Integrated Metering Systems, Inc.

Models beginning with S3

Single Meter in Enclosure

Product Features

Installation Instructions

User’s Manual

PN: 114-0005
Revision 0.12

INTEGRATED METERING SYSTEMS, INC.
Metering Excellence Since 1989

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Definitions

5-point rolling average: The valuations method used for most 'instantaneous' readings, including volts, amps, VA, and demand. It consists of the average of the 5 most recent sample data, with samples occuring approximately every second.

Accuracy: The extent to which a given measurement agrees with the defined value.

Demand: The average power or related quantity over a specified period of time.

Demand-Maximum: The highest demand measured over a selected period of time.

Percentage Error: The difference between percentage registration and 100%.

Percentage Registration: The ratio of the actual registration to the true value, expressed as a percent.

Power-Active: The time average of the instantaneous power over one period of a wave, measured in Watts (W).

Power-Apparent: The product of rms current and voltage, measured in Volt-Amperes (VA).

Registration: The amount of electric energy, or other quantity, recorded by the meter.

1. Product Description

1.1 General Description

The Series 3000 Meter is a revenue grade kWh electrical meter featuring Time of Use (TOU) meter readings, per-phase meter data, two-way RS485 communication that supports Modbus protocol, compatibility with either 3-phase Delta or Wye distributions, and a user friendly LCD display.

1.2 Meter Features

- Revenue-grade accuracy with solid-core or easy to install split core CTs
- Wh accuracy over a wide temperature range
- Built in LCD display
- LEDs for load monitoring
- Battery operated real time clock (RTC) for TOU meter readings
- Low voltage detection
- CT reverse phase indicator
- Voltage, current, and power consumption per phase
- RS485 communications with Modbus protocol
- Watchdog timer

1.3 Meter Certifications

1.4 Physical Description

1.4.1 Single Meter

Figure 1: Single Series 3000 meter dimensions

1.4.2 Enclosures

Series 3000 meters are available in two enclosures: a plastic enclosure for outdoor applications and a metal enclosure for indoor only use. The dimensions of the two enclosures are shown below in Figure 2 and Figure 3.

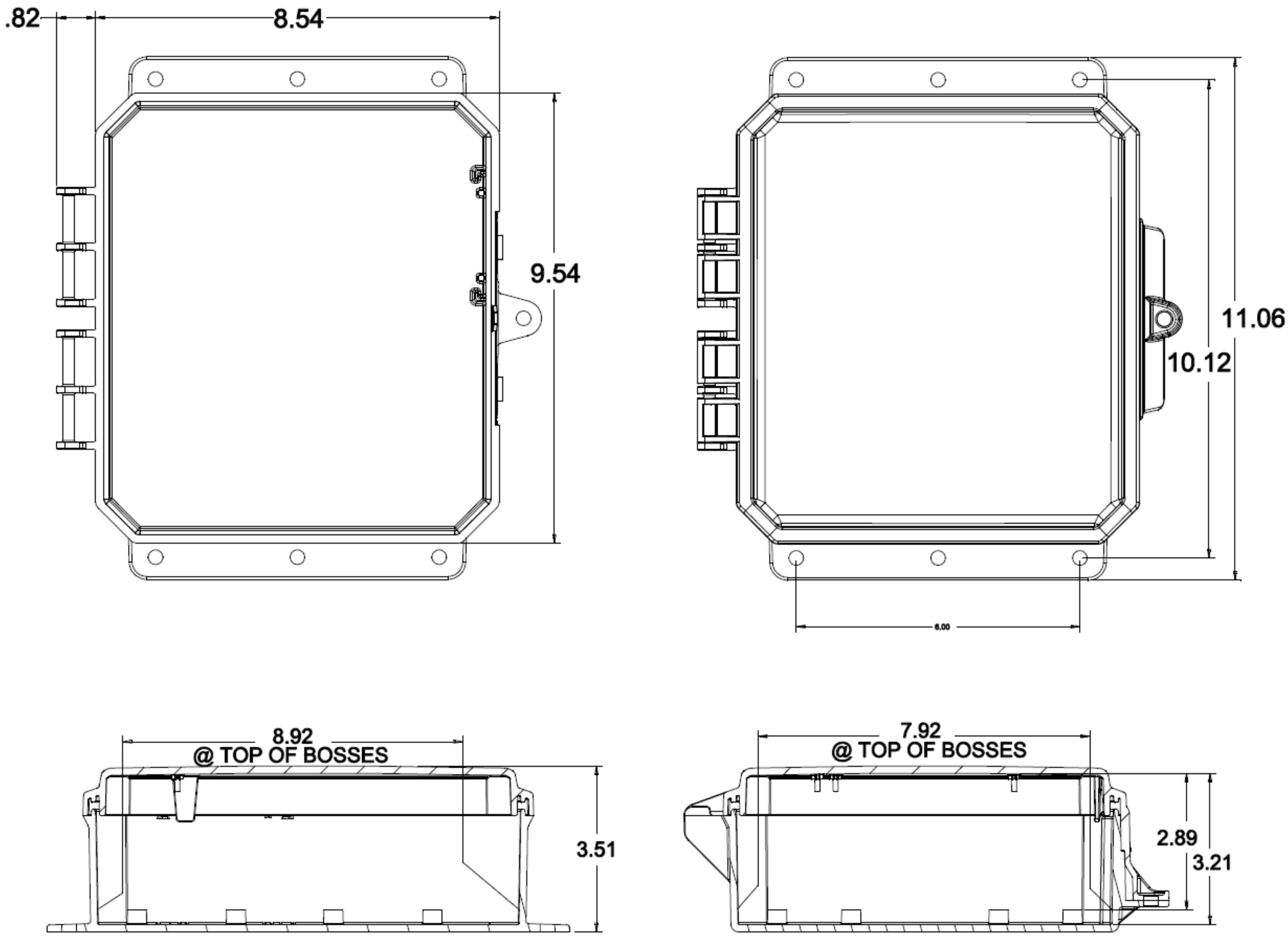


Figure 2: Series 3000 outdoor (plastic) enclosure dimensions

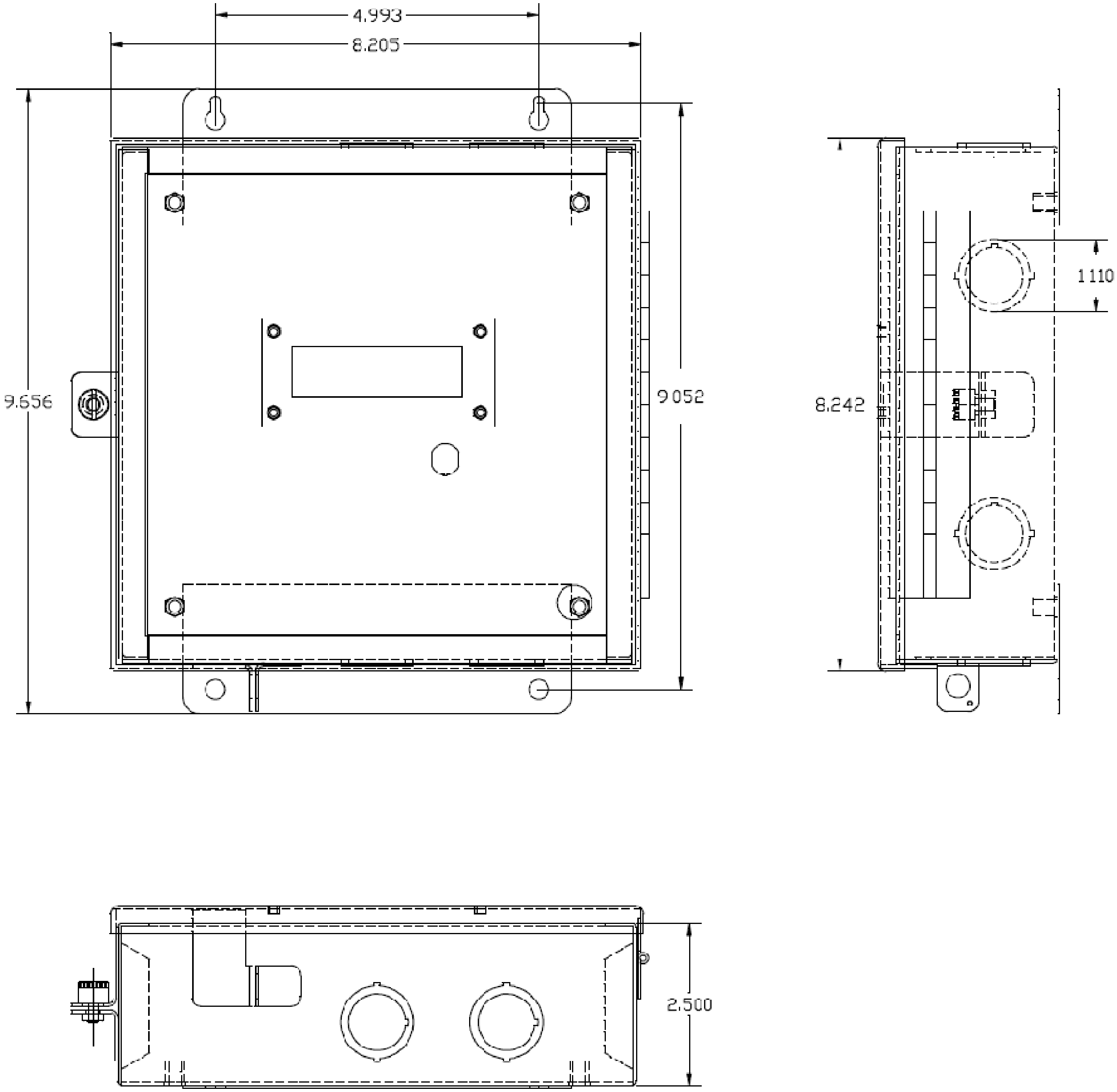


Figure 3: Series 3000 indoor (metal) enclosure dimensions

1.5 Applications

- Apartments
- Marinas
- Mobile Home Parks
- Campgrounds
- Anywhere accurate electric submetering is needed

2. Technical Specifications

2.1 Model Number Description

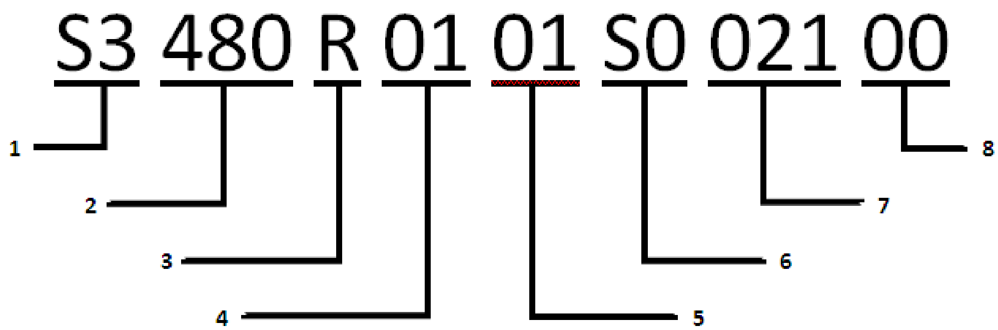


Figure 4: Series 3000 model number format

1. Meter Series
   S3 – Series 3000 meter
2. Voltage Configuration: Rated voltage
   1PH, 2W (120 or 277 V): Voltage rating is Line-to-Neutral
   1 or 2PH, 3W (208, 240 or 480 V): Voltage rating is Line-to-Line
   2PH, 2W (240, 480 or 600): Voltage rating is Line-to-Line
   3PH, 3 or 4W (208, 416, 480 or 600): Voltage rating is Line-to-Line
3. Enclosure
   R – Small outdoor with clear lid
   N – Indoor surface mount
4. Meter Capacity: Enclosure maximum capacity
5. Number of Installed Meters
6. Display Type
   M0 – Mechanical kWh
   T0 – Mechanical 1/10 kWh
   S0 – Self Contained LCD
7. CT Rating

011 – 100:0.1	081 – 800:0.1
021 – 200:0.1	101 – 1000:0.1
022 – 200:0.2	121 – 1200:0.1
041 – 400:0.1	161 – 1600:0.1
061 – 600:0.1	322 – 3200:0.2

8. Additional Options
   00 – No Options
   01 – Demand
   05 – Grounded Delta

2.2 Serial Number Description

The Series 3000 serial number format is shown below in Figure 5.

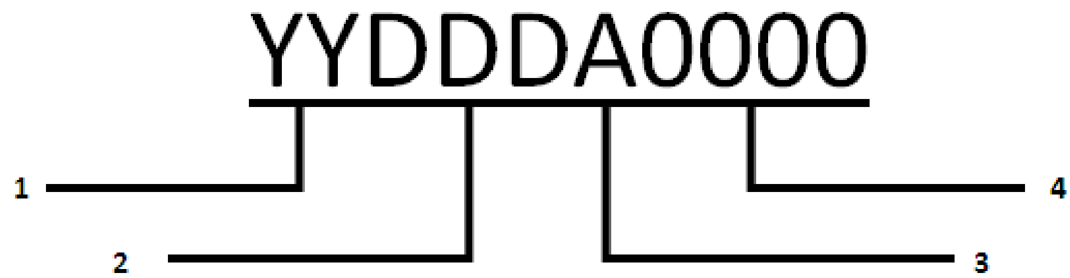


Figure 5: Meter serial number description

1. YY: Last two digits of the manufacturing year
2. DDD: Day of manufacture, 1-366
3. A: First digit of meter serial number, alphabetic A-Z
4. 0000: Last four digits of meter serial number, numeric 0-9

For storage purposes, the last five digits of the serial number are converted to a hexadecimal number. For instance, meter C3591 is stored as 0x005C27.

2.3 Electrical Specifications

Input Configurations	**1 Phase, 2 wire (120 V or 277 V)**	**1 or 2 Phase, 3 Wire (120/208, 120/240 or 277/480 V)**
Supply Voltage Range (Line to Neutral)	102-138 VAC 235-320 VAC	102-138 VAC 235-320 VAC
Maximum Input Power	7 VA	7 VA
Maximum Rated Current	Primary: Max Oper. Current + 10% Secondary: 0.12 A	Primary: Max Oper. Current + 10% Secondary: 0.12 A
Line Frequency	50-60 Hz	50-60 Hz
Power Factor Range	0.5 to 1.0 leading or lagging	0.5 to 1.0 leading or lagging

Accuracy[1]	+/- 0.5% of registration @ 1.0pf, 1% to 100% of rated current +/- 0.75% of registration @ 0.5pf, 1% to 100% of rated current	+/- 0.5% of registration @ 1.0pf, 1% to 100% of rated current +/- 0.75% of registration @ 0.5pf, 1% to 100% of rated current
Meter Operating Temperature	-30 to +60 degrees C	-30 to +60 degrees C
Display Operating Temperature	-20 to +50 degrees C	-20 to +50 degrees C
Rated Pollution Degree[2]	2	2
Rated Relative Humidity	80%	80%
Terminal Blocks: **Voltage Terminal:** **Molex** **386344304 or equiv.** **CT Terminal:** **Camden** **CTB9308 & CTB9208 or equiv.** **I/O Terminal:** **Dinkle/International Connector** **EK508-11P or equiv.**	14-18 AWG 12 in-lb of torque maximum 14-18 AWG 4.4 in-lb of torque maximum 13-18 AWG 4.4 in-lb of torque maximum	14-18 AWG 12 in-lb of torque maximum 14-18 AWG 4.4 in-lb of torque maximum 13-18 AWG 4.4 in-lb of torque maximum

Table 1: 1PH, 2W and 1or 2 phase, 3W Series 3000 electrical specifications

[1]Accuracy based on IMS solid core current transformers (included), with 100 mA secondary output. Meter input burden resistance at 2 Ohm

[2]Pollution Degree 2: Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.

Input Configurations	**2Phase, 2 Wire Delta** **3 Phase, 3 Wire Delta** **(208, 480, 600 V)**	**3 Phase, 4 Wire Wye** **(120/208 , 240/416, 277/480 or 347/600 V)**
Supply Voltage Range	Line to Line: 177-230 VAC 408-552 VAC 510-690 VAC	Line to Neutral: 102-138 VAC 204-276 VAC 235-320 VAC 295-400 VAC
Maximum Input Power	7 VA	7 VA
Maximum Rated Current	Primary: Max Oper. Current + 10% Secondary: 0.12 A	Primary: Max Oper. Current + 10% Secondary: 0.12 A
Line Frequency	50-60 Hz	50-60 Hz
Power Factor Range	0.5 to 1.0 leading or lagging	0.5 to 1.0 leading or lagging

Accuracy[1]	+/- 0.5% of registration @ 1.0pf, 1% to 100% of rated current +/- 0.75% of registration @ 0.5pf, 1% to 100% of rated current	+/- 0.5% of registration @ 1.0pf, 1% to 100% of rated current +/- 0.75% of registration @ 0.5pf, 1% to 100% of rated current
Meter Operating Temperature	-30 to +60 degrees C	-30 to +60 degrees C
Display Operating Temperature	-20 to +50 degrees C	-20 to +50 degrees C
Rated Pollution Degree[2]	2	2
Rated Relative Humidity	80%	80%
Terminal Blocks: **See Table 1**	See Table 1	See Table 1

Table 2: 2PH, 2W and 3PH, 3 or 4W Series 3000 electrical specifications

[1]Accuracy based on IMS solid core current transformers (included), with 100 mA secondary output. Meter input burden resistance at 2 Ohm

[2]Pollution Degree 2: Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.

