ALPHA® Plus Meter

Electronic Meter for Electric Energy Measurement

Technical Manual

TM42–2182C
English (en)

ABB

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For more information:

Contact your local ABB representative for more information on any of the products mentioned in this manual.

ABB Corporate Web Site	http://www.abb.com
ABB Electricity Metering Web Site	http://www.abb.com/metering
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Contents

FCC Compliance

Most ALPHA Plus meters are Class B devices. However, some meters in some applications, when equipped with certain option boards, are certified as Class A devices. Additional FCC compliance information can be found in the documentation shipped with each meter, option board, kit, or other ALPHA Plus meter component.

Class B Devices

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. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- reorient or relocate the receiving antenna
- increase the separation between the equipment and the receiver
- connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- consult the dealer or an experienced radio/TV technician for help

Class A Devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment on a residential service may cause harmful interference, in which case the user will be required to correct the interference at his or her own expense.

Telephone Regulatory Information

The ALPHA Plus meter internal modem complies with part 68 of the FCC Rules. A label on the meter nameplate contains the FCC registration number and ringer equivalence number (REN) for this equipment. If requested, this information must be provided to the telephone company. The connection to the telephone network is through a modular jack USOC RJ–11C.

The REN is used to determine the number of devices that can be connected to the telephone line. If there is excessive ringer load on the telephone line, it is possible that a device will not ring in response to an incoming call. On most lines, but not all, the sum of the RENs should not exceed 5. To be certain of the number of devices that can be connected to a line, the local telephone company should be contacted.

If this equipment causes harm to the telephone network, the telephone company will notify the user in advance that temporary discontinuance of service may be required. If advance notice is not deemed practical, the telephone company will notify the user as soon as possible thereafter. At that time, the telephone company will also advise the user of the right to file a compliant with the FCC if believed to be warranted.

The telephone company may make changes in its facilities, equipment, operations, or procedures that could affect the operation of the equipment. If this happens, the telephone company will notify the user in advance that any necessary modifications can be made to ensure uninterrupted service.

If the user experiences trouble with this equipment, the ABB RMR Department should be contacted at +1 919 212 4700. If the equipment is causing harm to the telephone network, the telephone company may request that the equipment be disconnected until the problem is resolved.

This equipment should not be repaired by unauthorized personnel except when replacing an entire module. This meter is not intended to be used on digital PBX lines, party lines, or pay telephone service provided by the telephone company.

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There are no understandings, agreements, representations, or warranties either expressed or implied, including warranties of merchantability or fitness for a particular purpose, other than those specifically set out by any existing contract between the parties. Any such contract states the entire obligation of the seller. The contents of this technical manual shall not become part of or modify any prior or existing agreement, commitment, or relationship.

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Safety Information

Installation, operation, and maintenance of this product can present potentially hazardous conditions (for example, high voltages) if safety procedures are not followed. To ensure that this product is used safely, it is important that you:

- Review, understand, and observe all safety notices and recommendations within this manual.
- Do not remove or copy individual pages from this manual, as this manual is intended for use in its entirety. If you were to remove or copy individual pages, cross–references and safety notices may be overlooked, possibly resulting in damage to the equipment, personal injury, or even death.

- Inform personnel involved in the installation, operation, and maintenance of the product about safety notices and recommendations contained in this manual.

Within this manual, safety notices appear preceding the text or step to which they apply. Safety notices are divided into the following 4 classifications:

NOTICE

Notice is used to alert personnel to installation, operation, or maintenance information that is important but not hazard related.

⚠ CAUTION

Caution is used to alert personnel to the presence of a hazard that will or can cause minor personal injury, equipment damage, or property damage if the notice is ignored.

⚠ WARNING

Warning is used to alert personnel to the presence of a hazard that can cause severe personal injury, death, equipment damage, or property damage if notice is ignored.

⚠ DANGER

Danger is used to alert personnel to the presence of a hazard that will cause severe personal injury, death, equipment damage, or property damage if the notice is ignored.

Revisions to this Document

The *ALPHA Plus Meter Technical Manual* can be referred to by its document number: TM42–2182. Each revision of this manual is designated with a letter, with the first revision being “A,” the second being “B,” and so forth. The document number and revision letter are located at the bottom of each page.

The following table lists the revisions to this document, the date of release, and a brief description of the changes made.

Revision	Date	Brief description
A	22.July.1997	First release of this document.
B	02.November.1998	Major revisions throughout document.
C	19.July.2000	Corrected figures in Appendix C and Appendix D. Clarified startup current and secondary time base specifications in Appendix E. Added FCC Class A device statement.

1: Introduction

The ALPHA Plus Meter

Upon its introduction in 1992, the ALPHA meter has been the standard for totally electronic electricity metering. As features have been continually added, the ALPHA has been able to maintain its position as the leader in solid state metering. Building on patented and proven ABB ALPHA meter technology, the ALPHA Plus meter provides a meter design platform that supports a variety of metering requirements.

The ALPHA Plus meter is a totally electronic meter that can perform a wide range of functions. From a simple one–rate kWh and kW demand meter up through a multi–rate, real/reactive meter that automatically validates the meter service connections, provides instrumentation readings, performs power quality monitoring, and provides load profile reading with remote communications: the ALPHA Plus meter does them all.

This meter provides the following general functionality on either a single rate or time-of-use (TOU) basis:

- collects energy use and demand data
- processes energy use and demand data
- stores energy use and demand data

The ALPHA Plus meter meets or exceeds the ANSI standards for electricity metering, and it is intended for use by industrial and electric utility customers. See Figure 1–1 for an illustration of the ALPHA Plus meter.

The ALPHA Plus meter may be programmed using ABB meter support software at any of the following locations:

- factory (before shipment)
- meter shop
- installation site

A liquid crystal display (LCD) on the meter provides a visual indication of both energy usage and demand. The optical port allows data to be retrieved directly from the meter using a handheld or portable computer. Data can also be collected remotely with appropriate ABB meter support software if the meter has been equipped with an optional communications interface.

The ALPHA Plus meter may have up to 6 output relays added through an optional relay board. The following types of output relays are available:

- KYZ pulse output
- load control
- end of interval

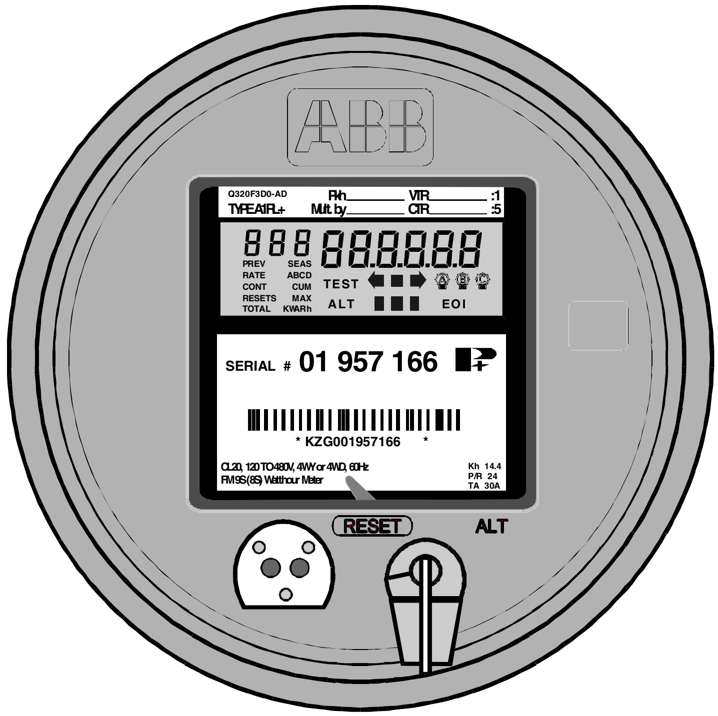

Figure 1–1. The ALPHA Plus Meter

General Features

See “Standard Features” in chapter 2 for more details on the features of the ALPHA Plus meter. Listed below are some of the standard features:

- fully programmable
- wide operating ranges for voltage, current, and temperature (see Appendix E, “Technical Specifications”)
- per phase values for:
  - kW
  - kVA or kVAR
  - voltage and voltage angle
  - current and current angle

  - power factor and power factor angle
- average power factor
- easy access battery
- high accuracy internal clock
- polycarbonate enclosure
- easy to upgrade through software and optional hardware

Reliability

Unlike electromechanical meters, the ALPHA Plus meter has no moving parts. This results in improved service reliability and ensures many years of trouble–free service. Both EEPROM and RAM are used to store meter data. The RAM has power backup supplied by a supercapacitor which is integral to the meter main board. An optional lithium battery can be installed to prevent data and time loss during an extended power outage.

The ALPHA Plus meter uses the power line frequency to maintain time and date functions. In configurations where the line frequency is known to be unstable, the ALPHA Plus meter can be programmed to always use its internal crystal oscillator for keeping accurate time.

The ALPHA Plus meter contains circuits which have been designed to function with the battery to provide a long battery life. Because of the low current drain, the service life of the lithium battery is expected to exceed the life of the meter.

Maintainability

The ALPHA Plus meter is easy to maintain. Meter and register functions are fully integrated on a single, surface-mount technology circuit board. This combines with the modular design of the meter to allow parts to be replaced quickly and easily.

Adaptability

The ALPHA Plus meter allows configuration for custom TOU rates, offering a broad range of demand and time–of–use operations. Almost all common services and mounting configurations have been accounted for, and functional upgrades are easily performed as new situations arise. The wide operating voltage range allows installation at any of the common meter voltages.

Economy

The ALPHA Plus meter saves both time and money. It will dramatically increase personnel productivity due to the following features:

- no user calibration required (factory calibrated)
- reduced testing times
- fewer styles to learn and maintain
- automated data retrieval
- system service verification
- on site instrumentation displays
- power quality monitoring (PQM) tests

Security

The ALPHA Plus meter is tamper resistant. Passwords may be specified which prevents unauthorized access to meter data. Since there are no moving parts in this fully electronic meter, tampering which would affect an electromechanical meter will not affect the ALPHA Plus meter.

The optional PQM feature can also be used to detect conditions which may result from meter tampering designed to affect energy measurement. All ALPHA Plus meters provide auditing capabilities in order to indicate potential meter tampering. These capabilities provide a record of the following:

- programming changes
- power outages
- number of manual demand resets
- many other security related quantities available on TOU meters

Multiple Configurations

See “Standard Features” in chapter 2 for more details on the features of the ALPHA Plus meter. Listed below are some of the features available on ALPHA Plus meters:

- energy: kWh, kVARh, kVAh
- demand: kW, kVAR, kVA
- up to 4 TOU rate periods
- 4–quadrant metering of reactive energy
- many different wiring configurations (See Appendix C, “Internal Meter Wiring Diagrams” and Appendix D, “Wiring Diagrams for Installation” for wiring diagrams)

Accuracy

The ALPHA Plus meter meets or exceeds requirements of ANSI standards. The meter precisely measures and displays energy usage and demand data consistent with the meter class purchased, and through a wide range of the following:

- current variations
- voltage variations
- temperature variations
- power factor variations

The low current sensor burden may also improve the accuracy of external current transformers when measuring light loads.

Advanced Options

There are also some advanced options available. Some of these are part of the main board and others are available as installable components:

- pre–programming at factory
- load profile with up to 4 channels
- output relays
- RS232 option board
- RS485 option board
- internal modem with outage reporting capabilities
- 20mA current loop option board
- wide area network (WAN) option board for ALPHA STARS

- factory installed lithium battery
- external auxiliary power supply connector

See “Optional Features” in chapter 2 for more details on the optional features of the ALPHA Plus meter.

Software

Meter Support Software

The ALPHA Plus meter requires ABB meter support software in order to program the operational parameters of the meter. Although specific functionality may change, all ABB meter software provides the following general features:

- program development
  create user–defined configuration data
- meter programming
  sending user–defined configuration data or commands to the meter
- meter reading
  receiving data which has been stored by the meter

PQ Inspector Software

PQ Inspector software is a comprehensive package which provides an easy to use tool for collecting electric service and meter status information from ALPHA Plus meters. The software can be configured to match local computer system features, and it is used to program selected service and PQM thresholds in the meter. Below are some of the features provided by PQ Inspector software:

- collection of electric service information from the meter
- collection of meter status reports from the meter
- selecting and downloading PQM thresholds to the meter

PQ Inspector software supports all ABB ALPHA Plus meters and is comprised of two parts. Diagnostics is the read–only portion which collects and then reports or graphs meter data. Thresholds provides the capability to select PQM thresholds and program these values into an ALPHA Plus meter.

Alpha Keys Software

Alpha Keys software allows ALPHA Plus meters to be upgraded so they provide additional functionality. Upgrading with Alpha Keys software means that the meter does not have to be returned to the factory and new meters do not have to be purchased in order to gain functionality. Alpha Keys may be used as a standalone program or with ABB meter support software.

The following types of upgrades may be performed with Alpha Keys software:

Current meter type	Can be upgraded to
A1D+	A1T+ A1K+ A1R+
A1T+	A1K+ A1R+
A1K+	A1R+
A1R+	A1K+

In addition, the following can be added to all of the meter types (except the A1D+):

- Add power quality monitoring (PQM)
- Add load profile storage

Optical Probe

To use ABB meter support software to read or program an ALPHA Plus meter through the optical port, an optical probe is required. This probe connects from the serial port of the computer to the optical port on the ALPHA Plus meter and provides the required interface for communications.

2: Product Details

Meter Capabilities

Different ALPHA Plus meters have specific capabilities as shown in Table 2–1. Descriptions of the meter type suffixes can be seen in Table 2–2.

Table 2–1. ALPHA Plus meter types

Meter type	**kWh kW**	**kVARh kVAR**	**kVAh kVA**	**TOU**	**Load profile**[1]	**PQM**	**2 metered quantities**
A1D+	✓						
A1T+	✓			✓			
A1R+	✓	✓	✓[2]	✓			✓
A1K+	✓	✓	✓[3]	✓			✓
A1TL+	✓			✓	✓		
A1RL+	✓	✓	✓[2]	✓	✓		✓
A1KL+	✓	✓	✓[3]	✓	✓		✓
A1DQ+	✓					✓	
A1TQ+	✓			✓		✓	
A1RQ+	✓	✓	✓[2]	✓		✓	✓
A1KQ+	✓	✓	✓[3]	✓		✓	✓
A1TLQ+	✓			✓	✓	✓	
A1RLQ+	✓	✓	✓[2]	✓	✓	✓	✓
A1KLQ+	✓	✓	✓[3]	✓	✓	✓	✓

[1] 12K for ALPHA Plus meters Release 2.0 or 2.1; 28K for ALPHA Plus meters Release 2.2 or higher

[2] kVAh and kVA quantities calculated vectorially from kWh and kVARh

[3] kVAh and kVA quantities measured and calculated arithmetically

Table 2–2. ALPHA Plus meter type suffixes

Suffix	**Added functionality to the meter**
T	Time of use (TOU); A1R+ and A1K+ also have TOU capabilities
L	Load profile (LP)
Q	Power quality monitoring (PQM)

Physical Components

The physical components of the ALPHA Plus meter consist of the following:

- cover assembly
- electronic assembly
- base assembly

See Figure 2–1 for an illustration of the ALPHA Plus meter physical components.

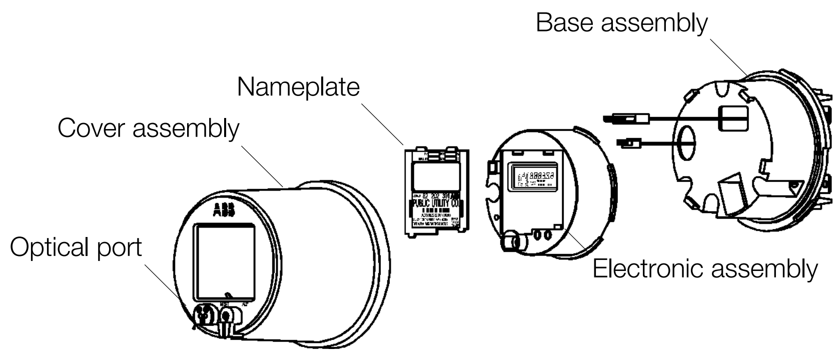

Figure 2–1. Exploded view of the ALPHA Plus meter

Cover Assembly

The cover assembly of the ALPHA Plus meter is a polycarbonate housing designed to protect the inner assemblies of the meter. The ultraviolet (UV) stabilized polycarbonate reflects solar radiation, resulting in minimized discoloration and reduced internal heating. The cover has an abrasion resistant clear plastic window that allows the meter LCD to be viewed.

Electronic Assembly

The enclosure houses the following electronic components:

- liquid crystal display (LCD)
- optical port
- **RESET/ALT** mechanism
- push buttons
- nameplate
- ALPHA Plus meter main circuit board (contains meter and integral register electronics with power supply)

The enclosure also accommodates the following optional electronic components:

- optional lithium battery
- relay option board
- internal modem option board
- RS232 communication board
- RS485 communication board
- 20mA current loop option board
- external serial communication option board
- wide area network (WAN) option board for ALPHA STARS

Base Assembly

The base assembly contains the following components:

- base housing
- current and voltage blades
- connecting cables for the main meter circuit board

The base assembly also includes a battery well for the internal modem when supplied with the outage modem reporting features. Table 2–3 shows the available ANSI compatible configurations for a socket connected (S-base) or bottom connected (A-base) ALPHA Plus meter according to the type of service being metered.

Table 2–3. ALPHA Plus meter available wiring forms

Meter style	Form	Test Amps	Class	Elements	Kh	Type of service
QA30xxxx	1S	30	200	1	7.2	2-wire single phase
QC30xxxx	2S	30	200	1	7.2	3-wire single phase
QA20xxxx	3S	2.5	20	1	0.6	2 or 3-wire single phase
QC20xxxx	4S	2.5	20	1	0.6	3-wire single phase
Q220xxxx	35S[1]	2.5	20	2	1.2	3 or 4-wire delta, 4-wire wye, network
Q2B0xxxx	35A[1]	2.5	20	2	1.2	3 or 4-wire delta, 4-wire wye, network
Q530xxxx	12S	30	200	2	14.4	3-wire delta, network
Q230xxxx	13S	30	200	2	14.4	3 or 4–wire delta/wye
Q2C0xxxx	13A	30	100	2	14.4	3-wire delta, network
Q820xxxx	36S[2]	2.5	20	2 ½	1.8	4-wire wye
Q8B0xxxx	36A[2]	2.5	20	2 ½	1.8	4-wire wye
Q320xxxx	9S[3]	2.5	20	3	1.8	4-wire wye or delta
Q420xxxx	10S[4]	2.5	20	3	1.8	4-wire wye or delta
Q4B0xxxx	10A[3]	2.5	20	3	1.8	4-wire wye or delta
Q330xxxx	16S[5]	30	200	3	21.6	4-wire wye or delta
Q3C0xxxx	16A[5]	30	100	3	21.6	4-wire wye or delta

[1] Form 35 replaces Form 5 circuit applications. Because the voltage elements share a common point of reference on one side, this form cannot be used with phase shifting transformers or to sum separate single phase services.

[2] Form 36 replaces Form 6 circuit applications. Because the voltage elements share a common point of reference on one side, this form cannot be used with phase shifting transformers.

[3] Form 9S replaces Form 8S, and Form 10A replaces Form 8A circuit applications.

[4] Form 10S is actually a Form 9S with jumpers across the three common (neutral) connections of the voltage circuit. This meter style provides a means of replacing a Form 10S meter without requiring changes to the socket wiring. This form should not be used with phase shifting transformers.

[5] Form 16S replaces Forms 14S and 15S, while Form 16A replaces Forms 14A and 15A circuit applications.

Electronic Components

The ALPHA Plus meter main circuit board contains all the electronics that comprise the meter and integral register. See Figure 2–2 for a meter circuit board block diagram.

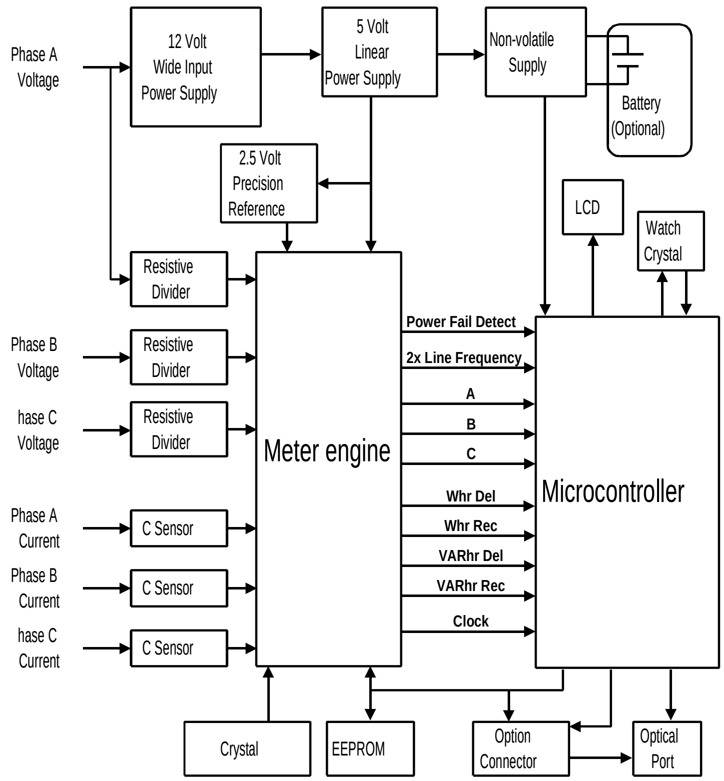

Figure 2–2. Circuit board block diagram

The circuit board, as shown in Figure 2–3 contains the following components:

- meter engine and reset circuitry
- microcontroller
- EEPROM memory
- resistive voltage dividers for the 3 phase voltages
- load resistors for the 3 current sensors
- power supply
- high frequency crystal oscillator
- 32 kHz low power, time-keeping crystal oscillator
- optical port components

- liquid crystal display (LCD) interface
- option board interface

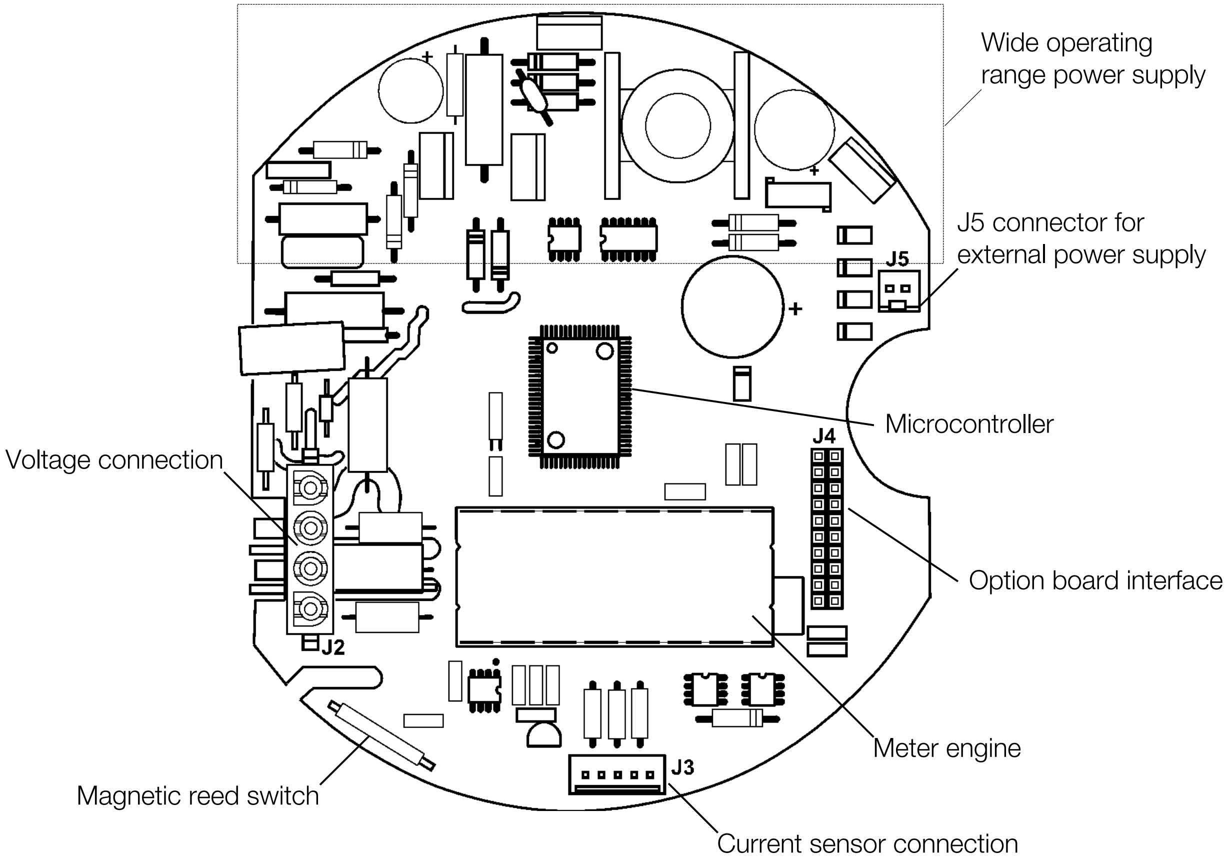

Figure 2–3. ALPHA Plus meter main circuit board

Voltage and Current Sensing

The power line currents and voltages are sensed using specialized current sensors and resistive voltage dividers respectively. Multiplication and other calculations are performed using the meter engine. This meter engine contains a digital signal processor (DSP) with built in analog-to-digital (A/D) converters capable of sampling each voltage and current input.

Voltage Sensing

The electronic assembly receives each phase voltage through resistive dividers to ensure that a linear logic level voltage is maintained. This also serves to minimize phase shift over a wide dynamic range. The meter engine within the electronic assembly samples the scaled inputs provided by the resistive dividers to provide accurate voltage measurement.

Current Sensing

The electronic assembly receives each phase current through a precision wound current sensor which reduces the line current proportionally. The meter engine within the electronic assembly samples the individual phase currents to provide accurate current measurement.

Signal Conversion and Multiplication

The meter engine contains A/D converters that measure the voltage and current inputs for a given phase, and a DSP that multiplies signals appropriately. Calibration constants (stored in EEPROM) are programmed into the meter at the factory, and become part of the appropriate multiplication within the DSP.

The meter engine includes power failure circuitry that responds to any power failure greater than 100ms in duration. The meter IC processes voltages and currents into energy pulses, which are then fed to the microcontroller for processing. All information necessary to ensure the integrity of the demand or TOU calculations is stored in the EEPROM, including:

- configuration data
- constants
- energy usage
- maximum demand
- cumulative demand
- all TOU data
- number of demand resets
- cumulative power outages
- cumulative number of data altering communications

Power Supply

Power is supplied to the ALPHA Plus meter using a wide voltage range power supply. Phase A voltage must be present to power the meter circuitry. The 12V output from the power supply is then fed to a low voltage linear regulator to attain the logic level voltage.

Liquid Crystal Display (LCD)

The LCD is used to display meter data and status information. As shown in Figure 2–4, the LCD can be divided into different display fields, with each displaying a particular type of information.

