



Digital Multifunction Electricity Meter

User Manual

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Important Safety Notice

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

- Review, understand, and observe all safety notices and recommendations within this manual.
- Review your company safety procedures for meter installation and service.

DANGER!

Hazardous voltages are present during normal servicing of this device that can cause severe injury or death. These voltages are present throughout the utility's potential transformer (PT) and current transformer (CT) circuits, and the meter's connection terminals. Only qualified, properly trained personnel should perform installation and servicing on this equipment.

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GENERAL INFORMATION

OVERVIEW

The JEMStar II Digital Power Meter is a multifunction electricity meter for use in revenue & billing, energy management and power quality applications. JEMStar II is available in a variety of installation styles including Socket-base (S-base), A-base using an adapter, Switchboard case and a several retrofits of older meters.

JEMStar II incorporates features common to modern electronic polyphase meters including:

- Real and reactive power and energy measurement
- Display of consumption, demand, and "instantaneous" registers
- Load Profile data collection and storage
- Multiple communication options for remote retrieval of registers and Load Profile data, as well as programming
- Time of Use metering
- Digital inputs and outputs
- Loss Compensation (Transformer and Line)
- Voltage and Current Transformer Gain Correction
- Field Diagnostics
- Power Quality monitoring
- Demand prediction
- Analog outputs
- Alarm outputs
- Wide Voltage range (55 – 530V)
- Self power or external aux power
- Easy field-upgradeable meter firmware

Note: Certain features may require the installation of an optional module, firmware upgrade, or software package.

Supporting Software

The following packages are available for use with JEMStar II:

- **JEMWare II** Configuration software for setting up the meter's operation.

It is also used to read the meter's registers and load profile data, retrieve meter events and display site conditions via phasor diagram. The JEMWARE II Software can be used offline or online while connected to a meter.

- **JEMRead** Data Retrieval Program to perform the following functions:

- Read and download data registers
- Read and download Load Profile data
- Read and download Load Profile and register data in HHF format
- Read and download system Health and Status information
- Read Self-Read Registers
- Read Event Logs
- Set Time of Day and Date
- Perform Billing Period Reset

- **UTS MV-90™/ Translation Interface Module (TIM)** software that can be added to an existing MV-90 system. This package will perform the data retrieval functions that are normally assigned by JEMRead. For further information, contact AMETEK, or go to the web at www.itron.com. Display Navigation & Menus

On power up, the JEMStar II meter displays the AMETEK Power Instruments welcome screen. After a predetermined time, it begins scrolling register displays.

Display Scrolling:

During normal operation, the display scrolls the registers. The meter display can show from 1 to 4 registers per display screen. The scroll rate is selectable using the JEMWare II software.



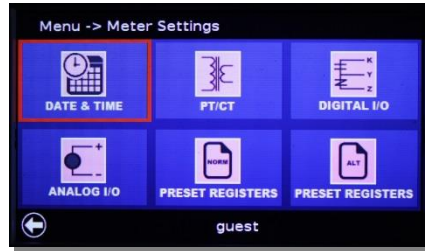
Meter Display Menu:

Pressing the Left front arrow button will invoke the Meter Display Menu. The red perimeter around a menu item indicates it is selected. Meter Settings is the default starting location. To enter or select the menu item, press the Set button in the center of the navigation keys. To exit any menu, navigate to the Left arrow on the display and press Set. Or press the Read button.



Meter Settings:

To enter, press Set. Using this menu you can configure features such as: Date/Time, PT/CT, I/O and Register Presets.



Communications:

From the Meter Display Menu press the Right arrow once. And press Set. This will invoke the Communications menu where you can configure the ports.



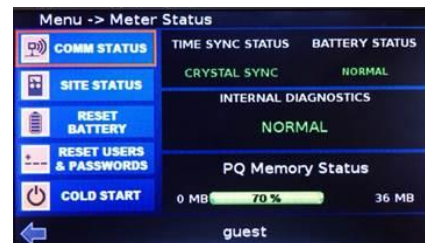
Test Mode:

From the Meter Display Menu press the Right arrow twice. Press Set. This will invoke the Test Mode menu where you can configure various tests.



Meter Status:

From the Meter Display Menu press the Down arrow once. Press Set. This will invoke the Meter Status menu where you can check the Comm and Site Status, check the battery state, reset users and passwords and do a cold start.



Meter ID:

From the Meter Display Menu, press the Down and Right arrow once each. Press Set. This will invoke the Meter ID menu where you can view the identification and firmware version.



Unlocking the Meter

Refer to the Meter Display Menu and Meter Settings menus. Before you can change any configuration parameters, the meter must be unlocked.

This is accomplished from the configuration screen you wish to make a change to.

Log-in to the Meter:

To change a configuration item from the meter display menu, you need to log in to the meter with the correct username and password



TECHNICAL DESCRIPTION

JEMStar II offers a large variety of meter register data that can be viewed from the meter's display or retrieved using serial communications. Some of the register types include:

- Consumption (Summation)
- Peak Demand
- Time and Date of Peak Demand
- Coincident Demand
- Average Power Factor
- Coincident Power Factor
- Date & Time
- Cumulative Registers
- Continuous Cumulative Registers
- Firmware Version
- Health Status.

JEMStar II also has Time-Of-Use (TOU) capabilities, and most registers can be associated with a particular TOU rate.

The meter has an internal pulse recorder for storing load-profile data. The standard meter provides enough memory to store 16 channels of recorded data in 15-minute intervals for up to 365 days. Utilizing fewer channels will extend the length of time data may be recorded (for example, reducing the number of channels by ½ doubles the length of recording time). [see Load Profile charts in the Advanced Features section for more detail.] Special events such as power failures, time sets, and demand resets are also stored in the load-profile data. This data can be retrieved through serial communications and Ethernet using JEMWare II or JEMRead™ software. Optionally, a custom Translation Interface Module (TIM) is available for the popular MV-90™ software supplied by Itron, Inc. The JEMStar II meter can also provide analog and contact outputs for external monitoring devices.

Serial communications are performed through an optical port on the front of the meter and optional communication board (RS-232, RS-485, Ethernet, internal modem). The meter has multiple levels of password protection with assignable privileges to accommodate read-only applications.

JEMStar II is software configurable using JEMWare II™. This software allows the meter to be scaled for direct primary readings, demand information, register information, load-profile configuration, and Time-Of-Use rates. Refer to the JEMWare II instruction manual 1079-699 for details on all the different parameters that can be programmed into the JEMStar II.

Event Recording

JEMStar II maintains records of certain events independent of the Load Profile features. JEMWare II or JEMRead is able to retrieve some of this information independently. However, if you need access to the data for troubleshooting or historical purposes, it is available in the meter

All recorded events include the following information:

- Type of event description
- The date and time at which the event occurred
- If applicable, the time after the event

The following events are recorded:

- **Power Outage:** any recognizable failure of the auxiliary power is recorded with the time when power went down, the time at which it was restored, and an indication of which voltage inputs were live (as displayed on the potential indicators) when power went down. **Time Set and Daylight Saving Time Change:** these are recorded in the same list. They include the time before the change, the time after the change, and an indication of whether it was a manual (front panel or serial data) or automatic (Daylight Saving Time) change. **Register Freeze:** Each Freeze includes the time the Freeze was performed, as well as an indication of whether the Freeze was manual (serial command) or automatic.
- **Register Preset:** The most recent Register Preset is recorded with the time at which the Preset occurred.
- **Test Mode:** The most recent Test Mode session is recorded with the time at which the Test Mode session was entered and left.
- **Calibration:** The most recent Calibration is recorded with the time at which it occurred.
- **Site Monitoring: Billing Period Reset:** Each Billing Period Reset event includes the time at which the reset was performed and an indication of whether the reset was automatic, a serial command, or a front-panel reset.
- **Configuration:** Each configuration event includes the time at which the configuration occurred as well as an indication of whether it was a front-panel or remote (serial) configuration.
- **Voltage Sag / Swell:** The 500 most recent voltage sags or swells detected by the meter are logged. Each event records the minimum, maximum, and average voltage and current and the average power factor for the duration of the event.

**Note that some events (such as power outages and freezes) are also reported in the JEMRead Load Profile download.*

MODEL NUMBER DESCRIPTION

This user manual is applicable to a broad range of JEMStar II meter options. To determine the options on your meter, read the model number located in the center front of the meter faceplate and compare it to the following guide.

JEMStar II Model Number

You build a model number by selecting options from each selection.

JEMStar II Base Meter				Communication and I/O Options		Additional Options	Power Quality
Meter Form	Enclosure	Frequency	Current Class	Communication Options	I/O Options	Comms, Power, Time Sync	Power Quality / PMU
05 = Form 5 3 phase, 3 wire Delta	S = S Base A = A Base R = Switchboard	50 = 50Hz 60 = 60Hz	02 = Class 2 10 = Class 10 20 = Class 20	0 None 1A Single Serial: RS-232 1B Dual Serial: RS-232/485	0 None DIO Internal Ch 6 D I/O DIOP Internal 6 Ch D I/O w/PS	0 = No Additional Options	0 = No Additional Options
06 = Form 6 3 phase, 4 wire Wye	J1 = JEM1 Tall Retrofit			1C Triple Serial: (2) RS-232/485, (1) RS-232	AO1 Internal 4 Ch AO (0-1mA) AO2 Internal 4 Ch AO (4-20mA)	Ethernet Options IEC = IEC 61850 Protocol	Power Quality Options PQ PQ Ready Meter can be upgraded in the field for a future PQ Option
08 = Form 8 3 phase, 4 wire Delta	J1F = JEM1 Front Retrofit J2 = JEM2 Retrofit J10 = JEM10 Retrofit			2A Single Ethernet Port 2B Dual Ethernet Port	You can select 1 each of Items: DIO or DIOP AO1 or AO2 EXDIO or EXAI or EXDA (Ex. DIO/AO1/EXAI)	Time Sync Options IB = IRIG-B Time Sync	PQ1 PQ Basic High Speed RMS, Power Availability
09 = Form 9 3 phase, 4 wire Wye	J5 = JEMStar Retrofit Q = Q121, 220 Retrofit Q4 = Quad 4 Retrofit Q4T = Quad 4 Retrofit (Tall)			3A Internal Analog Modem			PQ2 PQ Advanced Waveform capture, Harmonic Recording, Flicker (includes Measurement Logging)
45 = Form 45 3 phase, 3 wire Delta	TD = MarkV Retrofit G1 = GE DS63 Retrofit G2 = GE DSW63 Retrofit G3 = GE DS64 Retrofit G4 = GE DSW64 Retrofit G5 = GE Phase 3 Retrofit G6 = GE DS65 Retrofit			You can select 1 each of Items: 1,2,3 (Ex. 1B/2A/3A)		Measurement Recording Options DLP = Dual 16 ch Load Profile ML = Measurement Logging (2x50 channels)	PQ3 PQ Max PQ Basic and PQ Advanced
U = Universal Form 5/9 3 phase, 4 wire Wye 3 wire Delta (use w/A Base & SWBD)	W = Westinhouse Retrofit All retrofits are based on switchboard enclosure					Meter Power Options EAP = External Power (socket) DC = DC Power (19-58VDC)	

Typical Model Number

JSII-09S6020-1B/2A/3A-DIOP

JSII	JEMStar Meter
09	Form 9
S	Socket Base
60	60 Hz
20	Current Class 20
1B/2A/3A	Dual serial, single Ethernet, Analog Modem
DIOP	6 Channel I/O w/ power supply

JEMStar II Base Meter			
Meter Form	Enclosure	Frequency	Current Class
05 = Form 5 3 phase, 3 wire Delta	S = S Base	50 = 50Hz	02 = Class 2
	A = A Base	60 = 60Hz	10 = Class 10
	R = Switchboard		20 = Class 20
06 = Form 6 3 phase, 4 wire Wye			
	J1 = JEM1 Tall Retrofit		
08 = Form 8 3 phase, 4 wire Delta	J1F = JEM1 Front Retrofit		
	J2 = JEM2 Retrofit		
	J10 = JEM10 Retrofit		
09 = Form 9 3 phase, 4 wire Wye	JS = JEMStar Retrofit		
	Q = Q121, 220 Retrofit		
	Q4 = Quad 4 Retrofit		
45 = Form 45 3 phase, 3 wire Delta	Q4T = Quad 4 Retrofit (Tall)		
	TD = MarkV Retrofit		
	G1 = GE DS63 Retrofit		
	G2 = GE DSW63 Retrofit		
U = Universal Form 5/9 3 phase, 4 wire Wye 3 wire Delta (use w/A Base & SWBD)	G3 = GE DS64 Retrofit		
	G4 = GE DSW64 Retrofit		
	G5 = GE Phase 3 Retrofit		
	G6 = GE DS65 Retrofit		
	W = Westinhouse Retrofit		
	All retrofits are based on switchboard enclosure		

Communication and I/O Options			
Communication Options		I/O Options	
0	None	0	None
1A	Single Serial: RS-232	DIO	Internal Ch 6 D I/O
1B	Dual Serial: RS-232/485	DIOP	Internal 6 Ch D I/O w/PS
1C	Triple Serial: (2) RS-232/485, (1) RS-232	AO1	Internal 4 Ch AO (0-1mA)
		AO2	Internal 4 Ch AO (4-20mA)
2A	Single Ethernet Port	<p>You can select 1 each of Items: DIO or DIOP AO1 or AO2</p>	
2B	Dual Ethernet Port		
3A	Internal Analog Modem		
<p>You can select 1 each of Items: 1,2,3 (Ex. 1B/2A/3A)</p>			

Additional Options	Power Quality
Comms, Power, Time Sync	Power Quality / PMU
0 = No Additional Options	0 = No Additional Options
Ethernet Options	Power Quality Options
IEC = IEC 61850 Protocol	PQ <u>PQ Ready</u> Meter can be upgraded in the field for a future PQ Option
Time Sync Options	PQ1 <u>PQ Basic</u> High Speed RMS, Power Availability
IB = IRIG-B Time Sync	PQ2 <u>PQ Advanced</u> Waveform capture, Harmonic Recording, Flicker (includes Measurement Logging)
Measurement Recording Options	PQ3 <u>PQ Max</u> PQ Basic and PQ Advanced
DLP = Dual 16 ch Load Profile	
ML = Measurement Logging (2x50 channels)	
Meter Power Options	
EAP = External Power (socket)	
DC = DC Power (19-58VDC)	

SPECIFICATIONS

Product specifications are subject to change. Please consult the factory for updates, improvements, and new features.

