A3 ALPHA® Meter

Electronic Meter for
Electric Energy Measurement

Technical Manual

TM42-2190B
US English (en)

ELSTER

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Contents

FCC Compliance

Most A3 ALPHA 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 A3 ALPHA 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 A3 ALPHA 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 complaint 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 Elster Electricity 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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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 the 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 *A3 ALPHA Meter Technical Manual* can be referred to by its document number: TM42–2190. 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 its revision are located at the bottom of each page.

The following table lists the revisions to this document, the date of the release, and any notes about the changes made.

Revision	Date	Brief Description
A	02.April.2001	First release of the document.
B	28.February.2003	Changed “ABB” to “Elster Electricity.” Added “Loss Compensation” to Chapter 8. Corrected specifications in Appendix E.

1. Introduction

The A3 ALPHA Meter

Upon its introduction in 1992, the ALPHA meter set the standard for totally electronic, high function, multiple tariff electricity metering. As features have been continually added, the ALPHA meter has been able to maintain its position as the leader in solid state metering technology. Building on patented ALPHA meter technology, the A3 ALPHA meter is the first Elster Electricity meter to support the American National Standards Institute (ANSI) C12.18, C12.19, and C12.21 standards.

The A3 ALPHA meter provides a meter design platform that supports a variety of metering requirements. From a simple one–rate kWh and kW demand meter up through a multi–rate, real/reactive, bi–directional meter that automatically validates the meter service connections, provides instrumentation readings, performs power quality monitoring, logs events, and provides load and instrumentation profile readings with remote communications—the A3 ALPHA meter does them all.

This manual is a guide to the features, flexibility, and operating characteristics of the A3 ALPHA meter.

The A3 ALPHA meter is a totally electronic polyphase electricity meter and integral register. 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

See Figure 1-1 for an example of an A3 ALPHA meter.

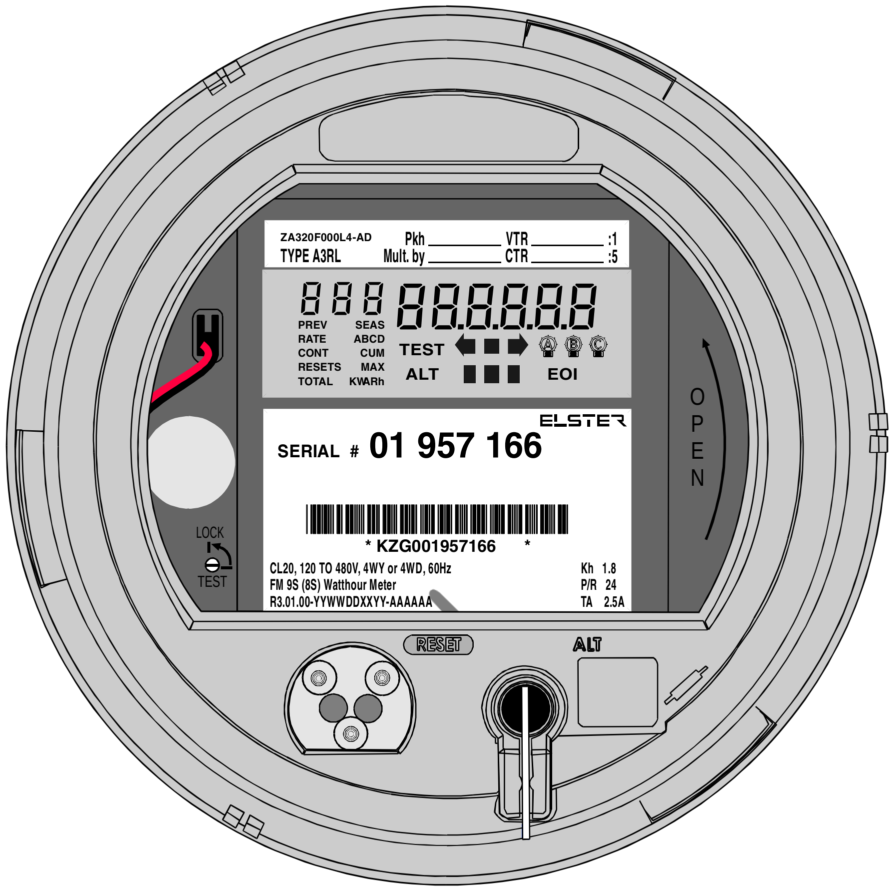


Figure 1-1. A3 ALPHA meter

Standards Compliance

The A3 ALPHA meter meets or exceeds the ANSI standards for electricity metering, and it is intended for use by commercial and industrial utility customers.

Number	Date	Title
ANSI C12.1	1995	American National Standard for Electric Meters – Code for Electricity Metering
ANSI C12.10	1997	Electromechanical Watthour Meters
ANSI C12.18	1996	Protocol Specification for ANSI Type 2 Optical Port
ANSI C12.19	1997	Utility Industry End Device Data Tables
ANSI C12.20	1998	American National Standard for Electricity Meters 0.2 and 0.5 Accuracy Classes
ANSI C12.21	1999	Protocol Specification for Telephone Modem Communications

Benefits

Reliability

The A3 ALPHA meter, part of the ALPHA line of meters, uses the patented ALPHA meter technology for measurement and accurate calculation of energy quantities. With over 2 million ALPHA meters in operation throughout the world, the A3 ALPHA continues the tradition of reliable electronic meters.

The A3 ALPHA meter can use its internal crystal oscillator or the power line frequency to maintain time and date functions. The crystal oscillator can be used when the power line frequency is known to be too unstable for accurate timekeeping.

The A3 ALPHA meter contains circuits that have been designed to function with the battery to provide a long battery life. Due to the low current drain, the service life of the lithium battery can exceed the life of the meter.

The A3 ALPHA meter uses nonvolatile memory to store its data. If the power fails, the data is preserved.

Maintainability

The A3 ALPHA 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 for quickly and easily replacing parts.

ANSI Standard Communication

The A3 ALPHA meter complies with the ANSI C12.18, C12.19, and C12.21 standards. These standards include communication protocols for a wide range of metering products. They are the basis for common industry data structures and a common protocol for transporting the data structures. By supporting the ANSI protocols, the A3 ALPHA meter will reduce maintenance cost, make it easier to add new products to existing systems, and provide an open standard for meter data communications.

Adaptability

The A3 ALPHA meter allows configuration for custom TOU rates, offering a broad range of demand and TOU operations. Practically all common services and mounting configurations have been accounted for, and functional upgrades are easily performed as new situations arise. The wide operating range allows installation at any of the common meter voltages.

Economy

The A3 ALPHA 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
- onsite instrumentation displays
- power quality monitoring (PQM) tests
- event logging

Security

The A3 ALPHA meter is tamper–resistant. Passwords may be specified that prevent unauthorized access to meter data. Since there are no moving parts in this fully electronic meter, tampering that would normally affect the electromechanical meter will not affect the A3 ALPHA meter. The optional PQM feature or the optional instrumentation profiling (or both) can be used to detect possible tampering of energy measurements.

All A3 ALPHA meters provide auditing capabilities that can be used to indicate potential meter tampering.

Accuracy

The A3 ALPHA meter meets or exceeds requirements of ANSI standards. The meter precisely measures and displays energy usage and demand data consistently 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.

Features

Standard Features

The A3 ALPHA meter comes with many options that make it a powerful meter:

- fully programmable
- pre–programmed at the factory
- wide operating ranges for voltage, current, and temperature
- complete ANSI C12 protocol capable
- over 50 displayable instrumentation values including:
  - per phase kW, kVA, and kVAR
  - per phase voltage and voltage angle
  - per phase current and current angle
  - per phase power factor and power factor angle
  - per phase total harmonic distortion for voltage and current
  - per phase total demand distortion for current
  - system kW, kVA, and kVAR
- average power factor
- high accuracy internal clock
- polycarbonate enclosure
- easily upgradeable through software and optional hardware
- factory–installed lithium battery (for TOU meters)
- easy access battery

Advanced Features

There are also some advanced options available. All of these are part of the main meter board:

- advanced four–quadrant metering
- basic load profiling with up to 8 channels
- instrumentation profiling with up to 32 channels
- loss compensation
- power quality monitoring

Option Boards

Some of the option boards available for the A3 ALPHA meter are indicated below:

- output relay option board
- communications
  - internal modem option board
  - external serial communications option board
  - RS232 option board
  - RS485 option board
  - 20mA current loop option board
- 1 MB extended memory board

Meter Types

Different A3 ALPHA meters have specific capabilities. Table 1-1 through Table 1-4 identify all the possible meter types. Descriptions of the suffixes can be seen in Table 1-6.

Demand Meters

For the demand meter, the following base meter and additional functionalities are available:

Table 1-1. Demand meter configuration options

Type	kWh	kVARh	kVAh	TOU	LP	IP	LC	PQM	Quantities
A3D	✓								1
A3DQ	✓							✓	1

TOU Meters

For the time–of–use (TOU) meter, the following base meter and additional functionalities are available.

Table 1-2. TOU meter options

Type	kWh	kVARh	kVAh	TOU	LP	IP	LC	PQM	Quantities
A3T	✓			✓					1
A3TQ	✓			✓				✓	1
A3TL	✓			✓	✓				1
A3TLQ	✓			✓	✓			✓	1
A3TLN	✓			✓	✓	✓			1
A3TLNQ	✓			✓	✓	✓		✓	1

kVA Meters

For the kVA meter, the following base meter and additional functionalities are available:

Table 1-3. kVA meter configuration options

Type	kWh	kVARh	kVAh[1]	TOU	LP	IP	LC	PQM	Quantities
A3K	✓	✓	✓	✓					2
A3KQ	✓	✓	✓	✓				✓	2
A3KL	✓	✓	✓	✓	✓				2
A3KLQ	✓	✓	✓	✓	✓			✓	2
A3KLN	✓	✓	✓	✓	✓	✓			2
A3KLNQ	✓	✓	✓	✓	✓	✓		✓	2
A3KA	✓	✓	✓	✓					6
A3KAQ	✓	✓	✓	✓				✓	6
A3KAL	✓	✓	✓	✓	✓				6

Table 1-3. kVA meter configuration options

Type	kWh	kVARh	kVAh[1]	TOU	LP	IP	LC	PQM	Quantities
A3KALQ	✓	✓	✓	✓	✓			✓	6
A3KALN	✓	✓	✓	✓	✓	✓			6
A3KALNQ	✓	✓	✓	✓	✓	✓		✓	6

1. kVAh and kVA quantities measured and calculated arithmetically.

Reactive Meters

For the reactive meter, the following base meter and additional functionalities are available:

Table 1-4. Reactive meter options

Type	kWh	kVARh	kVAh[1]	TOU	LP	IP	LC	PQM	Quantities
A3R	✓	✓	✓	✓					2
A3RQ	✓	✓	✓	✓				✓	2
A3RC	✓	✓	✓	✓			✓		2
A3RCQ	✓	✓	✓	✓			✓	✓	2
A3RL	✓	✓	✓	✓	✓				2
A3RLQ	✓	✓	✓	✓	✓			✓	2
A3RLC	✓	✓	✓	✓	✓		✓		2
A3RLCQ	✓	✓	✓	✓	✓		✓	✓	2
A3RLN	✓	✓	✓	✓	✓	✓			2
A3RLNQ	✓	✓	✓	✓	✓	✓		✓	2
A3RLNC	✓	✓	✓	✓	✓	✓	✓		2
A3RLNCQ	✓	✓	✓	✓	✓	✓	✓	✓	2
A3RA	✓	✓	✓	✓					6
A3RAQ	✓	✓	✓	✓				✓	6
A3RAC	✓	✓	✓	✓			✓		6
A3RACQ	✓	✓	✓	✓			✓	✓	6
A3RAL	✓	✓	✓	✓	✓				6
A3RALQ	✓	✓	✓	✓	✓			✓	6
A3RALC	✓	✓	✓	✓	✓		✓		6
A3RALCQ	✓	✓	✓	✓	✓		✓	✓	6
A3RALN	✓	✓	✓	✓	✓	✓			6
A3RALNQ	✓	✓	✓	✓	✓	✓		✓	6
A3RALNC	✓	✓	✓	✓	✓	✓	✓		6
A3RALNCQ	✓	✓	✓	✓	✓	✓	✓	✓	6

1. kVA/kVAh quantities calculated vectorially from kW/kWh and kVAR/kVARh.

Meter Types Suffixes

There are 4 basic types of meters as shown below:

Table 1-5. A3 ALPHA basic meter types

Meter type	Description of functions
A3D	Measures watts (W) and watthours (Wh)
A3T	Measures W and Wh on a time–of–use basis
A3K	Measures Wh and apparent energy (VAh)
A3R	Measures Wh and reactive energy (VARh)

The additional functions can be applied to the various meter configurations as shown above.

Table 1-6. A3 ALPHA meter type suffixes

Suffix	Description of functions
Q	Power quality monitoring (PQM)
L	Load profiling (LP)
N	Instrumentation profiling (IP)
C	Transformer and line loss compensation (LC)
A	Advanced metering (6 quantities)

Alpha Keys

Alpha Keys software allows A3 ALPHA 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 to gain functionality.

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

Table 1-7. Meter type upgrades

Current meter type	Can be upgraded to
A3D	A3T A3K A3R
A3T	A3K A3R
A3K	A3R
A3R	A3K

Additionally, the following options can be added to the meter by using Alpha Keys:

Table 1-8. Configuration option upgrades

Additional function	Can be added to
Power quality monitoring	A3D A3T A3K A3R
Load profiling	A3T A3K A3R
Instrumentation profiling	A3TL A3KL A3RL
Transformer and line loss compensation	A3R
Advanced four quadrant metering	A3K A3R

2. Product Description

System Overview

System Architecture

The A3 ALPHA meter main circuit board contains all the electronics that make up the meter and integral registers. See Figure 2-1 for the meter circuit board block diagram.

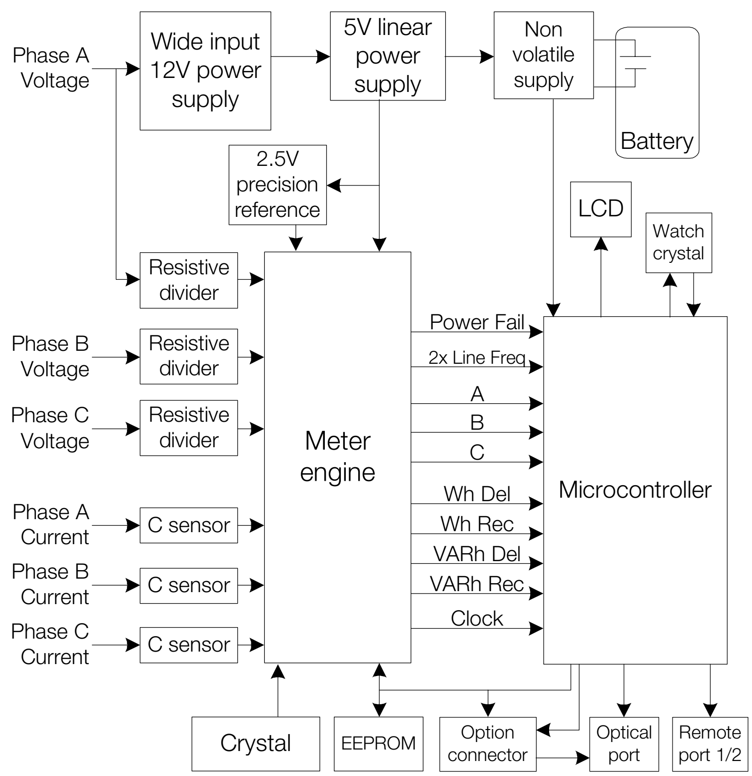


Figure 2-1. Circuit board block diagram

General Theory of Operation

Power Supply

Power is supplied to the A3 ALPHA meter using a wide voltage range power supply that accepts voltages from 96 to 528V AC. 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.

Current and Voltage Sensing

Power line currents and voltages are sensed using specialized current sensors and resistive dividers, respectively. Multiplication and other calculations are performed using a custom integrated circuit (called the *meter engine*).

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

The meter 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 samples the scaled inputs provided by the resistive dividers to provide accurate voltage measurements.

Meter Engine

Multiplication and other calculations are performed using a custom integrated circuit, called the *meter engine*. The meter engine contains the digital signal processor (DSP) with built–in analog–to–digital (A/D) converters capable of sampling each current and voltage input. The A/D converters measure the voltage and current inputs for a given phase. The DSP multiplies the signals appropriately, using the factory–programmed calibration constants.

Microcontroller

The microcontroller performs many different functions, for example:

- communicates with the DSP and EEPROM
- provides for serial communication over the optical port
- provides for serial communication over the remote ports
- sends output pulses over the optical port
- controls the display (LCD)
- controls any option boards

The microcontroller and the meter engine communicate with each other constantly to process voltage and current inputs. When the microcontroller detects a power failure, it initiates the shutdown and stores billing and status information in EEPROM.

EEPROM

The A3 ALPHA uses electrically erasable programmable read only memory (EEPROM) for nonvolatile storage of manufacturing data, meter configuration data, and energy measurement values. During a power failure, the EEPROM provides storage of all the information needed to ensure the integrity of the demand or TOU calculations, including the following:

- configuration data
- billing data

- all TOU data
- log and profiling data
- meter status
- constants
- energy usage
- maximum demand
- cumulative demand

Billing Data

Metered Energy and Demand Quantities

All A3 ALPHA meters are capable of measuring delivered and received kWh and kW demand. The A3R and A3K meters can also measure reactive and apparent energy and demand, respectively. The meter engine samples the voltage and current inputs and sends these measurements to the microcontroller. In the meter engine, each pulse is equal to one K_e defined as one of the following:

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

Table 2-1 shows the available metered quantities for each meter type. Basic metered quantities can be selected as a source for relay or optical pulse outputs. The remaining metered quantities are calculated from 2 or more basic metered quantities.

Table 2-1. Metered quantities by meter type

Metered quantity	A3D, A3T	A3K	A3R
kWh delivered	✓[1]	✓[1]	✓[1]
kWh received	✓[1]	✓[1]	✓[1]
kWh sum	✓[1]	✓[1]	✓[1]
kWh net	✓	✓	✓
kVAh delivered		✓[1]	✓
kVAh received		✓[1]	✓
kVAh sum		✓[1]	✓
kVAh net		✓	
kVAh Q1			✓
kVAh Q2			✓
kVAh Q3			✓
kVAh Q4			✓
kVARh delivered			✓[1]

Table 2-1. Metered quantities by meter type

Metered quantity	A3D, A3T	A3K	A3R
kVARh received			✓[1]
kVARh sum			✓[1]
kVARh net			✓
kVARh Q1			✓[1]
kVARh Q2			✓[1]
kVARh Q3			✓[1]
kVARh Q4			✓[1]
kVARh (Q1 + Q4)		✓	✓[1]
kVARh (Q2 + Q3)		✓	✓[1]
kVARh (Q1 - Q4)			✓
kVARh (Q2 - Q3)			✓
kVARh (Q3 - Q2)			✓

1. Basic metered quantity

Average Power Factor

The A3K and A3R meters can calculate the average power factor. Average power factor (AvgPF) is calculated by the meter using the following values since the last demand reset:

- kWh
- kVARh or kVAh

The AvgPF uses one of the following equations:

Method 1	Method 2
$\text{AvgPF} = \frac{\text{kWh}}{\text{kVAh}}$	$\text{AvgPF} = \frac{\text{kWh}}{\sqrt{\text{kVARh}^2 + \text{kWh}^2}}$

Average power factor is calculated every second. The values used in this calculation will be set to zero at a demand reset, and the AvgPF will be set to 1.000.

Demand Calculations

Demand is the average value of power over a specified interval of time. The A3 ALPHA meter supports three different methods for demand calculation:

- rolling interval
- block interval
- thermal time constant

An interval is the time in which demand is calculated. The length of a demand interval is programmable using Elster Electricity meter support software, but the value must be evenly divisible into an hour. Common demand interval lengths are 15 or 30 minutes.

Rolling Interval

Rolling demand is defined by two parameters: the demand interval length and the subinterval length.

- The demand interval length is specified in minutes and may be any value that is evenly divisible into 60.
- The demand subinterval length is also specified in minutes and may be any value that is evenly divisible into the interval length.

Both of these values are configurable by Elster Electricity meter support software. The demand is calculated at the end of each subinterval, resulting in overlapping demand intervals (or a “rolling” demand).

For example, the A3 ALPHA meter can be configured for a 15–minute demand interval length and a 5–minute subinterval length. In this case, the demand is calculated every 5 minutes based on the 3 previous subintervals (see Figure 2-2).

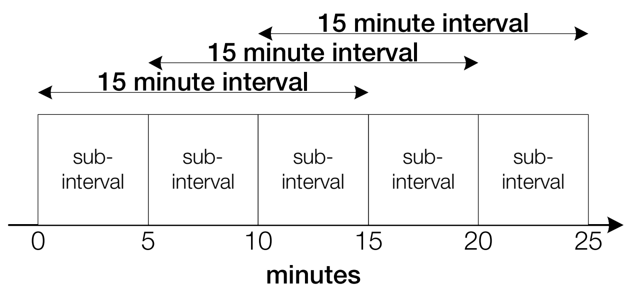


Figure 2-2. Rolling demand intervals

The block interval calculates demand by using the following equation:

$$D = \frac{\text{total accumulated energy}}{t_{hours}}$$

For example, if the demand interval is 15 minutes and the total accumulated energy is 50kWh, then the demand is 200kW.

$$D = \frac{50\text{kWh}}{.25\text{h}} = 200\text{kW}$$

Block Interval

Block interval demand is a special case of rolling interval demand in which the subinterval is the same size as the interval (see Figure 2-3).

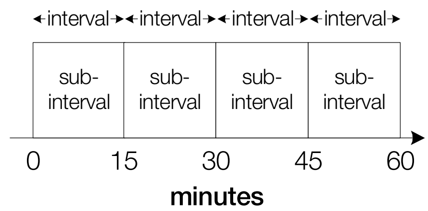


Figure 2-3. Block demand intervals

Thermal Time Constant

The A3 ALPHA meter can perform thermal demand emulation. The meter calculates demand based on a logarithmic scale that accurately emulates thermal demand meters. The thermal demand time constants vary depending upon the operational mode of the meter.

- Normal mode time constant is 15 minutes.
- Test mode time constant is 1 minute.

See “Operating Modes” on page 3-11 for more information.

Maximum Demand

Maximum demand (also referred to as *indicating demand*) is the highest demand value that occurs in a billing period. The demand for each demand 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 is stored as the maximum demand (see Figure 2-4). When a demand reset occurs, the maximum demand is reset to zero. The demand for the first full interval after a demand reset becomes the maximum demand.

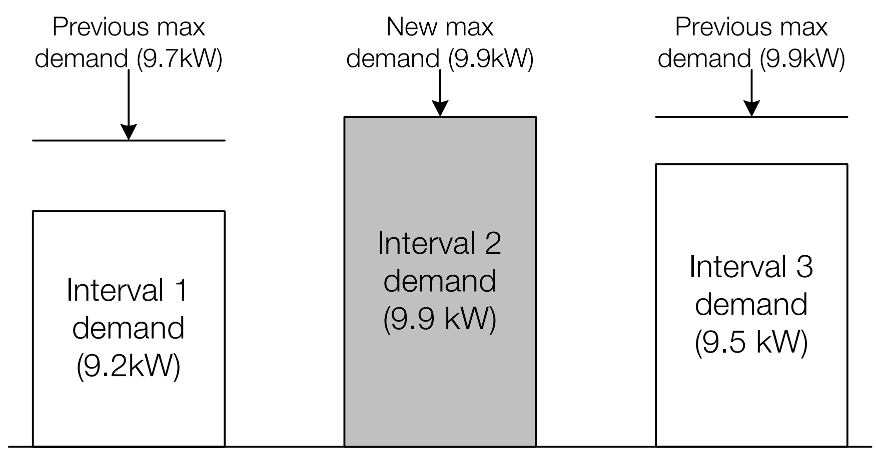


Figure 2-4. Indicating maximum demand

In addition to maximum demand, the A3 ALPHA meter also stores either the cumulative or continuous cumulative demand. A3K and A3R meters can be programmed to trigger the recording of a coincident demand or power factor.

Cumulative Maximum Demand

Using cumulative maximum demand, a demand reset adds the current maximum demand value to the cumulative maximum demand. Since the cumulative demand is not reset to zero, unauthorized demand resets do not cause a loss of the maximum demand data.

To determine the maximum demand for a billing period after a demand reset, subtract the previous cumulative demand from the current cumulative demand.

Continuous Cumulative Maximum Demand

Continuous cumulative maximum demand works similarly to cumulative maximum demand. Continuous cumulative demand, however, is always equal to the sum of the previous billing period continuous cumulative demand and the current maximum demand.

Coincident Demand or Power Factor

Coincident demand refers to a demand value that occurs at the same time as another demand reaches its peak value. For example, an electric utility may want to record the kVAR demand at the time of a maximum kW demand. This requires that kVAR demand be stored and reported during the same interval as the maximum kW demand.

Similarly, coincident power factor refers to a power factor that occurs at the same time as a demand value reaches its peak value. For example, an electric utility may want to record the average power factor at the time of a maximum kVAR demand. This requires the average power factor be stored and reported during the same interval as the maximum kVAR demand.

Coincident values are only available on reactive meter types (A3R and A3K). The number of coincident values that may be captured by the A3 ALPHA meter depends on whether or not the advanced four–quadrant metering option is present.

Table 2-2. Meter type and number of coincident values

Meter type	Total number of coincident demand or power factor values
A3D	None
A3T	None
A3K, A3R	2
A3KA, A3RA	4

Demand Forgiveness

Demand forgiveness is the time during which demand is not calculated or stored after a power outage. Demand forgiveness has two programmable settings:

- the number of minutes a power outage must last to qualify for demand forgiveness (zero to 15 minutes)
- the number of minutes that demand is not calculated or stored (zero to 255 minutes) following a qualified power outage

NOTICE

If demand forgiveness is programmed on an A3D meter, *any* power outage will result in the forgiveness time being applied.

Primary and Secondary Metering

The A3 ALPHA meter can be programmed for either primary or secondary metering. With both primary and secondary metering, Elster Electricity meter support software can be used to program the meter with a preferred external multiplier. The metered quantities must be manually multiplied by this external multiplier to calculate the actual energy and demand values.

Primary Metering

When configured for primary metering, the A3 ALPHA meter internally converts the measured energy and demand quantities to primary units using the voltage transformer ratio and the current transformer ratio. These ratios are programmed using Elster Electricity meter support software. The metered quantities reflect energy and demand on the primary side of the instrument transformers.

Secondary Metering

When configured for secondary metering, the A3 ALPHA meter does not use the voltage transformer ratio or the current transformer ratio to adjust the metered quantities. The metered quantities reflect the energy and demand on the secondary side of the instrument transformers even if the voltage and current ratios are programmed into the meter.

TOU Data

All A3 ALPHA meters store the total (single–rate) data for energy and demand. TOU meters can store the total data and the data for up to 4 rates. TOU rates can be based on any combination of day, time, or season. All selected metered quantities are stored according to the TOU rate. The meter stores the energy, demand, and average power factor for each rate.

Power Fail Data

The A3 ALPHA meter monitors and records the total power failure data. The following information is recorded:

- cumulative number of power failures (demand only and TOU meters)
- cumulative number of minutes of all power failures (TOU meters)
- start date and time of the most recent power failure (TOU meters)
- end date and time of the most recent power failure (TOU meters)

These values can be programmed to display on the LCD. See Appendix B, “Display Table,” for more information about displayable items.

Logs and Data Sets

The A3 ALPHA meter records the following logs and data sets in dynamically–allocated, shared memory:

- event log
- history log
- self reads
- load profiling
- instrumentation profiling
- PQM log
- voltage sag log

All of the logs and data sets share the meter’s memory. The sizes of each may vary to allow more room for a different log or data set. For example, self reads can store less data so that the load profiling can store more data.

