrence
	Display Code Digit Position 2		
Load Profile Overflow	01000000	Load profile memory overflow occurred; unread records have been overwritten.	Every load-profile interval
Self-Read Occurred	02000000	New self-read has been recorded. Diagnostic event coincides with self-read schedule.	At self-read
Load Disconnect Open	04000000	Disconnect switch has been opened (turned off) by meter internal command.	Upon occurrence and every hour while off command is active

Error or Caution Item	Display Code	Description	Self-Test Schedule
Control Relay Open	08000000	Control relay is in open state.	Upon occurrence and every hour while relay is open
	Display Code Digit Position 1		
Phase Loss	10000000	Phase loss detected. By default, this indicates that voltage below 61% of rated voltage has been detected on at least one phase. However, the percentage that constitutes a phase loss is user-configurable. Considered a possible tamper event.	Upon occurrence
Phase Inversion	20000000	Phase inversion detected. Neutral and one phase have been swapped. Considered a possible tamper event.	Upon occurrence
PLC Config Failure	40000000	Error reading PLC configuration data. Data may be corrupted.	At power-up
General Error	80000000	Power-down process error and/or display read-back failed.	Upon occurrence
Screen 2			
	Display Code Digit Position 8		
Invalid Password	00000001	An invalid password was entered during optical communications.	Upon occurrence
Remote Communications Inactive	00000002	Remote communications (PLC) inactive for the last 24 hours, by default. The duration required to trigger this alarm is now user-configurable.	Daily
Current on Missing or Unused Phase	00000004	Current flow greater than 2A detected on a phase with low or no voltage. This usually indicates that a Potential Test Link is open. Considered a possible tamper event.	Upon occurrence
Reserved	00000008	N/A	N/A
	Display Code Digit Position 7		
Reserved	00000010	N/A	N/A
Software CRC Error	00000020	Image ID or CRC error during boot-up procedure.	Upon occurrence
Code Bank Changed	00000040	Active (executing) code bank has been changed.	Upon occurrence
Load Profile Backfill Failed	00000080	Load profile was not backfilled at power-up because meter was off across midnight.	Upon occurrence
	Display Code Digit Position 6		
MEP Installed or Removed	00000100	Indicates that a MEP (Multipurpose Expansion Port) module has been field installed or removed from the electric meter.	Upon occurrence

Error or Caution Item	Display Code	Description	Self-Test Schedule
MEP Alarm	00000200	A MEP alarm has occurred.	Upon occurrence
Reserved	00000400	N/A	N/A
Phase Rotation Changed	00000800	Wiring positions for a 3-phase meter have changed, or any of the phases are inactive or missing.	Once per second
	Display Code Digit Position 5		
Prepay Credit Exhausted	00001000	Prepay credit has gone to 0 (zero).	Upon occurrence
Prepay Warning Acknowledged	00002000	User has pushed the button on the front of the meter to turn off the audible prepay low credit alarm.	Upon occurrence
Event Log Overflow	00004000	The event log is within 10% of using its total capacity.	Upon occurrence
Mfg Log Entry Available	00008000	A meter One-time-read or M-Bus One-time-read has occurred.	Upon occurrence
	Display Code Digit Position 4		
Log Dimension Changed	00010000	The size of one or more logs has changed, possibly impacting how the data is read. For internal use only.	Upon occurrence.
Not used	00020000		
Access Lockout Override	00040000	The access lockout has been deactivated. The access lockout settings were not, or are not, in effect.	Upon occurrence
Power Quality Event Detected	00080000	A power quality event (sag/surge/over-current) has been detected on one or more phases.	When any new event is detected on any phase, or when any event is removed from any phase.
	Display Code Digit Position 3		
Event Log Unread Entries	00100000	One or more unread entries exist in the event log. This alarm is cleared automatically when there are 0 unread entries.	Upon occurrence
THD Event Detected	00200000	A THD (total harmonic distortion) event has occurred.	Upon occurrence
Unread Entries Exist in Load Profile	00400000	Unread entries exist in the load profile log.	Upon occurrence

Reading Diagnostic Code Combinations

The diagnostic codes are assigned a display digit position, with up to 4 items assigned to each position. When more than one diagnostic event is being reported for the same digit position, the displayed value is the sum of all event codes. When the

added value of the code digits exceeds 9, it will be represented by a hexadecimal letter. The following table shows the numeric equivalent of the hexadecimal letter.

Hexadecimal Character Shown on Display	Numeric Value
A	10
B	11
C	12
D	13
E	14
F	15

Figure 3.3 shows the reference numbering of the display digit positions, and the 4-character value ID location.

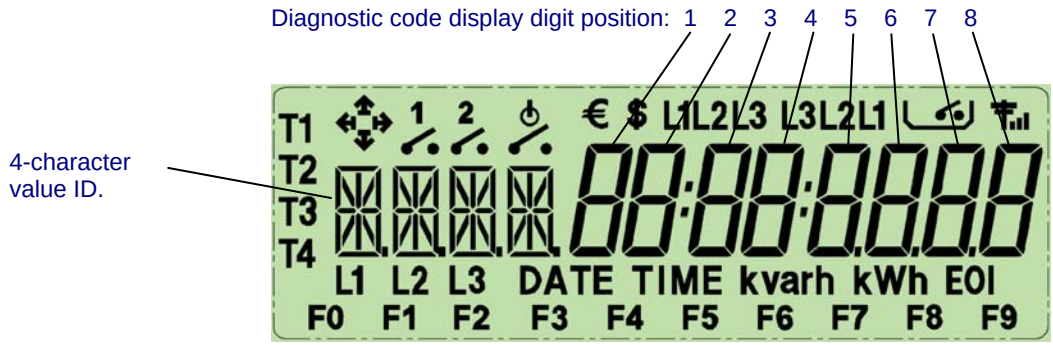


Figure 3.3: Display, All Segments Lit. Diagnostic Code Display Character Locations

Diagnostic Code Interpretation Examples

The display shows on screen 1: **0E001000**

For this example, "E" is in Display Code Digit Position 2. E = a numeric value of 14. The following diagnostic events are indicated since their display code sum is 14: "Self-Read Occurred, Disconnect Switch Open, and Control Relay Open."

"1" is in Display Code Digit Position 5. The following diagnostic event is indicated: "Cover Removed."

The display shows on screen 2: **00000180**

For this example, "1" is in Display Code Digit Position 6. The following diagnostic event is indicated since its display code sum is 1: "Low Battery."

"8" is in Display Code Digit Position 7. The following diagnostic event is indicated since its display code sum is 8: "LP Fill Error."

Look-Up Table for Code Combinations

The following look-up tables show the diagnostic events indicated for all possible display characters in each digit position for screen 1 and screen 2.

Codes for screen 1:

Display Character	Digit Position – Screen 1							
	1	2	3 (not used)	4 (not used)	5	6	7	8
1	Phase Loss	LP Overflow			Cover Off	Low Battery	ROM Failure	
2	Phase Inv.	Self-Read			Rev. Energy		NV Mem Fail	Config Error
3	Phase Loss	LP Overflow			Cover Off		ROM Failure	
	Phase Inv.	Self-Read			Rev. Energy		NV Mem Fail	
4	PLC Fail	Disconnect Open			Backup Incomplete		Clock Error	System Reset
5	Phase Loss	LP Overflow			Cover Off		ROM Failure	
	PLC Fail	Disconnect Open			Backup Incomplete		Clock Error	
6	Phase Inv.	Self-Read			Rev. Energy		NV Mem Fail	Config Error
	PLC Fail	Disconnect Open			Backup Incomplete		Clock Error	System Reset
7	Phase Loss	LP Overflow			Cover Off		ROM Failure	
	Phase Inv.	Self-Read			Rev. Energy		NV Mem Fail	
	PLC Fail	Disconnect Open			Backup Incomplete		Clock Error	
8	General Error	Relay Open			Disconnect Switch Error	Power Fail	Meas. Error	RAM Failure
9	Phase Loss	LP Overflow			Cover Off	Low Battery	ROM Failure	
	General Error	Relay Open			Disconnect Switch Error	Power Fail	Meas. Error	
A (=10)	Phase Inv.	Self-Read			Rev. Energy		NV Mem Fail	Config Error
	General Error	Relay Open			Disconnect Switch Error		Meas. Error	RAM Failure
B (=11)	Phase Loss	LP Overflow			Cover Off		ROM Failure	
	Phase Inv.	Self-Read			Rev. Energy		NV Mem Fail	

Display Character	Digit Position – Screen 1							
	1	2	3 (not used)	4 (not used)	5	6	7	8
	General Error	Relay Open			Disconnect Switch Error		Meas. Error	
C	PLC Fail	Disconnect Open			Backup Incomplete		Clock Error	System Reset
(=12)	General Error	Relay Open			Disconnect Switch Error		Meas. Error	RAM Failure
D	Phase Loss	LP Overflow			Cover Off		ROM Failure	
(=13)	PLC Fail	Disconnect Open			Backup Incomplete		Clock Error	
	General Error	Relay Open			Disconnect Switch Error		Meas. Error	
E	Phase Inv.	Self-Read			Rev. Energy		NV Mem Fail	Config Error
(=14)	PLC Fail	Disconnect Open			Backup Incomplete		Clock Error	System Reset
	General Error	Relay Open			Disconnect Switch Error		Meas. Error	RAM Failure
F	Phase Loss	LP Overflow			Cover Off		ROM Failure	
(=15)	Phase Inv.	Self-Read			Rev. Energy		NV Mem Fail	
	PLC Fail	Disconnect Open			Backup Incomplete		Clock Error	
	General Error	Relay Open			Disconnect Switch Error		Meas. Error	

Codes for screen 2:

Display Charac-ter	Digit Position – Screen 2							
	1 (not used)	2 (not used)	3 (not used)	4 (not used)	5	6	7	8
1			Event Log Unread Entries	Dimension Change	Prepay Exhausted	MEP Install / Remove	N/A	Bad PW
2			THD Event Detected	Not Used	Prepay Warn Ack	N/A	SW CRC Error	No Comm
3			Event Log Unread Entries	Dimension Change	Prepay Exhausted	MEP Install / Remove	N/A	Bad PW
			THD Event Detected	Not Used	Prepay Warn Ack	N/A	SW CRC Error	No Comm

Display Character	Digit Position – Screen 2							
	1 (not used)	**2** (not used)	**3** (not used)	**4** (not used)	**5**	**6**	**7**	**8**
4			Unread Entries Exist in Load Profile	Access Lockout Override	Event Log Overflow	N/A	Code Bank Changed	0 V Current
5			Event Log Unread Entries	Dimension Change	Prepay Exhausted	MEP Install / Remove	N/A	Bad PW
			Unread Entries Exist in Load Profile	Access Lockout Override	Event Log Overflow	N/A	Code Bank Changed	0 V Current
6			THD Event Detected	Not Used	Prepay Warn Ack	N/A	SW CRC Error	No Comm
			Unread Entries Exist in Load Profile	Acces Lockout Override	Event Log Overflow	N/A	Code Bank Changed	0 V Current
7			Event Log Unread Entries	Dimension Change	Prepay Exhausted	MEP Install / Remove	N/A	Bad PW
			THD Event Detected	Not Used	Prepay Warn Ack	N/A	SW CRC Error	No Comm
			Unread Entries Exist In Load Profile	Acces Lockout Override	Event Log Overflow	N/A	Code Bank Changed	0 V Current
8				Power Quality Event Detected	Mfg Log Entry Available	Phase Changed	LP Fill Error	N/A
9				Dimension Change	Prepay Exhausted	MEP Install / Remove	N/A	Bad PW
				Power Quality Event Detected	Mfg Log Entry Available	Phase Changed	LP Fill Error	N/A
A				Not Used	Prepay Warn Ack	N/A	SW CRC Error	No Comm
(=10)				Power Quality Event Detected	Mfg Log Entry Available	Phase Changed	LP Fill Error	N/A
B				Dimension Change	Prepay Exhausted	MEP Install / Remove	N/A	Bad PW
(=11)				Not Used	Prepay Warn Ack	N/A	SW CRC Error	No Comm

Display Character	Digit Position – Screen 2							
	1 (not used)	2 (not used)	3 (not used)	4 (not used)	5	6	7	8
				Power Quality Event Detected	Mfg Log Entry Available	Phase Changed	LP Fill Error	N/A
C (=12)				Access Lockout Override	Event Log Overflow	N/A	Code Bank Changed	0 V Current
				Power Quality Event Detected	Mfg Log Entry Available	Phase Changed	LP Fill Error	N/A
D (=13)				Dimension Change	Prepay Exhausted	MEP Install / Remove	N/A	Bad PW
				Access Lockout Override	Event Log Overflow	N/A	Code Bank Changed	0 V Current
				Power Quality Event Detected	Mfg Log Entry Available	Phase Changed	LP Fill Error	N/A
E (=14)				Not Used	Prepay Warn Ack	N/A	SW CRC Error	No Comm
				Access Lockout Override	Event Log Overflow	N/A	Code Bank Changed	0 V Current
				Power Quality Event Detected	Mfg Log Entry Available	Phase Changed	LP Fill Error	N/A
F (=15)				Dimesnion Change	Prepay Exhausted	MEP Install / Remove	N/A	Bad PW
				Not Used	Prepay Warn Ack	N/A	SW CRC Error	No Comm
				Access Lockout Override	Event Log Overflow	N/A	Code Bank Changed	0 V Current
				Power Quality Event Detected	Mfg Log Entry Available	Phase Changed	LP Fill Error	N/A

Power Quality

The meter monitors various parameters for power quality. Power quality events can be read by the Data Concentrator and transmitted to NES System Software, and can also be read directly from the meter via the optical port. When a power quality event

occurs, the status must return to normal for at least 1 second for another power quality event to be recorded. The meter provides power quality measurements for:

- **Voltage (RMS) sag (under voltage):** Records the number of voltage sag occurrences on any one phase. A voltage sag must last continuously for the time set in the meter Sag/Swell Duration Threshold to be recorded as an event. The threshold that determines if a voltage sag is recorded, is configurable as a percentage below the factory-rated voltage. The threshold range is 1 to 99%. The lowest voltage that occurred during the most recent sag (after the duration threshold is met) is recorded, as well as the date and time that the lowest recorded voltage occurred.

  The user-configurable Sag/Swell Duration Threshold sets the number of minutes that a voltage sag or swell must be sustained to be recorded as an event. A setting of 0 (zero) forces the recording of every detected event. The range is 0 to 255 minutes.