2.4 I/O Connections and User Display

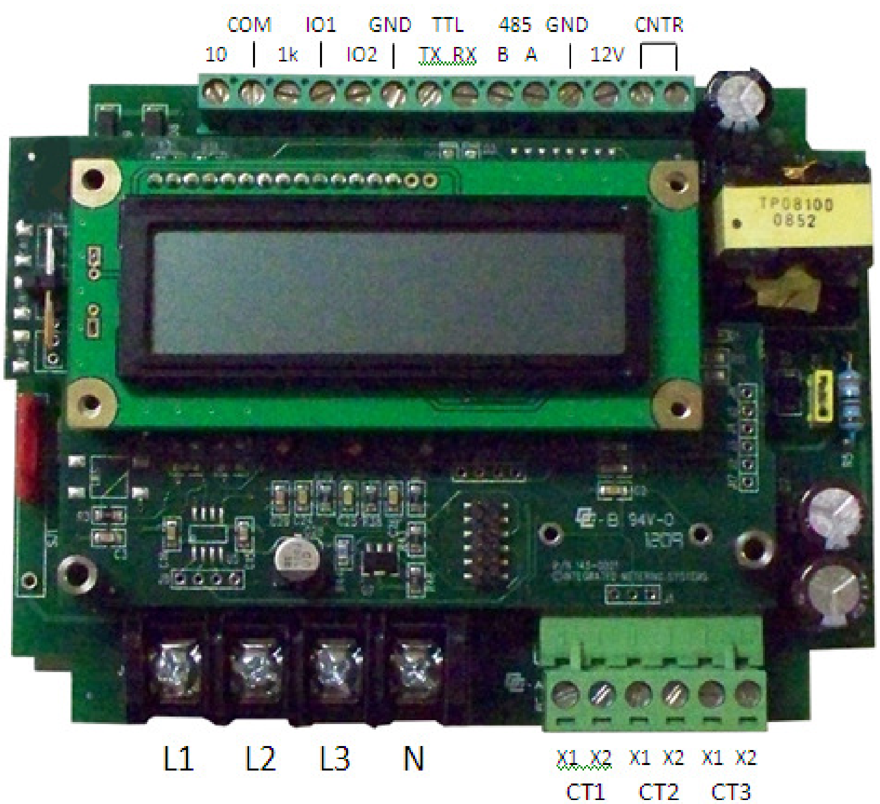


Figure 6: Series 3000 connections and display

Voltage Inputs	**Description**
L1	Voltage Input, Line 1
L2	Voltage Input, Line 2
L3	Voltage Input, Line 3
N	Neutral input (No connect for Delta meters)
CT Inputs	
CT1 : X1	Current Transformer input, CT1. Colored wire of CT1
CT1 : X2	Current Transformer input, CT1. White wire of CT1
CT2 : X1	Current Transformer input, CT2. Colored wire of CT2
CT2 : X2	Current Transformer input, CT2. White wire of CT2
CT3 : X1	Current Transformer input, CT3. Colored wire of CT3
CT3 : X2	Current Transformer input, CT3. White wire of CT3
Outputs (Pin Number)	
10 (1)	Isolated kWh pulse output for power consumption. 5 watthours on, 5 watthours off
COM (2)	Isolated common for 10 and 1k pulse outputs
1k (3)	Isolated kWh pulse output for power consumption. 500 watthours on, 500 watthours off (50 watthours on, 50 watthours off for T0 meters)
DIO2 (4)	Digital input 2 for custom applications (No current connection)

DIO1 (5)	Digital input 1 for custom applications (No current connection)
GND (6)	Isolated circuit common
TTL TX (7)	TTL transmit terminal for factory programming and future applications
TTL RX (8)	TTL receive terminal for factory programming and future applications
RS485 A (9)	RS485 A connection (Tx/Rx+)
RS485 B (10)	RS485 B connection (Tx/Rx-)
GND (11)	12 V Common
+12 VDC (12)	12 V DC output; current rating is 200 mA max.
Counter (13 and 14)	Output to electromechanical kWh counter

Table 3: Series 3000 I/O connections

3. Installation Instructions

The following section contains installation and wiring instructions for single Series 3000 meters in an outdoor enclosure. If technical assistance is required at any point during the installation, contact information can be found at the end of this manual. IMS is not responsible for damage to the meter caused by incorrect wiring.

3.1. Explanation of Warning Symbols

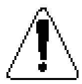
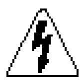
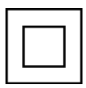
	Indicates the need to consult the operation manual due to the presence of a potential risk.
	Indicates the presence of electric shock hazards. Prior to proceeding, de-energize the circuit and consult the operation manual.
	Indicates that the equipment is protected throughout by double insulation.

Table 4: Warning symbols

3.2 Safety Precautions

WARNING

- **Installation of electric meters requires working with possibly hazardous voltages. These instructions are meant to be a supplement to aid trained, qualified professionals.**
- **Turn off all power supplying the equipment before performing any wiring operations. Use a properly rated voltage sensing device to confirm power is off.**
- **Bonding is not automatic for metal conduit connections; separate bonding is to be provided[1].**
- **Installations should be done in accordance with local codes and current National Electric Code requirements.**
- **Equipment used in a manner not specified by this document impairs the protection provided by the equipment.**

Failure to follow these warnings could result in serious injury or death.

[1] Bonding kit must be UL recognized. IMS recommends Rockwell Automation 855BM-ABK

3.3 Preparation

1. Verify the model number and electrical specifications of the device being installed to confirm they are appropriate for the intended electrical service (see Section 2).

2. Consult local codes for any possible permits or inspections required before beginning electrical work.

3. Ensure the conduit for the installation is flexible and non-metallic. For outdoor applications, conduit and conduit fittings must be rated UL Type 4X for outdoor enclosures. Failure to use the appropriate conduit impairs the degree of equipment protection.

4. Make sure all tools to be used during installation have proper insulation ratings.

5. Look inside the meter enclosure and electrical panel for possible exposed wire, broken wire, damaged components or loose connections.

3.4 List of Materials

- Series 3000 meter and associated mounting materials.
- Line 1, Line 2, Line 3 and Neutral hook-up wires as needed for the electrical service. Wires must be 18 AWG or larger and insulated for 600 VAC min.
- Current Transformers (CTs): This product is designed for use with IMS CTs; see Section 2.2 for details.
- Flexible, non-metallic conduit and fittings; UL Type 4X for outdoor applications.

3.5 Mounting the Enclosure

3.5.1 Mounting Location

- Series 3000 meters require a switch or circuit breaker as part of the building installation.
- The switch or circuit breaker must be marked as the disconnecting device for the meter.
- It is recommended that the enclosure be mounted near the disconnecting device in an area with adequate ventilation.
- The enclosure should not be positioned in a manner that makes it difficult to operate the disconnecting device.
- Ensure that the CT and voltage lead lengths (and conduit lengths) are capable of reaching the enclosure from the breaker panel.

- If a suitable mounting location near the panel cannot be found, additional in-line fuses or circuit breaker may be required in accordance with NEC regulations.

3.5.2 Making Conduit Holes

Steel Enclosure

The Series 3000 steel enclosure comes with five 1 1/16" knockouts (3/4"conduit); two on the bottom of the enclosure, two on the top, and one on the side. To remove a knockout, use a flathead screwdriver (or other rigid device) to puncture the indentations first, and then pry off and discard the knockout.

Figure 7: Steel enclosure knockouts

Outdoor Plastic Enclosure

The bottom, top, and non-hinge side of the plastic enclosure can be used as the conduit location in outdoor single meter enclosures. The bottom and lower-half of the side panel will make connecting wires the easiest. Conduit openings should be as far away from inner components as possible for the installation. Opening sizes must be appropriate to fittings, and large enough to fit all voltage and CT wiring (4-10 18 AWG min. wires insulated for 600 V min.). Care should be exercised to keep drill bit away from components inside the enclosure.

3.5.3 Mounting Procedure and Conduit Installation

1. Fasten the enclosure to the selected surface using the provided mounting holes and screws. Figure 8 depicts the top mounting holes for both enclosures. There are also mounting holes on the bottom of each enclosure. See Section 1.4 for mounting dimensions.
2. Verify that the enclosure is not loose and that all connections are secure.

3. Attach the conduit between enclosure and load center, routing wires as necessary for later use. **UL Type 4X conduit and fittings must be used in order to maintain the outdoor rating of the enclosure.**
4. Make sure the conduit fittings are aligned properly and tightened securely to prevent moisture from entering the enclosure (outdoor applications).

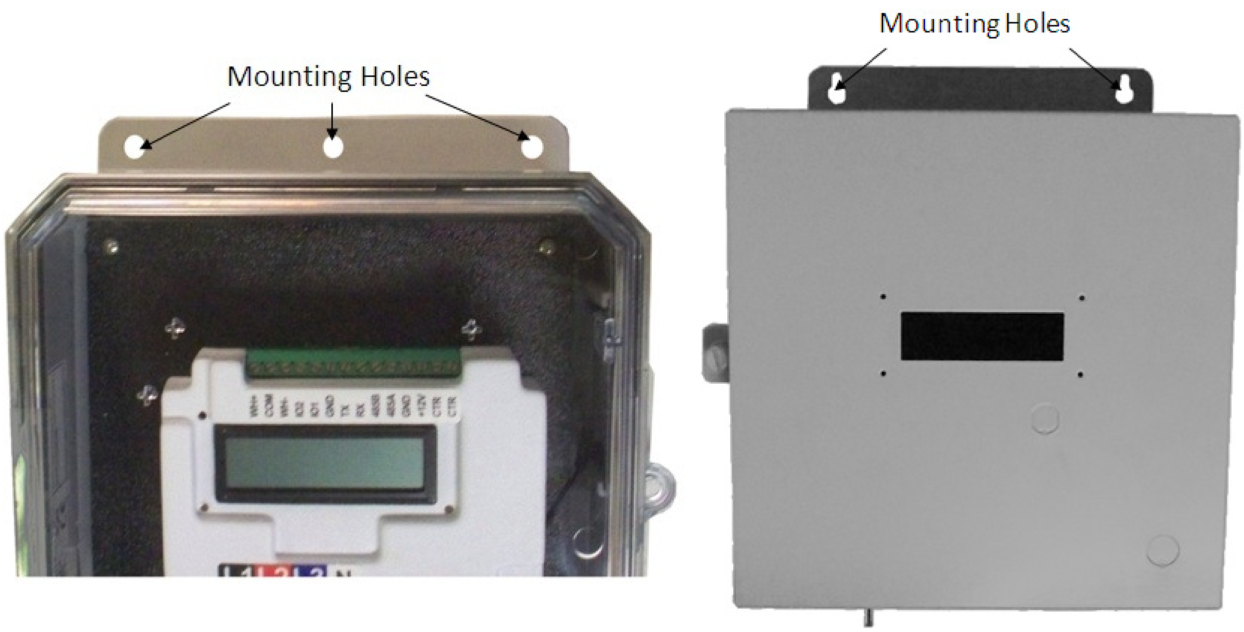
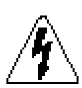


Figure 8: Enclosure mounting holes

3.6 Installation of Voltage Lines



Check to make sure service is disconnected before any connections are made. Verify if additional in line fuses are required based on National and Local electrical codes.

1. Field wired voltage connections are made to the Series 3000 voltage terminal block (see Table 1). The rated torque for these terminal blocks is 12 in-lb., and can be used with solid and stranded copper wires, at 12-18 AWG.
2. Connect 600 V min. insulated wiring for Line voltages and Neutral to the appropriate locations in the breaker panel, in accordance with all national and local electrical codes; see Figure 14 for 1Ph, 2-wire applications; Figure 16 for 1 or 2 Ph, 3-wire applications; Figure 17 for 3 Ph, 4-wire applications; and Figure 18 for 3 Ph, 3-wire applications.
3. Route wires through the conduit if not already done.
4. Trim the wire to the appropriate length to avoid coils of excess wiring.
5. Connect additional in line fuses if required.
6. For connections to the Series 3000 terminal, strip wiring to approximately .300 inches and connect to the appropriate terminals. Wires should be tightened so that they are held

snuggly in place, but do not to over-tighten, as this may compress and weaken the conductor.

3.7 Variations and Installation of Current Transformers

To reduce risk of electric shock, always open or disconnect the circuit from the power distribution system of a building before installing or servicing current transformers.

In accordance with NEC, CTs may not be installed in any panel board where they exceed 75% of the wiring space of any cross-sectional area.

General Requirements:

- Splices on the CT leads must be within the meter enclosure, not inside the conduit. IMS provided CT leads are 24 inches minimum. Wire insulation should be stripped so that the bare conductor length that connects to the meter terminal block does not exceed 0.300 inches.
- CTs should be securely fastened such that they will not slide down to live terminals.
- Wires should be tightened so that they are held snuggly in place, but do not to over-tighten, as this may compress and weaken the conductor. Maximum rated torque for CT terminal blocks is 4.4 in-lb.
- For 1 or 2 Ph 3-Wire electrical panels, current and voltage inputs must be installed 'in phase' for accurate readings (e.g. CT1 on Line 1, CT2 on Line 2); see Figure 16.
- For 3 Ph 4-wire electrical panels, see Figure 17 and follow factory-provided meter schedules for correct CT locations.

<u>CT Variations</u>

- IMS solid core CTs (Figure 9): In accordance with CT label, the LINE side of CT must face incoming Line. White lead connects to X2 of CT connection (CT1:X2 or CT2:X2). Colored lead connects to X1 of the corresponding CT connection (CT1:X1 or CT2:X1).

Figure 9: IMS solid core CTs

Installing solid core CTs

1. Route CT wires through the conduit if not already done.
2. Trim the wire to the appropriate length to avoid coils of excess wiring.
3. At meter, strip insulation from wires to approximately .300 inches.
4. Connect CT leads to the appropriate terminals.
5. With power turned off, disconnect each monitored conductor and slide on a CT, ensuring the CT is correctly oriented as noted above.
6. Reconnect the conductors.

- IMS split core CTs (Figure 10): The side with the white dot, H1, must face the incoming LINE. White wire connects to X2 terminal, black wire connects to X1 terminal.

Figure 10: IMS split core CTs

Installing split core CTs

1. Route CT wires through conduit if not already done.
2. Trim the wire to the appropriate length to avoid coils of excess wiring.
3. Strip wiring to approximately .300 inches.
4. Connect the CT leads to the appropriate meter as described above.

5. With power to the conductors turned off, place one CT around each conductor, ensuring that the white dot is facing the line side.

Failure to install CTs in the correct orientation will lead to inaccurate meter readings. Figure 14 through Figure 18 show wiring diagrams for the various voltage configurations.

3.8 Securing the Enclosure

Metal Enclosure

The metal enclosure comes with an attached bolt for securing the door. Once the installation is complete, tighten the bolt so that the enclosure is secure.

Plastic Enclosure

The plastic enclosure comes with additional hardware for securing the cover. There is a hole on the door snap for the provided nut and bolt to be installed. Once the installation is complete, close the cover and secure the cover to the rest of the enclosure.

4. General Metering Features

4.1 Accuracy

Metering Chip

Series 3000 meters use a Teridian 71M6513 metering chip. Page 75 of the 71M6513 data sheet indicates the chip accuracy over temperature, graphically reproduced below in Figure 11. More information can be found at http://www.teridian.com.

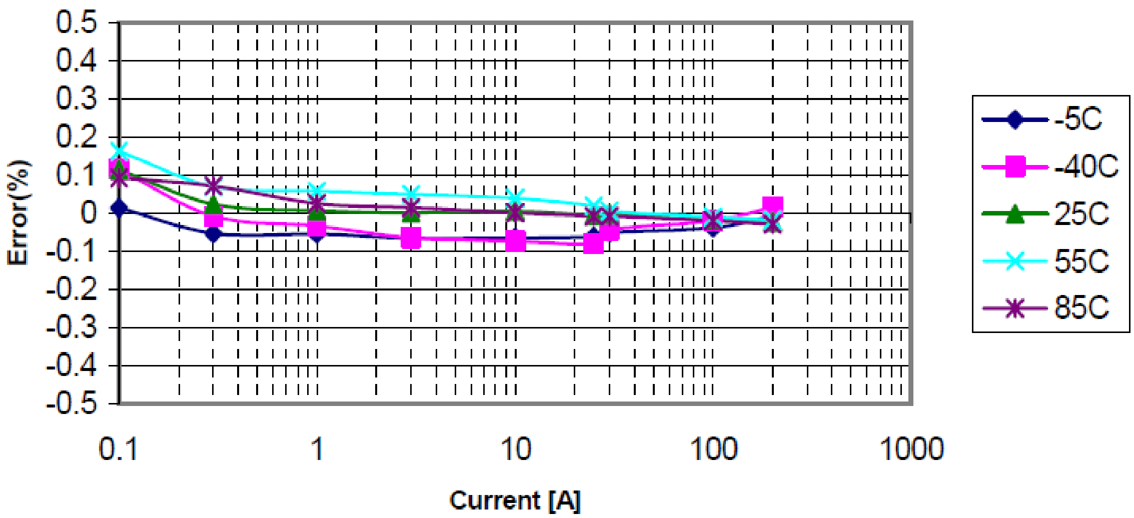


Figure 11: Metering chip accuracy over temperature and current

Additionally, all meters are calibrated and for accuracy using internal variables and external hardware before being shipped.