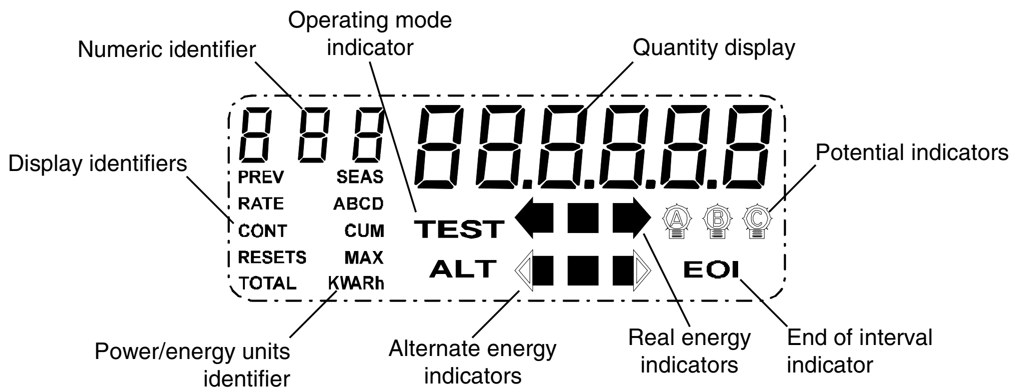

Figure 2–4. Liquid crystal display

Numeric Identifier

This 3–digit field identifies the displayed quantity as defined and programmed with ABB meter support software. A numeric identifier can be assigned to each display quantity (excluding system instrumentation quantities) in the display sequence.

This field will display system, service, and phase indicators when a system instrumentation quantity is being displayed. When an error or warning condition exists, the numeric identifier field will be used to display the type of error or warning (Er, F, SEr, or C), and the quantity display field will show the numeric error code.

Quantity Display

This 6–digit display on the LCD shows either metered quantities or other displayable information depending upon how the ALPHA Plus meter has been programmed.

The display digits are definable through ABB meter support software for both energy and demand readings. From 3 to 6 total digits with up to 4 decimal places can be used. These digits are also used to report the error codes for the following error conditions:

- operational errors (Er)
- system instrumentation and service test errors (SEr)
- warnings (F)
- communications errors (C)

When the numeric identifier field indicates an error or warning condition, the numerical value in the quantity display will identify the type of error or warning found. See “Error Codes and Warnings” in chapter 7 for more information.

Display Identifiers

Display identifiers are used to more precisely identify the information presented on the ALPHA Plus meter LCD. Using ABB meter support software, the display identifiers can be disabled. See Table 2–4 for a description of the display identifiers.

Table 2–4. LCD identifiers

Identifier	Description	Appears with
RATE	Indicates that TOU rate data is being shown on the LCD	ABCD
ABCD	Indicates rate for presently displayed data; blinking letter indicates present TOU rate	RATE
CONT	Indicates continuous cumulative demand value	CUM
CUM	Indicates cumulative demand value	Power units identifier
MAX	Indicates maximum demand value	Power units identifier
PREV	Indicates previous billing period or, when used with SEAS identifier, previous season	SEAS
RESETS	Indicates number of demand resets	
SEAS	Indicates season information	PREV
TOTAL	Indicates total energy value	Energy units identifier

These identifiers may be shown individually or in combination to describe a particular displayed quantity.

Power/Energy Units Identifier

The power/energy units identifier is used to indicate the unit of measurement for the quantity displayed on the ALPHA Plus meter LCD. The power/energy units identifier can reflect the following information by turning on specific segments of the LCD:

- kW
- kWh
- kVA
- kVAh
- kVAR
- kVARh

Operating Mode Indicator

Table 2–5 shows which operating modes correspond with the operating mode display on the ALPHA Plus meter LCD. See “Operating Modes” in chapter 3 for more information.

Table 2–5. LCD operating mode indicator

Indicator	Operating mode	Description
None	Normal mode	The ALPHA Plus meter is in this mode most of the time. If an error has occurred, a message will be displayed on the LCD. After exiting any other mode, the meter will usually return to this mode.
TEST	Test mode	In this mode the ALPHA Plus meter will display test mode quantities.
ALT	Alternate display mode	In this mode the ALPHA Plus meter will scroll through its alternate display settings.

Real Energy Indicators

The real energy indicators are fixed to represent kWh energy measurements. The center square indicator will blink to indicate pulses of K_h while the left and right arrows blink at a faster rate representing K_e. Each time an arrow pulses (turns on and off again) indicates 1/12 K_h energy measurement. This means a single transition of an arrow pulse (off to on, or on to off) represents 1/24 K_h. The left and right arrows indicate energy being either received or delivered respectively.

Alternate Energy Indicators

These indicators function similarly to the real energy indicators, except that they are used to indicate reactive or apparent energy, depending upon whether an A1R+ or A1K+ meter is used. On an A1R+ meter, the alternate energy indicators are fixed to represent kVARh. Similarly on an A1K+ meter, they are fixed to represent kVAh.

The left and right arrow indicators indicate energy that is leading or lagging for kVARh on an A1R+ meter. On an A1K+ meter the left and right arrow indicators indicate kVAh while kWh is being received or delivered respectively. The same K_h and K_e pulse constants are used here as for the real energy indicators.

Potential Indicators

Each potential indicator corresponds to a phase voltage present on the ALPHA Plus meter connections. If the potential indicators are on, then all phase voltages are present. If an indicator is blinking steadily then that phase voltage is either missing or below the defined threshold for voltage sag detection. See “Momentary Voltage Sag” in chapter 4 for more information. Since the meter is powered by phase A voltage, that phase must be present for the meter to function.

End of Interval (EOI) Indicator

The EOI indicator can be used to verify the timing of the demand interval except when configured for thermal demand. Ten seconds before the end of a demand interval, the EOI indicator will be turned on and remain on until the end of the interval. The EOI indicator is not active for thermal demand.

Note: Rolling demand intervals end after each subinterval.

Standard Features

In addition to the general features discussed in “General Features,” in chapter 1, there are other standard features available for the ALPHA Plus meter. Most of these features can be configured through ABB meter support software when programming the meter. All information displayed on the ALPHA Plus meter LCD is configurable. See Appendix B, “Meter Display Quantities,” for a complete listing of all displayable quantities.

Metered Energy and Demand Quantities

The ALPHA Plus meter always provides a measurement for delivered kWh and kW demand. The A1R+ and A1K+ meters can also measure reactive and apparent energy and demand. Voltage and current inputs are sampled accurately to provide these measurements. The microcontroller receives pulses from the meter engine, where each pulse is equal to one K_e (energy constant) defined as one of the following:

- secondary rated Wh per pulse
- secondary VARh per pulse
- secondary VAh per pulse

Some display quantities are dependent upon which metered quantities are selected when the ALPHA Plus meter is programmed with ABB meter support software. Table 2–6 shows the available metered quantities for each meter type. For A1D+, A1T+, only 1 quantity can be selected. For A1K+ and A1R+, only 2 quantities can be selected.

Table 2–6. Metered quantities by meter type

A1D+, A1T+	A1K+	A1R+
kW-Del	kW-Del	kW-Del
kW-Rec	kW-Rec	kW-Rec
kW-Sum	kW-Sum	kW-Sum
	kVA-Del (Q1+Q4)	kVA-Del (Q1+Q4)[1]
	kVA-Rec (Q2+Q3)	kVA-Rec (Q2+Q3)[1]
	kVA-Sum (Del + Rec)	kVA-Q1[1]
	kVAR-Q1+Q4[1]	kVA-Q2[1]
	kVAR-Q2+Q3[1]	kVA-Q3[1]
		kVA-Q4[1]
		kVAR-Del (Q1+Q2)
		kVAR-Rec (Q3+Q4)
		kVAR-Sum (Del + Rec)
		kVAR-Q1[2]
		kVAR-Q2[2]
		kVAR-Q3[2]
		kVAR-Q4[2]
		kVAR-Q1+Q4
		kVAR-Q2+Q3

[1]Release 2.2 or higher ALPHA Plus meters only

[2]kVARh values for each quadrant are available whether selected as a metered quantity or not

Demand Data

Demand data can be classified as one of the following types:

- block interval demand
- rolling (sliding) interval demand
- cumulative demand
- continuous cumulative demand
- coincident demand
- thermal demand

In Table 2–7 the billing periods for different demand types are separated by a demand reset at the end of each billing period.

Table 2–7. Sample billing data over three periods

Demand type	Start billing period 1	End billing period 1	Start billing period 2	End billing period 2	Start billing period 3	End billing period 3
Block interval max demand	0 kW	9.6 kW	0 kW	9.2 kW	0 kW	9.7 kW
Cumulative demand	0 kW	0 kW	9.6 kW	9.6 kW	18.8 kW	18.8 kW
Continuous cumulative demand	0 kW	9.6 kW	9.6 kW	18.8 kW	18.8 kW	28.5 kW

Block Interval Demand

The demand for each time interval is calculated and compared to an earlier maximum demand value. If the new interval demand exceeds the previous maximum demand, then the new demand will be stored as the new maximum value.

Rolling (Sliding) Demand Interval

The maximum demand may also be calculated based upon a rolling (sliding) demand interval. The rolling demand interval is comprised of a set of subintervals which are shorter, consecutive time periods that when added together will equal the demand interval time period. One common example of this would be to use 3 consecutive 5–minute subintervals to create a 15 minute demand interval. This 15 minute demand interval will then "roll" around the clock in 5–minute increments.

Cumulative Demand

Cumulative demand adds the present maximum demand to the cumulative sum of earlier billing period maximum demand values each time a demand reset is performed. This provides a cumulative number which reflects all of the previous billing period maximum demand values in summation. It can also serve as a security feature for detecting unauthorized demand resets during a billing period.

Cumulative demand can also be helpful in recreating billing data in the event of billing data record loss following a reading. The result of subtracting the previous cumulative demand from the present cumulative demand will yield the maximum demand for the previous complete billing period.

Continuous Cumulative Demand

Continuous cumulative demand is based upon the same general principal as cumulative demand. The main difference is that upon performing a demand reset, the continuous cumulative demand value will become the new base value. Continuous cumulative demand is equal to the cumulative demand added to the present billing period maximum demand.

Coincident Demand

Coincident demand refers to a demand value which occurs at the same time (coincident) with another maximum demand value. For example, a kVAR demand coincident with maximum kW demand might be a requirement of a particular electric utility company rate. This would require the kVAR demand which occurs during the same interval as the peak kW demand to be stored and reported. This would allow the power factor at the time of maximum demand to be calculated manually by the utility.

Thermal Demand

The ALPHA Plus meter Release 2.2 or higher also provides thermal demand emulation features. This feature stores demand data based upon a logarithmic scale which accurately emulates the function of thermal demand meters. This is useful for utilities which will be incorporating ALPHA Plus meters in environments which already include thermal demand meters.

Demand Reset

Demand reset adds the present demand value to the cumulative demand or sets the continuous cumulative demand to the new base value. It also sets the present interval demand to zero. The normal display sequence is also restarted. Confirmation of a demand reset is indicated by all zeroes on the meter LCD.

The present billing data will be copied to the previous billing data as a result of a demand reset. Certain other security features of the ALPHA Plus meter will also be reset, including the following:

- number of days since last demand reset
- warning codes

The cumulative number of demand resets will be recorded by the meter. This number will roll over to zero after 99 demand resets have occurred. For TOU configurations, the date of the last demand reset and the number of days since the last demand reset will also be recorded. Season changes and autoread initiated demand resets do not affect either this count or the date.

Demand Reset Lockout

Through ABB meter support software, a demand reset lockout time can be defined. Demand reset lockout prevents multiple, sequential manual demand resets from occurring. Up to 255 minutes after a demand reset can be programmed to protect the meter against unwanted demand resets. During the defined lockout period, subsequent manual demand resets will be ignored by the meter. Demand resets issued through ABB meter support software are not affected by this feature.

Demand Forgiveness

Demand forgiveness is the time (in minutes) during which demand will not be calculated following a total power outage. Immediately following a power restoration, startup power requirements of the customer will not be included in the calculated demand for the demand forgiveness period.

In many situations following a complete power outage, customer equipment may use a higher than normal amount of energy for a short time. This feature allows the utility to forgive this power consumption following a power outage so that customers are not charged for this additional consumption.

Primary and Secondary Metering

The ALPHA Plus meter can be programmed for either primary or secondary metering. Primary metering results in the measured energy and demand quantities being multiplied by voltage and current transformer ratios for that meter location. The displayed quantities on the LCD would then reflect energy and demand on the primary side of the instrument transformers. These ratios would be programmed into the meter with ABB meter support software.

If the transformer multiplier (product of both the voltage and current transformer ratios) creates a factor larger than can be stored within the ALPHA Plus meter, an external dial multiplier will be required. ABB meter support software can be used to program the meter with a preferred external dial multiplier when displaying quantities on the LCD. The displayed quantities will not be valid unless multiplied by this external dial multiplier manually at the time of reading.

Secondary metering does not take into account voltage or current transformer ratios. Even if voltage and current transformer values are programmed into the meter with ABB meter support software, the displayed quantities on the LCD would reflect energy and demand on the secondary side of the instrument transformers.

Average Power Factor

A1K+ and A1R+ meters Release 2.2 or higher can calculate the average power factor from collected energy–use data. The two metered quantities selected in ABB meter support software must be kWh and kVAh to get AvgPF. Average power factor (AvgPF) is calculated by the meter using kWh and kVAh values since the most recent demand reset with the following formula:

$$\text{AvgPF} = \frac{\text{kWh}}{\text{kVAh}}$$

Average power factor will be calculated once every second. The kWh and kVAh values used in this calculation will be set to zero upon a demand reset and AvgPF will be set to a value of 1.000. Average power factor will not be calculated while the ALPHA Plus meter is in test mode.

Note: Since kVAh and kWh must be selected to obtain AvgPF, kVARh and average power factor are mutually exclusive.

Time of Use (TOU) Data

Some ALPHA Plus meters are equipped with TOU capabilities. These meters may be used as either single–rate or TOU meters. Up to 4 TOU rates may be defined. According to the TOU rate schedule which was programmed into the meter, these TOU rates may be based upon either day, time, or season changes.

In TOU configurations, meter data is accumulated during individual TOU rate periods and displayed as energy and demand values on the LCD for the specified rate. Demand intervals are synchronized to whole hour or evenly divisible fractional hour time periods according to real–time. A1R+ and A1K+ meters store the selected metered quantities according to the TOU rate configuration.

Note: If Alpha Keys software was used to upgrade an A1D+ meter to include TOU capabilities, a lithium battery[6] will be required.

Automatic Functions

The ALPHA Plus meter may be programmed with ABB meter support software to perform the following functions automatically:

- demand forgiveness after a power interruption
- demand reset after season change (TOU configurations only)
- autoread and demand reset (TOU configurations only):

[6] The lithium battery can be ordered from ABB. See Appendix F, “Renewal Parts,” for style numbers.

    - specified day of month
    - specified number of days after most recent demand reset
    - ALPHA Plus meters Release 2.2 or higher support autoread without performing a demand reset
- perform system service tests:
    - upon power restoration after a failure or initial power-up
    - every 24 hours (A1D+) or at midnight (TOU configurations only)
    - following data–altering communications
    - during normal or alternate mode sequences with system service tests
- perform PQM background tests on a continual basis on meters with the optional PQM feature

Load Profile Recording Memory

ALPHA Plus meters may have the load profile feature with additional storage memory added to them for recording interval-by-interval data. A maximum of 4 channels may be recorded. The “L” meter type suffix signifies an ALPHA Plus meter having load profile capability. Load profile is stored in 12K (28K on ALPHA Plus meters Release 2.2 or higher) of the non–volatile EEPROM on the meter main circuit board. See Table 2–8 for quantities which can be stored.

Table 2–8. Quantities available for load profile storage

Quantity	A1TL+	A1KL+	A1RL+
kW-Del	✓	✓	✓
kW-Rec	✓	✓	✓
kW-Sum	✓[1]	✓[1]	✓[1]
kVAR-Del (Q1+Q2)			✓
kVAR-Rec (Q3+Q4)			✓
kVAR Sum (Del + Rec)			✓[1]
kVA-Del (Q1+Q4)		✓	✓[1 2]
kVA-Rec (Q2+Q3)		✓	✓[1 2]
kVA Sum (Del + Rec)		✓[1]	
kVAR-Q1			✓
kVAR-Q2			✓
kVAR-Q3			✓
kVAR-Q4			✓
kVA-Q1			✓[1 2]
kVA-Q2			✓[1 2]
kVA-Q3			✓[1 2]
kVA-Q4			✓[1 2]
kVAR-Q1+Q4		✓[1 2]	✓[1]
kVAR-Q2+Q3		✓[1 2]	✓[1]

[1]Must select as a metered quantity to be stored as load profile

[2]Release 2.2 or higher ALPHA Plus meters only

The amount of memory available in EEPROM for load profile data is dependent upon the event log configuration. PQM events also are stored in this location except for the voltage sag events which are stored in a separate voltage sag log (ALPHA Plus Release 2.2 or higher). See Table 2–9 for a general idea of how much load profile data can be stored in available memory.

Table 2–9. Load profile storage capacity

ALPHA Plus Meters Release 2.2 and higher

	1 channel			2 channels			4 channels		
Interval (min.)	5	15	30	5	15	30	5	15	30
Maximum days[1]	48	141	255	24	71	141	12	36	71
Minimum days[2]	44	132	255	22	67	132	11	33	67

ALPHA Plus Meters Release 2.0 and 2.1

	1 channel			2 channels			4 channels		
Interval (min.)	5	15	30	5	15	30	5	15	30
Maximum days[1]	21	61	119	10	31	61	5	15	31
Minimum days[2]	17	52	102	9	26	52	4	13	26

[1] No event log entries

[2] 255 event log entries

Outage Detection

Total power outages are monitored by the ALPHA Plus meter. The cumulative number of power outages will be recorded. This number rolls over to zero after 9999 total outages have been recorded. For all but the A1D+ meter the following will also be recorded:

- cumulative total of all power outages in minutes
- start date and time of most recent power outage
- end date and time of most recent power outage

These values are also available as display quantities for the LCD when programmed with ABB meter support software. See Appendix B, “Meter Display Quantities,” for a listing of all available display quantities.

Logs

The ALPHA Plus meter records the following types of logs:

- event log
- communications log
- voltage sag log (ALPHA Plus Release 2.2 only)

See “Voltage Sag Log” in chapter 4 for more information.

Event Log

Up to 255 date and time stamped entries for various events can be stored on an ALPHA Plus meter which has the load profile feature. ABB meter support software can be used to define and program the

ALPHA Plus meter for the number of event log entries which will be recorded. When the maximum amount of event log entries has been stored, the meter will begin overwriting the oldest entries. Events included in this log are:

- power failure start and stop times (2 event log entries)
- date and time change information (2 event log entries)
- date and time of manually performed or communication-initiated demand resets (1 event log entry)
- date and time of test mode activity (2 event log entries)

Since load profile data can share this memory, more event log entries results in less available space for load profile data. The event log may also be disabled through ABB meter support software.

Note: PQM tests may also create entries within the event log. See “PQM Event Log Entries” in chapter 4 for details about PQM event log entries.

Communications Log

The ALPHA Plus meter records the cumulative number of data–altering communications. This number will roll over to zero after 99 total communications. For TOU configurations, the date and time of the most recent data–altering communications will also be recorded.

Note: Programming an ALPHA Plus meter will reset the communications log, and the programming session will not be counted within the cumulative number of data–altering communications.

Optional Features

Some optional features available for the ALPHA Plus meter are indicated below:

- lithium battery
- external power source (only available on A–base meters)
- output relays
- AMR Datalink
- internal modem with outage reporting capabilities
- external communications option board:
  - RS232 communication board
  - RS485 communication board
  - 20mA current loop option board
  - external serial communications option board
  - wide area network (WAN) option board for ALPHA STARS

Most of these features can be configured through ABB meter support software when programming the meter.

Battery

The ALPHA Plus meter is equipped with a supercapacitor that sustains data storage and time (TOU configurations only) over temporary outages.[7] In the event of an extended power outage, a battery[8] is required by TOU configurations to maintain data storage and to ensure accurate time. The battery is a lithium thionyl chloride cell with the identical form factor and rating as used in some competitive TOU meters. See "Installing an Optional Battery" in chapter 5 for installation instructions or "Removing an Optional Battery" in chapter 5 for removal instructions.

Note: While not required by demand configurations, if a battery is installed it will be used during extended power outages.

External Power Source (A–base Meters Only)

The ALPHA Plus meter has been designed to use the electrical service voltage as its power source for operation. During a power outage, the meter will be in an inoperative state and the LCD will not function.

[7] The supercapacitor sustains data storage and time for approximately 6 hours at 25°C. See "General Performance Characteristics" in Appendix E for complete details.
[8] The battery can be ordered from ABB. See Appendix F, "Renewal Parts," for style numbers.

To provide power for both the LCD and communication features, the ALPHA Plus meter may be connected to an external power source using the J5 connector (see Figure 2–3).

The external power source must be at least 12.5V and less than 16V DC and is capable of supplying a minimum of 100mA of current to power the meter during an outage condition.

If the system service test is enabled, and if the J5 connector is used, and there is no voltage applied to the meter blades, then SEr 555000 will cycle on the LCD. To display the billing quantities:

- see “Normal Mode” in Table 3–2 (ALPHA Plus Release 2.0 and 2.1)
- see “Error Mode” in Table 3–2 (ALPHA Plus Release 2.2 or higher)

Output Relays

A relay output board may be connected to the ALPHA Plus meter main circuit board via the 20–pin header (J4), as shown in Figure 2–5, to provide pulse and indication relay outputs. In cases where remote communications are also desired, the relay board may have communication connections. The four general relay configurations are listed below:

- Single relay (KYZ1) dedicated to kWh-Del pulse output.
- Two relays (KYZ1 and one programmable) where the programmable can be used as KYZ2 (pulse output), load control, or EOI.
- Four relays (KYZ1, one programmable, load control, and EOI) where the programmable can be used as KYZ2 (pulse output), load control, or EOI.
- Six relays (KYZ1, one programmable, KYZ3, KYZ4, load control, and EOI) where the programmable can be used as KYZ2 (pulse output), load control, or EOI. In this configuration, KYZ3 and KYZ4 are not supported with programmable pulse divisors.

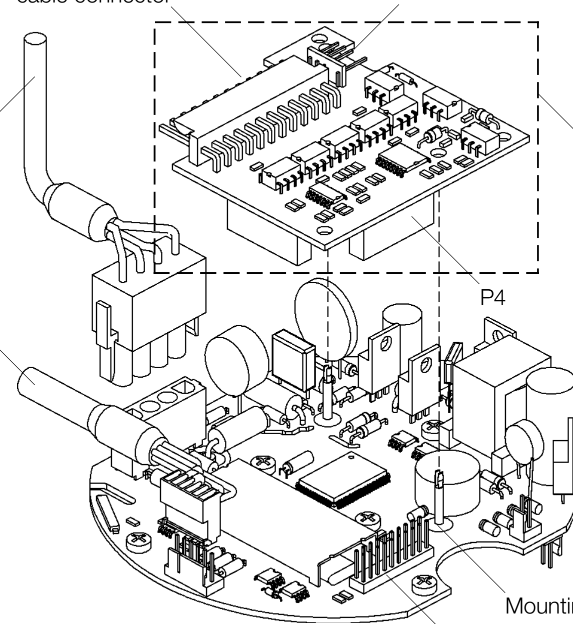

Figure 2–5. ALPHA Plus meter with relay option board

The KYZ1 relay is a dedicated kWh-Del pulse output which is controlled by the K_e value of Wh-Del. In most configurations, K_e is equal to K_h divided by 24. A software programmable divider can be used to reduce the output frequency of the relay, effectively multiplying the output K_e value by the divider. The selection of this divider is important because it prevents overdriving external recorders when the ALPHA Plus meter is operated at high line voltages or current levels.

The programmable relay is a versatile output relay which can be programmed in any of the following ways with ABB meter support software:

- KYZ2 pulse output
- load control
- end of interval (EOI)

When defined as KYZ2 pulse output, the programmable relay is controlled by the K_e value of kVAh-Del on an A1K+ or kVARh-Del on an A1R+ meter. The operation is similar to that of KYZ1 in that the output divisor also applies to KYZ2 pulse output.

Load control relay output provides the following:

- relay closed during programmed TOU rates (TOU configurations only)
- relay closed for remainder of present interval when the demand threshold level is exceeded; the relay will remain closed until one complete demand interval occurs with demand below the threshold
- relay closed when one of the PQM tests has failed

The end of interval (EOI) relay will indicate the completion of the demand interval by closing at the end of the interval and remaining closed for 5 seconds into the next interval.

The KYZ3 relay is fixed to kWh-Rec pulse output, while the KYZ4 relay is fixed according to the ALPHA Plus meter type. On an A1K+ meter KYZ4 pulse output is controlled by kVAh-Rec. Similarly, on an A1R+ meter KYZ4 pulse output is controlled by kVARh-Rec. Neither of these relays support an output divisor.

Relay Specifications

The output relays can optionally switch up to 120V AC or 200V DC at up to 100mA. The KYZ1 relay can be terminated to 3 small voltage blades in 13–terminal socket applications (or to specified terminals for A-base meters) as shown in Appendix C, "Internal Meter Wiring Diagram" and Appendix D, "Wiring Diagrams for Installation."

The standard relay output is a cable from the relay option board which exits the meter base or terminal block. For a relay option board providing 1 or 2 output relays, a 6–conductor cable is provided. A 12–conductor cable is provided for the 6 relay option board. Table 2–10 shows color codes for each of these cables.

Table 2–10. Relay wiring information

One or two relays	KYZ1	KYZ2
Common (K)	Red	Orange
Closed contact (Y)	Yellow	Black/White
Open contact (Z)	Black	Blue

Six relays	KYZ1	KYZ2	KYZ3	KYZ4	LC	EOI
Common (K)	Red	Red	Red	Red	Green	Red
Closed contact (Y)	Yellow	Black/ White	Violet	Grey		
Open contact (Z)	Black	Blue	White	Brown/ White	Brown	Orange

AMR Datalink

The AMR Datalink feature offers specific data retrieval options to an ALPHA Plus meter Release 2.2 or higher. AMR Datalink must be requested at the time of purchase and requires special programming at the factory. An AMR system may then be configured to retrieve specific data from a meter, instead of a full diagnostic read. AMR Datalink can potentially reduce total communication time.

Internal Modem

The internal modem option board[9] provides modem communication capabilities to the ALPHA Plus meter. It houses telephone system interface hardware for modem communication and can contain two relays. Two additional relays may be optionally included on the modem interface board. These output relays function as described in "Output Relays" on page 2–23. See Figure 2–6 for an illustration of a meter equipped with an internal modem and 2 relays.

[9] The internal modem option board and interface board can be ordered from ABB. Contact your ABB representative for details.