Meter Forms

Form Number	Type
Form 5S, 5A, 5R	2 Element [2PTs, 2CTs] (3 phase, 3 wire Delta)
	2 Element [2PTs, 2CTs] (3 phase, 3 wire Open Delta)
	2 Element [2PTs, 2CTs] (3 Phase, 3 wire Network)
	2 Element [2PTs, 2CTs] (3 phase, 3 wire Wye)
Form 6S, 6A, 6R	2-½ Element [2PTs, 3CTs] (3 phase, 4 wire Wye)
Form 8S, 8A, 8R	3 Element [3PTs, 3CTs] (3 Phase, 4 wire Delta)
Form 9S, 9A, 9R	3 Element [3PTs, 3CTs] (3 Phase, 4 wire Wye)
Form 45S, 45A, 45R	2 Element [3PT's, 2CT's] (3 Phase, 3 wire Delta)
U (Universal) A-Base and Switchboard Meters	2 Element [2PTs, 2CTs] (3 phase, 3 wire Delta)
	2 Element [2PTs, 2CTs] (3 phase, 3 wire Open Delta)
	2 Element [2PTs, 2CTs] (3 Phase, 3 wire Network)
	2 Element [2PTs, 2CTs] (3 phase, 3 wire Wye)
	2-½ Element [2PTs, 3CTs] (3 phase, 4 wire Wye)
	3 Element [3PTs, 3CTs] (3 Phase, 4 wire Delta)
	3 Element [3PTs, 3CTs] (3 Phase, 4 wire Wye)
	2 Element [3PT's, 2CT's] (3 Phase, 3 wire Delta)

Current Classes

2 Amp	(.001 – 2A)
10 Amp	(.002 – 10A)
20 Amp	(.002 – 20A)

Measured Quantities

Integrated quantities

Integrated quantities are power measurement quantities that are integrated over time, and which may be accumulated. Integrated quantities are used for developing Consumption, Fixed or Sliding Window Demand (Peak or Coincident), Load Profile, or Pulse Contact outputs.

JEMStar II measures the following integrated quantities:

- Watthours delivered/received, Net/Absolute per-phase, polyphase total
- VARhours delivered/received, Net/Absolute per-phase, polyphase total
- VAhours delivered/received, Net/Absolute per-phase, polyphase total
- Amphours, per-phase (up to 3 phases), polyphase total
- Qhours delivered/received, Net/Absolute per-phase, polyphase total
- V²hours, A²hours per-phase, polyphase total

Instantaneous quantities

Instantaneous quantities are short-term average or RMS measurements of electrical characteristics in a circuit. Instantaneous quantities are suitable for Instantaneous Registers, or analog outputs.

JEMStar II measures the following instantaneous quantities:

- Watts and VARs delivered, received, or bidirectional per-phase, polyphase
- VA delivered, received, or bidirectional per-phase, polyphase
- Q delivered, received, or bidirectional per-phase, polyphase
- Volts and Volts² per-phase (up to 3 phases)
- System Volts (average of 2 or 3 phases depending on meter form)
- Amps per-phase, polyphase plus Neutral Current
- Amps² per-phase, polyphase
- PF per-phase, polyphase
- Frequency
- Volts THD per-phase
- Amps THD per-phase

Uncompensated Quantities

JEMStar II is able to simultaneously provide both uncompensated and transformer- or line-loss compensated measurements for Watt / Watthour, VAR / VARhour, VA / VAhour, Q / Qhour, and Power Factor quantities in Display Registers, Load Profile, and KYZ pulse outputs. Analog outputs are always loss compensated if compensation is enabled in the meter.

Input Range Limits and Burdens

Current Inputs and Burden

Class 2

- Starting Current: 0.001 A
- Operating Range: 0.001 to 2A
- Maximum Overload with accuracy: 2.2A
- Maximum Continuous Overload without damage : 3A
- Burden: < 0.5VA @ 2A Socket
< 0.5VA @ 2A Switchboard

Class 10, 20

- Starting Current: 0.002A
- Operating Range: 0.002 to 20A
- Maximum Overload with accuracy: 22A
- Maximum Continuous Overload without damage 30A
- Burden: < 0.125VA @ 10A Socket
< 0.5VA @ 20A Socket
< 0.625VA @ 10A Switchboard
< 2.5VA @ 20A Switchboard

Voltage Inputs and Burden

Operating Range	3 Phase: 55 to 306 Vac (L-N) 95–530 Vac (L-L)
Maximum Overload	550 Vac L-L
Burden	0.5 VA @ 530V

Current Overload

1.5x rated class current continuous 20x rated class current for 1 second

Auxiliary Power and Burden

Socket Meters, S-base or A-base

Self Powered (standard):

55–530VAC self powered from any of the three phases

Maximum burden of 25VA total or 15VA per phase.

Externally Powered (optional):

55–530VAC or 90–300VDC externally powered via a cable

Maximum burden of 25VA.

Switchboard

55–530VAC or 90–300VDC externally powered via terminals

Maximum burden of 25VA.

Operating Frequency Range

50 Hz 42.5-57.5 Hz

60 Hz 51-69 Hz

Clock

50/60 Hz

AC Line frequency can be used as time synchronization input

When the AC line sync is selected, it will be used as a backup time sync whenever there is no other external time sync connected.

Internal Crystal

The internal crystal will be used whenever there is no external time sync methods used.

Accuracy: 0.5 sec/day

The internal clock is maintained by a battery when powered is off.

Battery life: 10 years

IRIG-B

Time sync input (modulated or de-modulated) accurate to +/- 1 ms UTC Time

Modulated or Demodulated (auto-sensing), 9.3K ohm input impedance

The IRIG-B Option can be used for external time synchronization. When enabled, the IRIG-B becomes the default time sync. When not available, the meter reverts to the AC Line Sync or Internal Crystal.

Accuracy

The nominal conditions referenced in the specifications are defined as follows:

V_{INPUT} = Nominal Input Voltage

I_{CLASS} = Meter Class Current

T_A = Test Amperes = 1/2 Class Amps

Full Scale = $I_{CLASS} \times V_{INPUT}$

Class 10 and 20:				
Watthours	Class 10 Input Current	Class 20 Input Current	Accuracy (PF=1)	Accuracy (PF=0.5 lag)
(per phase, polyphase total)	0.5 to 10 A	0.5 to 20 A	0.05 % RD (0.01% RD typ)	0.07 % RD (0.01% RD typ)
	0.1 to 0.5 A	0.1 to 0.5 A	0.15 % RD	0.2 % RD
	0.05 to 0.1 A	0.05 to 0.1 A	0.2 % RD	0.35 % RD
VARhours	Class 10 Input Current	Class 20 Input Current	Accuracy (PF=0)	Accuracy (PF=0.5 lag)
(per phase, polyphase total)	0.2 to 10 A	0.2 to 20 A	0.1 % RD	0.15 % RD
	0.1 to 0.2 A	0.1 to 0.2 A	0.2 % RD	0.25 % RD
	0.05 to 0.1 A	0.05 to 0.1 A	0.3 % RD	0.35 % RD
VAhours, Qhours	Class 10 Input Current	Class 20 Input Current	Accuracy (PF=1)	Accuracy (PF=0.5 lag)
(per phase, polyphase total)	0.2 to 10 A	0.2 to 20 A	0.1 % RD	0.15 % RD
	0.1 to 0.2 A	0.1 to 0.2 A	0.2 % RD	0.25 % RD
	0.05 to 0.1 A	0.05 to 0.1 A	0.3 % RD	0.35 % RD
Volts²hours	Class 10 Input Current	Class 20 Input Current	Accuracy	
(per phase, polyphase total)	0 to 10 A	0 to 20 A	0.1 % RD	
AMP²hours	Class 10 Input Current	Class 20 Input Current	Accuracy	
(per phase, polyphase total)	0.3 to 10 A	0.3 to 20 A	0.5 % RD	
	0.1 to 0.3 A	0.1 to 0.3 A	2.0 % RD	
AMPhours	Class 10 Input Current	Class 20 Input Current	Accuracy	
(per phase, polyphase total)	0.3 to 10 A	0.3 to 20 A	0.1 % RD	
	0.1 to 0.3 A	0.1 to 0.3 A	0.2 % RD	

Instantaneous Watts	Class 10 Input Current	Class 20 Input Current	Accuracy (PF=1)	Accuracy (PF=0.5 lag)
----------------------------	-------------------------------	-------------------------------	------------------------	------------------------------

(per phase, polyphase total)	0.5 to 10 A	0.5 to 20 A	0.1 % RD	0.12 % RD
	0.1 to 0.5 A	0.1 to 0.5 A	0.2 % RD	0.25 % RD
	0.05 to 0.1 A	0.05 to 0.1 A	0.25 % RD	0.4 % RD
Instantaneous Vars				
(per phase, polyphase total)	Class 10 Input Current	Class 20 Input Current	Accuracy (PF=0)	Accuracy (PF=0.5 lag)
	0.2 to 10 A	0.2 to 20 A	0.15 % RD	0.2 % RD
	0.1 to 0.2 A	0.1 to 0.2 A	0.25 % RD	0.3 % RD
	0.05 to 0.1 A	0.05 to 0.1 A	0.35 % RD	0.4 % RD
Instantaneous VA, Q				
(per phase, polyphase total)	Class 10 Input Current	Class 20 Input Current	Accuracy (PF=1)	Accuracy (PF=0.5 lag)
	0.2 to 10 A	0.2 to 20 A	0.15 % RD	0.2 % RD
	0.1 to 0.2 A	0.1 to 0.2 A	0.25 % RD	0.3 % RD
	0.05 to 0.1 A	0.05 to 0.1 A	0.35 % RD	0.4 % RD

Instantaneous Amps	Class 10 Input Current	Class 20 Input Current	Accuracy
(per phase, polyphase total)	0 to 10 A	0 to 20 A	0.04 % RD + 0.025 % Iclass
	0.15 to 10 A	0.15 to 20 A	0.4 % RD

Instantaneous Amps²	Class 10 Input Current	Class 20 Input Current	Accuracy
(per phase, polyphase total)	0.3 to 10 A	0.3 to 20 A	0.5 % RD
	0.1 to 0.3 A	0.1 to 0.3 A	2.0 % RD

Class 2:			
Wathours	Class 2 Input Current	Accuracy (PF=1)	Accuracy (PF=0.5 lag)
(per phase, polyphase total)	0.1 to 2 A	0.1 % RD	0.2 % RD
	0.05 to 0.1 A	0.2 % RD	0.3 % RD
	0.015 to 0.05 A	0.4 % RD	0.6 % RD
Varhours			
(per phase, polyphase total)	Class 2 Input Current	Accuracy (PF=0)	Accuracy (PF=0.5 lag)
	0.1 to 2 A	0.15 % RD	0.2 % RD
	0.025 to 0.1 A	0.4 % RD	0.5 % RD
	0.01 to 0.025 A	0.8 % RD	0.9 % RD
VAhours, Qhours			
	Class 2 Input Current	Accuracy (PF=1)	Accuracy (PF=0.5 lag)

(per phase, polyphase total)	0.1 to 2 A	0.15 % RD	0.2 % RD
	0.025 to 0.1 A	0.4 % RD	0.5 % RD
	0.01 to 0.025 A	0.8 % RD	0.9 % RD
Volts²hours			
(per phase, polyphase total)	Class 2 Input Current	Accuracy	
	0 to 2 A	0.1 % RD	
AMP²hours			
(per phase, polyphase total)	Class 2 Input Current	Accuracy	
	0.03 to 2 A	0.5 % RD	
	0.01 to 0.03 A	2.0 % RD	
AMPhours			
(per phase, polyphase total)	Class 2 Input Current	Accuracy	
	0.1 to 2 A	0.3 % RD	
	0.01 to 0.1 A	2.0 % RD	
Instantaneous Watts			
(per phase, polyphase total)	Class 2 Input Current	Accuracy (PF=1)	Accuracy (PF=0.5 lag)
	0.1 to 2 A	0.15 % RD	0.25 % RD
	0.05 to 0.1 A	0.25 % RD	0.35 % RD
	0.015 to 0.05 A	0.45 % RD	0.65 % RD
Instantaneous Vars			
(per phase, polyphase total)	Class 2 Input Current	Accuracy (PF=0)	Accuracy (PF=0.5 lag)
	0.1 to 2 A	0.2 % RD	0.25 % RD
	0.025 to 0.1 A	0.45 % RD	0.55 % RD
	0.01 to 0.025 A	0.85 % RD	0.95 % RD
Instantaneous VA, Q			
(per phase, polyphase total)	Class 2 Input Current	Accuracy (PF=1)	Accuracy (PF=0.5 lag)
	0.1 to 2 A	0.2 % RD	0.25 % RD
	0.025 to 0.1 A	0.45 % RD	0.55 % RD
	0.01 to 0.025 A	0.85 % RD	0.95 % RD