Event Log

All A3 ALPHA meters have an event log. Demand only meters store a sequential listing of events. TOU meters store the date and time that events occur. Elster Electricity meter support software is used to define and program the number of event log entries that the meter will record. Events that can be included in the event log are as follows:

- power fail start and stop (2 event log entries)
- date and time change information (2 event log entries)
- date and time of demand resets (1 event log entry)
- date and time of event log reset (1 event log entry)
- date and time of test mode activity (2 event log entries)
- start and stop time when the current TOU rate is overridden by the alternate TOU rate schedule (2 event log entries)

After the maximum number of entries has been stored, the meter will begin overwriting the oldest entries. The event log can be disabled through Elster Electricity meter support software.

History Log

All A3 ALPHA meters have a history log that stores table information and procedure ID for configuration–altering writes to the meter. Demand only meters store a sequential listing of records. TOU meters also record the date and time. The meter records this information as an audit trail, maintaining a history of programming changes made to the meter.

After the maximum number of entries has been stored, the meter will begin overwriting the oldest entries. The history log can be disabled through Elster Electricity meter support software.

Self Reads

All A3 ALPHA meters can support self reads. A self read captures the current billing data and stores it in memory. This data can be retrieved later for analysis or billing. If the meter has recorded the maximum number of self reads, the next self read will overwrite the oldest copy.

Self reads are events that can be triggered by any of the following:

- scheduled calendar events
- every demand reset

Self reads are different from previous billing data copies. The previous billing data copy stores only one copy of billing data at a time and only when a demand reset occurs. See “Demand Reset Data Area” on page 3-15 for more information.

Load Profiling

For meters with load profiling capabilities (designated with an -L suffix), the A3 ALPHA meter is capable of recording up to 8 channels of information, depending on the meter type (see Table 2-3).

- A3TL meters can record two quantities.
- A3KL and A3RL meters can record eight channels of information.

Table 2-3. Quantities available for load profiling

Quantity	A3TL	A3KL	A3RL
kWh delivered	✓	✓	✓
kWh received	✓	✓	✓
kWh sum	✓	✓	✓
kWh net	✓	✓	✓
kVAh delivered		✓	✓
kVAh received		✓	✓
kVAh sum		✓	✓
kVAh net			
kVAh Q1			✓
kVAh Q2			✓
kVAh Q3			✓
kVAh Q4			✓
kVARh delivered			✓
kVARh received			✓
kVARh sum			✓
kVARh net			✓
kVARh Q1			✓
kVARh Q2			✓
kVARh Q3			✓
kVARh Q4			✓
kVARh (Q1 + Q4)		✓	✓
kVARh (Q2 + Q3)		✓	✓
kVARh (Q1 - Q4)			✓
kVARh (Q2 - Q3)			✓
kVARh (Q3 - Q2)			✓

Load profiling has its own, separate interval length that is configured independently from the demand interval length. The length of the load profiling interval must adhere to the following rules:

- the length must be between 1 and 60 minutes
- the time must be evenly divisible into an hour

Instrumentation Profiling

In meters with instrumentation profiling (designated with an -N suffix), the meter has two sets of instrumentation profiling. Each set can record up to 16 channels from the following:

- frequency
- per phase current
- per phase voltage
- per phase watts
- per phase VA
- per phase voltage angle with respect to phase A voltage
- per phase fundamental (1st harmonic) current magnitude
- per phase fundamental (1st harmonic) voltage magnitude
- per phase 2nd harmonic current magnitude
- per phase 2nd harmonic voltage magnitude
- per phase voltage % THD
- per phase current % THD
- per phase harmonic current (sum of 2nd through 15th)
- system watts
- system VA (arithmetic)
- per phase PF
- system PF (arithmetic)
- per phase PF angle
- system PF angle (arithmetic)
- per phase current angle with respect to phase A voltage
- per phase VARs (vectorial)
- system VARs (vectorial)
- system VA (vectorial)
- system VAR (arithmetic)

- system PF (vectorial)
- system PF angle (vectorial)
- per phase 2nd harmonic voltage %
- per phase TDD

Each channel can be configured to record the instrumentation profiling in any one of four ways (see Table 2-4):

Table 2-4. Instrumentation profiling recording options

Option	Description
Minimum	The meter samples the selected quantity over the instrumentation interval. The minimum value of all the samples is recorded.
Maximum	The meter samples the selected quantity over the instrumentation interval. The maximum value of all the samples is recorded.
Average	The meter samples the selected quantity over the instrumentation interval. The average value of all the samples is recorded.
End	The meter samples the selected quantity over the instrumentation interval. The last value of all the samples is recorded.

Each set of instrumentation profiling has its own, separate interval length that is configured independently from the demand interval length. The length of the instrumentation profiling interval must adhere to the following rules:

- the length must be between 1 and 60 minutes
- the time must be evenly divisible into an hour

PQM Log

In meters with power quality monitoring capabilities (designated with a -Q suffix), the A3 ALPHA meter has a PQM log that records PQM test failures. Elster Electricity meter support software is used to define and program the number of PQM log entries that the meter will record. Elster Electricity meter support software is also used to define which tests can record failures in the PQM log.

TOU meters can record the following data associated with the PQM test:

- the date and time when the PQM first detects a failure and the identifier of the PQM (1 PQM log entry)
- the date and time when the PQM no longer detects a failure and the identifier of the PQM (1 PQM log entry)

Demand only meters do not record the time. Instead, the log provides a sequential list of PQM log entries.

For each PQM entry, the meter also records an instrumentation measurement related to the PQM test.

When the maximum number of entries has been stored, the meter will begin overwriting the oldest entries.

See “PQM” on page 4-18 for more information.

Voltage Sag Log

In meters with power quality monitoring capabilities (designated with a -Q suffix), the A3 ALPHA meter has a voltage sag log. For TOU meters, the voltage sag log records the date, time, and phases of any detected voltage sags. Demand only meters provide a sequential list of voltage sag log events. The log records a maximum of 1 entry per second.

When the maximum number of entries has been stored, the meter will begin overwriting the oldest entries.

See “Voltage Sags” on page 4-19 for more information.

User Defined Tables

User defined tables (called *AMR Datalink* in ALPHA Plus meters) offer specific data retrieval options for A3 ALPHA meters. User defined table configuration may be requested at the time of purchase, and the specific configuration may be programmed at the factory. An AMR system can then be configured to retrieve the user defined table information from the meter instead of individual table reads. This reduces the total communications time.

The user defined table features are defined by the ANSI C12.19 standards.

Physical Description

The physical components of the A3 ALPHA meter consist of the following:

- cover assembly
- electronic assembly
- base assembly

See Figure 2-5 for an illustration of the A3 ALPHA meter physical components.

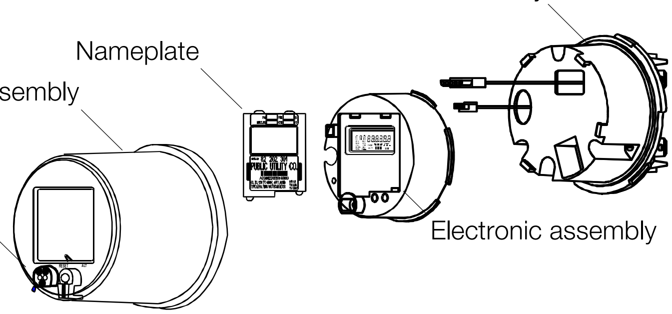


Figure 2-5. Exploded view of the A3 ALPHA meter

Cover Assembly

The cover assembly of the A3 ALPHA 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.

The components on the cover provide the basic user interface to the meter, such as the optical port and the **RESET**/**ALT** button mechanism. Removing the cover reveals the electronic assembly and **TEST** button.

Electronic Assembly

The electronic assembly houses the following components:

- LCD
- optical port
- **RESET** push button
- **ALT** push button
- magnetic **ALT** button
- **TEST** push button

- nameplate
- A3 ALPHA main circuit board (contains meter and integral register electronics with power supply)

The assembly can also accommodate the following optional electronic components:

- extended memory option board
- internal modem option board
- RS232 communications option board
- RS485 communications option board
- 20mA current loop option board
- external serial communications option board
- relay option board

See “General Theory of Operation” on page 2-2 for an explanation of the general operation of the A3 ALPHA meter.

Optical Port

To use Elster Electricity meter support software to read or program the A3 ALPHA 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 A3 ALPHA meter and provides the required interface for communications. For information on ordering the optical probe, contact your local Elster Electricity representative.

Base Assembly

The base assembly contains the following components:

- base housing
- battery well for internal modem with outage reporting capabilities
- current and voltage blades
- current sensing transformers
- 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 2-5 shows the available ANSI compatible configurations for a socket–connected (S–base) or bottom–connected (A–base) A3 ALPHA meter according to the type of service being metered.

Table 2-5. A3 ALPHA meter available wiring forms

Meter style	Form	Test Amps	Class	Elements	K_h	Type of service
ZAA30xxxxxx	1S	30	200	1	7.2	2–wire single phase
ZAA40xxxxxx	1S	50	320	1	12	2–wire single phase
ZAC30xxxxxx	2S	30	200	1	7.2	3–wire single phase
ZAC40xxxxxx	2S	50	320	1	12	3–wire single phase
ZAA20xxxxxx	3S	2.5	20	1	0.6	2– or 3–wire single phase
ZAC20xxxxxx	4S	2.5	20	1	0.6	3–wire single phase
ZA220xxxxxx	35S[1]	2.5	20	2	1.2	3– or 4–wire delta, 4–wire wye, network
ZA2B0xxxxxx	35A[1]	2.5	20	2	1.2	3– or 4–wire delta, 4–wire wye, network
ZA530xxxxxx	12S	30	200	2	14.4	3–wire delta, network
ZA540xxxxxx	12S	50	320	2	24	3–wire delta, network
ZA2C0xxxxxx	13A	30	100	2	14.4	3–wire delta, network
ZA820xxxxxx	36S[2]	2.5	20	2½	1.8	4–wire wye
ZA8B0xxxxxx	36A[2]	2.5	20	2½	1.8	4–wire wye
ZA320xxxxxx	9S[3]	2.5	20	3	1.8	4–wire wye or delta
ZA420xxxxxx	10S[4]	2.5	20	3	1.8	4–wire wye or delta
ZA4B0xxxxxx	10A[3]	2.5	20	3	1.8	4–wire wye or delta
ZA330xxxxxx	16S[5]	30	200	3	21.6	4–wire wye or delta
ZA340xxxxxx	16S[5]	50	320	3	36	4–wire wye or delta
ZA3C0xxxxx	16A	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, the form cannot be used with phase shifting transformers or to totalize 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 Form 14S and 15S, while Form 16A replaces Form 14A and 15A circuit applications.

Physical Dimensions

The A3 ALPHA meter fits all standard S–base services. Meters with an A–base are also available. See Figure 2-6 for an illustration of the S–base meter type and dimensions. See Figure 2-7 and Figure 2-8 for illustrations of the A–base meter type and dimensions.

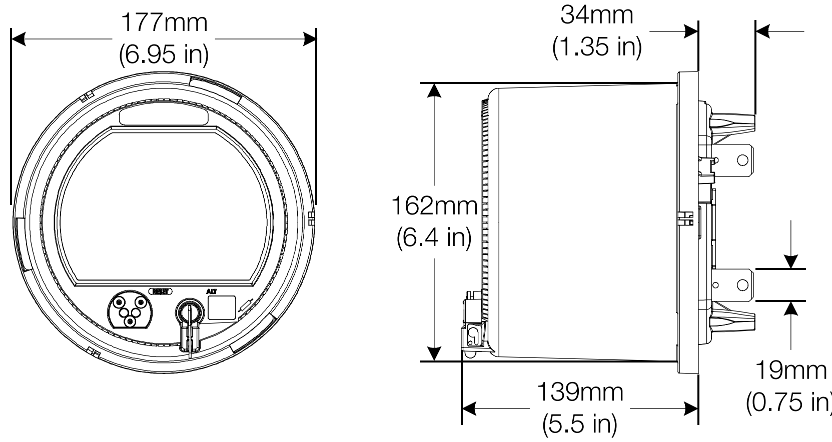


Figure 2-6. S–base meter type and dimensions, front and side view

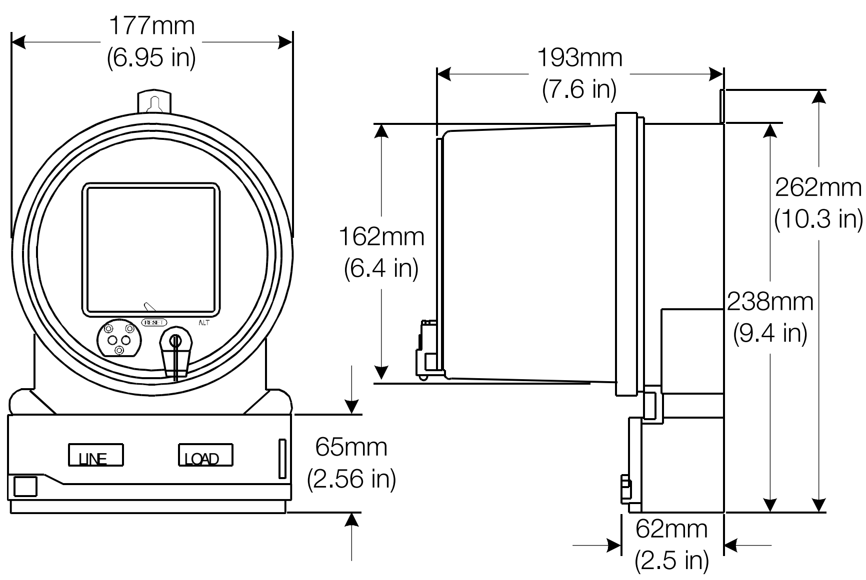


Figure 2-7. A–base meter type and dimensions, front and side view

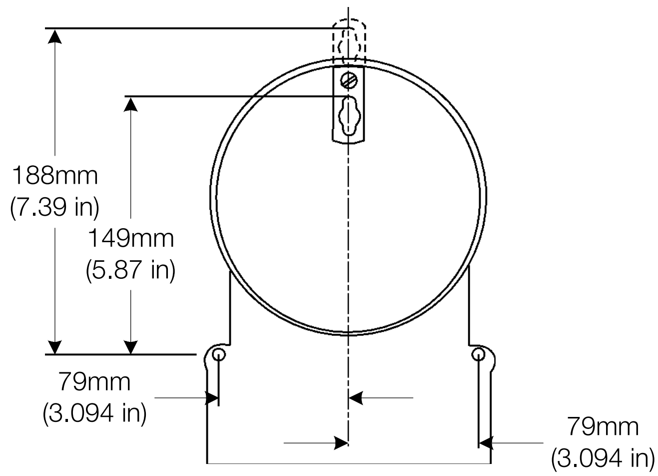


Figure 2-8. A–base meter type and dimensions, back view

3. Operating Instructions

Indicators and Controls

LCD

The liquid crystal display (LCD) is used to display meter data and status information. As shown in Figure 3-1, the LCD can be divided into different display regions.

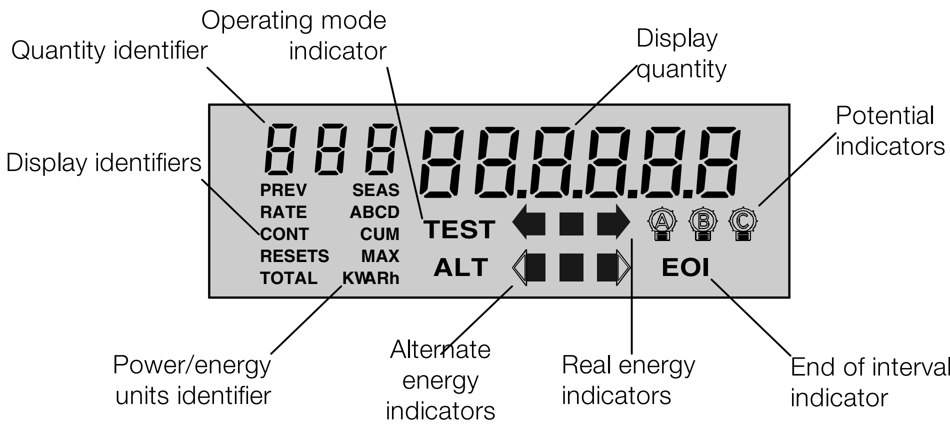


Figure 3-1. Liquid crystal display

Quantity Identifier

This 3–digit region identifies the displayed quantity as defined and programmed with Elster Electricity meter support software. An identifier can be assigned to most display quantities in the display sequence. See Appendix B, “Display Table,” for more information.

Display Quantity

This 6–digit display on the LCD shows either metered quantities or other displayable information, depending upon how the A3 ALPHA meter has been programmed.

The displayable digits are definable through Elster Electricity 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 error codes for the following error conditions:

- operational errors (**Erl**, **Er2**, or **Er3**)
- system instrumentation and service test errors (**SEr**)
- warnings (**Fl** or **F2**)
- communication codes (**C**)

For instrumentation values and tests, numeric values may be replaced by or mixed with alphabetic characters to better define the value. See Appendix B, “Display Table,” for more information.

Potential Indicators

Each potential indicator corresponds to a phase voltage present on the A3 ALPHA meter connections. If the potential indicators are on, then all phase voltages are present. If an indicator is blinking, then that phase voltage is either missing or below the defined threshold for voltage sag detection. See “Voltage Sags” on page 4-19 for more details on momentary voltage sag detection and the potential indicators. Although phase A voltage must be present for the meter to function, the meter may still operate even if the phase A voltage is below the threshold. In this case, the phase A potential indicator will blink.

EOI Indicator

The end–of–interval (EOI) indicator is used to verify the timing of the demand interval. Ten seconds before the end of the demand interval, the EOI indicator will be turned on and remain on until the end of the interval.

NOTICE

For rolling demand, the EOI indicator turns on for 10 seconds before the end of each subinterval.

Real Energy Indicators

The real energy indicators blink at a rate proportional to kWh consumption. The center square indicator will blink to indicate pulses of K_h. Each square indicator pulse (turns on and off) indicates 1 K_h. A single transition (on–to–off or off–to–on) indicates ½ K_h. The left and right arrows blink at a faster rate representing K_e. Each arrow pulse (turns on and off) indicates 1/12 K_h energy measurement. This means that 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 on whether an A3K or A3R is used, as shown in Table 3-1.

Table 3-1. Alternate energy indicator arrows

Meter type	Left arrow source	Right arrow source
A3K	kVAh received	kVAh delivered
A3R	kVARh received	kVARh delivered

Power/Energy Units Identifier

The power/energy units identifier is used to indicate the unit of measurement for the quantity displayed on the meter's LCD. The power/energy units identifier can display the following:

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

Figure 3-2 shows examples of how the power/energy unit identifier segments are combined to display any of the valid quantities. In some cases, it may not be possible to represent the displayed quantity using the power/energy units identifier. If this is the case, then the power/energy units identifier will not be used. Instead, the quantity must be identified using the quantity identifier.

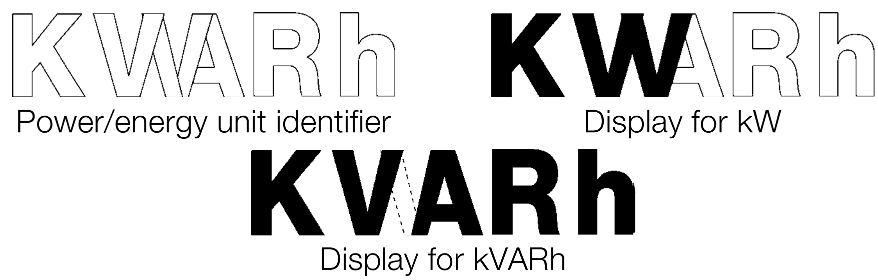


Figure 3-2. Power/energy units identifier

Operating Mode Indicator

This indicator shows the current operating mode of the A3 ALPHA meter. Table 3-2 shows which operating modes correspond with the operating mode indicator on the LCD. See "Operating Mode Indicator" on page 3-4 for more information on the different operating modes.

Table 3-2. LCD operating mode indicator

Indicator	Operating mode
None	Normal mode
TEST	Test mode
ALT	Alternate mode

Display Identifiers

Display identifiers are used to more precisely identify the information presented on the meter's LCD. Using Elster Electricity meter support software, the display identifiers can be disabled. See Table 3-3 for a description of the display identifiers.

Table 3-3. Display identifiers

Identifier	Description	Used with
RATE	TOU rate data is being shown on the LCD	ABCD
ABCD	The rate for presently displayed data; blinking letter indicates present TOU rate	RATE
CONT	Continuous cumulative demand value	CUM
CUM	Cumulative demand value	Power/energy units identifier
MAX	Maximum demand value	Power/energy units identifier
PREV	Previous billing period, or when used with SEAS identifier, previous season	SEAS
RESETS	Number of demand resets; visible when reset is performed by button–press	
SEAS	Season information	PREV
TOTAL	Total energy value	Power/energy units identifier

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

Using the Push Buttons

The following push buttons are located on the front of the A3 ALPHA 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 3-3 for the location of these push buttons.

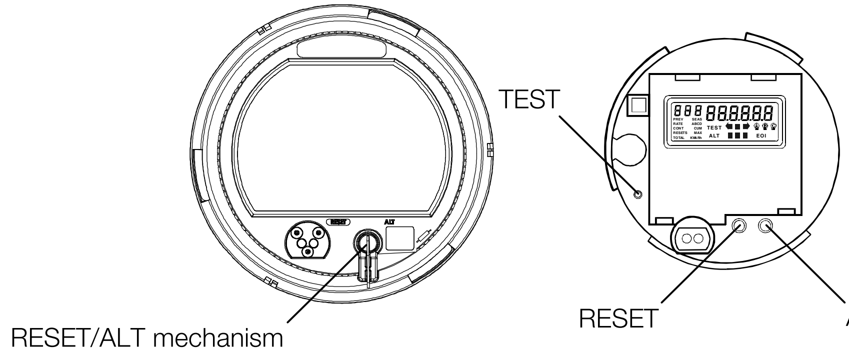


Figure 3-3. Location of push buttons and RESET/ALT mechanism

The magnetic **ALT** button may also be “pressed” by placing a magnet against the right side of the meter cover about 1" (2.54cm) back from the meter face at the 5 o’clock position. The magnetic **ALT** button can operate identically as the **ALT** push button, except it cannot be used to clear billing data (see “Clearing Billing Data” on page 3-9 for more information) .

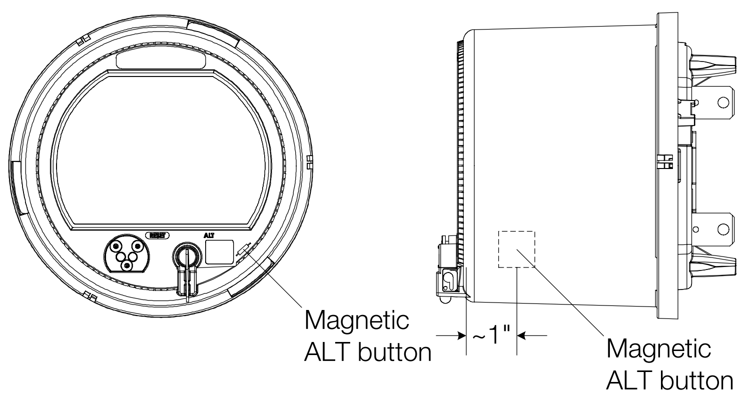


Figure 3-4. Location of magnetic ALT button

RESET Button

Pressing the **RESET** button performs a demand reset. See “Demand Reset” on page 3-14 for a description on what happens during a demand reset. The **RESET** button performs differently depending on the A3 ALPHA operating mode, as shown in Table 3-4.

Table 3-4. RESET button function in different operating modes

Mode	Description
Normal	Performs a demand reset.
Alternate	Exits the alternate mode, returns to normal mode, and performs a demand reset.

Table 3-4. RESET button function in different operating modes

Mode	Description
Test	Resets all test values (kWh, kW, total pulses, test mode timeout) and restarts test mode for 3 more demand intervals without affecting any billing data.
Error	No effect, unless in alternate mode. In this case, the alternate display sequence will be terminated and the error code restored on the LCD.

NOTICE

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

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 A3 ALPHA meter. See "System Service Locking" on page 4-7 for more details.

ALT Button

Pressing the **ALT** button normally initiates the alternate mode. See "Operating Modes" on page 3-11 for more information about the A3 ALPHA operating modes. The **ALT** button performs differently depending on the operating mode, as shown in Table 3-5.

Table 3-5. ALT button function in different operating modes

Mode	Press method	Description
Normal	Less than 1 second	Initiates alternate mode, scrolls through the alternate display list once, and returns to normal mode.
Alternate	Continuous	Scrolls quickly (approximately ½ second per display quantity) through the alternate mode display sequence while pressed, locks LCD on display quantity when released.
Alternate	Press and release	If the LCD is locked on a display quantity, each press steps to the next quantity in the alternate mode display list.
Test	Continuous	Scrolls quickly (approximately ½ second per display quantity) through the test mode display sequence while pressed, locks LCD on display quantity when released.
Test	Press and release	If the LCD is locked on a display quantity, each press steps to the next quantity in the test mode display list.

Table 3-5. ALT button function in different operating modes

Mode	Press method	Description
Error	Less than 1 second	Scrolls through the normal display sequence one time and then the alternate display sequence one time; returns to error locked on display.
Error	Continuous	Scrolls quickly (approximately ½ second per display quantity) through the normal mode and then scrolls through the alternate mode while pressed.
Error	Press and release	If the LCD is locked on a display quantity, each press steps to the next quantity in the display list (first through the normal display list and then the alternate display list).

RESET/ALT Mechanism

The **RESET/ALT** mechanism located on the front 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 counterclockwise to select the desired function as listed below:

- clockwise selects the alternate mode function. Pressing the mechanism actually presses 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. Pressing the mechanism actually presses the **RESET** button.

TEST Button

Pressing the **TEST** button normally initiates the test mode. See "Test Mode" on page 3-12 for more information about it. The **TEST** button performs differently depending on the operating mode, as shown in Table 3-6.

Table 3-6. TEST button function in different operating modes

Mode	Press Method	Description
Normal	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	Continuous	Initiates test mode, displays test quantities while button is pressed, and returns to normal mode when button is released.
Alternate	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.

Table 3-6. TEST button function in different operating modes

Mode	Press Method	Description
Alternate	Continuous	Initiates test mode, displays test quantities while button is pressed, and returns to normal mode when button is released.
Test	Press	If test mode was entered by pressing and releasing for between 1 and 6 seconds, a subsequent press will exit the test mode.
Test	Release	If test mode was entered by continuously pressing, releasing will exit the test mode immediately.

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 it again and rotating it clockwise will release the button.

NOTICE

When the **TEST** button is continually pressed, the 3 demand interval timeout does not apply. The A3 ALPHA meter will also remain in the test mode following a power failure and restoration as long as the **TEST** button is continually pressed.

Clearing Billing Data

NOTICE

Make sure you press all three buttons simultaneously to avoid switching to a different mode instead of clearing the billing data. For example, if you press the **TEST** button before **RESET** and **ALT**, the meter will switch to test mode instead of clearing the billing data. If this happens, return the meter to normal mode first, then attempt the procedure again.

A3 ALPHA meters permit the clearing of billing data by using the push buttons. The billing data can be cleared by this procedure:

1. Set the meter to normal mode.
2. Simultaneously press and hold the **TEST**, **RESET**, and **ALT** buttons for about 1 second. The LCD displays Clr CldAtA (see Figure 3-5).

3. Release the buttons. If performed properly, the meter restarts the normal display cycle.

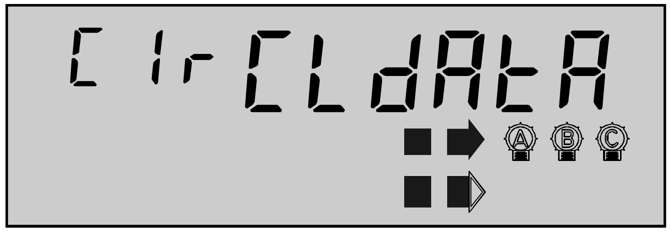


Figure 3-5. Billing data cleared

Operating Modes

The A3 ALPHA meter operates in one of the following modes:

- normal mode
- alternate mode
- test mode

As part of its function, the meter performs self tests to make sure it is operating normally. The self test ensures that the A3 ALPHA meter is functioning properly and that its displayed quantities are accurate. If the self test indicates an error, an error code will "lock" the display. The meter attempts to function normally, however, the meter data may be suspect. See "Meter Self Test" on page 6-2 for more information on self tests and errors.