- **Voltage (RMS) swell (over voltage):** Records the number of voltage swell occurrences on any one phase. A voltage swell must last continuously for the time set in the meter Sag/Swell Duration Threshold to be recorded as an event. The threshold that determines if a voltage swell is recorded is configurable as a percentage above the factory-rated voltage. The threshold range is 1 to 99%. The highest voltage that occurred during the most recent swell (after the duration threshold is met) is recorded, as well as the date and time that the highest recorded voltage occurred.
- **Over-current (RMS):** Records the number of over-current events on any one phase. The over-current condition must last continuously for 10 seconds to be recorded as an event. The threshold that determines if an over-current condition is recorded is configurable as a percentage above the maximum current (as labeled on the meter cover) on any one phase.
- **Power outages:** Records the duration, power on date and time, and power off date/time of the last 10 long power outages. Records a count of all short power outages. The voltage must be below the internal power outage level and last longer than the time (in seconds) set in the user-configurable Power Outage Duration Threshold to be recorded as a long power outage event. The internal power outage level is permanently set to approximately 74% of the rated voltage. The range of the Power Outage Time Threshold is 0 to 65,535 seconds. Power outages that are shorter than the Power Outage Time Threshold, but at least 200 milliseconds (approximately), are counted as a short power outage. If the Power Outage Duration Threshold is set to 0 (zero) the duration and date/time of every power outage event longer than approximately 200 milliseconds is recorded, with complete records for the last 10 long outages. In this case, the short outage count is not incremented.
- **Frequency:** The frequency is constantly monitored (except for the first 1 to 2 seconds after power-up) and the maximum and minimum values, since last reset, are recorded along with the time of the event.
- **Phase loss:** Records the number of phase loss occurrences on any one phase as well as the date and time of the last occurrence. Voltage (RMS) drop on any phase below the internal phase loss level for a sustained duration of 10 seconds is considered a phase loss. The internal phase loss level is set to approximately 61% of the rated voltage by default, although this figure is user-configurable as of version 3.1. Since this event can affect the accuracy of the meter, energy accumulation is automatically reconfigured to exclude the lost phase. A phase loss error message can be shown on the display if

configured by the user. Phase loss also causes a diagnostic code to be activated.

- **Total harmonic distortion (THD)**: Records three types of total harmonic distortion: voltage total harmonic distortion (VTHD), current total harmonic distortion (ITHD) and VA (volts-amperes) total harmonic distortion (VATHD). THD is a ratio of the voltage or current at harmonic frequencies to the voltage or current at the fundamental frequency for the meter, expressed as a percentage. A THD event occurs when the value of any THD measurement exceeds the defined threshold for the duration specified for that threshold. For ANSI meters, THD measurements are made for the system and not per phase, meaning that if you have different harmonics on separate phases, the THD value reported by the ANSI meter will be a combination of those values.

  The number of total harmonic distortion events, the date/time of the last occurrence, the average value of the last occurrence, and the maximum value of the last occurrence are stored as power quality data, and can be recorded in the meter event log. A THD event occurs when the value for any THD measurement goes above the defined threshold for that THD value for the duration specified for that threshold.

Note: *ITHD calculations will be disabled when the current is lower than 200 mA,, because the current wave form will be distorted under these circumstances and the ITHD calculation will be invalid. VATHD calculation will also be affected by this threshold since its calculation is related to ITHD.*

Note: *THD calculations may be impacted by the meter's optical or PLC communications, so the time required to perform each THD calculation may vary.*

THD Calculations

There are two methods of calculating the VTHD and ITHD. The method used is user-configurable. The first method, shown below, is defined in IEC 61000-4-7.

$$VTHD = \sqrt{\frac{\sum_{N=2}^{10} V^2 rms\ of\ \ Nth\ order\ harmonic}{V^2 rms\ of\ \ fundamental\ component}}$$

$$ITHD = \sqrt{\frac{\sum_{N=2}^{10} I^2 rms\ of\ \ Nth\ order\ harmonic}{I^2 rms\ of\ \ fundamental\ component}}$$

The second method used to calculate VTHD and ITHD uses the RMS value to calculate the THD.

$$VTHD = \frac{\sum_{N=2}^{10} Vrms\ of\ \ Nth\ order\ harmonic}{Vrms\ of\ \ fundamental\ component}$$

$$ITHD = \frac{\sum_{N=2}^{10} Irms\ of\ \ Nth\ order\ harmonic}{Irms\ of\ \ fundamental\ component}$$

The following method is used to calculate VATHD.

$$VATHD = \frac{\sum_{N=2}^{10} (Vrms\ of\ \ Nth\ order\ harmonic\ *\ Irms\ of\ \ Nth\ order\ harmonic)}{Vrms\ of\ \ fundamental\ component\ *\ Irms\ of\ \ fundamental\ component}$$

Event Log

The event log records the occurrence of meter events and fault conditions that are selected to be logged. The date and time of each event occurrence is included in the log. Some events include numeric codes to provide more detail about the event, such as the specific type of action that occurred, a table or procedure number, or the new season or tariff that took effect. The event log shows a zero (0) when no code value is available for that event, or if one of the available codes is zero and that is the valid indication.

The event log stores up to 100 of the most recent events. When the event log is full, the oldest events are over-written.

Status Events

The following are status events that can be selected for inclusion in the event log.

Status Name	Description	Event ID	Descriptor
Primary Power Down	Power off date and time. **Note:** Power Up and Power Down events are only logged after the Power Outage Duration Threshold time has elapsed.	1	
Primary Power Up	Power on date and time. This event is triggered upon power restoration and also the other reset causes listed in the Codes column.	2	3 = Power failure 4 = Watchdog reset 5 = Code Bank Switchover event 8 = Brown-out 11 = Bootrom Switchover Other codes are for Echelon internal use
Time Changed (old time)	The previous date and time in effect when the time was changed.	3	0 = A specific, absolute new time was written to the meter. A time = An amount of gradual time change requested from the System Software. See procedures 2064 and 10 in the meter procedure tables below.

Status Name	Description	Event ID	Descriptor
Time Changed (new time)	If procedure 10 (absolute change) is used for the time change, this event time is the new time that was set. If procedure 2064 (gradual change) is used for the time change, this event time is the resulting new time after completion of the gradual change.	4	
Meter Accessed for Write	Date and time an outside source wrote data into a meter table or via a meter procedure into a table.	8	
Procedure Invoked	Date and time an outside source invoked a specific meter procedure. Enabling this event allows access to the procedure folders. Choose those procedures that are to trigger this event.	9	Procedure number
Table Written To	Date and time an outside source wrote to a specific meter table. Enabling this event allows access to the table folders. Choose those tables that, when written to, are to trigger this event.	10	Table number
Reset List Pointers	List pointers for load profile, self read or event log were reset. This changes the number of unread records to zero.	14	2 = self read 3, 7 = load profile 8 = event log 255 = all of the above
Update List Pointers	List pointers for load profile, self read, or event log were updated. This changes the number of unread records.	15	2 = self read 3, 7 = load profile 8 = event log 255 = all of the above
Event Log Erased	The event log was erased.	18	
Event Log Pointers Changed	Event log pointer position was changed.	19	New value for pointer
Demand Reset Occurred	A demand reset has occurred.	20	
Self-Read Occurred	A Self-Read occurred.	21	
Daylight Saving Time On	The meter switched into Daylight Saving Time.	22	
Daylight Saving Time Off	The meter switched out of Daylight Saving Time.	23	

Status Name	Description	Event ID	Descriptor
Season Change	A TOU season change occurred.	24	0 = Season 1 1 = Season 2 2 = Season 3 3 = Season 4
Special Schedule Activation	A day deemed as a TOU holiday.	26	0 = Special schedule A 1 = Special schedule B
Tier Switch Change	The meter switched from one tariff to another per day table settings or via procedure (forced tariff change).	27	0 = Tariff 1 1 = Tariff 2 2 = Tariff 3 3 = Tariff 4
Pending Table Activation	The TOU pending table was activated.	28	4119 = Internal system use 4150 = Preset TOU schedule changeover
Pending Table Clear	The TOU pending table was cleared.	29	4119 = Internal system use 4150 = Preset TOU schedule changeover was cancelled
Test Mode Started	The meter has entered test mode.	30	
Test Mode Stopped	The meter has exited test mode.	31	
Meter Reprogrammed	New firmware operating code was written to the meter.	36	New firmware version number (Echelon-internal formatting)

Status Name	Description	Event ID	Descriptor
Load Disconnect State Changed	The state of the load disconnect contactor has changed. This event codes return indicate the load disconnect contactor's current state, as well as the reason for the change in state.	66	Bits 0..3 indicate the current state: 1 = closed 2 = opened 3 = locked open Bit 4 indicates whether or not the change in state was successful: 0 = successful 1 = failure Bits 5 is reserved for future use. Bit 6: Previous internal status (MP30 and power-up resynchronizations only) 0 = open, 1 = closed Bit 7: Previous external status (MP30 and power-up resynchronizations only) 0 = open 1 = closed High byte indicates the reason the state has changed: 1 = MP02 operation 2 = Maximum Power 3 = Prepay 4 = Prepay Power 5 = MP23 operation 6 = Manual operation 7 = Schedule 8 = MP30 invoked 9 = Disconnect resynchronization occurred 10 = Power-up resynchronization occurred
Control Relay Open	Control relay is in open state.	67	
Invalid Password	An invalid password was entered during optical communications.	72	
Code Bank Changed	Active (executing) code bank has been changed.	78	
Load Profile Backfill Failed	Load profile was not backfilled completely at power-up because meter was off across midnight.	79	
MEP Auto-Discovery Complete	Indicates that the meter has completed a MEP auto-discovery process.	82	
Manufacturer Log Entry Occurred	An entry has been made in the manufacturer log.	87	

Status Name	Description	Event ID	Descriptor
Log Dimension Changed	The dimensions or semantics of the meter's interface have changed.	88	0000 = Initial meter load 0002 = Interface compatibility setting changed during commissioning. 0003 = Interface compatibility changed via a table write. 0xxx = Procedure invoked causing interface compatibility change, where xxx is the number of the procedure invoking the change
Unread Load Profile Entries Exist	Unread entries exist in the load profile log.	94	
MEP Status Changed	Status has changed for a MEP device.	96	0 = Device 0 is commissioned and assigned to position 1, 2, 3, or 4 1 = Device 0 commission failed, no available position 2 = Device 0 commission failed, lost communication 4 = Device 0 removed logically from meter 8192 = Device 1 is commissioned 8193 = Device 1 commissioned failed, no available position 8194 = Device 1 commission failed, lost communication 8196 = Device 1 removed logically from meter 16384 = Device 2 is commissioned 16385 = Device 2 commission failed, no available position 16386 = Device 2 commission failed, lost communication 16388 = Device 2 removed logically from meter 24576 = Device 3 is commissioned 24577 = Device 3 commission failed, no available position 24578 = Device 3 commission failed, lost communication 24580 = Device 3 removed logically from meter 32768 = Device 4 is commissioned 32769 = Device 4 commission failed, no available position 32770 = Device 4 commission failed, lost communication 32772 = Device 4 removed logically from meter 40960 = Device 5 is commissioned 40961 = Device 5 commission failed, no available position 40962 = Device 5 commission failed, lost communication 40964 = Device 5 removed logically from meter 40965 = Device 5 registered (MEP devices only)

Status Name	Description	Event ID	Descriptor
Maximum Power Level Threshold Switched	The maximum power level has changed.	97	0 = Max power level changed from primary to secondary 1 = Max power level changed from secondary to primary. The event is not generated if switch is attempted when meter is already in primary mode.
Maximum Value for Voltage THD Event	Maximum THD (total harmonic distortion) of the last finished voltage THD event, for the peroid that VTHD goes beyond or below the threshold.	100	Bits 0-1 of the argument is used to indicate the phase: 0 = phase A 1 = phase B 2 = phase C The remaining bits are used for the VTHD value. You can divide the argument value by 4 to get the THD value
Maximum Value for Current THD Event	Maximum THD of last finished ITHD event, for the peroid that ITHD goes beyond or below the threshold.	101	Bits 0-1 of the argument is used to indicate the phase: 0 = phase A 1 = phase B 2 = phase C The remaining bits are used for the ITHD value. You can divide the argument value by 4 to get the THD value
Maximum Value for Apparent Power THD Event	Maximum THD of last finished VATHD event, for the peroid that VATHD goes beyond or below the threshold.	102	Bits 0-1 of the argument is used to indicate the phase: 0 = phase A 1 = phase B 2 = phase C The remaining bits are used for the VATHD value. You can divide the argument value by 4 to get the THD value
Average Value for Voltage THD Event	Average THD of last finished VTHD event, for the peroid that VTHD goes beyond or below the threshold	103	Bits 0-1 of the argument is used to indicate the phase: 0 = phase A 1 = phase B 2 = phase C The remaining bits are used for the VTHD value. You can divide the argument value by 4 to get the THD value

Status Name	Description	Event ID	Descriptor
Average Value for Current THD Event	Average THD of last finished THD event, for the peroid that THD goes beyond or below the threshold	104	Bits 0-1 of the argument is used to indicate the phase: 0 = phase A 1 = phase B 2 = phase C The remaining bits are used for the ITHD value. You can divide the argument value by 4 to get the THD value
Average Value for Apparent Power THD Event	Average THD of last finished VATHD event, for the peroid that VATHD goes beyond or below the threshold.	105	Bits 0-1 of the argument is used to indicate the phase: 0 = phase A 1 = phase B 2 = phase C The remaining bits are used for the VATHD value. You can divide the argument value by 4 to get the THD value.
Disconnect Pulsed	The meter has pulsed the load disconnect contactor. This may occur when the physical state of the load disconnect contactor does not match the desired internal state. For more information on this, see "Load Disconnect Re-Synchronization" on page 1.	106	This event is primarily for diagnostic purposes. High byte nonzero → Argument format 1 Bit 0 = desired external state (0 = open, 1 = closed) Bit 1 = power down pending (0 => not pending) Bit 2..15 = low 16 bits of the program counter of the calling routine divided by 4 High byte all 0s → Argument format 2 Bits 0..7 = disconnect pulse count

Alarm Events

The following are alarm events that can be selected for inclusion in the event log.