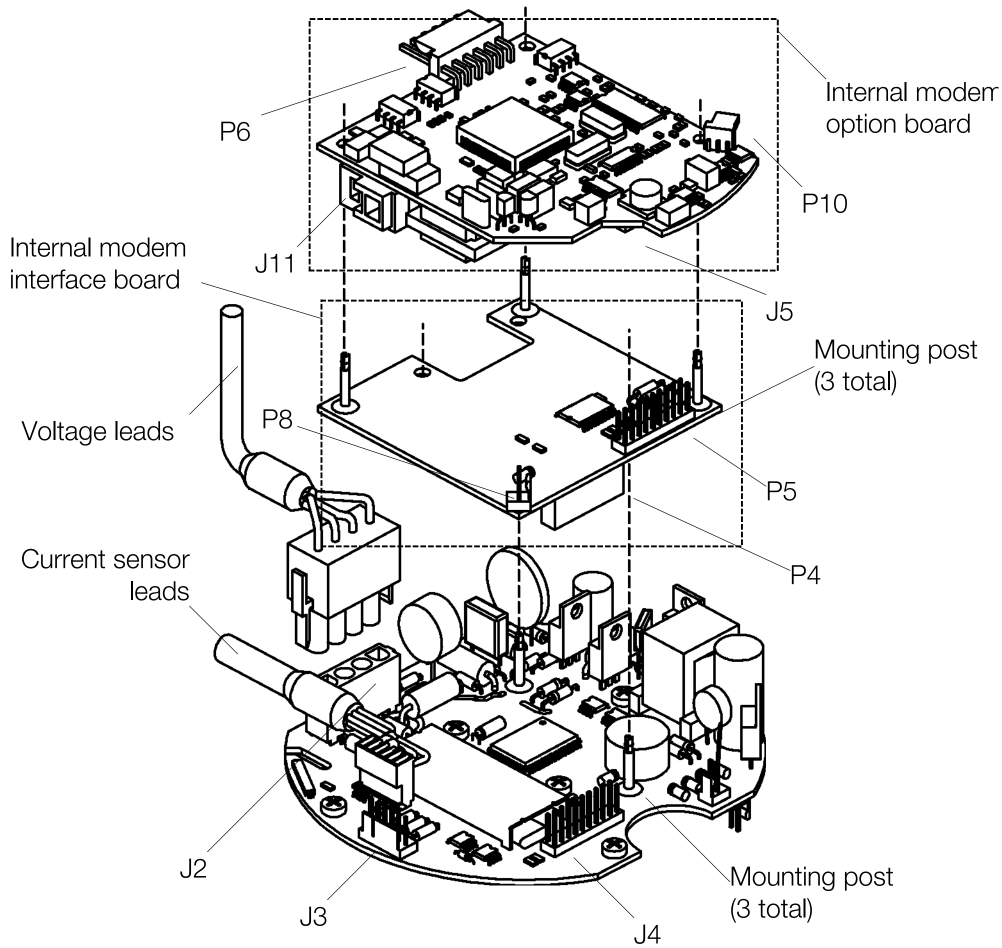

Figure 2–6. ALPHA Plus meter with internal modem (2 relays)

An ALPHA Plus meter equipped with an internal modem is capable of remote communications when connected to an analog telephone line. Once programmed for remote communications with ABB meter support software, the meter can be read or programmed over a telephone line from any computer which is also equipped with a modem. The internal modem provides both receiving and origination features.

An ALPHA Plus meter Release 2.2 or higher can also make calls to report power outages. This outage detection and reporting feature also requires an outage reporting battery[10] for the internal modem to provide power during the power outage. See Figure 2–7 for the location of the outage modem battery.

[10] The internal modem battery may be ordered from ABB. Contact your ABB representative for details.

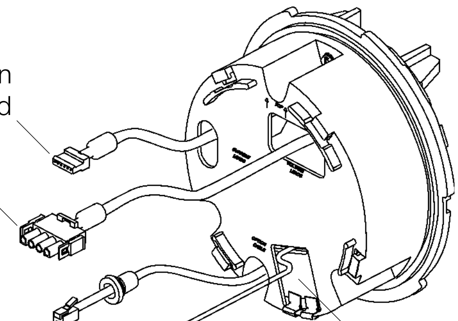

Figure 2–7. Internal modem wiring and outage battery location

The internal modem also provides off–hook and intrusion detection. These features are designed to address situations that may arise from the use of a modem equipped meter on a telephone line which is shared by other telephone extensions.

Note: In order to use an internal modem option board, a modem interface board is also required for the ALPHA Plus meter. The modem interface board provides communications between the modem and the meter main board, and allows the internal modem to be mounted properly.

Off–hook Detection

Off–hook detection recognizes that the telephone line is in use before the modem tries to place a call. When this occurs the modem will schedule the call attempt for a later time to try again when the line is available.

Intrusion Detection

Intrusion detection recognizes when another telephone extension sharing the telephone line is attempting to place a call. The internal modem will cease communications and disconnect immediately allowing the other extension to use the telephone line.

External Communications

Any ALPHA Plus meter (except A1D+) can have an external communication option board installed. This will provide an interface for connection to a modem sharing unit or other external communications device. External communications option boards connect to the ALPHA Plus meter main circuit board via the 20–pin header (J4) as shown in Figure 2–8. The following types of external communications options are available:

- RS232 option board
- RS485 option board
- 20mA current loop option board
- external serial interface option board
- wide area network (WAN) for ALPHA STARS

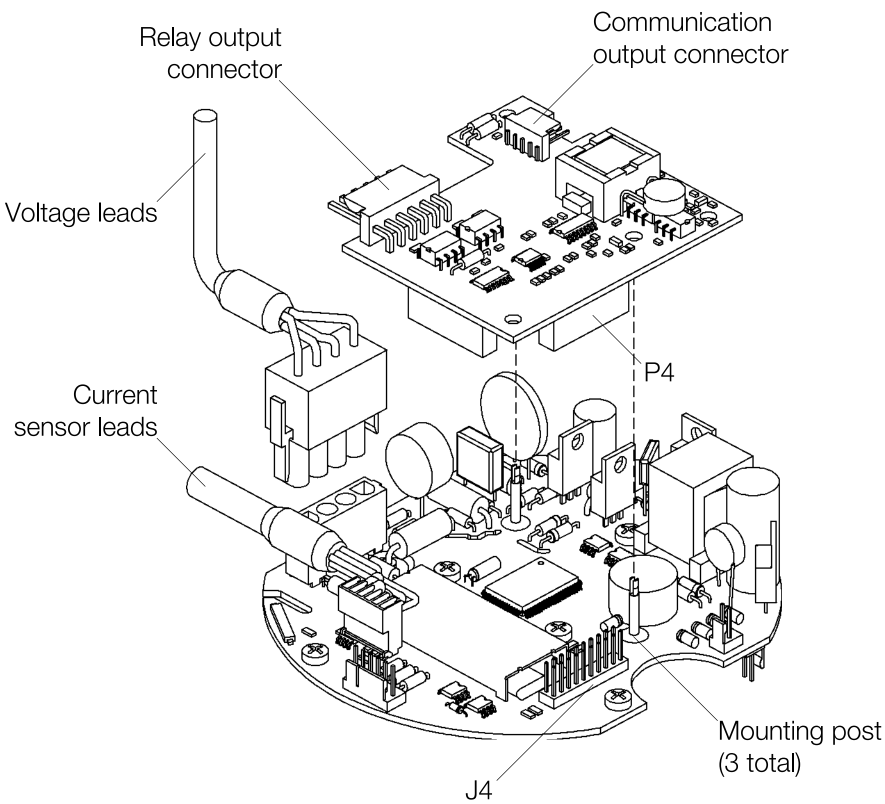

Figure 2–8. ALPHA Plus meter with external communications option board (RS232/485 option board with 2 relays shown)

RS232 Option Board Connections

The RS232 cable exits the ALPHA Plus meter through the opening in the meter base and is terminated in an RJ-11 jack. An optional adapter can be used to convert the RJ-11 jack into a DB-25 type connector. RS232 connections are point–to–point and primarily intended for use with an external telephone modem.

The RS232 option board may also be equipped with 2 or 4 optional output relays. These relays function as described in “Output Relays” on page 2–23.

RS485 Option Board Connections

The RS485 cable exits the ALPHA Plus meter through the opening in the meter base and is terminated in an RJ-11 jack. RS485 connections can be used to link up to 31 meters with a single RS485 controller. Multiple meters used in this manner must be programmed with a unique remote device identification number using ABB meter support software.

The RS485 option board may also be equipped with 2 or 4 optional output relays. These relays function as described in “Output Relays” on page 2–23.

20mA Current Loop Option Board Connections

The cable from the 20mA current loop option board exits the ALPHA Plus meter through the opening in the meter base and is terminated in an RJ-11 jack. This option board is used to interface with an external communications controller which will communicate with the ALPHA Plus meter via 20mA signaling.

The 20mA current loop option board may also be equipped with up to 6 optional output relays. These relays function as described in “Output Relays” on page 2–23.

External Serial Communications Option Board Connections

The external serial communication option board provides a serial interface via a cable which exits the ALPHA Plus meter base and terminates in an RJ-11 jack. This option board is designed for use with an ABB modem sharing unit (MSU-12). The option board and the MSU-12 provide the ability to connect up to 12 ALPHA Plus meters to a single telephone modem. The MSU-12 provides an enclosure for housing the power supply and circuitry which will accept RJ-11 input from the ALPHA Plus meters.

The external serial communications option board may also be equipped with up to 6 optional output relays. These relays function as described in “Output Relays” on page 2–23.

Wide Area Network (WAN) Option Board Connections

The WAN option board connects to the ALPHA Plus meter main circuit board via the 20–pin header (J4) as shown in Figure 2–9. A 4–lead cable exits the meter base and terminates in a 4-pin connector. This option board is required for interface with an ALPHA STARS unit.

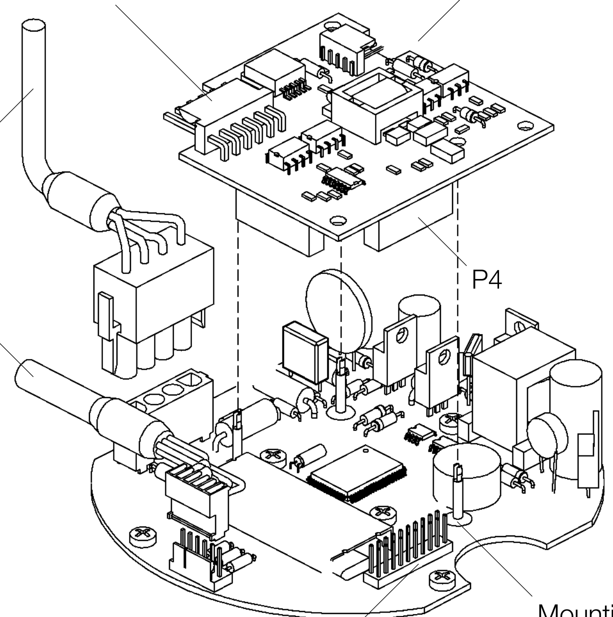

Figure 2–9. ALPHA Plus meter with WAN option board

The WAN option board may also be equipped with 2 optional output relays. These relays function as one KYZ1 pulse output relay and one programmable relay as described in “Output Relays” on page 2–23.

3: Operation

Operation Modes

The ALPHA Plus meter has 4 modes of operation which provide details about the metered quantities and status of operation. These modes are configurable through ABB meter support software and can be negotiated with convenient push buttons located on the front of the meter. Self test and system instrumentation quantities also provide useful information about the ALPHA Plus meter.

The ALPHA Plus meter operates in one of the following modes:

- normal mode
- alternate mode
- test mode
- error mode

The meter will typically operate in the normal mode. See Appendix B, "Meter Display Quantities," for a complete listing of all display quantities.

Normal Mode

Normal mode is the default operation mode for the ALPHA Plus meter. It is generally used to display billing data. The meter is fully operational in this mode and will process and store data while the LCD scrolls through the display quantities. The normal mode display cycle will usually begin with an LCD test which turns on all of the display segments. This is recommended as it provides a quick way to determine if the LCD is functioning properly, but it can be disabled through ABB meter support software. The normal display cycle will scroll through all programmed display quantities before beginning the cycle again.

Note: The LCD test will always appear immediately after power is connected to the ALPHA Plus meter or after a power restoration from an outage.

Alternate Mode

The alternate mode can be programmed with ABB meter support software to display a second set of quantities on the LCD. Alternate mode is most often used for displaying non–billing data, but it can be programmed to display any of the available display quantities. This mode is activated in one of the following ways:

- pressing the **ALT** button on the ALPHA Plus meter
- momentarily placing a magnet against the right side of the meter cover at the 5 o'clock position, about one inch back from the meter face
- cycling power to the meter results in the alternate display sequence being shown for one full cycle

The meter is fully operational while in alternate mode. The LCD will scroll through the entire alternate display sequence before returning to normal mode. There is a 2–minute time out on the alternate display sequence during fast scroll, or it may be aborted manually by pressing the **RESET** button. While in alternate mode, the LCD operating mode indicator will display **ALT**.

Note: Pressing the RESET button to abort the alternate mode display sequence will also perform a demand reset on the meter.

When the ALPHA Plus meter is in alternate mode, the optical port cannot be used to communicate with the meter. This is because the optical port is used to send watt–hour pulses equal to the K_h value while in alternate mode. This allows some testing of the meter while in alternate mode when other features in test mode are not required.

Note: While the meter is showing the alternate display sequence immediately after a power outage, it is not actually in alternate mode. In this situation the optical port is not used for pulses and may be used to communicate with the ALPHA Plus meter.

Test Mode

Test mode displays test readings without affecting the present energy usage and demand billing data values in the ALPHA Plus meter. Shorter demand intervals may be used in test mode to reduce demand test time and will not interfere with demand data. When normal mode is resumed, readings taken during test mode will be discarded and present energy usage and demand billing data values will be restored. The LCD operating mode indicator will blink **TEST** while the meter is in test mode.

Test mode may be initiated by pressing the **TEST** button or through ABB meter support software. When this is done, the LCD will begin to flash **TEST** while the remainder of the LCD will show all zeros for approximately 6 seconds. The test mode display sequence will then cycle for three block demand test intervals unless test mode is exited before then. If thermal demand has been selected, test mode will remain in effect for 45 minutes. Test mode may be exited through ABB meter support software or using the **TEST** button. A power outage will also result in test mode being exited.

Note: During a button–press initiated test mode the optical port will issue watt–hour pulses at the K_h value. If ABB meter support software is used to initiate the test mode, the pulse output may be selected as Wh, VAh (A1K+), or VARh (A1R+). The optical port cannot be used to communicate with the meter except to exit test mode.

Error Mode

The ALPHA Plus meter will display error codes when it detects a condition that adversely affects the normal operation of the meter. Error mode will lock the display upon detecting an error. Depending upon the severity of the error, the meter may be able to continue reading and storing data while locked in error mode. Er will be shown in the display identifier portion of the LCD and a 6–digit numerical error code will be shown in the quantity display field when in error mode.

Pressing the **ALT** button while in error mode will allow the normal display sequence to be shown on the LCD. After a complete sequence, the display will once again lock on the error code. Pressing and holding the **ALT** button will allow the normal display sequence to be scrolled quickly, followed by the alternate mode display sequence on the LCD. The following conditions will cause a return to the error mode display:

- pressing the **RESET** button
- power restoration following a power failure
- the display sequences complete their cycle
- the 2–minute inactivity time out occurs

The error message can only be cleared by correcting the condition which is causing the error. See “Error Codes and Warnings” in chapter 7 for a description of the error and warning codes. After correcting the error condition, the meter will need to be reprogrammed using ABB meter support software.

Note: If the ALPHA Plus meter was programmed with error codes as part of the normal or alternate display sequence, then Er 000000 will be shown on the LCD when no error conditions exist.

Using the Push Buttons

The following push buttons are located on the front of the ALPHA Plus meter:

- **RESET**
- **ALT**
- **TEST**

There is also a **RESET/ALT** mechanism located on the meter cover assembly so that the **RESET** and **ALT** buttons may be accessed without removing the meter cover. The **TEST** button is only accessible after the meter cover has been removed. These buttons are primarily used to select operating modes and toggle display sequences. See Figure 3–1 for the location of these push buttons.

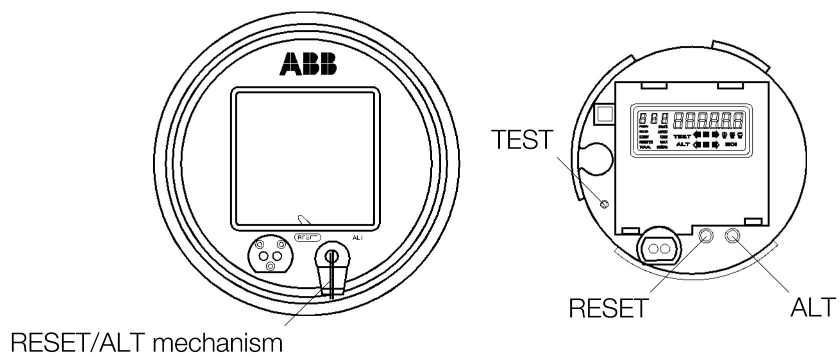

Figure 3–1. Location of push buttons and RESET/ALT mechanism

The alternate mode may also be initiated by placing a magnet against the right side of the meter cover about one inch back from the meter face, at the 5 o'clock position. This will activate the reed switch on the main circuit board. See Figure 3–2 for an illustration of this.

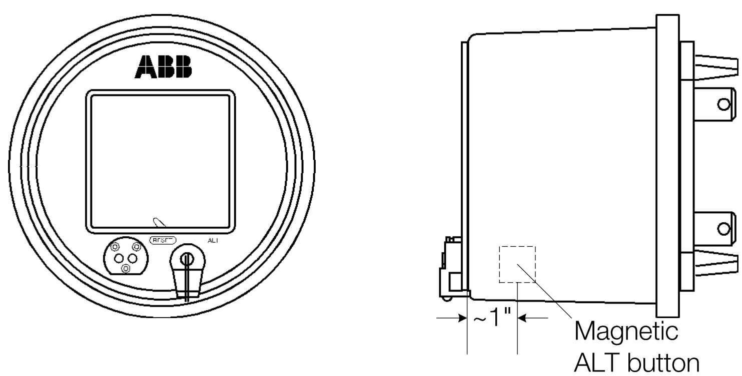

Figure 3–2. Magnetic placement for activating alternate mode

The RESET Button

Pressing the **RESET** button performs a demand reset. See “Demand Reset” in chapter 2 for a description on what happens during a demand reset. The **RESET** button performs differently depending upon the ALPHA Plus meter operating mode as indicated in Table 3–1.

Table 3–1. RESET button function in different operating modes

Mode	Description
Normal mode	Performs a demand reset
Alternate mode	Exits alternate mode, returns to the normal mode, and performs a demand reset
Test mode	Resets all test values (kWh, kW, total pulses, test mode time out), and restarts test mode for 3 more block intervals without affecting any billing data
Error mode	No effect, unless in alternate display mode in which case the alternate display sequence will be terminated and the error code restored on the LCD

Pressing the **RESET** button will accept and lock the detected service when the service test lock mode has been set to manual, and the system service voltage test has just been performed by the ALPHA Plus meter. See “System Service Locking” on page 3–15 for more details. The following information will be stored in the meter when the service is locked:

- service type identification
- nominal service voltage
- voltage phase rotation
- service voltage and current limits
- voltage sag detection threshold

Note: Using the RESET button to lock the service will not perform a demand reset unless it is pressed a second time.

The ALT Button

Pressing the **ALT** button normally initiates the alternate mode. See "Operation Modes" on page 3–2 for more information about ALPHA Plus meter operating modes. The **ALT** button performs differently according to the operating mode as shown in Table 3–2.

Table 3–2. ALT button function in different operating modes

Mode	Press method	Description
Normal mode	Less than 1 second	Initiates alternate mode
Normal mode	Press more than 1 second and release (not continuous)	Freezes the LCD with the alternate display quantity presently being displayed
Alternate mode	Press and release	Steps through alternate display quantities one at a time with each button press after display has been frozen
Alternate mode	Continuous	Scrolls fast (approximately 0.5s per display quantity) through the alternate mode display sequence while pressed, freezes LCD on display quantity when released
Test mode	Press more than 1 second and release (not continuous)	Freezes the LCD with the test display quantity presently being displayed
Test mode	Press and release	Steps through test display quantities one at a time with each button press after display has been frozen
Test mode	Continuous	Scrolls fast (approximately 0.5s per display quantity) through test mode display sequence while pressed, freezes LCD on display quantity when released
Error mode	Press and release	Scrolls through the normal display sequence once; returns to error mode
Error mode	Continuous	Scrolls fast (approximately 0.5s per display quantity) through the normal mode (once) and alternate mode (continuous) display sequences while pressed

The RESET/ALT Mechanism

The **RESET/ALT** mechanism located on the front of the meter cover allows access to the **RESET** and **ALT** button functions without removing the meter cover. Pulling the lever forward from the rest position will allow it to be rotated either clockwise or counter-clockwise to select the desired function as listed below:

- Clockwise selects the alternate mode function, and when the mechanism is pressed will actually press the **ALT** button. A notch on the lever allows the button to be locked, holding the **ALT** button pressed.

- Counterclockwise selects the demand reset function, and when the mechanism is pressed will actually press the **RESET** button.

The TEST Button

Pressing the **TEST** button normally initiates test mode. See "Test Mode" on page 3–3 for more information about test mode. The **TEST** button performs differently depending upon the ALPHA Plus meter operating mode as indicated in Table 3–3.

Table 3–3. TEST button function in different operating modes

Mode	Press method	Description
Normal mode	More than 1 second, less than 6 seconds	Initiates test mode, displays test quantities for 3 test mode block demand intervals, and returns to normal mode
Normal mode	Continuous	Initiates test mode, displays test quantities while the button is pressed, and returns to normal mode when button is released
Alternate mode	More than 1 second, less than 6 seconds	Initiates test mode, displays test quantities for 3 test mode block demand intervals, and returns to normal mode
Alternate mode	Continuous	Initiates test mode, displays test quantities while the button is pressed, and returns to normal mode when button is released
Test mode	Press	If test mode was entered by pressing and releasing for between 1 and 6 seconds, a subsequent press will exit test mode
Test mode	Release	If test mode was entered by continuously pressing, releasing will exit test mode immediately
Error mode	More than 1 second, less than 6 seconds	Initiates test mode, displays test quantities for 3 test mode block demand intervals, and returns to normal mode
Error mode	Continuous	Initiates test mode, displays test quantities while the button is pressed, and returns to normal mode when button is released

Pressing the **TEST** button and rotating it 90° counterclockwise will lock the button in the pressed position. This allows for continuous pressing of the button without having to hold the button down manually. Pressing again and rotating clockwise will allow the button to be released.

Note: When the TEST button is continually pressed, the 3 block interval time out does not apply. The ALPHA Plus meter will also remain in test mode following a power failure and restoration as long as the TEST button is continually pressed.

Meter Self Test

The ALPHA Plus meter periodically performs a self test to determine if it is operating properly. Any errors encountered will be displayed on the LCD. See “Error Codes and Warnings” in chapter 7 for a description of the error and warning codes. The self test process serves to ensure that the ALPHA Plus meter is functioning properly and its displayed quantities are accurate.

The meter self test will be performed automatically under the following conditions:

- after any power restoration following a power outage
- at midnight (all except A1D+) or every 24 hours from initial power up (A1D+ only)
- immediately after a communications session

The self test incorporates a series of electronic analyses which verify many aspects of the ALPHA Plus meter. After the meter passes its self test, all of the LCD segments will be turned on briefly before beginning the normal display sequence. Below is a listing of the specific tests performed during a meter self test:

- verification of configuration data
- confirmation of the crystal oscillator accuracy
- detection of low battery voltage (for TOU configurations)
- verification of normal microprocessor function
- detection of unexpected microprocessor resets

System Instrumentation

System instrumentation is a collection of display quantities designed to assist in evaluating a service by providing real time analysis of the conditions present at the ALPHA Plus meter installation. Instrumentation quantities should not be confused with billing quantities because they are intended for a different purpose entirely.

The instrumentation measurements are near instantaneous and require no memory storage within the meter. Using ABB meter support software, system instrumentation may be configured to select which quantities to display as well as the display sequence where they will be shown.

Instrumentation quantities may be placed in either the normal or alternate mode display sequences. The alternate mode display sequence is recommended because it is generally not necessary for these quantities to be displayed at all times. The 3–digit display identifier gives information about the quantity being displayed on the ALPHA Plus meter LCD as indicated in Table 3–4.

Table 3–4. System instrumentation display identifiers

Display identifier	Description
SYS	System measurements
PhA	Phase A measurements
Phb	Phase B measurements
PhC	Phase C measurements
ThA	Phase A total harmonic distortion
Thb	Phase B total harmonic distortion
ThC	Phase C total harmonic distortion
2hA	Phase A 2nd harmonic distortion
2hb	Phase B 2nd harmonic distortion
2hC	Phase C 2nd harmonic distortion

The displayed quantity will show a measurement and a unit of measure on the ALPHA Plus meter LCD. See Figure 3–3 and Figure 3–4 for illustrations showing a system instrumentation quantity. See Appendix B, "Meter Display Quantities," for a complete listing of available system instrumentation quantities.

Figure 3–3. Instrumentation phase A voltage

Figure 3–4. Instrumentation system kVA

Immediately prior to displaying a system instrumentation quantity, the meter begins to measure that quantity. If the display is required before measurement has been completed, the display identifier and quantity units will be shown on the ALPHA Plus meter LCD but dashes (-) will be shown instead of a quantity until the quantity has been measured. See Figure 3–5 and Figure 3–6 for system instrumentation display quantities while measurement is in progress.

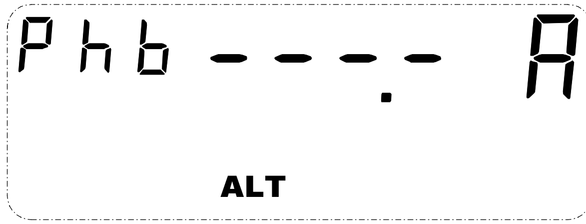

Figure 3–5. Instrumentation phase B current in process

Figure 3–6. Instrumentation phase B current measured

If an ALPHA Plus meter is programmed to display a system instrumentation quantity for a phase which does not exist (phase B or C on a single element meter for instance), then that display quantity will automatically be skipped. This allows different meter types to be programmed with a similar configuration using ABB meter support software.

System instrumentation quantities are measured instantaneously while billing quantities are measured and averaged over a number of minutes. Instrumentation quantities are generally provided on a per phase basis, while billing quantities represent a combination of all present phases. This can result in discrepancies between similar billing and instrumentation data, and this is to be expected.

Most instrumentation quantities are true rms measurements over an even number of line cycles, but others are compound quantities. Compound quantities require multiple measurements at slightly different times with the results calculated from these multiple measurements. Instrumentation quantities can also round or restrict the quantity to a desirable value under certain system conditions. See Table 3–5 for more information about how the instrumentation quantities are obtained:

Table 3–5. Calculation of system instrumentation quantities

Instrumentation quantity	Method used to obtain
Frequency	Measured on Phase A voltage and rounded to 2 decimal places
System kW	The signed sum of the kW measurement on each phase taken only moments apart

Instrumentation quantity	Method used to obtain
System kVAR (Vectorial)	The signed sum of the kVAR measurement on each phase taken only moments apart
System kVA (Vectorial)	Calculated using the following equation: $kVA_{vect} = \sqrt{\left(kW^2 + kVAR_{vect}{}^2\right)}$
System Power Factor (Vectorial)	System kW divided by the system kVA (vectorial)
Phase Voltages and Currents	The voltage and current of each phase are measured simultaneously, as true rms values, and rounded to 2 decimal places (voltages to tenths of a volt, current to tenths or hundredths of an ampere)
Phase Voltage Angle relative to Phase A Voltage	Each voltage angle is measured relative to phase A voltage zero crossings and rounded to 30°
Phase Current Angle relative to Phase A Voltage	Each current angle is measured relative to Phase A voltage zero crossings
Phase Power Factor	Phase kW divided by phase kVA, both measured simultaneously, and rounded to 2 decimal places Phase power factor is set to 1.00 if phase kVA is less than the absolute minimum current (twice starting amperes)
Power Factor Angle	Each phase power factor angle is measured using the specific phase current relative to the same phase voltage
Phase kW and kVA	Each phase kW and kVA is measured simultaneously and rounded to 2 decimal places
Phase kVAR	Calculated using the following equation: $kVAR = \sqrt{\left(kVA^2 - kW^2\right)}$
Total Harmonic Distortion Percentage	Calculated using the following equation: $THD = \frac{\sqrt{rms^2 - fundamental^2}}{magnitude} \times 100$ where rms represents an rms phase voltage or current, fundamental represents a phase quantity fundamental, and magnitude represents the fundamental magnitude of the phase quantity
2nd Harmonic Voltage Percentage	The phase quantity 2nd harmonic voltage magnitude divided by the phase quantity fundamental magnitude, rounded to 2 decimal places
2nd Harmonic Current Magnitude	The phase quantity 2nd harmonic current magnitude rounded to 2 decimal places

Voltage, current, kW, kVAR, and kVA instrumentation quantities should be well within ±0.25% and other quantities with a maximum error of 0.7%. Accuracy will diminish as the value of the quantity becomes smaller.