Factory Calibration

IMS meters are factory calibrated for compliance with ANSI C12.1. Every meter is associated with an up-to-date watt-hour standard traceable to NIST. Watt-hour standards are calibrated on a yearly basis by an independent test lab. For more accuracy information, see Table 1 and Table 2.

4.2 3-phase Delta vs. 3-phase Wye operation

The Series 3000 meter is compatible with both 3-phase Delta and 3-phase Wye systems. For 3-phase Delta applications, the meter is powered from Line 1 and Line 2, and the Neutral connection is left floating. For 3-phase Wye configuration, the meter is powered from Line 2 to Neutral. For more information on connecting the meter, please see section 3.

4.3 kWh and Demand

All versions of the Series 3000 meter provide kWh, maximum demand, and instantaneous power measurements on the LCD.

- kWh

  Calculations

  Calculations for kWh are stored in multiple registers for higher accuracy, specifically in light load situations. One register is used as a holding register and another is used as an incremental register. The incremental register is a fast 'roll over' register, which resets at 1000 kWh. The holding register is updated on each roll over of the incremental register. The running kWh total is a sum of the two registers.

  This design prevents the loss of fractional Wh during calculations and maintains kWh and demand accuracy across a wide range of loads.

  Display

  KWh is displayed in three different ways depending on the current reading:

kWh Total	**Digits Left of Decimal**	**Digits Right of Decimal**
Less than 100,000	5	2
Between 100,000 and 1,000,000	6	1
Greater than 1,000,000	7	0

  KWh rolls over when it reaches 10,000,000. See section 6.3 for more display information.

- Maximum Demand

  Calculations

  Maximum demand (in Watts) can be set to be calculated in 15 or 30 minute blocks. The default value is 15 minutes. The interval can be changed using the RS485 communication port (see section 8.1.5 Common Modbus Write Commands). For each block, there are 3 sub-intervals in which a sub-interval demand is calculated.

  Sub-interval calculation:

  Sub-intervals last 5 or 10 minutes, depending on the length of demand blocks. For each sub-interval, the total Wh consumption during the interval is divided by the number of accumulations during the interval to give average demand for the sub-interval. Accumulations occur approximately every second.

Maximum demand calculation:

After each sub-interval is finished, a new block demand is calculated. The block demand is comprised of the average of the 3 most recent sub-intervals. The largest block demand since a demand reset is stored as the maximum demand. When an update of the maximum demand occurs, the new value and current date and time are saved to EEPROM.

Display

Maximum demand is displayed in Watts, and can range from 0.00 to 9999999. The display functions the same as kWh display, shown again below.

Maximum Demand	**Digits Left of Decimal**	**Digits Right of Decimal**
Less than 100,000	5	2
Between 100,000 and 1,000,000	6	1
Greater than 1,000,000	7	0

After the maximum demand value is displayed, the time and date for when the maximum demand occurred is shown on the following screens. See section 6.3 for more display information.

- Instantaneous Demand

  Instantaneous demand is a 5-point rolling average of the combined Watt usage of all three phases. Instantaneous demand can range from 0.00 to 9999999, and is displayed the same as maximum demand shown in the table above.

4.4 Voltage, current, and power per phase

Calculations

Volts, Amps, and Watts per phase are update approximately every second. Volts and Amps are saved and displayed as root mean square (RMS) values. All values are calculated as a 5-point rolling average of the most recent samples.

Display

All Series 3000 meters have per phase values available through the RS485 communications port (see section 8.1 RS485 (Modbus) Information). For certain meters, this information is also available on the LCD. See section 6 for more information on the LCD display.

4.5 Frequency

Calculations

Frequency information is received by monitoring a single phase, with priority order being Line 1 => Line 2 => Line 3. The frequency monitor only switches off a line when a low voltage is detected on that line. Frequency is calculated as a 5-point rolling average of the most recent samples.

Display

The standard Series 3000 meter does not display frequency information to the LCD. This information is only available by using the RS485 communications port (see section 8.1 RS485 (Modbus) Information). Frequency is displayed down to hundredths of a Hertz, and can range from 0.00 to 9999999.

4.6 Demand Reset

All series 3000 meters have the capability to reset maximum demand. When maximum demand is reset, the maximum block demand and all current sub-interval demands are set to zero (see section 4.3 kWh and Demand). An internal register is also incremented upon demand reset to keep a total of the times this action was taken. The register is a single byte, and rolls over at 255. The register content is accessible using Modbus 'Report Slave ID' command; see section 8.1.3 Implemented Functions for more information.

How to reset the demand

Demand can be reset either using the demand reset key lock or using RS485 communications.

Key lock: Turn the key lock into the 'on' position for at least 5 seconds. The LCD will give a visual confirmation that the demand was reset.

RS485 Communications: Demand reset information over the RS485 port can be found in section 8.1.5 Common Modbus Write Commands. When demand is reset over the RS485 port, the confirmation comes over the communication line and the LCD will give a visual confirmation that the demand was reset.

4.7 Real Time Clock and Time of Use Metering

Real Time Clock

The Real time clock (RTC) continuously runs when power is supplied to the metering board. An optional battery backup is available to maintain the RTC in power loss situations. If the battery backup is not in place, the RTC resets to 01/01/00 00:00:00 when power returns.

The battery backup is a standard CR2025 lithium coin cell, rated at 3 V and 165 mAh. The lifetime of the battery depends on the operating temperature of the meter, as shown below in Table 5.

Operating Temperature (°C)	Estimated Battery Life (No external power) (Years)	Estimated Battery Life (90% power uptime) (Years)
Temp < 25	3	19
25 < Temp < 60	2	12
Temp > 60	1	9

Table 5: RTC battery backup lifetime

For information on replacing the battery, please see section 9.1 Battery Replacement. The RTC can be set using the communications port as described in section 8.1.5 Common Modbus Write Commands.

Time of Use Metering

All meter readings saved to the EEPROM are time-stamped with the current date and time of day from the RTC. The save interval is selectable from 5, 15, 30, and 60 minute intervals, which can be changed using the RS485 port (see section 8.1 RS485 (Modbus) Information). Depending on the save interval selected, the EEPROM can hold between 25 and 300 days worth of data, as shown below:

5 minute – ~25 days

15 minute - ~75 days

30 minute – ~150 days

60 minute – ~300 days

Data is saved in FIFO format to keep the most recent readings in memory. For more information regarding data saving, see section 7.

5. Advanced Metering Features

5.1 Low Voltage Detection

Diagnosis and Response

The Series 3000 meter provides low line voltage monitoring capabilities. The threshold for this detection is 80% of rated voltage, and the voltage must stay below that level for approximately 20ms before the voltage drop is confirmed. When the voltage drop is confirmed, the Series 3000 meter attempts to store the current time of the RTC and the current kWh readings. In conditions where the voltage loss is immediate, the meter will lose power before this information is stored (see section X.X for more information regarding restoration of kWh readings during brownouts). If the voltage drop is gradual (more than 20ms from 80% of rated voltage until the loss of meter power), the information will be saved accurately. Only the most recent power loss time is saved in the EEPROM.

In order to preserve the lifetime of the EEPROM, the meter readings are only stored at when the initial voltage drop is confirmed. The meter then returns to normal operation. Once the voltage returns to proper levels, the meter will again save immediately on the next voltage drop. **Based on this operation, a consistently unstable voltage can significantly decrease the lifetime of the EEPROM.** For information see section 7.3 EEPROM Lifetime.

Display

When low voltage is detected on a phase, it is indicated with a simultaneous blinking of the 'V' and the corresponding phase letter. For more information see section 6.

5.2 Reverse Phase Indication

Diagnosis and Response

Series 3000 meters are designed specifically to measure energy consumption. As a consumption-only meter, it is expected that the energy flow will always be from the power grid and in the same direction across all lines. If the measured power usage on a phase is negative, the meter will report the corresponding CT as being reversed. More information regarding CT installation can be found in the Series 3000 Installation Instructions documentation.

Display

When a reverse CT is detected, it is indicated with a simultaneous blinking of the 'A' and the corresponding phase letter. For more information see section 6.

5.3 Temperature Compensation

An on-chip temperature sensor is used to measure the current operating temperature of the metering chip as it differs from the temperature during calibration. As the temperature increases or decreases, the meter updates the change and either speeds up or slows down to compensate for the new temperature. This leads to higher meter accuracy in all climates.

Determining nominal temperature

The nominal temperature for comparison is determined and stored during the initial calibration of the meter at IMS facilities. This temperature is stored in EEPROM along with the traditional calibration variables. Temperature readings are measured to tenths of a degree Celsius.

Temperature variation response

When the temperature sensor detects an operating temperature that differs from the nominal temperature, the meter re-calculates a gain adjustment parameter, used for scaling all voltage and current inputs.

6. Liquid Crystal Display (LCD)

6.1 LCD Sections

The LCD and corresponding sections are shown below in Figure 12.

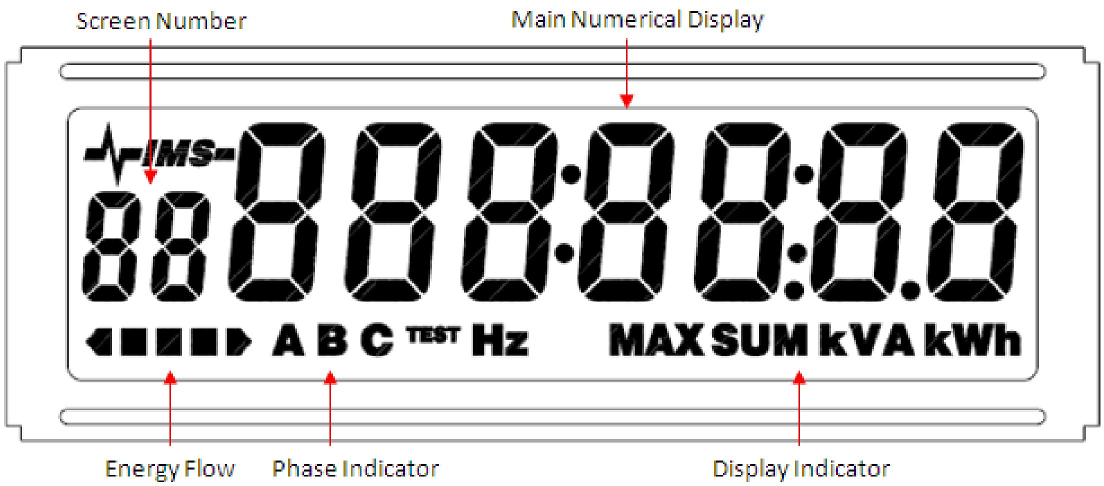


Figure 12: Custom LCD sections

Main Numerical Display

The main numerical display section indicates the numerical value of the current item.

Phase Indicator and Display Indicator

The phase and display indicator sections have two purposes. The phase indicator section shows the phase currently being displayed on per-phase values. The display indicator section gives information about the value on the main numerical display, such as units. The other purpose of these sections is to indicate low voltage and reverse current flow.

- Low Voltage

  Low voltage on a phase is shown by a blinking of the 'V' on the display indicator in conjunction with corresponding phase blinking in the phase section. For example, if low voltage is detected on phase A, the 'V' in the display indicator and the 'A' in the phase indicator will be blinking simultaneously.

- Reverse Current

Reverse current is displayed in the same manner as low voltage, but instead of the 'V' from the phase indicator section blinking, the 'A' blinks, indicating a reverse energy flow.

Energy Flow

The energy flow section indicates the direction of energy flow (either to the grid or from the grid) using an arrow indicator. When the arrow points to right it indicates consumption (energy from the grid). When the arrow points to left it indicates production (energy to the grid). When values that apply across all phases are shown, such as instantaneous power, the net energy flow direction is shown.

Screen Number

The screen number section is an alternate way to determine what information is currently being displayed. The screen numbers and corresponding value are shown below in Table 6.

Screen Number	**Displayed Value**
00	Current RTC Time
01	Phase A Voltage
02	Phase A Current
03	Phase B Voltage
04	Phase B Current
05	Phase C Voltage
06	Phase C Current
07	Frequency
08	Phase A kW
09	Phase B kW
10	Phase C kW
11	Instantaneous Demand
12	Maximum Demand
13	Maximum Demand Time
14	Maximum Demand Date (YY MM:DD)
15	kWh to Grid (Production)
16	kWh from Grid (Consumption)

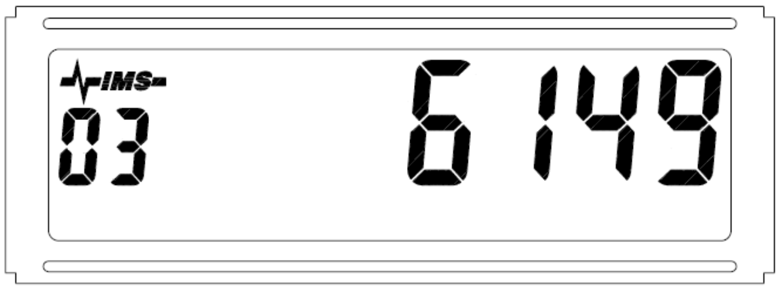
Table 6: LCD screen numbers

6.2 Power-on Sequence

When the Series 3000 meter is initially powered on it displays the following sequence of information:

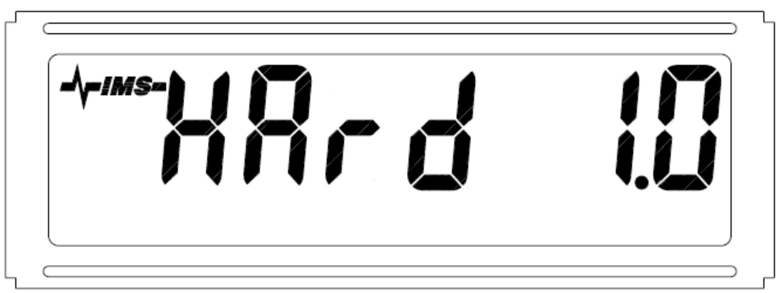
1. Meter Serial Number

The Meter Serial Number screen is shown below. The lower left number is the alphabetical digit from the meter serial number (from 01=A to 26=Z), and the main display shows the numerical portion of the Serial Number. For example, the image below represents meter serial number XXXXXC6149, with the X's indicating the manufacturing day and year. See section 2.2 for more information on meter serial numbers.



2. Hardware Version

The Hardware Version screen displays the word 'Hard' and the meter's hardware version.

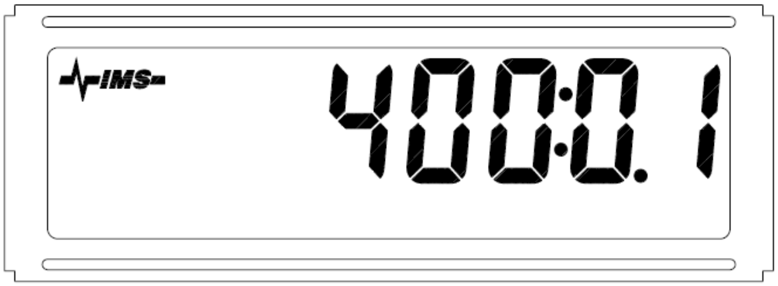


3. Software Version

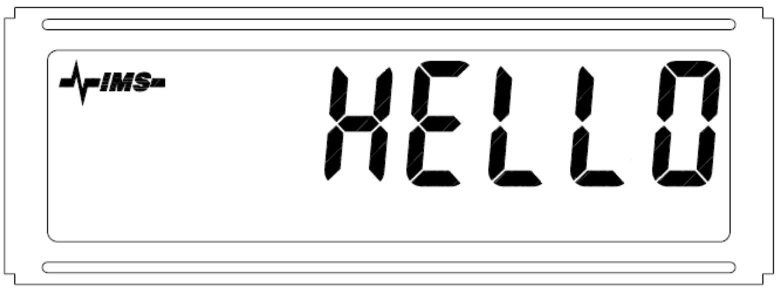
The Software Version screen displays the word "Soft' and the meter's software version.