Normal Mode

Normal mode is the default operation mode for the A3 ALPHA meter. It is generally used to display billing data. The meter is fully operational in this mode, and it will process and store data while the LCD scrolls through the normal display list quantities. While in normal mode, the optical port transmits test pulses proportional to metered energy. The default pulse is Wh, and there is one pulse for each K_h transition. See "Optical Pulse Outputs" on page 5-6 for more information.

NOTICE

The LCD test will always appear immediately after power is connected to the A3 ALPHA meter or after a power restoration from an outage.

Typically, the normal mode display cycle begins with an LCD test which turns on all of the display segments. This is recommended because it provides a quick way to determine if the LCD is functioning properly. The LCD test can be disabled using Elster Electricity meter support software. The normal display cycle will scroll through all programmed display quantities before beginning the cycle again.

Alternate Mode

Alternate mode can be programmed with Elster Electricity 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 quantities. This mode is activated in one of the following ways:

- pressing the **ALT** button on the A3 ALPHA meter

- momentarily placing a magnet against the right side of the meter cover at the 5 o'clock position, about 1" back from the meter face
- after power up (for one sequence of the alternate display list)

The meter is fully operational while in alternate mode. While in alternate mode, the optical port transmits test pulses proportional to metered energy. The default pulse is Wh, and there is one pulse for each K_h transition.

NOTICE

If the LCD is remains on a pulse line cumulative counter, the meter will exit the alternate mode at midnight. For the A3D meter, which uses relative timekeeping, midnight may not be synchronous with a realtime clock.

There are several different ways to exit alternate mode:

Table 3-7. Exiting the alternate mode

Method	Description
Waiting for the end of the alternate display list	If the meter is scrolling through the alternate display list automatically, the meter exits alternate mode after the last item is displayed. Normal mode begins at the start of the display list.
Pressing the RESET button	Exits alternate mode and performs a demand reset.
Pressing the TEST button	Exits alternate mode and initiates test mode.
Waiting for the timeout	If the LCD is frozen on a quantity, the meter exits alternate mode after 2 minutes of inactivity and begins normal mode. However, if the frozen display quantity is a pulse line cumulative counter, the 2–minute timeout does not apply.

Test Mode

Test mode displays test readings without affecting the present energy usage and billing data values in the A3 ALPHA meter. Shorter demand intervals may be used in test mode to reduce demand test time and will not interfere with billing data. When normal mode is resumed, readings taken during test mode will be discarded and present energy usage and billing data values will be restored. While in test mode, the operating mode indicator will blink TEST on the LCD.

While in test mode, the optical port transmits test pulses proportional to metered energy. The default pulse is Wh, and there is one pulse for each K_h transition. See "Optical Pulse Outputs" on page 5-6.

The test mode may be initiated by one of three ways. There are different capabilities of the test mode depending on the method used to enter the test mode.

- optically initiated test mode (see "Optically–Initiated Test Mode" on page 3-13 for how the optical port works in test mode)
- button press initiated test mode (see Table 3-6 for how buttons work in the test mode)
- button lock initiated test mode (see Table 3-6 for how buttons work in the test mode)

Typically, the meter exits the test mode under any of the following conditions:

- three test mode demand intervals have expired and the test button is not locked
- the **TEST** button is pressed again
- the meter receives a valid exit from test mode command over the optical port
- a power fail occurs and the test button is not locked

The status of the meter (including billing data, profiling data, errors, and warnings) before the meter entered test mode is preserved. When the meter exits test mode, the status of the meter is restored to its previous state.

Optically–Initiated Test Mode

The meter can enter test mode when it receives a command issued by Elster Electricity meter support software over the optical port. The command can include parameters that select the pulse source and pulse speed:

- pulse source
  - kWh energy
  - alternate energy (kVAh for A3K meters, kVARh for A3R meters)
- pulse speed
  - slow pulses (pulses = K_h)
  - fast pulses (pulses = K_e)

Demand Reset

A demand reset can be performed one of three ways:

- pressing the **RESET** button
- issuing a command over the optical or remote ports
- as a scheduled calendar event

Regardless of how the demand was reset, the meter performs many different functions, including the following:

- the present billing data is copied to the demand reset data area
- the billing data's present maximum demand is added to the cumulative demand, and then the billing data's present maximum demand is reset to zero
- the billing data's dates and times of the maximum demands are reset to zero
- the billing data's present coincident values are reset to zero
- all demand calculations are reset to zero and a new demand interval is started
- previous interval demands are reset to zero
- present interval demands are reset to zero
- all average power factor calculations are restarted
- pulse line cumulative counters are cleared
- current conditions for certain errors or warnings are cleared

As a security feature, the meter records these values:

- the cumulative number of demand resets (rolls over to zero after 255)
- the cumulative number of manual demand resets (pressing the **RESET** button or issuing a command)
- date and time of last demand reset
- number of days since the last demand reset
- the method of the most recent demand reset (for example, button press, procedure, or calendar)
- if configured, the event log records every demand reset

Demand Reset Lockout

Through Elster Electricity meter support software, a demand reset lockout time can be defined. The demand reset lockout can remain in effect for up to 255 minutes after a demand reset (regardless of the method of demand reset). During the demand reset lockout, subsequent demand resets will be ignored by the meter. This prevents accidental, subsequent demand resets. If a power failure occurs during the demand reset lockout period, the lockout is released upon power restoration.

Demand Reset Data Area

In all demand reset occurrences, the meter copies the present billing data and stores it in the demand reset data area. This data is referred to as the *previous billing data* because its general purpose is to preserve the data as one billing period ends and the next billing period begins. The meter stores only one copy of the previous billing data. The next demand reset overwrites whatever is currently stored as the previous billing data.

Previous billing data is different from self reads, which can store multiple copies of the billing data. See “Self Reads” on page 2-11 for more information.

4. Meter Tools

System Instrumentation

System instrumentation is a collection of displayable items designed to assist in evaluating a service by providing real time analysis of the conditions present at the A3 ALPHA installation. Instrumentation quantities should not be confused with billing quantities because they are intended for an entirely different purpose.

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 respresent a combination of all present phases. This can result in discrepancies between similar billing and instrumentation data, and this is to be expected.

The instrumentation measurements are near instantaneous. Using Elster Electricity meter support software, instrumentation quantities may be placed in normal, alternate, or test 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.

NOTICE

If the LCD remains on an instrumentation quantity while in alternate or test mode, the displayed instrumentation quantity updates once per second. See “ALT Button” on page 3-7 for more information on locking the LCD on a desired quantity.

The 3–digit quantity identifier gives information about the quantity being displayed on the A3 ALPHA meter LCD, as indicated in Table 4-1.

Table 4-1. System instrumentation quantity identifiers

Quantity Identifier	Description
SYS	System measurements
PhA	Phase A measurements
Phb	Phase B measurements
PhC	Phase C measurements
ThA	Phase A total harmonic
Thb	Phase B total harmonic
ThC	Phase C total harmonic
IhA	Phase A 1st harmonic
Ihb	Phase B 1st harmonic
IhC	Phase C 1st harmonic
2hA	Phase A 2nd harmonic
2hb	Phase B 2nd harmonic

Table 4-1. System instrumentation quantity identifiers

Quantity Identifier	Description
2hC	Phase C 2nd harmonic
TdA	Phase A total demand distortion
Tdb	Phase B total demand distortion
TdC	Phase C total demand distortion

The display quantity will show a measurement and a unit of measure on the A3 ALPHA meter LCD. See Figure 4-1 and Figure 4-2 for examples showing system instrumentation quantities. See Appendix B, "Display Table," for information about displayable items.

Figure 4-1. Instrumentation phase A voltage

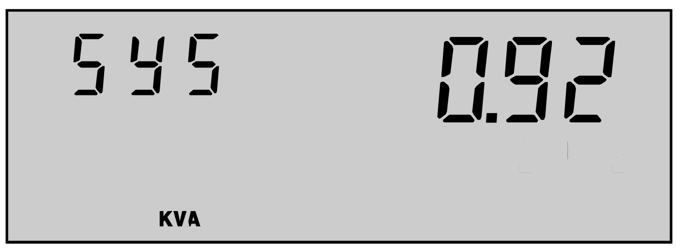


Figure 4-2. Instrumentation system kVA

Immediately before displaying a system instrumentation quantity, the meter begins to measure that quantity. If the result of the instrumentation measurement is not immediately available, dashes (-) will be shown in the display quantity until the measurement is complete. See Figure 4-3 and Figure 4-4 for examples of system instrumentation display quantities while the measurement is in progress and when a result is available.

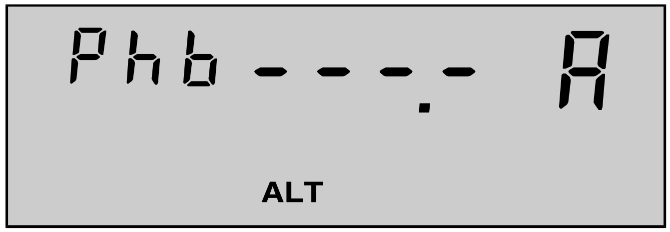


Figure 4-3. Instrumentation phase B current in progress

Figure 4-4. Instrumentation phase B current measured

If an A3 ALPHA meter is programmed to display a system measurement quantity for a phase that does not exist (phase B or C on a single element meter, for example), then that display quantity will automatically be skipped. This allows different meter types to be programmed with similar configurations using Elster Electricity meter support software.

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 4-2 for more information about how the instrumentation quantities are obtained:

Table 4-2. Description of system instrumentation quantities

Instrumentation quantity	Description
Frequency	Measured on phase A voltage.
System kW	The signed sum of the kW measurement on each phase taken only moments apart.
System kVA (arithmetic)	The signed sum of the kVA measurement on each phase taken only moments apart.
System kVAR (arithmetic)	Calculated using the following equation: $kVAR_{arith} = \sqrt{(\text{system kVA}_{arith})^2 - \text{system kW}^2}$

Table 4-2. Description of system instrumentation quantities

Instrumentation quantity	Description
System power factor (arithmetic)	System kW divided by system kVA (arithmetic)
System power factor angle (arithmetic)	The arccosine of system power factor (arithmetic)
Phase kW and kVA	Measured directly by meter engine.
Phase kVAR (vectorial)	Calculated using the following equation (where kVA and kW are measured simultaneously): $$\text{kVAR} = \sqrt{\text{kVA}^2 - \text{kW}^2}$$ The result is then signed based on the kVAR direction.
System kVAR (vectorial)	Sum of the per phase kVAR (vectorial)
System kVA (vectorial)	Calculated using the following equation: $$\text{kVA}_{\text{vect}} = \sqrt{\text{system kW}^2 + (\text{system kVAR}_{\text{vect}})^2}$$
System power factor (vectorial)	System kW divided by system kVA (vectorial)
System power factor angle (vectorial)	The arccosine of system power factor (vectorial)
Phase voltages and currents	True rms values measured by meter engine.
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. Phase power factor is set to 1.00 if phase current is less than the absolute minimum current (twice starting amps).
Phase power factor angle	The power factor angle is the arccosine of the phase power factor.
Phase 1st harmonic (fundamental) voltage magnitude	The per phase magnitude of the fundamental voltage.
Phase 1st harmonic (fundamental) current magnitude	The per phase magnitude of the fundamental current.
Phase 2nd harmonic voltage magnitude	The per phase magnitude of the 2nd harmonic voltage
Phase 2nd harmonic current magnitude	The per phase magnitude of the 2nd harmonic current
Phase 2nd harmonic voltage percentage	Per phase, the 2nd harmonic voltage magnitude divided by the fundamental voltage magnitude

Table 4-2. Description of system instrumentation quantities

Instrumentation quantity	Description
Phase total harmonic current magnitude	Per phase, the square root of the sum of the 2nd - 15th harmonic currents squared. In other words: $$THC = \sqrt{\sum_{i=2}^{i=15} HC_i^2}$$ where HC_i = *i*th harmonic current
Phase total harmonic distortion percentage (voltage or current)	Calculated by using: $$THD = \frac{\sqrt{rms^2 - fundamental^2}}{fundamental} \times 100$$ where: *rms* represents an unfiltered rms phase voltage or current *fundamental* represents the fundamental rms phase voltage or current
Per phase total demand distortion	Calculated by using: $$TDD = \frac{\sqrt{\sum_{i=2}^{15} HC_i^2}}{\text{Class amps}}$$ where HC_i represents the i^{th} harmonic current

Voltage, current, kW, kVAR, and kVA instrumentation quantities have an error of less than ±0.25%. Accuracy will diminish as the value of the quantity becomes smaller.

System Service Tests

System service tests can be performed to determine the validity of the electrical service that the A3 ALPHA meter is metering. The system service tests consist of a service voltage test and a service current test.

Service Voltage Test

Overview

The service voltage test is intended to assist in identifying the following:

- incorrectly wired or misapplied voltage transformers
- open or missing line fuses

The following are validated by this test:

- phase voltages
- phase voltage angles
- phase rotation

The meter measures each phase voltage and phase voltage angle and attempts to match the measurements to a stored list of valid services.

- If the service voltage test is successful, the validated service is shown on the meter's LCD and the meter will continue to the next display quantity in the sequence.
- If the test is not successful, a warning is set. Also, the LCD will indicate a service error by displaying SEr plus a code on the LCD. See "System Service Error Codes" on page 4-16 for more information 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 programmed into the meter with Elster Electricity meter support software

System Service Locking

Once a service voltage test has detected a valid service, it can be locked into the A3 ALPHA meter memory. A locked valid service is used as a basis for future system service tests and PQM tests. 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

The A3 ALPHA meter can lock a valid service in either of these ways:

- smart autolock
- manual lock

To indicate that a service voltage test is complete, the LCD displays the following (an example is shown in Figure 4-5):

- phase rotation (for example, AbC or CbA)
- voltage magnitude (for example, I20 or 240)
- service type showing the number of wires and the service type, for example:
    - IP is a single phase service
    - 3d is a 3–wire delta service
    - 4Y is a 4–wire wye service

Figure 4-5. Sample service voltage test result

An L is displayed between the voltage magnitude and service type to indicate that the service is locked (see Figure 4-6).

Figure 4-6. Sample display of locked service voltage

Smart Autolock

When smart autolock is enabled through Elster Electricity meter support software, the A3 ALPHA 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. The meter accepts the service that most closely matches one of the stored values in the A3 ALPHA meter.

The A3 ALPHA meter periodically checks the service. Under certain conditions, the smart autolocked service may lock on a different service. This is useful because the meter may have been moved to a new service. The service voltage test will be performed and the service may be changed in response to the following events:

- power up
- exit of test mode
- after a data–altering communication session

If a new, valid service is detected, the meter locks on the new service. If a valid service cannot be detected, the meter responds in the following manner:

- the meter remains locked on the last known valid service
- the LCD displays an error code

Manual Lock

When configured through Elster Electricity meter support software for manual lock, the A3 ALPHA 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 LCD; however, the **RESET** button must be pressed in order to lock the detected service.

When the service type has been detected, the phase rotation, voltage magnitude, and the service type will be displayed on the LCD. If the **RESET** button is not pressed to accept the service, the LCD will alternate between SYS –––––– and the detected service information until the service has been manually locked.

NOTICE

Once manually locked, the service never unlocks automatically. To move the A3 ALPHA meter to a new installation with a different type of service, the service must be unlocked using Elster Electricity meter support software. The new service type can then be detected and manually locked.

Initiating Service Voltage Tests

When enabled, the service voltage test is initiated at any of the following times:

- after power up, a data–altering communications session, or exiting test mode
- at midnight (for TOU meters) or every 24 hours (for demand–only meters)

Service voltage tests can also be initiated at any of these times, depending on meter configuration:

- as a display item
- as a PQM test (for meters with PQM capabilities)

The behavior of the service voltage test depends on these factors:

- the event that initiates the service voltage test
- the state of the service lock

After Power up, Data–altering Communications Session, or Exiting Test Mode

The following table explains meter behavior when the service voltage test is performed after any of the following:

- power is applied to the meter
- data–altering communications session
- exiting test mode

Smart autolock	**Manual lock** Current state is locked	**Manual lock** Current state is unlocked
1. The meter initiates the service voltage test. 2. The meter attempts to detect a valid service. • If a valid service is detected, the meter automatically locks on the detected service. The LCD displays the locked valid service. • If a valid service cannot be found, the meter displays SEr 555000. The meter restarts the service voltage test in diagnostic mode (see “Restarting the Service Voltage Test in Diagnostic Mode” on page 4-13). However, the meter remains locked on the last valid service until a new valid service is detected.	1. The meter initiates the service voltage test. 2. The phase indicator voltage threshold levels are based on the currently locked service. 3. The meter attempts to match the service. • If the service matches the presently locked service, then the LCD displays the locked valid service. • If the service does not match the presently locked service, then the LCD displays the service test error. The meter restarts the service voltage test in diagnostic mode (see “Restarting the Service Voltage Test in Diagnostic Mode” on page 4-13).	1. The meter initiates the service voltage test. 2. The phase indicator voltage thresholds are set at the default values. 3. The meter attempts to detect a valid service. • If a valid service is found, the LCD displays the data for the service it detected. • If a valid service is not found, the LCD displays SEr 555000. The meter restarts the service voltage test until a valid service is found. 4. While a valid service is displayed, the user can manually lock the service. • The user presses the **RESET** button to lock the service. The LCD displays the locked service. • If the user does not lock the service, the meter returns to the service test until a valid service is found and locked.

If the service voltage test is interrupted (for example, the **ALT** button is pressed or there is a communications session), the meter restarts the service voltage test after handling the interruption.

At Midnight or Every 24 Hours

If the service is locked, the meter checks the service at midnight (for TOU meters) or every 24 hours (for demand–only meters). The meter always does the following when the service voltage test is run at midnight:

Smart autolock	**Manual lock** Current state is locked
1. The meter initiates the service test. 2. The phase indicator voltage threshold levels are based on the currently locked service. 3. The meter attempts to match the service. • If the service matches the presently locked service, then the LCD displays the locked valid service. • If the service does not match the presently locked service, then the LCD displays SEr 555000. The meter restarts the service voltage test in diagnostic mode (see "Restarting the Service Voltage Test in Diagnostic Mode" on page 4-13). However, the lock remains on the last valid service until a new valid service is detected.	1. The meter initiates the service test. 2. The phase indicator voltage threshold levels are based on the currently locked service. 3. The meter attempts to match the service. • If the service matches the presently locked service, then the LCD displays the locked valid service. • If the service does not match the presently locked service, then the LCD displays a service test error. The meter restarts the service voltage test in diagnostic mode (see "Restarting the Service Voltage Test in Diagnostic Mode" on page 4-13). However, the lock remains on the last valid service until a new valid service is detected.

If the service test is interrupted (for example, the **ALT** button is pressed or there is a communications session), the meter restarts the service test after handling the interruption.

If the service has not been locked, the test is not performed and the LCD displays SEr 555000.

As a Display Item in a Display Sequence

Using Elster Electricity meter support software, the service voltage test can be programmed as a displayable quantity in any display sequence. The service test is initiated when the service test quantity is displayed on the LCD.

<table>
<tr><th>Smart autolock</th><th>Manual lock
Current state is locked</th><th>Service Locking Disabled</th></tr>
<tr><td>1. The meter initiates the service test.
2. The meter attempts to match the service.
• If the service detected matches the presently locked service, then the LCD displays the locked valid service.
• If the service does not match the presently locked service, then the LCD displays a service test error.
3. After the LCD displays the locked valid service or the service test error, the LCD continues to the next item in the display sequence.</td><td>The service test is performed as the autolock.</td><td>1. The meter initiates the service test.
• If a valid service is detected, the LCD displays the valid service.
• If a valid service cannot be found, the meter displays SEr 555000.
2. After the LCD displays the valid service or the service test error, the LCD continues to the next item in the display sequence.</td></tr>
</table>

As a PQM Test

When the service voltage test is programmed as a PQM test, the service test is performed only if the service is locked. PQM tests are available only on meters with PQM capabilities. See "Service Voltage Test" on page 4-21 for more information.

Restarting the Service Voltage Test in Diagnostic Mode

Depending on how the service voltage test was started, the test restarts in diagnostic mode if the test fails. The A3 ALPHA meter uses the diagnostic mode if the service voltage test was started in these ways:

- after power up, data–altering communications session, or exiting test mode
- at midnight (for TOU meters) or every 24 hours (for demand–only meters)

The diagnostic mode cycles through performing the service voltage test and displaying information about the service that may be useful in determining why the test failed, as listed below:

1. Perform the service voltage test.
2. Display phase A voltage.
3. Perform the service voltage test.
4. Display phase B voltage.
5. Perform service voltage test.

6. Display phase C voltage.
7. Perform service voltage test.
8. Display phase B voltage angle.
9. Perform service voltage test.
10. Display phase C voltage angle.

If at any point a valid service is found and locked, the meter displays the locked service on the LCD and continues to the next item in the display sequence. Otherwise, the cycle restarts at step 1.

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 A3 ALPHA meter LCD. The meter will continue to the next item in the display sequence. See Figure 4-7 for an example of a successful service current test.

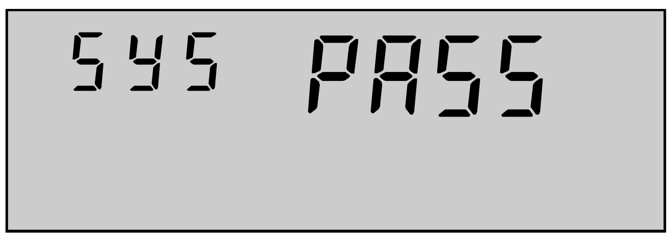


Figure 4-7. Service current test successful completion

If the test is not successful, a warning is set. Also, the LCD will indicate a service error by displaying SEr and a code, an example of which is shown in Figure 4-8. See “System Service Error Codes” on page 4-16 for more information. The following conditions can cause the service current test to fail:

- current remains on one phase while no current is on any 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 (reverse power)

- power factor on any phase is less than the limit set for leading or lagging power factor

If all phases are below the absolute minimum current threshold, the low and missing current failure will not be reported. It is assumed that this is a valid, no–load condition. The exception to this assumption is for a 1–element meter. In this case, the low and zero current warnings will display if the condition exists.

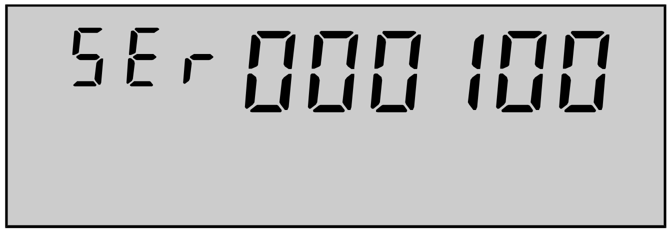


Figure 4-8. Service current test error

Initiating the Service Current Test

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

- the service current test may be placed in any display sequence. The service current test will be performed when the quantity is displayed in the display sequence.
- the service current test may be included in the PQM tests if the A3 ALPHA meter is equipped with this feature. The results of the PQM test will not be seen on the LCD. See “PQM” on page 4-18 for more details on PQM.
- the service current test may be programmed to be performed after successful service voltage tests that perform automatically (but not as part of a display list)

If the A3 ALPHA meter does not have a locked service, then the system service current test will be skipped regardless of how the test is initiated.

Parameters regarding the system service current tests can be changed without requiring the meter to be unlocked and then relocked or requiring the meter to be reset. These parameters (configurable with Elster Electricity meter support software) include the following:

- enable or disable per phase reverse power tests
- absolute minimum current
- per phase low currents
- absolute maximum current
- per phase leading and lagging power factor limits

System Service Error Codes

When SEr is shown on the LCD, the displayed quantity is a numeric code representing a system service error. This indicates that there is a service problem detected by the A3 ALPHA meter. Table 4-3 and Table 4-4 show all possible system service error codes.

Table 4-3. System service voltage test error codes

Error condition	Error code					
	Voltage phase					
	A	B	C			
Low nominal voltage on phase A	I	0	0	0	0	0
Low nominal voltage on phase B	0	I	0	0	0	0
Low nominal voltage on phase C	0	0	I	0	0	0
High nominal voltage on phase A	2	0	0	0	0	0
High nominal voltage on phase B	0	2	0	0	0	0
High nominal voltage on phase C	0	0	2	0	0	0
Unrecognized service	5	5	5	0	0	0
Bad phase angle on phase A	8	0	0	0	0	0
Bad phase angle on phase B	0	8	0	0	0	0
Bad phase angle on phase C	0	0	8	0	0	0
Low voltage & bad phase angle on phase A	9	0	0	0	0	0
Low voltage & bad phase angle on phase B	0	9	0	0	0	0
Low voltage & bad phase angle on phase C	0	0	9	0	0	0
High voltage & bad phase angle on phase A	A	0	0	0	0	0
High voltage & bad phase angle on phase B	0	A	0	0	0	0
High voltage & bad phase angle on phase C	0	0	A	0	0	0

Table 4-4. System service current test error codes

Error condition	Error code					
				Current phase		
				A	B	C
Missing phase A current	0	0	0	I	0	0
Missing phase B current	0	0	0	0	I	0
Missing phase C current	0	0	0	0	0	I
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
Low PF on phase A	0	0	0	4	0	0

Table 4-4. System service current test error codes

Error condition	**Error code**					
				Current phase		
				A	**B**	**C**
Low PF on phase B	0	0	0	0	4	0
Low 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
Low PF & low current on phase A	0	0	0	6	0	0
Low PF & low current on phase B	0	0	0	0	6	0
Low PF & low current on phase C	0	0	0	0	0	6
Reverse power & low current on phase A	0	0	0	7	0	0
Reverse power & low current on phase B	0	0	0	0	7	0
Reverse power & 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 & low PF on phase A	0	0	0	C	0	0
Excess current & low PF on phase B	0	0	0	0	C	0
Excess current & low PF on phase C	0	0	0	0	0	C
Excess current & reverse power on phase A	0	0	0	d	0	0
Excess current & reverse power on phase B	0	0	0	0	d	0
Excess current & reverse power on phase C	0	0	0	0	0	d

If 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.

PQM

A3 ALPHA meters equipped with the optional power quality monitoring (PQM) features (designated with the -Q suffix) can monitor circuit parameters on a cyclic basis, 24 hours a day throughout the billing period. Power quality monitoring (PQM) tests may be turned on or off through Elster Electricity meter support software.

PQM tests will recognize any deviation beyond the thresholds. When shipped, the meter is stored with default values for the thresholds. Using Elster Electricity meter support software, these thresholds can be edited.

In addition to defining thresholds for each test, a minimum time may also be defined. Once the monitored parameter falls outside the threshold and remains there longer than the minimum time, the failure 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 Elster Electricity meter support software.

The meter can be programmed to display a warning code on the LCD when a PQM test fails. Warning codes can be enabled or disabled on a test–by–test basis using Elster Electricity meter support software.

If one or more relays are installed in the A3 ALPHA meter, the relay can be programmed to close when the failure occurs. When a failure condition is no long present, the warning code will automatically clear; and any relays will open.

All A3 ALPHA meters with PQM record PQM events in the PQM log. Meters with TOU capability will also record the date and time of any PQM failure in the PQM log. See “PQM Log” on page 2-14 for more information about the PQM 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 meter engine. The rms voltages are calculated once every 2 line cycles, so the momentary voltage sag test is capable of recognizing any phase voltage deviation that remains below a specified threshold for as few as 2 line cycles.

NOTICE

A qualified PQM failure causes the `F2 020000` warning code to be shown on the LCD.