System Service Tests

System service tests can be performed in order to determine the validity of the electrical service which the ALPHA Plus meter is metering. The following are verified by these tests:

- service type
- phase rotation
- validity of phase voltages
- validity of phase currents

The system service tests consist of a system voltage test and a system current test. While system service tests are being performed, the meter LCD will show SYS in the display identifier, and all dashes in the quantity display as shown in Figure 3–7.

The system service tests may be initiated in several ways. In order for the service voltage test to automatically validate the service, there must be no meter error conditions present. Any such error will prevent the service from being validated.

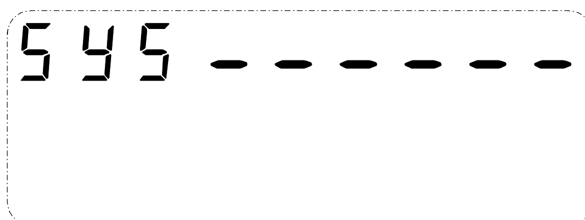

Figure 3–7. System service test in progress

Service Voltage Test

The service voltage test is intended to assist in identifying incorrectly wired or misapplied voltage transformers and open or missing line–side fuses. The following are validated by this test:

- system voltages
- voltage angles
- service type

If the service voltage test is successful, the validated voltage service is shown on the ALPHA Plus meter LCD and the test will continue to the next display quantity in the sequence. See Figure 3–8 for an illustration of a valid service.

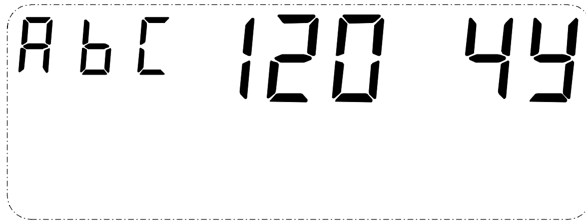

Figure 3–8. System test valid service found

If the test is not successful, a warning is set and the SEr 555000 service error code will be shown in the quantity display field on the LCD as shown in Figure 3–9. See “System Service Error Codes” on page 3–18 for more details about system service error codes. The following conditions can cause the service voltage test to fail:

- phase voltage angles not within ±15° of the expected service phase angles
- phase voltage magnitudes not within the tolerance of the nominal service voltages which have been programmed into the meter with ABB meter support software
- a different service is detected than the one which was previously locked, even if it is a valid service

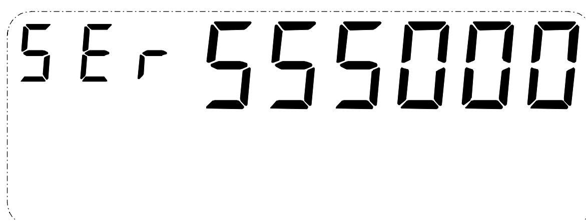

Figure 3–9. System test invalid service

Note: The service current test and power quality monitors can not be performed until the service voltage test is able to identify and lock a valid service.

Initiating the Service Voltage Test

The service voltage test may be initiated in any of the following ways:

- The ALPHA Plus meter may be programmed with ABB meter support software to enable or disable the service voltage test. When enabled the test will be performed automatically under the following conditions:
  - on power up

- once every 24 hours (A1D+ only) or at midnight (all except A1D+)
- following any data-altering communication
- upon exiting test mode

- The service voltage test may be placed in the alternate display sequence. When the alternate display sequence is shown on the LCD, the service voltage test will be performed.
- The service voltage test may be placed in the normal display sequence. Each time the normal display sequence cycles, the service voltage test would be performed.
- The service voltage test may be included in the PQM tests if the ALPHA Plus meter is equipped with this feature. The results of this PQM test will not be seen on the LCD. See chapter 4, "Power Quality Monitoring," for more details on PQM.

System Service Locking

The ALPHA Plus meter can determine and lock a valid service in either of the following ways:

- autolock
- manual locking

When the ALPHA Plus meter is in an unlocked state, and a service is detected which does not match any of the valid services stored within the meter memory, then the SEr 555000 error code will be displayed on the LCD. See "System Service Error Codes" on page 3–18 for further information about system service error codes.

Any time that the system service voltage test fails, it will automatically be performed again until the error condition has been corrected.

Once a service has been locked into the ALPHA Plus meter memory, it will be used as a basis for future system service tests as well as PQM tests. A manually locked service is stored in EEPROM and requires no additional locking beyond the first time it was detected.

Whether in autolock or manual lock mode, the system service voltage test will be performed at midnight (or every 24 hours on A1D+ meters) and compared with the locked service. If the detected service does not match the locked service, the SEr 555000 error code will be displayed on the LCD.

To display billing quantities:

- see "Normal Mode" in Table 3–2 (ALPHA Plus Release 2.0 and 2.1)
- see "Error Mode" in Table 3–2 (ALPHA Plus Release 2.2 or higher)

Autolock

When autolock is enabled through ABB meter support software, the ALPHA Plus meter will attempt to lock the service automatically once it is determined to be valid. Both the voltage magnitude and phase angle of the service are compared to a table of valid relationships stored within the meter memory. If the detected service matches one of the stored values, the ALPHA Plus meter will accept the service and display the following values on the LCD:

- phase rotation (AbC or CbA)
- voltage magnitude (120, 240, …)
- service type (1P, 3d, 4Y, …)

An autolocked service will be automatically unlocked, tested, and locked again following the detection of a valid service each time the system service voltage test is performed. This test will be performed upon power restoration following an outage, exiting of test mode, or following any data–altering communication with the ALPHA Plus meter.

Note: Autolock mode will result in the ALPHA Plus meter locking the first valid service detected. This service may be different from the one which was previously locked. Because of this, a meter can be easily moved from one installation to another and it will automatically lock the new service it detects.

Manual Lock

The ALPHA Plus meter will detect and evaluate the service in the same manner as it does when autolock is enabled. The identified service information will also be shown on the meter LCD. However, the **RESET** button must be manually pressed in order to lock the detected service.

An L will be shown on the LCD between the voltage magnitude and the service type in order to indicate that the manual locking has completed. See Figure 3–10 for an illustration of this. If the **RESET** button is not pressed to accept the service, the LCD will alternate between showing SYS and all dashes with the detected service information until the service has been manually locked.

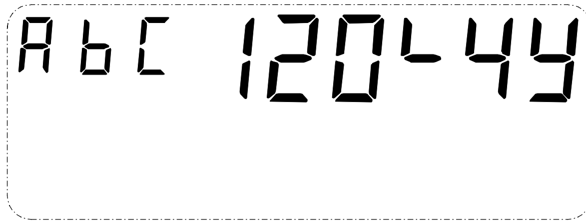

Figure 3–10. System test valid service found and locked

Note: Once manually locked, the service detected by the system service voltage test must always match the locked service. In order to move the ALPHA Plus meter to a new installation with a different service type, the meter must first be unlocked using ABB meter support software. The new service type can then be detected and manually locked.

Service Current Test

The service current test validates system currents and is intended to assist in identifying the following:

- incorrectly wired or misapplied current transformers
- incorrectly wired sockets
- open or missing load-side fuses

If the service current test is successful, SYS PASS is shown on the ALPHA Plus meter LCD and the test will continue to the next display quantity in the sequence. See Figure 3–11 for an illustration of a successful service current test.

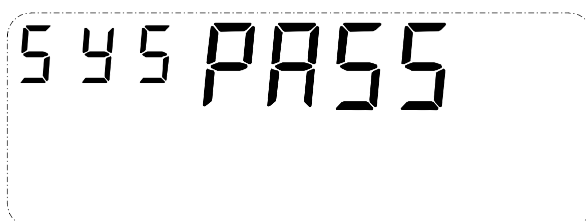

Figure 3–11. System test successful completion

If the service current test fails, a warning is set, and a service error code (for example, SYS 000100) will be shown in the quantity display field on the LCD as shown in Figure 3–12. See “System Service Error Codes” on page 3–18 for more details on system service error codes. The following conditions can cause the service current test to fail:

- no current on any phase while current remains on at least one other phase
- current on any single phase is below the programmed low current limit

- current on any phase is greater than the programmed absolute maximum
- current is negative on any phase
- power factor on any phase is less than the limit set for leading or lagging power factor

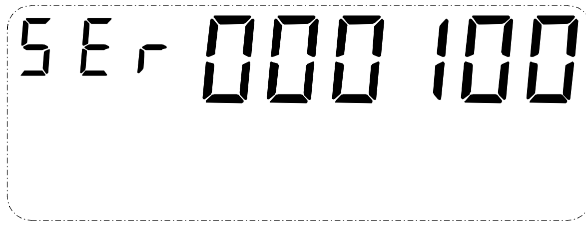

Figure 3–12. System test current service test error

Initiating the Service Current Test

The service current test may be initiated in any of the following ways:

- The service current test may be placed in the alternate display sequence. When the alternate display sequence is shown on the LCD, the service current test will be performed.
- The service current test may be placed in the normal display sequence. Each time the normal display sequence cycles, the service current test would be performed.
- The service current test may be included in the PQM tests if the ALPHA Plus meter is equipped with this feature. The results of this PQM test will not be seen on the LCD. See chapter 4, “Power Quality Monitoring,” for more details on PQM.

If the ALPHA Plus meter does not have a locked service, then the system service current test will be skipped regardless of the method of initiation.

System Service Error Codes

When SEr is shown in the display identifier on the LCD, the displayed quantity is a numeric representation of a system service error code. This indicates that there may be a service problem with the ALPHA Plus meter installation. Table 3–6 and Table 3–7 show all possible system service error codes.

Table 3–6. System service voltage test error code

System service voltage error condition	Error code					
Unknown service voltage or angles	5	5	5	0	0	0

Table 3–7. System service current test error codes

System service current error condition	Error code					
				Current phase		
				A	B	C
Missing phase A current	0	0	0	1	0	0
Missing phase B current	0	0	0	0	1	0
Missing phase C current	0	0	0	0	0	1
Low phase A current	0	0	0	2	0	0
Low phase B current	0	0	0	0	2	0
Low phase C current	0	0	0	0	0	2
Missing and low current on phase A	0	0	0	3	0	0
Missing and low current on phase B	0	0	0	0	3	0
Missing and low current on phase C	0	0	0	0	0	3
Inappropriate PF on phase A	0	0	0	4	0	0
Inappropriate PF on phase B	0	0	0	0	4	0
Inappropriate PF on phase C	0	0	0	0	0	4
Reverse power on phase A	0	0	0	5	0	0
Reverse power on phase B	0	0	0	0	5	0
Reverse power on phase C	0	0	0	0	0	5
Inappropriate PF and low current on phase A	0	0	0	6	0	0
Inappropriate PF and low current on phase B	0	0	0	0	6	0
Inappropriate PF and low current on phase C	0	0	0	0	0	6
Reverse power and low current on phase A	0	0	0	7	0	0
Reverse power and low current on phase B	0	0	0	0	7	0
Reverse power and low current on phase C	0	0	0	0	0	7
Excess current on phase A current	0	0	0	8	0	0
Excess current on phase B current	0	0	0	0	8	0
Excess current on phase C current	0	0	0	0	0	8
Excess current and inappropriate PF on phase A	0	0	0	C	0	0
Excess current and inappropriate PF on phase B	0	0	0	0	C	0
Excess current and inappropriate PF on phase C	0	0	0	0	0	C
Excess current and reverse power on phase A	0	0	0	d	0	0
Excess current and reverse power on phase B	0	0	0	0	d	0
Excess current and reverse power on phase C	0	0	0	0	0	d

In the event that service current errors are present on more than one phase, a single error code is displayed to represent all detected errors. For example, SEr 000308 indicates missing current on phase A and excess current on phase C.

4: Power Quality Monitoring

Test Definitions

The ALPHA Plus meter, equipped with the optional power quality monitoring features, can monitor circuit parameters on a cyclic basis, 24 hours a day throughout the billing period. Because the meter samples per phase voltage and current as part of the metering process, this information can be used to perform a series of tests. Power quality monitoring (PQM) tests may be turned on or off through ABB meter support software.

PQM tests will recognize any deviation beyond the programmed thresholds for each phase. In addition to defining thresholds for each test, a minimum time of duration may also be defined. Once the monitored parameter falls outside of the threshold and remains there for longer than the minimum time of duration, the event will be stored and the cumulative count will increase by one. A cumulative timer will also be activated and will run for as long as the event is detected. The cumulative count and timer for each test can be retrieved through ABB meter support software.

The meter can be programmed to display a warning code on the LCD when an event occurs. If a load control relay is installed in the ALPHA Plus meter, the relay can be programmed to close when the event occurs. When an event ends (the monitored condition returns to within normal operating parameters), the warning code will automatically clear and the load control relay will open. Meters with load profile capability will record the date and time of any PQM event in the event log.

Most PQM tests are performed individually so that circuit parameters are not being monitored continuously. Each subsequent test will begin immediately after the previous one has ended. The momentary voltage sag test, however, uses the per phase rms voltage calculation which is part of the voltage sensing process within the ALPHA Plus meter. The rms voltages are calculated once every 2 line cycles, so the momentary voltage sag test is capable of recognizing any phase voltage deviation which remains below a specified threshold for as few as two line cycles.

PQM tests do not interfere with any meter functions related to energy measurement. These tests are run separately from the metering functions. Table 4–1 shows the available monitors along with a description.

Table 4–1. PQM tests

PQM number	Test name	Configuration
Monitor 0	Momentary voltage sag	Based upon a uniquely specified voltage threshold
Monitor 1	Service voltage test	Based upon system service voltage test thresholds
Monitor 2	Low voltage test	Based upon a uniquely specified low voltage threshold
Monitor 3	High voltage test	Based upon a uniquely specified high voltage threshold
Monitor 4	Reverse power test & PF	Based upon service current test thresholds
Monitor 5	Low current test	Based upon service current test thresholds
Monitor 6	Power factor	Based upon a uniquely specified threshold for leading and lagging
Monitor 7	Second harmonic current test	Based upon a specified current threshold
Monitor 8	Total harmonic distortion current	Based upon a specified percentage of the fundamental threshold
Monitor 9	Total harmonic distortion voltage	Based upon a specified percentage of the fundamental threshold

Note: During the low current and the reverse power & PF tests, there will be no event detected if all measured line currents drop below the absolute minimum current threshold. An event will be detected if any single phase, or all phases but one, drop below the programmed threshold for the minimum duration time. This will eliminate false detection when the load is dramatically reduced or turned off.

Momentary Voltage Sag

This PQM test monitors decreases in voltage that last for a time period measured in cycles. Momentary voltage sag can reset process control equipment and computer systems even if the condition does not register as a power outage. This test can detect any voltage decrease which falls below a programmed threshold for as few as 2 line cycles. Threshold and time duration are defined using ABB meter support software.

The threshold is defined as a percentage of the lowest nominal per phase voltage and recommended to be in the range of 60% to 99.9%. On a 2–element 240V 3WD meter, 80% would be 192V since both phases are nominally 240V. However, on a 3-element 240V 4WD meter, 80% would be 96V since phase A and phase B are nominally 120V.

The duration is defined as a minimum time and a maximum sag event duration time (32 to 6000 milliseconds). If the condition exceeds the maximum duration time it will not be considered a sag event. Time is selected in milliseconds where each cycle is 16 milliseconds in length for a 60Hz system (20 milliseconds for a 50Hz system).

The potential indicators on the ALPHA Plus meter LCD will indicate when voltage is below the sag level threshold. When a phase voltage drops below the voltage sag threshold, the corresponding potential indicator will blink.

Service Voltage Test

This PQM test monitors the service voltage on an ongoing basis throughout the month. Voltage fluctuations outside of the programmed limits are detected and generally indicate one of the following:

- improper voltage transformer operation
- inappropriate transformer tap settings
- equipment failure

All voltage magnitudes and phase angles must match those of the locked service even if the detected service is valid. The threshold is defined as a specified limit for these magnitudes. The minimum duration is defined as 0 to 60 minutes where 0 causes the event to be recognized as soon as it is detected.

Note: Any service voltage test failure will immediately cause the F 010000 warning code to be shown on the meter LCD regardless of whether the PQM minimum duration has been exceeded.

Low Voltage Test

This PQM test monitors the service voltage for values that fall below a specified limit. The threshold value can be set at a value higher or lower than the limits selected for the service voltage test. This allows more thorough study of the voltage changes.

The threshold is defined as a percentage of the expected nominal voltage and recommended to be in the range of 60% to 99.9%. This percentage will be applied to each phase voltage. On a 3–element 240V 4WD meter, 80% will test phase A and phase B at 96V, and test phase C at 166V. The minimum duration is defined as 0 to 60 minutes where 0 causes the event to be recognized as soon as it is detected.

High Voltage Test

This PQM test monitors the service voltage for values that exceed a specified limit. The threshold value can be set at a value higher or lower than the limits selected for the service voltage test. This allows more thorough study of the voltage changes.

The threshold is defined as a percentage of the expected nominal voltage. This percentage will be applied to each phase voltage. On a 3–element 240V 4WD meter, 120% will test phase A and phase B at 144V, and test phase C at 250V. The minimum duration is defined as 0 to 60 minutes where 0 causes the event to be recognized as soon as it is detected.

Reverse Power Test & PF

This PQM test recognizes any application where the current transformer may be wired incorrectly or meter tampering may have occurred. The power factor threshold is typically set to a very low value to detect only abnormal conditions. Setting power factor thresholds at higher levels may create frequent warnings on delta services where per phase power factors are nominally low even under system unity conditions.

Consideration should be given when setting reverse power testing and power factor limits on 3WD and 4WD services. With solely polyphase unity power factor conditions, some phases (A and B on 4WD, and both A and C on 3WD) already have nominal phase power factors of 0.866 (30°). Subsequent power factor variation will cause a much greater power factor for one of the phases than if the same was measured on a single phase or 4WY service.

The thresholds for the power factor are defined on a per phase basis within the system service current test definition. Testing for reverse power can only be enabled or disabled for all phases simultaneously. The minimum duration is defined as 0 to 60 minutes where 0 causes the event to be recognized as soon as it is detected.

Low Current Test

This PQM test monitors the service current for values that fall below a specified limit. The test will check for erroneous operation or failure of a current transformer, and can detect signs of meter tampering. If all phase currents fall below the limit (on an initial no–load or test condition) then no warning or indication will be provided. A warning will be issued when one or more phase currents falls below the threshold value for the minimum duration while the remaining phase currents stay above the limits.

The threshold is defined as a percentage of the ALPHA Plus meter Class ampere rating from the system service current test definition.

This percentage is applied on a per phase basis. The minimum duration is defined as 0 to 60 minutes where 0 causes the event to be recognized as soon as it is detected.

Note: A–base self–contained ALPHA Plus meters are typically Class 100 due to thermal considerations. With respect to Class ampere ratings, however, they should be treated as Class 200.

Power Factor

This PQM test monitors the power factor for any deviation beyond the programmed threshold. This test may be used alone to monitor rate based conditions or in conjunction with the reverse power test and PF to provide a more thorough analysis of power factor fluctuations.

The threshold is defined as a power factor ratio for both leading and lagging conditions. These settings may be different than those defined for the reverse power test & PF. The duration is defined as 0 to 60 minutes where 0 causes the event to be recognized as soon as it is detected.

Note: Although leading and lagging thresholds are defined, they will be applied equally to all phases regardless of the service type or phase rotation.

Second Harmonic Current Test

This PQM test detects the presence of a second harmonic current in the service. The second harmonic may be created by equipment on the line or may indicate the presence of DC currents on the system. The threshold is defined as a value in AC amperes according to the meter class. Table 4–2 shows suggested threshold values for different meter classes.

Table 4–2. Suggested thresholds for second harmonic current test

Meter class	Suggested threshold
200	2.5
20	0.5
6	0.2
2	0.05

The minimum duration is defined as 0 to 60 minutes where 0 causes the event to be recognized as soon as it is detected. Fifteen minutes is a recommended duration so as not to generate false alarms from legitimate second harmonic current sources.

Total Harmonic Distortion Current

As the load on electrical systems becomes more saturated with electronic control devices (computers, communications systems, etc.), there is a growing concern with the harmonics that these devices can contribute to the electrical system. Total harmonic distortion, expressed as a percentage of the fundamental, is a measurement of the power quality of the circuit under these conditions.

This PQM test monitors current conditions and can be used to alert the utility to conditions which may be harmful or dangerous to the system or other equipment. The threshold is defined as a percentage of the fundamental. The minimum duration is defined as 0 to 60 minutes where 0 causes the event to be recognized as soon as it is detected.

Total Harmonic Distortion Voltage

As the load on electrical systems becomes more saturated with electronic control devices (computers, communications systems, etc.), there is a growing concern with the harmonics that these devices can contribute to the electrical system. Total harmonic distortion, expressed as a percentage of the fundamental, is a measurement of the power quality of the circuit under these conditions.

This PQM test monitors voltage conditions and can be used to alert the utility to conditions which may be harmful or dangerous to the system or other equipment. The threshold is defined as a percentage distortion of the fundamental. The minimum duration is defined as 0 to 60 minutes where 0 causes the event to be recognized as soon as it is detected.

PQM Event Counters and Timers

Each PQM test has an event counter associated with it. Each counter can accumulate to a maximum of 32,767 before rolling over to zero. An event occurring on one phase or across multiple phases is counted as a single event. The momentary voltage sag test, however, records counters and timers for each phase. See “Voltage Sag Counter and Timer” on page 4–8 for details.

The cumulative timer for each test can record time over 10,000 hours. An event is defined as starting when the condition has been recognized for a time exceeding the minimum duration. An event ends when the condition no longer is present. If an event occurs but does not last for the minimum duration, then neither the counter nor timer will reflect the event having occurred.

The counter and timer for each test are maintained within the ALPHA Plus meter memory. A report of these values can be obtained through ABB meter support software. These counter and timer values may also be cleared using the same software.

PQM Event Log Entries

The event log records the date and time that a PQM test detects the start and end of a PQM test failure. The start time is logged as when the minimum duration time has been exceeded. The stop time is logged as soon as the PQM test no longer fails. Momentary voltage sag test log entries are contained in a separate voltage sag log and are only available for ALPHA Plus meters Release 2.2 or higher. See “Voltage Sag Log” on page 4–9 for details.

Since the event log uses load profile memory for the log entries, load profile must be a feature of the meter in order for event logging to occur. A maximum of 255 events can be recorded for all monitors except the momentary voltage sag test. The event log may be cleared using ABB meter support software.

Voltage Sag Counter and Timer

Each phase voltage has a voltage sag counter and timer associated with it. Each counter can accumulate to a maximum of 65,535 before rolling over to zero. Each cumulative timer can record time for over 365 days.

A voltage sag event is only counted if the voltage remains below the voltage sag threshold for more than the minimum amount of time and less than the maximum amount of time. A voltage which remains below the voltage sag threshold for longer than the maximum amount of time is considered to be a low voltage condition and not counted by the momentary voltage sag test. Since phase A voltage must be present to supply the ALPHA Plus meter power, a power outage on phase A will result in voltage sags on all phases if the time from power down to powering up with service recognition falls within the momentary sag limits. Momentary voltage sags on phase A will be counted properly.

The counter and timer for each phase are maintained within the ALPHA Plus meter memory. A report of these values can be obtained through ABB meter support software. These counter and timer values may also be cleared using the same software.

Voltage Sag Log

The voltage sag log will contain the date, time, and phase (or phases) of any momentary voltage sag detected. The voltage sag log is available on ALPHA Plus Release 2.2 or higher.

Since a momentary voltage sag does not typically last very long, the log will contain just once date/time stamp to indicate the occurrence. Start and stop times are not recorded. If multiple voltage sags occur on the same phase within a one second interval, then only a single event will be recorded.

The voltage sag log is fixed at 40 log entries. Once the log is full, the oldest records will be overwritten with new ones. The voltage sag log can be cleared using ABB meter support software.

Since the voltage sag log uses load profile memory for the log entries, load profile must be a feature of the meter in order for event logging to occur.

5: Installation and Removal

Installing the ALPHA Plus Meter

The ALPHA Plus meter is calibrated and tested at the factory to be ready for installation. Proper installation and removal should be adhered to for personal safety and for protection of the meter from damage.

⚠ WARNING

Circuit–closing devices must be used on current transformer secondaries. This applies to Form 9S, 35S, 35A, 36S, 36A, and 10A. Dangerous currents and voltages are present if secondaries are open-circuited. Personal injury, death, or equipment damage can result if circuit-closing devices are not used.

The ALPHA Plus meter fits all standard socket–connected (S–base) services. Meters with integral bottom–connection (A–base) are also available for those service types. See Figure 5–1 and Figure 5–2 for illustrations of the S–base and A–base meter types showing their dimensions.

The installation for the S–base ALPHA Plus meter is different than the installation for A–base meters. It is important to follow the procedures according to the type of base connection.

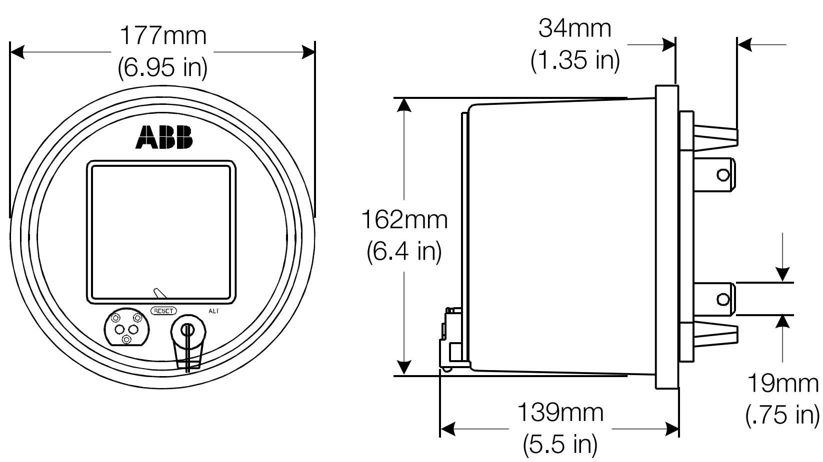

Figure 5–1. Socket–connected (S–base) meter, front and side view

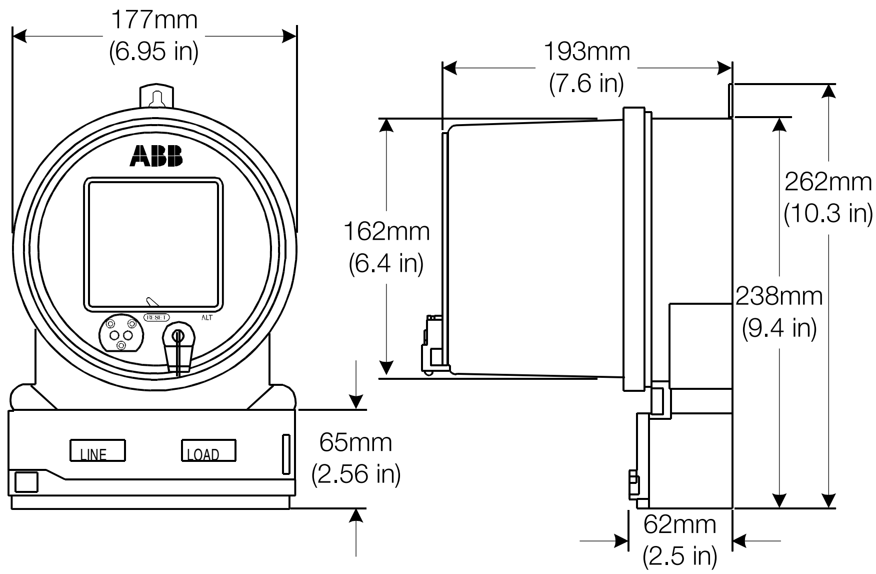

Figure 5–2. Bottom–connected (A–base) meter, front and side view

> ⚠ **CAUTION**
> Make sure the meter being installed matches the service type, maximum current, and capacity required. Installing a mismatched meter can damage equipment. ALPHA Plus meters are not intended for use with phase–shifting transformers. All phase voltages have a common internal to the meter, which can result in equipment damage if used with phase–shifting transformers. Always verify that the maximum meter voltage and current ratings are equal to or greater than the maximum service voltage and current.