4. CT Ratio

The CT Ratio screen displays the meter's programmed CT ratio.

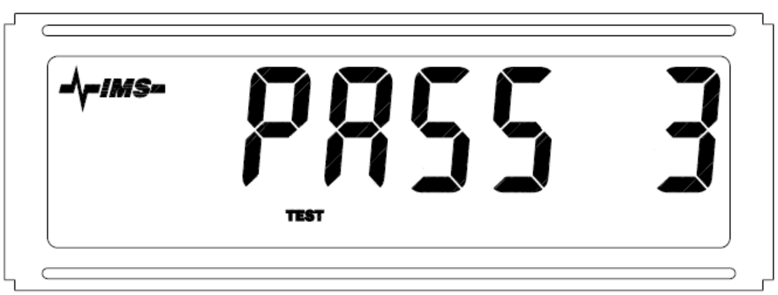


5. Hello Screen



6. Compute Engine Test Runs

The compute engine performs 10 test runs before the meter starts normal operation. The test runs are indicated by the TEST icon and the words 'Pass X', where X is the test run number.

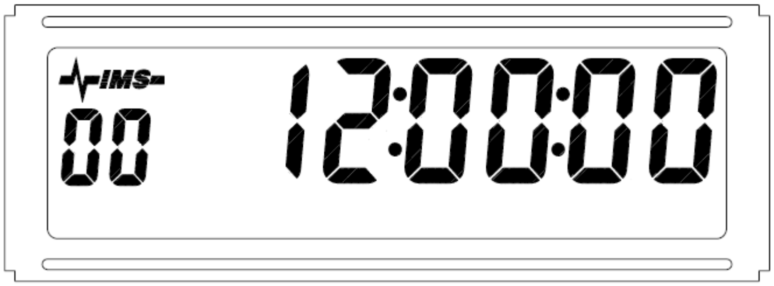


6.3 LCD Screens

The following section goes over the LCD screens and how to interpret them. **Note: Per phase screens and energy to grid not available on all models.**

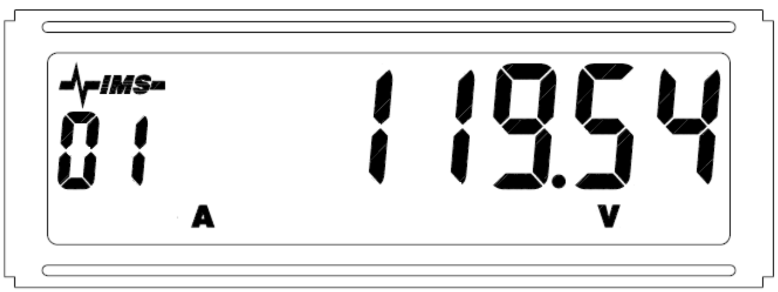
Current RTC Time (00)

The Current RTC Time screen displays the current time as stored in the RTC of the Series 3000 meter. The time is shown in typical HH:MM:SS format. Screen is only shown when LCD is in manual operation (see section 6.4).



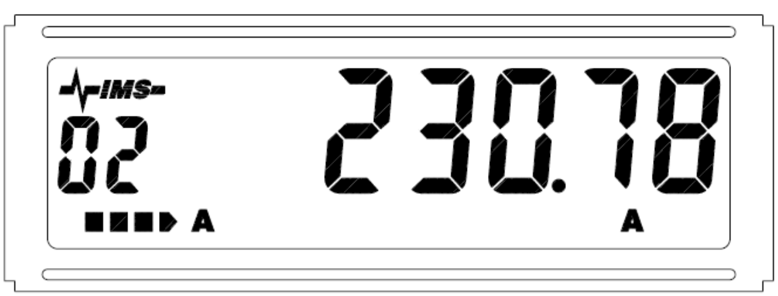
Phase A Voltage (01)

The Phase A Voltage screen displays the voltage on Line 1 with respect to Neutral, measured in Volts. The 'A' from the Phase Indicator section and the 'V' from the Display Indicator section will be on.



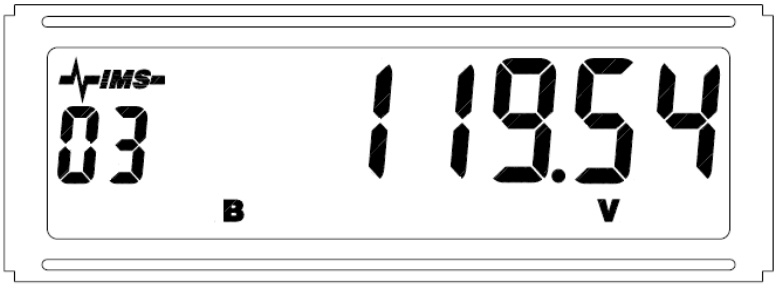
Phase A Current (02)

The Phase A Current screen displays the current measured on Line 1 in Amps. The 'A' from the Phase Indicator section and the 'A' from the Display Indicator section will be on. The energy flow section will point either left (production) or right (consumption).



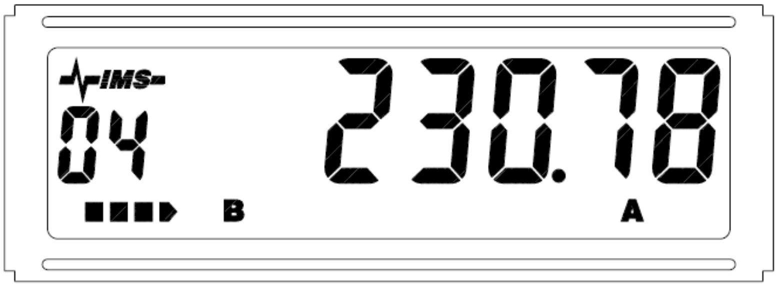
Phase B Voltage (03)

The Phase B Voltage screen displays the voltage on Line 2 with respect to Neutral, measured in Volts. The 'B' from the Phase Indicator section and the 'V' from the Display Indicator section will be on.



Phase B Current (04)

The Phase B Current screen displays the current measured on Line 2 in Amps. The 'B' from the Phase Indicator section and the 'A' from the Display Indicator section will be on. The energy flow section will point either left (production) or right (consumption).

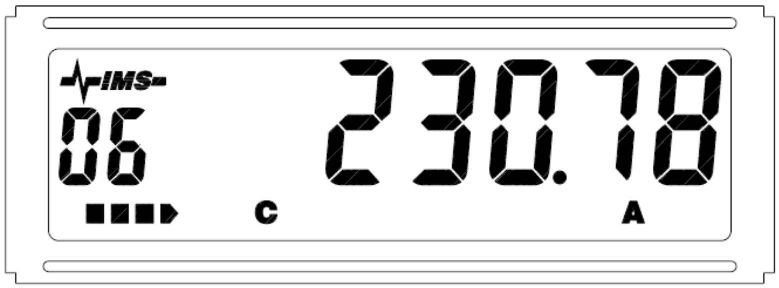


Phase C Voltage (05)

The Phase C Voltage screen displays the voltage on Line 3 with respect to Neutral, measured in volts. The 'C' from the Phase Indicator section and the 'V' from the Display Indicator section will be on.

Phase C Current (06)

The Phase C Current screen displays the current measured on Line 3 in Amps. The 'C' from the Phase Indicator section and the 'A' from the Display Indicator section will be on. The energy flow section will point either left (production) or right (consumption).



Frequency (07)

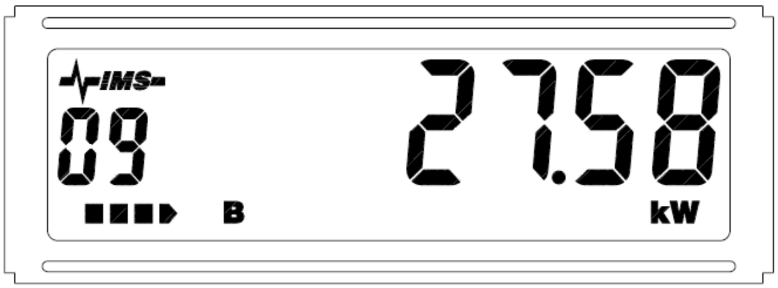
The Frequency screen displays the frequency reading on the active line, usually Line 1, measured in Hertz. The active line only changes in a low voltage detection situation. If the voltage on Line 1 is low, the active line will automatically shift to Line 2. If Line 2 has low voltage, it will switch to Line 3. There is nothing displayed in the Phase Indicator section and the Display Indicator section will display 'Hz'.

Phase A Real Power (08)

The Phase A Real Power screen displays the real power measured on Line 1 in kilowatts. The 'A' from the Phase Indicator section and the 'kW' from the Display Indicator section will be on. The energy flow section will point either left (production) or right (consumption).

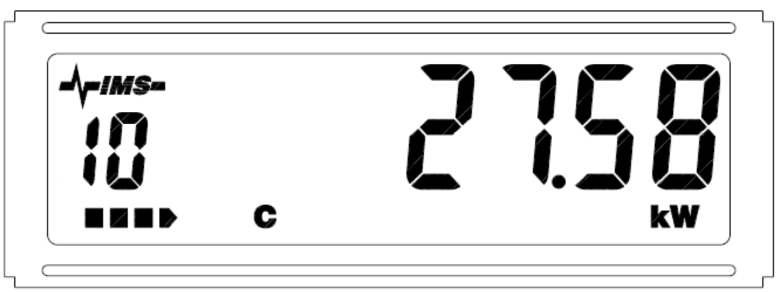
Phase B Real Power (09)

The Phase B Real Power screen displays the real power measured on Line 2 in kilowatts. The ‘B’ from the Phase Indicator section and the ‘kW’ from the Display Indicator section will be on. The energy flow section will point either left (production) or right (consumption).



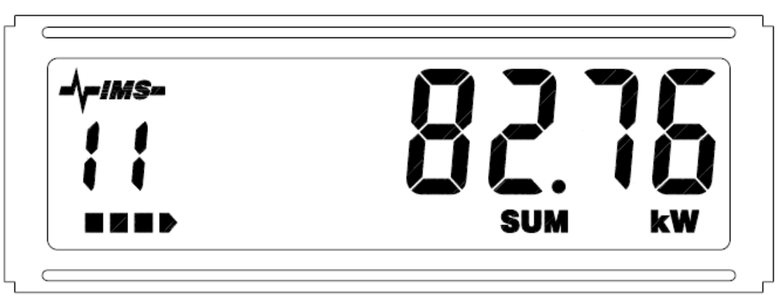
Phase C Real Power (10)

The Phase C Real Power screen displays the real power measured on Line 2 in kilowatts. The ‘C’ from the Phase Indicator section and the ‘kW’ from the Display Indicator section will be on. The energy flow section will point either left (production) or right (consumption).



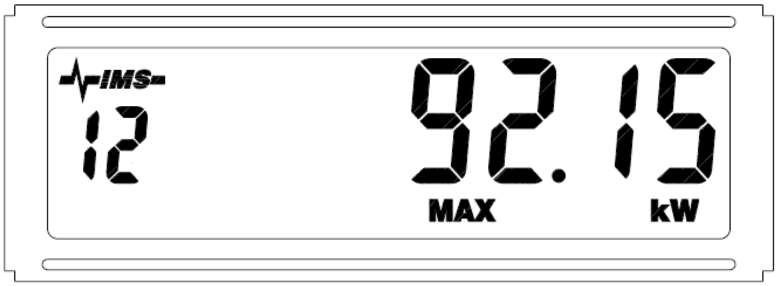
Instantaneous Demand (11)

The Instantaneous Demand screen displays the combined real power consumption of all phases. This is a net value. Nothing from the Phase Indicator section will be on, and the ‘kW’ and ‘SUM’ from the Display Indicator section will be on. The energy flow section will point either left (production) or right (consumption).



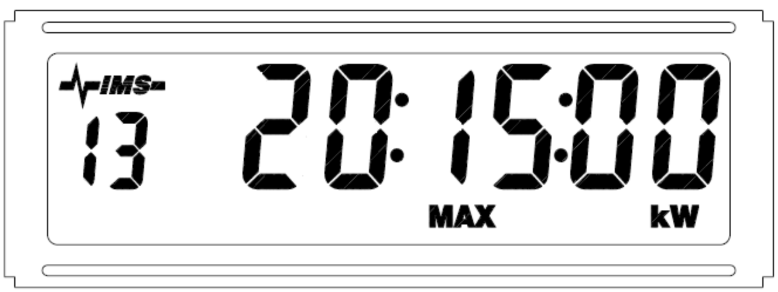
Maximum Demand (12)

The Maximum Demand screen displays the stored maximum demand. This is a net value. Nothing from the Phase Indicator section will be on, and the 'kW' and 'MAX' from the Display Indicator section will be on. For information on demand calculations, see section X.X.



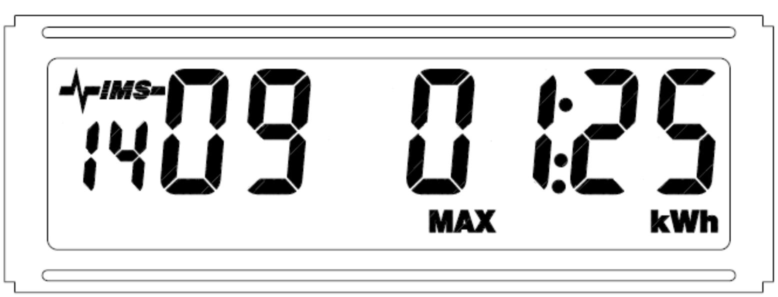
Maximum Demand Time (13)

The Maximum Demand Time screen displays the time of day that the stored maximum demand occurred. The format for the time is HH:MM:SS. Nothing from the Phase Indicator section will be on, and the 'kW' and 'MAX' from the Display Indicator section will be on.



Maximum Demand Date (14)

The Maximum Demand Date screen displays the date on which the stored maximum demand occurred. The format for the date is YY MM:DD. The image below indicates a maximum demand date of January 25, 2009. Nothing from the Phase Indicator section will be on, and the 'kW' and 'MAX' from the Display Indicator section will be on.



Energy to Grid (15)

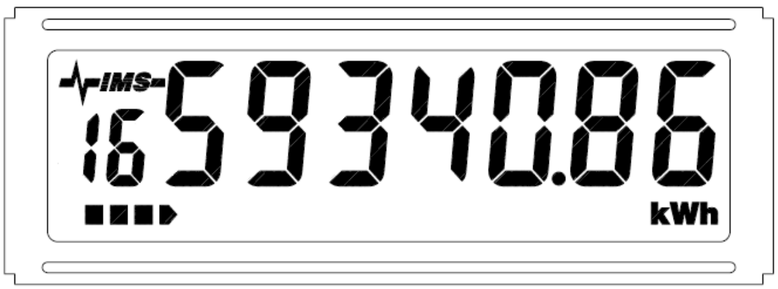
The Energy to Grid screen displays the total energy production measured in kWh. The displayed value is shown at different resolutions depending on the magnitude of the energy production total (see below). Regardless of the resolution of the display, the value is always read as a typical number. In the images below, the readings are 33,710.25 kWh; 337,102.5 kWh; and 3,371,025 kWh respectively. Nothing from the Phase Indicator section is displayed, and the 'kWh' from the Display Indicator section will be on. The energy flow section will point to the left, indicating production.

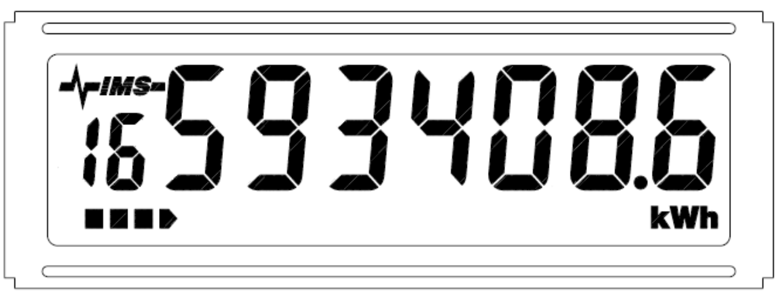
Energy to Grid	**Digits Left of Decimal**	**Digits Right of Decimal**
Less than 100,000	5	2
Between 100,000 and 1,000,000	6	1
Greater than 1,000,000	7	0

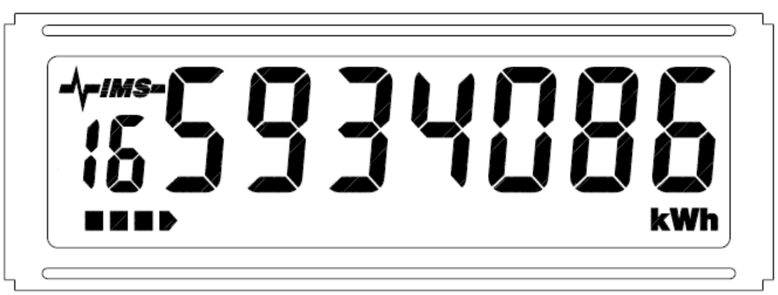
Energy from Grid (16)

The Energy from Grid screen displays the total energy consumption measured in kWh. The displayed value is shown at different resolutions depending on the magnitude of the energy consumption total (see below). Regardless of the resolution of the display, the value is always read as a typical number. In the images below, the readings are 59,340.86 kWh; 593,408.6 kWh; and 5,934,086 kWh respectively. Nothing from the Phase Indicator section is displayed, and the 'kWh' from the Display Indicator section will be on. The energy flow section will point to the right, indicating consumption.