(per phase, polyphase total)	Class 2 Input Current	Accuracy
	0 to 2 A	0.04 % RD + 0.025 % Iclass
	0.025 to 2 A	0.4 % RD

Instantaneous Amps ² (per phase, polyphase total)	Class 2 Input Current	Accuracy
	0.03 to 2 A	0.5 % RD
	0.01 to 0.03 A	2.0 % RD

Class 2, 10, 20			
Instantaneous Volts (per phase, polyphase total)	Class 2	Class 10	Class 20
	0.04% RD	0.04% RD	0.04% RD
Instantaneous Volts ² : (per phase)	Class 2	Class 10	Class 20
	0.15 % RD	0.15 % RD	0.15 % RD

Frequency (phase A)	Class 2	Class 10	Class 20	
	0.001 Hz	0.001 Hz	0.001 Hz	
Instantaneous Power Factor (per phase)	Class 2	Class 10	Class 20	
	0.002 % * (FS / VA)phase	0.002 % * (FS / VA)phase	0.002 % * (FS / VA)phase	
Instantaneous Power Factor:	Class 2	Class 10	Class 20	
	Form 5 (system)	0.002 % * (2FS / VA)phase	0.002 % * (2FS / VA)phase	0.002 % * (2FS / VA)phase
	Form 6, 8/9 (system)	0.002 % * (3FS / VA)phase	0.002 % * (3FS / VA)phase	0.002 % * (3FS / VA)phase
Volts THD: (system)	Class 2	Class 10	Class 20	
	0.5 % RD	0.5 % RD	0.5 % RD	
Amps THD: (system)	Class 2	Class 10	Class 20	
	0.5 % RD	0.5 % RD	0.5 % RD	

Loss Compensation

Type:	Transformer Loss Compensation (TLC) Line Loss Compensation (LLC)
Features:	Separate coefficients for delivered and received power User-configurable
Compensation Characteristics:	Line Watt loss Transformer copper Watt loss Transformer copper VAR loss Transformer iron Watt loss Transformer iron VAR loss
Loss Compensation On Registers:	Watts, Watthours, VARs, VARhours, VA, VAhours, Q, Qhours, PF

NOTE: Registers, Load Profile channels, or KYZ Pulse outputs that are individually selected to be "compensated" in JEMWare II have the following accuracy modifications:

Class 10, 20 current range	Class 2 current range	accuracy modifier (add to accuracy listed above)
0.3A to Class Amps	0.03A to Class Amps	add 0.05% of reading
up to 0.3A	up to 0.03A	add 0.10% of reading

For example, an uncompensated Watthour register will have an accuracy of 0.12% at 10 A and 1.0 PF. If the same register is compensated (even though no compensation is enabled in the meter overall), that register will have an accuracy of 0.07%. See the JEMWare II User Manual (document 1079-699) for details on how to select a register as "uncompensated."

Auxiliary Power

Requirements:	55 – 530 Volts AC 90 – 300 Volts DC (switchboard models and socket/A-Base with External Aux Power Options) 19 – 58 Volts DC (switchboard models and socket/A-Base with Low Voltage DC Power – Option DC)
Source:	S-base and A-base: derived from three phase voltage input Switchboard: separate terminals, AC or DC
Auxiliary Power Burden:	25 VA maximum
Power Factor Influence:	Maximum additional error due to power factor influence is $\pm 0.002\%$ /P.F. for P.F. less than 0.5.

Frequency Range

50 Hz	42.5-57.5 Hz
60 Hz	51-69 Hz

Clock Accuracy

External tracking (line frequency):	Accuracy of the clock is directly determined by the power system frequency, except during loss of auxiliary power to the meter. The internal reference accuracy is applicable for that time period.
Internal Tracking:	0.5 seconds per day maximum error.
External Time Sync Option	IRIG-B +/- 1 msec accuracy

Meter Creep

The meter does not creep. No pulses or registration will occur on any function that depends on current with the current circuit open

Analog Outputs (Option)

4 Channels
 Factory configurable for either 0–1 mA or 4–20 mA
 Accuracy: 0.15% of full scale
 Analog output accuracy is derated by 75 ppm of Rated Output per degree C difference from nominal

Test Outputs

Type	IR LED test pulse output provided through the optical port transmitter; emits bidirectional (delivered or received energy) Wh pulse when meter is in Normal mode, test pulse based on displayed register when in Test mode.
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Digital Inputs/Outputs

6 Channels
 User configurable for either an input or output
 When configured as an input the channel shall have the following requirements:
 Selectable as Form A or KYZ
 Maximum 40 Vdc input
 1 mS time accuracy
 Ability to capture 10 transitions per second
 * An optional isolated 24Vdc supply is available to be used for a contact input wetting voltage

When configured as an output the channel shall have the following requirements:

- Selectable as Form A or KYZ
- 200 Vdc, or 200 V peak AC @ 50mA contact rating
- Ability to transmit 25 transitions per second

Registers

Instantaneous

Characteristics	<ul style="list-style-type: none"> - Updated every 1.5 seconds - Average of 1.5 seconds
Displayed Quantities:	
Per Phase and Polyphase	W Del, W Rec., W Bidirectional, VAR Del, VAR Rec, VAR Q1, VAR Q2, VAR Q3, VAR Q4, VAR Bidirectional, VA Del, VA Rec, VA Bidirectional, Volts, Amps, Q Del, Q Rec, Q Bidirectional, PF Del, PF Rec, PF Bidirectional, V ² , A ²
Per Phase	Volts THD, Amps THD
Phase A only	Frequency

Consumption (Integrated Values)

Characteristics	<ul style="list-style-type: none"> - Updated no less than every 2 seconds - Configurable to be associated with any Time Of Use (TOU) Rate. If associated with any rate other than Total, the Consumption Register shall accumulate only energy measured while that rate is active
Displayed Quantities:	
Per Phase and Polyphase	Wh Del, Wh Rec, Wh Net, Wh Absolute, VARh Del, VARh Rec, VARh Net, VARh Absolute, VAh Del, VAh Rec, Vah Net, VAh Absolute, VARh per quadrant, Ah, Qh Del, Qh Rec, V ² h, A ² h
Display scaling	In secondary (at meter terminals) or primary (at PT / CT input) units
Preset	Any desired value that may be displayed
Register Retrieval	By any communication port

Average Power Factor

Characteristics	Configurable to be associated with any Time of Use (TOU) Rate. If associated with any rate other than Total, the Average PF Register is based only on energy accumulated while that rate is active. Average Power Factor is available only as a register.
Display	Average Power Factor (PF) for the Billing Period.

Calculation The PF is calculated continuously from Watts and VAs accumulated since the last Billing Period Reset. The accumulators are cleared on a Billing Period Reset.

Demand (Fixed or Sliding Window)

Displayed Quantities:

Per Phase and Polyphase W Del, W Rec, VAR Del, VAR Rec, VA Del, VA Rec, VAR per quadrant, A, Q Del, Q Rec

Display scaling In secondary (at meter terminals) or primary (at PT / CT input) units.

Demand Interval Length 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, or 60 minutes
Configurable for one or more subintervals per interval, as long as the total interval length (number of subintervals per interval times subinterval length) equals one of the periods listed above. No more than 12 subintervals per interval.

Preset Any desired value that can be displayed

Register Retrieval By any communication port

Peak Demand

Displayed Quantities Normal peak, Cumulative Demand, or Continuous Cumulative Demand

Characteristics Configurable to be associated with any Time of Use (TOU) Rate. If associated with any rate other than Total, the Peak Demand Register is calculated only on energy measured while that rate is active.

Time of Peak Demand

Displayed Quantities Time or Date at which the corresponding Peak Demand occurred

Coincident Demand

Displayed Quantities:

Per Phase and Polyphase W Del, W Rec, VAR Del, VAR Rec, VA Del, VA Rec, VAR per quadrant, A, Q Del, Q Rec

Display scaling In secondary (at meter terminals) or primary (at PT / CT input) units.

Demand Interval Length Matches the corresponding Peak Demand length

Preset Any desired value that may be displayed

Register Retrieval	By any communication port
Coincident Power Factor	
Displayed Quantities	Average PF over the Demand Interval in which a Peak Demand was established
Thermal Demand	
Types	Thermal Demand Peak Thermal Demand Time of Peak Thermal Demand
Displayed Quantities:	
Per Phase and Polyphase	W Del, W Rec, VAR Del, VAR Rec, VA Del, VA Rec, VAR per quadrant, Volts, A, Q Del, Q Rec, PF
Per Phase	Volts THD, Amps THD
Phase A only	Frequency
Demand Prediction	
Displayed Quantities:	
Per Phase and Polyphase	W Del, W Rec, VAR Del, VAR Rec, VA Del, VA Rec, VAR per quadrant, Amp, Q Del, Q Rec
Periodic Self-Read	
Records Displayed	Date and time of the Self Read Health Status summary Up to 4 Registering quantities
Storage	Up to the 36 most recent Self Read records
Configurable for:	– Every Demand (Sub)Interval Closure – Every Hour – Every Day – Every Month – Every Billing Period Reset
Status	
Storage	Time, date, firmware version, comm setting, and health status
Time Of Use (TOU)	
	– Four season schedules – Nine day types including each day of the week and two holiday types – Twenty-year calendar with up to 200 holidays specified – Each measurement register can be associated with one of nine time-of-use rates (A – H, and Total) – Up to eight rate changes can be specified for each day type

Totalization

Characteristics

- Special-purpose Consumption registers
- Displayed quantities, scaling, preset, and register retrieval are identical to Consumption registers.
- Combine multiple meter readings through digital inputs and outputs

Load Profile

Displayed Quantities:

Per Phase and Polyphase

Wh Del, Wh Rec, VARh Del, VARh Rec, VAh Del, VAh Rec, VARh per quadrant, Ah, Qh Del, Qh Rec, Avg. W Del, Avg. W Rec, Avg. VAR Del, Avg. VAR Rec, Avg. VAR per quadrant, VA, Volts, Amps, Power Factor, Hertz, Volts-THD, Amps-THD, Pulses, Status, A², V², A²h, V²h, Q, Qhr, Totalization channels 1–12

- Up to 32 channels of storage (16 standard)
- Programmable interval length (1, 2, 3, 4, 5, 6, 10, 12, 15, 30, and 60 minutes); independent of Demand Interval

Meter Memory

1GB NAND Flash (Non Volatile), 2GB RAM (Volatile)

The JEMStar II uses a combination of non-volatile NAND Flash memory, RAM (volatile memory) and battery backed memory. The distribution of memory for various functions is described below:

Meter Configuration	-	Stored in non-volatile memory the moment it's loaded into the meter
Register Measurements	-	Stored in non-volatile memory every 1 minute or directly after a Freeze command. Battery backed memory used to temporarily store measurements since the last write.
Load Profile Data	-	Stored in non-volatile memory after an interval has been completed. Battery backed memory used to temporarily store load profile data since the last interval write.
Event Logs	-	Stored in non-volatile memory after an event occurs.
Power Quality Data	-	Stored in non-volatile memory at the completion of every event.
Clock	-	The meter's internal clock saves the time and date using battery backed memory. If power is removed from the meter and the battery is dead (or removed), the time will revert to midnight, January 1, 1970 upon power up.

Communication Ports

Optical (Port 1)

- Type 2, Front panel mounted
- Mating Sensor can be attached with the meter cover installed (magnetic type), or cover removed (hanging type)
- Complies with ANSI C12.13-1991, Section 3.6
- Uses JEM Binary Protocol
- User configurable for 300 – 19200 baud
- Primarily used for calibration, verification and configuration

RS-232 (Port 2–4) (optional)

- Supports Tx, Rx, Gnd, and RTS signals
- Half duplex operation
- Configurable for 300 – 115,200 baud
- Mutually exclusive with RS-485 option (Ports 3,4)
- Configurable for all JEMStar II protocols
- Primarily used for direct connection to RTU, ext modem

RS-485 (Port 3, 4) (optional)

- Supports Tx, Rx, Gnd signals
- Configurable for 300 – 115,200 baud
- Mutually exclusive with RS-232 option
- Configurable for all JEMStar II protocols
- Network up to 32 meters with CommRepeater option
- Recommended max. cable length: 4000 feet; actual length is dependent upon environment

Internal Modem (Port 5) (optional)

- 56k Analog Modem
- Cell Modem (CDMA: Verizon, Sprint)
- (GSM/GPRS: Cingular, AT&T, Rogers, T-Mobile)
- Configurable Answer & Phone Home schedules
- Configurable for JEM Binary protocol

Ethernet (Port 6, 7) (optional)

- 12 simultaneous users
- 10 Base-T/100 Base-TX
- Optional internal Web server
- Fixed IP Address per Ethernet Port
- Configurable for JEM Binary protocol
- JEM Binary (max 4)
- Modbus TCP/IP (max 2) Master/Slave
- DNP Protocol (max 5)
- IEC 61850 (max 1)

Call-Home on Power Outage Modem Option (optional)

- Internal modem that calls up to 4 telephone numbers and transmits a message during power failure
- User configurable phone numbers and messages

Communication Repeater (optional)

- Permits up to 32 meters to be grouped using a single internal modem
- Requires the RS-485 option installed in each meter of a group