Voltage Sags

A momentary sag in voltage can reset process control equipment and computer systems. The momentary voltage sag monitor watches for decreases in voltage that last for a measured number of cycles. This monitor can detect any voltage decrease that falls below a programmed threshold for as few as 2 line cycles. Threshold and duration are defined using Elster Electricity meter support software.

The voltage sag 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 3–WD meter, 80% would be 192V because both phases are nominally 240V. However, on a 3–element 240V 4–WD meter, 80% would be 96V because phase A and phase B are nominally 120V.

A sag is defined as a drop in phase voltage below the threshold for a duration greater than the sag minimum time and less than the sag maximum time. If the condition exceeds the maximum sag time, it will not be considered a sag event. The sag times can be configured to a resolution of 8 milliseconds. The minimum time range can be from 32 milliseconds to 2.04 seconds. The maximum time range can be a time up to 546 seconds.

The potential indicators on the A3 ALPHA 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.

Voltage Sag Counter and Timer

Each phase voltage has a voltage sag counter and timer associated with it. Each counter can accumulate up to 65,535 before rolling over to zero. Each cumulative timer can record time for 414 days.

A voltage sag event is only counted if the voltage remains below the voltage sag threshold for more than the minimum time and less than the maximum time. A voltage that remains below the voltage sag threshold for longer than the maximum time is considered to be a low voltage condition, and it is not counted by the momentary voltage sag monitor. Since phase A voltage must be present to supply power to the A3 ALPHA meter, 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.

The counter and timer for each phase are maintained within the A3 ALPHA meter memory. These values can be reported and can be reset through Elster Electricity meter support software.

See “Voltage Sag Log” on page 2-15 for more information about the log of momentary voltage sag events.

PQM Tests

PQM tests do not interfere with any meter functions related to energy measurement. These tests run separately from the metering functions. Table 4-5 shows the available tests along with their description.

Table 4-5. PQM tests

PQM number	Test name	Configuration based upon
Test 1	Service voltage test	System service voltage test thresholds
Test 2	Low voltage test	A specified low voltage threshold
Test 3	High voltage test	A specified high voltage threshold
Test 4	Reverse power test & PF	Service current test thresholds
Test 5	Low current test	Service current test thresholds
Test 6	Power factor (PF)	A specified threshold for leading and lagging
Test 7	Second harmonic current test	A specified current threshold
Test 8	% Total harmonic distortion current	Specified THD percentage
Test 9	% Total harmonic distortion voltage	Specified THD percentage
Test 10	Voltage imbalance	Minimum high voltage threshold and imbalance threshold
Test 11	Current imbalance	Minimum high current threshold and imbalance threshold
Test 12	% total demand distortion	Specified TDD percentage

NOTICE

During the low current and reverse power and power factor 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 two phases drop below the programmed threshold for the qualification time. This eliminates false detection when the load is dramatically reduced or turned off.

PQM Event Counters and Timers

Each PQM test has its own event counter associated with it. Each counter can accumulate to a maximum of 65,535 before rolling over to zero. For each PQM test, an event occurring on one phase or across multiple phases is counted as a single event. The momentary voltage sag monitor, however, records counters and timers for each phase. See "Voltage Sag Counter and Timer" on page 4-19 for details.

The cumulative timer for each monitor can record time over 20 years. To increase the cumulative counter or timer, the PQM test must fail for a period greater than the qualification time. The cumulative timer includes the qualification time for the test (see Figure 4-9). The qualification time is defined as zero to 60 minutes where zero causes the event to be recognized immediately as it is detected.

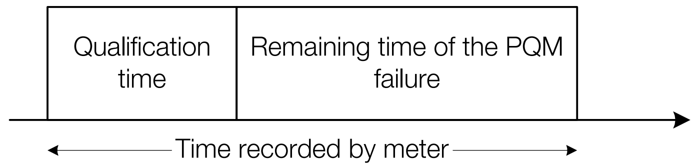


Figure 4-9. Total PQM failure time

An event ends when the condition is no longer present. If an event occurs but does not last for the qualification time, then neither the counter nor timer will reflect the event having occurred.

The counter and timer for each monitor are maintained within the A3 ALPHA meter memory. These values can be reported and can be reset through Elster Electricity meter support software.

Service Voltage Test

This test continually monitors service voltage. Voltage fluctuations outside the programmed limits are detected and can indicate one of the following:

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

All voltage magnitudes and phase angles must fall within the thresholds for the locked service. The thresholds are defined by the service voltage configuration.

Programming the service voltage as a PQM test allows it to run continually and create a log of the results. See “Service Voltage Test” on page 4-7 for more information.

Low Voltage Test

This test checks the per phase voltages for values that fall below a specified limit. Each phase threshold can be set individually and can be set at a value higher or lower than the limits selected for the service voltage test. This allows a more thorough study of the voltage changes.

The threshold is defined as a percentage of the expected per phase nominal voltage and recommended to be in the range of 60% to 99.9%. The percentage for each phase can be individually defined. The test fails if any phase voltage exceeds the threshold.

High Voltage Test

This test checks the per phase voltages for values that exceed a specific limit. The threshold values can be set at a value higher or lower than the limits selected for the service voltage test. This allows a more thorough study of the voltage changes.

The threshold is defined as a percentage of the expected per phase nominal voltage. The percentage for each phase can be individually defined. The test fails if any phase voltage exceeds the threshold.

Reverse Power Test & PF Test

This test recognizes any condition where the current transformer may be wired incorrectly or where meter tampering may have occurred. The power factor (PF) threshold in this test is typically set to a very low value to detect only abnormal conditions.

The PF thresholds are defined with the system service current test definition (see “Service Current Test” on page 4-14 for more information). Using the service current test definition permits independent PF settings to be set for each service type. Each service type can have individual leading and lagging thresholds.

Testing for reverse power can only be enabled or disabled for all phases simultaneously.

Low Current Test

This test checks the service current for values that fall below a specified limit (see “Service Current Test” on page 4-14). 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 fall below the threshold value for the qualification time while the remaining phase currents stay above the limits.

The threshold is defined as a percentage of the A3 ALPHA meter Class ampere rating from the system service test definition. This percentage is applied on a per phase basis. The thresholds are defined by the service current configuration.

NOTICE

A–base, self–contained A3 ALPHA meters are typically Class 100 due to thermal considerations. For purposes of configuring PQM tests on these meters, they should be treated as Class 200.

Power Factor Test

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

The leading and lagging thresholds are individually defined for each phase. These settings may be different than those defined in the service current configuration.

Second Harmonic Current Test

This test checks for the presence of second harmonic current. 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 values in AC amperes according to the meter class. Table 4-6 shows suggested threshold values for different meter classes. The test fails if any phase exceeds the threshold.

Table 4-6. Suggested thresholds for second harmonic current test

Meter class	Suggested threshold (as percentage of Class amps)
320	1.25% (4 amps)
200	1.25% (2.5 amps)
20	2.5% (0.5 amps)
6	2.5% (0.15 amps)
2	2.5% (0.05 amps)

To prevent the monitor from creating a false alarm from legitimate second harmonic current sources, the recommended qualification time is 15 minutes.

Total Harmonic Distortion Current Test

As the load on electrical systems becomes more saturated with electronic control devices (such as computers and communications systems), 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.

The total harmonic distortion current test measures per phase THD current and can alert the utility to conditions that may be harmful or dangerous to the system or other equipment. The threshold is defined as a percentage of the fundamental. The thresholds are defined by the service voltage configuration. The test fails if any phase exceeds the threshold.

Total Harmonic Distortion Voltage Test

As the load on electrical systems becomes more saturated with electronic control devices (such as computers and communications systems), 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.

The total harmonic distortion voltage monitor measures per phase THD voltage and can alert the utility to conditions that may be harmful or dangerous to the system or other equipment. The threshold is defined as a percentage of the fundamental. The thresholds are defined by the service voltage configuration. The test fails if any phase exceeds the threshold.

Voltage Imbalance Test

This test checks for an imbalance between phase voltages. The test first measures and normalizes each per phase voltage. The voltages are normalized to account for different per phase nominal voltages as specified by the locked service. To qualify as a failure, both of the following conditions must be exist:

- the highest normalized per phase voltage must be greater than the minimum voltage threshold

$$(V_a \text{ or } V_b \text{ or } V_c) > \text{minimum voltage threshold}$$

- the ratio of the lowest normalized per phase voltage to the highest (low/high) must be less than the imbalance threshold

$$\frac{\text{lowest per phase voltage}}{\text{highest per phase voltage}} < \text{imbalance threshold}$$

Using Elster Electricity meter support software, the minimum voltage threshold is defined as a percentage of the nominal voltage, and the imbalance threshold is a fraction (0-1).

Current Imbalance Test

This test checks for an imbalance between phase currents. To qualify as a failure, both of the following conditions must exist:

- the highest per phase current must be greater than the minimum current threshold

$$(I_a \text{ or } I_b \text{ or } I_c) > \text{minimum current threshold}$$

- the ratio of the lowest per phase current to the highest (low/ high) must be less than the imbalance threshold

$$\frac{\text{lowest per phase current}}{\text{highest per phase current}} < \text{imbalance threshold}$$

Using Elster Electricity meter support software, the minimum current threshold is defined as a percentage of class amps, and the imbalance threshold is a fraction (0-1).

Total Demand Distortion Test

This monitor checks the per phase total demand distortion (TDD) and makes sure that the TDD is less than the threshold. TDD measures the harmonic current distortion on each phase in percentage of the maximum demand load current (Class amps).

Security

All A3 ALPHA meters include features that help prevent unauthorized access to meter data and record events that may indicate meter tampering.

Meter Passwords

Access to the A3 ALPHA meter is protected through the use of passwords. When establishing communication with the meter, the meter will request a password. If the correct password is not supplied, the meter will not communicate or perform the commands that it is issued. Passwords help ensure that the meter data is protected and that the programming cannot be altered without proper authorization.

The A3 ALPHA meter uses three passwords to control access to the meter. As shown in Table 4-7, each password allows different activities that can be performed on the meter. For more information regarding passwords, see the documentation that comes with the Elster Electricity meter support software.

Table 4-7. A3 ALPHA meter passwords

Passwords	Allowed activity
Read only	The meter can be read. No alteration of data or programming is allowed.
Billing read	The meter can be read. Some basic data–altering activity relating to billing functions is allowed.
Unrestricted	The meter can be read. Full programming of the meter is allowed.

When communicating with the A3 ALPHA meter remotely, the A3 ALPHA meter supports the password encryption standards in accordance with ANSI C12.21. The password is not encrypted when communicating using the optical port.

The meter records the number of failed password attempts that were used in trying to access the meter. An internal warning will be generated if 10 failed password attempts occur since the last demand reset. This warning can be used to control a relay output or to trigger an alarm call.

Anti–Tampering

All A3 ALPHA meters provide auditing capabilities that can be used to indicate potential meter tampering. These capabilities can record such items as the following:

- programming changes
- power outages
- number of days since last pulse
- number of manually–initiated demand resets
- number of days since last demand reset
- reverse energy flow
- history log

5. Outputs

Relay Outputs

The A3 ALPHA meter supports the installation of one or two option boards. Either option board, or both, can include relay outputs. The meter supports up to 6 relays, depending upon the communications options being used. For more information about relay outputs and communications, see the instructional leaflet (IL) that comes with the option board.

The relay outputs are either Form C relays or Form A relays, as shown in Figure 5-1. In this figure, Form C relays are indicated by KYZ, and Form A relays are indicated by A.

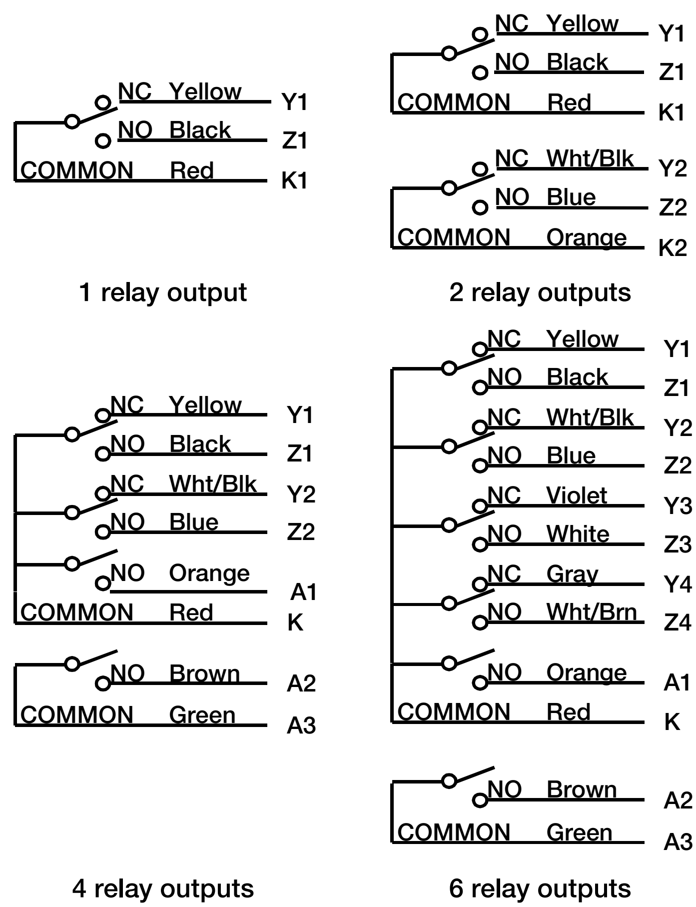


Figure 5-1. Color–coded wiring diagrams for 1, 2, 4, and 6 relays

With the A3 ALPHA meter, all relay outputs are programmable using Elster Electricity meter support software. Sources for relay outputs are as follows:

- energy pulse for any basic metered quantity[1] (see Table 2-1)

1 Form C relays only

- control output
  - end–of–interval
  - load control
  - TOU switches to a specific rate
  - specific errors or warnings
  - any PQM test failure (see “PQM” on page 4-18)
  - relay–related alarm condition (see “Relay–Related Alarms” on page 5-3)

Relay–Related Alarms

The A3 ALPHA meter periodically performs a self test to determine if it is operating properly. If any errors are detected, the meter can respond in any or all of the following ways:

- display an error or a warning (see “Error Codes and Warnings” on page 6-3)
- initiate a telephone call via a modem
- trigger a relay

See Table 5-1 and Table 5-2 for relay–related alarms that also display errors or warnings on the LCD. See Table 5-3 for other conditions that only trigger relays with no errors or warnings.

Table 5-1. Relay alarms and displayed errors

Condition	Can also display this error
General configuration error	See “Er1 100000: General configuration error” on page 6-6.
EEPROM access error	See “Er1 010000: EEPROM access error” on page 6-6.
Internal communication error	See “Er1 001000: Internal communication error” on page 6-6.
Crystal oscillator error	See “Er1 000010: Crystal oscillator error” on page 6-5.
Carryover error	See “Er1 000001: Carryover error” on page 6-5.
Power fail data save error	See “Er2 200000: Power fail data save error” on page 6-7.

Table 5-2. Relay alarms and displayed warning codes

Condition	Can also display this warning
Demand overload warning	See “F1 100000: Demand overload warning” on page 6-10.
Potential indicator warning	See “F1 010000: Potential indicator warning” on page 6-10.

Table 5-2. Relay alarms and displayed warning codes

Condition	Can also display this warning
Reverse energy flow warning	See “F1 000100: Reverse energy flow warning” on page 6-9.
Improper meter engine operation warning	See “F1 000010: Improper meter engine operation warning” on page 6-9.
Low battery warning	See “F1 000001: Low battery warning” on page 6-9.
End of calendar warning	See “F2 200000: End of calendar warning” on page 6-11.
Line frequency warning	See “F2 002000: Line frequency warning” on page 6-11.
Demand threshold exceeded warning	See “F2 000200: Demand threshold exceeded warning” on page 6-10.
Service current test failure warning	See “F2 000002: Service current test failure warning” on page 6-10.

Table 5-3. Conditions that only trigger a relay

Condition	Indicates
Event log overflow warning	The event log has exceeded the maximum number of entries, and the oldest records will be overwritten.
History log overflow warning	The history log has exceeded the maximum number of entries. Depending on programming, the meter will either lock the history log or start overwriting the oldest records. If the history log is locked, no further changes to the meter are allowed until the history log has been read.
Pulse profiling overflow	The pulse profiling log is within 2 days of overflowing. Data will be lost if the pulse profiling log is not read within 2 days.
Instrumentation profiling set 1 overflow warning	Set 1 of the instrumentation profiling log is within 2 days of overflowing. Data will be lost if the instrumentation profiling log is not read within 2 days.
Instrumentation profiling set 2 overflow warning	Set 2 of the instrumentation profiling log is within 2 days of overflowing. Data will be lost if the instrumentation profiling log is not read within 2 days.
Internal modem battery low warning	The optional battery used on the internal modem for outage reporting features is low.
Power failure	A power failure of any duration has occurred.
Qualified power failure warning	A power failure exceeding the power fail recognition time has occurred.
Rate override warning	The current TOU rate is being overridden by the alternate TOU rate schedule.
Tamper detect warning	Possible tampering of the meter because of a specified number of invalid passwords used to access the meter.
Service voltage test failure warning	The service voltage test was unable to find a valid service or the measured service does not match the locked service.

Relay Specifications

When the relay is used to echo any of the basic metered quantities, the relay output can have a programmable rate divisor with an integer value from 1 to 65,535. The relay energy outputs can be configured for either of the following:

- toggle for each energy transition
- pulse for a specified pulse width for each energy transition

When the relay is used for EOI indication, the EOI relay operates for 5 seconds after the end of each interval.

The output relays can switch up to 120V AC or 200V DC at up to 100mA. The KYZ1 relay can be terminated to three, small voltage blades in 13 terminal socket applications (or to specified terminals for A–base meters) as shown in Appendix D, “Wiring Diagrams.”

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.
- For a relay option board providing 4 output relays, an 8–conductor cable is provided.
- For a relay option board providing 6 output relays, a 12–conductor cable is provided.

Figure 5-1 shows the color codes for each of these cables.

Optical Pulse Outputs

The optical port contains a phototransistor and a light emitting diode (LED), as shown in Figure 5-2. The LED emits pulse outputs that can be used to test the A3 ALPHA meter in the field without removing the meter from service or breaking the seal.

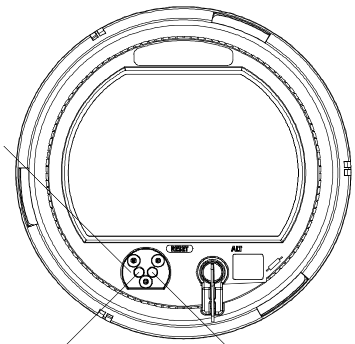


Figure 5-2. Optical port components

Any basic metered quantity (see Table 2-1) can be selected as the source for optical pulse output. Additionally, if the LCD remains on a pulse count quantity while in the alternate display sequence, then that quantity is automatically echoed on the optical port. This echoing provides a means to test quantities other than Wh–delivered without requiring the use of Elster Electricity meter support software.

Output Specifications

The optical port supports up to 120 pulses per second. The speed of the optical output signals can be controlled by a divisor.

The P/R ratio is the number of pulses (K_e) per equivalent disk rotation (K_h). The optical output rate can be set for “fast” or “slow.” The fast method sends out pulses at the K_e rate. The slow method typically uses P/R as a divider and sends out pulses as the K_h rate. Depending on the operation mode of the meter, the optical port will either pulse or toggle for each energy transition.

- In normal mode, the optical port will pulse for each “slow” energy transition. The default divisor is set to P/R, meaning that a pulse will be output for each K_h transition.
- In alternate and test modes, the optical port will toggle for each “slow” energy transition. The default divisor is set to P/R ÷ 2, meaning that the output will toggle for each K_h ÷ 2 transition or pulse for each K_h transition.

6. Testing

Overview

A3 ALPHA 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 normal, however, to test installed A3 ALPHA meters periodically to ensure accurate billing.

The A3 ALPHA meter performs its own self tests. Additionally, the system instrumentation and PQM features provide valuable information about the meter service. See Chapter 4, "Meter Tools," for more information about the instrumentation and power quality features of the meter.

Testing procedures are the same regardless of the type of meter being tested.

Meter Self Test

The A3 ALPHA meter periodically performs a self test to determine if it is operating properly. The self test ensures that the A3 ALPHA meter is functioning properly and its displayed quantities are accurate. Any errors encountered will be displayed on the LCD. Certain errors may also initiate a telephone call via a modem or trigger a relay.

- For LCD errors and warnings, see "Error Codes and Warnings" on page 6-3.
- For relay alarms, see "Relay–Related Alarms" on page 5-3.

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

- after any power restoration
- at midnight (meters with timekeeping abilities)
- every 24 hours from power up (meters without timekeeping abilities)
- immediately after a data–altering communication session

The self test incorporates a series of electronic analyses verifying many aspects of the A3 ALPHA meter. After the meter passes its self test upon power restoration, all of the LCD segments will be turned on briefly before beginning the normal display sequence. The following is a listing of the specific tests performed during a self test:

- verification of the configuration data and checksums
- detection of low battery voltage (for meters programmed as TOU meters)
- verification of normal microcontroller function

Error Codes and Warnings

The A3 ALPHA meter displays error codes and warnings as an indication of a problem that may be adversely affecting its operation. The meter will continue to function as normally as possible when displaying an error or warning. The **ALT**, **RESET**, and **TEST** buttons operate differently if an error or warning is displayed. See “Using the Push Buttons” on page 3-5 for information on how the push buttons operate when an error or warning is displayed.

There are 3 types of codes:

- error codes
- warning codes
- communication codes

Error codes indicate conditions that may be affecting billing data. It is not recommended to operate the A3 ALPHA meter for an extended time when it is displaying an error code. Warning codes indicate conditions that may be of concern but do not affect the integrity of billing data.

Communication codes generally indicate a condition affecting communications with the meter through the optical port or remote port. Not all communication codes indicate potential problems; some codes provide an indication of the present communication process.

Error Codes

Error codes override any other item that is being displayed on the LCD. They always “lock” the display, preventing other items from being displayed. There are exceptions to errors locking the display:

- The normal and alternate display sequence can be viewed even when an error code locks the display. See “ALT Button” on page 3-7 for more information.
- Warning codes can be programmed to display an error code. When the condition causing the warning code is clear, the error code is no longer displayed. See “Er3 300000: Display locked by warning” on page 6-7 for more information.
- Communication codes are temporarily displayed on the LCD even when the LCD is “locked” by an error code. After the communication code clears, LCD returns to showing the error code.

Error codes are indicated on the LCD by a group code and a numerical code. The group code makes it easier to identify the error on the LCD. The numerical code indicates the specific condition that has occurred. See Figure 6-1 for a sample error code displayed on the meter LCD. Table 6-1 through Table 6-3 describe the different error conditions and their codes.

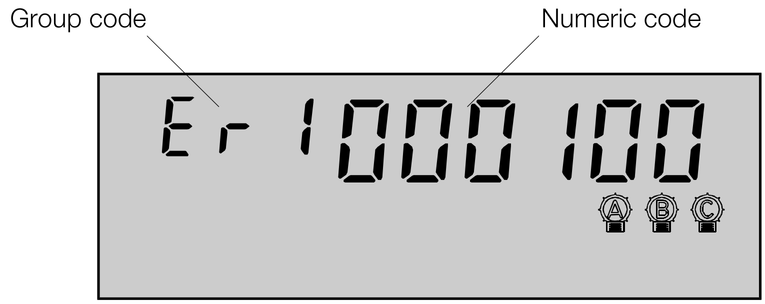


Figure 6-1. Sample error code displayed on the LCD

Table 6-1. Group Er1 error conditions and codes

Condition	Code					
Carryover error	0	0	0	0	0	1
Crystal oscillator error	0	0	0	0	1	0
Table CRC error	0	0	0	1	0	0
Internal communication error	0	0	1	0	0	0
EEPROM access error	0	1	0	0	0	0
General configuration error	1	0	0	0	0	0

Table 6-2. Group Er2 error conditions and codes

Condition	Code					
Security configuration error	0	0	0	0	0	2
Password table CRC error	0	0	0	0	2	0
Encryption key table CRC error	0	0	0	2	0	0
Power fail data save error	2	0	0	0	0	0

Table 6-3. Group Er3 error conditions and codes

Condition	Code					
Clock error	0	3	0	0	0	0
Display locked by warning	3	0	0	0	0	0

Error codes of the same group are displayed in combination (Er1 001010, for example), indicating that more than one error condition has been detected. If errors exist in more than one group, the meter will continually cycle through the different groups. Any problems must be corrected before normal operation can continue. In some cases, the meter may need to be reprogrammed or returned to the factory for repair or replacement.

Er1 000001: Carryover error

NOTICE

Since shipping can take several days, this error will likely be seen on timekeeping meters shipped without a battery.

This code indicates a failure of a RAM checksum test on data stored in the meter's volatile RAM during a power outage. When a loss of line voltage occurs, the meter's RAM is maintained by the super capacitor and an optional battery. If both of these fail, the data stored in RAM is lost. Billing data is stored in nonvolatile memory and will still be available.[1] The push buttons and communications ports will function normally.

The meter battery may need to be replaced, and the error will need to be reset through Elster Electricity meter support software. If the error code is still shown after using Elster Electricity meter support software, the meter must be returned to the factory for repair or replacement.

Er1 000010: Crystal oscillator error

This codes indicates a problem with the crystal oscillator. The A3 ALPHA meter must be returned to the factory for repair or replacement.

Er1 000100: Table CRC error

This code indicates a possible error in the A3 ALPHA meter's programming. This code might appear if a communications interruption occurs during meter programming. Depending on which area of the meter is affected, billing data may not be reliably accumulated while this error condition exists. The push buttons and optical port will continue to function normally.

1 Billing data is always stored in nonvolatile memory. Depending on meter configuration, other data may be stored in RAM, which uses a battery to preserve memory. If the battery fails, this data would be lost.

Reprogramming the meter with Elster Electricity meter support software may correct the problem. If the error code is displayed after reprogramming, the A3 ALPHA meter should be returned to the factory for repair or replacement.

Er1 001000: Internal communication error

This code indicates the meter had an internal communication error. The A3 ALPHA meter must be returned to the factory for repair or replacement.

Er1 010000: EEPROM access error

This code indicates the meter had a problem accessing its nonvolatile EEPROM. The A3 ALPHA meter should be returned to the factory for repair or replacement.

Er1 100000: General configuration error

This code indicates a problem with the meter's configuration or program. The meter can usually be reprogrammed using Elster Electricity meter support software to correct the errors.

Er2 000002: Security configuration error

NOTICE

If this error occurs, the meter is vulnerable to tampering. Prompt correction of the error will maximize the A3 ALPHA meter's security protection.

This code indicates an error is present in the meter's security configuration. Contact Elster Electricity if this error is displayed on the LCD.

Er2 000020: Password table CRC error

NOTICE

If this error occurs, the meter is vulnerable to tampering. Prompt correction of the error will maximize the A3 ALPHA meter's security protection.

This code indicates a CRC error is present in the meter's ANSI C12.21 password configuration table. Contact Elster Electricity if this error is displayed on the LCD.

Er2 000200: Encryption key table CRC error

NOTICE

If this error occurs, the meter is vulnerable to tampering. Prompt correction of the error will maximize the A3 ALPHA meter's security protection.

This code indicates a CRC error is present in the meter's ANSI C12.21 encryption key configuration table. Encryption keys are used for secure access to the meter's data and configuration through the remote communication port. Contact Elster Electricity if this error is displayed on the LCD.

Er2 200000: Power fail data save error

This code indicates that the data saved in the nonvolatile EEPROM during a power fail may be invalid. This error will be displayed when power is restored to the meter, and a self check has discovered an error with the EEPROM data. The A3 ALPHA meter must be returned to the factory for repair or replacement.

Er3 030000: Clock error

This code indicates an error with the meter's timekeeping ability. The error can be a result of either of the following situations:

- When a carryover error occurs (See "Er1 000001: Carryover error" on page 6-5 for more information.), reference to real time is lost. The meter battery may need to be replaced, and the error will need to be reset through Elster Electricity meter support software. If the error code is still present, the meter must be returned to the factory for repair or replacement.
- When an A3D meter is upgraded to a timekeeping capable meter (that is, an A3T, A3K, or A3R meter) and the time has not been set. Using Elster Electricity meter support software, program the meter time to the correct time.