Installing an S-base Meter

To ensure proper operation of the ALPHA Plus meter, use the following procedure to install an S-base meter:

1. Examine the socket and verify that the wiring of the service matches the base form of the meter type that is being installed. See Appendix C, “Internal Meter Wiring Diagrams,” and Appendix D, “Wiring Diagrams for Installation,” for illustrations of wiring diagrams.
2. Align the meter blades and socket jaws on the base of the meter with the service socket.
3. Plug the meter firmly into the socket. This is done by grasping each side of the meter and pushing it into the socket until firmly in place. If the meter resists sliding into the socket, gently rock it up and down while pushing forward.
4. Once the meter is firmly in place, power should be applied to it.

After installing and powering the ALPHA Plus meter, verify the following:

- The system service voltage test (if enabled) shows the valid service for this installation. The phase rotation, service voltage, and service type should be indicated on the LCD. Additional validation information may be obtained using the system instrumentation display quantities.
- All potential indicators (from 1 to 3 depending upon the wiring) are present and not flashing. The potential indicators appear as stylized light bulbs surrounding each phase indicator on the LCD. If an indicator is blinking, this means that the phase is missing the required voltage or that it is below the programmed minimum voltage threshold value.
- The pulse indicator on the LCD should be flashing and the arrows should indicate the correct direction of energy flow.
- The meter is not in test mode.
- Required meter seals are installed.
- Any information such as registration and location about the ALPHA Plus meter have been written down.

Installing an A–base Meter

An integral A–base ALPHA Plus meter may be used, or an S–base meter with the S–base to A–base adapter, for installing to bottom-connected services. To ensure proper operation of the ALPHA Plus meter, use the following procedure to install an A–base meter:

1. Verify that the meter hanger, as shown in Figure 5–3, is in the desired position. The top supporting screw may be made visible, if desired, by removing the hanger screw and reversing the hanger.
2. Install a screw for the top supporting screw position, using at least a #12 screw.
3. Hang the meter on the top supporting screw in the upright position, making sure that it is level.
4. Apply the bottom–supporting screws.

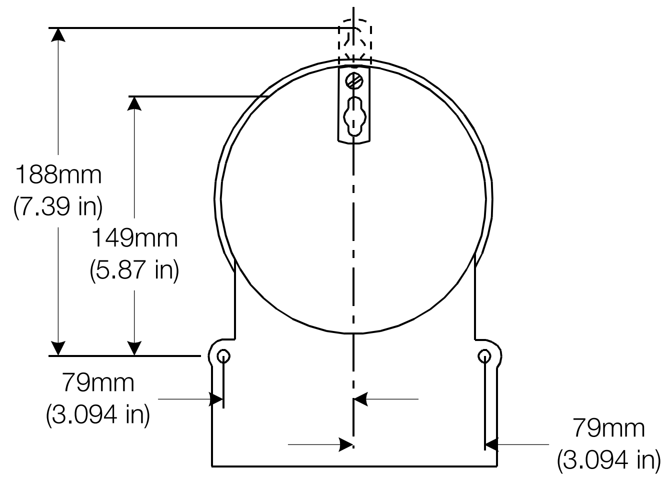

Figure 5–3. Mounting diagram for A–base meters

> **⚠ WARNING**
>
> Use authorized utility procedures and safety precautions in wiring the meter. Dangerous voltages can be present. Personal injury, death, or equipment damage can result from improper wiring procedures.

5. As required by authorized utility procedures, install the ground connections.

> **NOTICE**
>
> If aluminum cable is used, follow the proper aluminum wiring practices in wiring bottom–connected units. Aluminum wiring compound or wiring paste (grease) should be used when attaching the bottom–connected terminals. Tighten the connections, allow them to relax for a few minutes, then tighten them again. This will minimize the cold-flow effects of aluminum cable.

6. Wire the meter using color–coded wire (if required by the specifications) according to locally applicable specifications. Standard wiring diagrams are depicted in Appendix C and Appendix D.
7. After wiring the meter assemble the terminal cover and apply power.

After installing and powering the ALPHA Plus meter, verify the following:

- The system service voltage test (if enabled) shows the valid service for this installation. The phase rotation, service voltage, and service type should be indicated on the LCD. Additional validation information may be obtained using the system instrumentation display quantities.
- All potential indicators (from one to three depending upon the wiring) are present and not flashing. The potential indicators appear as stylized light bulbs surrounding each phase indicator on the LCD. If an indicator is blinking, this means that the phase is missing the required voltage or that it is below the programmed minimum voltage threshold value.
- The pulse indicator on the LCD should be flashing and the arrows should indicate the correct direction of energy flow.
- The meter is not in test mode.
- Required meter seals are installed.
- Any information such as registration and location about the ALPHA Plus meter have been written down.

Installing an Optional Battery

> **⚠ WARNING**
>
> The meter should be de–energized before installing the battery. Dangerous voltages are present; and personal injury, death, or equipment damage can result if safety precautions are not followed. Use authorized procedures to install the battery while power is removed from the meter.

Before installing the optional battery, the ALPHA Plus meter must have been energized for at least 1 minute within the preceding hour. This is to ensure that the supercapacitor is properly charged and that the battery is not immediately drained upon installation. If this is not done, the battery may be damaged and the meter may not function correctly. While the meter is powered, verify that the LCD is active and functioning.

If the meter has been energized for at least 1 minute during the previous hour, install the battery by following this procedure:

1. De–energize the meter.
2. Remove the meter cover to expose the battery well where the battery is to be installed.
3. Connect the battery leads to the terminal on the front of the ALPHA Plus meter, just above the battery well.

4. Place the battery firmly in the battery well with the battery leads located near the bottom of the well, extending through the broad slot.
5. Replace the meter cover.
6. Energize the meter and verify that the LCD becomes active and functioning correctly.
7. Replace the seals.
8. Reprogram the meter or clear the errors (as necessary).

If the meter *has not* been energized for at least 1 minute during the previous hour, use the following procedure:

1. Energize the meter for one minute.
2. De–energize the meter.
3. Remove the meter cover to expose the battery well where the battery is to be installed.
4. Connect the battery leads to the terminal on the front of the ALPHA Plus meter, just above the battery well.
5. Place the battery firmly in the battery well with the battery leads located near the bottom of the well.
6. Replace the meter cover.
7. Energize the meter and verify that the LCD becomes active and functioning correctly.
8. Replace the seals.
9. Reprogram the meter or clear the errors (as necessary).

Failure to follow the preceding steps for the installation of the battery can cause the meter to function improperly. In the event a battery is installed incorrectly and the meter is not functioning properly (for example, display is blank but the meter is powered), the following procedure may be followed:

1. De–energize the meter and let it set without power for 48 to 72 hours. This will provide ample time for the supercapacitor to discharge and the meter's microcontroller to completely shut down.[1]
2. Energize the meter for at least 1 minute. The microcontroller should power up correctly and the supercapacitor will charge. Verify the LCD becomes active and functioning correctly.

[1] If the battery was installed with the polarity reversed, the battery should not be damaged. If the battery was installed without having the meter properly energized, the battery will lose approximately 8.5% of its service life each day.

3. De–energize the meter and insert the battery, following the instructions listed previously in this section.

If the meter still will not function properly, then it should be returned to the factory.

Removing an ALPHA Plus Meter from Service

The removal procedures for S–base ALPHA Plus meters differs slightly from A–base meters. The removal procedure should be used according to the service wiring type.

⚠ WARNING

Use authorized utility procedures to remove metering equipment. Dangerous voltages are present, and personal injury, death, or equipment damage can result if safety precautions are not followed.

Removing an S–base Meter

If it becomes necessary or desired to remove an ALPHA Plus meter from service, the following procedure should be used for an S–base meter:

1. Prior to disconnecting the ALPHA Plus meter, make sure that existing meter data has been obtained using ABB meter support software or written manually from observing the LCD.
2. Remove power from the meter (remove voltage and disconnect or short current circuits).
3. Break the seal holding the ALPHA Plus meter in place.
4. Remove the seal and collar (or other security/locking device).
5. Remove the meter from the socket. This is done by firmly grasping each side of the meter and gently pulling it from the socket. If the meter resists being pulled, gently rock it from top to bottom while pulling.

Removing an A-base Meter

If it becomes necessary or desired to remove an ALPHA Plus meter from service, the following procedure should be used for an A-base meter:

1. Prior to disconnecting the ALPHA Plus meter, make sure that existing meter data has been obtained using ABB meter support software or written manually from observing the LCD.
2. Remove power from the meter (remove voltage and disconnect or short current circuits).

3. Break the seal holding the ALPHA Plus meter terminal cover in place.
4. Remove the terminal cover screw and take off the terminal cover.
5. Disconnect the wiring.
6. Remove the lower supporting screws.
7. Lift the meter off of the top supporting screw and remove the screw as well.

Removing an Optional Battery

> **⚠ WARNING**
> The meter should be de–energized before removing the battery. Dangerous voltages are present; and personal injury, death, or equipment damage can result if safety precautions are not followed. Use authorized procedures to remove the battery while power is removed from the meter.

Use the following procedure to properly remove a battery from an ALPHA Plus meter:

1. De–energize the meter.
2. Remove the meter cover to expose the location of the battery.
3. Firmly grasp the battery and lift it from the battery well.
4. Disconnect the battery leads from the terminal located on the front of the ALPHA Plus meter, just above the battery well.
5. Replace the meter cover and ensure that the seals are in place.

If the battery removed is still good, it should be stored safely for future use. Non–functional batteries should be disposed of according to local governmental laws and electric utility policies.

6: Testing the ALPHA Plus Meter

Overview

ALPHA Plus meters are factory calibrated and tested to provide years of trouble free service. No field calibrations or adjustments are required to ensure accurate operation of the meter. It is customary, however, to periodically test installed ALPHA Plus meters in order to ensure accurate billing.

The ALPHA Plus meter performs its own self test as described in "Meter Self Test" in chapter 3. The system instrumentation feature discussed in "System Instrumentation" in chapter 3 and PQM discussed in chapter 4 also provide valuable information about the meter service. There are also additional tests which can be performed to ensure that the ALPHA Plus meter is performing and recording billing data properly. Testing procedures are the same regardless of the type of meter.

Test Equipment

Meter shops develop testing configurations specific to their own needs. Below is a list of standard test equipment which can be useful in testing an ALPHA Plus meter:

- stable mounting assembly for the ALPHA Plus meter to be temporarily installed in order to ensure proper orientation and allow the necessary voltage and current connections to be made
- reliable power supply with at least the following characteristics:
  - voltage source for energizing the meter at its rated voltage
  - provides unity power factor
  - supplies lagging power factor of 0.0 (for VARh testing) or 0.5
- reference Wh standard
- reference VARh standard
- phantom load device or other loading circuit which has the current capacity ranges suitable for the desired test amperes
- control equipment for counting and timing the following:
  - pulse output
  - precision voltage and current transformers
  - voltmeters, ammeters, phase angle meters, power factor meters, and any other measuring equipment being used

- at least one of the following:
  - an infrared pick–up head for detecting the K_h pulses of the optical port while in test or alternate mode
  - a reflective pick–up assembly for detecting the pulse indicators on the meter LCD
  - a method for counting the pulse output from output relays

Test Setup

Before testing the ALPHA Plus meter, check the nameplate for the following:

- test amperes
- appropriate operating voltage range

Table 6–1 shows how the meter K_h relates to the energy value of the LCD arrows.

Table 6–1. Nameplate K_h and Energy Value of LCD Arrow Indicators

Nameplate meter K_h	Energy value of LCD arrows	Pulse ratio
0.6	0.05	24
1.2	0.1	24
1.2	0.05	48
1.8	0.15	24
2.4	0.1	48
3.6	0.15	48
4.8	0.1	96
7.2	0.6	24
14.4	1.2	24
14.4	0.6	48
21.6	1.8	24
28.8	1.2	48
43.2	1.8	48
57.6	1.2	96

Note: Pulses on the optical port during a button-press initiated test mode are fixed to Wh. Output can be selected as Wh, VAh (A1K+), or VARh (A1R+) when ABB meter support software is used to initiate test mode.

General Test Setup

The following general procedure should be used to create a setup location for the ALPHA Plus meter:

⚠ WARNING

Use only authorized personnel and proper test procedures to test metering equipment. Dangerous voltages are present. Personal injury, death, or equipment damage can result if safety precautions are not followed.

1. Temporarily install the meter in a mounting device which will hold it in the proper operating position.
2. Place the test standard measuring device and precision voltage and current transformers (as required) in series with the meter being tested.
   If voltage transformers are not required, then the voltages of the meter and the standard should be in parallel. See Appendix C, “Internal Meter Wiring Diagrams,” and Appendix D, “Wiring Diagrams for Installation,” for appropriate wiring diagrams for the ALPHA Plus meter.
3. Connect the control equipment used for switching the voltage to the test standard device and for counting the standard’s output pulses.
4. Apply the rated current and voltage to the terminals of the meter.

After applying the voltages and currents, one of the following should be performed:

- Align the reflective pick–up assembly over the appropriate pulse indicator on the meter LCD, just slightly off of perpendicular with the meter cover. This will minimize reflections from the cover face.
- Place the meter in test mode and then position the infrared pick–up head over the optical port to detect the pulse output. Alternatively, the infrared pick-up head could be connected to a test pulse adapter and that adapter can be positioned over the optical port on the meter. See Figure 6–1 for the location of the optical port on the ALPHA Plus meter.

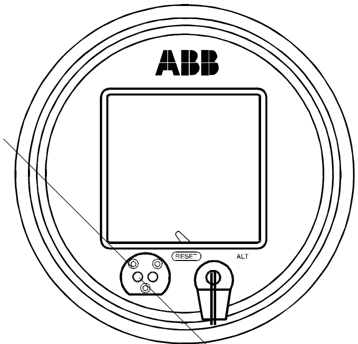

Figure 6–1. Location of the Meter Optical Port and LED Pulse Output

Formulas Used in Testing

When testing the ALPHA Plus meter, manual calculations may be necessary to verify meter quantities. Table 6–2 shows the naming conventions used to indicate variable quantities in these calculations.

Table 6–2. Variables used in manual conventions

Variable	Represents
CTR	Current transformer ratio
I	Current
K_e	Pulse constant (watt–hours per pulse)
Kh_{std}	Wh constant of reference standard (watt–hours per pulse–period)
Kh_{meter}	Wh test constant of meter (watt–hours per pulse–period)
kW	Power in kilowatts
P	Number of flashes of test indicator on the LCD or optical port
p	Number of pulses of reference standard
N	Number of elements in series
P/R	Ratio of Kh_{meter} to K_e, pulses per K_h, or K_h period
t	Time in minutes
TA	Test amperes
Θ	Phase angle by which current lags voltage
V	Voltage
VTR	Voltage transformer ratio

Watt–hour Constant (K_h)

The watt–hour constant (K_h) is a measure of the electrical energy metered per pulse of the optical port infrared LED. This measurement is expressed in watt–hours (Wh) per 500 pulse periods per hour. In a single element meter 1000 pulses per hour would be used in the equation instead of 500. The K_h value can be calculated using the following formula:

$$Kh = \frac{(TA \times TestVoltage \times N)}{500}$$

Note: The number of elements used in the equation shown above should be 3 for Z–coil type meters even though they are called 2 ½ element meters.

For transformer rated meters, the K_h value is called the secondary Kh (Kh_{sec}) if the transformer ratios are not included. When instrument transformers are included, then K_h is called the primary K_h (Kh_{pri}) and is calculated with the following formula:

$$Kh_{pri} = Kh_{sec} \times CTR \times VTR$$

A 3–element ALPHA Plus meter rated at 2.5A and 120 test volts that is being used with 400:5 current transformers would yield the following values for K_h:

$$Kh_{sec} = \frac{(2.5 \times 120 \times 3)}{500} = 1.8 \text{ Wh per pulse period}$$

$$Kh_{pri} = Kh_{sec} \times \frac{400}{5} = 144 \text{ Wh per pulse period}$$

Calculating Meter Accuracy

Meter accuracy (percent registration) can be calculated by comparing the meter pulse rate to the standard pulse rate, and using the following formula:

$$Accuracy = 100 \times \frac{(P \times Kh_{meter})/N}{(p \times Kh_{std})}$$

In order to calculate meter accuracy by comparing the calculated power to the measured power, the following formula can be used:

$$\text{Accuracy} = 100 \times \frac{\text{Power}_{\text{read}}}{\text{Power}_{\text{calc}}}$$

Note: If a reference standard with precision current or voltage transformers (such as the Knopp transformer) is used, then the standard K_h or K_e must include CTR and VTR.

Determining the Power from the Output Pulse Rate

The approximate power of the meter load in kilowatts during a time period can be obtained by measuring the time it takes to receive multiple test flashes (P). The test flashes can be counted from the optical port or the pulse indicators on the meter LCD. The approximate power may then be calculated using the following formula:

$$\text{kW} = \frac{(P \times Kh \times 60)}{(t \times 1000)}$$

Note: If the primary load on a transformer rated meter is to be calculated, the kW value obtained from the equation shown above must be multiplied by CTR and VTR.

Calculating Power

If a precision power supply is available it may be used to calculate the different types of demand which can be metered by the ALPHA Plus meter. The power supply must provide the following stable and accurate quantities:

- voltage
- current
- power factor

The power supply output values may then be used with the following formulas in order to calculate power:

$$\text{Power}_{\text{real}}(\text{watts}) = V \times I \times N \times \cos\Theta$$

$$\text{Power}_{\text{reactive}}(\text{watts}) = V \times I \times N \times \sin\Theta$$

$$\text{Power}_{\text{apparent}}(\text{watts}) = V \times I \times N$$

Meter Shop Testing

Since no adjustments are required for the ALPHA Plus meter in the field, testing a meter is primarily done to ensure that it is operating within factory specifications. This is normally done by simply checking the meter calibration. For precise test results, meters should be tested at the same temperature as the testing equipment. This will ideally be about 22°C (72°F).

Most polyphase ALPHA Plus meters operate at 8 1/3 pulse periods per minute when run at test amperes and voltages. The 2 ½ element 4WY meters, however, operate at 11 1/9 pulse periods per minute (4/3 speed) when testing single phase loading on combined elements. A single phase meter will operate at 16 2/3 pulse periods per minute (twice speed).

Voltage should be applied to the meter for at least 10 seconds prior to measuring, allowing the power supply circuitry to stabilize. Polyphase meters may also be tested with single phase loading. This is done by connecting the voltage inputs in parallel and the current sensors in series to combine element operation. Each current sensor should be connected separately for single element operation.

Note: The ALPHA Plus meter must have phase A voltage present at all times to function. Other phases may be supplied as necessary according to the meter type being tested.

Watt–hour Testing

To maintain compatibility between procedures for testing electronic and electromechanical meters, the ALPHA Plus meter has been designed with the same test points. These test points are described in Table 6–3.

Table 6–3. Watt–hour test points

Test point	Definition
Full load	100% of the rated current (nameplate rating for test amperes), test voltage, and rated frequency at unity power factor
Light load	10% of the rated current, test voltage, and rated frequency at unity power factor
Lagging power factor	100% of the rated current, test voltage, and rated frequency at 0.50 lagging power factor (current lagging voltage by 60° phase angle)

Whereas electromechanical meters have adjustments to calibrate the meter at all three test points, the ALPHA Plus meter is calibrated in the factory.

To obtain standard calibration readings from an ALPHA Plus meter, the following procedure should be used:

1. Verify the meter calibration at full load, using the formula for calculating the meter accuracy as shown in “Calculating Meter Accuracy” on page 6–6 to determine the percent accuracy.
2. Verify the meter calibration at light load, using the same formula as in step 1.
3. Verify the power calibration of the meter at full load with lagging power factor, using the same meter accuracy formula as in step 1.
4. Check for creeping at the rated voltage level with no current. The meter must produce 2 pulses to be considered creeping, with creep being defined as continuous output pulses from the meter with normal operating voltage but the load terminals open circuited.

VAR-hour Verification

The VARh information is used to generate the reactive quantities kVARh energy and kVAR demand. Using ABB meter support software, the ALPHA Plus meter can be programmed to output VARh pulses on the optical port for an A1R+ meter.

In order to maintain compatibility between procedures for testing electronic and electromechanical meters, the ALPHA Plus meter has been designed with the same test points. These test points are described in Table 6–4.

Table 6–4. VAR–hour test points

Test point	Definition
Full load	100% of the rated current (nameplate rating for test amperes), test voltage, and rated frequency at 0.0 lagging power factor
Light load	10% of the rated current, test voltage, and rated frequency at 0.0 lagging power factor

Under normal circumstances, the VARh measurement of the meter does not need to be checked because it is automatically adjusted whenever the watt–hour portion has been calibrated. However, if VARh measurement is desired to be verified, the same procedure discussed in “Watt–hour Testing” on page 6–8 can be used or use the following procedure:

1. Apply a known reactive load to the meter.
2. Calculate the actual demand being applied to the meter using one of the power calculation formulas shown in “Determining

the Power from the Output Pulse Rate” on page 6–7 or “Calculating Power” on page 6–7.

3. Verify that the calculated reactive power agrees with the known reactive load.

VA-hour Verification

The VAh information is used to generate the reactive quantities kVAh energy and kVA demand. Using ABB meter support software, the ALPHA Plus meter can be programmed to output VAh pulses on the optical port for an A1K+ meter.

In order to maintain compatibility between procedures for testing electronic and electromechanical meters, the ALPHA Plus meter has been designed with the same test points. These test points are described in Table 6–5.

Table 6–5. VA–hour test points

Test point	Definition
Full load	100% of the rated current (nameplate rating for test amperes), test voltage, and rated frequency at unity power factor[1]
Light load	10% of the rated current, test voltage, and rated frequency at unity power factor

Under normal circumstances, the VAh measurement of the meter does not need to be checked because it is automatically adjusted whenever the watt-hour portion has been calibrated. However, if VAh measurement is desired to be verified, the same procedure discussed in “Watt–hour Testing” on page 6–8 can be used or use the following procedure:

1. Apply a known load to the meter.
2. Calculate the apparent demand being applied to the meter using one of the power calculation formulas shown in “Determining the Power from the Output Pulse Rate” on page 6–7 or “Calculating Power” on page 6–7.
3. Verify that the calculated apparent power agrees with the known load.

[1] While it may be desired to have the power factor for VAh measurements contain reactive as well as real energy, most metering standards cannot verify VAh. Unity power factor is used so that VAh can be compared to the standard Wh output. Alternatively a power factor of 0.0 lagging could be used with the standard VARh output to test VAh.

Installation Site Testing

Since no adjustments are required for the ALPHA Plus meter in the field, testing a meter is primarily done to ensure that it is operating within factory specifications. This is normally done by simply checking the meter calibration. There are several tests which may be performed while the meter is in service in order to verify proper operation.

Test Mode

Test mode allows the timing and registration of the ALPHA Plus meter to be verified without losing billing data. The test mode demand intervals can be shorter to speed up the testing process and no accumulated energy or demand data while in test mode will affect the normal billing data.

⚠ WARNING

Exercise extreme caution when removing the meter cover while power is still supplied to the ALPHA Plus meter. Dangerous voltages are present. Personal injury, death, or equipment damage can result if safety precautions are not followed.

The meter cover will need to be removed in order to access the **TEST** button. Pressing this button will place the meter into test mode. See "Test Mode" in chapter 3 for more details about test mode operation.

Timing Tests

Timing tests may be performed on the ALPHA Plus meter in the following ways:

- in test mode, using the EOI indicator on the LCD and a stopwatch
- in test mode, using the time remaining in subinterval display quantity
- in normal mode, using the EOI indicator on the LCD and a stopwatch

Either of the first two methods is highly recommended because each takes advantage of the shorter time intervals available while the meter is in test mode. Also the first demand interval will be a complete interval and not synchronized to real time as in normal mode. The EOI indicator is not active for thermal demand.

The primary advantage of the third option is that the cover assembly will not have to be removed in order to access the **TEST** button and ABB meter support software is not required.

Using the EOI Indicator in Test Mode

The subinterval timing of the meter may be verified by measuring the time between EOI pulses according to the following procedure:

1. Activate test mode by pressing the **TEST** button or through ABB meter support software.
2. Press the **RESET** button to start a new test interval and simultaneously start the stopwatch.
3. Watch the meter LCD for the EOI indicator to appear 10s before the end of the subinterval. Stop the stopwatch when the EOI indicator is turned off.
4. Verify that the time on the stopwatch is equal to the test mode subinterval length.

Using the Time Remaining in Subinterval Quantity

If the meter has been programmed to display the time remaining in the subinterval as a display quantity, then the following procedure may be used to verify the timing:

1. Activate test mode by pressing the **TEST** button or through ABB meter support software.
2. Press the **RESET** button to start a new test interval and simultaneously start the stopwatch.
3. Press the **ALT** button to advance through the display quantities until the time remaining in the subinterval quantity is displayed.
4. Verify that the displayed quantity synchronizes with the stopwatch and counts down to zero at the same moment.

Using the EOI Indicator in Normal Mode

The meter timing can be verified while in normal mode, but because subintervals may be much longer than in test mode the process may take more time. There is also no way to control when an interval begins, so it may be necessary to wait for the present interval to end before testing can begin. The following procedure can be used to verify the meter timing in normal mode:

1. Wait for the EOI indicator to be shown on the meter LCD.
2. When the EOI indicator is no longer shown on the LCD, start the stopwatch.
3. Watch the meter LCD for the EOI indicator to appear 10 seconds before the end of the subinterval. Stop the stopwatch when the EOI indicator is turned off.

4. Verify that the normal mode subinterval length equals the measured time on the stopwatch.

Accuracy Tests

Accuracy tests can be used to confirm that the kWh readings are accurate as calibrated. Accuracy tests may be performed on the ALPHA Plus meter in any of the following ways:

- using the pulse count display quantity and a stopwatch
- manually counting pulses with a stopwatch

The first method is recommended.

Note: The accuracy tests also verify the meter timing.

Using Pulse Count Display Quantity

The following procedure should be used to perform an accuracy test on the meter using the pulse count quantity:

1. Place the meter in test mode by pressing the **TEST** button or through ABB meter support software.
2. Place a known load on the meter.
3. Start the stopwatch and simultaneously press the **RESET** button.
4. At the end of one complete interval, remove the load and simultaneously stop and record the reading on the stopwatch.
5. Read the pulse count from the meter LCD and calculate the number of pulses using the following formula (time should be measured in minutes):

$$\text{pulses} = \frac{\text{load} \times \text{time}}{K_e} \times \frac{100}{60}$$

6. Verify that the calculated value matches the pulse count observed, indicating that the meter is performing accurately.
7. Calculate the kWh using the following formula:

$$\text{kWh} = \frac{(K_e \times \text{pulses})}{1000}$$

8. Verify that the calculated kWh equals the kWh observed, indicating that the meter is calculating kWh accurately.
9. Verify that the observed demand equals the load kilowatts after one complete interval, indicating that the meter calculations of demand are accurate.