Alarm Name	Description	Event ID	Descriptor
Configuration Error	Power Line Carrier (PLC) communications IC initialization failed. PLC may be non-functional. Urgent reporting priority is recommended.	37	Echelon internal use
System Reset	Watch-dog reset or event buffer overflow occurred. May be due to momentary voltage interruption. An unexpected software error has occurred. Urgent reporting priority is recommended.	38	0 = Watch-dog timeout 1 = Event buffer overflow, some events may be lost 2 = Abnormal power interrupt Other codes are for Echelon internal use

Alarm Name	Description	Event ID	Descriptor
RAM Failure	Memory corruption occurred.	39	1 = LP value corrupted 3 = Disconnect or control relay value corrupted 4 = RAM memory test error 5 = RTC code in NVRAM corrupted 6 = NVRAM alarm variable corrupted
ROM Failure	Invalid CRC in Bootrom.	40	
Non-Volatile Memory Failure	CRC verification failed. Memory may have been corrupted.	41	Table number: 65534 = Bootrom FRAM CRC/signature invalid 65535 = all tables
Clock Error	Loss of clock memory data or clock functions have been suspended due to meter having been without AC power for an extended period of time.	42	Echelon-internal use
Measurement Error	Metering error occurred. **Note:** This event is reported again on every power-up if the condition continues.	43	Echelon-internal use
Low Battery	Real Time Clock (RTC) backup battery is below 2.5V.	44	
Cover Removed / Tilt Detected	The meter main cover has been removed, or the meter has detected a tilt condition. Considered a tamper event. **Note:** This event is reported again on every power-up until the tamper condition is cleared.	47	If bit 0 is set to 1, then the cover has been removed. If bit 3 is set to 1, then a tilt condition has been detected.
Reverse Energy	Meter has registered reverse power for 10 consecutive seconds. Considered a possible tamper event.	48	
Data Backup Incomplete	A data backup procedure did not complete. Up to one hour's worth of billing and other FRAM data may have been lost. Urgent reporting priority is recommended.	49	

Alarm Name	Description	Event ID	Descriptor
Disconnect Switch Error	Disconnect open/closed state may be incorrect. This generally indicates that the internal state of the load disconnect contact does not match the acutal physical state of the load disconnect contactor. Depending on your meter's configuration, this even may also incicate that the meter has detected load side voltage. You can configure the meter to trigger either this alarm or the Load Side Voltage Detected alarm when load side voltage is detected. By default, the meter will use the Load Side Voltage Detected alarm, unless your meter was upgraded to use the v3.1 firmware from a version that did not include the Load Side Voltage Detected alarm. **Note:** This event is also set when the voltage isolation link is removed for accuracy testing.	50	For a complete description of the bits returned with this event, see "Load Disconnect Re-Synchronization" on page 1.
Load Profile Overflow	Load profile memory overflow occurred; unread records have been overwritten.	64	
Phase Loss	Phase loss detected. By default, this indicates that voltage below 61% of rated voltage has been detected on at least one phase. However, the percentage that constitutes a phase loss is user-configurable. Considered a possible tamper event. **Note:** This event is reported again on every power-up until the phase has been recovered.	68	1 = Line 1 Phase Lost (L1) 2 = Line 2 Phase Lost (L2) 3 = L1 & L2 4 = Line 3 Phase Lost (L3) 5 = L1 & L3 6 = L2 & L3 7 = L1 & L2 & L3
Phase Inversion	Phase inversion detected. Neutral and one phase have been swapped. Considered a possible tamper event.	69	2 = Plus 120° Inverted 4 = Plus 180° Inverted 6 = Minus 120° Inverted
PLC Config Failure	Error reading PLC configuration data. Data may be corrupted.	70	
General Error	Power-down process error and/or display read-back failed. An unexpected power-down sequence occurred. Urgent reporting priority is recommended.	71	0 = Power-down 1 = Display
Remote Communications Inactive	Remote communications (PLC) inactive for a user-specified length of time. You can specify the duration required to trigger this alarm (in minutes), and you can also disable the alarm completely.	73	

Alarm Name	Description	Event ID	Descriptor
Current on Missing or Unused Phase	Current flow greater than 2A detected on a phase with low or no voltage. This usually indicates that a Potential Test Link is open. Considered a possible tamper event. **Note:** This event is reported again on every power-up until the condition no longer exists.	74	1 = On line 1 (L1) 2 = On line 2 (L2) 3 = L1 & L2 4 = On line 3 (L3) 5 = L1 & L3 6 = L2 & L3 7 = L1 & L2 & L3
Software CRC Error	Downloaded firmware update image ID or CRC error during boot-up procedure. The code in the downloaded application may be corrupted. Non-urgent reporting priority is recommended.	77	
MEP Installed or Removed	Indicates that a MEP (Multipurpose Expansion Port) module has been field installed or removed from the electric meter.	80	0 = MEP module installed 1 = MEP module removed
MEP Alarm	A MEP alarm has occurred.	81	The MEP Status event returns a 15-bit argument indicating which MEP device the event has occurred on, and what event has occurred. Bits 15..13 identify the MEP device: 101 = MEP device Bits 12..0 identify the event that has occurred: 0 = Scheduled billing read completed 1 = Scheduled billing read completed with application errors 2 = Status read completed with device alarms 3 = Billing read overflow 4 = Device read failed 5 = Serial number mismatch occurred on billing read
Phase Rotation Changed	Wiring positions for a 3-phase meter have changed, or any of the phases are inactive or missing.	83	Present status: 0 = L1L2L3 1 = L3L2L1 2 = Rotation Unknown
Prepay Credit Exhausted	Prepay credit has gone to 0 (zero).	84	
Prepay Warning Acknowledged	User has pushed the button on the front of the meter to turn off the audible prepay low credit alarm.	85	
Magnetic Tamper	A magnetic tamper event has been detected.	89	

Alarm Name	Description	Event ID	Descriptor
Access Lockout Override	The access lockout settings have been deactivated.	90	0 = Override condition gone 1 = Override detected
Power Quality State Changed	A power quality event (sag/surge/over-current) has been detected. Bit mask, bit value 1 means event detected, value 0 means event cleared.	91	Bit 0 = phase A sag Bit 1 = phase B sag Bit 2 = phase C sag Bit 3 = phase A surge Bit 4 = phase B surge Bit 5 = phase C surge Bit 6 = phase A over-current Bit 7 = phase B over-current Bit 8 = phase C over-current
Voltage Sag	The lowest voltage of the last finished sag event. The timestamp indicates when the lowest voltage was detected. When a sag event occurs, the fractional part of the voltage value that caused the event is removed before it is recorded into the meter event log. As a result of this truncation, the voltage values in the event log that correspond to some sag events may not appear to exceed the threshold defined for sag events.	98	Bits 0-1 of the argument are used to indicate the phase: 0 = phase A 1 = phase B 2 = phase C The remaining bits are used for the voltage value in volts. You can divide the argument value by 4 to get the voltage value
Voltage Swell	The highest voltage of last finished surge event. The timestamp of this event indicates when the highest voltage is detected. When a swell event occurs, the fractional part of the voltage value that caused the event is removed before it is recorded into the meter event log. As a result of this truncation, the voltage values in the event log that correspond to some swell events may not appear to exceed the threshold defined for swell events.	99	Bits 0-1 of the argument are used to indicate the phase: 0 = phase A 1 = phase B 2 = phase C. The remaining bits are used for the voltage value, in volts. You can divide the argument value by 4 to get the voltage value.

Alarm Name	Description	Event ID	Descriptor
Load Side Voltage Detected	Depending on your meter's configuration, this even may incicate that the meter has detected load side voltage when the load disconnect contactor is in the open state. You can configure the meter to trigger either this alarm or the Disconnect Switch Error alarm when load side voltage is detected. By default, the meter will use the Load Side Voltage Detected alarm, unless your meter was upgraded to use the v3.1 firmware from a version that did not include the Load Side Voltage Detected alarm.	107	Bits 0-1 of the argument are used to indicate the type of load side voltage detected: 0 = Unknown 1 = Load side present, but phase cannot be determined. 2 = Load side voltage is present. If this is set to 1, then the following rules regarding bits 2-4 apply: • If Bit 2 is set to 1, then load side voltage is present on phase A. • If Bit 3 is set to 1, then load side voltage is present on phase B. • If Bit 4 is set to 1, then load side voltage is present on phase C.

Standard Tables

The following are the standard meter tables that can be selected for inclusion in the event log, when the status event Table Written To is selected.

Table	Name	Description
3	Meter Alarms and Status	Present meter status and all triggered alarms.
5	Device Identification	Meter hardware configuration and user-specified identification information.
6	Utility Information 1	Includes software version and vendor information and username of last user to provision the meter.
15	Transformer Ratio	Current transformer ratio.
23	Present Register Data	Present register data of energy measurements and calculations as well as error counters, total power outage minutes and number of occurrences.
24	Previous Season Data	A snapshot of the present register data taken at the time of the last season change.
26	Self-Read Data	A snapshot of the present register data taken at the programmed Self-Read time intervals. The most recent and up to 11 sets of previous Self-Read data are included.
33	Primary Display List	Items included for display and the duration and order.
53	Time Offset	Time zone offset and daylight saving time settings.
54	TOU Calendar	The Time-of-Use and Self-Read schedule settings.
73	Event Log Setup	Controls which events are logged.
4150	Pending TOU Calendar	Contains the pending TOU calendar for the meter.

Manufacturer Tables

The following are the meter manufacturer tables that can be selected for inclusion in the event log, when the status event Table Written To is selected.

Table	Name	Description
2048	Calibration Data	Contains the meter calibration data for power measurement.
2049	KYZ Setup	Contains the KYZ pulse rate and width.
2050	Clock Calibration	Contains the calibration parameters for the Real Time Clock.
2051	Utility Information 2	The utility serial number, program date and time, program number and program ID, and metering point identifier.
2052	System Information	Contains node, PLC setup information, as well as meter configuration and LonTalk information.
2053	Disconnect and Control Relay Settings	Contains settings for the load disconnect and control relay.
2055	Display Data Formatting	Sets data formatting and name-plate message for the meter display.
2057	Power Quality	Contains the power quality settings and recorded data.
2061	MEP Device Configuration	Contains the programmable configuration settings for each commissioned MEP device.
2070	Error Codes Configuration	Configuration of error codes shown on meter display.
2075	Transaction Requests	Contains records of transaction requests.
2078	Maximum Power Level Control	Contains the configuration information and status of the maximum power level control.
2079	One-time-read Data	A snapshot of the present register data taken at the programmed One-time-read time intervals. The most recent data set and up to 11 sets of previous One-time-read data sets are included.
2080	MEP One-time-read Data	A snapshot of the present MEP data taken at the programmed MEP One-time-read time intervals. The most recent and up to 11 sets of previous MEP One-time-read data are included.
2081	Group Configuration	Contains the group IDs assigned to the meter for group broadcast messages.
2082	MEP Device Configuration Parameters	Contains additional M-Bus and MEP device configuration parameters used for time synchronization and group broadcasting.
2086	Configuration ID Log	Contains a log of subsets of the meter’s configuration parameters.
2087	Previous Demand	Contains the demand values calculated at the end of the last demand sub-interval for each of the configured demand registers. Its values are set to 0 before demand is activated and configured.

Table	Name	Description
2088	Demand Configuration	Contains some configuration for demand and demand reset. Changing the demand reset time of day in this table could cause a reset cycle to be missed.
2089	Historical Demand Reset Log	Contains an adjustable log of previous demand reset data, including the latest demand reset data.
2093	MEP Recurring Log	Contains a log of MEP billing data.
2094	Control Output Read-Only Data	Contains control output data that are read only.
2095	Calendar Override Settings	Contains additional TOU calendar settings for manual override.
2097	LCD Output DIsplay	Contains the current contents of the meter display
2098	MEP Inbound Data Space	Holds status and controls relevant to the MEP device, and is normally only modified by the MEP device.
2099	MEP Device Configuration	Holds configuration parameters for the MEP device that control how the meter treats the MEP interface.
2100	MEP Transaction Request	Contains transaction requests from the MEP device.
2101	MEP Transaction Response	Contains transaction responses for the transactions requested from the MEP device.
2102	Meter Status	Holds meter status information.
2103	Meter Configuration	Holds meter configuration information.
2114	Load Profile Source ID Mapping	Contains a mapping of mapped source IDs to extended source IDs.
2115	Display Source ID Mapping	Contains a mapping of mapped source IDs to extended source IDs.
2098	MEP Inbound Data Space	Holds status and controls relevant to the MEP device, and is normally only modified by the MEP device.
2099	MEP Device Configuration	Holds configuration parameters for the MEP device that control how the meter treats the MEP interface.
2100	MEP Transaction Request	Contains transaction requests from the MEP device.
2101	MEP Transaction Response	Contains transaction responses for the transactions requested from the MEP device.
2102	Meter Status	Holds meter status information.
2103	Meter Configuration	Holds meter configuration information.
2114	Load Profile Source ID Mapping	Contains a mapping of mapped source IDs to extended source IDs.
2115	Display Source ID Mapping	Contains a mapping of mapped source IDs to extended source IDs.

Standard Procedures

The following are the standard meter procedures that can be selected for inclusion in the event log, when the status event Procedure Invoked is also selected.

Procedure	Name	Description
4	Reset List Pointers	Changes the number of unread records for load profile, self-read, or when the event log is set to zero, and clears the selected list.
5	Update Last Read Entry	Changes the number of unread records for load profile, self-read or event log.
10	Set Date and Time	Sets initial meter UTC date and time and adjusts for DST and time zone settings.
12	Activate all Pending Tables	Activates all pending tables.
13	Activate Specific Pending Tables	Activates specified pending tables (such as a pending TOU calendar).
14	Clear all Pending Tables	Clears all pending tables.
15	Clear Specific Pending Tables	Clears specified pending tables.

Manufacturer Procedures

The following are the meter manufacturer procedures that can be selected for inclusion in the event log, when the status event Procedure Invoked is also selected.

Procedure	Name	Description
2048	Self Calibration	The manufacturer self-calibration procedure started.
2049	Flash Refresh	Erases the flash and reprograms it with the currently executing code. A meter reset is invoked.
2050	Disconnect and Control Relay Command	Used to change the state of the load disconnect or control relay – forcing them open overrides the auto-determination of output state setup via provisioning. Invoking the procedure to close them either performs that action or, if activated via the provisioning program, returns back to the auto-determination state.
2051	Clear Alarms	Used to clear some or all of the meter alarms.
2056	Erase Code Bank	Used to erase memory for meter software updates.
2057	Download Code Packets	Used to download a new software image to the meter.
2058	Switch Code Bank	Switches to the code bank that is not currently in use.
2059	Configure/Reset Load Profile	Used to configure and erase the load profile.
2060	Record Self-Read	Used to perform an instantaneous Self-Read.
2061	Write Single Bit in Table	Used to modify a single bit in a single byte in a table.
2063	Force Tariff	Used to set meter into a specific tariff period, either indefinitely or until the next regularly scheduled change.

Procedure	Name	Description
2064	Update Clock Gradually	Performs a gradual clock adjustment to avoid skipping scheduled events and load profile records.
2066	Clear MEP Alarms	Clears the MEP (Multi-Purpose Expansion Port) meter detected and device alarms from table MT14.
2068	Change PLC Encryption Key	Used to modify the PLC encryption key value.
2069	Add Prepay Credit	Used to add prepay total or emergency credit.
2070	Switch Maximum Power Level	Switches from the primary to the secondary maximum power level, or vice versa.
2071	Remote Disconnect Reconnect	Remotely closes the load disconnect contactor. This will only be enabled if the remote disconnect feature is enabled in the meter.
2072	Post One-time-read Request	Requests a meter or M-Bus One-time-read,
2073	Reset Manufacturer Table Logs and Queues	Resets or clears all of the manufacturer logs and queues, including all One-time-read data.
2074	Update Mfg List Unread Entries	Updates the number of unread entries in all of the manufacturer logs and queues, including all One-time-read data.
2075	Add/Remove Group ID	Adds or removes the meter from a specific broadcast group.
2076	Enable/Disable Battery	Enables or disables the battery circuit within the meter hardware.
2082	Demand Reset	Triggers an immediate demand reset.
2084	Schedule Disconnect Lock Open	Schedules the load disconnect contactor to be locked in the open state.
2087	Post MEP Data	Posts on-demand MEP data to the MT16, or TOU-scheduled MEP data into MT45.
2089	MEP Download Initialize	Initializes firmware downloads to a MEP device.

Tamper Detection

Some diagnostic events can indicate a tamper condition. These tamper conditions are each tracked separately. Detected tamper events are sent to the Data Concentrator and transmitted to NES System Software, and can also be read directly from the meter via the optical port using the Provisioning Tool. Diagnostic or alarm flags are set for the specific condition and must be cleared either via the optical port, or by NES System Software through the Data Concentrator.