TOU features cannot be performed when time is lost. Previously accumulated data is stored in nonvolatile memory and will still be available.

Er3 300000: Display locked by warning

This code indicates that one or more warning codes (see "Warning Codes" on page 6-8) has locked the display. The A3 ALPHA meter can be programmed to lock the display if a warning condition is present. Elster Electricity meter support software is used to select the individual warnings that will cause this error code to display. If the condition causing the warning clears, the error code will also clear.

Warning Codes

Warning codes indicate conditions of concern that do not yet affect the integrity of billing data. When the condition is present, a warning code is automatically inserted as the last item in the normal and alternate display sequences. When the condition clears, the warning code, is removed from the display sequence. Elster Electricity meter support software can be used to select individual warnings that will lock the display as an error. See “Error Codes” on page 6-3 for more information.

Warning codes are indicated on the LCD by a group code and a numerical code. The group code makes it easier to identify the error on the LCD. The numeric code indicates the specific condition that has occurred. See Figure 6-2 for a sample warning code displayed on the LCD. Table 6-4 and Table 6-5 describe the different warning conditions and their codes.

Figure 6-2. Sample warning code displayed on the LCD

Table 6-4. Group F1 warning codes

Condition	Code					
Low battery warning	0	0	0	0	0	1
Improper meter engine operation warning	0	0	0	0	1	0
Reverse energy flow warning	0	0	0	1	0	0
Potential indicator warning	0	1	0	0	0	0
Demand overload warning	1	0	0	0	0	0

Table 6-5. Group F2 warning codes

Condition	Code					
Service current test failure warning	0	0	0	0	0	2
Demand threshold exceeded warning	0	0	0	2	0	0
Line frequency warning	0	0	2	0	0	0
PQM test failure warning	0	2	0	0	0	0
End of calendar warning	2	0	0	0	0	0

Warning codes of the same group are displayed in combination (for example, `F2 202000`), indicating that one or more warning conditions are present. If warnings exist in more than one group, the meter displays each group at the end of the display sequence before returning to the first item in the display sequence.

F1 000001: Low battery warning

NOTICE

For meters configured for demand–only operation, this warning code is automatically disabled by Elster Electricity meter support software.

This warning code indicates a low battery voltage or missing battery. A3 ALPHA meters having realtime TOU functionality require a battery to maintain date and time over an extended power outage.

For timekeeping configurations, the meter should be de–energized and the battery should be replaced. Once the new battery has been installed and the meter is energized, the code is automatically cleared. See “Removing a Battery” on page 7-9 and “Installing a Battery” on page 7-4 for instructions on replacing batteries.

F1 000010: Improper meter engine operation warning

This code indicates that the meter engine program may be corrupt or is not executing correctly. This warning condition is typically triggered when the microcontroller reinitializes the meter engine. An unstable or noisy electrical environment at the A3 ALPHA meter installation can interfere with this operation.

If the meter engine is successfully reinitialized, then the warning code will be automatically cleared from the LCD. If the code continues to be displayed on the LCD, the A3 ALPHA meter should be returned to the factory for repair or replacement.

F1 000100: Reverse energy flow warning

This warning code indicates that reverse energy flow has been detected equivalent to twice the K_h since the last reset. It may be an indication of tampering with the A3 ALPHA meter installation. If reverse energy flow is expected, then this warning code can be disabled through Elster Electricity meter support software. If the service being metered is not expected to return energy to the utility, further investigation is required. In some cases, it may be necessary to return the A3 ALPHA meter to the factory for repair or replacement.

The code is cleared by these methods:

- performing a demand reset

- issuing the clear values and status command through Elster Electricity meter support software

F1 010000: Potential indicator warning

This code indicates that one or more of the phase potentials are missing or below the defined threshold for voltage sag detection. This code will display at the same time as one or more of the potential indicators blink. See “Potential Indicators” on page 3-3 and “Voltage Sags” on page 4-19 for more details on potential indicators and voltage sags.

The code is automatically cleared when the phase potential returns a value within the programmed thresholds.

F1 100000: Demand overload warning

This code indicates that the demand value exceeded 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 handle.

If the demand overload value has been set lower than appropriate for the installation, the A3 ALPHA meter may be reprogrammed with a higher threshold value.

The code is cleared by these methods:

- performing a demand reset
- issuing the clear values and status command through Elster Electricity meter support software

F2 000002: Service current test failure warning

This code indicates that the most recently performed service current test has failed. See “Service Current Test” on page 4-14 for more information.

The code is cleared by these methods:

- the service current test is performed again and the test does not fail
- issuing the clear values and status command through Elster Electricity meter support software

F2 000200: Demand threshold exceeded warning

This code indicates that the demand has exceeded one of the programmed demand thresholds. This warning follows the state of any relay programmed for demand threshold operation. It is set once the demand threshold has been exceeded and only cleared after one complete demand interval during which the threshold is not exceeded.

F2 002000: Line frequency warning

If a meter is configured to use the line frequency instead of the crystal oscillator as the time base, this code indicates that the line frequency is off by ±5% of its programmed setting. When this condition occurs, the meter switches timekeeping to the crystal oscillator.

The code will be automatically cleared once the line frequency returns to within 5% of the nominal frequency. This warning will never appear on meters configured for constant timekeeping operation from the internal crystal.

F2 020000: PQM test failure warning

This code indicates that one or more PQM tests have detected a value outside the programmed thresholds. Use the meter system instrumentation displays or Elster Electricity meter support software to gain additional information on the specific PQM test causing the problem.

The code will be automatically cleared once PQM conditions return to a value within the programmed thresholds.

F2 200000: End of calendar warning

This code indicates that the meter calendar has expired or is about to expire. The date at which this code appears is configurable using Elster Electricity meter support software. Program a new calendar using Elster Electricity meter support software.

The code is cleared by these methods:

- performing a demand reset
- issuing the clear values and status command through Elster Electricity meter support software

Communication Codes

Communication codes temporarily override any other item that is being displayed on the LCD (including error codes). Communication codes are indicated on the LCD by a port code and a numerical code. The port code identifies the affected port. The numerical code indicates the status of the communication session. See Figure 6-3 for a sample communication code displayed on the meter's LCD. See Table 6-6 for the port codes and Table 6-7 for the communication codes that can be displayed.

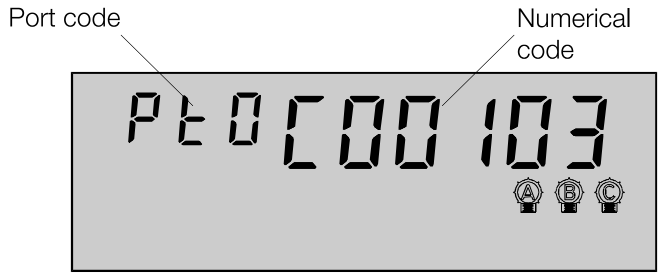


Figure 6-3. Sample communication code displayed on the LCD

Table 6-6. Port codes

Code	Port
Pt0	Optical port
PtI	Remote port 1
Pt2	Remote port 2

Table 6-7. Communication codes

Condition	Code					
CRC error	C	0	0	I	0	I
Syntax error	C	0	0	I	0	3
Framing error	C	0	0	I	0	4
Timeout error	C	0	0	I	0	5

For most communication errors, it is recommended to attempt the communication again. It may be necessary to cycle power to the A3 ALPHA meter or to reattempt the Elster Electricity meter support software function. If communication errors persist, the meter will have to be returned to the factory for repair or replacement.

Meter Shop Testing

Test Equipment

Meter shops develop testing configurations specific to their own needs. The following is a list of standard test equipment that can be useful when testing an A3 ALPHA meter:

- stable mounting assembly for the A3 ALPHA meter to be temporarily installed to ensure proper orientation and allow the necessary voltage and current connections to be made
- reliable power supply with at least the following characteristics:
    - provides voltage source for energizing the meter at its rated voltage
    - provides unity power factor
    - supplies lagging power factor of 60° (for VARh testing) or 0.5
- reference Wh standard
- reference VARh standard
- phantom load device or other loading circuit that 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 pulse output from output relays

Test Setup

Before testing the A3 ALPHA meter, check the nameplate for the following:

- test amperes
- appropriate operating voltage range

Table 6-8 shows how the meter K_h relates to the energy value of the LCD arrows.

Table 6-8. Nameplate K_h and energy values of arrow indicators

Nameplate meter K_h	Energy value of arrows[1]	Pulse ratio
	P/R = 24	
0.6	0.025	24
1.2	0.05	24
1.8	0.075	24
7.2	0.3	24
14.4	0.6	24
21.6	0.9	24
24	1.0	24
36	1.5	24
	P/R = 48	
1.2	0.025	48
2.4	0.05	48
14.4	0.3	48
28.8	0.6	48
43.2	0.9	48
	P/R = 96	
4.8	0.05	96
57.6	0.6	96

1. The value is based on a single transition of an arrow (on–to–off or off–to–on), referred to as the K_e. Each "flash" of an arrow represents twice the K_e value shown in the table. See "Real Energy Indicators" on page 3-3 and "Alternate Energy Indicators" on page 3-3 for more information.

NOTICE

Pulses on the optical port during a button–press initiated test mode are fixed to Wh. Output can be selected as Wh, VAh (A3K), or VARh (A3R) when Elster Electricity meter support software is used to initiate the test mode.

General Test Setup

The following general procedure should be used to create a setup location for the A3 ALPHA meter:

⚠ WARNING

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

1. Temporarily install the meter in a mounting device that 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 D, “Wiring Diagrams,” for appropriate wiring diagrams for the A3 ALPHA 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–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 6-4 for the location of the optical port on the A3 ALPHA meter.

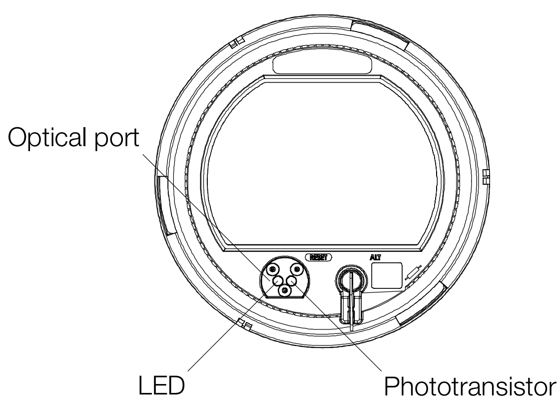


Figure 6-4. Location of the optical port and LED pulse output

Formulas Used in Testing

When testing the A3 ALPHA meter, manual calculations may be necessary to verify meter quantities. Table 6-9 shows the naming conventions used to indicate variable quantities in these calculations.

Table 6-9. Variables used in manual calculations

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

Watthour Constant

The watthour constant (K_h) is a measure of the electrical energy metered per pulse of the optical port infrared LED. The K_h value can be calculated using the following formula:

$$K_h = \frac{(TA \cdot \text{Test voltage} \cdot N)}{500}$$

Note: The number of elements used in the equation shown above should be 3 for Z–coil type meters even though they are called 2½–element meters.

Note: For single element meters, 1000 pulses per hour should be used in the equation instead of 500.

For transformer rated meters, the K_h value is called the secondary K_h (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:

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

A 3–element A3 ALPHA 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:

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

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

Calculating Meter Accuracy

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

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

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

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

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

Determining the Power

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:

$$kW = \frac{P \cdot Kh \cdot 60}{t \cdot 1000}$$

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 the CTR and VTR.

Calculating Power

If a precision power supply is available, it may be used to calculate the different types of demand that can be metered by the A3 ALPHA 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 to calculate power (in watts):

$$Power_{real} = V \cdot I \cdot N \cdot \cos\Theta$$

$$Power_{reactive} = V \cdot I \cdot N \cdot \sin\Theta$$

$$Power_{apparent} = V \cdot I \cdot N$$

Meter Testing

Since no field adjustments are required for the A3 ALPHA meter, meter testing is primarily done to ensure operation 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. Ideally, this will be at 22°C (72°F).

Most polyphase A3 ALPHA meters operate at 8 1/3 pulse periods per minute when run at test amperes and voltages. The 2 ½–element, 4–wire wye 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 before 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.

NOTICE

The A3 ALPHA 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.

Watthour Testing

To maintain compatibility between procedures for testing electronic and electromechanical meters, the A3 ALPHA meter has been designed with the same test points. These test points are described in Table 6-10.

Table 6-10. Watthour 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 factory
Lagging power factor	100% of the rated current, test voltage, and rated frequency at 0.5 lagging power factor (current lagging voltage by 60° phase angles)

Whereas electromechanical meters have adjustments to calibrate the meter at all three test points, the A3 ALPHA meter is calibrated in the factory.

To obtain standard calibration readings from an A3 ALPHA meter, the following procedure should be used:

1. Verify the meter calibration at full load using the formula for calculating meter accuracy. See “Calculating Meter Accuracy” on page 6-17 to determine the percent accuracy.
2. Verify the meter calibration at light load using the same formula in step 1.
3. Verify the power calibration of the meter at full load with lagging power factor using the same formula in step 1.
4. Check for creeping at the rated voltage level with no current. The meter must produce two 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.

VARhour Verification

The VARh information is used to generate the reactive quantities kVARh energy and kVAR demand. Using Elster Electricity meter support software, the A3 ALPHA meter can be programmed to output VARh pulses on the optical port for an A3R meter.

To maintain compatibility between procedures for electronic and electromechanical meters, the A3 ALPHA meter has been designed with the same test points. These test points are described in Table 6-11.

Table 6-11. VARh 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 watthour portion has been calibrated. If VARh measurement is to be verified, however, the same procedure discussed in "Watthour Testing" on page 6-19 can be used. Alternatively, the following procedure can be used:

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" on page 6-17 or "Calculating Power" on page 6-18 .
3. Verify that the calculated reactive power agrees with the known reactive load.

VAhour Verification

The VAh information generates the apparent quantities kVAh energy and kVA demand. Using Elster Electricity meter support software, the A3 ALPHA meter can be programmed to output VAh pulses on the optical port for an A3K meter.

To maintain compatibility between procedures for electronic and electromechanical meters, the A3 ALPHA meter has been designed with the same test points. These test points are described in Table 6-12.

Table 6-12. VAhour 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

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 standard VARh output to test VAh.

Under normal circumstances, the VAh measurement of the meter does not need to be checked because it is automatically adjusted whenever the watthour portion has been calibrated. If VAh measurement is to be verified, however, the same procedure discussed in “Watthour Testing” on page 6-19 can be used. Alternatively, the following procedure can also be used:

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” on page 6-17 or “Calculating Power” on page 6-18.
3. Verify that the calculated apparent power agrees with the known load.

Installation Site Testing

Since no adjustments are required for the A3 ALPHA meter, the main reason to test a meter is to make sure it is operating within factory specifications. Typically, all that needs to be done is to check the meter calibration. There are many ways to test the meter while its in service to verify correct operation.

Test Mode

The test mode verifies the A3 ALPHA meter's timing and registration without losing billing data. To make the testing process faster, the test mode interval can be shortened. Even with a shorter test interval, the test mode accumulated energy and demand data will not affect the normal billing data.

⚠ WARNING

Exercise extreme caution when moving the meter cover when power is supplied to the A3 ALPHA meter. Dangerous voltages are present. Equipment damage, personal injury, or death can result if safety precautions are not followed.

The meter cover must be removed before the **TEST** button can be used. The meter enters test mode when the **TEST** button is pressed. See "Test Mode" on page 3-12 for more information about test mode operation.

Timing Tests

There are different ways to perform timing tests on the A3 ALPHA meter. Each method has its advantages and separate procedures. All methods require a stopwatch.

- using the EOI indicator while in test mode
- displaying the time remaining in a test mode subinterval
- using the EOI indicator while in normal mode

The first two methods are recommended because each method takes advantage of the shorter intervals of the test mode. Also, the first test interval will be a complete interval and not synchronized to a real time clock.

The third method is useful because it can be done while the meter is in normal mode. Removing the meter cover or pressing the **TEST** button is not necessary.

Using the EOI Indicator While in Test Mode

The test mode subinterval timing can be verified by measuring the time between EOI pulses.

1. Start test mode.
2. Press the **RESET** button and start the stopwatch at the same time. This starts a new test interval.
3. Watch the meter's LCD for the EOI indicator to appear 10 seconds before the end of the subinterval.
4. Stop the stopwatch when the EOI indicator turns off.
5. Verify that the time on the stopwatch equals the time of the test mode subinterval.

Displaying the Time Remaining

This timing test can be used if the meter has been programmed to display the time remaining in a subinterval as display quantity in test mode.

1. Start test mode.
2. Press the **RESET** button and start the stopwatch at the same time. This starts a new test interval.
3. Press the **ALT** button until the time remaining in subinterval quantity is displayed.
4. The displayed time remaining in the interval is accurate to a second and can be used to get a feel of when the interval ends. Use the EOI indicator for accurate timing.

Using the EOI Indicator While in Normal Mode

Testing the meter timing in normal mode takes longer than the other methods because it is necessary to wait for the present interval to end before testing can begin.

1. Wait for the EOI indicator to appear on the LCD. This indicates the end of the present interval.
2. Start the stopwatch immediately after the EOI indicator turns off.
3. Watch the meter's LCD for the EOI indicator to appear 10 seconds before the end of the subinterval.
4. Stop the stopwatch when the EOI indicator turns off.
5. Verify that the time on the stopwatch equals the time of the normal mode subinterval.

Accuracy Tests

Accuracy tests confirm that the kWh readings meet calibration standards. There are two ways of testing accuracy. The first method is recommended. Both methods require a stopwatch.

- using the pulse count display
- manually counting pulses

NOTICE

Accuracy tests also verify the meter timing.

Using the Pulse Count Display

To perform an accuracy test on the meter using the pulse count quantity, use the following procedure:

1. Start test mode.
2. Place a known load on the meter.
3. Press the **RESET** button and start the stopwatch at the same time.
4. At the end of a complete interval, simultaneously remove the load and stop the stopwatch. Record the time on the stopwatch.
5. Read the pulse count from the meter LCD and calculate the expected number of pulses using this formula:

$$\text{pulses} = \frac{\text{load} \times \text{time}}{K_e} \times \frac{1000}{60}$$

   Time is measured in minutes.

6. Verify that the calculated value is the same as the observed pulse count. This indicates that the meter is performing accurately.
7. Calculate the kWh using this formula:

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

8. Verify that the calculated kWh is the same as the observed kWh. This indicates that the meter is calculating kWh accurately.
9. Verify that the observed demand is the same as the load kilowatts after one complete interval.

Manually Counting Pulses

Use this procedure to count pulses manually.

1. Start test mode.
2. Place a known load on the meter.
3. Start the stopwatch when the LCD pulse indicator turns off and start counting the number of pulses made by the indicator. Be sure to count each time the square indicator turns off (and not the arrow indicators).
4. After a sufficient time to account for various response times, stop the stopwatch when the LCD pulse indicator turns off. Record both the time on the stopwatch and number of pulses counted.
5. Remove the load from the meter.
6. Calculate the number of pulses using this formula:

$$\text{pulses} = \frac{\text{load} \times \text{time}}{K_h} \times \frac{1000}{60}$$

   Time is measured in minutes.

7. Verify that the calculated value matches the observed pulse count. This indicates that the meter is performing accurately
8. Calculate the kWh using this formula:

$$\text{kWh} = \frac{K_h \times \text{pulses}}{1000}$$

9. Verify that the calculated kWh is equal to the observed kWh. This indicates that the meter is calculating kWh accurately.
10. Verify that the observed demand equals the load kilowatts after one complete interval. This indicates that the meter calculations of the demand are accurate.

NOTICE

The calculated kWh may not be exactly equal to the observed kWh. The time the meter was in test mode with the load applied and the time between starting and stopping the stopwatch can vary the calculations. This is normal and does not necessarily reflect inaccurate measurements.

7. Installation and Removal

Preliminary Inspection

⚠ WARNING

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

The A3 ALPHA meter is calibrated and tested at the factory, and it is ready for installation. Follow proper installation and removal procedures for personal safety and protection of the meter.

Before installing and applying power to the A3 ALPHA meter, a quick inspection of the meter itself is recommended. Check for some of the following items:

- no broken or missing parts
- no missing or broken wiring
- no bent or cracked components
- no evidence of overheating
- check the nameplate to make sure it is appropriate for the service

Physical damage to the outside of the A3 ALPHA meter could indicate potential electronic damage in the inside of the meter. Do not connect power to a meter that is suspected to have unknown internal damage. Contact your local Elster Electricity representative if you suspect your meter may be damaged.

Placing the Meter into Service

The installation for the S–base A3 ALPHA meter is different from the installation for A–base meters. See Appendix D, “Wiring Diagrams,” for illustrations of both internal and connection wiring diagrams.

⚠ CAUTION

Make sure to install the correct meter for the service type, maximum current, and capacity required. Installing mismatched meters can damage equipment. Do not use A3 ALPHA meters on phase–shifting transformers. Equipment damage can result if phase–shifting transformers are used because the meter uses a common internal. 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 use the A3 ALPHA meter effectively and safely, follow this procedure:

1. Align the meter blades and meter base socket jaws to the service socket.
2. Grasp each meter side and push it into the socket until the meter is firmly in place. If the meter resists sliding into place, rock the meter up and down while pushing forward.
3. Once firmly in place, power can be applied to the meter.

Installing an A–Base Meter

Bottom–connected services require either of the following types of meters:

- an integral A–base meter
- an S–base meter with the S–base to A–base adapter

To use the A3 ALPHA meter effectively and safely, follow this procedure:

1. Verify that the meter hanger is in the desired position. To hide the top supporting screw, slide the hanger down to the hidden position.
2. Install a screw for the top supporting screw position. Use at least a #12 screw.
3. Hang the meter upright on the top supporting screw. Make sure it is level.

⚠ WARNING

Use authorized utility procedures and safety precautions in wiring the meter. Dangerous voltages are present. Equipment damage, personal injury, or death can result from improper wiring procedures.

4. 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 bottom–connected terminals. Tighten the connections, allow them to relax for a few minutes, and then tighten them again. This will minimize the cold–flow effects of the aluminum cable.

5. If required, wire the meter using color–coded wire according to the local specifications. See Appendix D, "Wiring Diagrams," for illustrations of the wiring diagrams.
6. Assemble the terminal cover and apply power to the meter.

Installing a Battery

⚠ WARNING

The meter should be de–energized before installing the battery. Dangerous voltages are present; and equipment damage, personal injury, or death 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 battery, the A3 ALPHA meter must have been energized for at least 1 minute within the preceding hour. This ensures that the supercap is properly charged and that the battery is not immediately drained upon installation. If this is not done, then 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.

Energized for at Least 1 Minute

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

1. De–energize the meter.
2. Remove the meter cover to expose the battery well.
3. Connect the battery leads to the terminal on the front of the A3 ALPHA meter, just above the battery well.
4. Place the battery firmly in the battery well with the leads located near the bottom, extending through the broad slot.
5. Replace the meter cover.
6. Energize the meter and verify that the LCD becomes active and functioning properly.
7. Replace the seals.
8. Reprogram the meter or clear the errors (as necessary).

Not Energized for at Least 1 Minute

If the meter has not been energized for at least 1 minute during the previous hour, install the battery following this procedure:

1. Energize the meter for 1 minute.
2. De–energize the meter.
3. Remove the meter cover to expose the battery well.
4. Connect the battery leads to the terminal on the front of the A3 ALPHA meter, just above the battery well.
5. Place the battery firmly in the battery well with the leads located near the bottom, extending through the broad slot.
6. Replace the meter cover.
7. Energize the meter and verify that the LCD becomes active and functioning properly.
8. Replace the seals.
9. Reprogram the meter or clear the errors (as necessary).

Not following this procedure can cause the meter to function improperly. In case a battery has been installed correctly and the meter is not functioning properly (for example, display is blank but the meter is powered), use the following procedure:

1. De–energize the meter and let it sit without power for 48 to 72 hours. This provides sufficient time for the supercap to discharge and for the microcontroller to shut down.[1]
2. Energize the meter for at least 1 minute. The microcontroller should power up correctly and the supercap will charge. Verify that the LCD becomes active and functioning correctly.

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

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

[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, then the battery will lose approximately 8.5% of its service life each day.

Initial Setup

After installing and powering the A3 ALPHA 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. Other validation information can be obtained using the system instrumentation display quantities.
- All potential indicators (from 1 to 3 depending on the wiring) are present and are not flashing. A blinking indicator means that the phase is missing the required voltage or is below the programmed minimum voltage threshold value.
- The pulse indicator on the LCD is flashing, and the arrows indicate the correct energy flow direction.
- The meter is not in test mode.
- Required meter seals are in place.
- Any information (such as registration and location of the meter) has been recorded.

If the meter is not working correctly after it has been installed, then check for improper installation or wiring. If the installation and wiring are correct, then verify these other areas:

- the meter installation matches the meter nameplate
- the correct type of A3 ALPHA meter is installed in the existing service
- no evidence of mechanical or electrical damage to either the meter or the installation location
- the service voltage falls within the operating range as indicated on the nameplate
- the optical port is free of dirt or other obstructions
- the seals are not broken

NOTICE

A broken seal could be an indication of tampering with the A3 ALPHA meter installation.

Removing the Meter from Service

Removing an S–base meter is slightly different than removing an A–base meter. Use the appropriate procedure when removing an A3 ALPHA meter from service.

⚠ WARNING

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

Removing an S–Base Meter

⚠ WARNING

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

In case it becomes necessary to remove an A3 ALPHA meter from service, use the following procedure:

1. Before disconnecting the meter, make sure that the existing meter data has been copied, either manually or electronically using Elster Electricity meter support software.
2. Remove the voltage and disconnecting the current circuits.
3. Break the seal holding the A3 ALPHA meter in place.
4. Remove the seal and collar (or other security device).
5. Grasp each side of the meter and gently pull it from the socket. If the meter resists removal, gently rock it while pulling.

Removing an A–Base Meter

⚠ WARNING

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

In case it becomes necessary to remove an A3 ALPHA meter from service, use the following procedure:

1. Before disconnecting the meter, make sure that the existing meter data has been copied, either manually or electronically using Elster Electricity meter support software.
2. Remove the voltage and disconnect the current circuits.
3. Break the seal holding the A3 ALPHA 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 the top supporting screw.

Removing a Battery

⚠ WARNING

The meter should be de–energized before removing the battery. Dangerous voltages are present; and equipment damage, personal injury, or death 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 remove a battery from an A3 ALPHA meter:

1. De–energize the meter.
2. Remove the meter cover to expose the battery's location.
3. Firmly grasp the battery and lift it from the well.
4. Disconnect the battery leads from the terminal.
5. Replace the meter cover and ensure the seals are in place.

If the removed battery is still in working condition, it can be stored safely for future use. Non–functioning batteries should be disposed of according to local laws, regulations, or electric utility policies.

Disassembling the Meter

The A3 ALPHA meter can be disassembled. Figure 7-1 shows a disassembled meter and the various components.

⚠ WARNING

Do not disassemble the meter chassis or remove the electronic components with power present. Doing so could result in exposure to dangerous voltages resulting in equipment damage, personal injury, or death.