Energy from Grid	**Digits Left of Decimal**	**Digits Right of Decimal**
Less than 100,000	5	2
Between 100,000 and 1,000,000	6	1
Greater than 1,000,000	7	0







6.4 Controlling the LCD

The LCD has two modes of operation, automatic scroll and manual scroll.

Changing the Mode of Operation

The LCD starts in automatic scroll mode. To change to manual mode, press and release the Scroll button once.

To change back to automatic scroll, press and hold the Scroll button. Once the screen changes, release the Scroll button (this will take approx. 5 seconds).

Manual Scrolling

When the LCD is in manual scroll mode, press and release (do not hold long) the Scroll button once to go to the next screen available on the meter. Holding the button for too long will put the LCD back in automatic scroll mode as described above.

7. Data Storage

7.1 Memory Size

Each EEPROM contains 131 072 bytes of information, enough for approximately 3,120 profiles of meter information. 115 bytes are used to store meter information, calibration information, and power loss information; this leaves storing capability of 6,236 profiles. Series 3000 meters can be programmed for four different data saving intervals: 5 minutes, 15 minutes, 30 minutes, and 60 minutes. For each of these selections, the meter will begin to overwrite old information after the following time periods:

5 minute – ~21.5 days

15 minute - ~65 days

30 minute – ~130 days

60 minute – ~260 days

The save intervals can be field-programmed via RS485 communications (see section 8.1). The stored information is also retrievable using the RS485 connection.

7.2 Data Layout

Basic meter information is stored in the EEPROM. KWh-, kWh+, VAh-, and VAh+ are stored separate from traditional data (in addition to with each profile) to make sure the reading stays up to the minute during power loss situations. Power loss timestamp is stored just before the calibration information. The rest of the EEPROM space is used for storage of data profiles. The structure of data profiles is shown in Table 7. Data profile information, except RTC, kWh and VAh, is saved in 16-bit floating point format using truncation of the least significant decimal information. To increase resolution from truncating data for storage, each part of the profile has an associated multiplier. When data is extracted, first make the 16-bit value into a 32-bit float by appending 0x7FFF and then multiply by the multiplier. VAh and kWh are stored as 32-bit floating point numbers and do not need a multiplier.

As an example of using the multiplier, assume the phase A voltage reading is 276.7 V. This value is divided by the multiplier (100) to become 2.767 (0x40311687) and is stored in the data profile as 0x4031. When translated back from hex to a float, 0x40317FFF becomes 2.7734, and using the 100 multiplier gives a value of 277.34 V. This data condensing is used to increase storage capacity, and does not affect long term meter accuracy. The running kWh and VAh totals are a combination of two floating point numbers, which maintains accuracy beyond thousandths of a kWh, even when high values are reached (see section 4.3 kWh and Demand).

Data Profile Information	Bytes	Multiplier
RTC Year	1	1
RTC Month	1	1
RTC Day	1	1
RTC Hour	1	1
RTC Minute	1	1
RTC Second	1	1
Phase A Voltage	2	100
Phase B Voltage	2	100
Phase C Voltage	2	100
Phase A Current	2	100
Phase B Current	2	100
Phase C Current	2	100
Phase A Watts	2	1
Phase B Watts	2	1
Phase C Watts	2	1
Total kWh+	4	1
Total kWh-	4	1
Total kVA+	4	1
Total kVA-	4	1
Maximum Demand	2	100
--------	42	

Table 7: Data profile format

7.3 EEPROM Lifetime

EEPROM lifetime is rated based on the number of write cycles per page. Due to this, selecting smaller data save intervals can have a large affect on EEPROM lifetime. Table 8 below gives worst case EEPROM lifetime based on various meter setups. Series 3000 meters have a default kWh save interval of 5 minutes.

Data Save Interval (minutes)	kWh Save Interval (minutes)	Lifetime (years)
5	1	1.8
	2	3.4
	5	7.6
	10	12.6
	15	15.0
15	1	1.8
	2	3.6
	5	8.7
	10	15.0

	15	15.0
30	1	1.8
	2	3.7
	5	9.1
	10	15.0
	15	15.0
60	1	1.9
	2	3.7
	5	9.3
	10	15.0
	15	15.0

Table 8: Estimated EEPROM lifetime

EEPROM lifetime is also highly dependant on operating temperature. Meters installed in high temperature locations will, on average, experience EEPROM failure times shorter than those listed above.

8. Communications

8.1 RS485 (Modbus) Information

8.1.1 Introduction

Series 3000 meters feature RS-485 communication using Modbus protocol. Many functions are supported, including current and historical data retrieval, selection of meter operating modes, and demand reset. Each meter can operate as a slave device hooked up to a Modbus network of up to 255 meters.

8.1.2 General Information

Series 3000 meters use Modbus RTU encoding. An RTU data byte features a start bit followed by 8 bits of data, two stop bits (no parity check) and a CRC.

Start	D0	D1	D2	D3	D4	D5	D6	D7	P/Stop	Stop	CRC

RTU data byte format

Each frame begins with the start sequence, which is a silence of 3.5 data intervals. This means that there must be a silence of 3.5 data intervals following a Modbus transaction before another can be sent (7 data intervals including both the end sequence and the next start sequence). After the start sequence, the meter network ID is sent, followed by the function code, n bytes of data, CRC check, and then the end sequence, which is another 3.5 data intervals of silence.

Start	Address (meter ID)	Function	Data	CRC	End
T1-T2 T3-T4	8bits	8bits	nx8 bits	16bits	T1-T2 T3-T4

RTU frame format

When connected to a network, each meter must be given a unique 8-bit network address. This address requires knowledge of the meter serial number to set. If this is not set, the meter will only respond to broadcast commands (addressed to 0x00). Valid network ID values are 0x01 to 0xFF.

8.1.3 Implemented Functions

<u>0x03 – Read Holding Registers</u>

The Read Holding Registers command will return information stored in a certain holding register to the master device (see Appendix A: Modbus point map). The read holding register function is sent with the start address and the number of registers to read.

Frame Item	Contents
Meter Address	Meter Network ID
Function Code	0x03
Start Address High	High Byte
Start Address Low	Low Byte
Number of Registers High	High Byte
Number of Registers Low	Low Byte
CRC	CRC

The response to the Read Holding Registers command will send the data stored at the requested holding register(s) back to the master device. Register data is transferred with the most significant byte first.

Frame Item	Contents
Meter Address	Meter Network ID
Function Code	0x03
Byte Count	Number of Registers * 2
Register 1 Data High	High Byte
Register 1 Data Low	Low Byte
…	…
Register N Data High	High Byte
Register N Data Low	Low Byte
CRC	CRC

0x11 – Report Slave ID

The Report Slave ID command format is shown below.

Frame Item	Contents
Meter Address	Meter Network ID
Function Code	0x10
CRC	CRC

The response to the report slave ID command returns pertinent meter information. For more information on reading and converting specific values, refer to section 8.1.4 Read Instructions and Examples.

Frame Item	Content
Meter Address	Meter Network ID
Function Code	0x11
Byte Count	0x0B (0d11)
Meter Serial Number High	S/N High Byte
Meter Serial Number Middle	S/N Middle Byte
Meter Serial Number Low	S/N Low Byte

Hardware Version	Hardware Version
Software Version	Software Version
Program Number High	Program Number High Byte
Program Number Low	Program Number Low Byte
Meter Type	Meter Type Enumerator
EEPROM Save Interval	Data Storage Interval Enumerator
Demand Interval	Demand Calculation Interval Enumerator
Demand Reset Counter	Demand Reset Count
CRC	CRC

0x06 – Preset Single Register

The Preset Single Register command sets the value of a specified Modbus holding register. Only certain registers allow writes (see Appendix A: Modbus point map). The Preset Single Register command frame is shown below, and the response is simply an echo of the command frame.

Frame Item	Contents
Meter Address	Meter Network ID
Function Code	0x06
Address High	High Byte
Address Low	Low Byte
Data High	High Byte
Data Low	Low Byte
CRC	CRC

0x10 – Preset Multiple Registers

The Preset Multiple Registers command functions the same as the Preset Single Register command, but allows the master device to write to a series of registers using just one command. The command frame indicates the starting register address, the number of registers to write to, and the data to be written to each register. The basic format is shown below.

Frame Item	Contents
Meter Address	Meter Network ID
Function Code	0x10
Start Address High	High Byte
Start Address Low	Low Byte
Number of Registers High	High Byte
Number of Registers Low	Low Byte
Byte Count	Number of Registers * 2
Register 1 Data High	High Byte

Register 1 Data Low	Low Byte
…	…
Register N Data High	High Byte
Register N Data Low	Low Byte
CRC	CRC

Attempting to write data to non-write enabled registers will have no affect. The response frame to the Preset Multiple Registers command is shown below. Appendix A: Modbus point map and section 8.1.5 Common Modbus Write Commands provide detailed information on altering registers.

Frame Item	Contents
Meter Address	Meter Network ID
Function Code	0x10
Start Address High	High Byte
Start Address Low	Low Byte
Number of Registers High	High Byte
Number of Registers Low	Low Byte
CRC	CRC

8.1.4 Read Instructions and Examples

Current Meter Data Reads

Current meter data resides in registers 40001 – 40062. Data can be read one register at a time or in large blocks. Readings are stored in 32-bit floating point format, with each reading occupying two registers.

Example: Read Phase-A Voltage from meter with network ID 0x11

Frame Item	Value
Meter Address	0x11
Function Code	0x03
Start Address High	0x00
Start Address Low	0x10
Number of Registers High	0x00
Number of Registers Low	0x02
CRC	CRC

Example: Get all current readings

Frame Item	Value
Meter Address	0x11
Function Code	0x03
Start Address High	0x00

Start Address Low	0x00
Number of Registers High	0x00
Number of Registers Low	0x3E
CRC	CRC

Timestamp Reads

Timestamps are stored with two bytes of information in each register. The most significant byte of the register is one part of the timestamp, and the least significant byte of the register is another part of the timestamp. Timestamps are stored in the following format:

Year: Years since 2000 (0-99)
Month: Month of the year (1-12)
Day: Day of the month (1-31)
Hour: Hour of the day (0-23)
Minute: Minute of the hour (0-59)
Second: Second of the Minute (0-59)
Day of the Week: Sunday = 0x01 (1-7)

For example, if the current RTC time was Tuesday, March 31, 2009 at 1:15:32 PM, the corresponding registers would look as shown below.

Register	Value
40069	0x0903
40070	0x1F0D
40071	0x0F20
40072	0x0003

Calibration Variable Reads

Calibration variables, excluding meter CT ratio and voltage setup, are stored in 32-bit signed integer format with each variable occupying two registers. CT ratio and voltage setup are stored in a single register, the most significant byte indicates CT ratio, and the least significant byte indicates voltage setup. The possible values for CT ratio and voltage setup are shown below.

Variable	Enumerated Value	Description
CT Ratio	0x11	100:0.1
	0x22	200:0.1
	0x33	400:0.1
	0x44	600:0.1

	0x55 0x66 0x77	800:0.1 1200:0.1 1600:0.1
Voltage Setup	0x11 0x22	Low Voltage = 96 V Low Voltage = 220 V

Calibration variables are read in the same manner as meter data. Default calibration variable values are shown below in Table 9.

Calibration Parameters	Default Value
Calibration Temperature	Ambient Temp During Factory Calibration
Phase A Current Gain	16384
Phase B Current Gain	16384
Phase C Current Gain	16384
Phase A Voltage Gain	16384
Phase B Voltage Gain	16384
Phase C Voltage Gain	16384
V3 Gain Control	8192
CT Phase Compensation (A)	0
CT Phase Compensation (B)	0
CT Phase Compensation (C)	0
Watt calculation input noise compensation	0
VAR calculation input noise compensation	0
RMS calculation input noise compensation	0
Offset for low-current V3 measurement	0

Table 9: Default calibration parameter settings

Meter Information Reads

Important meter information is stored starting at register 45001. This section gives instructions for interpreting this information.

Register	Stored Information	Conversion Method	Example
45001-45002	Meter Serial Number and Modbus network ID	Concatenate register 45001 contents with the most significant byte in 45002 for Serial Number. Modbus network ID is the least significant byte in 45002.	45001: 0x013F 45002: 0xCA33 Meter Serial Number: 0x013FCA Modbus network ID: 0x33 = 0d51
45003	Hardware Version and Software Version	Most significant byte is HW Version	45003: 0x1310

		Least significant byte is SW version	HW version: 1.3 SW version: 1.0
45004	Program Number	Convert to 16-bit integer	45004: 0xAAAA PN = 43690
45005	Meter type and demand reset counter	Most significant byte is meter type (enum). Least significant byte is demand reset counter. Convert to integer.	45005: 0x0213 Meter type: 0x02 Demand reset cntr: 0x13 = 0d19
45006	Demand calculation interval and EEPROM save interval	Most significant byte is demand calculation interval (enum). Least significant byte is EEPROM save interval (enum).	45006: 0x0106 Demand calculation interval: 0x01 EEPROM save interval: 0x06
45007	Additional meter options	Reserved for future use	N/A
45008	EEPROM save pointer device and page	Most significant byte is EEPROM device (0 or 2). Convert to integer. Least significant byte is EERPOM page (0 or 1). Convert to integer.	45008: 0x0201 Saving to EEPROM #2, Page #1.
45009	EEPROM save pointer address	16-bit hex value	0x3144

Table 10: Interpreting meter information registers

Enumerations

Meter Type

0x01 – Series 3000 kWh-only Meter
0x02 – Series 3000 Demand Meter
0x03 – Series 3000 Demand Meter w/Per Phase Display
0x05 – Series 4000 Net Meter (Single-Phase)
0x06 – Series 4000 Net Production/Consumption Meter (Single-Phase)
0x07 – Series 4100 Net Meter (Three-Phase)
0x08 – Series 4100 Net Production/Consumption Meter (Three-Phase)

0x09 – Series 5000 Meter

Demand Calculation Interval

0x00 – 15-minute blocks
0x01 – 30-minute blocks

EEPROM Save Interval

0x01 – 5-minute save interval
0x03 – 15-minute save interval
0x06 – 30-minute save interval
0x0C – 60-minute save interval

Note: EEPROM lifetime is averaged at 1 million write cycles. If data save interval is set to 5 minutes (105,000 write cycles per year), there is a higher likelihood of EEPROM failure prior to the 10-year warranty.

Communication Settings Reads

Series 3000 meters have two communications ports; the RS485/Modbus port and a TTL communications port for custom use. Acceptable baud rates are:

2400(0x0960)
4800(0x12C0)
9600(0x2580, Default)
19200(0x4B00)

Baud rates revert to 9600 when meter is reset.

8.1.5 Common Modbus Write Commands

Setting the Modbus network ID

To set the Modbus network ID, issue a broadcast Preset Multiple Register command to register 45001 with a length of 2. The data must contain the serial number of the meter to be programmed and the desired network ID, as described in Table 10.

Example: Program meter with serial number 0x3122AC to have network ID of 0d44.

Frame Item	Value
Meter Address (Broadcast)	0x00
Function Code	0x10
Start Address High	0x13

Start Address Low	0x88
Number of Registers High	0x00
Number of Registers Low	0x02
Data 1 High (Meter S/N MSB)	0x31
Data 1 Low (Meter S/N middle byte)	0x22
Data 2 High (Meter S/N LSB)	0xAC
Data 2 Low (Desired Meter ID)	0x2C
CRC	CRC

Setting the Real Time Clock

Each RTC register can be written to individually or as part of a Preset Multiple Register command. Since RTC information is stored with two parts per register (see Timestamp Read information above), both parts must be included in the command. The meter address for setting the RTC can be an individual meter or a broadcast address.

Example: Set the RTC to Wednesday, April 1, 2009 at 11:30 AM.

Frame Item	Value
Meter Address	0x00
Function Code	0x10
Start Address High	0x00
Start Address Low	0x44
Number of Registers High	0x00
Number of Registers Low	0x04
Data 1 High (2009)	0x09
Data 1 Low (April)	0x04
Data 2 High (1st)	0x01
Data 2 Low (11 hours)	0x0B
Data 3 High (30 minutes)	0x1E
Data 3 Low (0 seconds)	0x00
Data 4 High (N/A)	0x00
Data 4 Low (Wednesday)	0x04
CRC	CRC

Resetting the Maximum Demand

The maximum demand register cannot be written to directly. In order to reset the maximum demand, the hex value 0x00AA must be written to register 40501. Demand reset can be a broadcast command or sent to a specific meter.