Counting Pulses Manually

The accuracy of the meter can be tested by manually counting pulses according to the following procedure:

1. Place the meter in test mode by pressing the **TEST** button or through ABB meter support software.
2. Place a known load on the meter.
3. Start the stopwatch as the LCD pulse indicator disappears from the meter LCD and simultaneously begin counting the number of pulses made by the indicator. Make sure to count the square indicator (each time it turns off) and not the arrow indicators.
4. After a period of time sufficiently long enough to average out variations due to response time, stop the stopwatch as the LCD pulse indicator disappears from the meter LCD. Record the reading on the stopwatch and the number of pulses which were counted during the interval and then remove the load from the meter.
5. Calculate the number of pulses using the following formula (time should be measured in minutes):

$$\text{pulses} = \frac{\text{load} \times (\text{time}/60)}{\text{Kh}} \times 1000$$

6. Verify that the calculated value matches the pulse count observed, indicating that the meter is performing accurately.
7. Calculate the kWh using the following formula:

$$\text{kWh} = \frac{(\text{Kh} \times \text{pulses})}{1000}$$

8. Verify that the calculated kWh equals the kWh observed, indicating that the meter is calculating kWh accurately.
9. Verify that the observed demand equals the load kilowatts after one complete interval, indicating that the meter calculations of demand are accurate.

Note: The kWh calculated may not be exactly the same as kWh observed. This is due to the amount of time the meter was in test mode with the load applied before starting the stopwatch, and the amount of time after stopping the stopwatch before removing the load. This is normal and does not necessarily indicate a meter which is providing inaccurate measurements.

7: Troubleshooting

Preliminary Inspection

In most cases the ALPHA Plus meter will provide years of trouble free service. In the event that a problem with the meter is suspected, there are some troubleshooting techniques which can be used to help isolate the cause of the problem. Some indicators of meter problems could be:

- error or warning codes on the LCD
- system instrumentation values which are not as expected
- testing procedures performed as discussed in chapter 6, "Testing the ALPHA Plus Meter," and a problem was indicated

Visual Check

Before applying power to the ALPHA Plus meter, a quick check of the meter itself is recommended. Below are some items to look for:

- broken parts
- missing or broken wiring
- bent or cracked components
- evidence of overheating

Physical damage to the outside of the ALPHA Plus meter could indicate potential electronic damage on the inside. Do not connect power to a meter which may have unknown internal damage.

⚠ DANGER

Never power up a meter that may have been damaged. Powering up a defective meter could result in personal injury, damage to equipment, or death.

Meter Installation Check

A common cause of incorrect meter operation is improper installation or wiring of the ALPHA Plus meter. Below are some other areas around the installation site that should be checked:

- verify that the meter installation matches the meter nameplate
- verify that the correct type of ALPHA Plus meter is installed for the existing service
- verify that there is no evidence of mechanical or electrical damage either to the meter or its installation location
- verify that the service voltage falls within the operating range on the meter nameplate

- verify that the meter optical port is free of dirt or other obstructions
- verify that the seal has not been broken

Note: A broken seal could be an indication of tampering with the ALPHA Plus meter installation.

Disassembling the Meter

The ALPHA Plus meter can be disassembled as shown in Figure 7–1.

> **⚠ WARNING**
> Do not disassemble the meter chassis or remove the electronic module from the meter chassis with power present. Doing so could result in exposure to dangerous voltages resulting in possible personal injury, death, or equipment damage.

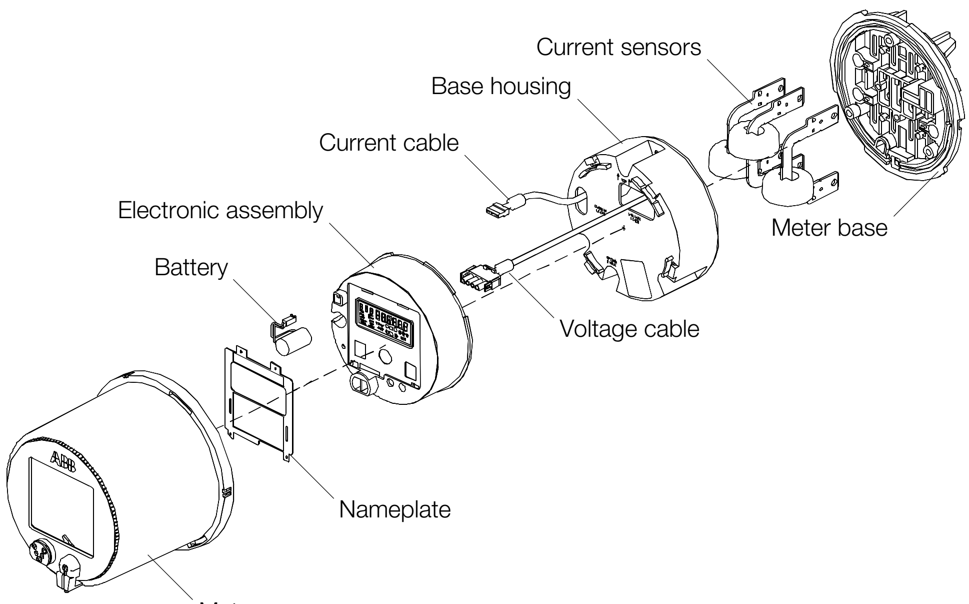

Figure 7–1. Disassembled ALPHA Plus meter

Removing the Cover Assembly

To disassemble the ALPHA Plus meter, the cover assembly must be removed first according to the following procedure:

1. Remove the T–seal or wire seal from the back of the meter.
2. While holding the back of the meter (bottom of the base housing) stationary with one hand, grasp and turn the front of the cover assembly in a counterclockwise direction until it stops.
3. Pull the cover assembly forward and off of the meter to expose the electronics and base housing.

Removing the Nameplate

In order to remove the nameplate, the cover assembly must first be removed. Once the cover has been removed, the following procedure should be used to remove the nameplate:

1. Flex the nameplate using a screwdriver until the tabs clear the slots on the face of the electronic assembly.

Removing the Electronic Assembly

In order to remove the electronic assembly, the cover assembly must first be removed. Once the cover has been removed, the following procedure should be used to remove the electronic assembly:

1. While holding the back of the meter (bottom of the base housing) stationary with one hand, grasp and turn the front of the electronics assembly in a counterclockwise direction until it stops and releases from the base housing.
2. Pull the electronics assembly away from the base housing exposing the cables.
3. Disconnect the two (or more if optional relay/communication boards are installed) cables from the back of the electronic assembly.

Error Codes and Warnings

The ALPHA Plus meter displays error codes and warnings as an indication of a problem which may be adversely affecting its operation. When a meter is displaying an error or warning code, it will continue to function as normally as possible. See “Operating Modes,” in chapter 3 for more details about error mode. Below are the classifications of error and warning codes:

- error codes

- warning codes
- communication error codes

Error codes generally indicate a condition which is likely to be affecting the meter data which is being measured and stored. Warning codes generally indicate a condition which is not yet affecting the meter data. It is not recommended to operate the ALPHA Plus meter for an extended period while it is displaying an error or warning code.

Communication error codes generally indicate a condition which is affecting communications with a computer through the optical port or modem. Not all communication codes indicate a problem with the meter. Some communication codes provide an indication of the present communication process.

Error Codes

Error codes are indicated on the LCD by Er and a numerical error code, and indicate a serious condition which is affecting either stored data or the ALPHA Plus meter operation. See Table 7–1 for the error codes which may be displayed.

Table 7–1. ALPHA Plus meter error codes

Display	Definition
Er 000000	Display inhibited by a warning condition
Er 000001	Carryover error (for TOU configurations)
Er 000010	Crystal oscillator or personality error
Er 000100	Memory checksum error or internal serial comm. error

Error codes can be displayed in combination (Er 000101 for example) indicating that more than one error condition has been detected. For all error codes (except code 0), the problem must be corrected and the meter reprogrammed before being put back into service. In some cases this may require return to the factory for repair or replacement.

Er 000000 will be continually shown on the normal display if the ALPHA Plus meter has been programmed to lock on warning codes. In this case, a warning condition exists and the warning code can be seen using the alternate mode display sequence. See “Warning Codes” on page 7–7 for a description of possible warning codes.

Note: The error code may also be selected as a display quantity when programmed with ABB meter support software. Er 000000 will be shown in the display sequence when no error condition exists. If an error condition does exist, it will be shown here and in error mode.

Er 000000: Display inhibited by warning condition

This error code is shown on the display when a warning condition is present and the ALPHA Plus meter has been programmed to lock on warning codes through ABB meter support software. It may also appear in the normal display sequence if the error code display quantity has been selected for display.

When the meter display is locked on this error code, there is a warning condition present. The actual warning code can be viewed in the alternate mode display sequence, or by using ABB meter support software. See “Warning Codes” on page 7–7 for a description of warning codes.

Er 000001: Carryover error for TOU configurations

This error code indicates either a failure of a checksum test on data stored in meter volatile RAM, or a loss of timekeeping during a power outage. When a loss of line voltage occurs, the meter receives power from the supercapacitor or optional lithium battery. If both of these fail, time will be lost and meter data stored in RAM will be lost or become suspect.

TOU features cannot be performed when time is lost. Previously accumulated billing data will still be available and the push buttons and optical port will function normally. When power is lost, all billing data is stored in non–volatile memory so the information can still be retrieved.

Note: If Er 000001 is displayed on the LCD after power is restored to the meter, further billing data is accumulated in the default rate. The default rate can be set by using the ABB meter support software.

Note: Since shipping can take several days, it is possible to see this error set on TOU meters which have been shipped without batteries.

All displayed quantities should be manually recorded to preserve existing information before powering down the ALPHA Plus meter. The meter battery may need to be replaced at this time, and the error statuses then reset through ABB meter support software. If the error code still is shown, the meter must be returned to the factory for repair.

Er 000010: Crystal oscillator or personality error

This error code indicates a problem with the crystal oscillator or designated functionality of the meter. All displayed quantities should be recorded manually to preserve data. The ALPHA Plus meter must then be returned to the factory for repair.

Er 000100: Memory checksum error or internal serial communication error

This error code indicates a possible error in the ALPHA Plus meter programming. Billing data cannot be reliably accumulated while this error condition exists because the meter is unable to determine if the rate constants are correct. The push buttons and optical port will continue to function normally.

A break in communications during the programming process can also cause this error to be displayed. This can occur with internal communications between the meter microcontroller and a memory location, or with external communications between the ALPHA Plus meter and a computer.

Programming the meter with ABB meter support software may correct the problem. If the error code is still displayed after reprogramming, the ALPHA Plus meter must be returned to the factory for repair.

Note: Meters which have not yet been programmed will always display this error code.

Warning Codes

Warning codes are indicated on the LCD by F and a numerical warning code, and indicate a potential problem which is not yet affecting the ALPHA Plus meter operation or stored data. Warning codes are inserted automatically as the first display quantity in a display sequence. See Table 7–2 for the warning codes which may be displayed.

Table 7–2. ALPHA Plus Meter Warning Codes

Display	Definition
F 000000	No warning
F 000001	Battery warning
F 000010	Improper meter engine operation
F 000100	Reverse energy flow
F 001000	Modem configuration checksum error
F 010000	Potential indicator or PQM error
F 100000	Demand overload

Potential indicator and meter engine warnings will be automatically cleared when the condition causing the warning has been corrected. A PQM warning will only be cleared once all of the PQM tests pass. The low battery warning will be cleared when the battery has been replaced and the meter has performed a self test.

The reverse energy flow warning and demand overload warning will only be cleared by a demand reset or optical communication with ABB meter support software which resets statuses.

F 000000: No warning

This warning code is only displayed when the warning code display quantity has been programmed into the normal or alternate mode display sequence with ABB meter support software. This indicates that no warning condition exists.

F 000001: Battery warning

This warning code indicates a low battery voltage or missing battery. ALPHA Plus meters having TOU functionality require a battery to maintain time and data over an extended power outage.

For TOU configurations, the meter should be de–energized and the battery should be replaced. Once the new battery has been installed, a demand reset or communication via ABB meter support software will clear the warning code.

Note: Since a battery is not required for demand only ALPHA Plus meters, this warning can be ignored. It may also be disabled through ABB meter support software.

F 000010: Improper meter engine operation

This warning code indicates that the meter engine program may be corrupt or is not executing correctly. This warning condition is typically triggered when the meter engine signals the microcontroller to reinitialize itself. An unstable (noisy) electrical environment at the ALPHA Plus meter installation can interfere with this operation.

If the meter engine successfully reinitializes, then the warning code will be automatically cleared from the LCD. If an unstable electrical environment exists, it may be necessary to relocate the meter installation. If the warning code continues to be displayed on the LCD, the ALPHA Plus meter must be returned to the factory for repair.

F 000100: Reverse energy flow

This warning code indicates that reverse energy flow in excess of two times the P/R value was detected during a single demand interval. It may also be an indication of tampering with the ALPHA Plus meter installation.

If the service being metered should be returning energy to the utility, then this warning code can be disabled through ABB meter support software. In this case the warning does not necessarily indicate a problem with the present ALPHA Plus meter installation. If the service being metered is not expected to return energy to the utility, some further investigation is required. In some cases it may be necessary to return the ALPHA Plus meter to the factory for repair.

The warning code will only be cleared after a demand reset or optical communications with ABB meter support software which resets statuses.

F 001000: Modem configuration checksum error

This warning code indicates that remote configuration data is corrupt due to loss of memory or incomplete programming. No modem communications will be attempted by the ALPHA Plus meter while this condition exists. Reprogramming the meter with ABB meter support software and a remote definition may correct this warning condition, otherwise it must be returned to the factory for repair.

F 010000: Potential indicator or PQM error

This warning code indicates that one or more of the phase potentials are missing. If one of the phase voltages is determined to be missing, correcting the problem will result in the warning code being cleared from the LCD automatically.

This warning code may also indicate that the selected power quality monitoring tests or service voltage test has detected a circuit parameter outside of the programmed thresholds. Using the meter system instrumentation features and other tests, the utility can determine whether this is the result of a meter malfunction or a problem with the installed service. The warning code will be automatically cleared once all conditions which are causing it have been corrected.

F 100000: Demand overload

This warning code indicates that the demand value exceeds the programmed overload value. It is generally intended to inform a utility when the installation is requiring more power than the service equipment was originally designed to process.

If the demand overload value has been set lower than is appropriate for the installation, the ALPHA Plus meter may be reprogrammed with a higher threshold value via ABB meter support software. Performing a demand reset or using ABB meter support software to reset the statuses will clear this warning code from the LCD.

Communication Error Codes

Communication error codes are indicated on the LCD by C and a numerical error code, and indicate a condition which is affecting communications with a computer through the optical port or modem. See Table 7–3 for the communication error codes which may be displayed.

Table 7–3. ALPHA Plus meter communication error codes

Display	Definition
C 000001	CRC error
C 000003	Syntax error
C 000004	Framing error
C 000005	Timeout error
C 000006	Incorrect password
C 000007	NAK received from computer

For most communication errors, it is recommended to attempt the communication again. It may be necessary in some cases to cycle power to the ALPHA Plus meter or to restart the ABB meter support software. If communication errors continue, the meter will have to be returned to the factory for repair.

Returning the Meter to the Factory

The ALPHA Plus meter should never be returned to the factory for repair or replacement without a meter return authorization number (RMR). In order to obtain this authorization, the information on the following form must be provided. Upon receipt of this information, an ABB representative will issue a RMR with instructions on how the meter should be packaged for return.

Meter Return Authorization Request Form

Customer Information Section

Contact Person ____________________

Contact Person's Phone Number ____________________

Return Shipping Address ____________________

____

____

Return Shipping Value (for Customs) ____________________

ALPHA Plus Meter Information Section

Purchase Order # ____________________

Meter Serial # ____________________

ABB Style # ____________________

Component Type Description ____________________

____

Details of Problem Section

Error or Warning Codes Displayed ____________________

____

____

____

Actions Taken to Correct Problem ____________________

____

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Details of Reason for Return ____________________

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A: Glossary

Glossary

Alpha Keys. A system combining hardware and software to upgrade existing ALPHA Plus meters; "keys" allow addition of new functionality to an existing meter for an additional fee.

ALT button. See *alternate mode*

alternate mode. Operating mode in ALPHA Plus meters used to display a second set of display quantities on the LCD and activated through the use of the **ALT** button or magnetic reed switch on the meter; generally used to display non-billing data as programmed by ABB meter support software.

annunciator. Liquid crystal display indicators used to more precisely define the information shown on the meter LCD.

autoread period. Either the number of days between each automatic reading of the meter or the day of the month upon which each reading is to occur.

AvgPF. See *average power factor*

average power factor. Calculated once every second, when the meter is not in test mode from kWh and kVAh using the following formula:

$$\text{AvgPF} = \frac{\text{kWh}}{\text{kVAh}}$$

base housing. Contains all of the following components:

- base
- current sensors
- current and voltage blades
- connecting cables for meter circuit board

bit. The smallest information unit used in data communications and storage

coincident. Information regarding one parameter occurring (existing) at the same time as another; ex. coincident kVAR demand is the kVAR demand occurring during the interval of peak kW demand.

communication session count. The number of data-altering communications occurring since the ALPHA Plus meter was last programmed or a clear values & statuses command was issued.

complete LCD test. A display showing 8 in all digit display areas, and all annunciators on the LCD turned on to visually confirm that all segments are operating properly.

continuous cumulative. A display technique used with demand calculations and similar to cumulative demand, except that upon demand reset the continuous cumulative demand becomes the new base to which the new demand will be added.

CTR. See *current transformer ratio*

cumulative. Increasing by successive additions; used to describe a method for storing and displaying demand data; ex. upon demand reset the present maximum demand will be added to the sum of the previous maximum billing period demand values; this technique provides a security feature which indicates if unauthorized demand resets have occurred.

current transformer ratio. The ratio of primary current to secondary current of a current transformer; for example, 400A to 5A would have a current transformer ratio of 400:5 or 80:1.

Del. See *delivered*

delivered. Used to specify the energy delivered (provided) to an electric service.

demand. The average power computed over a specific time interval.

demand forgiveness. The number of minutes that demand will not be calculated following a recognized power outage; this provides a time period immediately following the restoration of power during which startup power requirements will not be included in the calculated demand.

demand interval. The period of time over which demand is calculated (must be evenly divisible into 60 minutes).

demand reset. The act of resetting the present maximum demand to zero.

demand reset count. The total number of demand resets since the meter was last programmed.

demand reset date. The date of the last demand reset; only for TOU meters.

demand threshold. The preset value of demand which, when reached, will initiate a relay closure or other programmed action.

display quantity. Any value available for display on the LCD.

EEPROM. Electrically erasable programmable read-only memory; this memory retains all information even when electric power is removed from the circuit.

EOI. See *end of interval*

end of interval. The indication that the end of the time interval used to calculate demand has occurred; an EOI indicator is on the LCD and an optional relay can be supplied to provide an EOI indication.

energy. Power measured over time

error mode. A meter display mode which locks the display on an error message which consists of "Er" followed by a 6 digit numerical code; the code will indicate a condition which can adversely affect the correct operation of the meter.

event log. Only available on TOU meters with LP capability and provides a record of up to 255 entries which date & time stamp specific events such as:

- power outages
- demand resets
- uses of test mode
- time changes
- PQM events

external dial multiplier. Used when the transformer factor is larger than can be stored within the ALPHA Plus meter; when programmed with ABB meter support software for an external dial multiplier, display quantities read from the meter LCD must be manually multiplied by this value to yield proper readings.

factory default. Operating parameters which are programmed into the meter at the factory and assure that the meter is ready for correct energy measurement when installed.

four quadrant metering. See Figure A–1 for an illustration of energy relationships for delivered and received real power (kW), apparent power (kVA), and reactive power (kVAR).

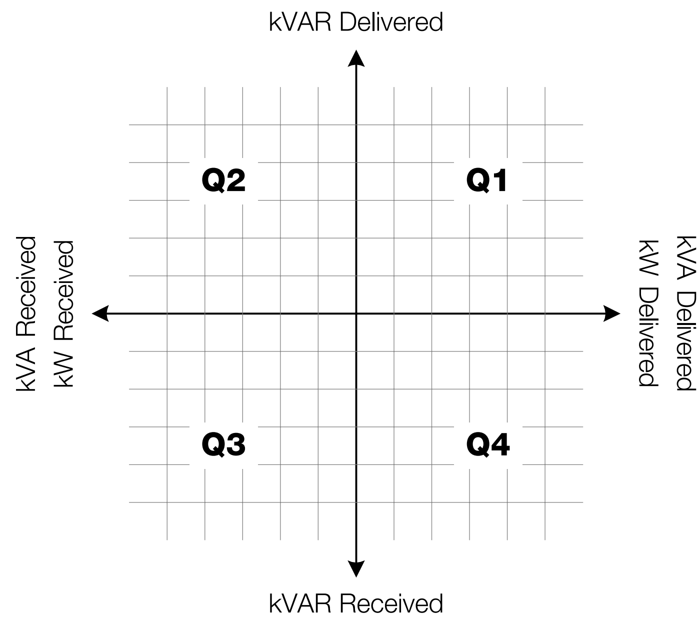

Figure A–1. Four quadrant metering quantity relationships

future program. In TOU meters a meter program can be stored within the meter and scheduled to take effect on a specified future date.

instrument transformer. A transformer used to reduce current and voltage to a level which does not damage the meter; meter readings will need to be increased by the transformer ratios in order to reflect the energy and demand values on the primary side of the instrument transformer.

K_e. The smallest discrete amount of energy available within the meter; value of a single pulse used between the meter IC and the microcontroller.

K_h. A meter constant representing the watt-hours per output pulse on the optical port; historically represents energy equivalent to one revolution of an electromechanical meter.

kW overload value. The kW threshold which, when exceeded, will cause the display of the kW overload warning message.

LC. See *load control*

LCD. see *liquid crystal display*

LP. see *load profile*

line frequency. The frequency of the AC current on the transmission line, often used in time-keeping applications in lieu of the internal oscillator; may be either 50Hz or 60Hz depending upon the country (region).

liquid crystal display. The LCD allows metered quantities and other information about the ALPHA Plus meter and installed service to be viewed; display quantities are programmable through ABB meter support software.

load control. Used to describe a relay dedicated to operate based upon entering a specific TOU rate period or when a demand threshold is reached.

load profile. The load profile feature records energy usage per a specified time interval while the meter is energized; load profile data provides a 24 hour record of energy usage for each day of the billing period.

maximum demand. The highest demand calculated during any demand interval over a billing period.

meter engine. Generally used to reference the custom meter integrated circuit used in ALPHA Plus meters for per phase voltage and current sampling plus energy measurements.

microcontroller. A single chip that contains the following components:

- main processor
- RAM
- ROM
- clock
- I/O control unit

non–recurring dates. Holidays or special dates which are based upon no predictable repeated interval.

normal mode. The default operating mode of the ALPHA Plus meter; typically displays billing data on the LCD following a programmed sequence.

optical port. The photo–transistor and an LED on the face of the meter which is used to transfer data between a computer and the meter via pulses of light.

outage log. Display quantity which shows the cumulative total of outage time in minutes; not available on A1D+ meters.

P/R. See *pulse ratio*

PB. See *previous billing period*

PS. See *previous season data*

polyphase. Power metering involving multiple AC phases.

power outage count. The number of power outages which have occurred since the last time the meter was programmed or had values and statuses reset.

previous billing period. Used to describe billing energy and demand from the previous billing period.

previous season data. Used to describe the billing energy and demand for the season preceding the present TOU season; only available on TOU meters.

primary rated. A condition where the energy and demand as measured by the meter are increased by the current and voltage transformer ratios; meter data will now reflect the energy and demand actually transferred on the primary side of the instrument transformers.

program change date. The date when the meter program was last changed; for TOU meters only.

pulse count. kWh delivered; the cumulative pulse count, where one pulse is equal to K_e, of delivered energy.

pulse ratio. Ratio of K_h to K_e (K_h/K_e).

pulse relay. A relay used with the meter to provide output pulses from the meter to an external pulse collector; each pulse represents a specific amount of energy consumption.

Rec. See *received*

received. Used to specify the energy received by the utility at an electric service.

recurring dates. Special dates or holidays that occur on a predictable basis.

TOU. See *time of use*

test mode. Test mode stores billing data in a secure memory location while the meter measures and displays energy and demand data for testing purposes; when test mode is exited the accumulated test data is discarded and the original billing data restored; **TEST** will flash on the LCD while test mode is active.

time of use. A billing rate which requires energy usage and demand data related to specific times during the day.

transformer factor. The product of the current transformer and voltage transformer ratios.

transformer rated. A meter designed to work with current or voltage transformers; the maximum current of a transformer rated ALPHA Plus meter is typically 20A.

voltage transformer ratio. The ratio of primary voltage to secondary voltage of a voltage transformer; for example, 12,000V to 120V would have a voltage transformer ratio of 100:1.

VTR. See *voltage transformer ratio*

B: Meter Display Quantities

Display Quantities

Display quantities for the ALPHA Plus meter are grouped as shown below:

- general
- metered quantity dependent
- system instrumentation

See “Metered Energy and Demand Quantities” in chapter 2 for a list of metered quantities for ALPHA Plus meters.

General Display Quantities

Account: 1,2,3. Displays the assigned account identification which can be comprised of either 14 alphanumeric characters or 27 numeric digits. When using an alphanumeric identification the following characters will only show up in reports generated by ABB meter support software because the LCD is incapable of displaying them: *k*, *m*, *q*, *w*, and *x*. If all 14 characters are used, the following assignments occur:

- Account: 1 is the first 6 characters
- Account: 2 is the next 6 characters
- Account: 3 is the last 2 characters

In order to use the 27–digit numeric format, exactly 27 numbers must be assigned to the account identification when programmed through ABB meter support software. Each Account: 1,2,3 will contain 9 digits of the full identification number.

Alpha–to–modem Baud. The baud rate programmed for the ALPHA Plus meter equipped with either a modem or RS232 option, or all zeroes if neither is used.

Comm Session Count. The number of data altering communications which have occurred since the last time the ALPHA Plus meter was programmed or ABB meter support software was used to perform a status and values reset.

Complete LCD Test. Shows all character 8’s and turns on all other identifiers to verify the proper functionality of the LCD.

CT Ratio. The programmed current transformer ratio.

Days Since Input Pulse. The number of days since the last data pulse was received.

Days Since Reset. The number of days which have passed since the last demand reset was performed on the meter.

Demand Interval. The demand interval and subinterval as defined in minutes, and shown in the LCD separated by two dash "-" characters.

Demand Reset Count. The total number of demand resets which have been performed since the last time the ALPHA Plus meter was programmed with ABB meter support software.

Demand Reset Date. The date of the most recent demand reset which was performed on a TOU capable ALPHA Plus meter.

End Power Out Date. The date at which the most recent complete power failure ended (power was restored) on a TOU capable ALPHA Plus meter.

End Power Out Time. The time at which the most recent complete power failure ended (power was restored) on a TOU capable ALPHA Plus meter.

Errors. Shows error code or Er 000000 if no error condition exists.

Future Program Date. The date at which a new program which has been stored within a TOU capable ALPHA Plus meter will take effect.

kW Overload Value. The kW threshold which, when exceeded, will cause the overload warning condition to occur.

Meter ID: 1,2. Displays the meter identification number which has been programmed into the ALPHA Plus meter via ABB meter support software. A maximum of 10 numerical digits can be used with the following assignments made:

- Meter ID: 1 will contain the first 6 digits
- Meter ID: 2 will contain the last 4 digits

Meter Kh. The programmed constant for the ALPHA Plus meter used to calculate energy and demand values.

Outage Log. The cumulative amount of time for power outages (in minutes) since the last time the TOU capable ALPHA Plus meter was programmed.

Power Outage Count. The number of power outages which have occurred since the last time the meter was programmed or ABB meter support software was used to clear statuses and values.

Present Date. The present date on a TOU capable ALPHA Plus meter.