You can configure each type of tamper message to be shown on the display as either an error or caution message, or to not appear on the display.

Main Cover Removal

Removal of the meter main cover will initiate a tamper event. A cover removal tamper event is recorded whether power is on or off to the meter. Once power is restored, a report of the tamper condition is sent to NES System Software, if the meter is communicating with a Data Concentrator.

When the meter is installed, or the main cover is removed for servicing, a tamper diagnostic event is set in the meter.

Note: *When the main cover tamper event flag is set, additional activations of the tamper switch are not recorded. In this state, unauthorized removal and replacement of the cover could occur without detection. All tamper signals should be recorded and cleared regularly by NES System Software to reset the tamper event flag into a state to enable detection.*

Display Indicator for Cover Tamper Switch

This display indicator,  , is illuminated when the main cover tamper switch is open. This indicates that the main cover is not installed or not installed properly. Meter installation or service personnel should make sure this indicator is off after they have replaced the cover, to be sure the cover is installed properly and that the tamper switch is closed.

Reverse Energy

Reverse energy flow occurs when the meter has been installed upside down, or if the premise being metered generates power. The meter can detect reverse current flow on individual phases. If reverse current is detected for 10 consecutive seconds this tamper event is signaled.

Phase Inversion

Phase inversion is detected by the Data Concentrator only for single-phase applications and indicates that the neutral and the phase have been swapped. The Data Concentrator can be programmed to alert NES System Software to this condition.

The meter stores the last reported phase inversion status from the Data Concentrator. If a meter is connected to a Data Concentrator and a phase inversion is measured and reported to the meter, the alarm condition will persist, even if the meter is later powered up without a Data Concentrator and there is no longer a phase inversion present (unless this status was cleared by the system). A Data Concentrator must be connected to the meter and must measure and report the corrected phase status to the meter for the meter to stop logging this alarm.

Current Flow with No Voltage

When current flow greater than 2 amps is detected on a phase for which there is low or no voltage, the meter can report the event as a tamper condition. For this tamper detection to operate, at least one meter-phase must be powered (voltage present).

If a polyphase meter is configured for single-phase or two-phase operation, this tamper detection is not reported on unused phases.

Magnetic Tamper

The meter is equipped with a sensor that detects large external magnetic fields. If an external magnetic field is detected, the meter will automatically set an alarm. The alarm is read and reset through NES System Software, or via the local optical communications port. Typically, the magnetic tamper sensor is used to detect potential fraud when strong magnets (such as rare earth magnets) are placed in close proximity to the meter.

Tilt Conditions

The meter includes a sensor that will detect when the meter has been tilted, indicating that it may have been moved or tampered with. This meter display includes an icon that will appear when the sensor has detected a tilt condition. The meter event log also now includes an alarm indicating when a tilt condition has been detected.

Load Disconnect

The load disconnect contactor in the meter provides a manual means of load disconnect, automatic prepay control, automatic trip at programmed power levels, and remote disconnect operation. The load disconnect contactor can be electronically turned off as a result of several configurable conditions. It can be turned on manually using the disconnect switch push buttons. It can also be turned on remotely with NES System Software, or directly via the optical port using the Provisioning Tool. Note that the ability to turn on the load disconnect contactor remotely can be disabled, as described later in this section.

Display Indicator for Disconnect Position and Load Side Voltage

This display indicator,  can be configured by the user to either reflect the current state of the load disconnect contactor, or to indicate whether load side voltage has been detected by the meter.

If it is configured to reflect the current state of the load disconnect contactor, it will be illuminated when the load disconnect contactor is in the open position.

If it configured to indicate whether or not load side voltage has been detected by the meter, it will be illuminated when there is no load side voltage detected by the meter. When the load side voltage changes state, it can take up to one second for this icon to reflect the change. You should take care to notice when this icon is not illuminated and load side voltage is present for safety reasons, as the meter does not automatically close the load disconnect contactor when there is load side voltage present.

Note: *If this display indicator is configured to reflect the current position of the load disconnect contactor, the F4 icon will be used to indicate whether or not load side voltage has been detected. In this case, the F4 icon will be illuminated when there is no load side voltage detected.*

There are two conditions that must be true for this display indicator (or the **F4** icon) to illuminate when load side voltage has been detected. First, the load disconnect contactor must be open. Second, there must not be any load side generation (such as

from a portable generator or solar panel). This is done for safety considerations, as it is important to note that

Disconnect Push Button

The push button on the front of the meter closes the load disconnect contactor. If a command has been sent to the meter to set the load disconnect into the off state, manual activation of the button will not turn the disconnect contactor on.

The length of time that the button must be pushed to activate the load disconnect contactor is programmable. The range is 0 to 2.5 seconds. A setting of 0 provides immediate activation.

Remote Disconnect

The meter can be commanded to trigger the load disconnect contactor to the off-state, either remotely from NES System Software, or directly via the optical port using the Provisioning Tool. However, the capability to close the load disconnect contactor remotely can be disabled, since it could create a hazardous situation if a user who has opened the load disconnect contactor manually may not realize it has been closed remotely. You can disable this feature completely, so that the ability to close the load disconnect contactor remotely is always disabled. As an alternative, you can disable the feature partially, so that the ability to close the load disconnect feature remotely is only disabled if it has been manually opened.

You can also disable the ability to close the load disconnect contactor remotely if load side voltage is present or if load has been sensed. There are two ways to configure these settings. The meter can be configured to check if load side voltage is present and if load has been sensed. If either case is true, the ability to close the load disconnect contactor remotely will be disabled. The meter can also be configured to check if load side voltage is present without also checking if load has been sensed. In this case, the ability to close the load disconnect contactor remotely will be disabled if load side voltage is detected.

If a user attempts to close the load disconnect contactor remotely while either of these conditions exist, the operation will fail and a Load Disconnect State Changed alarm indicating the failure will be logged. In addition, you can specify text that will be shown on the meter display when an attempt to close the load disconnect contactor fails due to either one of these settings. Attempts to remotely close the load disconnect contactor will also fail if the meter is unable to determine whether or not load side voltage or load exists. This may occur if someone attempts to close the load disconnect contactor shortly after it was opened, as it will take the meter a moment to detect whether or not load side voltage is present. You can specify text that will be shown on the meter display when this occurs, as well.

Consumers will not be able to prevent or defeat load disconnect triggering since the disconnect mechanism operates even if the button is continuously pressed.

Disconnect Status

The OFF (open) or ON (closed) status of the load disconnect can be determined remotely via NES System Software and locally via the Provisioning Tool.

Locking the Disconnect in the Open State

You can configure the meter to lock the load disconnect contactor in the open state at a specific time for a set period of time. This procedure can also be used to cancel whatever schedule currently exists regarding the status of the load disconnect contactor. The load disconnect contactor will be locked open at the scheduled date/time until the configured duration has passed. If the duration is set to 0, the load disconnect contactor will remain open indefinitely until another a new command is issued that overrides the previous one.

If the meter is powered down at the preset date/time and the duration has not passed when it is powered back on, the meter will be locked open until the specified duration has elapsed (starting form the time the load disconnect contactor was locked open, and not when the meter was powered back on). The scheduled date/time and duration will be set to 0 if the duration expires while the meter is powered down, meaning that the load disconnect contactor will no longer be locked in the open state when power returns.

Prepaid Metering

The meter will automatically turn off the load disconnect contactor once the credit level in energy (not currency) has gone to zero in a prepaid metering installation. The meter reduces the amount of remaining credit based on energy usage and tariff level. This feature can be enabled or disabled.

The consumer must manually reset the load disconnect once a credit level is re-established in the meter. The meter will not allow re-engagement of the disconnect until credit is loaded into it remotely from NES System Software, or directly via the Provisioning Tool.

The meter can be configured so that a reverse energy flow deducts prepay credit just as if it was forward energy, or the meter can be configured so reverse energy does not deduct prepay credit.

Switching to Maximum Power when Prepay is Exhausted

The meter can either be configured to turn off the load disconnect or to switch into Maximum Power mode (to avoid complete power shutoff at the premises) once the prepaid credit is exhausted (has reached zero). When switching to Maximum Power mode, the Power Threshold on Exhausted Credit value (in watts) and the Maximum Power Duration Threshold settings are in effect (see descriptions below). Normal operation resumes when the prepay credit value is increased to above zero.

Emergency Prepay Credit

The meter can be configured to provide emergency credit after exhaustion of the standard prepay credit. The maximum emergency credit amount is configurable. If the emergency credit option is activated, it is automatically used upon exhaustion of standard prepay credit. Once emergency credit is exhausted, the load disconnect switch is turned off. It can only be turned back on when prepay credit level is reestablished.

The emergency credit can be replenished separately from the standard prepay credit, or they can be replenished together, with the emergency credit filling up to its maximum value and the balance going into the standard prepay credit.

Emergency credit can be used with either standard prepay mode or Prepay Maximum Power mode. If used with Prepay Maximum Power mode, either exhaustion of emergency credit or exceeding the maximum power threshold will cause the load disconnect to be turned off.

Audible Low Prepay Credit Alarm

The audible meter alarm can be configured to activate on a low or exhausted prepay credit level. The level of activation is configurable. You can turn the alarm off by pushing the button on the front of the meter. Once the audible alarm is turned on, it stays on until the button is pressed or until prepay credit is added above the alarm threshold. An event can be logged when the user acknowledges the alarm by pressing the button.

Meter Settings for Prepay

The values entered into the meter for prepay are in watt-hours (Wh). When there is just one tariff, T1 ("Prepay tariff rate 1" in the Provisioning Tool) should be set to 1,000 Wh per kWh. (The currency rate is whatever the utility charges per kWh, and that value is not entered into the provisioning program or meter.)

When there are additional prepay tariffs, the 1,000 Wh per kWh becomes the baseline and other tariff settings are a ratio of the baseline. The lowest value should always go into T1. Here's an example with all four tariffs used:

Tariff	Example Currency Rate, per kWh	Equivalent Setting in Meter - Wh per kWh
T1	0.09	750
T2	0.12	1,000 (this is the baseline amount)
T3	0.15	1,250
T4	0.18	1,500

Maximum Power Disconnect

The trip point of the load disconnect for excessive power use is programmable, and is based on a maximum active power value threshold and time duration that is utility configurable. After an excessive power condition trips the load disconnect, the consumer can manually reset it. If the trip point is still exceeded after manual re-latching, the load disconnect will shut off again within less than a minute.

This feature is intended primarily to limit consumer power usage, and is not to be used as the system safety over-current protection. This feature can be enabled or disabled. If both the regular Maximum Power and Maximum Power when Prepay Credit is Exhausted are active, either condition will turn off the disconnect contactor.

Warning: The load disconnect contactor does not have thermal overload or over-current protection. External fuses or a circuit breaker must be provided to protect the premises wiring system.

Primary and Secondary Maximum Power Level Thresholds

The meter contains both a Primary Power Level Threshold and a Secondary Power Level Threshold value. The meter can be programmed to use either value to determine when the load disconnect reaches its trip point. This value is the active

power level setting, in watts, at which the load disconnect contactor will turn off. This value is the sum of all 3 phases in a polyphase meter. The minimum value is 1,000 and the maximum is 72,000. As an example, a setting of 27,600 watts equals 40 amps per phase at 230 volts in a three-phase meter.

Switching the Maximum Power Level Thresholds

The meter can be programmed to switch from Primary Power Level Threshold to the Secondary Power Level Threshold at a specific time. If the start time specified has already passed, the switch will occur immediately.

The switch can be programmed to last indefinitely, or it can be programmed to last for a specific switch duration which can be set in minutes. If a switch duration is specified, the meter will use the Secondary Power Level Threshold for that duration before automatically switching back to the Primary Power Level Threshold.

This section provides additional information describing the behavior of the meter when switching between the two power level thresholds:

1. The meter tracks the switch duration across power outages. For example, consider a case where the meter receives a switch command at 8:00 A.M. with a start time of 9:00 A.M. and a switch duration of 4 hours. If a power outage occurs at 10:00 A.M. and power is not restored until 11:00 A.M, then the meter will still switch back to the Primary Maximum Power Level Threshold at 1:00 P.M.
2. The meter honors the start time of the switch in the event of a power outage. In this example, the meter receives a command at 8:00 A.M. to perform a switch at 9:00 A.M. with a switch duration of 4 hours. If a power outage occurs at 8:30AM and power is restored at 9:30AM, the meter will switch power level thresholds as soon as power is restored, and will switch back at 1:00 P.M, as initially scheduled.
3. If the start time for a switch has already passed when the meter receives the command, the meter will not prorate the switch duration for the difference between the requested start time and the time the command was received. The meter will evaluate at the new power level threshold for the entire switch duration. For example, if the meter receives a command at 8:00 A.M. with a start time of 7:00 A.M. and a switch duration of 4 hours, the switch will still last 4 hours, and the meter will switch back to the Secondary Maximum Power Level at 12:00 P.M.
4. If the meter receives a new switch command while it is already using the Secondary Maximum Power Level Threshold or has a pending start time to switch to the Secondary Maximum Power Level Threshold, the meter will disregard the previous command and follow the instructions of the new switch command. This results in the following 4 possible scenarios:

Old Command	New Command	Comments
In the future	In the future	The parameters of the new command replace those of the old command. The meter acts as if the old command never existed.
In the future	In the past	The meter behaves as if the old command never existed. The meter immediately switches to Secondary Maximum Power Level Threshold,

Old Command	New Command	Comments
		and remains at that level until the switch duration expires.
In the past	In the future	The meter is already using the Secondary Maximum Power Level Threshold when the new command is received. Since the meter is to ignore the old command and only follow the new command (which isn't active yet), it will immediately switch back to the Primary Maximum Power Level Threshold. The new command will be executed at its specified start time for its specified duration.
In the past	In the past	The meter is already using the Secondary Maximum Power Level Threshold when the new command is received. Since the meter is supposed to use the Secondary Maximum Power Level Threshold per the new command, it will continue to do so. The switch duration will be reset to use the entire duration specified for the new command. For example, consider a case where the meter is evaluating at the Secondary Maximum Power Level Threshold and is supposed to switch back to the Primary trip point at 11:00 A.M, per the old command. If the meter receives the new command at 10:00 A.M with a start time of 9:00 A.M. and a switch duration of 4 hours, the meter will switch back to the Primary Maximum Power Level Threshold at 2:00 P.M, 4 hours after receiving the new command.

Primary and Secondary Maximum Power Duration Thresholds

The meter contains both a Primary Maximum Power Duration Threshold and a Secondary Maximum Power Duration Threshold value. The Primary Maximum Power Duration Threshold is used when the Primary Power Level Threshold value is in use, and the Secondary Maximum Power Duration Threshold is used when the Secondary Power Level Threshold is in use.

This setting determines the duration (in minutes) that the active Maximum Power Level Threshold, or the Power Threshold on Exhausted Credit (described below), must be continuously met or exceeded for the load disconnect contactor to turn off. If the power drops below the level threshold, the duration is reset and starts counting again from zero when the power exceeds the level threshold again. When set to 0, the disconnect turns off immediately when the power value threshold is reached. The range is 0 to 255 minutes.