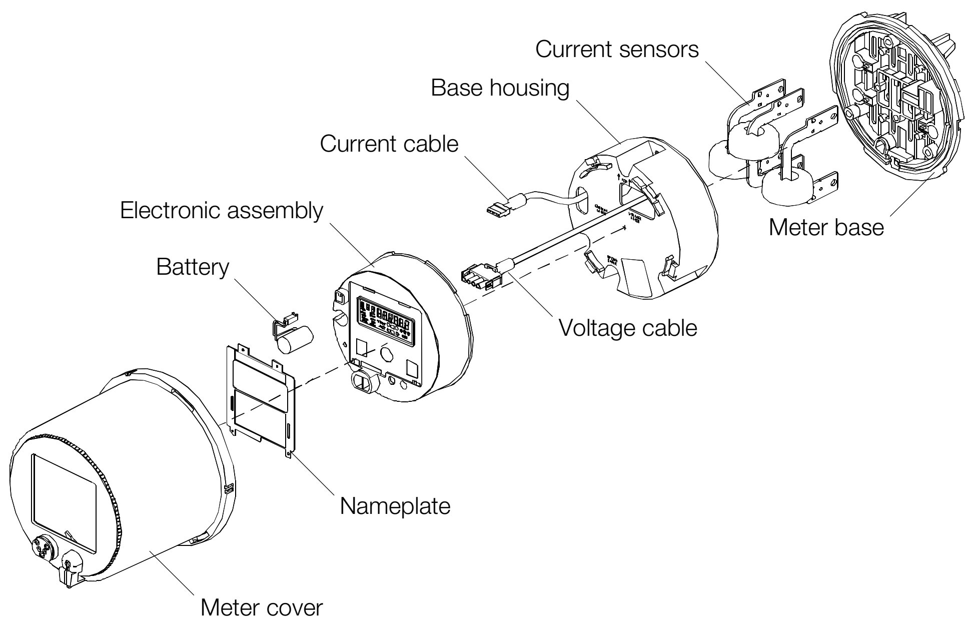


Figure 7-1. Disassembled A3 ALPHA meter

Removing the Meter Cover

Before disassembling the A3 ALPHA meter, first remove the meter cover.

1. Remove the T–seal or wire seal from the back of the meter.
2. While holding the bottom of the meter base, grasp the front of the meter cover and turn counterclockwise until it stops.
3. Pull the meter cover to reveal the electronic assembly and nameplate.

Removing the Nameplate

The meter cover must be off before the nameplate can be removed. Use this procedure to remove the nameplate:

- Flex the nameplate using a screwdriver until the tabs come out of the slots.

Removing the Electronic Assembly

The meter cover must be off before the electronic assembly can be removed. Use this procedure to remove the electronic assembly:

1. While holding the meter base, grasp the front of the electronic assembly and turn it counterclockwise until it stops.
2. Pull the electronic assembly away from the base housing. This reveals the relay cable (if option board is installed), current cable, and voltage cable.
3. Disconnect the cables from the back of the electronic assembly.

8. Loss Compensation

Introduction

What is Loss Compensation?

As defined in the *Handbook for Electricity Metering*, loss compensation is “a means for correcting the reading of a meter when the metering point and the point of service are physically separated resulting in measurable losses including I^2R losses in conductors and transformers, and iron-core losses. These losses may be added to, or subtracted from the meter registration.”[1] For example, it may be desirable to measure the energy usage on the low voltage side of a distribution transformer that serves an industrial customer even though the end-point customer actually owns the transformer and is responsible for any transformer losses. In this case, the utility billing point is actually the high voltage side of the transformer. Using loss compensation, the meter on the low voltage side of the transformer can actively adjust the energy registration to account for the losses in the transformer.

Availability

The loss compensation functionality is available only on the following A3 ALPHA meter configurations:

- Form 35S
- Form 35A
- Form 9S
- Form 10A
- Form 36S
- Form 36A
- 2-element FT case
- 2-½ element FT case
- 3-element FT case

[1] Edison Electric Institute, *Handbook for Electricity Metering*, tenth edition, Washington, DC: Edison Electric Institute, 2002, p. 16.

Software Support

A meter with loss compensation must first be programmed with the proper utility rate configuration using Metercat software just as you would with any other A3 ALPHA meter. Next a special programming step is performed to load the proper loss constants into the meter. This is done with special Windows–based software titled A3 ALPHA Meter Loss Compensation Tool.

Calculating the % Correction Values for Configuring the Meter

To configure the loss compensation feature of an A3 ALPHA meter you must input the following values into the loss compensation software. These values are site specific and must be uniquely determined for each loss compensation application.

Parameter	Description
%LWFe	Iron watts correction percentage
%LWCu	Copper watts correction percentage
%LVFe	Iron VARs correction percentage
%LVCu	Copper VARs correction percentage
Meter current	Meter current when power transformer is operating at maximum rating
Meter voltage	Meter voltage when power transformer is operating at rated voltage

These values must be calculated on the basis of the power transformer test report and, if line losses are to be included, the characteristics of the primary/secondary conductors at the specific site in question. The following sections describe these calculations.

Calculation of loss compensation parameters is dependent on the location of the meter with respect to the power transformer. The rated voltage and rated current used in the calculations must represent the values on the same side of the power transformer as the meter is located.

- If the meter is located on the secondary side of the power transformer, then the rated voltage and rated current used in the calculations must be secondary values.
- If the meter is located on the primary side of the power transformer, then the rated voltage and rated current used in the calculations must be primary values.

Gather Data Necessary for Calculation of Loss Compensation Parameters

The following information is necessary to calculate the loss compensation configuration parameters.

Parameter	Description
KVA_{rated}	Rated kVA of power transformer
$V_{pri\ L\text{-}L}$	Primary line-to-line voltage of power transformer
$V_{sec\ L\text{-}L}$	Secondary line-to-line voltage of power transformer
LWCu	Full load watts loss of power transformer (copper or winding losses)
LWFe	No load watts loss of power transformer (iron or core losses)
%EXC	Percent excitation current of the power transformer
%Z	Percent impedance of the power transformer
CTR	Current transformer ratio for instrument transformers supplying current to the meter
VTR	Voltage transformer ratio for instrument transformers supplying voltage to the meter
Elements	Number of meter elements (use 3 for all 2 ½ element meters)

Note: There may be one 3-phase transformer or a bank of three single phase transformers. If there are three single phase transformers then test data is needed for all three.

Calculate the meter configuration parameters

Step 1. Calculate the following quantities.

Parameter	Description
VA_{phase}	Per phase VA rating of power transformer
$V_{sec\ rated}$	Rated secondary voltage of power transformer
$I_{sec\ rated}$	Rated secondary current of power transformer
$V_{pri\ rated}$	Rated primary voltage of power transformer
$I_{pri\ rated}$	Rated primary current of power transformer
LWFe	No load watt loss of power transformer (loss watt iron)
LWCu	Full load watt loss of power transformer (loss watt copper)
LVAFe	No load VA loss of power transformer (loss VA iron)
LVACu	Full load VA loss of power transformer (loss VA copper)
LVFe	No load VAR loss of power transformer (loss VAR iron)
LVCu	Full load VAR loss of power transformer (loss VAR copper)

Item	Equation	
VA_{phase}	If bank of 3 transformers	$VA_{phase} = KVA_{rated} \times 1000$
	If one 3-phase transformer	$VA_{phase} = (KVA_{rated} \times 1000)/3$
$V_{sec\ rated}$	For 2 element, 3-wire delta applications	$V_{sec\ rated} = V_{sec\ L\text{-}L}$
	For 3 (and 2½) element, 4-wire wye applications	$V_{sec\ rated} = V_{sec\ L\text{-}L} / \sqrt{3}$
$V_{pri\ rated}$	For 2 element, 3-wire delta applications	$V_{pri\ rated} = V_{pri\ L\ -\ L}$
	For 3 (and 2½) element, 4-wire wye applications	$V_{pri\ rated} = V_{pri\ L\ -\ L} / \sqrt{3}$
$I_{sec\ rated}$	All applications	$I_{sec\ rated} = \sqrt{3} \times VA_{phase} / V_{sec\ L\text{-}L}$
$I_{pri\ rated}$	All applications	$I_{pri\ rated} = \sqrt{3} \times VA_{phase} / V_{pri\ L\text{-}L}$

Note: For a bank of three single phase transformers the below calculations should be performed independently for each transformer and then summed to obtain the total losses.

Parameter	Equation
LWFe	Take directly from power transformer test report
LWCu	Take directly from power transformer test report
LVAFe	$KVA_{rated} \times 1000 \times (\%EXC/100)$
LVACu	$KVA_{rated} \times 1000 \times (\%Z/100)$
LVFe	$\sqrt{LVAFe^2 - LWFe^2}$
LVCu	$\sqrt{LVCu^2 - LWCu^2}$

Step 2. If it is desired to compensate for line losses then calculate the Full Load Watt Line Loss and the Full Load VAR Line Loss values (see next section for details on line loss calculation)

Parameter	Description
LiW_{TOT}	Total full load watt line loss (line loss watt)
LiV_{TOT}	Total full load VAR line loss (line loss VAR)

Step 3. Calculate the Per Element % Correction Factors, the Meter Voltage, and the Meter Current. These are the values that must be entered into the loss compensation software to configure the meter properly.

- If the meter is on the primary side of the power transformer, then $V_{rated} = V_{pri\ rated}$ and $I_{rated} = I_{pri\ rated}$.
- If the meter is on the secondary side of the power transformer, then $V_{rated} = V_{sec\ rated}$ and $I_{rated} = I_{sec\ rated}$.

Parameter	Equation
%LWFe	$\frac{LWFe \times 100}{V_{rated} \times I_{rated} \times Elements}$
%LWCu	$\frac{(LWCu + LiW_{TOT}) \times 100}{V_{rated} \times I_{rated} \times Elements}$
%LVFe	$\frac{LVFe \times 100}{V_{rated} \times I_{rated} \times Elements}$
%LVCu	$\frac{(LVCu + LiV_{TOT}) \times 100}{V_{rated} \times I_{rated} \times Elements}$
Meter current	I_{rated} / CTR
Meter voltage	V_{rated} / VTR

Line Loss Calculations

Compensation for line losses may include primary losses, secondary losses, or both depending on the application.

Input Data Necessary to Calculate Line Losses

The following information is necessary to calculate the line losses.

Item	Description
f	Frequency
n	Number of conductors
L	Line length (units compatible with conductor resistance)
R_a	Conductor resistance (Ω/mile or Ω/1000 feet)
GMR[1]	Geometric mean radius of the phase conductors (ft)
X_a[1]	Inductive reactance of the conductor at 1ft. spacing (Ω/mile or Ω/1000 feet)

1. Either GMR or X_a is required (but not both). The available information determines which is used in the calculations.

Step 1. Calculate Line Resistance and Line Reactance

The equations below should be applied individually to the primary and the secondary conductors.

Item	Description
R_L	Line resistance (Ω)
X_L	Line reactance (Ω)
Deq	Geometric mean distance between phase conductors (ft)
Dab	Distance between phases A and B (ft)
Dbc	Distance between phases B and C (ft)
Dca	Distance between phases C and A (ft)

Item	Equation
R_L	$L \times Ra$

Calculating the reactive component of the impedance is not as straight forward as the resistance calculation, and the calculation depends on the wiring configuration. The most common configuration is one where the wires are unbundled and the spacing between wires is uniform. Other types of wiring, such as bundled conductors, will not be discussed in this document. Two equations can be used to calculate line reactance. The choice of which equation to use is based on the whether GMR or X_a is available.

Item	Equation	
X_L	If using GMR	$L \times 0.2794 \times (f/60) \times \text{Log}(D_{eq}/GMR)$
	If using X_a	$L \times [X_a + (0.2794 \times (f/60) \times \text{Log } D_{eq})]$

where $Deq = \sqrt[3]{Dab \times Dbc \times Dca}$

Step 2. Calculate the Line Losses

Item	Description
LiW_{TOT}	Total full load watt line loss (line loss watt)
LiV_{TOT}	Total full load VAR line loss (line loss VAR)
$V_{pri\ L\text{-}L}$	Primary line-to-line voltage of power transformer
$V_{sec\ L\text{-}L}$	Secondary line-to-line voltage of power transformer
$I_{sec\ rated}$	Rated secondary current of power transformer
$I_{pri\ rated}$	Rated primary current of power transformer

Note: $V_{pri\ L\text{-}L}$, $V_{sec\ L\text{-}L}$, $I_{pri\ rated}$, and $I_{sec\ rated}$ are the same values as used in calculation of transformer losses (see previous section).

When compensating for both transformer and line losses:

Item	Equation
LiW_{sec}	$I_{sec\ rated}^2 \times R_{L\ sec} \times n$
LiV_{sec}	$I_{sec\ rated}^2 \times X_{L\ sec} \times n$
LiW_{pri}	$I_{pri\ rated}^2 \times R_{L\ pri} \times n$
LiV_{pri}	$I_{pri\ rated}^2 \times X_{L\ pri} \times n$
LiW_{TOT}	$LiW_{sec} + LiW_{pri}$
LiV_{TOT}	$LiV_{sec} + LiV_{pri}$

Note: In the special case that you are compensating only for line loss (no transformer losses), then the values for $I_{pri\ rated}$ and $I_{sec\ rated}$ must be directly specified by the user. Typically, these two values will be inversely proportional to the rated secondary and primary voltages of the power transformer. That is,
$I_{pri\ rated}/I_{sec\ rated} = V_{sec\ rated}/V_{pri\ rated}$.

Step 3. If compensating for both transformer and line losses return to Step 3 of the previous section using the above calculated line losses to help calculate the %LWCu and %LVCu values. If compensating only for line losses use the following equations to calculate the per element % Correction Factors, the Meter Voltage, and the Meter Current for entry in the Loss Compensation software fields.

- If the meter is on the primary side of the power transformer, $I_{rated} = I_{pri\ rated}$.
- If the meter is on the secondary side of the power transformer, $I_{rated} = I_{sec\ rated}$.

V_{rated} is the nominal voltage seen on the high side of the instrument transformer supplying voltage to the meter.

Item	Equation
%LWFe	0
%LWCu	$\frac{LiW_{TOT} \times 100}{V_{rated} \times I_{rated} \times Elements}$
%LVFe	0
%LVCu	$\frac{LiV_{TOT} \times 100}{V_{rated} \times I_{rated} \times Elements}$
Meter current	I_{rated} / CTR
Meter voltage	V_{rated} / VTR

Calculation Example

The following example can be used as a guideline. This is based on the sample transformer data for loss compensation shown in chapter 10 of the *Handbook for Electricity Metering* (10^{th} edition).[2]

Application notes:

- The application is a bank of three single-phase power transformers.
- The metering occurs on the low (secondary) side of a power transformer, and losses will be added to the measured energy.
- There is a Delta connection on the secondary of the power transformer and thus a 2-element meter will be used to measure the service.
- Losses are being compensated for the power transformer only (no line losses).

Inputs

Table 8-1. Power Transformer Data (from Transformer Manufacturer)

	Phase 1	Phase 2	Phase 3
KVA_{rated}	3333	3333	3333
$V_{pri\ L\text{-}L}$	115000	115000	115000
$V_{sec\ L\text{-}L}$	2520	2520	2520
LWFe	9650	9690	9340
LWCu	18935	18400	18692
%EXC	1.00	1.06	0.91
%Z	8.16	8.03	8.12

Table 8-2. Instrument Transformer Data

Item	Value
CTR	3000/5 = 600
VTR	2400/120 = 20

Meter Data

- Elements = 2

2 Edison Electric Institute, *Handbook for Electricity Metering*, tenth edition, Washington, DC: Edison Electric Institute, 2002, Chapter 10, “Special Metering,” pp. 249-288.

Calculations

Note: Because the metering is on the secondary side of the power transformer, all references to rated voltage and rated current refer to the *secondary* rated values.

Item	Description
VA_{phase}	$KVA_{rated} \times 1000 = 3333 \times 1000 = 3{,}333{,}000$
V_{rated}	$V_{sec\ L\text{-}L} = 2520$
I_{rated}	$\sqrt{3} \times VA_{phase} / V_{sec\ L\text{-}L} = \sqrt{3} \times 3{,}333{,}000 / 2520 = 2290.84$
Meter voltage	V_{rated} / PT = 126V
Meter current	I_{rated} / CT = 3.82A

Phase 1. Calculations

Item	Value
LWFe	9650
LWCu	18935
LVAFe	$KVA_{rated} \times 1000 \times (\%EXC/100) = 3333 \times 1000 \times (1.00/100) = 33330$
LVACu	$KVA_{rated} \times 1000 \times (\%Z/100) = 3333 \times 1000 \times (8.16/100) = 271973$
LVFe	$\sqrt{LVAFe^2 - LWFe^2} = \sqrt{33330^2 - 9650^2} = 31902$
LVCu	$\sqrt{LVACu^2 - LWCu^2} = \sqrt{271973^2 - 18935^2} = 271313$

Phase 2. Calculations

Item	Value
LWFe	9690
LWCu	18400
LVAFe	$KVA_{rated} \times 1000 \times (\%EXC/100) = 3333 \times 1000 \times (1.06 / 100) = 35330$
LVACu	$KVA_{rated} \times 1000 \times (\%Z/100) = 3333 \times 1000 \times (8.03 / 100) = 267640$
LVFe	$\sqrt{LVAFe^2 - LWFe^2} = \sqrt{35330^2 - 9690^2} = 33975$
LVCu	$\sqrt{LVACu^2 - LWCu^2} = \sqrt{267640^2 - 18400^2} = 267007$

Phase 3. Calculations

Item	Value
LWFe	9340
LWCu	18692
LVAFe	$KVA_{rated} \times 1000 \times (\%EXC/100) = 3333 \times 1000 \times (0.91 / 100) = 30330$
LVACu	$KVA_{rated} \times 1000 \times (\%Z/100) = 3333 \times 1000 \times (8.12 / 100) = 270640$
LVFe	$\sqrt{LVAFe^2 - LWFe^2} = \sqrt{30330^2 - 9340^2} = 28856$
LVCu	$\sqrt{LVACu^2 - LWCu^2} = \sqrt{270640^2 - 18692^2} = 269993$

From the above:

Item	Value
LWFe	9650 + 9690 + 9340 = 28680
LWCu	18935 + 18400 + 18692 = 56027
LVFe	31902 + 33975 + 28856 = 94734
LVCu	271313 + 267007 + 269993 = 808313

Per the stated assumptions, there is no compensating for line losses:

Item	Value
LiW_{TOT}	0
LiV_{TOT}	0

Now the per element % Correction Factors may be calculated:

Item	Value
%LWFe	$\frac{LWFe \times 100}{V_{rated} \times I_{rated} \times Elements} = \frac{28680 \times 100}{2520 \times 2290.84 \times 2} = 0.2484$
%LWCu	$\frac{(LWCu + LiW_{TOT}) \times 100}{V_{rated} \times I_{rated} \times Elements} = \frac{56027 \times 100}{2520 \times 2290.84 \times 2} = 0.4853$
%LVFe	$\frac{LVFe \times 100}{V_{rated} \times I_{rated} \times Elements} = \frac{94734 \times 100}{2520 \times 2290.84 \times 2} = 0.8205$
%LVCu	$\frac{(LVCu + LiV_{TOT}) \times 100}{V_{rated} \times I_{rated} \times Elements} = \frac{808313 \times 100}{2520 \times 2290.84 \times 2} = 7.0009$

Item	Value
Meter current	I_{rated} / CTR = 2290.84 / 600 = 3.82A
Meter voltage	V_{rated} / VTR = 2520 / 20 = 126V

Summary of Calculated Values to Enter in A3 ALPHA Meter Loss Compensation Tool:

Parameter	Value
Registration	Add losses
Iron watts correction %	0.2484
Copper watts correction %	0.4853
Iron VARs correction %	0.8205
Copper VARs correction %	7.0009
Meter current	3.82
Meter voltage	126

Internal Meter Calculations

To understand the loss compensation calculations, it is first necessary to understand a little bit about how the A3 ALPHA meter engine operates. Internal to the meter engine Vrms and Irms are measured independently on each phase every two line cycles. These values are used to perform the normal energy calculations on each phase every two line cycles. The individual phase measurements are then summed. This drives an internal accumulator in the meter engine that generates a pulse to the microcontroller when a threshold level is reached. The threshold level at which a pulse is generated is known as the meter K_e (energy per pulse). There are separate calculations, separate accumulators and separate K_e pulses generated for each measured energy quantity (for example, kWh-delivered, kVARh-delivered).

When loss compensation is turned on, additional calculations are performed. Every two line cycles on each phase, the Vrms and Irms values used in the normal energy calculations are also used to calculate a watt compensation value and a VAR compensation value. The following equations indicate the compensation terms that are calculated and applied to the normal energy measurements every two line cycles.

For a 3–element meter, watts and VARs are compensated every two line cycles according to the following equations:

Compensation	Equation
Watt	$R \times (Ia_{meas}^2 + Ib_{meas}^2 + Ic_{meas}^2) + G \times (Va_{meas}^2 + Vb_{meas}^2 + Vc_{meas}^2)$
VAR	$X \times (Ia_{meas}^2 + Ib_{meas}^2 + Ic_{meas}^2) + B \times (Va_{meas}^4 + Vb_{meas}^4 + Vc_{meas}^4)$

For a 2 element meter, watts and VARs are compensated every two line cycles according to the following equations:

Compensation	Equation
Watt	$R \times (Ia_{meas}^2 + Ic_{meas}^2) + G \times (Va_{meas}^2 + Vc_{meas}^2)$
VAR	$X \times (Ia_{meas}^2 + Ic_{meas}^2) + B \times (Va_{meas}^4 + Vc_{meas}^4)$

Where

Item	Description
R	Per element resistance
G	Per element conductance
X	Per element reactance
B	Per element susceptance
Ix_{meas}	Per phase rms current
Vx_{meas}	Per phase rms voltage

The A3 ALPHA Meter Loss Compensation Tool calculates R, G, X, and B using the following formulas and then programs these values into the meter.

Item	Equation
R	$\frac{\%LWCu \times \text{Meter voltage}}{\text{Meter current} \times 100}$
G	$\frac{\%LWFe \times \text{Meter current}}{\text{Meter voltage} \times 100}$
X	$\frac{\%LVCu \times \text{Meter voltage}}{\text{Meter current} \times 100}$
B	$\frac{\%LVFe \times \text{Meter current}}{(\text{Meter voltage})^3 \times 100}$

The compensation terms will be either positive or negative depending on whether losses are configured to be added or subtracted from the energy measurements. So, the key difference on meters with loss compensation is that every two line cycles on each phase, the calculated Watt compensation value is summed with the normal

Watthour energy calculations. Similarly, the VAR compensation term is summed per phase every two line cycles with the normal VARhour energy calculations. From that point everything is essentially the same (individual phases are then summed to drive an accumulator).

Note regarding two-element meters: Two-element ALPHA meters are unique in that they create an artificial internal reference that is used to measure the phase voltages. In the special case that phase C experiences a loss of voltage while the meter remains powered (either from phase A or from an auxiliary supply) the internal meter engine will still measure a phase C voltage equal to one-half of the phase A voltage. In applications where loss compensation is not applied this has no impact on the measurement of energy because no power will be drawn by the load on phase C. That is, phase C current equals zero and so the net energy measured on phase C is accurately calculated as zero. However, in the special case of a meter that is compensating for transformer losses, the no-load compensation terms are based solely on the measured voltage on each phase (see above formulas). Therefore, on 2-element ALPHA meters with loss compensation enabled, if phase C voltage is lost while the meter remains powered, the no load compensation terms for phase C will be in error because they will be calculated based on one-half the phase A voltage.

Meter Outputs

Introduction

When loss compensation is enabled on an A3 ALPHA meter all of the following use the compensated values:

- all register billing data
- all pulse profile data
- all KYZ pulse outputs
- all test pulses (both in the LCD and on the LED)

Compensation does not affect instrumentation values or the meter features that use instrumentation values. Regardless of the status of loss compensation all instrumentation values reflect the actual measured values as seen at the meter terminals. For example, per phase voltage values are not affected (whether displayed on the LCD or reported in Metercat software). Likewise PQM functions and instrumentation profiling values are not affected when compensation is active.

Testing a Meter with Compensation

The test LED on A3 ALPHA meters always reflects the current measurement algorithm in the meter engine. That is, if compensation is turned on then the LED will indicate compensated energy. If compensation is turned off then the LED will indicate uncompensated energy. Because the test LED always reflects the state of the compensation it reduces the chance that a meter with active compensation is accidentally installed unknowingly.

Using the A3 ALPHA Meter Loss Compensation Tool, it is possible to configure the meter to automatically turn off compensation whenever the meter enters test mode. This may or may not be desired depending on utility testing practices.

The loss compensation software also permits the A3 ALPHA meter loss compensation function to be manually turned off and turned on without altering the loss compensation parameters configured in the meter.

Utilities may desire to calculate the expected test results of a compensated meter and then test the meter with active compensation to verify that the expected results are obtained.

A. Glossary

Alpha Keys. A system combining hardware and software to upgrade existing A3 ALPHA meters. Keys allow addition of new functionality to an existing meter for an additional fee.

ALT button. The push button that activates the alternate mode. It also can be used to control the scrolling of display quantities in the different operating modes.

alternate mode. The operating mode in A3 ALPHA meters used to display a second set of display quantities on the LCD. It is generally activated by pressing the **ALT** button or using the magnetic reed switch on the meter. A typical use of the alternate mode is to display non–billing data as programmed by Elster Electricity meter support software.

AvgPF. see *average power factor.*

average power factor. Calculated once every second, when the meter is not in test mode, using the following formulas:

Method 1	Method 2
$\text{AvgPF} = \frac{\text{kWh}}{\text{kVAh}}$	$\text{AvgPF} = \frac{\text{kWh}}{\sqrt{\text{kVARh}^2 + \text{kWh}^2}}$

base housing. The part of the meter containing all of the following components:

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

billing data. The measured quantities recorded and stored by the meter for use in billing the consumer. May also be referred to as *tariff data*.

bit. Short for *binary digit*. It is the smallest information unit used in data communications and storage.

coincident. Information regarding one parameter occurring at the same time as another. For example, 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 A3 ALPHA meter was last programmed or a clear of the values and status.

complete LCD test. A display showing 8 in all the display areas and all identifiers on the LCD turned on. This confirms that all segments are operating properly.

continuous cumulative. A display technique used with demand calculations and similar to cumulative demand except continuous cumulative demand is updated constantly.

CTR. see *current transformer ratio*.

cumulative. A display technique used with demand calculations. Upon a demand reset, the present maximum demand is added to the sum of the previous maximum billing period demand values.

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

data–altering communication. Any communication that performs any of the following actions:

- writes to a meter table
- clears data
- resets log pointers or data set pointers
- resets the demand
- performs a self read
- performs a season change

del. see *delivered*.

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

demand. The average power computed over a specific time.

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 time period over which demand is calculated. Demand interval must be evenly divisible into 60 minutes.

demand–only meter. An A3D meter or any other meter type that has been programmed as a demand meter. See also *TOU meter*.

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.

demand threshold. The present value of demand which when reached initiates a relay closure or other programmed action.

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

EEPROM. Acronym for *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 display. The method by which the meter displays an error message which consists of Er and numeric codes. The code indicates a condition or conditions that can adversely affect the proper operation of the meter.

event log. The event log provides a record of entries that date and time stamp specific events such as:

- power outages
- demand resets
- entering test mode
- time changes

external display multiplier. Used when the transformer factor is larger than can be stored within the A3 ALPHA meter. When programmed with Elster Electricity meter support software for an external display multiplier, display quantities read from the meter LCD must be manually multiplied by this value to yield proper readings.

factory default. Operating parameters that 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).

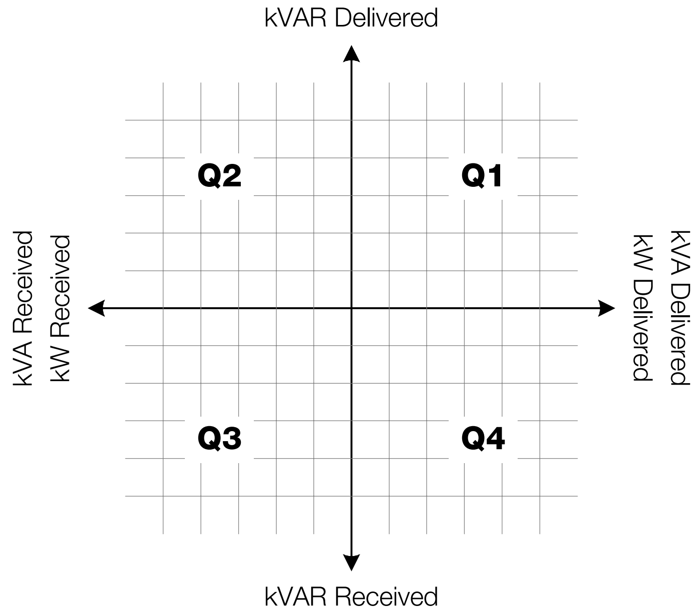


Figure A-1. Four quadrant metering quantity relationships

IC. see *integrated circuit*.

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 to reflect the energy and demand values on the primary side of the instrument transformer.

integrated circuit. Generally used to reference the custom meter circuit used in the A3 ALPHA meter for per phase voltage and current sampling plus energy measurements.