Communication Protocols

Protocol	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7
	Optical	RS-232	RS-232/485	RS-232/485	Modem	Ethernet	Ethernet
JEM Binary	1	1	1	1	1	4	4
Modbus RTU		1	1	1	1		
Modbus TCP/IP						2	2
DNP		1	1	1	1	5	5
DLMS/COSEM	1	1	1	1		1	1
IEC 61850						1	1

Environmental

Temperature

- Operating
 - Continuous operating temperature: -30 to +70 °C
 - Short term (24 hour maximum operating temperature) per ANSI C12.20: +85 °C
 - Display operating range: -20 to +55 °C
 - Basic meter accuracy shall be derated by 50 ppm of Rated Output per degree C difference from nominal
- Storage
 - The storage temperature range shall be -30 to +85 °C

Humidity

- Continuous operating humidity: 95% at +40 °C

Insulation

Voltage / Current Inputs	In accordance with ANSI Standard C12.20
Auxiliary Power Input: (Switchboard only)	1500 Vrms, 60Hz for 1 minute between Aux. Power and voltage input. 2500 Vrms, 60Hz for 1 minute between Aux. Power and all other inputs, outputs and case.
Contact Inputs	500V RMS, 60Hz for 1 minute between each contact input circuit and any other contact input circuit 1 kV RMS, 60Hz for 1 minute between each contact input circuit and all other circuits, terminals, and case
Contact Outputs	500V RMS, 60Hz for 1 minute between each contact output circuit and any other contact output circuit 1 kV RMS, 60Hz for 1 minute between each contact output circuit and all other circuits, terminals, and case
Communication Ports	
RS-232/485, Ethernet:	1 kV RMS, 60Hz for 1 minute between the RS-232/485 and Ethernet circuits and all other circuits, terminals, and case
Modem	1 kV RMS, 60Hz for 1 minute between the modem telephone line circuit and all other circuits, terminals, and case

Surge

- IEC 61000-4-5

Magnetic Field

- 100 A-turn

EFT

- IEC 61000-4-4
 - 5/50 nS
 - 4kV on power inputs
 - 2kV on inputs/outputs

SWC

- IEEE 37.90.1, 2.5kV oscillatory

RF Susceptibility

- 15 V/m, 200kHz to 10 GHz

Emissions

- FCC Part 15, subpart A, class A

ESD

- IEC 61000-4-2, 15kV

Agency Standards and Certification

ANSI

Tested and certified to comply with ANSI Standard C12.20-2010
The S-base and A-base meet ANSI C12.20, for class A emissions

FCC

The internal modem complies with FCC Part 68

INSTALLATION

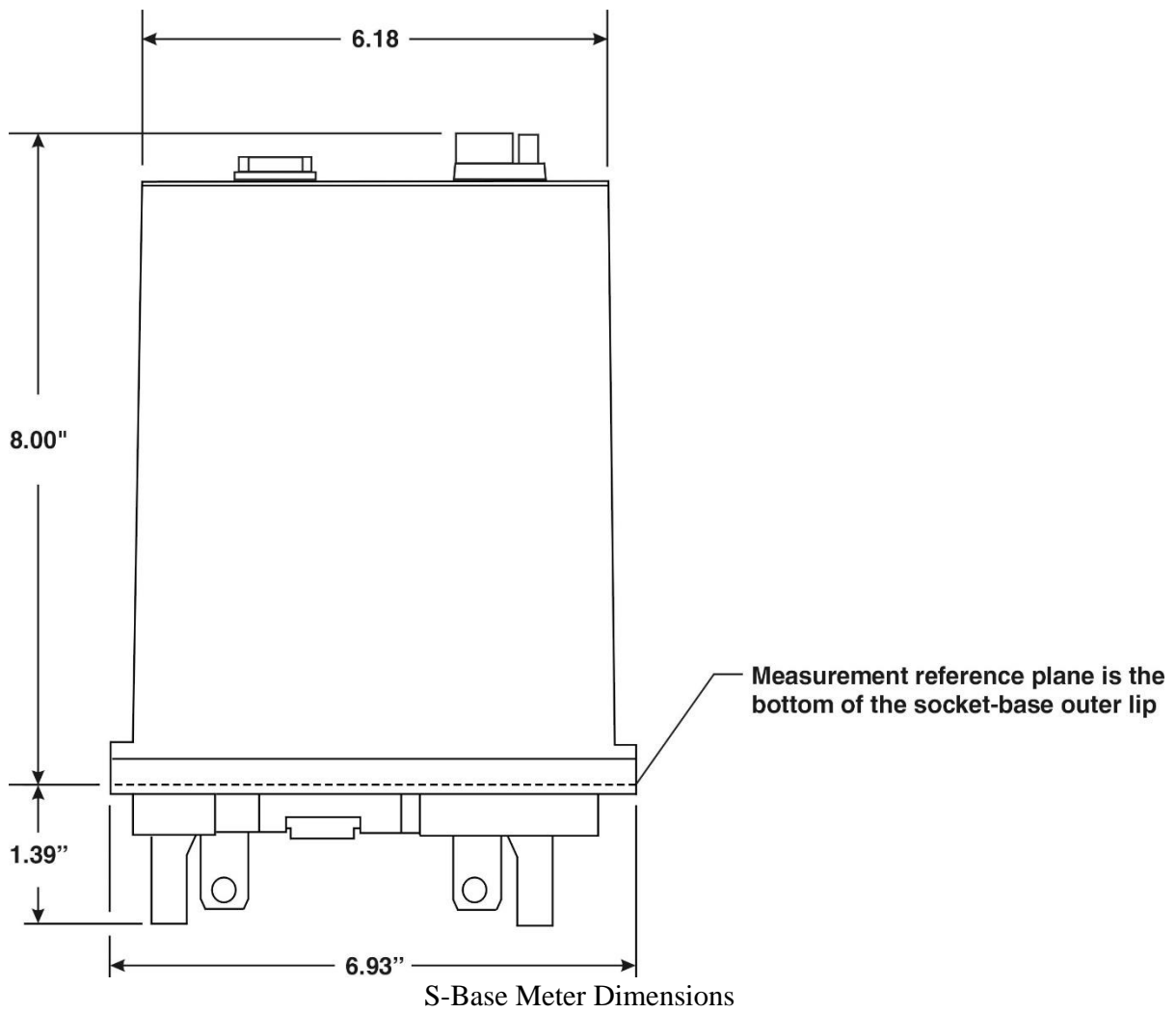
CASE STYLES

JEMStar II is available in the following case styles:

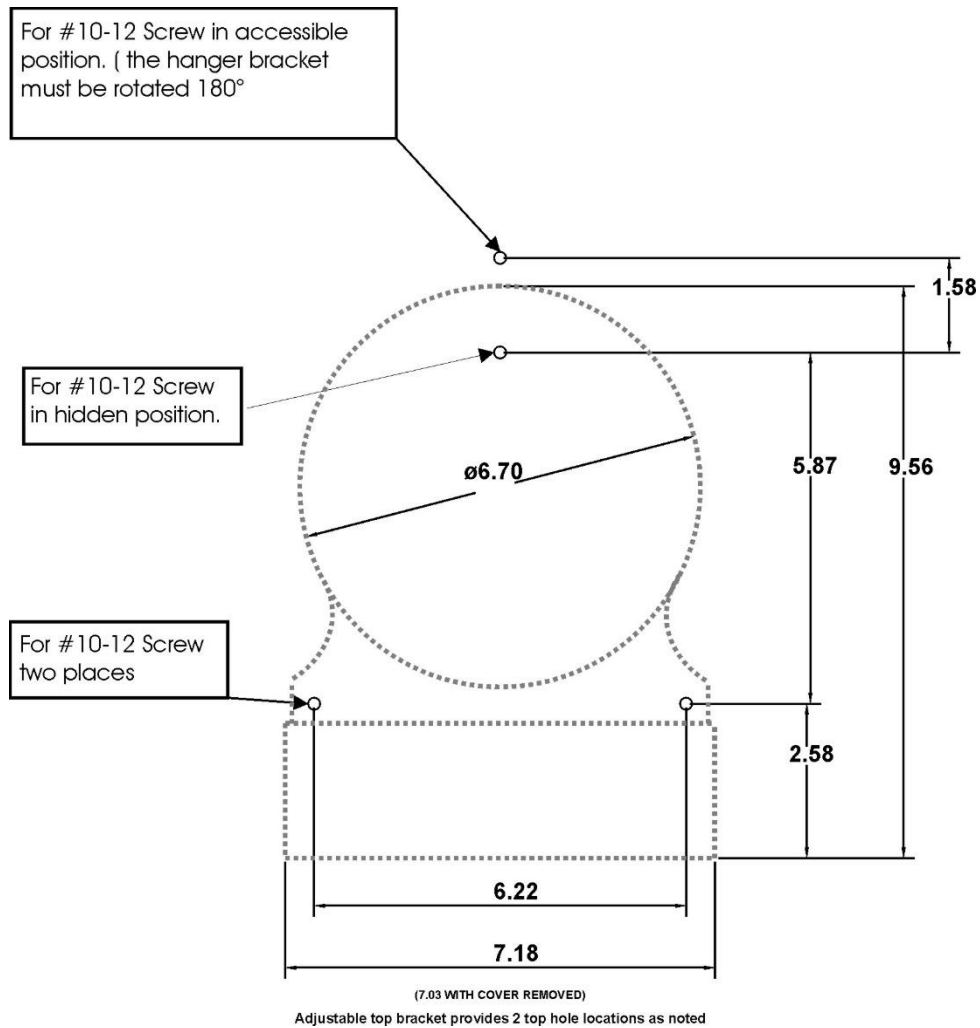
- Socket connected (S base), conforming to ANSI standard C12.10-2004, Section 5
- Small Switchboard case
- Adapter to convert S-base meter to bottom-connected (A-base) style

Size and Weight

- S base: 5.5 pounds
- Meter with A-base adapter: 7.5 pounds
- Small switchboard case: 11.5 pounds



A-Base Mounting

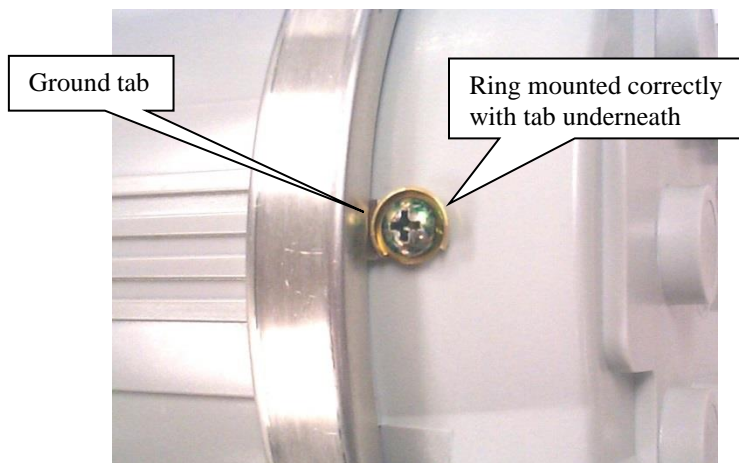


Adjustable top bracket provides 2 top hole locations as noted

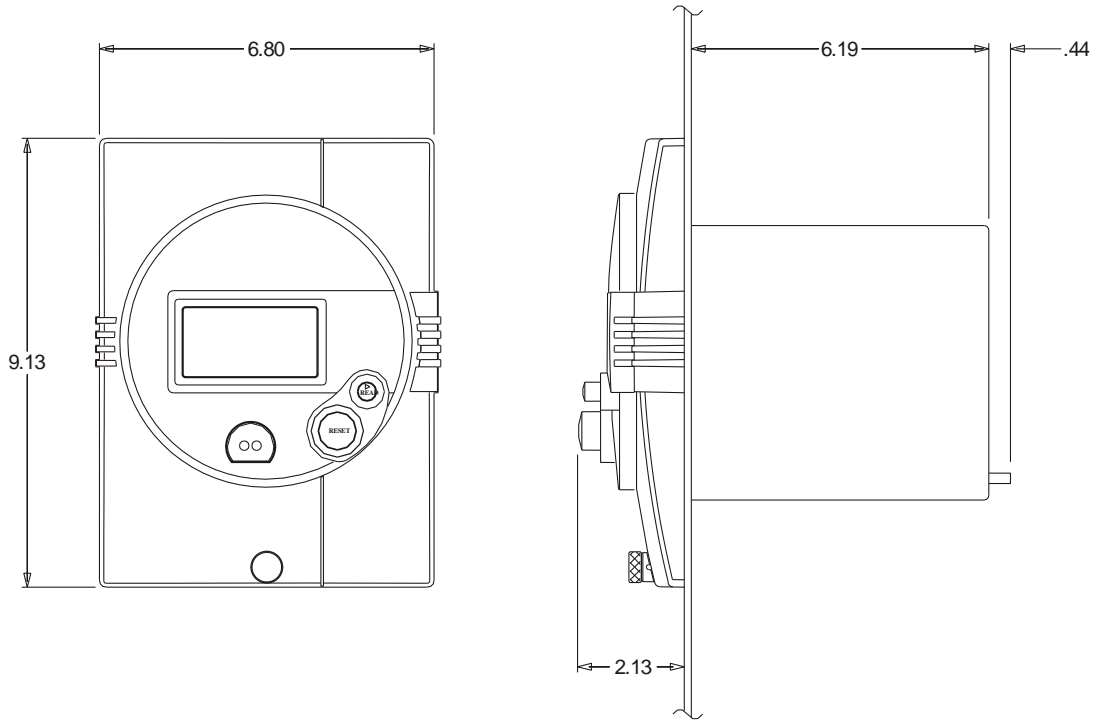
A-Base Adapter Mounting Dimensions

(With S-base meter installed, total depth in front of mounting panel is 10.25")

IMPORTANT: When installing the meter locking ring on the A-base adapter, be sure that the ground tab on the right side of the adapter is securely fitted *under* the ring.