After the disconnect is shut off due to exceeding the power threshold settings, if the power threshold is still being exceeded after manual re-latching of the load disconnect, the disconnect will turn-off again in less than 1 minute.

Disconnect Power Trip Point Source

You can specify the active power level to act as the source for the disconnect power trip point source. The power value selected can be either the active forward and active reverse energy, or active forward energy only.

Power Threshold on Exhausted Credit

This is the active power level setting, in watts, at which the load disconnect turns off when prepay credit is exhausted (goes to 0). The Maximum Power Duration Threshold setting also affects this feature.

Load Disconnect Re-Synchronization

In some situations, the internal state of the load disconnect contactor (meaning the desired status of the load disconnect contactor as requested by NES System Software or the meter program) may not match the actual physical state of the load disconnect contactor. When this occurs, the meter may attempt to re-synchronize by changing the physical state of the load disconnect contactor to match the internal state. A Load Disconnect State Changed alarm will be reported if the resynchronization attempt succeeds, and a Disconnect Switch Error alarm is reported if it fails.

You should be aware that re-synchronizations will only be attempted if the load disconnect contactor was synchronized properly before the error occurred, and no Disconnect Switch Error alarm has yet been logged for this condition (meaning that multiple re-synchronizations will not be attempted for the same error condition).

If the meter is not able to determine the physical state of the load disconnect contactor and this condition persists for at least 2.5 seconds, then the meter logs a Disconnect Switch Error alarm and no re-synchronization will be attempted. Some examples of when this can occur are:

- The load disconnect contactor is open, and there is load side generation. Note that you can configure the meter to trigger the Load Side Voltage Detected alarm when load side voltage is detected.
- The meter is not wired correctly.
- The link is open and the measured instantaneous power level is non-zero or the sensor on the load disconnect contactor indicates closed.
- Some form of hardware error has occurred.

Resynchronization can be configured to be always enabled, always disabled or enabled only once the meter has been commissioned. The latter is recommended as it avoids anomalous behavior when the meter is used in pre-installation lab situations where the link is open.

Generally, the disconnect switch is not resynchronized when the meter powers up. If an out-of-sync condition is detected when the meter powers up, the state of the load disconnect contactor will be left as it is (meaning that it will be closed if it was closed before it powered down, or open if it was open before it powered down).

Note: *If voltage will be applied variably to the load conductors with the test voltage link open, then it must not be not applied initially (for several seconds) after the meter powers up to ensure that the meter has effectively disabled resynchronization attempts.*

However, if the state of the load disconnect contactor is changing as the meter powers down, then the meter will resynchronize the internal state of the load disconnect contactor so that it matches the current physical state when it powers back on. A Load Disconnect State Change will be logged, as well as a Disconnect Switch Error event (argument format 1) in this case.

Disconnect Switch Error Event Argument Formats

The Disconnect Switch Error event has several different arguments that contain information about why the event was logged and the state of the meter at that time. In summary, an argument value of 0x0054 or 0x005C means that load side generation was detected, and any other argument is indicative of an unexpected fault related to the load disconnect contactor. Below is more detail on the argument encoding.

Note: *Your meter may be configured to use the Load Side Voltage Detected error to indicate when load side voltage is present, in which case all arguments relevant to load side voltage as described below are unused.*

The argument type is identified by the lowest 3 bits of the argument itself.

Argument Format 2:

If Bits [2..0] are binary xx1 (where x can be either 0 or 1), then bits 1..3 represent the current status of the load disconnect contactor and the remaining bits are reserved for internal use. This argument is included every time the Disconnect Switch Error event is logged:

- Bits1..2: Internal State
  - 1 = closed
  - 2 = opened
  - 3 = locked open
- Bit 3: External State
  - 0 = open
  - 1 = closed

Argument Format 3:

If Bits [2..0] are set to binary x10, then it is a new occurrence of the condition. The rest of the argument information is reserved for internal use, but the Disconnect Switch Error event with argument format 2 will also be logged in this case and should provide some information as to the current state of the load disconnect contactor.

Argument Format 4:

If Bits [2..0] are set to 4 (binary 100), then the event has been logged because the disconnect feedback is unreliable or because the meter has detected load side generation when the disconnect is open. In this case, bits 3-6 indicate the following status, and the remaining bits are reserved for internal use.

- Bits 3..4: Internal State
  - 1 = closed
  - 2 = opened
  - 3 = locked open
- Bit 5: External State
  - 0 = open (NES version 3.1 meter) or not applicable (NES version 3.0 meter)
  - 1 = closed

- Bit 6: Load side voltage status
  - 0 = none
  - 1 = present
- Bits 7..15: Instantaneous Power Level
  - Sum of first four registers in ST28 (0 implies no power consumption measured in last 50 cycles)

Note: *Remember that your meter may be configured to use the Load Side Voltage Detected error to indicate when load side voltage is present, in which case the values listed above for Argument Format 4 should not be used.*

Low Voltage Operation

When operating below certain voltage levels and under different phase combination, the operation of the load disconnect contactor may become unpredictable. This section describes how to avoid disconnect operation under these conditions, and describes how users can be made aware of these conditions.

A manufacturing configurable voltage threshold can also be used to decide if disconnect operation is safe, as the power fail threshold is configurable and can be configured to be lower than the safe threshold. The voltage threshold for each phase is initially established based on the meter's hardware configuration.

Each active phase voltage in the meter is monitored at all times, including whenever a disconnect push button action is acknowledged. An internal flag will be set in the meter whenever the voltage combination is considered unsafe based on the voltage threshold. The flag will be cleared when the unsafe condition ceases to exists. Until the condition ceases to exist, all disconnect operations that require pulsing the load disconnect contactor will trigger the Load Disconnect State Changed event to track this. In addition, any local operation of the load disconnect contactor, will trigger the Load Disconnect State Changed event. This includes use of the disconnect push button, and the load disconnect contactor being turned off due to exhaustion of prepay credit or maximum power thresholds being reached, You should also note that if these conditions exist when a remote procedure is called to open or close the load disconnect contactor, the procedure will fail and an error code will be returned. However, an event will not be triggered.

If an attempt to manually open or close the load disconnect contactor using the disconnect push buttons fails because of a low voltage condition, the meter display will show scrolling text indicating this. The text that is displayed, and the amount of time that the text will be displayed for, is user-configurable.

Control Relay

One optional control relay can operate an external low current device, such as a contactor coil, which in turn can control a larger amperage device. The open or closed state of the control relay is determined by the present tariff level that is in effect. The tariff period that activates the relay is configurable. The relay can also be set into the open or closed state remotely by NES System Software, or locally with the Provisioning Tool.

When a broadcast command is sent to all meters to close the control relay, a user-configurable maximum random number of seconds can allow the actual implementation time to vary per meter. This is provided to reduce the possibility of spikes or sags on the power grid when multiple loads come online at roughly the

same time. When the maximum random number of seconds is set to 0 (zero), the relay will close immediately.

The control relay is a single-pole single-throw normally-open (1P-1T NO) dry (no output voltage) switch. The maximum load rating is 5A. Voltages above 40V, but not exceeding 250V can be routed through the relay.

Note: *The control relay is not fully electrically isolated in regard to certain safety considerations. It is physically isolated.*

Display Indicator for Control Relay Position

This display indicator is illuminated when the control relay is in the open position.

Remote Relay Status

The OFF (open) or ON (closed) status of the control relay can be determined remotely via NES System Software, or locally via the Provisioning Tool.

LED Pulse OutputFor accuracy verification the meter has 2 infrared LED pulse outputs that blink at the rate of energy consumption for both active (kWh) and reactive (kvarh) energy. The rate is 1,000 impulses per kWh or kvarh. These LEDs can be read by test and calibration equipment.

Pulse Output Signal (KYZ)

An optional pulse output (KYZ) can be provided via a cable. The pulse rate is user definable with a range of 1 to 1000 pulses per kWh. A typical setting is 1000 pulses per kWh. The pulse width is user definable with a range of 10 to 500 milliseconds.

The KZ pulse output parameters are interlinked in that incorrect choices for these parameters can cause saturation of the pulse output before reaching the maximum power of the meter. As the pulse rate is increased, the pulse width must be decreased. For example, a pulse rate of 1,000 is compatible with a pulse width of 30ms. However, a pulse width of 100ms will not allow correct operation in a 3-phase meter.

The following formula provides the maximum pulse width that would cause saturation exactly at maximum power (100% duty-cycle). For proper operation and also dependent on the device to be connected to the KZ pulse output, a percentage of this time should be used. For example, for a 50% duty cycle at maximum power, the maximum pulse width must be divided by 2.

Maximum pulse width = $(3.6 \times 10^9) / (MP \times PR)$

where:

PR = pulse rate

MP = maximum power = “rated voltage” x “maximum current” x “number of phases”

Note: *The KZ output terminals are electrically and physically isolated in the Echelon meter in regard to safety considerations.*

Optical Port Communication

An optical port is provided for local communications at 9600 Baud.

The probe must be connected to a computer that is running the Echelon Provisioning Tool application. The computer can perform programming operations and may also be used to view accumulated data and diagnostic information. Refer to the *NES Provisioning Tool User's Guide* for more information about using the Provisioning Tool to communicate with the meter over the optical port.

The following are required to communicate via the optical port:

- A computer running the NES Provisioning Tool.
- A non-echoing ANSI optical probe, such as Abacus Electrics' ANSI Type 2 Optical Probe with DTR switch and USB Connector (model number: A9U-P-U04M-2A). See www.abacuselectrics.com for more information.

Power Line Carrier Communication

For data transfer to NES System Software, and operating maintenance and supervision, the meter uses Echelon's A-Band power line carrier (PLC) technology to communicate with a Data Concentrator over the power lines. The meter and the Data Concentrator must be installed on power lines supplied by the same transformer.

The meter supports broadcasting of PLC messages. Even though any valid PLC command is accepted by the meter as a broadcasted message, many commands are not suited to be broadcasted. The main use of broadcasting is to perform time critical actions such as load control. Please see the *NES System Software API Reference Guide* for the latest information on which messages can be broadcasted via the system.

PLC communication to and from the meter can be encrypted. This ability can be turned on or off in the meter using the Provisioning Tool.

PLC Display Indicators

The meter has two indicators on its display to show PLC traffic detection and received-message quality.

PLC Traffic Detection Indicator

When initially installed, the meter checks for PLC network traffic approximately every second. Once valid network traffic has been detected, the PLC Traffic Detection indicator is shown on the display. It may take up to several minutes for traffic to be detected, as communication on the network may not be constant. This depends on the amount of data requests and the number of meters per transformer. If communication with the specific meter never occurs, this indicator will remain lit as long as network traffic has been detected within the last X minutes (X is configurable from 1 to 65535 minutes).

Received Message Quality Indicator

 Once PLC communication with the specific meter occurs, the Received Message Quality indicator (or at least part of it) is also displayed. It shows the quality of the most recently received PLC message, in addition to indicating that PLC communication occurred with that specific meter. PLC communication is checked for received-message quality once each minute. After the PLC detection method has switched from network traffic to received-message quality, all bars on the Received Message Quality indicator and the PLC Traffic Detection indicator turn off, if no PLC communication has occurred with this meter within the last X minutes (X is configurable from 1 to 65535 minutes). This does not indicate that network traffic has stopped, only that communication with that specific meter has been disrupted. At this point, the meter returns to the initial network PLC detection method that occurs once per second.

The PLC Received Message Quality indicator operates as follows:

- No bars = no message received for this meter
- Smallest bar = a poor quality message
- Both smallest and medium bar = a medium quality message
- All three bars = a high quality message

Battery Backup

A battery in the meter provides power to maintain clock accuracy and allow for cover removal tamper detection during a power outage. The battery cannot be removed or replaced.

If the battery voltage falls below its normal operating range, an error message is generated and sent to NES System Software via the Data Concentrator. While powered, the meter will continue to operate normally if the internal battery fails. However, stop mode will be entered on the next power down.

This means that during power down, the meter clock will not be advanced, and tamper and tilt conditions will not be detected. On power up, clock error and primary power down entries will be recorded in the event log. The meter clock will resume from where it stopped when the meter was powered down. The clock error causes the following circumstances to occur:

- Missed Self-reads are not checked for.
- The One-time-read queue is not checked.
- The TOU calendar will not be assessed for DST, seasons, holidays, etc.; tariff 1 is assumed
- The load profile log will not include the power down time since the UTC clock was not updated.

If the battery is disabled or the battery voltage is below its normal operating range, then safe mode will not be entered following a switchover.

Clock Settings

The meter clock can be configured to synchronize itself internally at all times, or to synchronize itself with the utility line's frequency. If the utility line's frequency is selected and there is a power outage, the meter will synchronize the clock internally until power is restored, at which point it will re-synchronize itself with the utility line's frequency.

Note: *You can change this clock setting with the NES Provisioning Tool. However, the meter must be power cycled after the change for it to take effect.*

If the meter is powered up and starts without a valid clock setting, the following actions will be performed as soon as the clock is set:

- Any Self-read or One-time-read scheduled to occur during the power-off duration, or after the power-up and before the clock was set.
- The duration and date/time that the power outage occurred will be recorded in the meter event log.

Load Profile Back-fill Upon Power-up

When the meter is powered-up, the load profile is either fully or partially filled with records that would have been recorded, but were missed during the power outage time-period. The data that is stored in those records is dependent on the values selected for logging. Accumulators such as energy values, power-off minutes, and power-off counts are stored as the values that are present in the meter at power-up. Instantaneous values such as voltage, current, and power factor are stored as zero.

The following describes the load profile back-fill scenarios that could occur:

- If the power to the meter is lost and is restored on the same day, the missing entries are completely back-filled upon power-up.
- If the power is lost on one day and power-up occurs on the next day, the missing entries are completely back-filled upon power-up.
- If the power outage occurs on one day and power-up occurs on a day other than the same or the next day, data is only partially back-filled. The missing records are created for the remainder of the day on which the power was lost and for the start of the day on which power was restored. Data for any full calendar days of power outage between the day the power went off and the day it came back on is not included in the load profile. A full calendar day is considered to be the 24-hour period from midnight to midnight.

Start-up Time

Metering energy measurements are started in less than 1 second after the meter is powered-up at normal operating voltage. Full operation of all meter functions and communication systems occurs a little over 2 seconds after the meter is powered-up.

Energy Measurements and Calculations

The electrical values that are provided by the meter include meter energy (summation of phases; totals, or per individual tariff), instantaneous values such as voltage and current. All values are updated once per second for usage such as viewing, data logging, or communications.

The measured electrical values are:

- Active power (kW), summation: forward, reverse
- Active energy (kWh), summation: forward, reverse, forward + reverse, forward – reverse. Forward – reverse is limited to zero at the bottom of the range, negative values are not accumulated.
- Reactive power (kvar), summation: import, export
- Reactive energy (kvarh), summation: import, export
- RMS voltage, per phase
- RMS current, per phase
- Power factor, per phase
- Frequency
- Sine of phase angle, per phase
- Apparent power (VA), summation
- Maximum active power: forward, reverse
- Maximum reactive power per quadrant
- Maximum, continuous, and cumulative demand values
- Previous demand values
- Minimum and maximum per-phase voltages

Energy Register Capacity

The energy registers contain the present metering values of summation and instantaneous items, previous season data, and self-read data. The capacity of the energy registers is 999,999,999 Wh/varh (9 digits).