Example: Reset the maximum demand for meter with network ID 0x11

Frame Item	Value
Meter Address	0x11
Function Code	0x06
Start Address High	0x01
Start Address Low	0xF4
Data High	0x00
Data Low	0xAA
CRC	CRC

Setting the Demand Calculation Interval and Data Save Interval

The demand calculation interval and data save interval are both contained in register 45006. In order for these to be changed, **both** values must be given a valid enumeration as listed below. If either value is invalid, neither will be changed.

Demand Calculation Interval

0x00 – 15-minute blocks
0x01 – 30-minute blocks

EEPROM Save Interval

0x01 – 5-minute save interval
0x03 – 15-minute save interval
0x06 – 30-minute save interval
0x0C – 60-minute save interval

Example: Set meter with network ID 0x11 to 30-minute demand blocks and 30-minute save intervals.

Frame Item	Value
Meter Address	0x11
Function Code	0x06
Start Address High	0x13
Start Address Low	0x8D
Data High	0x01
Data Low	0x06
CRC	CRC

Changing the Modbus Baud Rate

Acceptable Modbus baud rates are listed below:

2400(0x0960)
4800(0x12C0)
9600(0x2580, Default)
19200(0x4B00)

When a command to change the baud rate is issued, the response will be initiated at the current baud rate before the change. Baud rates revert to 9600 when a meter is reset.

Example: Broadcast all meters to change their Modbus baud rate to 19200.

Frame Item	Value
Meter Address	0x00
Function Code	0x06
Start Address High	0x17
Start Address Low	0x70
Data High	0x4B
Data Low	0x00
CRC	CRC

8.1.6 Historical Data Retrieval

Historical readings are not stored in registers similar to the current meter readings. Instead, the historical readings are provided as a stream of data, controlled by date and a number of readings to send. The control options for the date and the number of readings are made available in registers 0504-0506. **Sending large streams of historical data halts the meter computation to avoid conflicting processor demands. As such, large historical reads should not be used on a frequent basis**. Once the transfer finishes, the meter will resume normal operations.

Setting the Date

The historical data access date provides criteria for data retrieval. By default, all historical data access dates start as 'don't cares' (0xFF). When a date value is don't care, it has no affect on the filtering of historical data. When a date value is set to something besides don't care (0xFF), then it acts as a filter for the data retrieved from memory. The date value specifies the oldest data to be retrieved. For instance, setting the historical data year to 0x08 will filter out any meter readings prior to 2008. Each part of the historical date is treated as an independent filter. Some examples are provided below in Table 11 to further illustrate.

Year	Month	Date	Hour	Meter Readings Sent
0xFF	0xFF	0xFF	0xFF	Any

0x08	0xFF	0xFF	0xFF	Any reading in 2008 or later
0xFF	0x06	0xFF	0xFF	Any reading from June-Dec in any year
0x09	0x06	0xFF	0xFF	Any reading in June, 2009 or later
0xFF	0xFF	0xFF	0x11	Any reading after 5:00 PM on any day of any year
0x09	0x03	0x01	0xFF	Any reading on March 01, 2009 or later
0xFF	0xFF	0x1C	0x17	Any reading after 11:00 PM on the 28th to the end of the month

Table 11: Setting the historical data access date

The historical data access date information is stored in holding registers 0504 and 0505 (0x01F8 and 0x01F9) as shown in Appendix A: Modbus point map. The year and month are stored in register 0504, and the date and hour are stored in register 0505. The historical date can be read from and written to in the same manner as other timestamps (described earlier).

Initiating Data Retrieval and Controlling the Number of Profiles Sent

In addition to filtering options, the number of data profiles sent can be controlled as well. To initiate historical data retrieval, a read holding register command is issued to address 0506 (see 8.1.4 Read Instructions and Examples). The number of registers variable in the read command controls the number of matching profiles to be sent. Once the desired number of readings has been found and transferred the transmission ends.

Historical Data Profile Structure

The historical data is transmitted in frames consisting of 40 bytes each. The frame structure is shown below. The structure for each profile and information for data interpretation can be found in the EEPROM section of the Series 3000 User's Manual.

Frame Item	Contents
Meter Address	Meter Network ID
Function Code	0x03
Profiles Remaining High	Number of Profiles Left to Send High
Profiles Remaining Low	Number of Profiled Left to Send Low
Profile N RTC Year	Time of Use Year
Profile N RTC Month	Time of Use Month
…	…
Profile N Maximum Demand High	High Byte
Profile N Maximum Demand Low	Low Byte
CRC	CRC

Once one frame is finished transmitting, the next frame will begin automatically until the number of profiles left to send reaches zero.

8.1.7 Error Reporting

Five error codes are implemented in the Series 3000 meters, listed in Table 12.

Error	Cause	Error Code
Illegal Function	Invalid Function Code	0x01
Illegal Data Address	Invalid Data Address	0x02
Illegal Data Value	Invalid Write Data	0x03
Slave Device Failure	Meter Failure	0x04
Checksum Failure	CRC Mismatch	0x05

Table 12: Modbus error codes

The error response frame follows Modbus protocol for error frames, shown below. The function code in the error response is the same function that was sent with the most significant bit set. For example, if preset multiple registers (0x10) was sent; the error response function would be 0x90.

Frame Item	Value
Meter Address	Meter Network ID
Function Code	Sent Function with MSB Set
Error Code	Error Code Enumerator
CRC	CRC

8.2 Ethernet (Modbus over TCP) Add-on Module

The Ethernet add-on module is not intended for direct connection to the telecommunications network. A connection to a gateway device, such as modem or router, is required to make an external link.

8.2.1 Introduction

IMS offers an optional Ethernet module to convert from RS485 to TCP/IP. Since the module primarily acts as a conversion device, the Modbus information, including commands, responses, error codes, and register locations is the same as described in Section 8.1.

8.2.2 Installation and Setup

8.3 Integration with BACNET

8.3.1 Introduction

The FieldServer ProtoCessor is hardware designed for converting between communication protocols; in this case, from Modbus RTU to BACnet IP. The ProtoCessor acts as a client node when communicating with a BACnet system (building automation network), and acts as a server node when communicating with the Series

3000 (end device). Through a programmable configuration file, the ProtoCessor maps BACnet objects on its client side to data arrays on its server side. Each server side data array is in turn mapped to a Modbus holding register on the Series 3000. The ProtoCessor polls the Modbus registers on the Series 3000 at a defined interval and updates the appropriate registers. Figure 13 below depicts a typical setup.

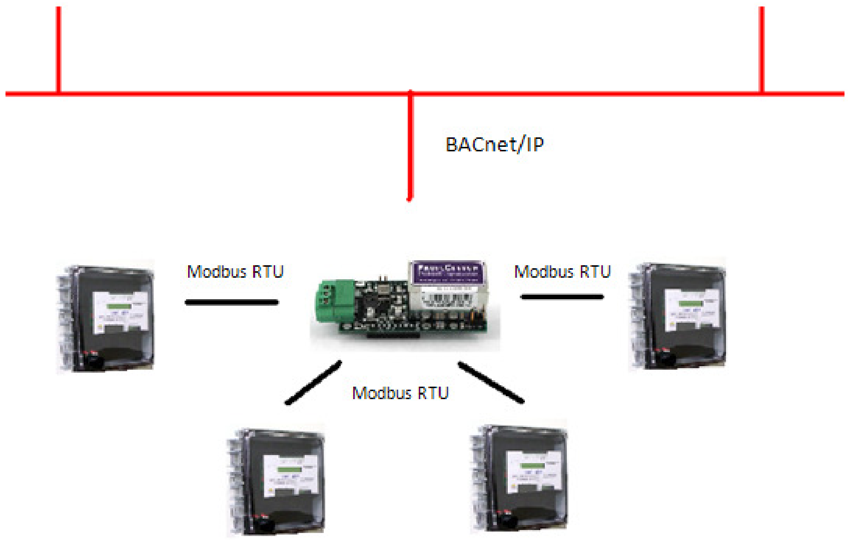


Figure 13: Typical Series 3000 connection to BACnet network

8.3.2 ProtoCessor Count vs. Information Provided

Each ProtoCessor is capable of communicating with multiple end devices, the number of which depends on the information that is made available. There are two types of configurations available, full service and reduced service. Full service provides all information described in the Series 3000 Modbus Register Map, excluding factory calibration parameters. A full service ProtoCessor can communicate with up to 5 Series 3000 meters. Reduced service limits the availability of certain information over the BACnet system. A reduced service ProtoCessor can communicate with up to 19 Series 3000 meters. Table 13 below gives a comparison between the two options.

Configuration Type	**Series 3000 Meters per ProtoCessor**	**BACnet objects available**
Full Service	Up to 5	All information from the Modbus Register Map, excluding calibration parameters.
Reduced Service	Up to 19	kWh Delivered Voltage and Current per phase

		Maximum Demand Calibration Temperature Real Time Clock reading Meter Information

Table 13: Full service vs. Reduce service BACnet

8.3.3 Node Network ID Assignment

ProtoCessor IP Address

The ProtoCessor IP address can be set to a static IP before shipping from IMS, or it can be obtained automatically using the DHCP client. Note that the network's DHCP Server must be setup correctly for dynamic allocation to work. The IP address can also be changed in the field via utilities provided by FieldServer.

ProtoCessor MAC Address

The MAC address of the ProtoCessor can be assigned dynamically and saved into memory. To assign the MAC address to the ProtoCessor, set the Present_Value of Analog Value 98 to the desired MAC address. The ProtoCessor will maintain this address until it is changed again.

ProtoCessor Node Network ID (Device Number)

The node network ID of the ProtoCessor can be assigned dynamically and saved into memory, enabling a one-time-only set up of a network of ProtoCessor devices. To assign the node address to the ProtoCessor, set the Present_Value of Analog Value 99 to the desired node address. The ProtoCessor will maintain this address until it is changed again.

Series 3000 Meter Node Network ID

Single Meter

In the case of a single meter combined with a single ProtoCessor unit, the ProtoCessor will issue only broadcast commands, making network ID for the Series 3000 meter unnecessary.

Multiple Meters

Knowledge of the Series 3000 meter Serial Numbers is required to set the network ID. Setting the network ID for a specific meter requires setting the Present_Value or Analog_Value_100 concatenation of the meter serial number and the desired network ID. The Present_Value must be sent as an unsigned 32-bit integer. For full service configuration, valid network IDs range from 1-5. For reduce service, valid network IDs range from 1-19.

Example: Set Series 3000 meter with serial number 0x12FF3C to network ID 15.

Write Present_Value of Analog_Value_100 to 318,716,943 (0x12FF3C0F)

Individual meter network IDs must be reset in the event of power loss.

8.3.4 Retrieving Data

All meter data from the Series 3000 is mapped to Analog Inputs by the ProtoCessor. Appendix B: BACnet Object Identifiers gives the appropriate mapping locations and data types. To access the data, simply read the Present_Value of the desired Analog Input.

8.3.5 Issuing Commands

Through the BACnet system, the operator has the ability to make a few changes to the Series 3000 options. These capabilities are RTC synchronization, demand reset, and setting the demand calculation and data save intervals.

RTC Synchronization

Synchronization of the RTC can be issued as a broadcast command to all Series 3000 meters on the sub-network or as a command to an individual meter. To set the RTC, write the appropriate Present_Value to the associated Analog Input or Analog Value as listed in Appendix B: BACnet Object Identifiers.

Example: Broadcast RTC synchronization to Thursday, April 2, 2009 at 2:44:00 pm.

Write Present_Value of Analog_Value_3 to 9
Write Present_Value of Analog_Value_4 to 4
Write Present_Value of Analog_Value_5 to 2
Write Present_Value of Analog_Value_6 to 14
Write Present_Value of Analog_Value_7 to 44
Write Present_Value of Analog_Value_8 to 0
Write Present_Value of Analog_Value_9 to 5

Maximum Demand Reset

Maximum demand reset can be issued as a broadcast command to all Series 3000 meters on the sub-network or as a command to an individual meter. To issue a demand reset, change the Present_Value property of the corresponding Analog Value to 170. See Appendix B: BACnet Object Identifiers for appropriate Analog Value numbers.

Example: Reset the maximum demand of Series 3000 meter with network ID = 4.

Write Present_Value of Analog_Value_40 to 170.

Change Demand Calculation Interval and/or Data Save Interval

Demand calculation interval and data save interval changes can be issued as a broadcast command to all Series 3000 meters on the sub-network or as a command to an individual meter. To issue a change, write the Present_Value property of the corresponding Analog Value based on the enumerations shown below. The Present_Value should be a 16-bit integer, with the most significant byte corresponding to the demand calculation enumerator, and the least significant byte corresponding to the data save enumerator. **Both** values must be included for the change to be successful. See Appendix B: BACnet Object Identifiers for Analog Value numbers corresponding to network IDs.

Demand Calculation Interval

0x00 – 15-minute blocks
0x01 – 30-minute blocks

Data Save Interval

0x01 – 5-minute save interval
0x03 – 15-minute save interval
0x06 – 30-minute save interval
0x0C – 60-minute save interval

Example: Change the demand calculation interval to 30-minute blocks and the data save interval to 15-minutes for meter at network ID = 2.

Write Present_Value of Analog_Value_25 to 259 (0x0103)

8.3.6 Alarms and Events

Alarms and Event codes are not currently supported.

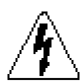
8.3.7 Error Rates

With the BACnet objects updating every 20 seconds, the error rate is in the range of 3-6%, depending on the number of meters connected to the sub-network. Most errors are due to data requests coming during higher priority meter actions (metering calculations). Error transmissions are discarded without affecting the current data and polling continues as normal. Observed errors on the BACnet side of the device have been minimal (< 1%).

9. Maintenance

9.1 Battery Replacement

The battery backup is a standard CR2025 lithium coin cell, rated at 3 V and 165 mAh. Since minimal current is drawn from the battery when the meter in powered on, most batteries do not need replaced over the lifetime of the meter. If a situation occurs in which the meter will be powered off for a prolonged period, battery life will be significantly reduced (see section 4.7). In the event that the battery needs replaced while the meter is still in operation, follow the instructions below.



To reduce risk of electric shock, always open or disconnect the circuit from the power distribution system of a building before servicing an electric meter. Use a properly rated voltage sensing device to confirm power is off.

1. After de-energizing, open the meter enclosure.
2. Grip the top metering board from both sides and pull to detach from the bottom board.
3. Remove the old battery from the coin slot with a pair of tweezers, noting the polarity.
4. Insert the new battery into the slot with the same polarity.
5. Reconnect the two boards and close the enclosure.
6. Power on the circuit to verify the meter is still working properly.
7. Resynchronize the RTC using the communications port as described in section 8.