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

K_h. A meter constant representing the watthours per output pulse on the optical port. Historically, K_h represents the 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 timekeeping applications in lieu of the internal oscillator. Depending upon the country or region, the line frequency is either 50Hz or 60Hz.

liquid crystal display. The LCD allows metered quantities and other information about the A3 ALPHA meter and installed service to be viewed. Display quantities are programmable through Elster Electricity 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 profiling. Load profiling records energy usage per a specific time interval while the meter is energized. Load profiling 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.

microcontroller. A single chip that contains the following components:

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

non–recurring dates. Holidays or other specific dates that are not based upon a predictable, repeated pattern.

normal mode. The default operating mode for the A3 ALPHA meter. Typically, normal mode displays billing data on the LCD following a programmed sequence.

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

outage log. Display quantity that shows the cumulative total outage time in minutes.

P/R. see *pulse ratio.*

previous billing data. Used to describe the billing data recorded at the demand reset. See also *self read.*

previous season data. Used to describe the billing data for the season preceding the present billing season.

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 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.

pulse ratio. Pulses per equivalent disk revolution. On ALPHA meters, 1 revolution is equal to 1 K_h period.

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. Holidays or other special dates that occur on a predictable basis.

self read. The capturing of current billing data and storing it in memory. Self reads are scheduled events that can be triggered by the specific day of month, every set number of days, or command by Elster Electricity meter support software. See also *previous billing data*.

tariff data. See *billing data.*

TOU. see *time–of–use.*

TOU meter. An A3T, A3K, or A3R meter that is programmed to record energy usage and demand data on a TOU basis. See also *demand–only meter.*

test mode. The test mode stores billing data in a secure memory location while the meter measures and displays energy and demand data for testing purposes. The **TEST** identifier will flash while the test mode is active. When test mode is exited, the accumulated test data is discarded and the original billing data is restored.

timekeeping. The ability of the meter to keep a real time clock, including date and time.

time–of–use. A billing rate that records energy usage and demand data related to specific times during the day. See also *timekeeping.*

transformer–rated. A meter designed to work with current or voltage transformers. The maximum current of a transformer–rated A3 ALPHA meter is typically 20A.

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

VTR. see *voltage transformer ratio*.

B. Display Table

Display Format

Displayable items are described in "Display Quantities" on page B-3. The A3 ALPHA meter supports up to 64 quantities for display on the LCD. The LCD can be divided into different regions, as described in Table B-1. See "LCD" on page 3-2 for more information on the LCD regions.

Table B-1. LCD regions

Item	Description
Quantity identifier	Identifies the displayed quantity. Using Elster Electricity meter support software, an identifier can be assigned to most quantities. For instrumentation quantities, the identifiers are fixed.
Display quantity	Shows metered quantities or other displayable information. From 3 to 6 total digits with up to 4 decimal places can be used. These digits are also used to report the following: • operational errors • system instrumentation and service test errors • warnings • communication codes
Display identifiers	More precisely identifies the information presented on the LCD.
Power/energy unit identifier	Indicates the unit of measurement for the quantity displayed on the LCD.

The display items for the normal mode, alternate mode, and test mode are programmed from the 64 available items.

The display format for all displayable items can be programmed using Elster Electricity meter support software. The A3 ALPHA meter LCD is capable of supporting the following characters in the quantity identifier and the display quantity regions:

- all numbers (0 to 9)
- all alphabetical characters (except *k*, *m*, *q*, *w*, and *x*)
- ° (degree)
- L (indicating locked service)

Display Quantities

NOTICE

Additional display items may also be available depending upon the version of Elster Electricity meter support software. See the software help or technical manual for a list of the displayable quantities.

Displayable items can be grouped into the following categories:

- general meter information
- LCD test
- metered quantities
- system instrumentation
- system service test
- errors and warnings
- communication codes
- PQM values

Display Formats

See Table B-2 for a description of some of the special characters that have been used in the dsiplay quantity examples.

Table B-2. 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 (alphanumeric)

The display format on the LCD (such as the quantity identifier, display identifier, and the value shown in the display quantity) is programmable through Elster Electricity meter support software. See “Display Format” on page B-2 for more information.

LCD Test

The A3 ALPHA meter tests the LCD by displaying all the identifiers, as shown in Table B-1. The meter tests the LCD for 3 seconds after power up.

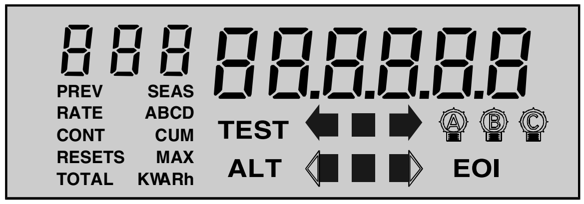


Figure B-1. LCD test

Display quantity	Display ID & units	ID	Value
LCD test		888	888888

General Meter Information Quantities

General meter information quantities are items that are not associated with any particular pulse or instrumentation source.

Display quantity	Display ID & units	ID	Value
Account:1		iii	aa
Account:2		iii	aaaaaa
Account:3		iii	aaaaaa
Account:4		iii	aaaaaa
Meter ID:1		iii	xx
Meter ID:2		iii	xxxxxx
Meter ID:3		iii	xxxxxx
Meter ID:4		iii	xxxxxx
Meter type		iii	aa
Firmware product		iii	aaaaaa
Firmware version		iii	aaa
Firmware revision		iii	aaa
Hardware version		iii	aaa
Hardware revision		iii	aaa
DSP code		iii	aa
DSP code revision		iii	aaa

Meter Configuration Quantities

Display quantity	Display ID and units	ID	Value
Program ID		iii	xxxxxx
Pulse ratio (P/R)		iii	xxx
Current transformer (CT) ratio		iii	xxxx.xx
Voltage transformer (VT) ratio		iii	xxxx.xx
Normal mode demand interval/subinterval		iii	xx xx
Test mode demand interval/subinterval		iii	xx xx
Watthours per pulse (K_e)		iii	xxx.xxx
Meter Kh		iii	xxxx.xx
Transformer factor (CT × VT)		iii	xxxxxx
External multiplier		iii	xxxxxx
Demand overload value		iii	xxx.xx (1)
Currently locked service		RRR	VVV^{L}TT

1. The decimal is adjusted based on the demand settings, as programmed by Elster Electricity meter support software.

Status Quantities

Display quantity	Display ID and units	ID	Value
Communication session count (port 1)		iii	xxxxx
Communication session count (port 2)		iii	xxxxx
Days since demand reset		iii	xxx
Days since input pulse		iii	xxx
Number of manual demand resets		iii	xxxxx
Number of all demand resets		iii	xxx
Power outage count		iii	xxx
Initial remote baud (port 1)		iii	xxxxxx
Initial remote baud (port 2)		iii	xxxxxx
Last Elster Electricity configuration change date		iii	xx.xx.xx (1)
Demand reset date		iii	xx.xx.xx (1)
Last power outage start date		iii	xx.xx.xx (1)
Last power outage start time		iii	xx.xx.xx (1)
Last power outage end date		iii	xx.xx.xx (1)
Last power outage end time		iii	xx.xx.xx (1)
Current date		iii	xx.xx.xx (1)
Current time		iii	xx.xx.xx (1)
Current day of week		iii	xx
Current season		iii	xx

Display quantity	Display ID and units	ID	Value
Date of last pending table activation		iii	xx.xx.xx (1)
Errors present?		iii	YES/nO
Warnings present?		iii	YES/nO
Time remaining in subinterval		iii	mm ss
Pulse count (Wh-delivered)		iii	xxxxxx
Pulse count (alternate energy-delivered)		iii	xxxxxx
Pulse count (Wh-received)		iii	xxxxxx
Pulse count (alternate energy-received)		iii	xxxxxx

1. Using Elster Electricity meter support software, the date format is programmable to allow any combination of month, day, and year.

Metered Quantities

A3D and A3T meters can measure only one quantity. The quantity to be measured is configurable with Elster Electricity meter support software. Typically, the measured quantity is kWh/kW.

A3K and A3R meters can measure two quantities. Meters with the optional advanced four–quadrant metering can measure six quantities. The A3 ALPHA meter can display the available metered quantities for each meter type. Date, time, and rate values are not available on A3D meters or any other meter configured for demand–only operation.

Display quantity (1)	Display ID and units (2)	ID	Value
Total energy	TOTAL KW h	iii	xxxxxx
Maximum demand	MAX	iii	xxxxxx
Date of maximum demand		iii	xx.xx.xx (3)
Time of maximum demand		iii	hh mm
Cumulative demand	CUM KW (4)	iii	xxxxxx
Rate A energy	RATE A KW h	iii	xxxxxx
Rate A maximum demand	RATE A MAX KW	iii	xxxxxx
Rate A date of maximum demand	RATE A	iii	xx.xx.xx (3)
Rate A time of maximum demand	RATE A	iii	hh mm
Rate A cumulative demand	RATE A CUM KW (4)	iii	xxxxxx
Rate B energy	RATE B KW h	iii	xxxxxx
Rate B maximum demand	RATE B MAX KW	iii	xxxxxx
Rate B date of maximum demand	RATE B	iii	xx.xx.xx (3)
Rate B time of maximum demand	RATE B	iii	hh mm
Rate B cumulative demand	RATE B CUM KW (4)	iii	xxxxxx
Rate C energy	RATE C KW h	iii	xxxxxx
Rate C maximum demand	RATE C MAX KW	iii	xxxxxx
Rate C date of maximum demand	RATE C	iii	xx.xx.xx (3)

Display quantity (1)	Display ID and units (2)	ID	Value
Rate C time of maximum demand	RATE C	iii	hh mm
Rate C cumulative demand	RATE C CUM KW (4)	iii	xxxxxx
Rate D energy	RATE B KW h	iii	xxxxxx
Rate D maximum demand	RATE B MAX KW	iii	xxxxxx
Rate D date of maximum demand	RATE B	iii	xx.xx.xx (3)
Rate D time of maximum demand	RATE B	iii	hh mm
Rate D cumulative demand	RATE B CUM KW (4)	iii	xxxxxx

1. The terms *energy* and *demand* represent any available metered quantity for a meter type. See “Metered Energy and Demand Quantities” on page 2-4 for more information.
2. If the meter is programmed for kVAh or kVARh, the display ID would indicate KVA h or KVARh. Similarly, if the meter is programmed for kVA or kVAR, the display ID would indicate KVA or KVAR.
3. Using Elster Electricity meter support software, the date format is programmable to allow any combination of month, day, and year.
4. If the meter is configured for continuous cumulative demand, the display ID for these quantities will include CONT along with CUM.

Average Power Factor Quantities

Only A3K and A3R meters can measure average power factor. Additionally, A3KA and A3RA meters can measure two different average power factors (for example, one for delivered energy and one for received energy). The method for calculating average power factor is configurable by Elster Electricity meter support software. For each average power factor, the following items are available for display.

Display quantity	Display ID and units	ID	Value
Average power factor		iii	x.xxx
Rate A average power factor	RATE A	iii	x.xxx
Rate B average power factor	RATE B	iii	x.xxx
Rate C average power factor	RATE C	iii	x.xxx
Rate D average power factor	RATE D	iii	x.xxx

Coincident Demand and Power Factor Quantities

A3D and A3T meters do not measure coincident quantities. A3K and A3R meters can measure two coincident quantities. Additionally, A3KA and A3RA meters can measure four coincident quantities. Coincident quantities are configurable with Elster Electricity meter support software to be any demand or average power factor value captured at the time of a maximum demand value. For each coincident value, the following items is available for display:

Display quantity	Display ID and units (1)	ID	Value
Coincident demand	KW	iii	xxxxxx
Rate A coincident demand	RATE A KW	iii	xxxxxx
Rate B coincident demand	RATE B KW	iii	xxxxxx
Rate C coincident demand	RATE C KW	iii	xxxxxx
Rate D coincident demand	RATE D KW	iii	xxxxxx

1. If the meter is configured to record coincident kVA or kVAR, the display ID would indicate KVA or KVAR.

Display quantity	Display ID and units	ID	Value
Coincident power factor		iii	x.xxx
Rate A coincident power factor	RATE A	iii	x.xxx
Rate B coincident power factor	RATE B	iii	x.xxx
Rate C coincident power factor	RATE C	iii	x.xxx
Rate D coincident power factor	RATE D	iii	x.xxx

System Instrumentation

The A3 ALPHA meter can display system instrumentation quantities. See “System Instrumentation” on page 4-2 for a listing of the instrumentation quantities that can be displayed.

Display quantity	Display ID and units	ID	Value
Line frequency		SYS	xx.xxhZ
Phase A voltage		PhA	xxx.x U
Phase B voltage		PhB	xxx.x U
Phase C voltage		PhC	xxx.x U
Phase A current		PhA	xxx.x A (1)
Phase B current		PhB	xxx.x A (1)
Phase C current		PhC	xxx.x A (1)
Phase A power factor		PhA	xx.xxPF
Phase B power factor		PhB	xx.xxPF
Phase C power factor		PhC	xx.xxPF
Phase A power factor angle		PhA	xx.xx°
Phase B power factor angle		PhB	xx.xx°
Phase C power factor angle		PhC	xx.xx°
Phase A voltage phase angle		PhA	xxx.x°U
Phase B voltage phase angle		PhB	xxx.x°U
Phase C voltage phase angle		PhC	xxx.x°U
Phase A current phase angle		PhA	xxx.x°A
Phase B current phase angle		PhB	xxx.x°A

Display quantity	Display ID and units	ID	Value
Phase C current phase angle		PhC	xxx.x°A
Phase A kW	KW	PhA	xxx.xxx
Phase B kW	KW	PhB	xxx.xxx
Phase C kW	KW	PhC	xxx.xxx
Phase A kVAR	KVAR	PhA	xxx.xxx
Phase B kVAR	KVAR	PhA	xxx.xxx
Phase C kVAR	KVAR	PhC	xxx.xxx
Phase A kVA	KVA	PhA	xxx.xxx
Phase B kVA	KVA	PhB	xxx.xxx
Phase C kVA	KVA	PhC	xxx.xxx
System kW	KW	SYS	xxx.xxx
System kVAR (arithmatic)	KVAR	SYS	xxx.xxx
System kVA (arithmatic)	KVA	SYS	xxx.xxx
System power factor (arithmatic)		SYS	xx.xxPF
System power factor angle (arithmatic)		SYS	xx.xx °
System kVAR (vectorial)	KVAR	SYS	xxx.xxx
System kVA (vectorial)	KVA	SYS	xxx.xxx
System power factor (vectorial)		SYS	xx.xxPF
System power factor angle (vectorial)		SYS	xx.xx °
Phase A voltage % THD		ThA	xx.xxdU
Phase B voltage % THD		ThB	xx.xxdU
Phase C voltage % THD		ThC	xx.xxdU
Phase A current % THD		ThA	xx.xxdA
Phase B current % THD		ThB	xx.xxdA
Phase C current % THD		ThC	xx.xxdA
Phase A TDD		TdA	xx.xxdA
Phase B TDD		TdB	xx.xxdA
Phase C TDD		TdC	xx.xxdA
Phase A fundamental voltage magnitude		IhA	xxx.x U
Phase B fundamental voltage magnitude		IhB	xxx.x U
Phase C fundamental voltage magnitude		IhC	xxx.x U
Phase A fundamental current magnitude		IhA	xxx.x A (1)
Phase B fundamental current magnitude		IhB	xxx.x A (1)
Phase C fundamental current magnitude		IhC	xxx.x A (1)
Phase A 2nd harmonic voltage magnitude		2hA	xxx.x U
Phase B 2nd harmonic voltage magnitude		2hb	xxx.x U
Phase C 2nd harmonic voltage magnitude		2hC	xxx.x U
Phase A 2nd harmonic current magnitude		2hA	xxx.x A (1)
Phase B 2nd harmonic current magnitude		2hb	xxx.x A (1)

Display quantity	Display ID and units	ID	Value
Phase C 2nd harmonic current magnitude		2hC	xxx.x A (1)
Phase A 2nd harmonic voltage % distortion		2hA	xx.xxdU
Phase B 2nd harmonic voltage % disotrion		2hb	xx.xxdU
Phase C 2nd harmonic voltage % distortion		2hC	xx.xxdU
Phase A harmonic current distortion (2nd - 15th)		ThA	xxx.x A (1)
Phase B harmonic current distortion (2nd - 15th)		Thb	xxx.x A (1)
Phase C harmonic current distortion (2nd - 15th)		ThC	xxx.x A (1)

1. Two decimals on meters of Class 20 and below. One decimal on meters of greater than Class 20.

System Service Tests

The A3 ALPHA meter can display the validity of the electricity service where it is installed. See "System Service Tests" on page 4-7 for more information.

Errors and Warnings

The A3 ALPHA meter displays error codes and warning codes as an indication of a problem that may be affecting its operation. See "Error Codes" on page 6-3 and "Warning Codes" on page 6-8 for more information.

Communication Codes

The A3 ALPHA meter indicates the status of a communication session by displaying it on the LCD. See "Communication Codes" on page 6-11.

C. Nameplate Information

A3 ALPHA Meter Nameplate

The A3 ALPHA nameplate provides important information about the meter. The nameplate can be configured to meet the needs of the utility company; however, Figure C-1 is an illustration of the standard A3 ALPHA nameplate for transformer rated meters.

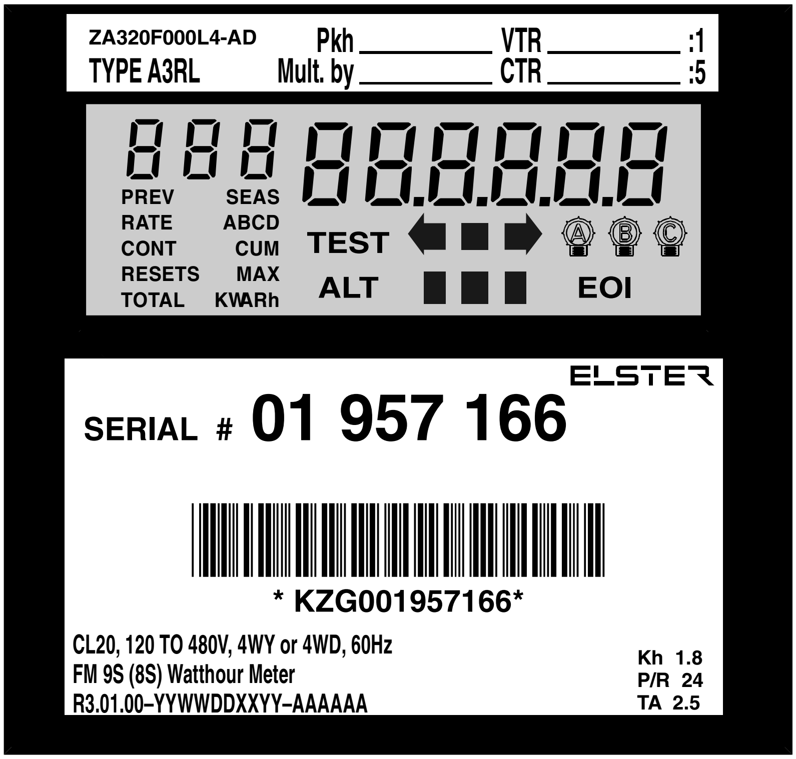


Figure C-1. Standard nameplate (transformer rated)

The following figures identify the different areas of the nameplate along with the information they convey.

Top Portion

Figure C-2 shows the top portion of the nameplate for transformer rated meters. The nameplate displays the style number, meter type, and multipliers for the meter.

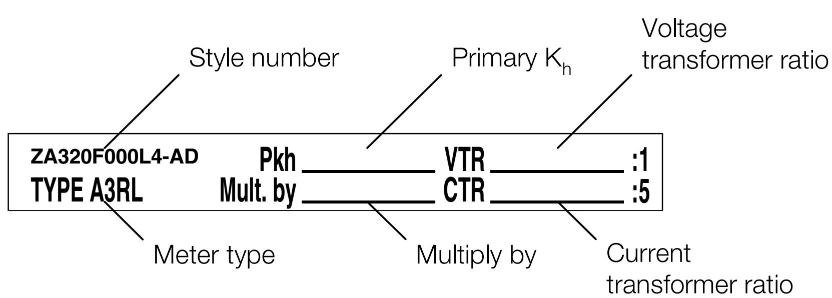


Figure C-2. Top portion of the standard nameplate (transformer rated)

Figure C-3 shows the top portion of the nameplate for self contained meters. The nameplate displays the style number and meter type.

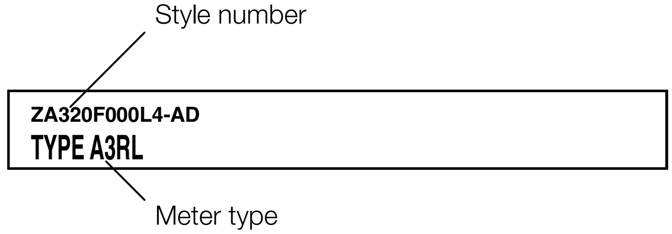


Figure C-3. Top portion of the standard nameplate (self contained)

LCD

See "LCD" on page 3-2 for information on the LCD.

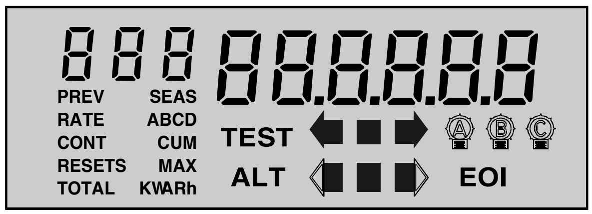


Figure C-4. Liquid crystal display

Lower Portion

The lower portion of the nameplate displays the serial number, barcode, form factor information, and meter constants for the meter.

See Table C-1 for a description of the firmware version information.

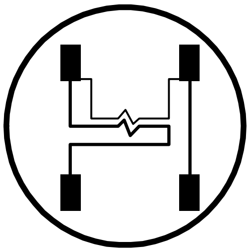
Figure C-5. Lower portion of standard nameplate

Table C-1. Firmware version information

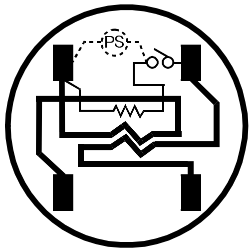
Code	Description
R	Meter release
3	A3 ALPHA meter
01	Firmware version number
00	Firmware revision number
YYWW	Manufacturing date code (year and week)
DD	Meter engine code set version
XX	Slot 1 option board firmware version, if installed (numbers are omitted from the nameplate if no option board is installed)
ZZ	Slot 2 option board firmware version, if installed (numbers are omitted from the nameplate if no option board is installed)
AAAAAA	Manufacturer order number

D. Wiring Diagrams

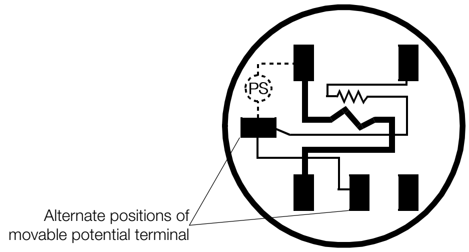
Installation Wiring Diagrams



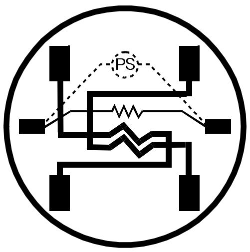
Form 1S



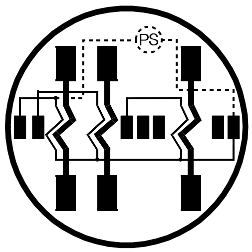
Form 2S



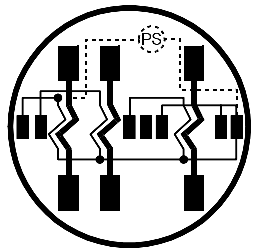
Form 3S



Form 4S

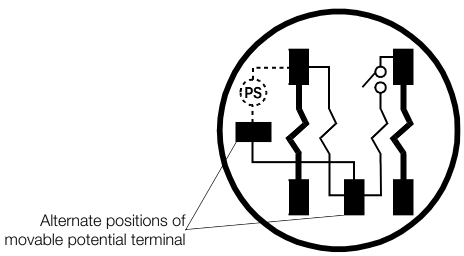


Form 9S

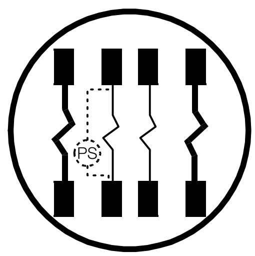


Form 10S

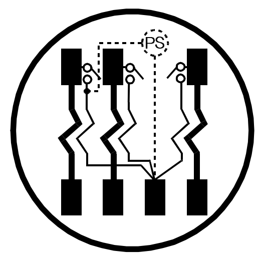
This Form 10S does not strictly conform to the traditional Form 10S wiring. It is intended for use in most 10S applications. One side of each voltage section is wired common within the meter. This wiring restricts the use of phase shifting transformers to perform reactive measurement. If attempted, equipment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