The Energy Register Capacity setting also affects the capacity of the number of power-off minutes, the number of power outages recorded, and the number of alarms occurrences in the error counter. When the capacity is reached by any of these values (including Wh/varh), the value rolls back over to zero.

Note: *The meter display shows 8 digits. When you set the energy register capacity to 9 digits, the highest number may not be shown on the display (depending on display configuration).*

Error Occurrence Recording

Certain errors can be recorded and are accumulated in a meter register. The count is incremented by one for every error occurrence. The errors are:

- RAM Failure
- Non-Volatile Memory Failure
- Clock Error
- Measurement Error
- Save-All Aborted

See “Diagnostic Event Descriptions” on page 1 for details of these errors.

Self-Reads

The meter can be programmed to perform an automatic periodic reading of measurement data, along with a timestamp. This is called a self-read. The time of day that a self-read occurs is configurable. A self-read can be set to repeat daily, weekly, monthly, or yearly.

If the meter is powered-down at the time a self-read is scheduled to occur, the self-read will be recorded the next time the meter is powered-up, with a timestamp of when the actual reading occurred.

The meter stores one copy of the most recent self-read data and up to 23 sets of previous self-reads. Whenever a new self-read occurs, the oldest stored self-read data set is overwritten if 24 sets are already stored. A snapshot of the following data is recorded during a self-read:

- Total and tariff-specific active and reactive energy values
- Time, date, and season when data was captured
- Total power outage minutes and counts that occurred since the meter went into operation (or since all registers were reset to zero)
- All demand metering data, if configured

One-Time Reads

You can also program the meter to perform a One-time-read. A One-time-read returns the same set of data as described for a Self-read in the previous section. The only difference between a One-time-read and a Self-read is the scheduling. One-time-reads do not occur multiple times in a scheduled pattern as Self-reads do. Each One-time-read is programmed to occur at a specific date and time, and occurs only once. You can schedule up to 3 separate One-time-reads in the meter at once.

If the meter is powered-down at the time a One-time-read is scheduled to occur, the One-time-read will be recorded the next time the meter is powered-up, with a timestamp of when the actual reading occurred.

The meter stores up to 2 sets of One-time-reads. Whenever a new One-time-read occurs, the oldest stored One-time-read data set is overwritten if 2 sets are already stored.

Daily Energy Consumption

Each day at UTC midnight the meter stores the total active and reactive energy consumption amounts for the previous 24 hours.

Time-of-Use (TOU) Tariffs

Time-of-Use (TOU) is the term used to describe the partitioning of energy usage into different registers based on a schedule. The meter supports four such registers, called tariffs (T1, T2, T3, and T4). The tariffs are selected for different time periods within a day (midnight to midnight). The time at which a tariff is changed is called a tier switch. Each 24-hour set of tier switches is called a day schedule. There may be different day schedules for weekdays, Saturday, Sunday, and holidays. Each year is identical with regard to season changes, holidays, and daylight saving time scheduling. This is called a perpetual calendar implementation. All of the measured

energy values are stored as totals into the four tariff registers based on the TOU schedule.

The available options of the perpetual TOU calendar are:

- Day schedules (per season):
  - 1 weekday schedule
  - 1 Saturday schedule
  - 1 Sunday schedule
  - 2 holiday schedules
- 4 seasons with programmable start dates
- 15 holidays per year
- 1 independent self-read schedule per year
- 10 tier switches per day
- 1 date for DST on, 1 date for DST off, with programmable time and minutes adjustment. DST on and off can be set to occur at different times of the day

The meter will store the following values, per tariff:

- Active energy, forward and reverse
- Active energy, forward + reverse
- Active energy, forward – reverse
- Reactive energy, import and export

TOU Calendar Identifier

When a new calendar setup is created, using either NES System Software or the NES Provisioning Tool, a corresponding numerical identifier can be set. This TOU Calendar ID is downloaded to the meter at the same time as the calendar. The TOU Calendar ID can be selected to appear on the meter display to show the Time-of-Use calendar that is presently operating.

Pending TOU Calendar

A second TOU calendar schedule can be programmed into the meter. The meter can be programmed by NES System Software to switch over to the second TOU schedule on a preset future date and time.

Load Profiles

The meter load profile data log can be configured to record up to 16 different energy values at once. The load profile log is divided into groups of data called blocks. You will specify the duration of each block by setting the number of intervals per block, as well as the length of each interval.

You can also specify the start time for each load profile block. When doing so, you should be aware that if the total block time (i.e. the interval duration multiplied by number of intervals per block) does not divide evenly into 24 hours or is not a integer multiple of 24 hours, then the actual block start time will not always match the configured block start time. For example, if you have a block start time of 00:00 and a block duration of 18 hours, then the actual block start times will rotate through these times: 00:00, 18:00, 12:00, 06:00.

Up to 16 channels can be recorded on the same interval. The 16 channels are selected from the measured electrical values, which are listed in the "Energy Measurements and Calculations" section on page 1. All channels are stored as total values (no differential values).

The number of storage days available in the load profile register depends on the meter channel and log interval configuration, as well as the memory available to the load profile log. The following table shows the maximum number of days of profile log capacity for the log interval and channel selections for log sizes of 22.5Kb, and approximately 47Kb. When the number of maximum days is reached, the log becomes full and wraps around to overwrite previous entries. The log intervals shown below are for 5, 15, 30, 60 minutes and 1 day. Other interval lengths are supported, although all interval lengths for ANSI meters must be in minutes. If you are using another interval length, you can use the figures below to estimate how many storage days will be available in the load profile register.

Load Profile Storage – 22.5Kb Log Size

Number of Channels	Log Interval	Maximum Days
1	1 day	2094
1	60 minutes	180
1	30 minutes	91
1	15 minutes	46
1	5 minutes	15
2	1 day	1440
2	60 minutes	92
2	30 minutes	46
2	15 minutes	23
2	5 minutes	7
3	1 day	1152
3	60 minutes	66
3	30 minutes	33
3	15 minutes	16
3	5 minutes	5
4	1 day	921
4	60 minutes	49
4	30 minutes	24
4	15 minutes	12
4	5 minutes	4
5	1 day	794
5	60 minutes	41
5	30 minutes	20
5	15 minutes	10
5	5 minutes	3
6	1 day	677
6	60 minutes	33
6	30 minutes	17

Load Profile Storage – 47.25Kb Log Size

Number of Channels	Log Interval	Maximum Days
1	1 day	4398
1	60 minutes	378
1	30 minutes	192
1	15 minutes	97
1	5 minutes	32
2	1 day	3024
2	60 minutes	195
2	30 minutes	98
2	15 minutes	49
2	5 minutes	16
3	1 day	2419
3	60 minutes	140
3	30 minutes	70
3	15 minutes	35
3	5 minutes	11
4	1 day	1935
4	60 minutes	104
4	30 minutes	52
4	15 minutes	26
4	5 minutes	8
5	1 day	1668
5	60 minutes	86
5	30 minutes	43
5	15 minutes	21
5	5 minutes	7
6	1 day	1423
6	60 minutes	71
6	30 minutes	35

Number of Channels	Log Interval	Maximum Days		Number of Channels	Log Interval	Maximum Days
6	15 minutes	8		6	15 minutes	17
6	5 minutes	2		6	5 minutes	5
7	1 day	606		7	1 day	1273
7	60 minutes	29		7	60 minutes	62
7	30 minutes	14		7	30 minutes	31
7	15 minutes	7		7	15 minutes	15
7	5 minutes	2		7	5 minutes	5
8	1 day	535		8	1 day	1125
8	60 minutes	25		8	60 minutes	54
8	30 minutes	12		8	30 minutes	27
8	15 minutes	6		8	15 minutes	13
8	5 minutes	2		8	5 minutes	4
9	1 day	490		9	1 day	1029
9	60 minutes	23		9	60 minutes	48
9	30 minutes	11		9	30 minutes	24
9	15 minutes	4		9	15 minutes	12
9	5 minutes	1		9	5 minutes	4
10	1 day	443		10	1 day	930
10	60 minutes	20		10	60 minutes	43
10	30 minutes	10		10	30 minutes	21
10	15 minutes	5		10	15 minutes	10
10	5 minutes	1		10	5 minutes	3
11	1 day	411		11	1 day	864
11	60 minutes	19		11	60 minutes	40
11	30 minutes	9		11	30 minutes	20
11	15 minutes	4		11	15 minutes	10
11	5 minutes	1		11	5 minutes	3
12	1 day	377		12	1 day	793
12	60 minutes	17		12	60 minutes	36
12	30 minutes	8		12	30 minutes	18
12	15 minutes	4		12	15 minutes	9
12	5 minutes	1		12	5 minutes	3
13	1 day	354		13	1 day	744
13	60 minutes	16		13	60 minutes	33
13	30 minutes	8		13	30 minutes	17
13	15 minutes	4		13	15 minutes	8
13	5 minutes	1		13	5 minutes	2
14	1 day	329		14	1 day	691

Number of Channels	Log Interval	Maximum Days		Number of Channels	Log Interval	Maximum Days
14	60 minutes	14		14	60 minutes	31
14	30 minutes	7		14	30 minutes	15
14	15 minutes	3		14	15 minutes	7
14	5 minutes	1		14	5 minutes	2
15	1 day	311		15	1 day	653
15	60 minutes	14		15	60 minutes	29
15	30 minutes	7		15	30 minutes	14
15	15 minutes	3		15	15 minutes	7
15	5 minutes	1		15	5 minutes	2
16	1 day	291		16	1 day	612
16	60 minutes	13		16	60 minutes	27
16	30 minutes	6		16	30 minutes	13
16	15 minutes	3		16	15 minutes	6
16	5 minutes	1		16	5 minutes	2

Caution: *When the profile log is filled to maximum capacity of unread records, the oldest unread records start being overwritten one day at a time. Set the log interval and number of channels so that the maximum number of log capacity days between readings is not exceeded. It is important to read the meter before the log becomes full to prevent loss of unread data.*

Meter UTC and DST Time Assignment

The following is a list of parameters in the meter that are set to UTC (Coordinated Universal Time, or GMT) and local DST (Daylight Saving Time).

Meter Parameters Set to UTC

The following date and time parameters are set to UTC in the meter:

- Meter system clock
- Load profile registers
- Daily consumption of active and reactive power and energy registers
- Power quality event reporting
- Meter event log

Meter Parameters Set to Local Time

The following date and time parameters are set to local DST in the meter:

- Meter display
- Meter time displayed in the Provisioning Tool
- Meter Time-of-Use clock and all TOU calendar events
- DST on and off time

- Self-read (billing reads)

Meter Data Collection

Meter log data and diagnostic information is normally collected from meters by a Data Concentrator, which in-turn sends the data to NES System Software. Data and diagnostics can also be read and viewed in the Provisioning Tool application by connecting a computer that is running the Provisioning Tool to the meter's optical port.

Read-Only Key

When accessing the meter via the optical port, the meter can be set to recognize an authentication key that only provides access for data that is pertinent to on-site data retrieval to be read from the meter. The Read-Only Key is set at the factory, and is the same for all meters sent to an individual project. This key is included in the NES Import File provided to the customer by Echelon. See the *NES Provisioning Tool User's Guide* for more information on using NES Import Files and authentication keys (or "device keys").

The meter readers in some utilities must be able to set the clock during a field visit. Therefore, the meter can be set to also allow this interaction when accessed with the Read-Only Key. This is per customer order and determined by permissions set in the meter at the factory. No other data or values, except for the date and time, can be written to the meter when this date/time option is enabled and access to the meter is granted using the Read-Only Key.

Security

The meter has several security features, such as data encryption, data authentication, and authentication keys that protect it against unauthorized access. Data encryption operates over the power line networks. Most of the security features are user-configurable. Additional details of meter and NES security functions are described in the NES *Provisioning Tool User's Guide* and *NES System Software Programmer's Guide*.

Group Broadcasting

Group IDs for up to 10 different broadcast groups can be programmed into each meter. When a meter receives a message formatted for group broadcasting, it will check the message header to determine whether it is being sent to a broadcast group to which it belongs. If this is the case, the meter will accept the message. Otherwise, the meter will discard the message. This allows you to send a single message to a specific group of meters by addressing it to the broadcast group containing those meters.

Meter Firmware Updates

The firmware of the meter can be updated remotely after the meter is installed. The update is transmitted from NES System Software and then distributed to the appropriate meters by a Data Concentrator. The meter will confirm a successful firmware update. Refer to the *NES System Software Programmer's Guide* for more information about the meter firmware update procedure.

Normal operation of the meter is not disrupted by a firmware update procedure.

Note: *This feature is subject to local regulations that may prohibit remote updates.*

4

Demand Metering

The meter offers various types of demand metering calculations that can be performed to measure the peak active and reactive power delivered to or by the system.

Demand Calculations and Settings

The ANSI v3.1 meter (83011-83301) offers various types of demand calculations that can be performed to measure the peak active and reactive power being delivered to the system over a designated time period. Demand measurements are useful in that they provide information on peak usage as opposed to accumulation over time, and by using averages instead of instantaneous maximum power values are not impacted by spikes and short surges. This chapter describes the different demand calculations you can make with the meter.

Demand metering is an optional feature for the ANSI version 3.1 meter (83011-83301). Please contact your Echelon sales representative for more information on this. Although demand metering can be enabled and configured in the field, Echelon strongly recommends anticipating its use and configuring the demand settings before installing your meters, so that system-wide resource allocations are not impacted later.

Demand Settings

In general, demand values (**D**) are calculated by measuring the energy (**E**) levels at the start (**t-1**) and end (**t**) of a time period, and dividing the difference between those two power levels by the time that has elapsed between them ($\triangle t$) to come up with an average power value for that interval.

$$D = \frac{E_t - E_{t-1}}{\triangle t}$$

You can customize exactly how the demand calculations will be made by configuring the demand settings for a meter, including the sub-interval and the main interval.

You can create one of two demand scenarios, depending on how you configure these settings:

Rolling demand. Rolling demand uses the interval and sub-interval to create interlaced measurement periods. This provides a way to calculate the peak power usage for a set period of time, and the meter continues to update the value as more time elapses to generate a rolling average. In this scenario, the sub-interval determines how frequently the value will be updated. The main interval determines the length of time for which demand measurements will be made. Each time a sub-interval elapses, the data for the oldest sub-interval is thrown out and replaced by the data for the most recent sub-interval, and the demand is measured again.

Note: *To establish the main interval value, you need to set the value of the demand multiplier. The demand multiplier determines how many sub-intervals exist per main interval, and so the duration of the main interval is determined by multiplying the sub-interval by the demand multiplier. You can set the sub-interval to any value between 1 and 60 minutes. You can set the demand multiplier to any value between 1 and 15.*

For example, if you wanted to measure the peak power usage for a meter for 45-minute periods, and you wanted an updated value to be reported every five minutes, you could use rolling demand. You would set the sub-interval

to 5 minutes in this case, and you would set the demand multiplier to 9, so that you would have main interval of 45 minutes.