10. Hookup Diagrams

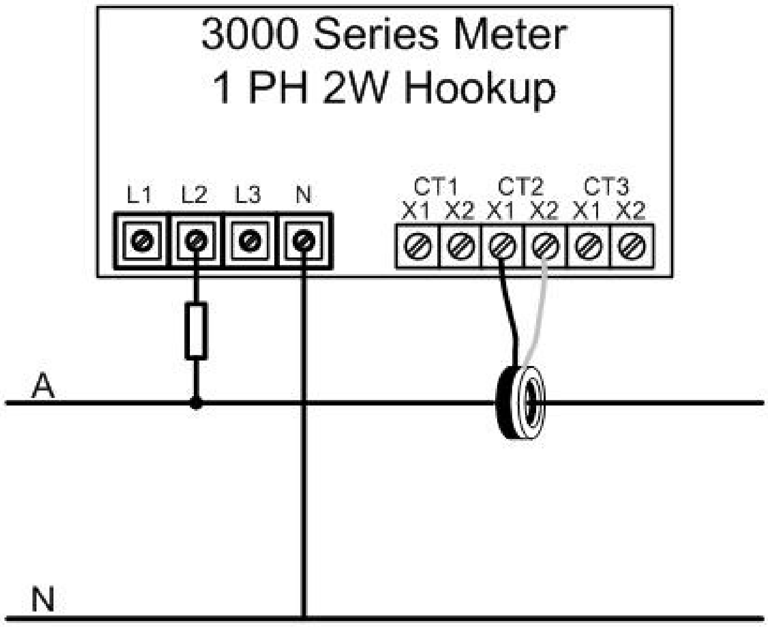


Figure 14: 1-phase, 2-wire hookup diagram

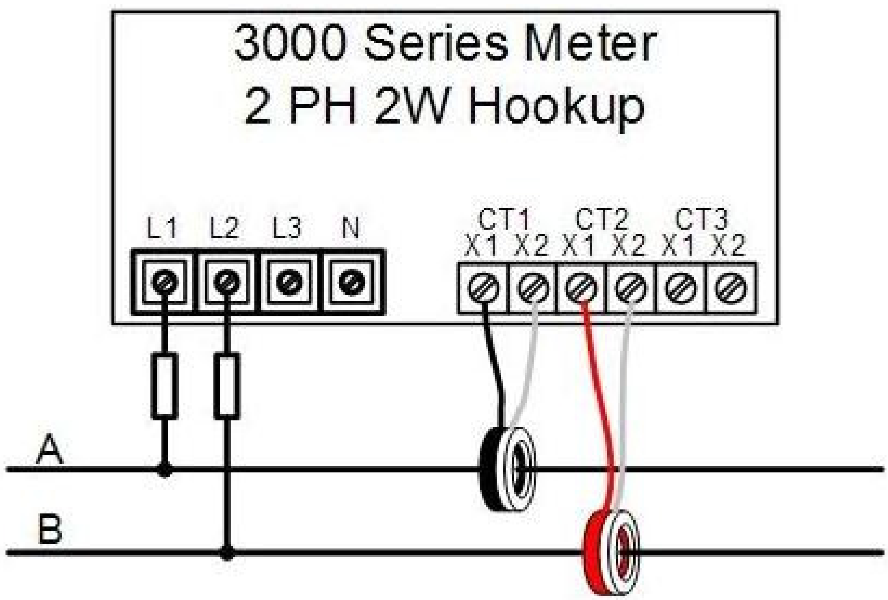


Figure 15: 2-phase 2-wire hookup diagram

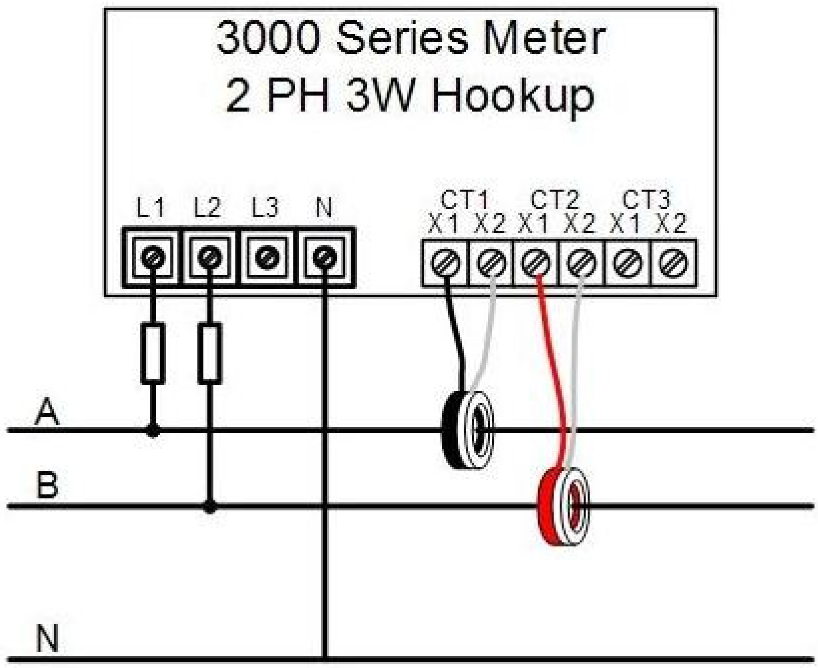


Figure 16: 2-phase, 3-wire (split phase) hookup diagram

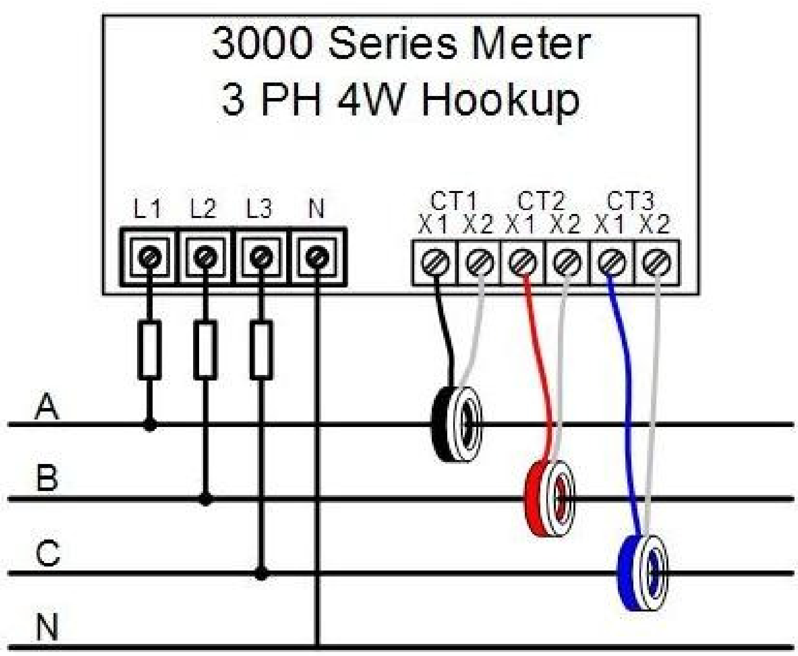


Figure 17: 3-phase, 4-wire hookup diagram

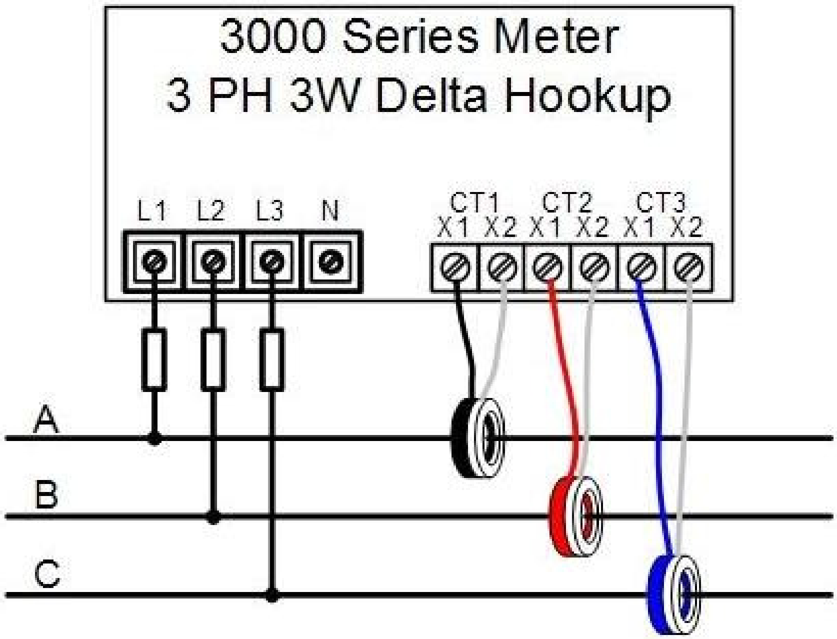


Figure 18: 3-phase, 3-wire hookup diagram

11. Troubleshooting/FAQ

Problem	Solution
1. Problem1	• Try11
2. Problem2	• Try21
3. Registered consumption low	• Try31 • Try32
4. Problem4	• Try41

FAQ

Q: Can you use additional sets of current transformers (CT's) with a submeter to accommodate more circuits?
A: Yes, you can use up to three sets of CTs in parallel per meter. Just make sure you do not exceed the current rating per phase. CTs should be sized according to the rated amperage of the meter. Example: Monitoring 3, 200 amp circuits with a 600 amp meter would require the use of 600 amp CTs.

Q: Can I use a single phase (3-wire) meter on a three phase feed?
A: Yes, but you should let the factory know you are monitoring a three phase feed so we can configure the package properly.

Q: What is AMR equipment?
A: AMR is Automatic Meter Reading equipment. This typically consists of radio transmitters, repeaters, and a collector that monitors, records, and transmits data to a third party billing service (RBC)

Q: Why do I need a third party billing service (RBC)?
A: RBC's are typically used with larger facilities that want to generate bills for the tenants. These companies will install, initialize, maintain, and monitor the meters not only for electrical usage but for trouble signals as well.

Q: Why are the current transformers color coded (Black & white, red & white, and blue & white)?
A: CT1 needs to monitor the same phase used to power the meter on line 1, CT2 needs to monitor the same phase used to power line 2, etc.

Q: Can volts, amps, and watts per phase be accessed without using the RS485 communications port?
A: Since most applications do not require the user to know per phase values, the standard Series 3000 meter only makes this information available over the communications port. Alternate meters are available that display per phase information to the LCD. For more information, contact IMS.

Q: Can digital input/output wires be routed through the same conduit as voltage input and current sensing wires?
A: No. In accordance with NEC and UL requirements, Class 2 wiring (digital inputs/outputs) must be separated from Class 1 wiring.

Q: I still can't get my meter to work, what now?
A: Contact technical support via phone or on our website given in the following section.

12. Contact Information

Integrated Metering Systems, Inc.
11701 S. Belcher Rd., Suite 123
Largo, FL 33773
Phone: 727-539-1813
Toll Free: 800-488-3594
On the web: http://www.imsmeters.com/

13. Revision History

Revision	Date	Changes
0.1	22 Jan 2009	Initial Draft
0.2	3 March 2009	Added Changes after Final UL MM Approval
0.3-0.4	31 March 2009	Added New Modbus Information
0.5	6 April 2009	Added BACnet Integration Section
0.6	6 April 2009	Reformatted
		Added Installation Instructions
0.12	17 Feb 2010	Revised Supply Voltage Ranges
		Added Ethernet Module Information
		Indicated N/C on DIO1 and DIO2
		Added Section 3.8 – Securing the Enclosure
		Added conduit bonding warning and reference kit

Table 14: Revision History

Appendix A: Modbus point map

Address	Hex Value	Holding Register	Width	Description	Unit of Measure	Data Type	R/W
				Meter Readings			
0000	0000	40001	2	kWh from grid	kWh	32-bit float	R
0002	0002	40003	2	kWh to grid	kWh	32-bit float	R
0004	0004	40005	2	kVAR from grid	kVAR	32-bit float	R
0006	0006	40007	2	kVAR to grid	kVAR	32-bit float	R
0008	0008	40009	2	Total Power (A+B+C)	kW	32-bit float	R
0010	000A	40011	2	Total Apparent Power (A+B+C)	kVA	32-bit float	R
0012	000C	40013	2	Total Reactive Power (A+B+C)	kVAR	32-bit float	R
0014	000E	40015	2	Total Power Factor	N/A	32-bit float	R
0016	0010	40017	2	Phase A Voltage (L-N)	V	32-bit float	R
0018	0012	40019	2	Phase B Voltage (L-N)	V	32-bit float	R
0020	0014	40021	2	Phase C Voltage (L-N)	V	32-bit float	R
0022	0016	40023	2	Phase A Current	A	32-bit float	R
0024	0018	40025	2	Phase B Current	A	32-bit float	R
0026	001A	40027	2	Phase C Current	A	32-bit float	R
0028	001C	40029	2	Phase A Real Power	W	32-bit float	R
0030	001E	40031	2	Phase B Real Power	W	32-bit float	R
0032	0020	40033	2	Phase C Real Power	W	32-bit float	R
0034	0022	40035	2	Phase A Apparent Power	VA	32-bit float	R
0036	0024	40037	2	Phase B Apparent Power	VA	32-bit float	R
0038	0026	40039	2	Phase C Apparent Power	VA	32-bit float	R
0040	0028	40041	2	Phase A Reactive Power	VAR	32-bit float	R
0042	002A	40043	2	Phase B Reactive Power	VAR	32-bit float	R
0044	002C	40045	2	Phase C Reactive Power	VAR	32-bit float	R
0046	002E	40047	2	Phase A Power Factor	N/A	32-bit float	R
0048	0030	40049	2	Phase B Power Factor	N/A	32-bit float	R
0050	0032	40051	2	Phase C Power Factor	N/A	32-bit float	R
0052	0034	40053	2	Voltage A to B (L-L)	V	32-bit float	R
0054	0036	40055	2	Voltage B to C (L-L)	V	32-bit float	R
0056	0038	40057	2	Voltage C to A (L-L)	V	32-bit float	R
0058	003A	40059	2	Line Frequency	Hz	32-bit float	R
0060	003C	40061	2	Maximum Demand	W	32-bit float	R
0062	003E	40063	1	Maximum Demand Timestamp: Year/Month	Year/Month	Two 8-bit integers	R
0063	003F	40064	1	Maximum Demand Timestamp: Day/Hour	Day/Hour	Two 8-bit integers	R
0064	0040	40065	1	Maximum Demand Timestamp: Minute/Second	Min/Sec	Two 8-bit integers	R
0065	0041	40066	1	Power Loss Timestamp: Year/Month	Year/Month	Two 8-bit integers	R
0066	0042	40067	1	Power Loss Timestamp: Day/Hour	Day/Hour	Two 8-bit integers	R
0067	0043	40068	1	Power Loss Timestamp: Minute/Second	Min/Sec	Two 8-bit integers	R
0068	0044	40069	1	RTC Year/Month	Year/Month	Two 8-bit integers	R/W
0069	0045	40070	1	RTC Day/Hour	Day/Hour	Two 8-bit integers	R/W
0070	0046	40071	1	RTC Minute/Second	Min/Sec	Two 8-bit integers	R/W
0071	0047	40072	1	RTC Day of the Week[1]	N/A	8-bit enum. in	R/W

						LSB	
				Control Registers			
0500	01F4	40501	1	Maximum Demand Reset	N/A	Write 0x00AA to initiate reset	W
0501	01F5	40502	1	Calibration Parameters Lock	N/A	0x9999:Unlock, 0xCCCC: Lock	R/W
0502	01F6	40503	1	Digital Output 0 Control	N/A	16-bit enumerated	
0503	01F7	40504	1	Digital Output 1 Control	N/A	16-bit enumerated	
				Calibration Information			
1000	03E8	41001	1	CT Ratio/Voltage Setup	N/A	Two 8-bit enumerated[2]	R
1001	03E9	41002	2	Nominal Calibration Temp	Deg C	32-bit signed integer	R
1003	03EB	41004	2	Phase A Current Gain	N/A	32-bit signed integer	R/W
1005	03ED	41006	2	Phase B Current Gain	N/A	32-bit signed integer	R/W
1007	03EF	41008	2	Phase C Current Gain	N/A	32-bit signed integer	R/W
1009	03F1	41010	2	Phase A Voltage Gain	N/A	32-bit signed integer	R/W
1011	03F3	41012	2	Phase B Voltage Gain	N/A	32-bit signed integer	R/W
1013	03F5	41014	2	Phase C Voltage Gain	N/A	32-bit signed integer	R/W
1015	03F7	41016	2	V3 Gain Control	N/A	32-bit signed integer	R/W
1017	03F9	41018	2	CT Phase Compensation (A)	N/A	32-bit signed integer	R/W
1019	03FB	41020	2	CT Phase Compensation (B)	N/A	32-bit signed integer	R/W
1021	03FD	41022	2	CT Phase Compensation (C)	N/A	32-bit signed integer	R/W
1023	03FF	41024	2	Watt calculation input noise compensation	N/A	32-bit signed integer	R/W
1025	0401	41026	2	VAR calculation input noise compensation	N/A	32-bit signed integer	R/W
1027	0403	41028	2	RMS calculation input noise compensation	N/A	32-bit signed integer	R/W
1029	0405	41030	2	Offset for low-current V3 measurement	N/A	32-bit signed integer	R/W
				Meter Information			
5000	1388	45001	2	Meter Serial Number and network ID	N/A	24-bit encoded[3] and 8-bit integer	R/W[4]
5002	138A	45003	1	Hardware Version/Software Version	N/A	Two 8-bit hex values[3]	R
5003	138B	45004	1	Program Number	N/A	16-bit integer	R
5004	138C	45005	1	Meter Type/Demand Reset Counter	N/A	8-bit enum[3] and 8-bit integer	R
5005	138D	45006	1	Demand Save Interval/EEPROM Save Interval	N/A	Two 8-bit	R/W

						enumerated[3]	
5006	138E	45007	2	Additional Meter Options	N/A	32-bit encoded[4]	R
5008	1390	45009	1	EEPROM Most Recent Device/Page	N/A	Two 8-bit hex values	R
5009	1391	45010	1	EEPROM Most Recent Address	N/A	16-bit hex value	R
Communications Settings							
6000	1770	46001	1	Modbus Baud Rate	bps	16-bit integer[5]	R/W
6001	1771	46002	1	RS232 Baud Rate	bps	16-bit integer[5]	R