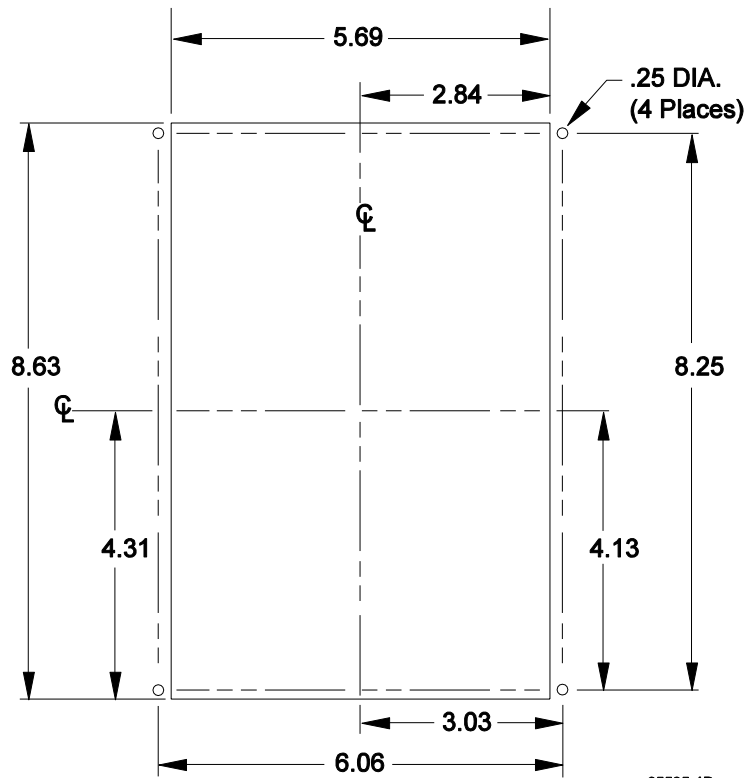


Switchboard Case Mounting



Switchboard Case Meter Dimensions

Panel Cutout Dimensions



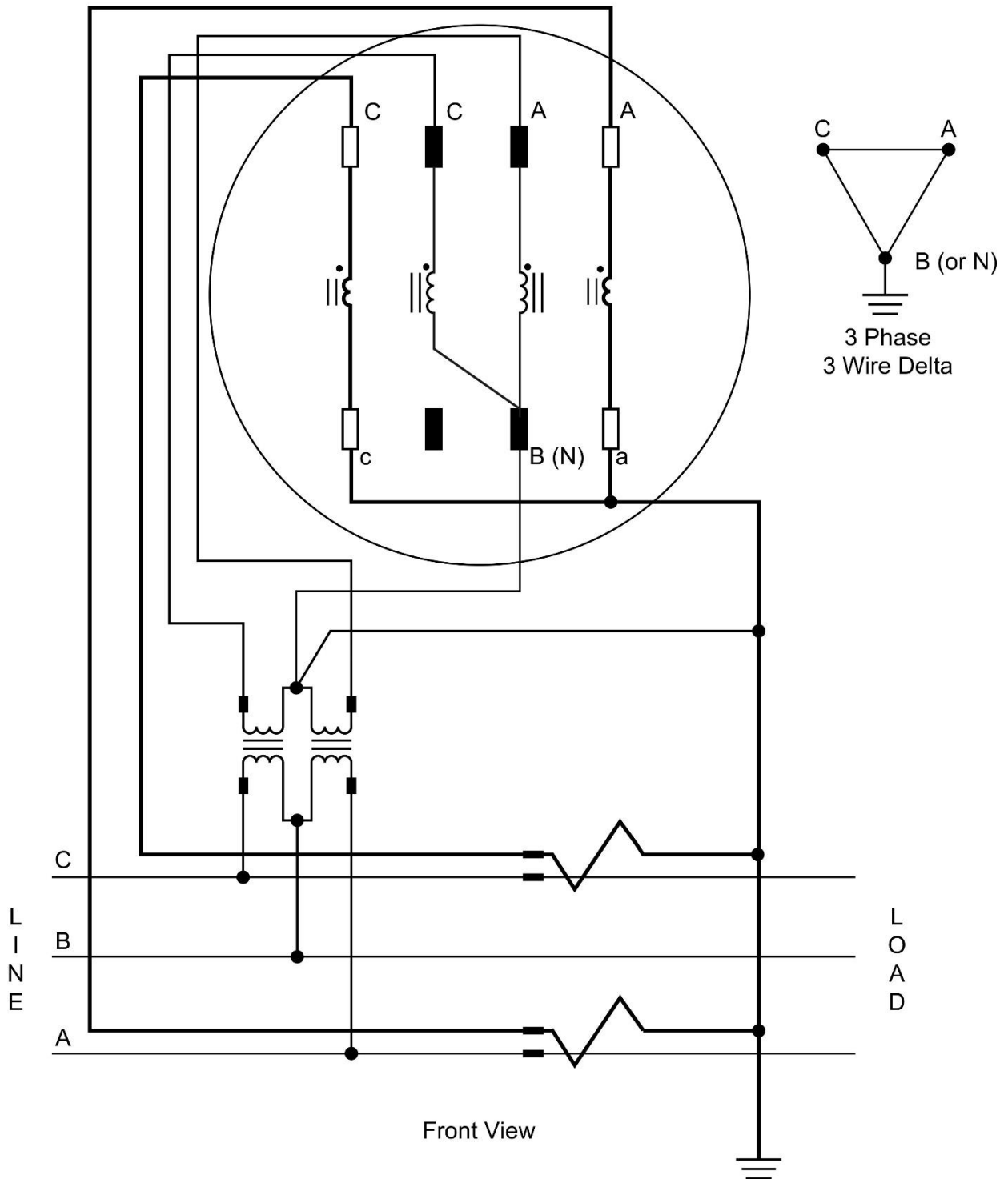
65595-1B

CURRENT AND VOLTAGE INPUT WIRING

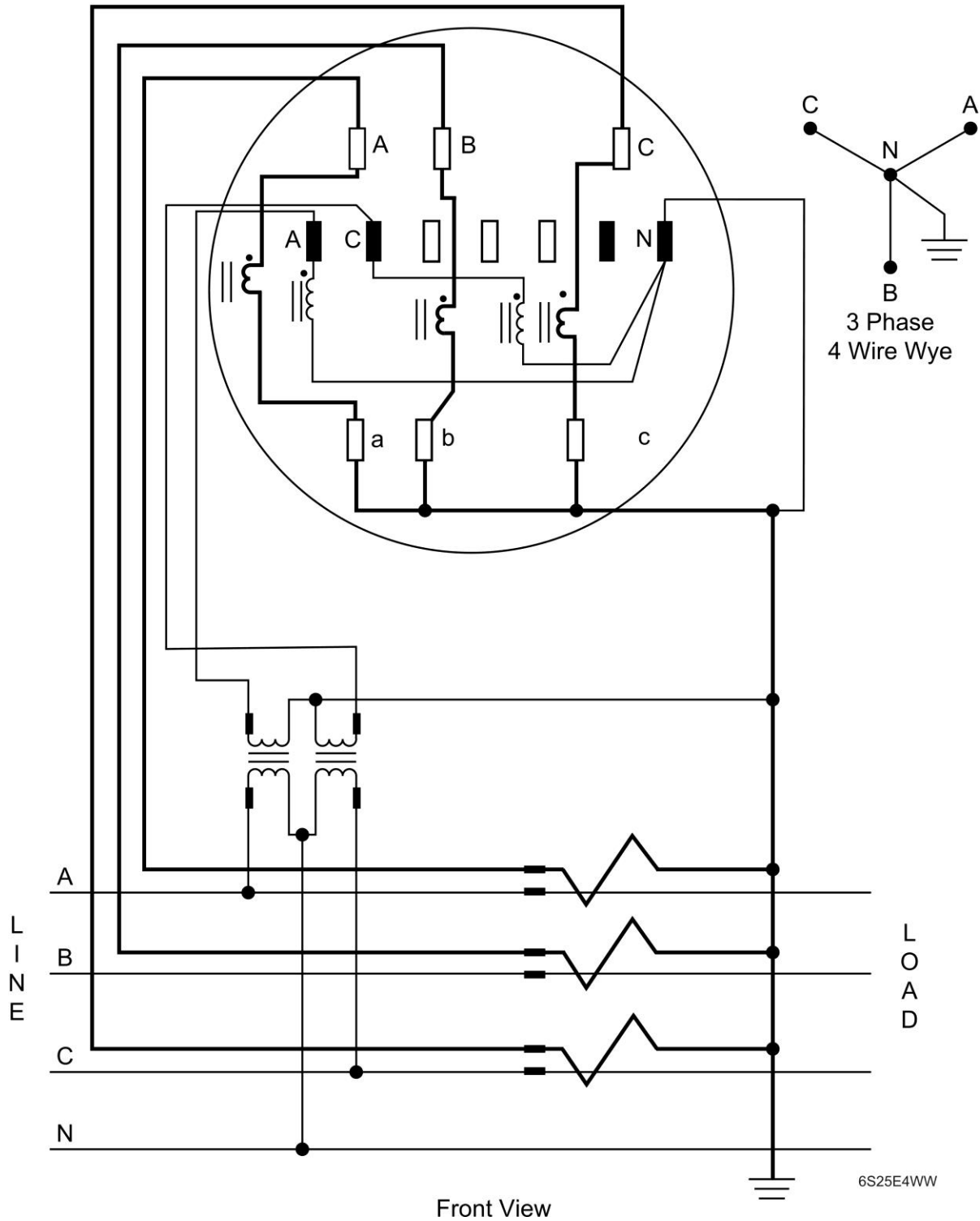
Meter Forms

Form Number	Type
Form 5S, 5A, 5R	2 Element [2PTs, 2CTs] (3 phase, 3 wire Delta)
	2 Element [2PTs, 2CTs] (3 phase, 3 wire Open Delta)
	2 Element [2PTs, 2CTs] (3 Phase, 3 wire Network)
	2 Element [2PTs, 2CTs] (3 phase, 3 wire Wye)
Form 6S, 6A, 6R	2-½ Element [2PTs, 3CTs] (3 phase, 4 wire Wye)
Form 8S, 8A, 8R	3 Element [3PTs, 3CTs] (3 Phase, 4 wire Delta)
Form 9S, 9A, 9R	3 Element [3PTs, 3CTs] (3 Phase, 4 wire Wye)
Form 45S, 45A, 45R	2 Element [3PT's, 2CT's] (3 Phase, 3 wire Delta)
U (Universal) A-Base and Switchboard Meters	2 Element [2PTs, 2CTs] (3 phase, 3 wire Delta)
	2 Element [2PTs, 2CTs] (3 phase, 3 wire Open Delta)
	2 Element [2PTs, 2CTs] (3 Phase, 3 wire Network)
	2 Element [2PTs, 2CTs] (3 phase, 3 wire Wye)
	2-½ Element [2PTs, 3CTs] (3 phase, 4 wire Wye)
	3 Element [3PTs, 3CTs] (3 Phase, 4 wire Delta)
	3 Element [3PTs, 3CTs] (3 Phase, 4 wire Wye)
	2 Element [3PT's, 2CT's] (3 Phase, 3 wire Delta)