In this scenario, if the meter begins calculating demand at 1:00, then the first main interval would elapse at 1:45. At 1:45 a demand record would be made for the first interval: the time period from 1:00-1:45. At 1:50, the end of the next sub-interval, a new demand record would be made for the time period from 1:05-1:50. At 1:55, a demand record would be made for the time period from 1:10-1:55. This would continue until the end of the demand billing cycle.

In Figure 4.1, the sub-interval is set to 5 minutes and the main interval is set to 10 minutes. Therefore, demand calculations are made every 5 minutes reflecting the last 10 minutes of data. For example, Interval 1 represents the period between 0-10 minutes. Interval 2 is the period from 5-15 minutes. Interval 3 is the period from 10-20 minutes, and so on.

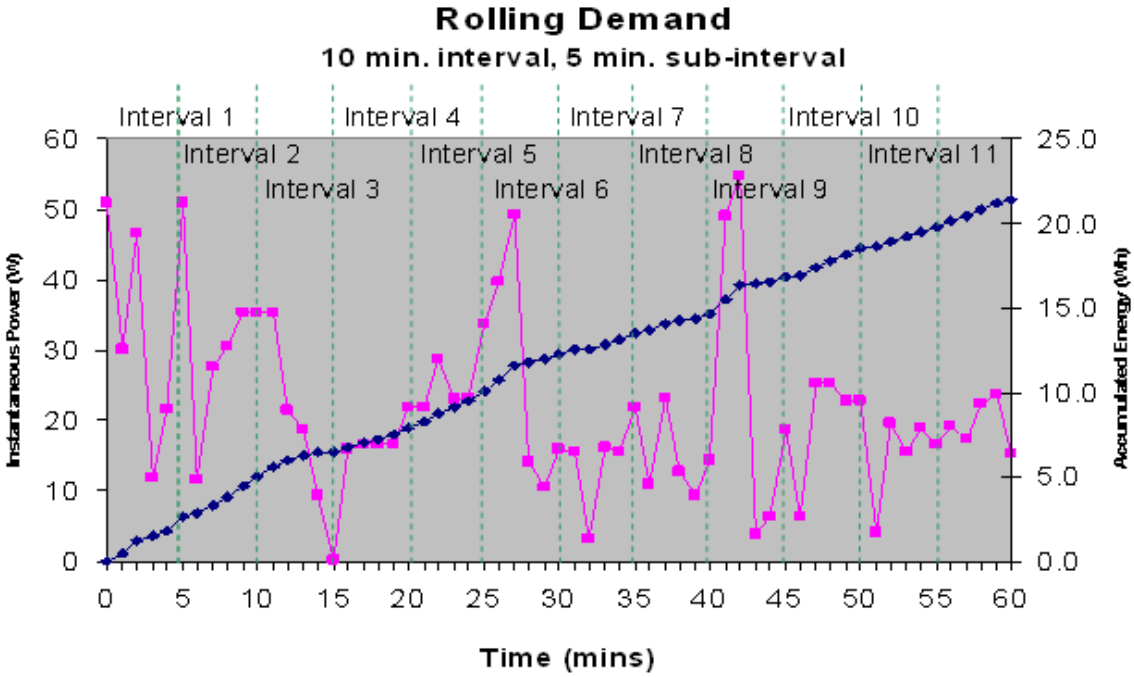


Figure 4.1 Rolling Demand

- Block demand. Block demand uses the interval setting to create independent measurement periods. Block demand is intended to measure the peak power usage for a specific time period, so that the values returned do not reflect rolling averages.

  To use block settings, set the sub-interval to the time period for which you want to measure the peak power usage, and set the demand multiplier to 1, so that the main interval value matches the sub-interval value.

  For example, if the main interval and sub-interval are both set to 60 minutes, demand values would be read and recorded once every hour, and would reflect peak power usage for the hour since the last reading only. So if you began calculating demand at 1:00, then the demand value at 2:00 would reflect peak power usage from 1:00-2:00. The demand value recorded at 3:00 would reflect peak power usage from 2:00-3:00, and so on.

Figure 4.2 shows a line graph charting two demand values. In this scenario, the main interval is set to 10 minutes, so values for each of the 6 intervals are recorded at 10, 20, 30, 40, 50, and 60 minutes.

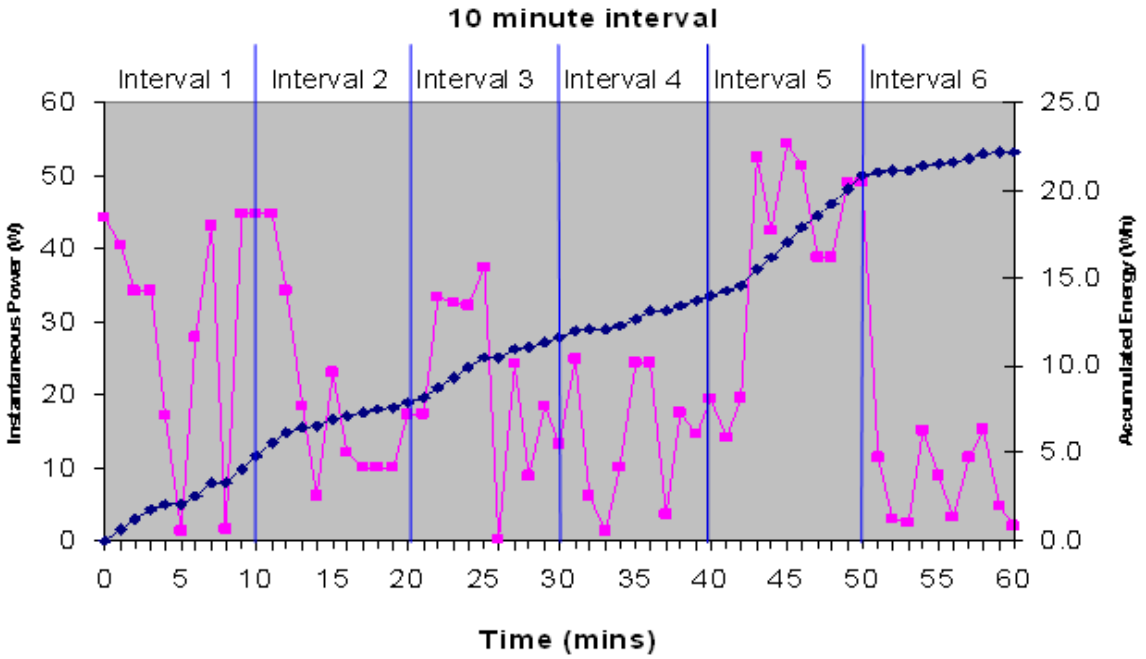


Figure 4.2 Block Demand

Demand Calculations

The previous section describes how the meter can calculate and record demand measurements. This section describes which energy measurements can be made using demand. The meter is capable of calculating the following energy measurements for any of the 8 configurable demand sources. The 8 demand sources are:

- Forward energy (Fwd Active [kWh] L1+L2+L3)
- Reverse energy (Rev Active [kWh] L1+L2+L3)
- Forward + reverse energy (Fwd+Rev Active [kWh] L1+L2+L3)
- Forward - reverse active energy (Fwd-Rev Active [kWh] L1+L2+L3)
- Reactive energy for all 4 quadrants (Reactive [kvarh] Q[1..4])

The meter can measure the following measurements for any of the 8 demand sources:

- **Present Demand.** Present demand is the demand value of the interval currently in progress. It is updated every second. There are two ways to calculate present demand, depending on the time value that is used to normalize the energy used in the interval.

  The first measures the accumulated energy since interval start based on the time expired since last end-of-interval, meaning that the demand value is calculated by dividing the accumulated energy by the amount of time that has passed since the current interval began. The second measures the accumulated energy since interval start based on the total interval time, meaning that the demand value is calculated by dividing the accumulated energy by the total length of the current interval (regardless of how much of that time has expired).

You can switch which type of calculation will be performed. If energy usage decreases because of forward and reverse configuration, the present demand is calculated to be 0.

- **Previous Demand.** Previous demand is the demand value for the last complete or partial demand interval. The previous demand is updated every time a sub-interval expires, and the demand value returned represents the accumulated energy for the main interval divided by the interval time.
- **Maximum (Peak) Demand** Maximum demand is the largest demand value calculated since the last demand reset. At every sub-interval for rolling demand or at every main interval for block demand, the previous demand value (i.e. the maximum demand calculated for the previous interval) is compared with the maximum value calculated for the present interval (i.e. the interval that has just elapsed). If the previous maximum demand value is greater than the present maximum demand value, the maximum demand for the present interval will be updated to be the value of the previous maximum demand value. In this way, the maximum value will be kept as each interval (or sub-interval) passes.

  In this way, the maximum demand is an average power calculation over the configured interval of time. The beginning and end of an interval are both synchronized to the top of each hour. This average mechanism avoids recording momentary spikes but catches general peaks in trends. At each demand reset, the maximum demand is reset to 0. Each maximum demand value is recorded with the corresponding date and time of occurrence.
- **Cumulative Demand.** Cumulative demand is the summation of all previous maximum demand values that were present at the time of their respective demand resets. At each demand reset, the cumulative demand is incremented with the value of the new maximum demand.
- **Continuous Cumulative Demand.** Continuous cumulative demand is the summation of cumulative demand and the maximum demand value since the last demand reset. Continuous cumulative demand is correctly calculated if cumulative demand is disabled and continuous cumulative demand is enabled.
- **Coincident Sources.** The meter can store up to two coincident values, chosen from the available measured and calculated values, along with each maximum demand value. When the maximum demand values are updated, the coincident values are also updated at the same time.

Demand Resets

A demand reset marks the end of a demand billing cycle. The following tasks are performed for each demand reset:

- Update all calculations evaluated at demand reset.
- Save the current demand values to previous (latest) demand reset table and historical demand reset table. The meter can hold one or more copies of demand reset data before the oldest data is overwritten. This figure is user-configurable.
- Reset current maximum demand and coincident values.

Demand resets can be scheduled into the meter with NES System Software, or with the Provisioning Tool. Resets can be configured to occur daily, weekly, monthly, or at any other daily interval up to once every 63 days (i.e. every second day, every third day, and so on). The exact time of the reset is configurable. If the meter is powered

down at the time a demand reset was scheduled to occur, the demand reset data will be recorded at the subsequent power-up with the timestamp of the power-up event.

You can also trigger a demand reset at any time manually by pressing the Demand Reset push button on the meter front cover for 2 seconds and then releasing it, or by using NES System Software. The Demand Reset button can be locked with a wire to prevent it from being activated, as shown in Figure 1.1.

Reset Lockout Period

You can program a demand reset lockout period into the meter (measured in seconds). After a demand reset has been performed, no subsequent demand reset of the same type can occur for the programmed amount of time. The three types of demand reset are the push button reset, by command via the optical port or power line channel, and through the TOU calendar.

Demand Interruptions

In general, any activity that interrupts or restarts the demand calculations results in the end of the current interval, and the start of a new one. Both of these intervals are classified as partial intervals by the meter. Their calculations are still performed using the nominal interval time, and the end time of the new partial interval remains synchronized to the hour. Examples of partial intervals are listed below:

- Power failure. The demand for the previous interval is equivalent to the energy measured from the start of the last main interval before the power failed, to the time that that power failure occurred, divided by one main interval duration. This will be computer after the meter is powered back on. The demand for the present interval will be set to 0 after the meter is powered back on, and demand calculations will resume normally.

  A power failure demand lockout time can also be configured (in seconds) to specify how long the meter should wait after powering up after a power failure before it starts making demand calculations again.

- Any demand reset, tier switch, absolute clock change, DST start and end, and entry into (or exit from) test mode. The demand for the previous interval will be set to the demand measured from the start of the interval to the time that the interruptive event occurred, and the demand for the present interval will begin measuring after the interruptive event has occurred.

End of Interval Display Icon

At the end of each demand main interval, an icon will display on the meter display indicating that a demand interval has ended. If a power failure occurs while this icon is displayed, it will not be displayed until the next end of interval after the meter is powered back on. For more information on the meter display, see *Reading the Display* on page 1.

5

MEP Devices

This chapter provides an introduction to an optional new bi-directional serial port that is called a *MEP port*. The MEP port will allow a connected smart device to access meter data, run meter procedures, and have limited write access to the meter.

MEP Interface

The ANSI v3.1 meter (83011-83301) optionally provides a new bi-directional, isolated UART serial port that is called a *MEP port*. The MEP port allows a connected smart device to access meter data, run meter procedures, and have limited write access to the meter.

The device that connects to the meter using the MEP port is referred to as a *MEP device*. The MEP device is controlled and accessed through NES in largely the same way as an M-Bus device is. However, there are several fundamental differences between a MEP device and an M-Bus device, most notably in the way a MEP device interacts with an Echelon electric meter – the MEP device initiates communication with the meter and can access meter tables and procedures. A separate document, the *MEP Device Developer's Guide,* provides an introduction to the MEP protocol and describes the MEP interface, including definitions of the meter tables and procedures you will use when programming your MEP device.

There are many different tasks you could accomplish with a MEP device. For example, you could connect a smart RF card that communicates with In Home Display devices that that would reflect the current state of the meter, as the MEP device is able to read meter data in real-time. Alternatively, you could connect an auxiliary I/O device meant to deliver external alarm signals to the meter using the MEP port.

The MEP port can optionally supply power to a low-powered MEP device. When you order your meter, you can specify whether you want the powered or the unpowered MEP option. MEP devices could reside under the terminal cover of an ANSI meter, although MEP applications with other mechanical or power constraints should be developed as external devices to the meter. The MEP port is accessible via the meter's auxiliary terminals. The meter terminals for the MEP interface are listed below. For more information on the MEP interface and MEP devices, including hardware details and an overview of the MEP protocol, consult the *MEP Device Developer's Guide.*

Electrical Specification

External MEP Interface				
Meter Terminal	**Name**	**MEP Direction**	**Function**	**Comments**
14	M-Bus(+)	O	M-Bus Power	4kV isolated M-Bus port (+)* (+12Vdc/+24Vdc)
15	M-Bus(-)	I/O	M-Bus Data	4kV isolated M-Bus port (-)*
16	MEP_PWR	O	MEP POWER	+24Vdc nominal *
16A	MEP_COM_TXD	O	MEP TXD	Meter's Transmit
17	MEP_COM_RXD	I	MEP RXD	Meter's Receive
18	MEP_COM_ENABLE	I	MEP COM ENABLE	MEP +12V/+5V Interface Enable
19	MEP_COM_GND	-	MEP GND	MEP GND Interface Power

Appendix A

Meter Troubleshooting

The following table describes problems that could occur with the Echelon ANSI electric meters, possible causes, and the most likely solutions:

Problem	Possible Cause	Solution
Load disconnect contactor will not turn on when button is pushed	Load disconnect is set to off-state in meter.	Contact utility service center and have reconnect command sent.
		Send reconnect command directly to meter via optical port using a computer running Provisioning Tool application.
	Disconnect switch state is set to off due to exhaustion of prepay credit.	Consumer must make payment and utility service center must load prepay credit into meter.
		Change setting so meter doesn't use prepay credit option.
L3L2L1 meter display indicator is lit.	Phase rotation of local service is CBA. (Polyphase meter only.)	Verify the wiring at the socket.
Communication from NES System Software to meter does not occur.	Meter is not communicating with a Data Concentrator over the power lines.	An operating Data Concentrator must be installed on the power line supplied from the same transformer as the meter.
Display does not scroll through different values. Only shows the error code.	An error occurred and has not been cleared.	The error message must be read and cleared by NES System Software via the Data Concentrator, or directly with the Provisioning Tool.