Present Day of Week. The numerical representation of the day of the week, where *1* represents Sunday, *2* represents Monday, etc. on a TOU capable ALPHA Plus meter.

Present Season. The present season for a TOU configuration based upon seasonal changes.

Present Time. The present time on a TOU capable ALPHA Plus meter.

Program Change Date. The date at which the TOU capable ALPHA Plus meter program was last changed.

Program ID. The program identification number which was assigned through ABB meter support software.

Pulse Ratio (P/R). The ratio of energy to pulses generated by the meter IC used to calculate energy and demand values.

Security Check Date. The most recent date where optical communication has affected billing data on a TOU capable ALPHA Plus meter; changing time or performing a demand reset would be considered here.

Start Power Out Date. The date at which the most recent complete power failure began on a TOU capable ALPHA Plus meter.

Start Power Out Time. The time at which the most recent complete power failure began on a TOU capable ALPHA Plus meter.

Time Left Interval. The number of minutes and seconds left in the present demand interval.

Transformer Factor. The combined factor of the current transformer ratio multiplied by the voltage transformer ratio.

VT Ratio. The programmed voltage transformer ratio.

Wh Per Pulse. Energy value per measured pulse used to calculate energy and demand values.

Warnings. Displays present warning conditions which have been detected in the normal display sequence.

Metered Quantity Dependent Display Quantities

Average PF. The calculated average power factor obtained from kVA and kW when they are selected as the two metered quantities; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

Coincident QTY. The coincident demand, where QTY represents one of the metered quantities, during the present billing period; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

Cumulative QTY. The cumulative demand, where QTY represents one of the metered quantities, over all billing periods; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

kVARh-Q1,2,3,4. The total kVARh measured for the quadrant; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

QTY. The energy, where QTY represents one of the metered quantities, which has been measured during the present billing period; the previous billing period value for this quantity is also available.

Maximum QTY. The maximum demand, where QTY represents one of the metered quantities, during the present billing period; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

Pres Int Dmd QTY. The present interval demand at the time of the display, where QTY represents one of the metered quantities.

Prev Int Dmd QTY. The previous interval demand at the time of the display, where QTY represents one of the metered quantities.

Pulse Count QTY. The cumulative pulse count, where QTY represents the metered quantity which was selected to drive the LED pulse output.

Rate A,B,C,D QTY. The total energy, where QTY represents one of the metered quantities, for the rate; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

Rate A,B,C,D Coincident QTY. The coincident demand, where QTY represents one of the metered quantities, for the rate; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

Rate A,B,C,D Cumulative QTY. The cumulative demand, where QTY represents one of the metered quantities, for the rate; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

Rate A,B,C,D Date, Max QTY. The date at which the maximum demand, where QTY represents one of the metered quantities, occurred for the rate; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

Rate A,B,C,D Maximum QTY. The maximum demand, where QTY represents one of the metered quantities, for the rate; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

Rate A,B,C,D Time, Max QTY. The time at which the maximum demand, where QTY represents one of the metered quantities, occurred for the rate; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

Total QTY. The total energy, where QTY represents one of the metered quantities, which has been measured during the present billing period; the previous billing period value for this quantity is also available, and previous season is available on TOU configurations.

System Instrumentation Display Quantities

PH A,B,C Current. The instantaneous current for the phase.

PH A,B,C Current Angle to PH A Voltage. The instantaneous current angle of the phase relative to the phase A voltage.

PH A,B,C Current THD. The total harmonic distortion for current for the phase.

PH A,B,C kW. The instantaneous kW for the phase.

PH A,B,C kVA. The instantaneous kVA for the phase.

PH A,B,C kVAR. The instantaneous kVAR for the phase.

PH A,B,C Power Factor. The instantaneous power factor for the phase.

PH A,B,C Power Factor Angle. The instantaneous power factor angle for the phase.

PH A,B,C Second Harmonic Current. The second harmonic current magnitude for the phase.

PH A,B,C Second Harmonic Voltage. The second harmonic voltage percentage for the phase.

PH A,B,C Voltage. The instantaneous voltage for the phase.

PH A,B,C Voltage Angle to PH A Voltage. The instantaneous voltage angle for the phase relative to the phase A voltage.

PH A,B,C Voltage THD. The total harmonic distortion for voltage for the phase .

Line Frequency. The instantaneous line frequency for the service.

System kW. The instantaneous kW for the service.

System kVA. The instantaneous kVA (vectorial) for the service.

System kVAR. The instantaneous kVAR (vectorial) for the service.

System Power Factor. The instantaneous power factor (vectorial) for the service.

System Power Factor Angle. The instantaneous power factor angle for the service.

System Service Current Test. Performs the system service current test (if a valid service is locked) and reports any errors.

System Service Type (locked). Displays the locked service type, phase rotation, and nominal voltage.

System Service Voltage Test. Performs the system service voltage test and displays the service type, phase rotation, and nominal voltage if they match the locked service.

ALPHA Plus Meter Display Formats

For the display items which are dependent upon the metered quantity selected, kWh-Del and kW-Del have been used as examples. The display item choices in ABB meter support software will vary according to which metered quantities were selected.

If 2 metered quantities are available and selected, then there will be more display quantities available for the ALPHA Plus meter being programmed. Coincident demand will also be available when two metered quantities are selected.

See Table B–1 for a description of some of the special characters which have been used in the display quantity examples.

Table B–1. Characters in display quantity examples

Character	Represents
a	Any alphanumeric character displayable on the LCD
x	Any numeric character
i	Numeric character; represents the display identifier
h	Numeric character; represents time in hours
m, M	Numeric character; represents time in minutes
R	Phase rotation (alphanumeric)
s	Numeric character; represents time in seconds
T	Service type (alphanumeric)
V	Service voltage (numeric)

General display quantities	Display ID & units	ID	Value
Account: 1		iii	aaaaaa
Account: 2		iii	aaaaaa
Account: 3		iii	xxxxaa
Alpha-to-modem baud		iii	-xxxxx
Comm session Count		iii	xx
Complete LCD test		888	888888
CT ratio		iii	xxxx.xx
Days since input pulse		iii	xx

General display quantities	**Display ID & units**	**ID**	**Value**
Days since reset		iii	xxxxxx
Demand interval		iii	mm--MM
Demand reset count	RESETS	iii	xxxxxx
Demand reset date		iii	xx.xx.xx
End power out date		iii	xx.xx.xx
End power out time		iii	hh mm
Errors		Er	xxxxxx
Future program date		iii	xx.xx.xx
kW overload value		iii	xxxxxx
Meter ID: 1		iii	xxxxxx
Meter ID: 2		iii	xxxx
Meter Kh		iii	xxx.xxx
Outage log		iii	mmmmmm
Power outage count		iii	xxxxxx
Present date		iii	xx.xx.xx
Present day of the week		iii	x
Present season		iii	x
Present time		iii	hh mm
Program change date		iii	xx.xx.xx
Program ID		iii	xxxx
Pulse ratio (P/R)		iii	xx
Security check date		iii	xx.xx.xx
Start power out date		iii	xx.xx.xx
Start power out time		iii	hh mm
Time left interval		iii	mm.ss
Transformer factor		iii	xxxxxx
VT ratio		iii	xxxx.xx
Wh per pulse		iii	xxx.xxx
Warnings		F	xxxxxx

Metered quantity dependent display quantities	**Display ID & units**	**ID**	**Value**
Average PF		iii	x.xxx
Coincident kW-Del	KW	iii	xxxxxx
Cumulative kW-Del	CUM KW	iii	xxxxxx
kVARh-Q1	KVARh	iii	xxxxxx
kVARh-Q2	KVARh	iii	xxxxxx
kVARh-Q3	KVARh	iii	xxxxxx
kVARh-Q4	KVARh	iii	xxxxxx
kWh-Del	KWh	iii	xxxxxx
Maximum kW-Del	MAX KW	iii	xxxxxx
Pres int dmd kW-Del	KW	iii	xxxxxx
Prev int dmd kW-Del	KW	iii	xxxxxx
Pulse count kWh-Del		iii	xxxxxx

Metered quantity dependent display quantities	Display ID & units	ID	Value
Rate A kWh-Del	RATE A KWh	iii	xxxxxx
Rate A coincident kW-Del	RATE A KW	iii	xxxxxx
Rate A cumulative kW-Del	RATE A CUM KW	iii	xxxxxx
Rate A date, Max kW-Del	RATE A	iii	xx.xx.xx
Rate A maximum kW-Del	RATE A MAX KW	iii	xxxxxx
Rate A time, Max kW-Del	RATE A	iii	hh mm
Rate B kWh-Del	RATE B KWh	iii	xxxxxx
Rate B coincident kW-Del	RATE B KW	iii	xxxxxx
Rate B cumulative kW-Del	RATE B CUM KW	iii	xxxxxx
Rate B date, Max kW-Del	RATE B	iii	xx.xx.xx
Rate B maximum kW-Del	RATE B MAX KW	iii	xxxxxx
Rate B time, Max kW-Del	RATE B	iii	hh mm
Rate C kWh-Del	RATE C KWh	iii	xxxxxx
Rate C coincident kW-Del	RATE C KW	iii	xxxxxx
Rate C cumulative kW-Del	RATE C CUM KW	iii	xxxxxx
Rate C date, Max kW-Del	RATE C	iii	xx.xx.xx
Rate C maximum kW-Del	RATE C MAX KW	iii	xxxxxx
Rate C time, Max kW-Del	RATE C	iii	hh mm
Rate D kWh-Del	RATE D KWh	iii	xxxxxx
Rate D coincident kW-Del	RATE D KW	iii	xxxxxx
Rate D cumulative kW-Del	RATE D CUM KW	iii	xxxxxx
Rate D date, Max kW-Del	RATE D	iii	xx.xx.xx
Rate D maximum kW-Del	RATE D MAX KW	iii	xxxxxx
Rate D time, Max kW-Del	RATE D	iii	hh mm
Total kWh-Del	TOTAL KWh	iii	xxxxxx

System instrumentation display quantities	Display ID & units	ID	Value
PHA current		PhA	xxx.x A
PHB current		Phb	xxx.x A
PHC current		PhC	xxx.x A
PHA current angle to PHA voltage		PhA	xxx.x°A
PHB current angle to PHA voltage		Phb	xxx.x°A
PHC current angle to PHA voltage		PhC	xxx.x°A
PHA current THD		ThA	xx.xxdA
PHB current THD		Thb	xx.xxdA
PHC current THD		ThC	xx.xxdA
PHA kW	KW	PhA	xxx.xxx
PHB kW	KW	Phb	xxx.xxx
PHC kW	KW	PhC	xxx.xxx
PHA kVA	KVA	PhA	xxx.xxx
PHB kVA	KVA	Phb	xxx.xxx
PHC kVA	KVA	PhC	xxx.xxx

System instrumentation display quantities	**Display ID & units**	**ID**	**Value**
PHA kVAR	KVAR	PhA	xxx.xxx
PHB kVAR	KVAR	Phb	xxx.xxx
PHC kVAR	KVAR	PhC	xxx.xxx
PHA power factor		PhA	x.xxPF
PHB power factor		Phb	x.xxPF
PHC power factor		PhC	x.xxPF
PHA power factor angle		PhA	x.xx°
PHB power factor angle		Phb	x.xx°
PHC power factor angle		PhC	x.xx°
PHA second harmonic current magnitude		2hA	xxx.x A
PHB second harmonic current magnitude		2hb	xxx.x A
PHC second harmonic current magnitude		2hC	xxx.x A
PHA second harmonic voltage (% of fundamental)		2hA	xxx.xdU
PHB second harmonic voltage (% of fundamental)		2hb	xxx.xdU
PHC second harmonic voltage (% of fundamental)		2hC	xxx.xdU
PHA voltage		PhA	xxx.x U
PHB voltage		Phb	xxx.x U
PHC voltage		PhC	xxx.x U
PHA voltage angle to PHA voltage		PhA	xxx.x°U
PHB voltage angle to PHA voltage		Phb	xxx.x°U
PHC voltage angle to PHA voltage		PhC	xxx.x°U
PHA voltage THD		ThA	xx.xxdU
PHB voltage THD		Thb	xx.xxdU
PHC voltage THD		ThC	xx.xxdU
Line frequency		SyS	xx.xxHZ
System kW	KW	SyS	xxx.xxx
System kVA	KVA	SyS	xxx.xxx
System kVAR	KVAR	SyS	xxx.xxx
System power factor		SyS	xxx.xPF
System power factor angle		SyS	xxx.x°
System service current test		SyS	PASS
System service type (locked)		RRR	VVV^{L}TT
System service voltage test		RRR	VVV TT

C: Internal Meter Wiring Diagrams

In all figures in Appendix C, the power supply is indicated by the following:

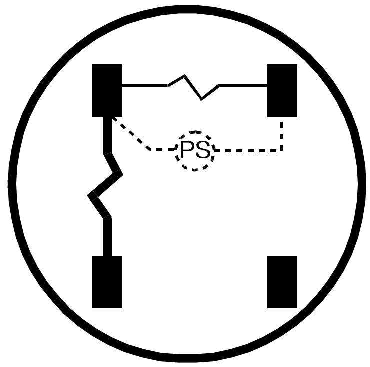

Figure C–1. Form 1S

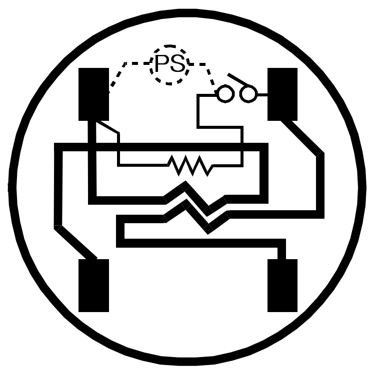

Figure C–2. Form 2S

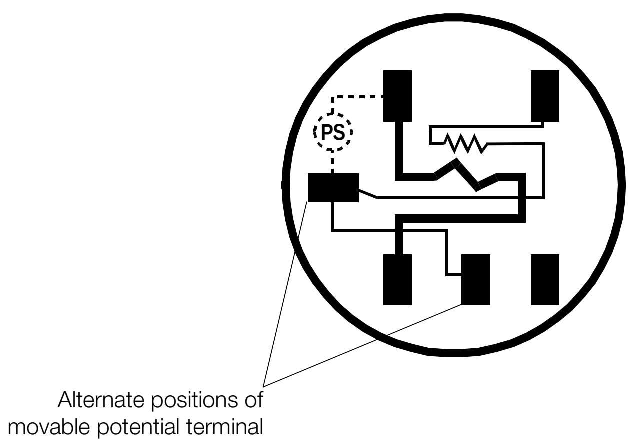

Figure C–3. Form 3S

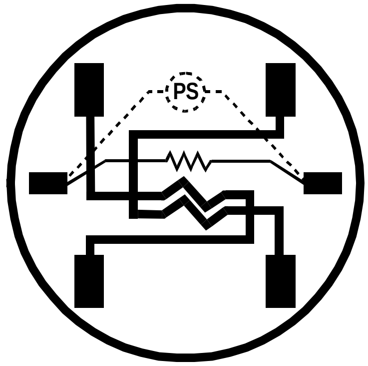

Figure C–4. Form 4S

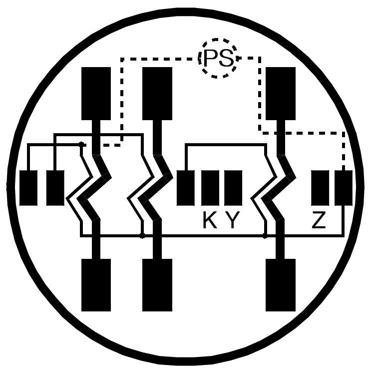

Figure C–5. Form 9S

⚠ CAUTION

This Form 10S does not strictly conform to the traditional Form 10S wiring. It is intended for use in most 10S applications. One side of each voltage section is wired common within the meter. This wiring restricts the use of phase shifting transformers to perform reactive measurement. If attempted, equipment damage can occur.

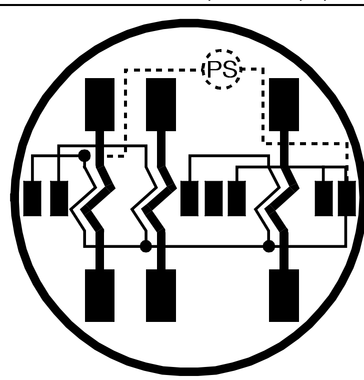

Figure C–6. Form 10S

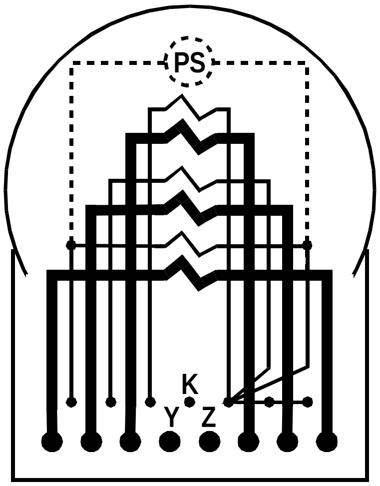

Figure C–7. Form 10A

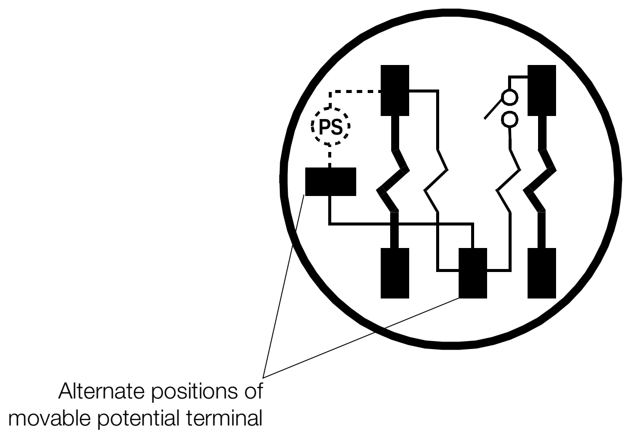

Figure C–8. Form 12S

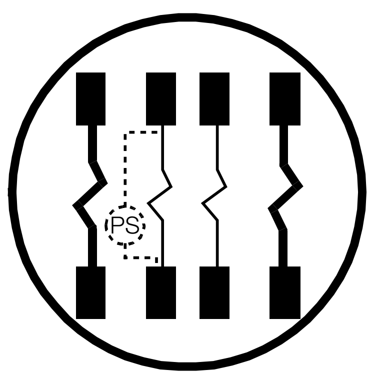

Figure C–9. Form 13S

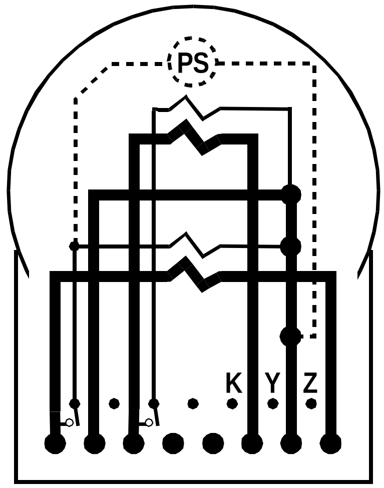

Figure C–10. Form 13A

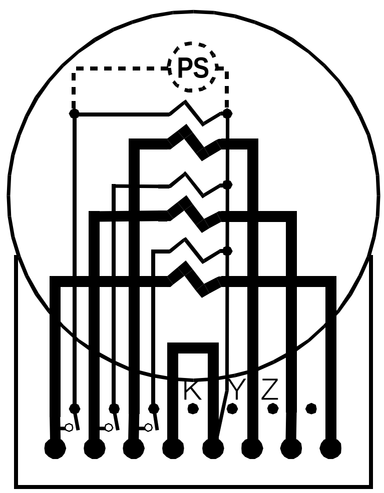

Figure C–11. Form 16A

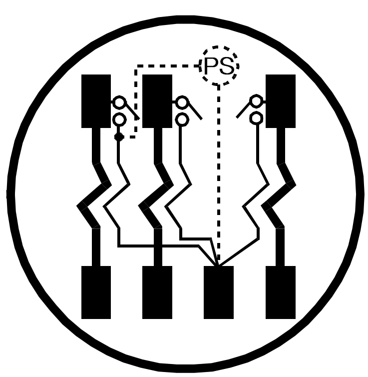

Figure C–12. Form 16S

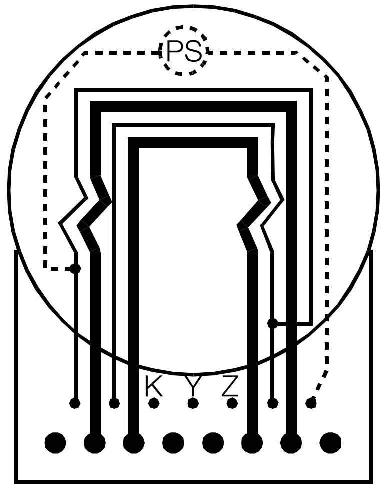

Figure C–13. Form 35A

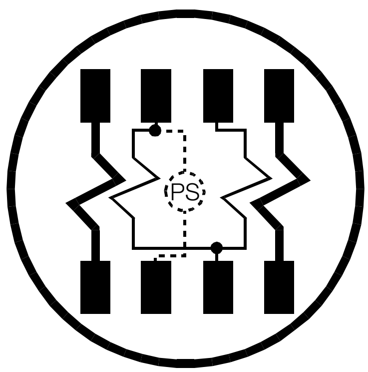

Figure C–14. Form 35S

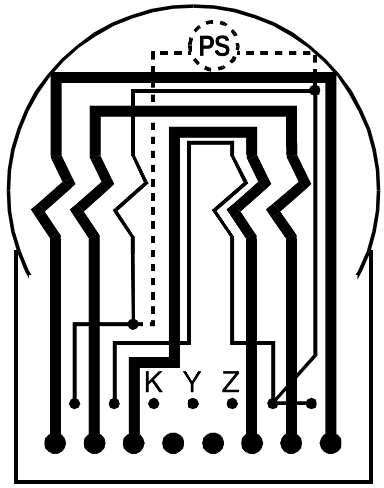

Figure C–15. Form 36A

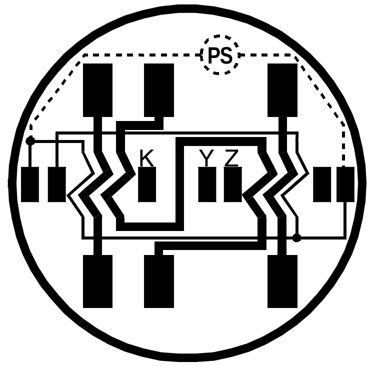

Figure C–16. Form 36S

D: Wiring Diagrams for Installation

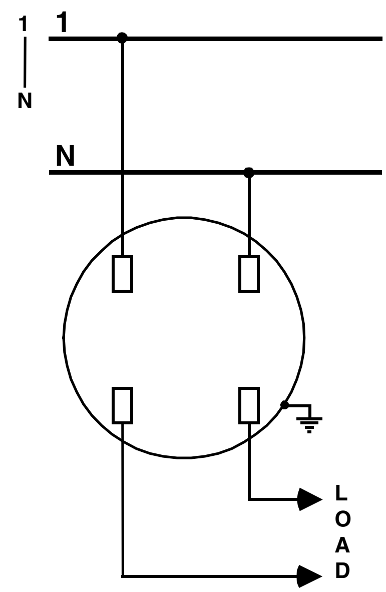

Figure D–1. Form 1S, 1–phase, 2–wire, self contained

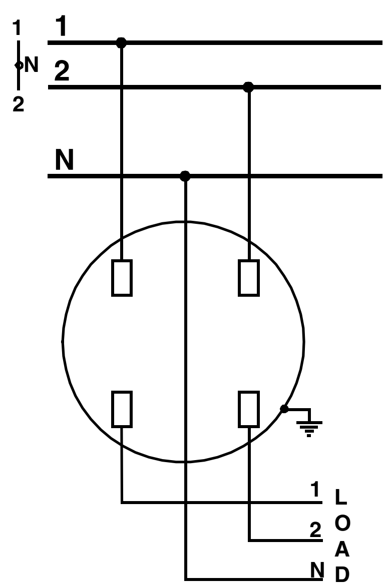

Figure D–2. Form 2S, 1–phase, 3–wire, self containted

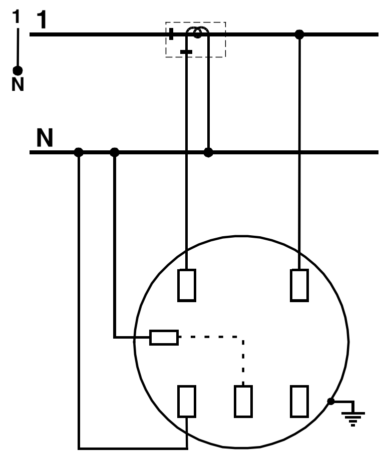

Figure D–3. Form 3S, 1–phase, 2–wire, transformer rated

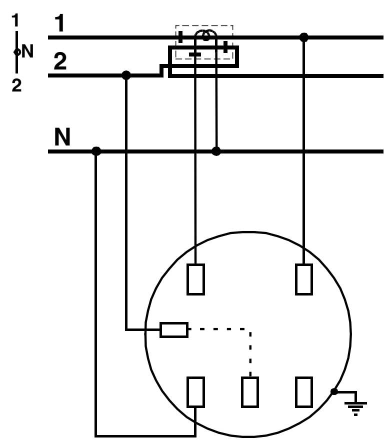

Figure D–4. Form 3S, 1–phase, 3–wire, transformer rated

Note: In this application, the CT ratio must be reduced by ½.