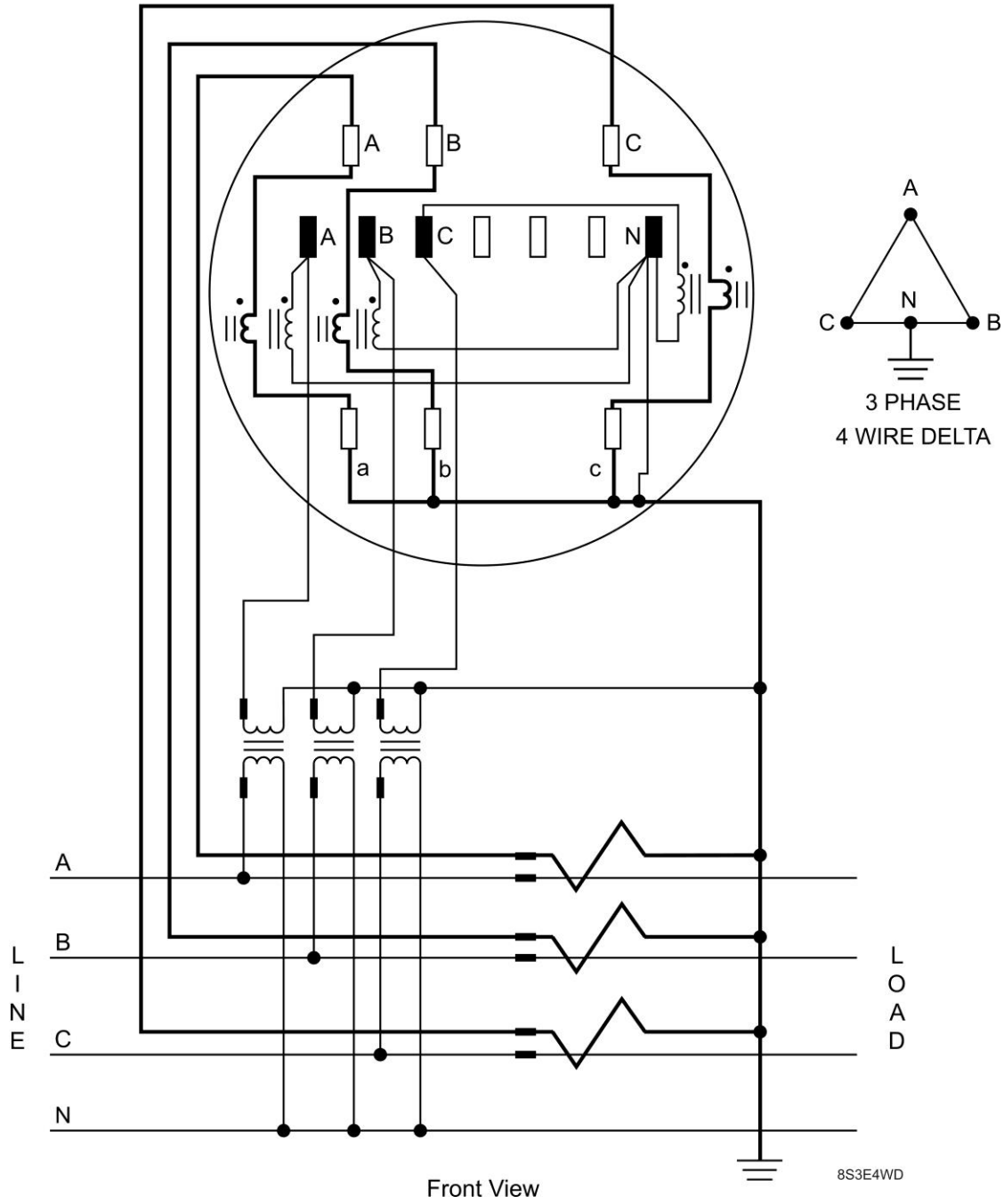
Form 5S 2 Element 3 Wire Delta



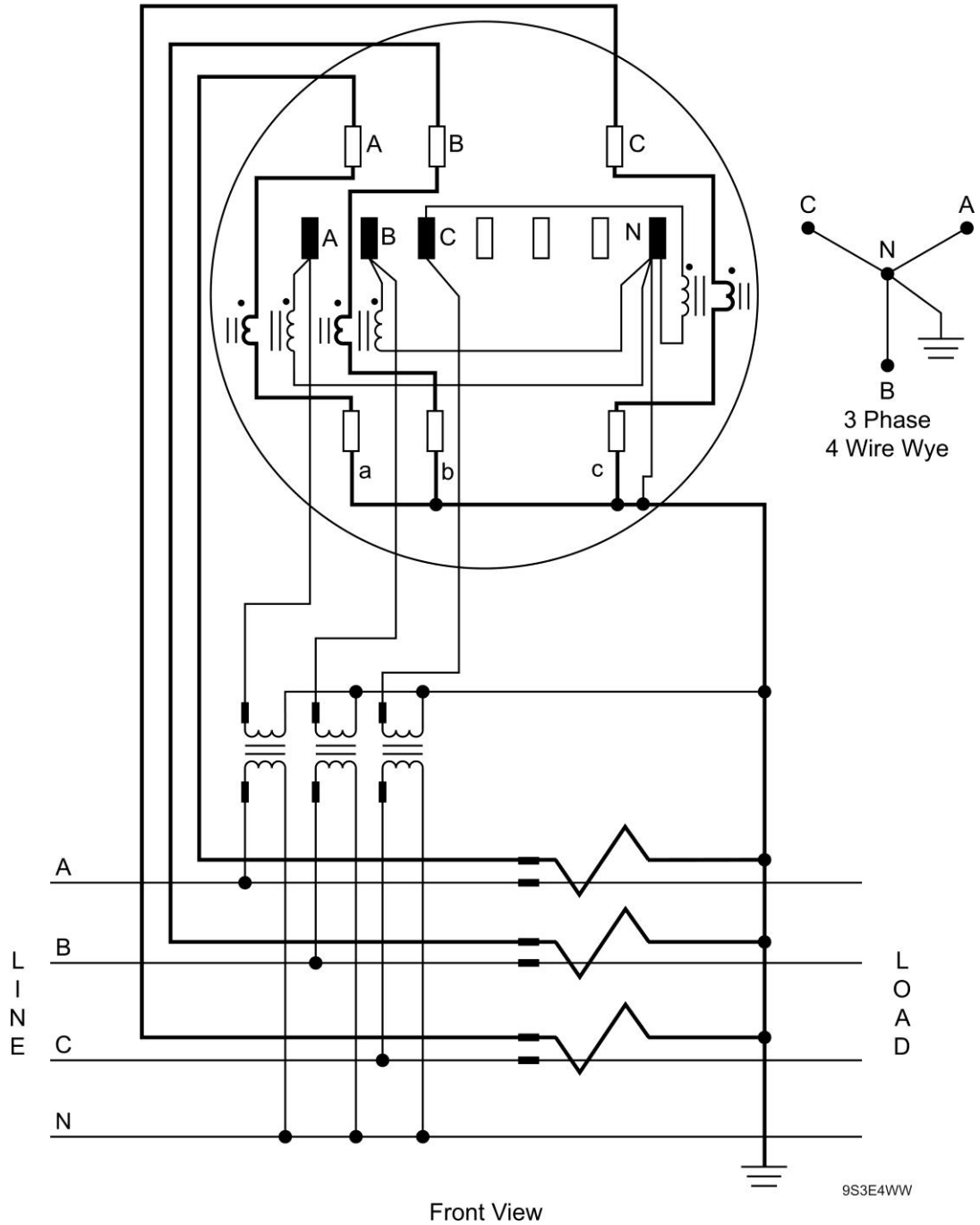
Form 6S 2½ Element 4 Wire Wye



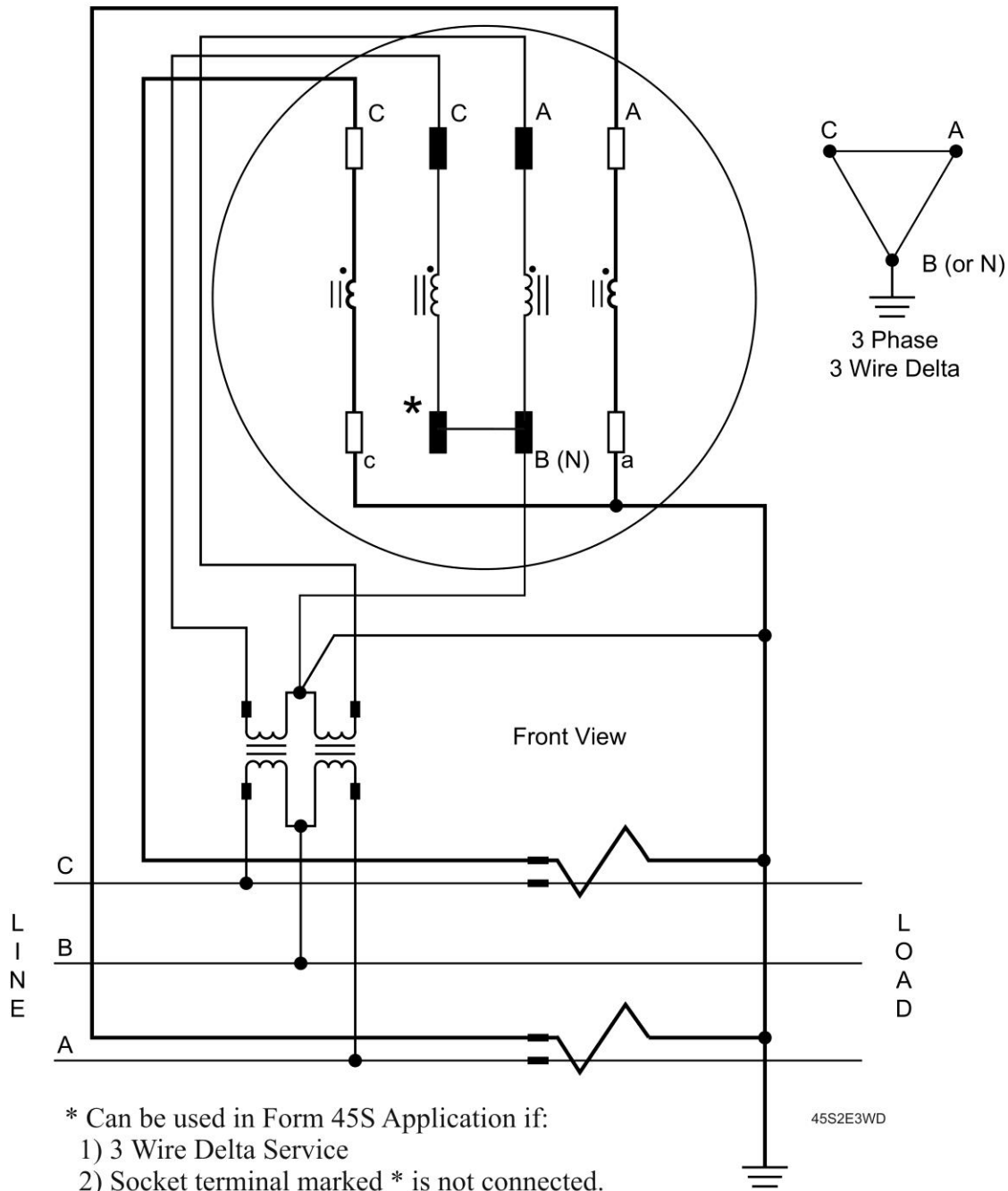
Form 8S 3 Element 4 Wire Delta



Form 9S 3 Element 4 Wire Wye

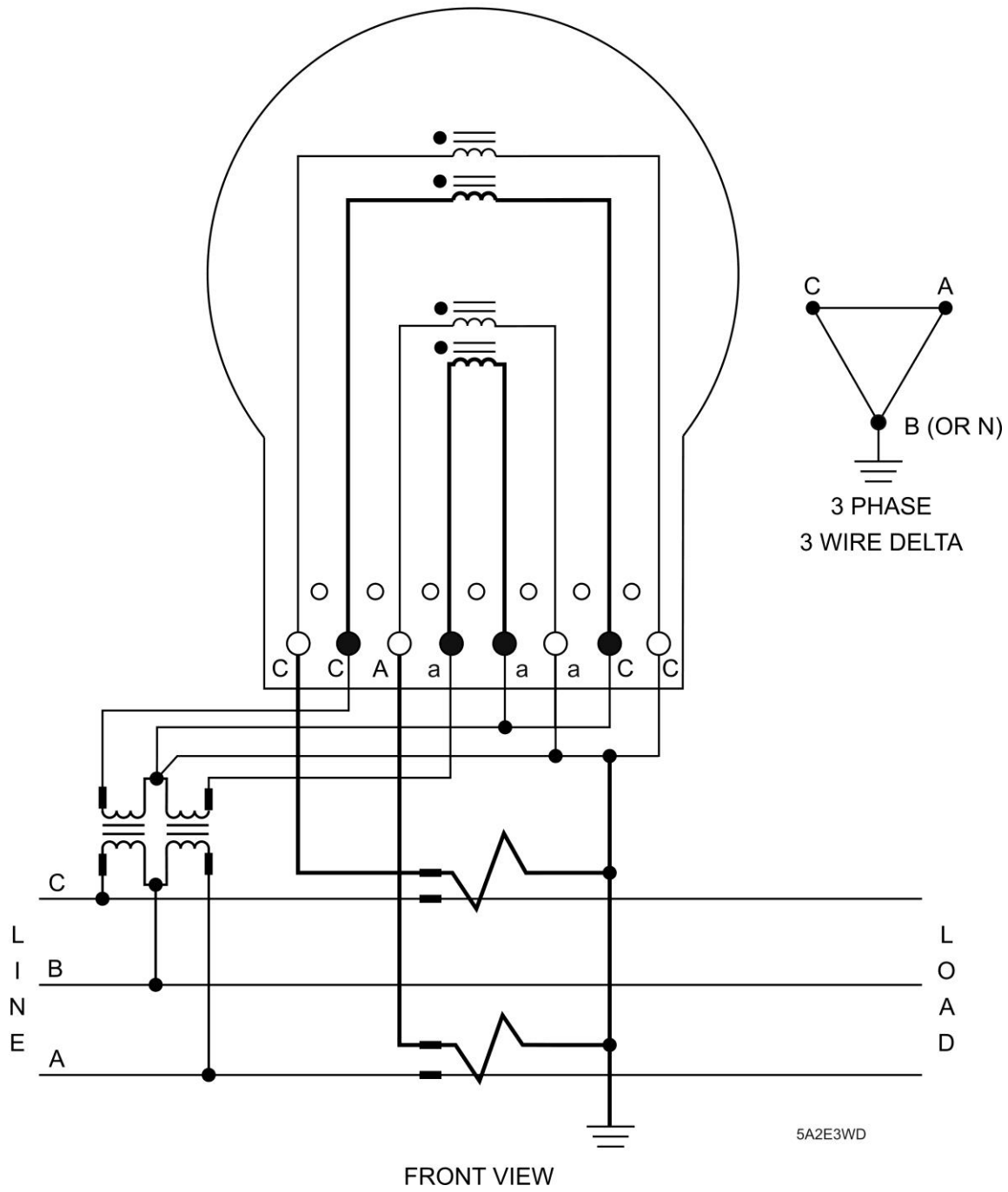


Form 45S 2 Element 3 Wire Delta

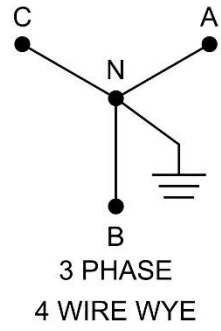
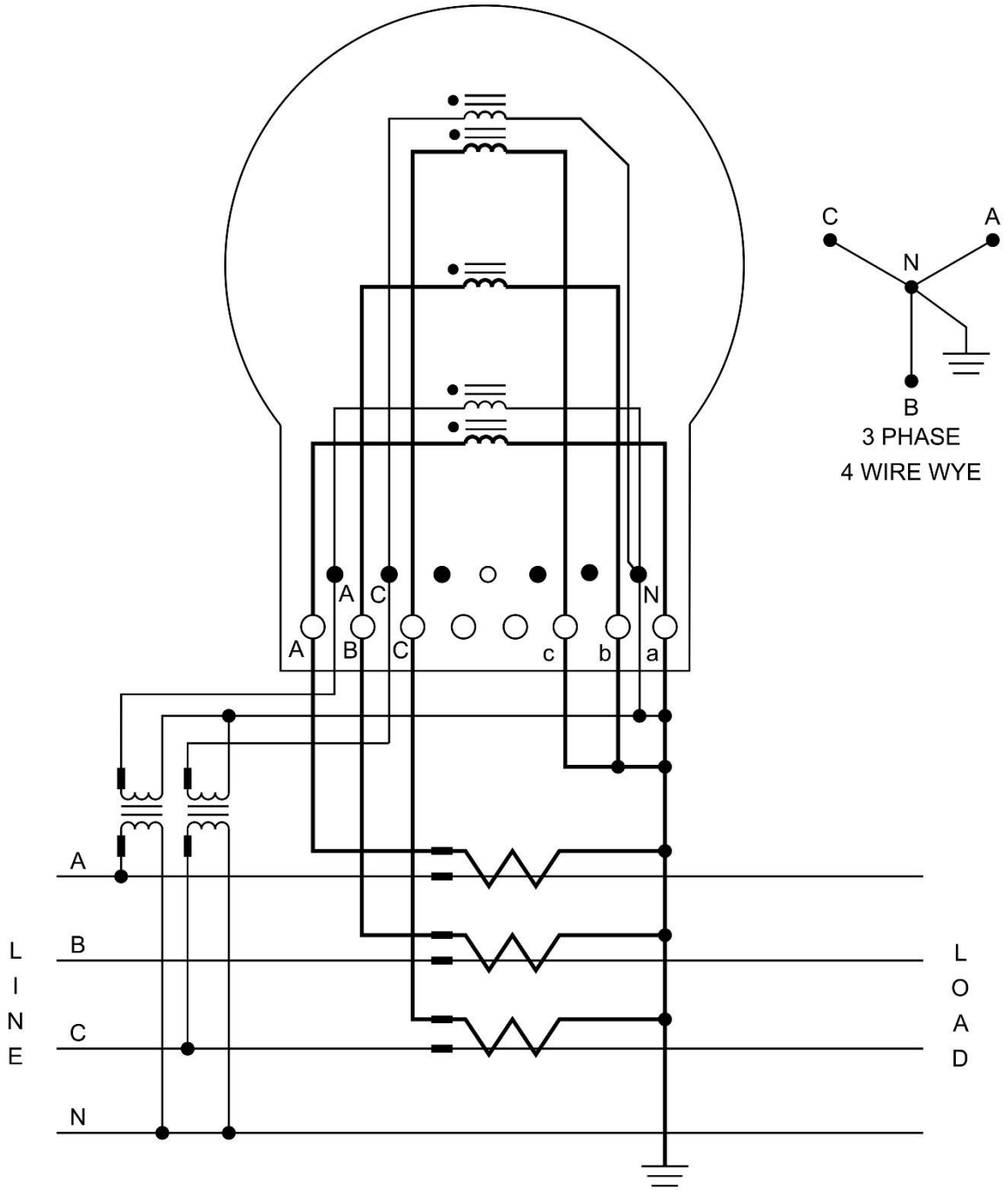


- * Can be used in Form 45S Application if:
- 1) 3 Wire Delta Service
 - 2) Socket terminal marked * is not connected.