Appendix B: BACnet Object Identifiers

Analog Values – Full Service

Analog Value Number	Meter Network ID	Description	Units	Data Type
1	Broadcast	Max Demand Reset	None	Enumerated
2	Broadcast	Demand Calc & Data Save Interval	None	Enumerated
3	Broadcast	RTC Year/Month	Years	16-bit Concatenated
4	Broadcast	RTC Day/Hour	Days	16-bit Concatenated
5	Broadcast	RTC Minute/Second	Minutes	16-bit Concatenated
6	Broadcast	RTC Day of The Week	None	Enumerated in LSB
7	1	Max Demand Reset	None	Enumerated
8	1	Meter SN (Most Sig 2 Bytes)	None	Integer
9	1	Meter SN (LSB) & Network ID	None	Integer & Enumerated
10	1	HW version & SW version	None	Integer
11	1	Program Number	None	Enumerated
12	1	Meter Type and Demand Counter	None	Enumerated and 8-bit integer
13	1	Demand Calc & Data Save Interval	None	Enumerated
14	1	Additional Meter Options1	None	Enumerated
15	1	Additional Meter Options2	None	Enumerated
16	1	EEPROM Most Recent Device/Page	None	Enumerated
17	1	EEPROM Most Recent Address	None	Hex Value
18	2	Max Demand Reset	None	Enumerated
19	2	Meter SN (Most Sig 2 Bytes)	None	Integer
20	2	Meter SN (LSB) & Network ID	None	Integer & Enumerated
21	2	HW version & SW version	None	Integer
22	2	Program Number	None	Enumerated
23	2	Meter Type and Demand Counter	None	Enumerated and 8-bit integer
24	2	Demand Calc & Data Save Interval	None	Enumerated
25	2	Additional Meter Options1	None	Enumerated
26	2	Additional Meter Options2	None	Enumerated
27	2	EEPROM Most Recent Device/Page	None	Enumerated
28	2	EEPROM Most Recent Address	None	Hex Value
29	3	Max Demand Reset	None	Enumerated
30	3	Meter SN (Most Sig 2 Bytes)	None	Integer
31	3	Meter SN (LSB) & Network ID	None	Integer & Enumerated
32	3	HW version & SW version	None	Integer
33	3	Program Number	None	Enumerated
34	3	Meter Type and Demand Counter	None	Enumerated and 8-bit integer
35	3	Demand Calc & Data Save Interval	None	Enumerated
36	3	Additional Meter Options1	None	Enumerated

37	3	Additional Meter Options2	None	Enumerated
38	3	EEPROM Most Recent Device/Page	None	Enumerated
39	3	EEPROM Most Recent Address	None	Hex Value
40	4	Max Demand Reset	None	Enumerated
41	4	Meter SN (Most Sig 2 Bytes)	None	Integer
42	4	Meter SN (LSB) & Network ID	None	Integer & Enumerated
43	4	HW version & SW version	None	Integer
44	4	Program Number	None	Enumerated
45	4	Meter Type and Demand Counter	None	Enumerated and 8-bit integer
46	4	Demand Calc & Data Save Interval	None	Enumerated
47	4	Additional Meter Options1	None	Enumerated
48	4	Additional Meter Options2	None	Enumerated
49	4	EEPROM Most Recent Device/Page	None	Enumerated
50	4	EEPROM Most Recent Address	None	Hex Value
51	5	Max Demand Reset	None	Enumerated
52	5	Meter SN (Most Sig 2 Bytes)	None	Integer
53	5	Meter SN (LSB) & Network ID	None	Integer & Enumerated
54	5	HW version & SW version	None	Integer
55	5	Program Number	None	Enumerated
56	5	Meter Type and Demand Counter	None	Enumerated and 8-bit integer
57	5	Demand Calc & Data Save Interval	None	Enumerated
58	5	Additional Meter Options1	None	Enumerated
59	5	Additional Meter Options2	None	Enumerated
60	5	EEPROM Most Recent Device/Page	None	Enumerated
61	5	EEPROM Most Recent Address	None	Hex Value

Analog Inputs – Full Service

Analog Input Number	Meter Network ID	Description	Units	Data Type
1	1	kWh from grid	kWh	Float
2	1	kWh to grid	kWh	Float
3	1	kVAR from grid	kVAR	Float
4	1	kVAR to grid	kVAR	Float
5	1	Total Power (A+B+C)	kW	Float
6	1	Total Apparent Power (A+B+C)	kVA	Float
7	1	Total Reactive Power (A+B+C)	kVAR	Float
8	1	Total Power Factor	N/A	Float
9	1	Phase A Voltage (L-N)	V	Float
10	1	Phase B Voltage (L-N)	V	Float
11	1	Phase C Voltage (L-N)	V	Float
12	1	Phase A Current	A	Float

13	1	Phase B Current	A	Float
14	1	Phase C Current	A	Float
15	1	Phase A Real Power	W	Float
16	1	Phase B Real Power	W	Float
17	1	Phase C Real Power	W	Float
18	1	Phase A Apparent Power	VA	Float
19	1	Phase B Apparent Power	VA	Float
20	1	Phase C Apparent Power	VA	Float
21	1	Phase A Reactive Power	VAR	Float
22	1	Phase B Reactive Power	VAR	Float
23	1	Phase C Reactive Power	VAR	Float
24	1	Phase A Power Factor	N/A	Float
25	1	Phase B Power Factor	N/A	Float
26	1	Phase C Power Factor	N/A	Float
27	1	Voltage A to B (L-L)	V	Float
28	1	Voltage B to C (L-L)	V	Float
29	1	Voltage C to A (L-L)	V	Float
30	1	Line Frequency	Hz	Float
31	1	Maximum Demand	W	Float
32	1	Factory Calibration Temperature	Deg C	Float
33	1	Maximum Demand Timestamp: Year	Years	Integer
34	1	Maximum Demand Timestamp: Month	Months	Integer
35	1	Maximum Demand Timestamp: Day	Days	Integer
36	1	Maximum Demand Timestamp: Hour	Hours	Integer
37	1	Maximum Demand Timestamp: Minute	Minutes	Integer
38	1	Maximum Demand Timestamp: Second	Seconds	Integer
39	1	Power Loss Timestamp: Year	Years	Integer
40	1	Power Loss Timestamp: Month	Months	Integer
41	1	Power Loss Timestamp: Day	Days	Integer
42	1	Power Loss Timestamp: Hour	Hours	Integer
43	1	Power Loss Timestamp: Minute	Minutes	Integer
44	1	Power Loss Timestamp: Second	Seconds	Integer
45	1	RTC Year/Month	Yr/Mo	16-bit Concatenated
46	1	RTC Day/Hour	Day/Hr	16-bit Concatenated
47	1	RTC Minute/Second	Min/Sec	16-bit Concatenated
48	1	RTC Day of the Week	None	Enumerated in LSB
49	2	kWh from grid	kWh	Float
50	2	kWh to grid	kWh	Float
51	2	kVAR from grid	kVAR	Float
52	2	kVAR to grid	kVAR	Float
53	2	Total Power (A+B+C)	W	Float
54	2	Total Apparent Power (A+B+C)	kVA	Float

55	2	Total Reactive Power (A+B+C)	kVAR	Float
56	2	Total Power Factor	N/A	Float
57	2	Phase A Voltage (L-N)	V	Float
58	2	Phase B Voltage (L-N)	V	Float
59	2	Phase C Voltage (L-N)	V	Float
60	2	Phase A Current	A	Float
61	2	Phase B Current	A	Float
62	2	Phase C Current	A	Float
63	2	Phase A Real Power	W	Float
64	2	Phase B Real Power	W	Float
65	2	Phase C Real Power	W	Float
66	2	Phase A Apparent Power	VA	Float
67	2	Phase B Apparent Power	VA	Float
68	2	Phase C Apparent Power	VA	Float
69	2	Phase A Reactive Power	VAR	Float
70	2	Phase B Reactive Power	VAR	Float
71	2	Phase C Reactive Power	VAR	Float
72	2	Phase A Power Factor	N/A	Float
73	2	Phase B Power Factor	N/A	Float
74	2	Phase C Power Factor	N/A	Float
75	2	Voltage A to B (L-L)	V	Float
76	2	Voltage B to C (L-L)	V	Float
77	2	Voltage C to A (L-L)	V	Float
78	2	Line Frequency	Hz	Float
79	2	Maximum Demand	W	Float
80	2	Factory Calibration Temperature	Deg C	Float
81	2	Maximum Demand Timestamp: Year	Years	Integer
82	2	Maximum Demand Timestamp: Month	Months	Integer
83	2	Maximum Demand Timestamp: Day	Days	Integer
84	2	Maximum Demand Timestamp: Hour	Hours	Integer
85	2	Maximum Demand Timestamp: Minute	Minutes	Integer
86	2	Maximum Demand Timestamp: Second	Seconds	Integer
87	2	Power Loss Timestamp: Year	Years	Integer
88	2	Power Loss Timestamp: Month	Months	Integer
89	2	Power Loss Timestamp: Day	Days	Integer
90	2	Power Loss Timestamp: Hour	Hours	Integer
91	2	Power Loss Timestamp: Minute	Minutes	Integer
92	2	Power Loss Timestamp: Second	Seconds	Integer
93	2	RTC Year/Month	Yr/Mo	16-bit Concatenated
94	2	RTC Day/Hour	Day/Hr	16-bit Concatenated
95	2	RTC Minute/Second	Min/Sec	16-bit Concatenated
96	2	RTC Day of the Week	None	Enumerated in LSB

101	3	kWh from grid	kWh	Float
102	3	kWh to grid	kWh	Float
103	3	kVAR from grid	kVAR	Float
104	3	kVAR to grid	kVAR	Float
105	3	Total Power (A+B+C)	W	Float
106	3	Total Apparent Power (A+B+C)	kVA	Float
107	3	Total Reactive Power (A+B+C)	kVAR	Float
108	3	Total Power Factor	N/A	Float
109	3	Phase A Voltage (L-N)	V	Float
110	3	Phase B Voltage (L-N)	V	Float
111	3	Phase C Voltage (L-N)	V	Float
112	3	Phase A Current	A	Float
113	3	Phase B Current	A	Float
114	3	Phase C Current	A	Float
115	3	Phase A Real Power	W	Float
116	3	Phase B Real Power	W	Float
117	3	Phase C Real Power	W	Float
118	3	Phase A Apparent Power	VA	Float
119	3	Phase B Apparent Power	VA	Float
120	3	Phase C Apparent Power	VA	Float
121	3	Phase A Reactive Power	VAR	Float
122	3	Phase B Reactive Power	VAR	Float
123	3	Phase C Reactive Power	VAR	Float
124	3	Phase A Power Factor	N/A	Float
125	3	Phase B Power Factor	N/A	Float
126	3	Phase C Power Factor	N/A	Float
127	3	Voltage A to B (L-L)	V	Float
128	3	Voltage B to C (L-L)	V	Float
129	3	Voltage C to A (L-L)	V	Float
130	3	Line Frequency	Hz	Float
131	3	Maximum Demand	W	Float
132	3	Factory Calibration Temperature	Deg C	Float
133	3	Maximum Demand Timestamp: Year	Years	Integer
134	3	Maximum Demand Timestamp: Month	Months	Integer
135	3	Maximum Demand Timestamp: Day	Days	Integer
136	3	Maximum Demand Timestamp: Hour	Hours	Integer
137	3	Maximum Demand Timestamp: Minute	Minutes	Integer
138	3	Maximum Demand Timestamp: Second	Seconds	Integer
139	3	Power Loss Timestamp: Year	Years	Integer
140	3	Power Loss Timestamp: Month	Months	Integer
141	3	Power Loss Timestamp: Day	Days	Integer
142	3	Power Loss Timestamp: Hour	Hours	Integer
143	3	Power Loss Timestamp: Minute	Minutes	Integer

144	3	Power Loss Timestamp: Second	Seconds	Integer
145	3	RTC Year/Month	Yr/Mo	16-bit Concatenated
146	3	RTC Day/Hour	Day/Hr	16-bit Concatenated
147	3	RTC Minute/Second	Min/Sec	16-bit Concatenated
148	3	RTC Day of the Week	None	Enumerated in LSB
149	4	kWh from grid	kWh	Float
150	4	kWh to grid	kWh	Float
151	4	kVAR from grid	kVAR	Float
152	4	kVAR to grid	kVAR	Float
153	4	Total Power (A+B+C)	W	Float
154	4	Total Apparent Power (A+B+C)	kVA	Float
155	4	Total Reactive Power (A+B+C)	kVAR	Float
156	4	Total Power Factor	N/A	Float
157	4	Phase A Voltage (L-N)	V	Float
158	4	Phase B Voltage (L-N)	V	Float
159	4	Phase C Voltage (L-N)	V	Float
160	4	Phase A Current	A	Float
161	4	Phase B Current	A	Float
162	4	Phase C Current	A	Float
163	4	Phase A Real Power	W	Float
164	4	Phase B Real Power	W	Float
165	4	Phase C Real Power	W	Float
166	4	Phase A Apparent Power	VA	Float
167	4	Phase B Apparent Power	VA	Float
168	4	Phase C Apparent Power	VA	Float
169	4	Phase A Reactive Power	VAR	Float
170	4	Phase B Reactive Power	VAR	Float
171	4	Phase C Reactive Power	VAR	Float
172	4	Phase A Power Factor	N/A	Float
173	4	Phase B Power Factor	N/A	Float
174	4	Phase C Power Factor	N/A	Float
175	4	Voltage A to B (L-L)	V	Float
176	4	Voltage B to C (L-L)	V	Float
177	4	Voltage C to A (L-L)	V	Float
178	4	Line Frequency	Hz	Float
179	4	Maximum Demand	W	Float
180	4	Factory Calibration Temperature	Deg C	Float
181	4	Maximum Demand Timestamp: Year	Years	Integer
182	4	Maximum Demand Timestamp: Month	Months	Integer
183	4	Maximum Demand Timestamp: Day	Days	Integer
184	4	Maximum Demand Timestamp: Hour	Hours	Integer
185	4	Maximum Demand Timestamp: Minute	Minutes	Integer

186	4	Maximum Demand Timestamp: Second	Seconds	Integer
187	4	Power Loss Timestamp: Year	Years	Integer
188	4	Power Loss Timestamp: Month	Months	Integer
189	4	Power Loss Timestamp: Day	Days	Integer
190	4	Power Loss Timestamp: Hour	Hours	Integer
191	4	Power Loss Timestamp: Minute	Minutes	Integer
192	4	Power Loss Timestamp: Second	Seconds	Integer
193	4	RTC Year/Month	Yr/Mo	16-bit Concatenated
194	4	RTC Day/Hour	Day/Hr	16-bit Concatenated
195	4	RTC Minute/Second	Min/Sec	16-bit Concatenated
196	4	RTC Day of the Week	None	Enumerated in LSB
201	5	kWh from grid	kWh	Float
202	5	kWh to grid	kWh	Float
203	5	kVAR from grid	kVAR	Float
204	5	kVAR to grid	kVAR	Float
205	5	Total Power (A+B+C)	W	Float
206	5	Total Apparent Power (A+B+C)	kVA	Float
207	5	Total Reactive Power (A+B+C)	kVAR	Float
208	5	Total Power Factor	N/A	Float
209	5	Phase A Voltage (L-N)	V	Float
210	5	Phase B Voltage (L-N)	V	Float
211	5	Phase C Voltage (L-N)	V	Float
212	5	Phase A Current	A	Float
213	5	Phase B Current	A	Float
214	5	Phase C Current	A	Float
215	5	Phase A Real Power	W	Float
216	5	Phase B Real Power	W	Float
217	5	Phase C Real Power	W	Float
218	5	Phase A Apparent Power	VA	Float
219	5	Phase B Apparent Power	VA	Float
220	5	Phase C Apparent Power	VA	Float
221	5	Phase A Reactive Power	VAR	Float
222	5	Phase B Reactive Power	VAR	Float
223	5	Phase C Reactive Power	VAR	Float
224	5	Phase A Power Factor	N/A	Float
225	5	Phase B Power Factor	N/A	Float
226	5	Phase C Power Factor	N/A	Float
227	5	Voltage A to B (L-L)	V	Float
228	5	Voltage B to C (L-L)	V	Float
229	5	Voltage C to A (L-L)	V	Float
230	5	Line Frequency	Hz	Float
231	5	Maximum Demand	W	Float

232	5	Factory Calibration Temperature	Deg C	Float
233	5	Maximum Demand Timestamp: Year	Years	Integer
234	5	Maximum Demand Timestamp: Month	Months	Integer
235	5	Maximum Demand Timestamp: Day	Days	Integer
236	5	Maximum Demand Timestamp: Hour	Hours	Integer
237	5	Maximum Demand Timestamp: Minute	Minutes	Integer
238	5	Maximum Demand Timestamp: Second	Seconds	Integer
239	5	Power Loss Timestamp: Year	Years	Integer
240	5	Power Loss Timestamp: Month	Months	Integer
241	5	Power Loss Timestamp: Day	Days	Integer
242	5	Power Loss Timestamp: Hour	Hours	Integer
243	5	Power Loss Timestamp: Minute	Minutes	Integer
244	5	Power Loss Timestamp: Second	Seconds	Integer
245	5	RTC Year/Month	Yr/Mo	16-bit Concatenated
246	5	RTC Day/Hour	Day/Hr	16-bit Concatenated
247	5	RTC Minute/Second	Min/Sec	16-bit Concatenated
248	5	RTC Day of the Week	None	Enumerated in LSB