Appendix B

Meter Specifications

The following are the specifications for the Echelon ANSI electric meters:

Category	Detail
Standards met:	ANSI C12.1, ANSI C12.10, ANSI C12.18, ANSI C12.19, ANSI C12.20
Accuracy:	Active: Class 0.5 Reactive: Class 0.5
Temperature, specified operating range:	–40° to +85° C (display is fully operational at –25° to +60° C)
Temperature, limit range of operation:	–40° to +85° C
Temperature, limit range for storage and transport:	–40° to +85° C
Humidity:	<= 95%, non-condensing
Power consumption:	Voltage circuit < 2W, < 5VA. Current circuit at TA: < 1 VA
Control relay (optional):	Single-pole single-throw normally-open (1P-1T NO) dry (no output voltage) switch. The maximum load rating is 5A. Voltages up to 250V can be routed through the relay.
Pulse output, KZ (optional):	1 reference and 2 signal connections
Load disconnect switch:	200 amps maximum. Remote disconnect and enable
Service types:	Dependent on ANSI form and model Form 2S: 1-phase, 2-wire
Units measured:	kW forward, reverse; kWh forward, reverse, forward + reverse, forward – reverse; kvar import, export; kvarh import, export; RMS voltage, per phase; RMS current, per phase; power factor, per phase; frequency; sine of phase angle, per phase
Power quality analysis:	Sag; swell; number of over-current occurrences; number of long power outages; duration and time of the last 10 long power outages; number of short outages; maximum and minimum frequency; phase loss (in polyphase meters)
Time of Use:	4 tariffs with 10 possible time assignments per day. 4-seasons per perpetual calendar (set by Day/Month). Perpetual holiday calendar for up to 15 holidays / year. Perpetual daylight savings changeover. 2 separate holiday day schedules per season. 1 weekday, 1 Saturday, and 1 Sunday day schedule per season

Category	Detail
Nominal voltage:	Dependent on ANSI form and model Form 2S: 240 VAC
Input voltage range:	-20% to +15% of nominal voltage
Frequency:	60 Hz (+/- 5%)
Current:	Dependent on ANSI form and model Form 2S: CL200, TA 30A
Timing:	Real-time clock accurate to +/- .5 seconds per day, battery-backed
Data logging intervals:	User-selected at 5, 15, 30, 60 minutes, or 1 day
Verification output:	2 pulse-output LEDs representing kWh and kvarh. Signaling at 1 Wh per pulse
Data security:	Password protection for optical communication. Authenticated and encrypted password-protected transactions for power line communication.
Data storage:	Non-volatile memory
Data communications:	Power line carrier (PLC) using Echelon's CENELEC A-Band compliant PLC technology
Optical port:	per ANSI C12.18
Communication error detect:	CRC for optical communication, authentication and handshaking for PLC communication
Life Expectancy	The NES meter has been designed for a life expectancy of at least 20 years, at annual average ambient temperatures less than or equal to 35°C and greater than or equal to -40°C. The predicted mean time between failures (MTBF) of the NES meter, based on MIL-217F Notice 2, with realistic modifications at 25°C, is approximately 341 years (2,991,000 hours). These MIL calculations are very conservative. NES meters have been designed such that the failure rate for 20 years at an annual average ambient temperature of up to 25°C will not exceed 0.3% failures per year.

Appendix C

Glossary

The following describes terms as they are used in this document and other related NES documents.

Active Energy	The measurement of active power used over a period of time.
Active Power	Total power is the product of the voltage and current. Active power is the part of total power that is expended due to a resistive load. It is considered to do the work in the system and is also called the real power. The value is determined by multiplying the total power by the cosine of the phase angle between voltage and current.
Accumulators	Meter registers that accumulate energy value readings for usage of power over time. Also known as summation registers.
AMR	Automated Meter Reading.
ANSI C12.18	An ANSI (American National Standards Institute) standard specifying hardware and low-level protocol for meter communication over optical ports.
ANSI C12.19	An ANSI standard specifying application-level meter information and transfer format.
Apparent Power	Apparent power is total power. It is the product of voltage and current. It is also the vector sum of active and reactive power.
Block Demand	One way to perform demand calculations. Block demand uses independent measurement periods that are intended to measure the peak power usage for a specific time period.
CT	Current Transformer. A current transformer is used, in conjunction with a meter connected to it, to measure the current flow in a conductor that is passed through the middle of the CT. A CT is typically used to measure current that is too high to pass directly through the meter.
DC-1000 Data Concentrator	Data Concentrators supervise electrical meters (and other devices) over an A-Band power line channel, and communicate with NES System Software located at the utility's service center. DC-1000 is a model number for one version of the Data Concentrator.

DC or DCX	A generic term referring to any Echelon Data Concentrator.
Demand Metering	The meter optionally offers various types of demand calculations that can be performed to measure the peak active and reactive power being delivered to the system. Demand measurements are useful in that they provide information on peak usage as opposed to accumulation over time, and by using averages instead of instantaneous maximum power values are not impacted by spikes and short surges. Consult Chapter 4 for more information on demand metering.
Device	In the context of this document, a device is normally a meter, a Data Concentrator, or other NES equipment that is designed to communicate over the power lines using Echelon's A–Band power line carrier signaling technology.
Energy	The summation of power over time.
Forward (Import) Energy	Energy delivered to the customer and consumed by the customer.
Key	Used to provide secure communication with meters and Data Concentrators. For details of some of the different types of authentication keys see LonTalk Authentication Key, Provisioning Key, Read-Only Key, and Unique Key.
Load Profile	The recording of consumption data over a period of time at a particular meter installation.
LonTalk Authentication Key	Provides a means of secure authenticated communication over the power lines between the Data Concentrator and the meter.
Meter	A device that measures and records the consumption or usage of a product or service.
Meter Utility Serial Number	A unique utility defined serial number of up to 30 characters associated with each meter.
MEP	Multipurpose Expansion Port. The port in the meter that provides the ability to add a MEP device for an expanded feature.
MEP Device	The device that connects to the meter using the MEP port is referred to as a *MEP device*. The MEP device is controlled and accessed through NES in largely the same way as an M-Bus device is. However, there are several fundamental differences between a MEP device and an M-Bus device, most notably in the way a MEP device interacts with an Echelon electric meter.
NES System Software	Software that is built on Echelon's Panoramix™ enterprise software platform. NES System Software supervises and communicates with Data Concentrators to deliver NES services and serves as the integration point between the NES system and the Utility Information Architecture.

Networked Energy Services (NES)	Echelon's Networked Energy Services (NES) system is an open, standards-based, adaptable infrastructure that enables a comprehensive set of utility applications. The NES system provides a bi-directional networked platform upon which many services — AMR, prepaid metering, distribution management, outage detection, and more — can be delivered.
Optical Port	Infrared communication port per ANSI C12.18. Used by the Provisioning Tool to talk to meters and Data Concentrators.
Phase Loss	In an Echelon meter, a phase that is at or below 61% (by default) of the rated voltage for a sustained duration of 10 seconds is considered a lost phase. The percentage that constitutes a phase loss is now user-configurable.
PLC	Power line carrier. Echelon's A–Band power line carrier technology that provides a device communication network over the secondary side of the power lines of a single or three-phase distribution transformer.
Power Factor	The result of active power divided by apparent power. Power factor may never exceed the range of –1 to 1.
Power Line Network	The network of LONWORKS® power line devices associated with a given Data Concentrator.
Program	Set of meter or Data Concentrator operating parameters and values (such as TOU tariffs, display settings, communication settings, or profile log configuration) created using the Provisioning Tool.
Provisioning	The act of configuring a device with specific operating parameters. Provisioning is performed by using the Provisioning Tool to write programs with preset values into devices. Operating parameter changes are made via NES System Software, or by using the Provisioning Tool maintenance or program edit functions.
Provisioning Key	A string of up to 20 characters which grants access to an Echelon meter or Data Concentrator for the initial provisioning operation. This key is assigned to each meter and Data Concentrator at time of manufacture and is usually the same for all devices sent to an individual utility. When the first provisioning operation is successfully completed, this key is usually deactivated and can no longer be used to access the device. Once deactivated, the Unique Key must be used to log into the device when using the Provisioning Tool.
Provisioning Tool	Echelon software that is used to create provisioning programs and to load provisioning information into meters or Data Concentrators. The desktop or laptop computer running the Provisioning Tool communicates with devices via an optical port connection.
PT	The NES Provisioning Tool.
Reactive Energy / Reactive Power	In an AC circuit whose impedance consists of reactance as well as resistance, the voltage and current are not in phase. This creates excess energy that is called reactive power, and represents energy alternately stored and released by inductors and/or capacitors (reactive load). The vector sum of the true and reactive power is known as apparent power. Reactive power is measured in Volt-Amperes-Reactive, abbreviated var.

Read-Only Key	Allows data to only be read from the meter when it is accessed via the optical port. A factory option can allow the date and time to also be changed with this key.
Reverse (Export) Energy	Energy delivered by the customer to the utility. Often considered a tamper condition if the user is not legitimately generating energy (for example, solar electric power) into the utility grid.
Rolling Demand	A way to perform demand calculations. Rolling demand uses interlaced measurement periods to calculate the peak power usage for a set period of time, and continues to update the value as more time elapses to generate a rolling average.
Root Mean Square (RMS)	Refers to the most common mathematical method of defining the effective voltage or current of an AC (Alternating Current) wave.
Sag	A measured voltage quantity detected at a level below a defined threshold.
Self-Read	Method by which a meter performs a snapshot read of pertinent registers along with a timestamp.
Summation Registers	Meter registers that accumulate energy value readings for usage of power over time. Also known as accumulators.
Swell (or Surge)	A measured voltage quantity detected at a level above a defined threshold.
Tariff	A published list of rate schedules, terms, and conditions. Or, as in the Echelon meter, the particular rate in effect at a given time.
Tier	A tier usually refers to a single tariff or its associated registers in the meter. In the NES system, tier can mean the same thing as tariff.
Tier Switch	The time at which the meter changes from accumulating energy in one set of tariff registers to a different set of tariff registers. This change is either due to a pre-programmed switch, per the tariff schedule, or is due to the activation of a new tariff schedule.
Time-of-Use (TOU)	The recording of metering quantities based on a time schedule (time of day, day of the week, month, and season). This allows the utility to track energy usage over time, track usage during specific daily time periods, set individual tariff rates for billing purposes, and provides information for load control. A TOU schedule consists of one or more tariffs.
Unique Key	A string of up to 20 characters which grants access to a meter or Data Concentrator after it has been provisioned. Every device is assigned a different Unique Key at time of manufacture.

Utility Enterprise Applications	The hardware and software infrastructure present at a utility that performs customer and distribution network functions, such as billing, customer care, and so on. The NES system integrates with the existing utility enterprise system to provide automatic communication with metering devices.
Utility Information Architecture	The Utility Information Architecture serves as the integration point between NES System Software and the Utility Enterprise Applications. This may consist of a vendor-supplied utility software framework or a utility-written architecture.
Work Order Tool	A software application for a hand-held computer used by an installer to collect information during the physical installation of meters or Data Concentrators. Essentially, this information is a record of where each device (identified by serial number) was installed (identified by customer location or transformer ID). This information is later transferred to the NES system software via a Utility Enterprise Application to enable it to complete the configuration process of system devices.

Appendix D

Model Changes

Model 83011-83301 Changes

The following describes significant changes to model 83011-83301 of the Echelon electric ANSI meter as compared to the previous model (83010 through 83300), and any additional significant changes to this document.

Item Added or Changed	Reference Pages
Test mode is an optional feature that is only supported by some NES version 3.1 ANSI meters. While in test mode, the meter will suspend standard energy accumulations, standard demand calculations, power quality analysis, tariff register calculations, automated control of the disconnect switch, and automated control of the control relay. You may find test mode useful if you want to test the meter's accuracy without disrupting its billing registers. Test mode can be activated with a push button on the meter front panel.	"Test Mode" on page 1
The meter display has been updated to: • Allow the user to configure whether or not, and for how long, the present firmware version will be displayed when the meter is powered on. • Include new display icons and diagnostic messages relevant to new features such as test mode, the tilt sensor, demand metering, as well as new icons intended to enhance the information displayed for other meter features such as the load disconnect contactor. • Allow the user to select the format in which the current date will be shown on the meter display. • Display various reasons the load disconnect contactor has been opened or closed, as a user-supplied text string. • Allow disabling of the automatic scroll feature.	"Reading the Display" on page 1 and "Self Tests and Diagnostic Messages" on page 1
The meter now provides power quality measurements for harmonic distortion. In addition, you can now configure a threshold level that determines when a phase loss event will logged in the event log.	"Power Quality" on page 1
New status and alarm events are available to be logged in the meter event log.	"Event Log" on page 1

Item Added or Changed	Reference Pages
New standard and manufacturer tables and procedures are now available.	"Event Log" on page 1
The meter includes a sensor that will detect when the meter has been tilted, indicating that it may have been moved or tampered with.	"Tilt Conditions" on page 1
Multiple enhancements have been made to the load disconnect contactor, including the following: • The capability to turn the load disconnect contactor off remotely can be disabled. You can disable this feature completely, so that the ability to close the load disconnect contactor remotely is always disabled. As an alternative, you can disable the feature partially, so that the ability to close the load disconnect feature remotely is only disabled if it has been manually opened or if load side voltage is present. • You can configure the meter to lock the load disconnect contactor in the open state at a specific time and for a specific duration. • You can calculate the trip point for the load disconnect contactor based on either the active power level, or the active present demand measurement. • The meter will automatically re-synchronize the state of the load disconnect contactor under certain circumstances if the physical state of the load disconnect contactor does not match its desired internal state.	"Load Disconnect" on page 1
The meter optionally contains a KYZ pulse output signal.	"Pulse Output Signal (KYZ)" on page 1
New options have been added regarding how the meter clock is synchronized. In addition, retroactive data capture now occurs after the meter is powered on without a valid clock setting as soon as the clock is set.	"Clock Settings" on page 1
Ability to schedule 2 One-time-reads for the meter, as well as store up to 12 Self-reads.	"Self-Reads" on page 1 and "One-Time Reads" on page 1.
Up to 16 channels of load profile storage.	"Load Profiles" on page 1.
Up to 10 group IDs for group broadcast addressing can be programmed into the meter.	"Group Broadcasting" on page 1.
The meter offers various types of demand calculations that can be performed to measure the active and reactive power delivered to or by the system.	"Demand Metering" on page 1
The meter optionally provides a new bi-directional, isolated UART serial port that is called a *MEP port*. The MEP port allows a connected smart device to access meter data, run meter procedures, and have limited write access to the meter. Both powered and unpowered MEP ports are available – this must be specified when you order your meter.	"MEP Devices" on page 1