Form 5A 2 Element 3 Wire Delta



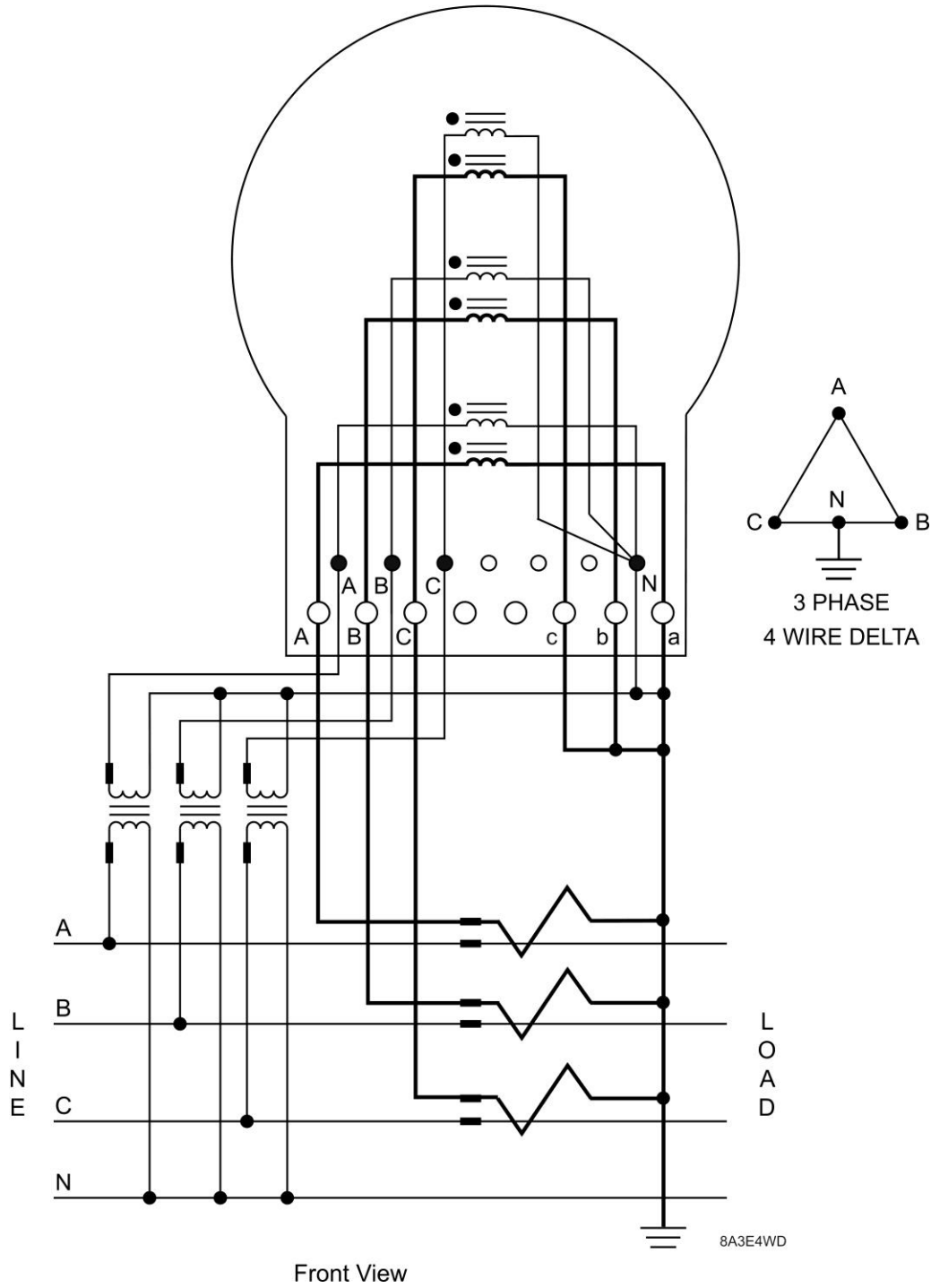
Form 6A 2 1/2 Element 4 Wire Wye



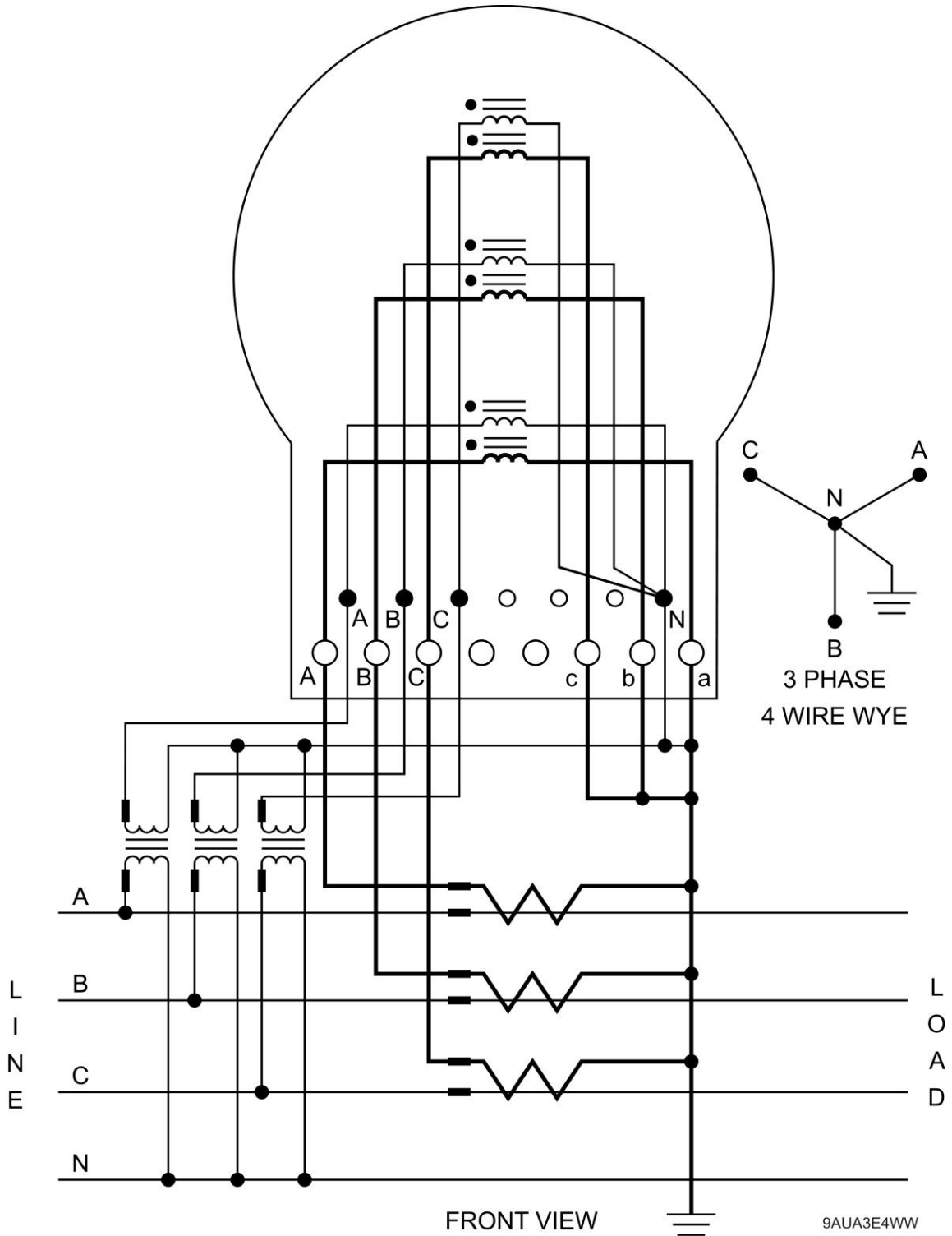
FRONT VIEW

6A25E4WW-A

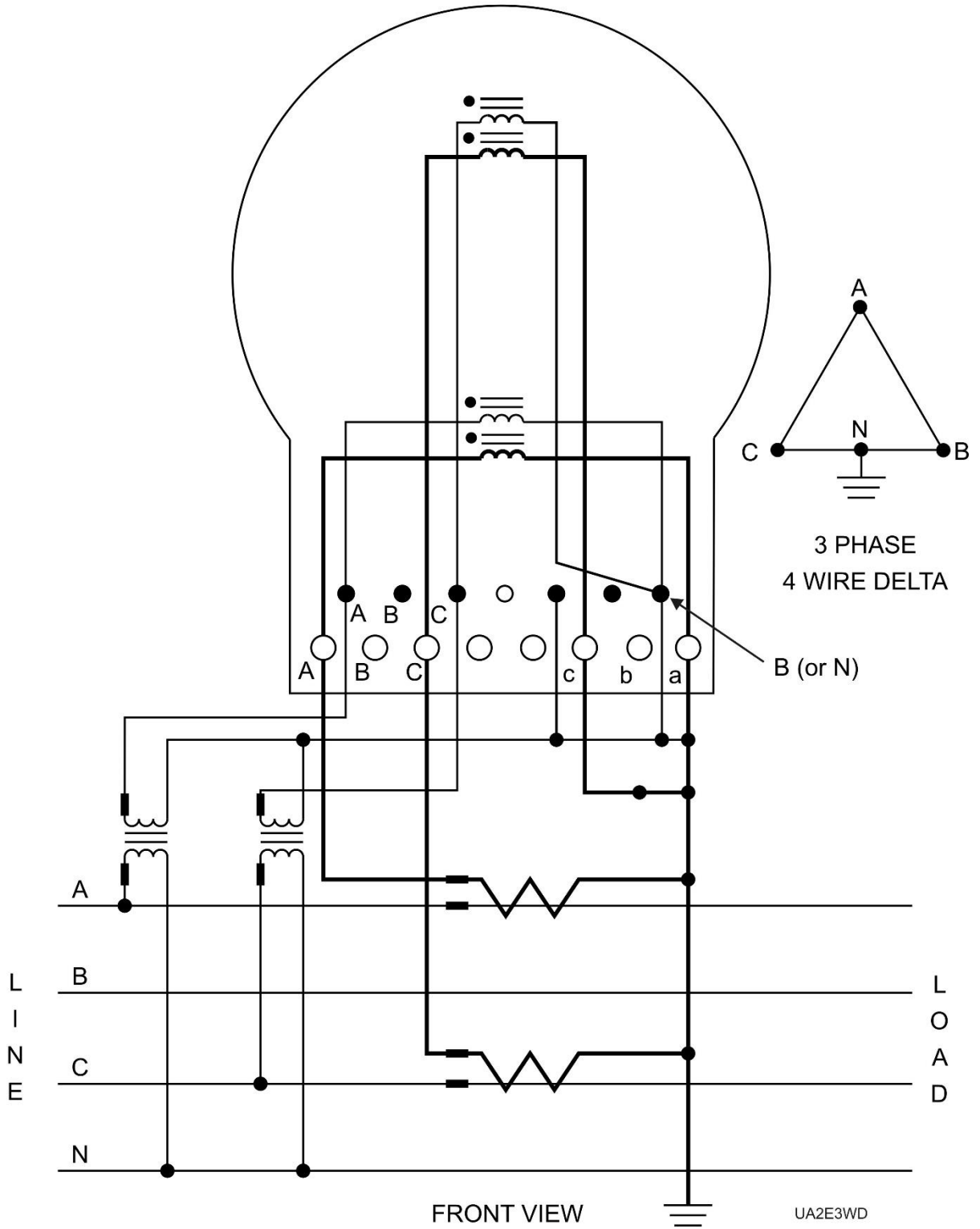
Form 8A 3 Element 4 Wire Delta