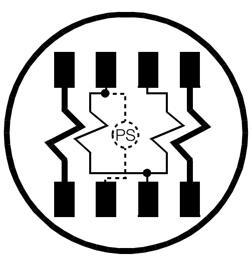
Form 12S



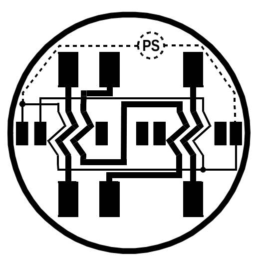
Form 13S



Form 16S

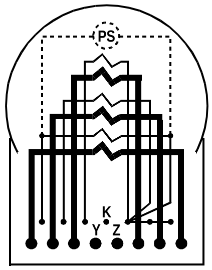


Form 35S

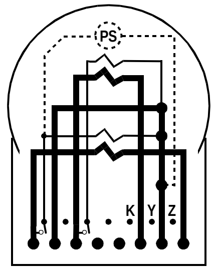


Form 36S

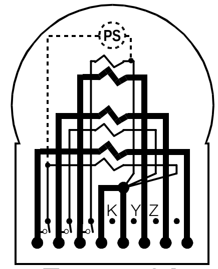
08E01



Form 10A

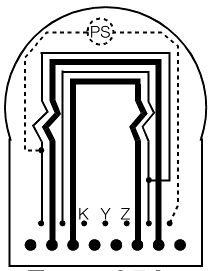


Form 13A

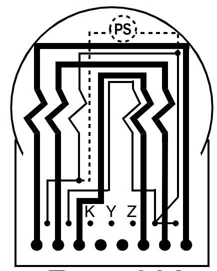


Form 16A

08E01



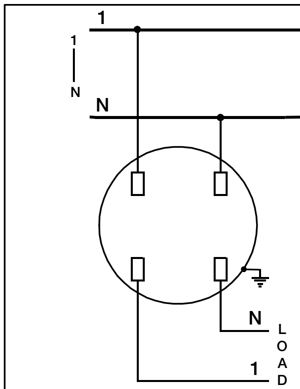
Form 35A



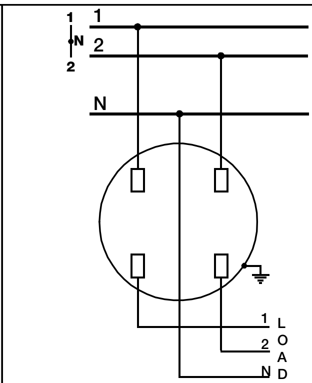
Form 36A

Wiring Diagrams for Installation

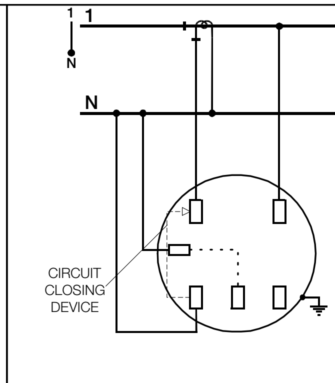
Single phase meters



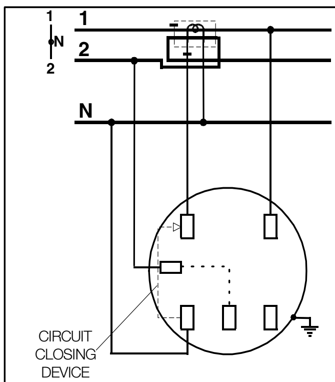
Form 1S
1 phase, 2 wire
self–contained



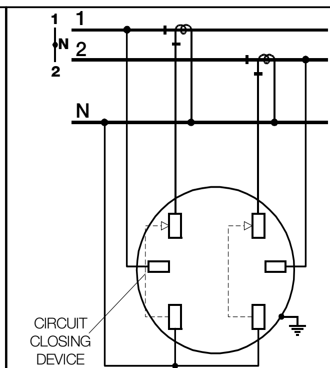
Form 2S
1 phase, 3 wire
self–contained



Form 3S
1 phase, 2 wire
1 CT, no PTs

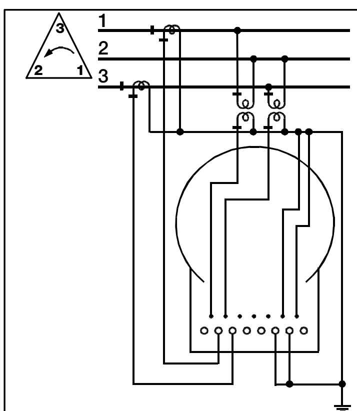


Form 3S
1 phase, 3 wire
1 CT, no PTs

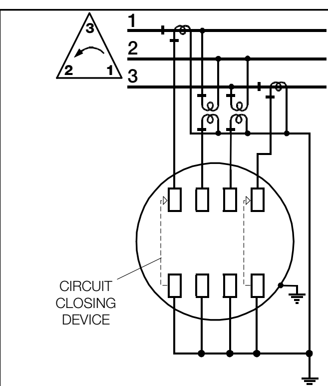


Form 4S
1 Phase, 3 Wire
2 CTs, no PTs

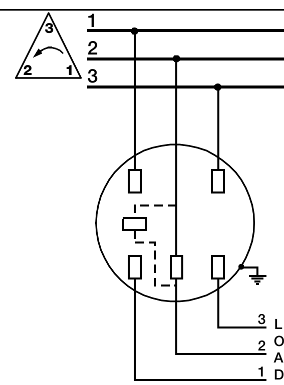
3 wire delta



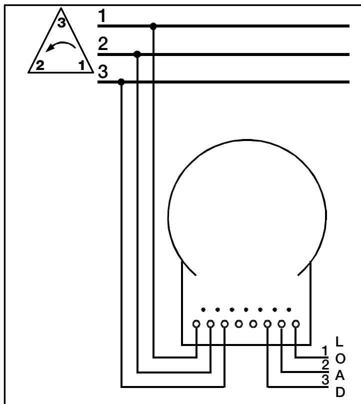
Form 5A
3 phase, 3 wire delta
2 CTs, 0 or 2 PTs



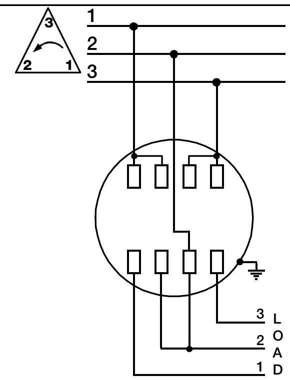
Form 5S
3 phase, 3 wire delta
2 CTs, 0 or 2 PTs



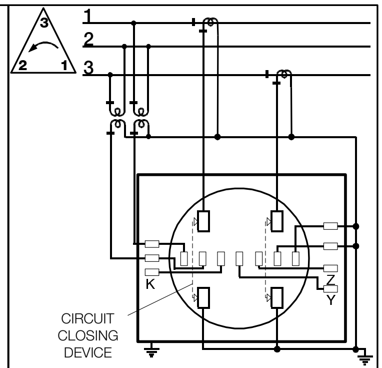
Form 12S
3 phase, 3 wire delta
self–contained



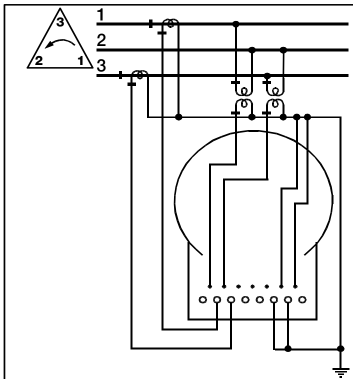
20E01
Form 13A
3 phase, 3 wire delta
self–contained



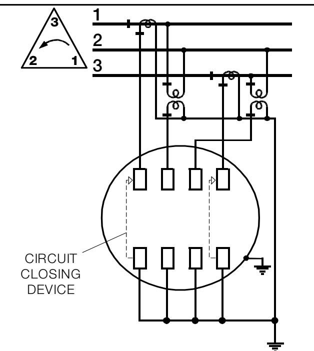
20E01
Form 13S
3 phase, 3 wire delta
self–contained



20E01
Form 26S
3 phase, 3 wire delta
2 CTs, 0 or 2 PTs

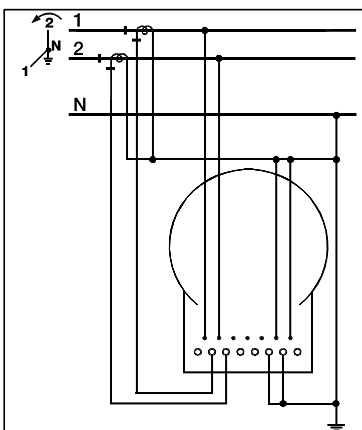


20E01
Form 35A
3 phase, 3 wire delta
2 CTs, 0 or 2 PTs

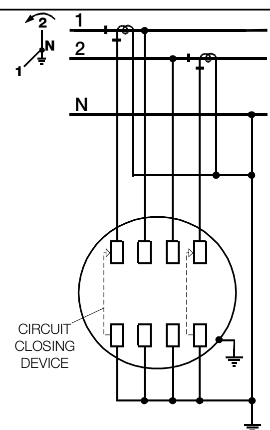


20E01
Form 35S
3 phase, 3 wire delta
2 CTs, 0 or 2 PTs

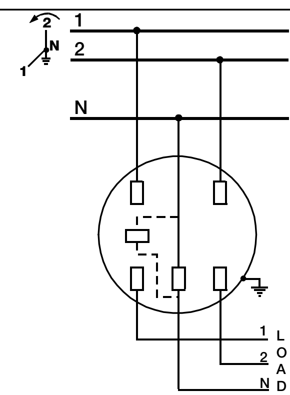
3 wire wye



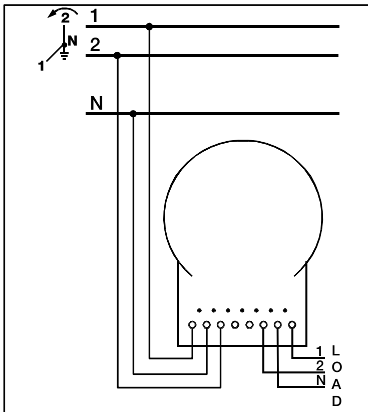
20E01
Form 5A
2 phase, 3 wire wye
2 CTs, no PTs



20E01
Form 5S
2 phase, 3 wire wye
2 CTs, no PTs

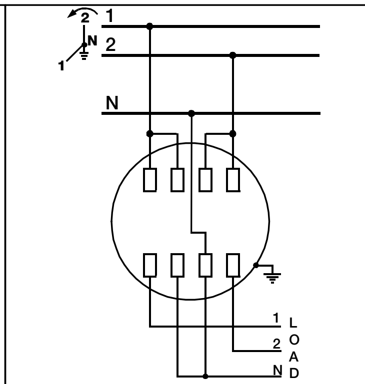


20E01
Form 12S
2 phase, 3 wire wye
self–contained



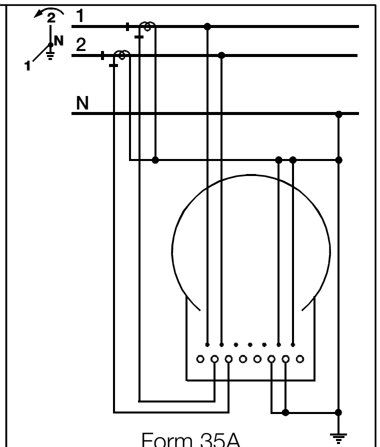
20E01

Form 13A
2 phase, 3 wire wye
self–contained



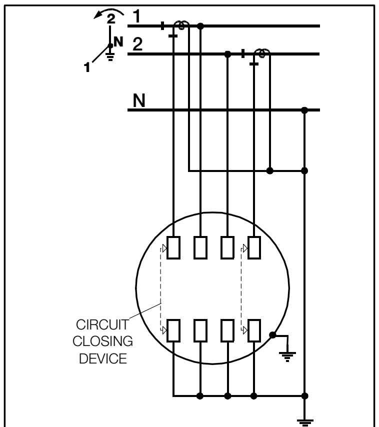
20E01

Form 13S
2 phase, 3 wire wye
self–contained



20E01

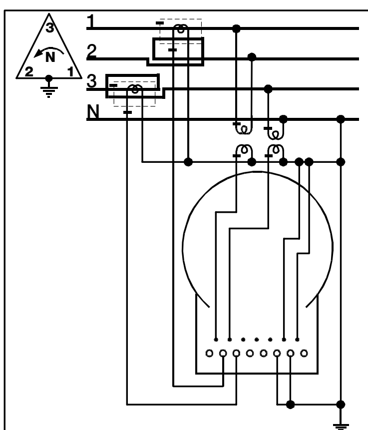
Form 35A
2 phase, 3 wire wye
2 CTs, no PTs



20E01

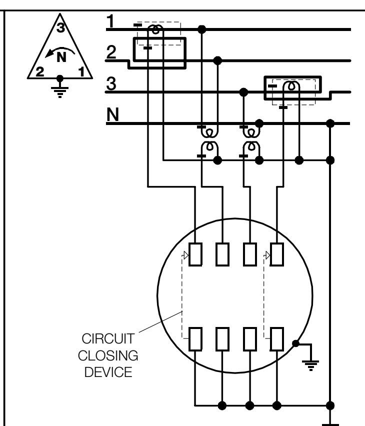
Form 35S
2 phase, 3 wire wye
2 CTs, no PTs

4 wire delta



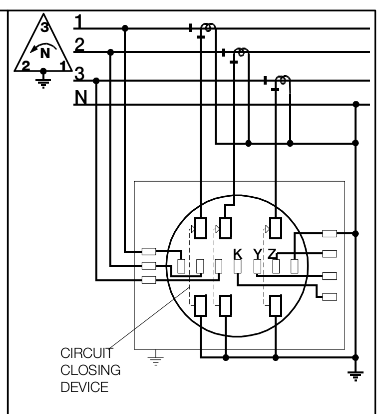
20E01

Form 5A[1]
3 phase, 4 wire delta
2 CTs, 2 PTs



20E01

Form 5S[1]
3 phase, 4 wire delta
2 CTs, 2 PTs

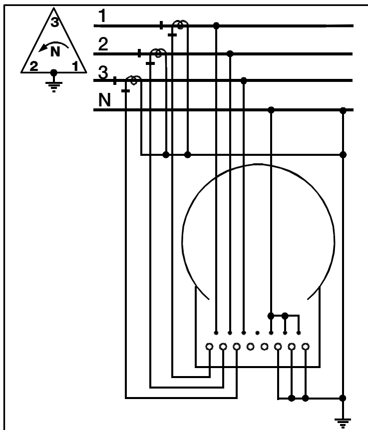


23E01

Form 9S (Form 8S application)
3 phase, 4 wire delta
3 CTs, no PTs

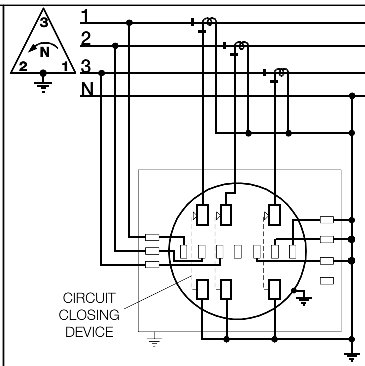
[1]If you use only 1 turn through the Line 3 current transformer (CT), the CT ratio must be reduced by ½.

4 wire delta



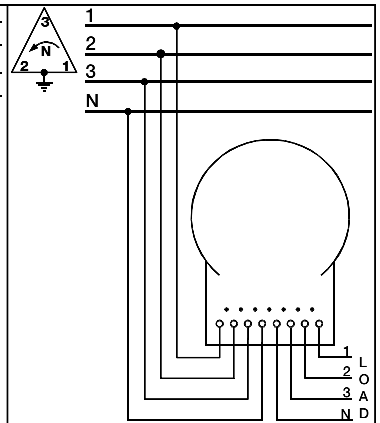
23E01

Form 10A (Form 8A application)[1]
3 phase, 4 wire delta
3 CTs, no PTs



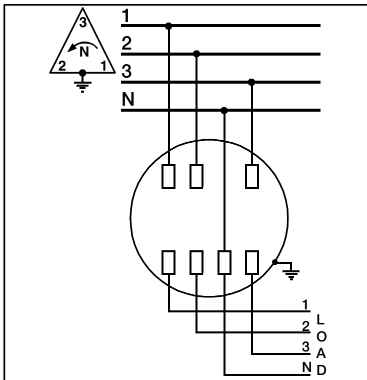
20E01

Form 10S (Form 8S application)[1]
3 phase, 4 wire delta
3 CTs, no PTs



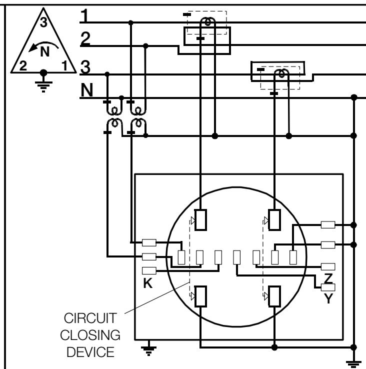
20E01

Form 16A (Form 15A application)
3 phase, 4 wire delta
self–contained



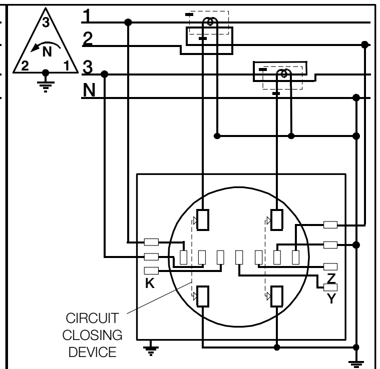
20E01

Form 16S (Form 15S application)
3 phase, 4 wire delta
self–contained



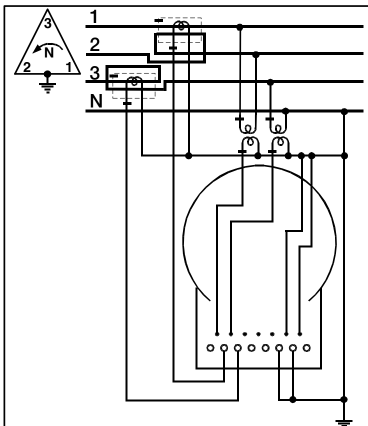
29A02

Form 26S[2]
3 phase, 4 wire delta
2 CTs, 2 PTs



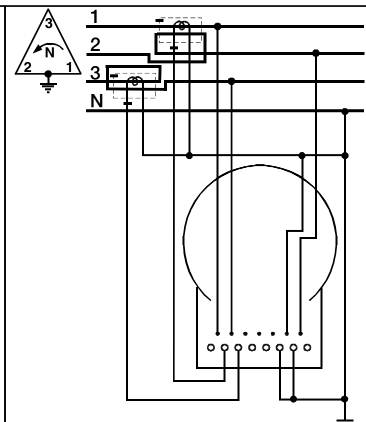
29A02

Form 26S[2,3]
3 phase, 4 wire delta
2 CTs, no PTs



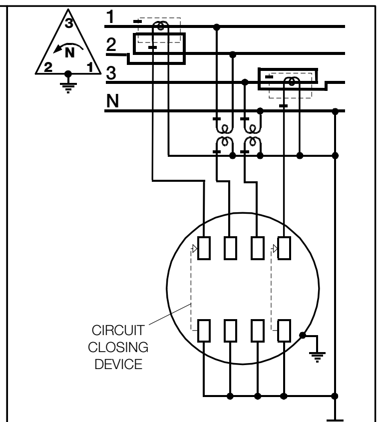
27A02

Form 35A[2]
3 phase, 4 wire delta
2 CTs, 2 PTs



29A02

Form 35A[2,3]
3 phase, 4 wire delta
2 CTs, no PTs



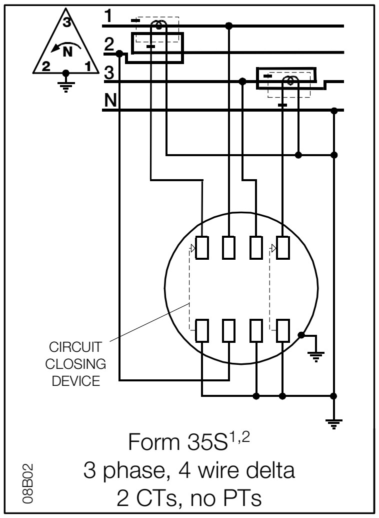
27A02

Form 35S[2]
3 phase, 4 wire delta
2 CTs, 2 PTs

[1]Wiring is different than a traditional Form 8 meter.

[2]If you use only 1 turn through the Line 3 current transformer (CT), the CT ratio must be reduced by ½.

[3]For ALPHA Plus meters, if using Form 35 in 4 wire delta applications, the autodetection feature must be enabled.

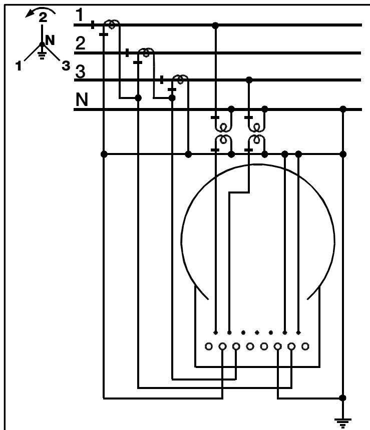


Form 35S[1,2]
3 phase, 4 wire delta
2 CTs, no PTs

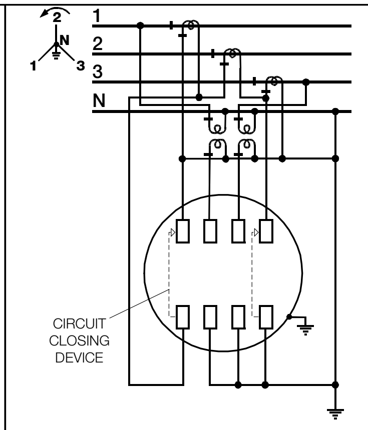
[1]If you use only 1 turn through the Line 3 current transformer (CT), the CT ratio must be reduced by ½.

[2]For ALPHA Plus meters, if using Form 35 in 4 wire delta applications, the autodetection feature must be enabled.

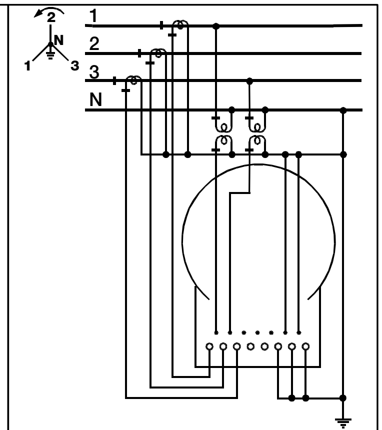
4 wire wye



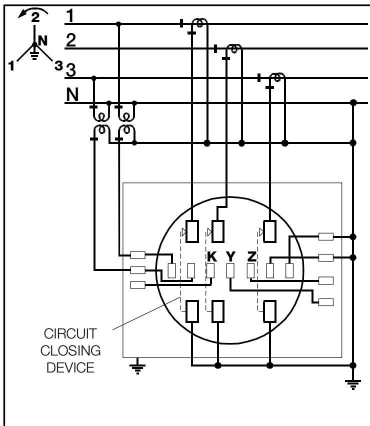
Form 5A
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs



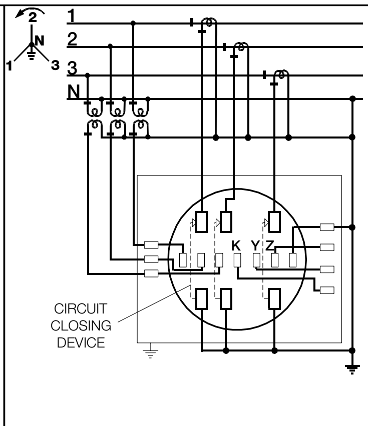
Form 5S
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs



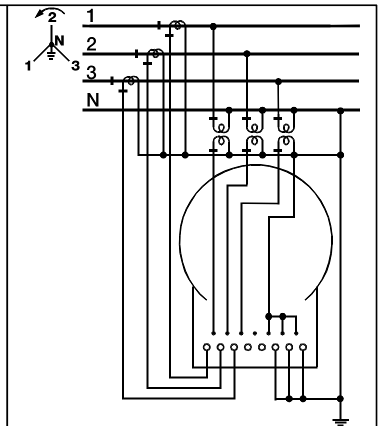
Form 6A
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs



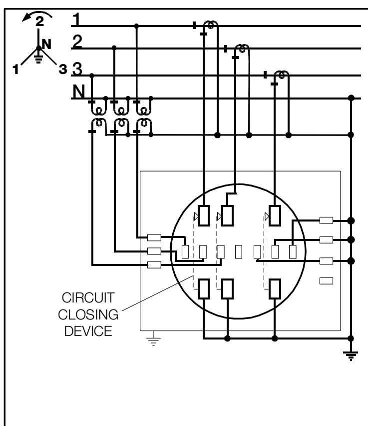
Form 6S
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs



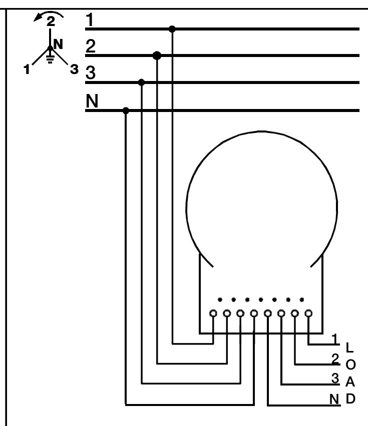
Form 9S
3 phase, 4 wire wye
3 CTs, 0 or 3 PTs



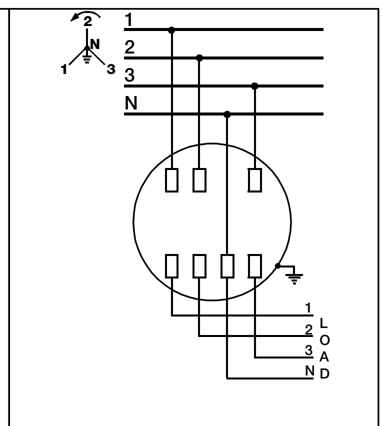
Form 10A (Form 9A application)
3 phase, 4 wire wye
3 CTs, 0 or 3 PTs



Form 10S (Form 9S application)[1]
3 phase, 4 wire wye
3 CTs, 0 or 3 PTs

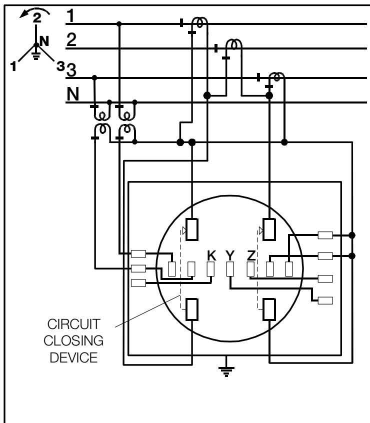


Form 16A (Form 14/16A application)
3 phase, 4 wire wye
self–contained



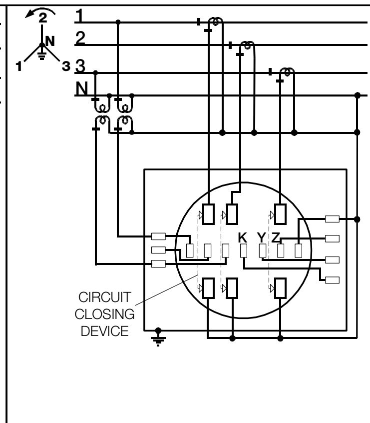
Form 16S (Form 14/16S application)
3 phase, 4 wire wye
self–contained

[1]Wiring is different than Form 9 meter.



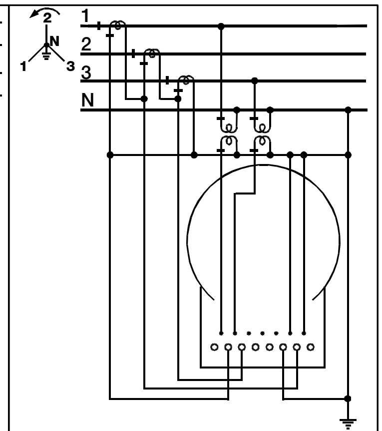
20E01

Form 26S
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs



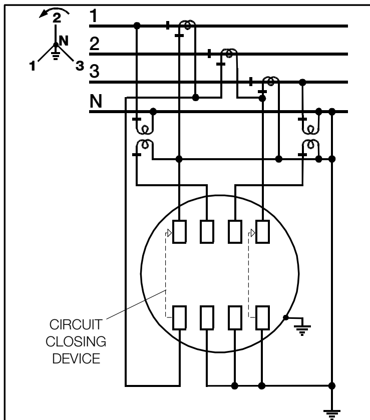
12B02

Form 29S
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs



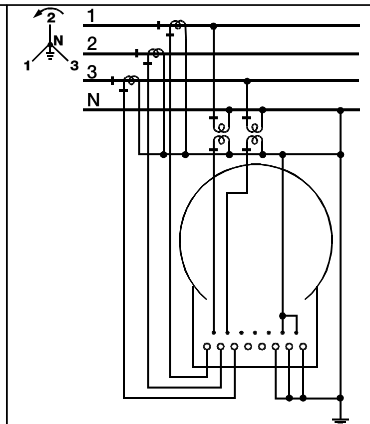
20E01

Form 35A
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs



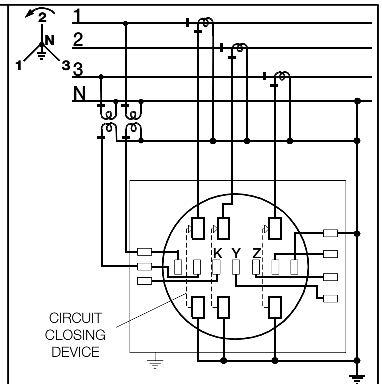
20E01

Form 35S
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs



20E01

Form 36A
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs



23E01

Form 36S
3 phase, 4 wire wye
3 CTs, 0 or 2 PTs

E. Technical Specifications

Absolute Maximums

Voltage	Continuous 528 VAC	
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 61000-4-4	4kV, 2.5kHz repetitive burst for 1 min
	ANSI C12.1 Insulation	2.5kV, 60Hz for 1 min
Current	Continuous at Class Amperes	
	Temporary (1 second) at 200% of meter maximum current	

Operating Ranges

Voltage	**Nameplate nominal range**	**Operating range**
	120 to 480V	96V to 528V
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% noncondensing	

Operating Characteristics

Power supply burden (phase A)	Less than 4W		
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	Meets ANSI C12.20 accuracy for accuracy class 0.2%		

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	< 3 seconds from power application to pulse accumulation		
Creep 0.000A (no current)	No more than 1 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 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 BPS (nominal)	1200 to 19,200 BPS	

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