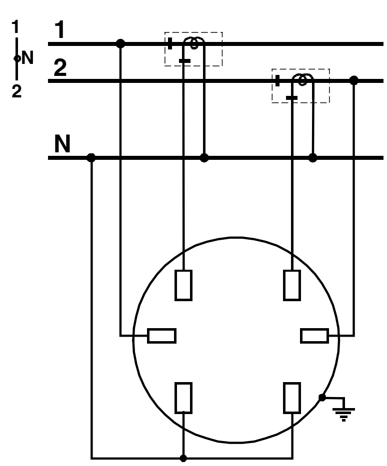

Figure D–5. Form 4S, 1–phase, 3–wire, transformer rated

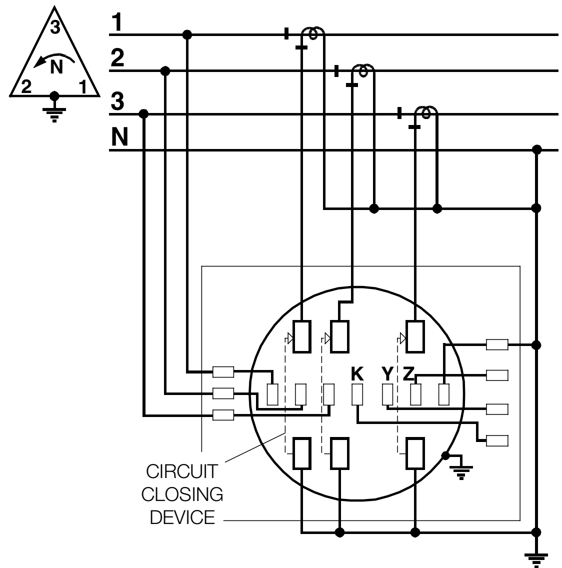

Figure D–6. Form 9S, 3–phase, 4–wire delta, 3 CTs, 0 VTs

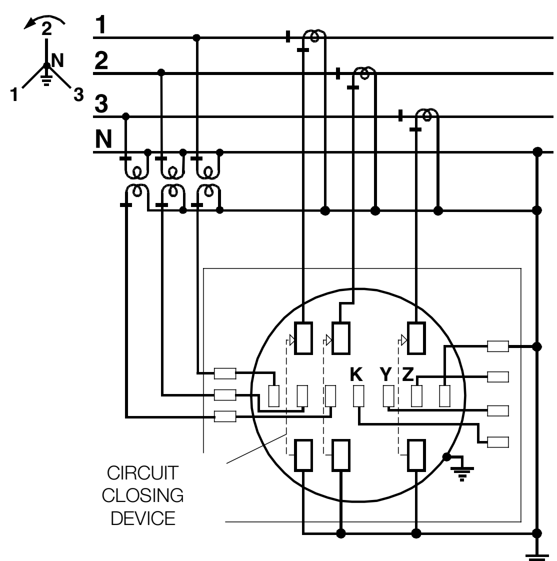

Figure D–7. Form 9S, 3–phase, 4–wire wye, 3 CTs, 0 or 3 VTs

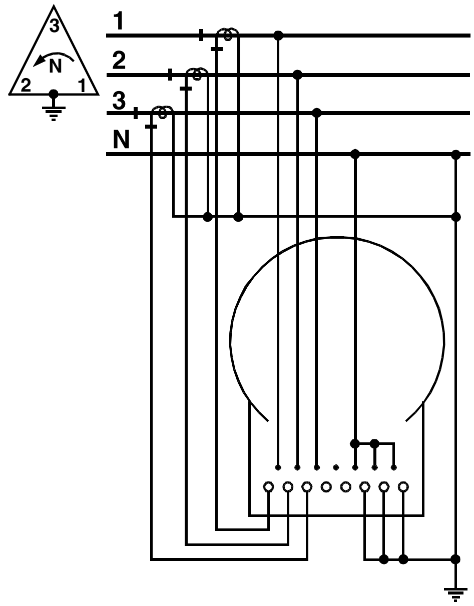

Figure D–8. Form 10A, 3–phase, 4–wire delta, 3 CTs, 0 VTs

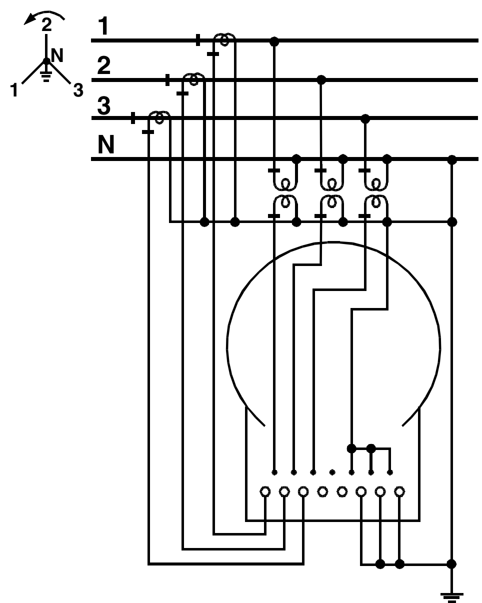

Figure D–9. Form 10A, 3–phase, 4–wire wye, 3 CTs, 0 or 3 VTs

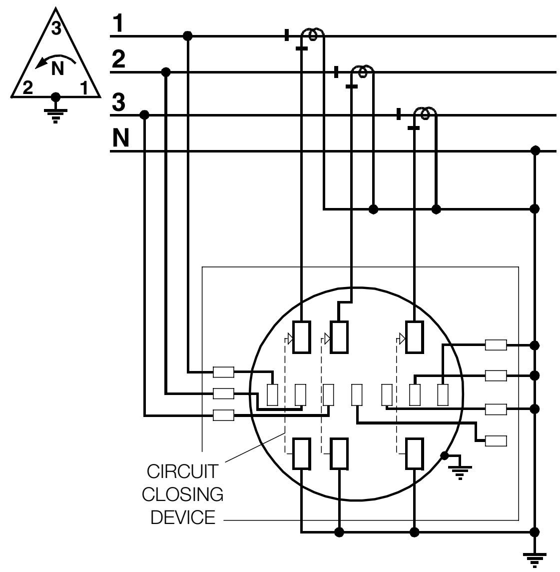

Figure D–10. Form 10S, 3–phase, 4–wire delta, 3 CTs, 0 VTs

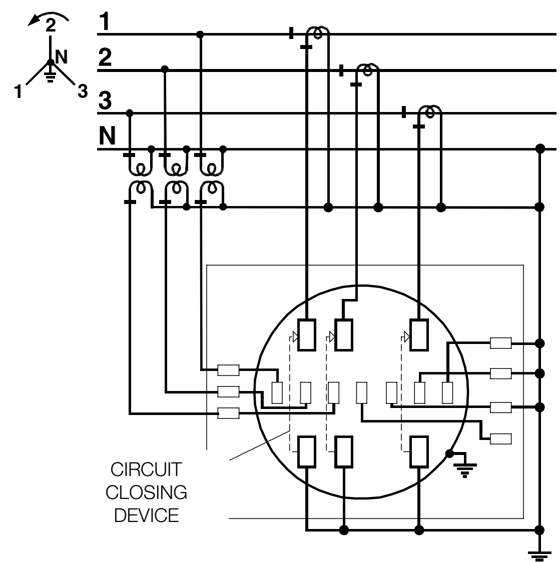

Figure 11. Form 10S, 3–phase, 4–wire wye, 3 CTs, 0 or 3 VTs

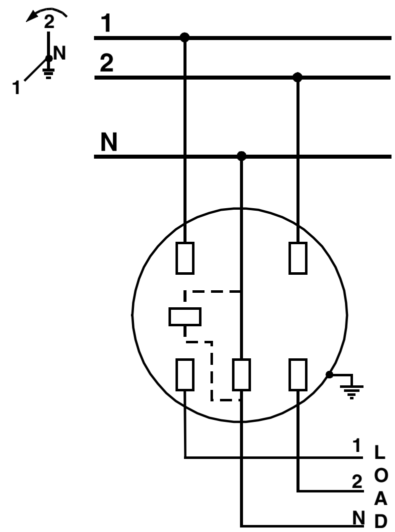

Figure D–12. Form 12S, 2–phase, 3–wire wye, self contained

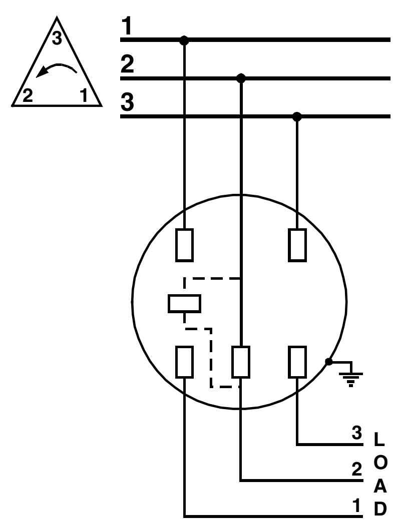

Figure D–13. Form 12S, 3–phase, 3–wire delta, self contained

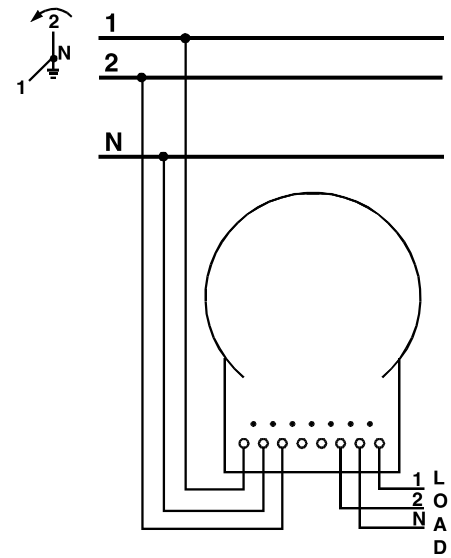

Figure D–14. Form 13A, 2–phase, 3–wire wye, self contained

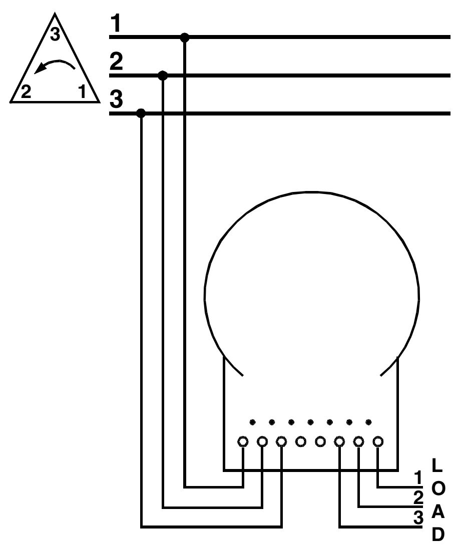

Figure D–15. Form 13A, 3–phase, 3–wire delta, self contained

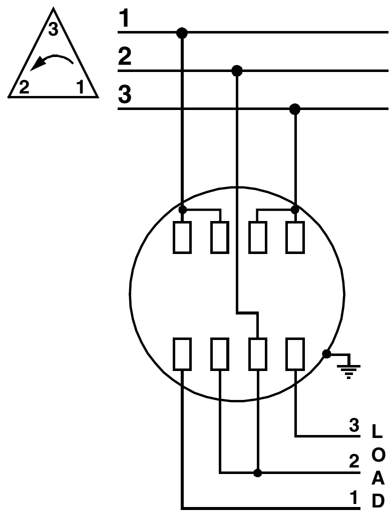

Figure D–16. Form 13S, 3–phase, 3–wire delta, self contained

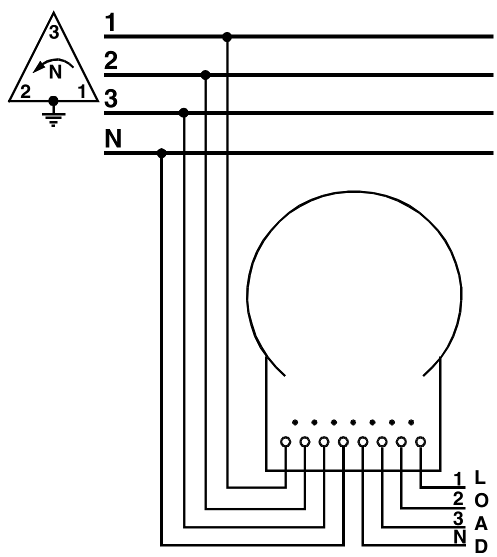

Figure D–17. Form 16A, 3–phase, 4–wire delta, self contained

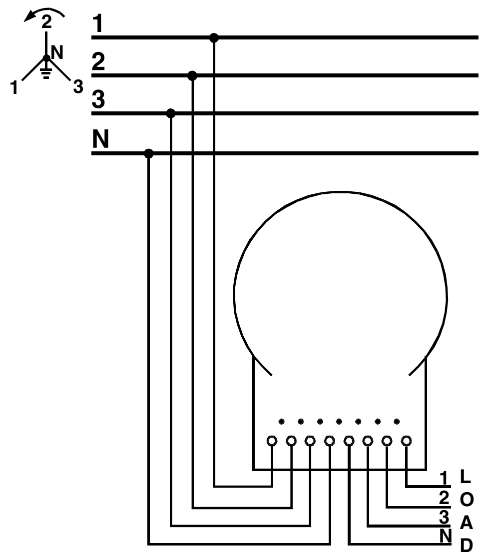

Figure 18. Form 16A, 3–phase, 4–wire wye, self contained

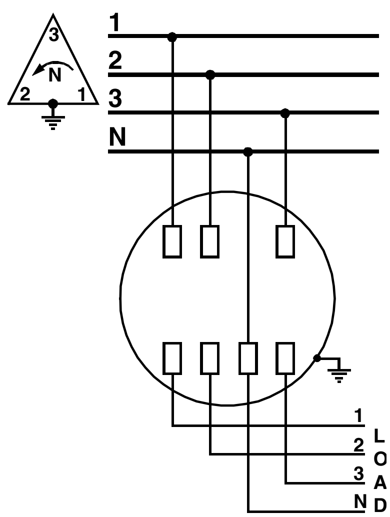

Figure D–19. Form 16S, 3–phase, 4–wire delta, self contained

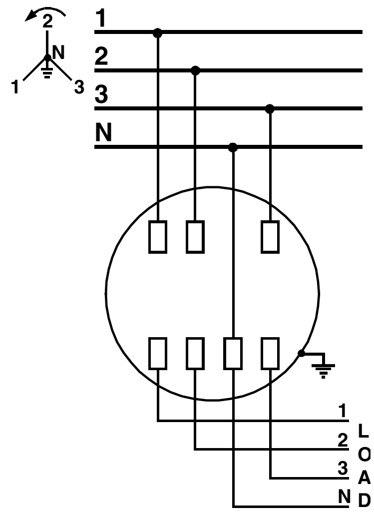

Figure D–20. Form 16S, 3–phase, 4–wire wye, self contained

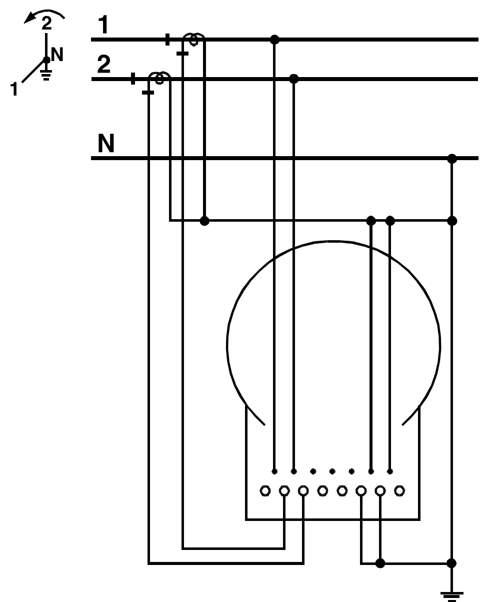

Figure D–21. Form 35A, 2–phase, 3–wire wye, 2 CTs, 0 or 2 VTs

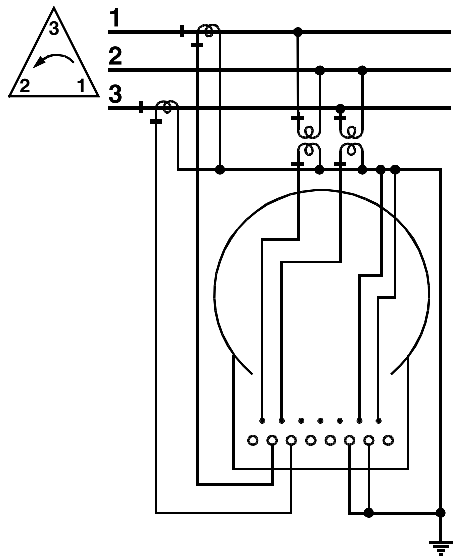

Figure D–22. Form 35A, 3–phase, 3–wire delta, 2 CTs, 0 or 2 VTs

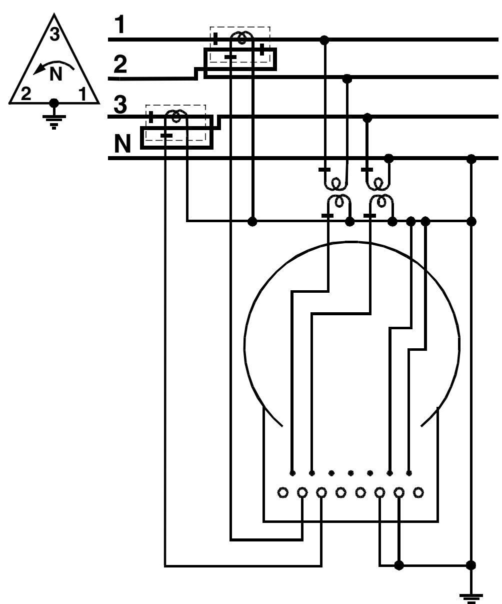

Figure D–23. Form 35A, 3–phase, 4–wire delta, 2 CTs, 2 VTs

Note: In this application, the CT ratio must be reduced by ½.

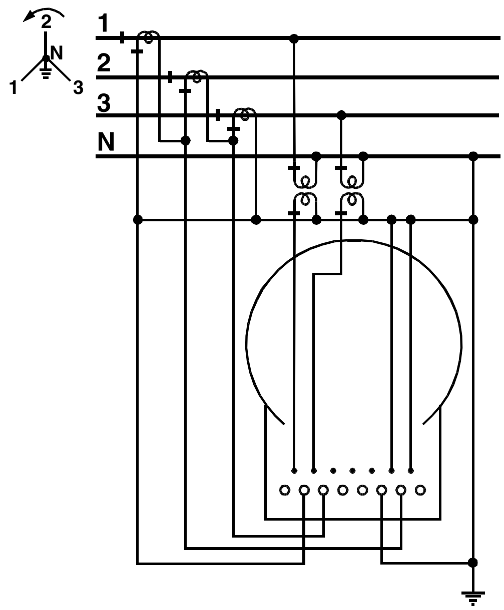

Figure D–24. Form 35A, 3–phase, 4–wire wye, 3 CTs, 0 or 2 VTs

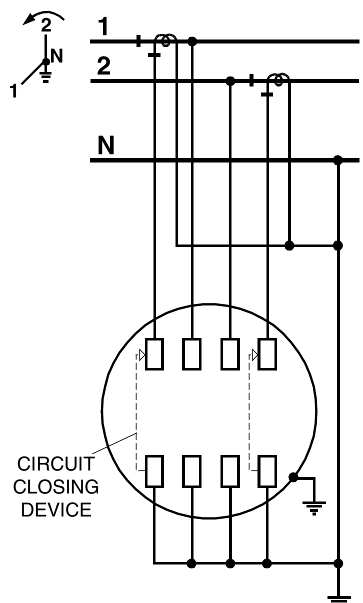

Figure D–25. Form 35S, 2–phase, 3–wire wye, 2 CTs, 0 or 2 VTs

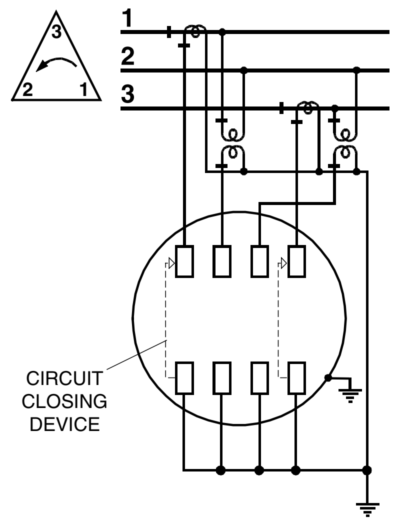

Figure D–26. Form 35S, 3–phase, 3–wire delta, 2 CTs, 0 or 2 VTs

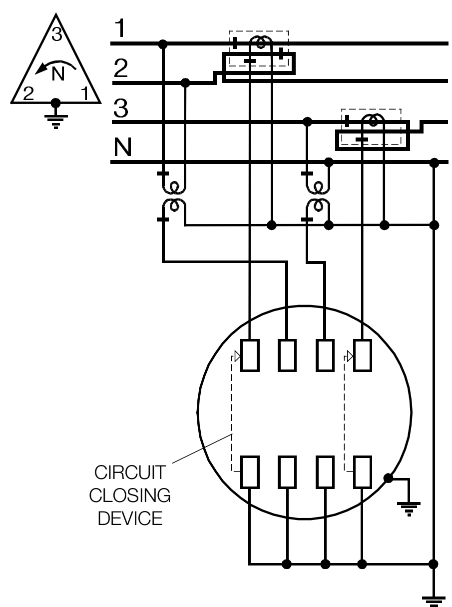

Figure D–27. Form 35S, 3–phase, 4–wire delta, 2 CTs, 2 VTs

Note: In this application, the CT ratio must be reduced by ½.

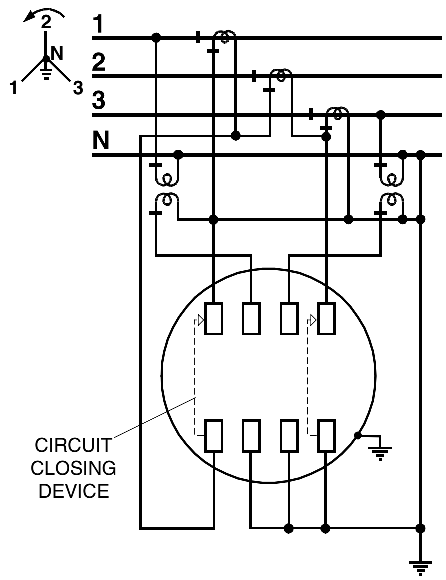

Figure D–28. Form 35S, 3–phase, 4–wire wye, 3 CTs, 0 or 2 VTs

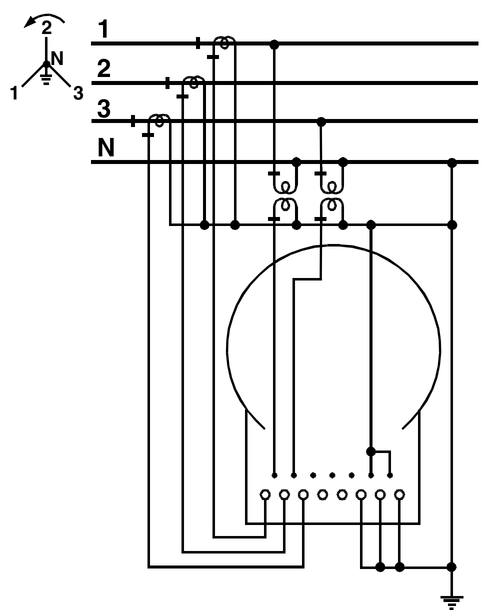

Figure D–29. Form 36A, 3–phase, 4–wire wye, 3 CTs, 0 or 2 VTs

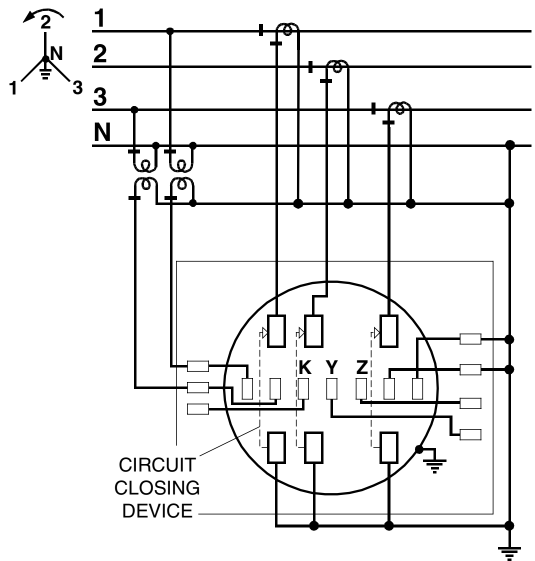

Figure D–30. Form 36S, 3–phase, 4–wire wye, 3 CTs, 0 or 2 VTs

E: Technical Specifications

Absolute Maximums

Voltage	Continuous at maximum of operating range	
Surge voltage withstand	**Test performed**	**Results**
	ANSI C37.90.1 oscillatory	2.5kV, 2500 strikes
	Fast transient	5kV, 2500 strikes
	ANSI C62.41	6kV @ 1.2/50μs, 10 strikes
	IEC 801-4	4kV, 2.5kHz repetitive burst for 1 min.
	ANSI C12.16 dielectric	2.5 kV, 60Hz for 1 min.
Current	Continuous at 120% of meter maximum current	
	Temporary (1s) at 200% of meter maximum current	

Operating Ranges

Voltage	**Nameplate nominal range**	**Operating range**
	120V – 480V	96V – 528V
	57.7V – 240V	46V – 264V
	120V – 240V	96V – 264V
Current	0 to Class amperes	
Frequency	Nominal 50 or 60Hz ±5%	
Temperature range	-40° to 85°C inside meter cover	
Humidity range	0 to 100% non-condensing	

Operating Characteristics

Power supply burden (Phase A)	Less than 3W		
Per phase current burden	0.1 milliohms typical at 25°C		
Per phase voltage burden	0.008W @ 120V	0.03W @ 240V	0.04W @ 480V
Accuracy	With load = ±{0.2 + 0.001(Class/I)(1 + Tanθ)} %		
Accuracy variations	Voltage coefficient = ±0.01% change from nominal		
	Temperature coefficient = ±0.01% per °C		

General Performance Characteristics

Starting current			
Form 1S and Form 3S	10mA for Class 20	100mA for Class 200	160mA for Class 320
All other forms	5mA for Class 20	50mA for Class 200	80mA for Class 320
Startup delay	<3s from power application to pulse accumulation		
Creep 0.000A (no current)	No more than one pulse measured per quantity, conforming to ANSI C12.1 requirements.		
Primary time base	Power line frequency (50 or 60Hz), with selectable crystal oscillator if line frequency of the isolated power system is considered to be too unstable for use as clock frequency.		
Secondary time base	Meets the ANSI limit of 0.02% using the 32.768kHz crystal. Initial performance is expected to be equal to or better than ±55 seconds per month at room temperature		
Outage carryover capacity	6 hours at 25°C. Supercapacitor rated at 0.1 Farads, 5.5V.		
Battery (optional)	$LiSOCl_2$ battery rated 800mAhr, 3.6V and shelf life of 20+ years. 5 years continuous duty at 25°C Supercapacitor is expected to provide carryover power for all normal power outages. The battery is not under load except when supercapacitor is discharged or when a programmed meter is stored for an extended period without line power. Based on this low duty cycle, the projected life of the battery in normal service is expected to be greater than 20 years.		
Communications baud	**Optical port**	**Communications option**	
	9600 baud (nominal)	1200 to 19,200 BPS	

F: Renewal Parts

Description	Style Number
Cover assembly	3D93309G01
Over assembly (with keylock reset)	3D93309G02
Form 1S base assembly	1C11452G01
Form 2S base assembly	1C11450G11
Form 2S base assembly (320 Amp)	1C11450G50
Form 3S base assembly	1C11450G21
Form 4S base assembly	1C11451G01
Form 35S (5S) base assembly	1C11447G01
Form 36S (6S) base assembly	1C11448G08
Form 36S (6S) base assembly with KYZ output to blades	1C11448G09
Form 9S (8S) base assembly	1C11448G01
Form 9S (8S) base assembly with KYZ output to blades	1C11448G02
Form 12S base assembly	1C11450G01
Form 12S base assembly (320 Amp)	1C11450G05
Form 16S (14S, 15S) base assembly	1C11449G01
Form 16S base assembly (320 Amp)	1C11449G08
Form 35A (5A) base assembly	1C11246G01
Form 36A (6A) base assembly	1C11246G02
Form 10A base assembly	1C11246G03
Form 13A base assembly	1C11246G04
Form 16A base assembly	1C11246G05
Form 1S electronics assembly	QA30xxxxE
Form 2S electronics assembly	QC30xxxxE
Form 3S electronics assembly	QA20xxxxE
Form 4S electronics assembly	QC20xxxxE
Form 35S (5S) electronics assembly	Q220xxxxE
Form 36S (6S) electronics assembly	Q820xxxxE
Form 9S (8S) electronics assembly	Q320xxxxE
Form 12S electronics assembly	Q530xxxxE
Form 16S (14S, 15S) electronics assembly	Q330xxxxE
1 KYZ relay output circuit board	3D93465G01
2 relay output circuit board (2 KYZ or 1 KYZ & 1 LC)	3D93465G02
Output board cable to meter blades	1C11204G01
Output board cable with conductors in a “pigtail” (6 conductor)	1C11204G06
Output board cable with conductors in a “pigtail” (12–conductor)	1C11204G03
Output board cable with conductors in a “pigtail” (10–conductor)	1C11640G01
Output board cable grommet (relays only)	4072B26H01
Output board cable grommet (communications only)	4072B26H02
Output board cable grommet (relays and communications)	4072B26H03
Battery for TOU 800mA lithium thionyl chloride	1A46869H01
Relay output circuit board standoff posts (3 per board)	4072B42H01
Liquid crystal display	1C11226H01
Elastomeric connector (for LCD)	4072B67H01

Index

L

M

N

O

P

R

S

T

V

W

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