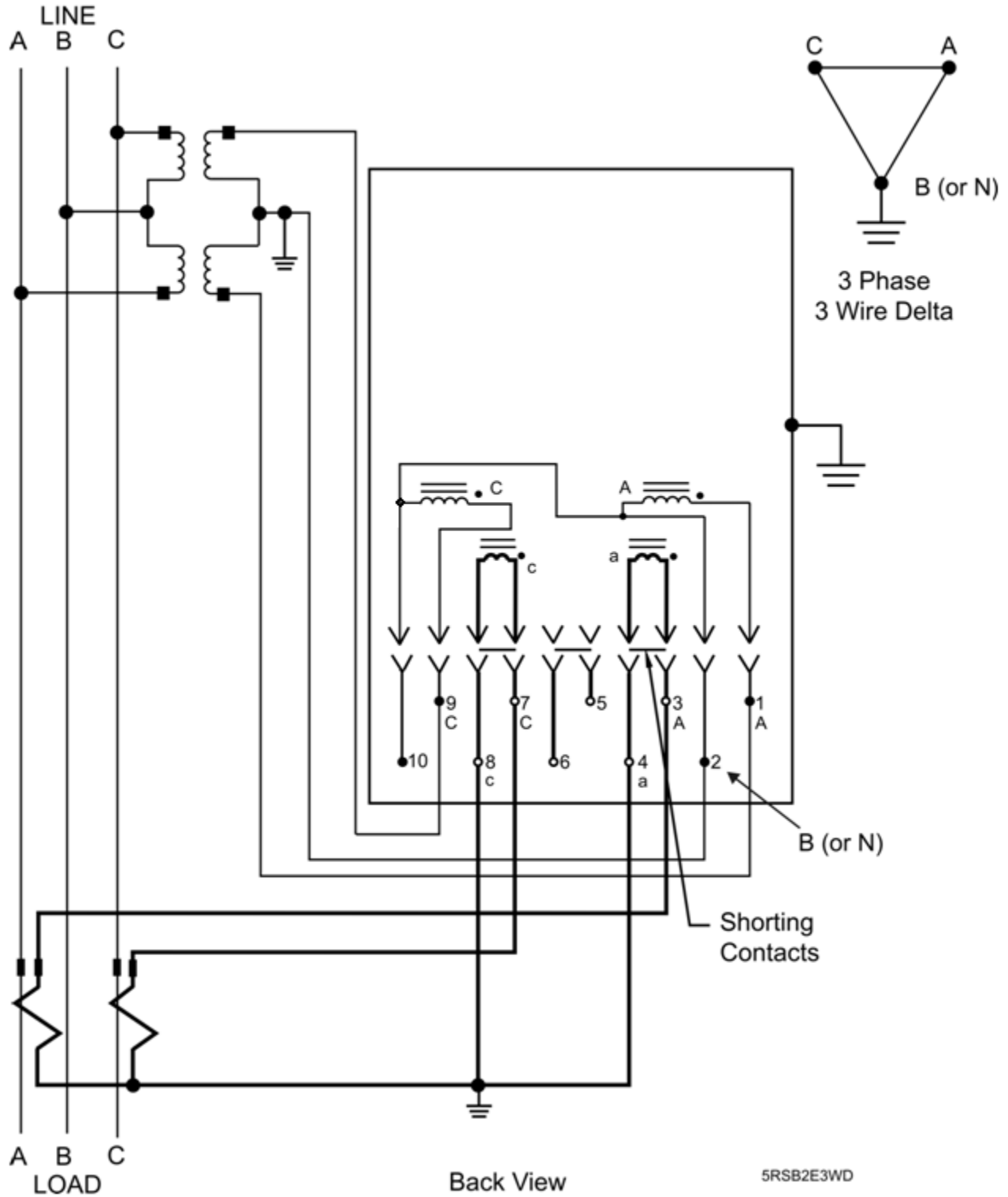
Form 9A/UA 3 Element 4 Wire Wye



Form UA 2 Element 3 Wire Delta

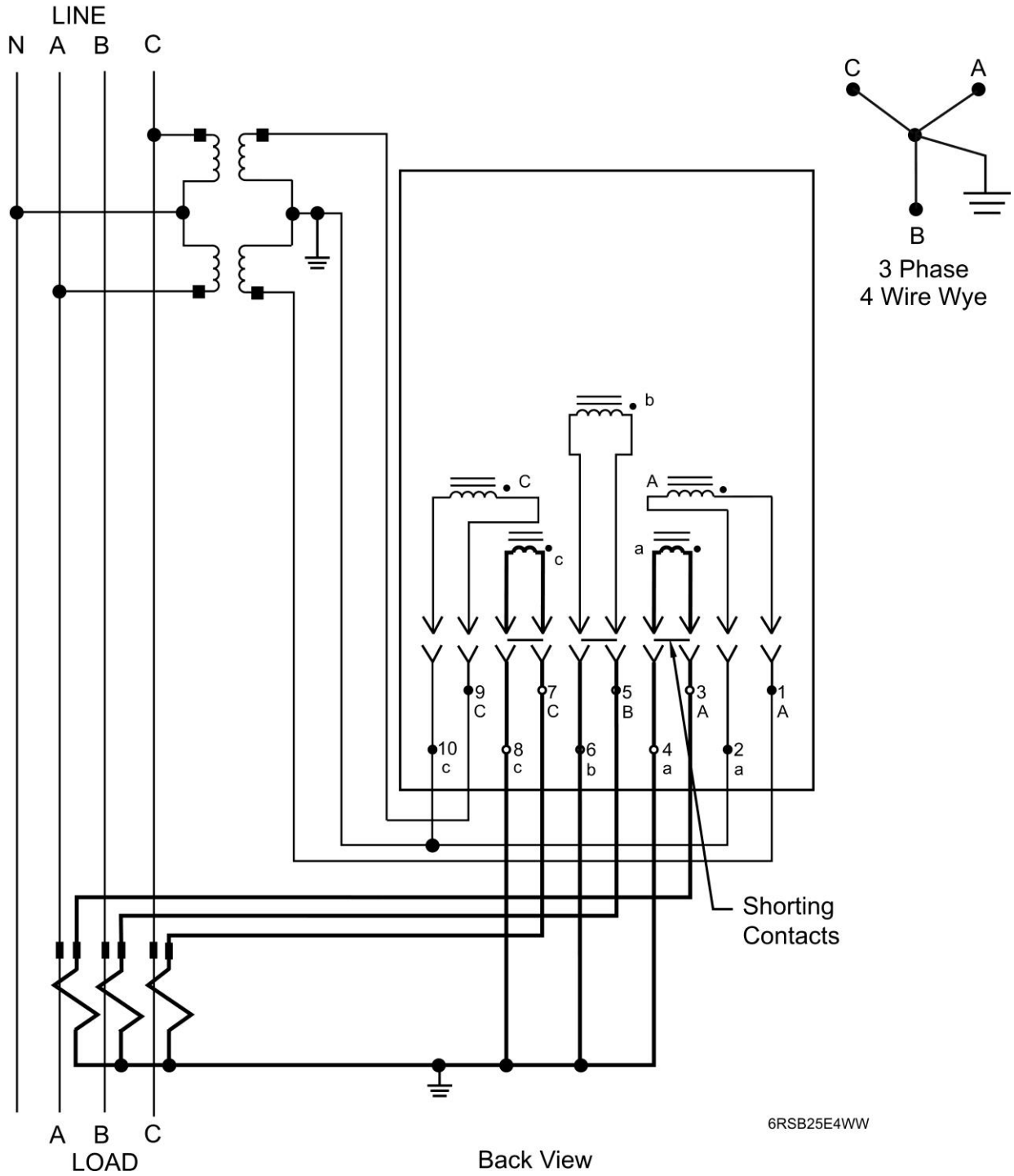


5R Switchboard 2 Element 3 Wire Delta

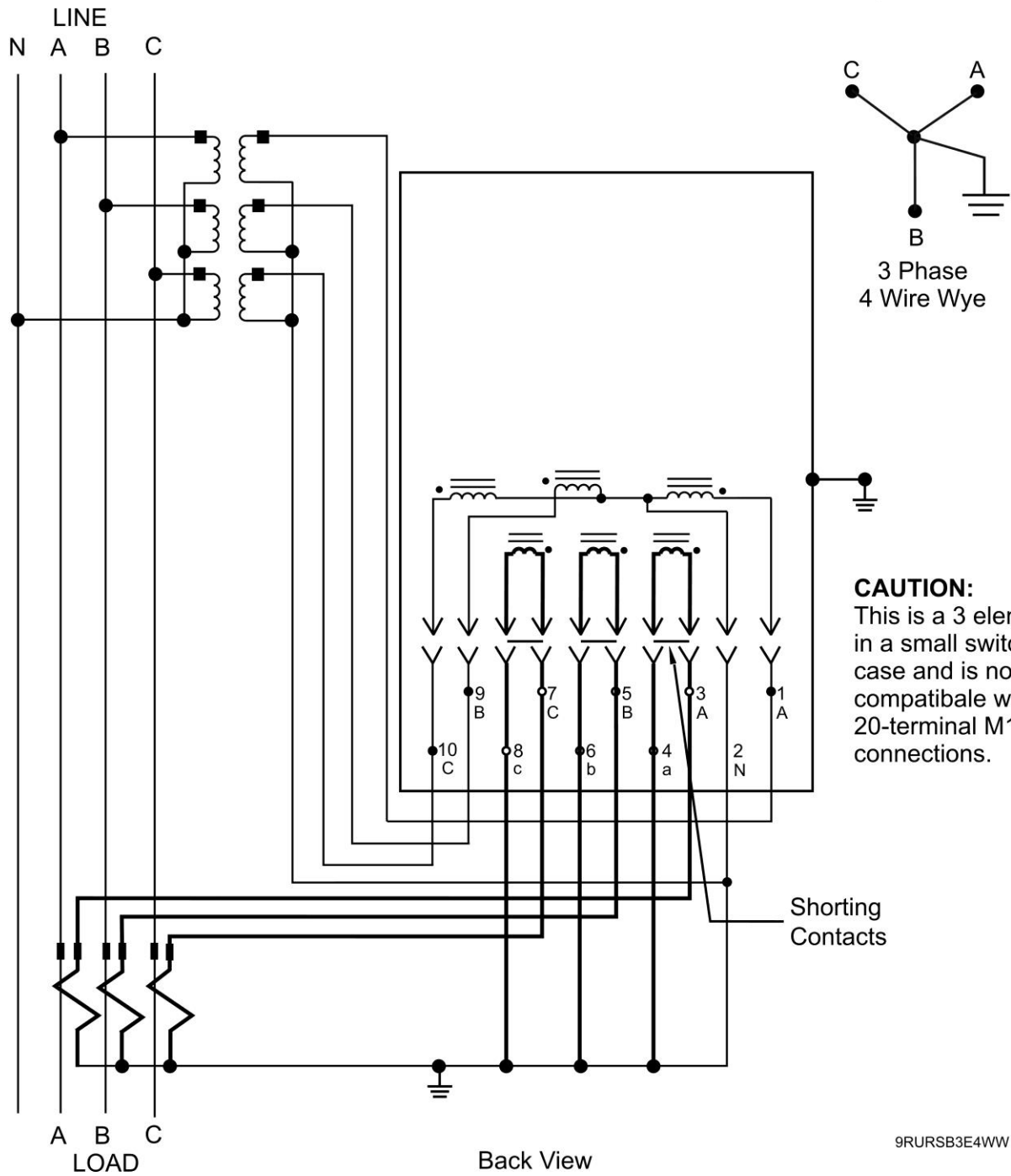


5RSB2E3WD

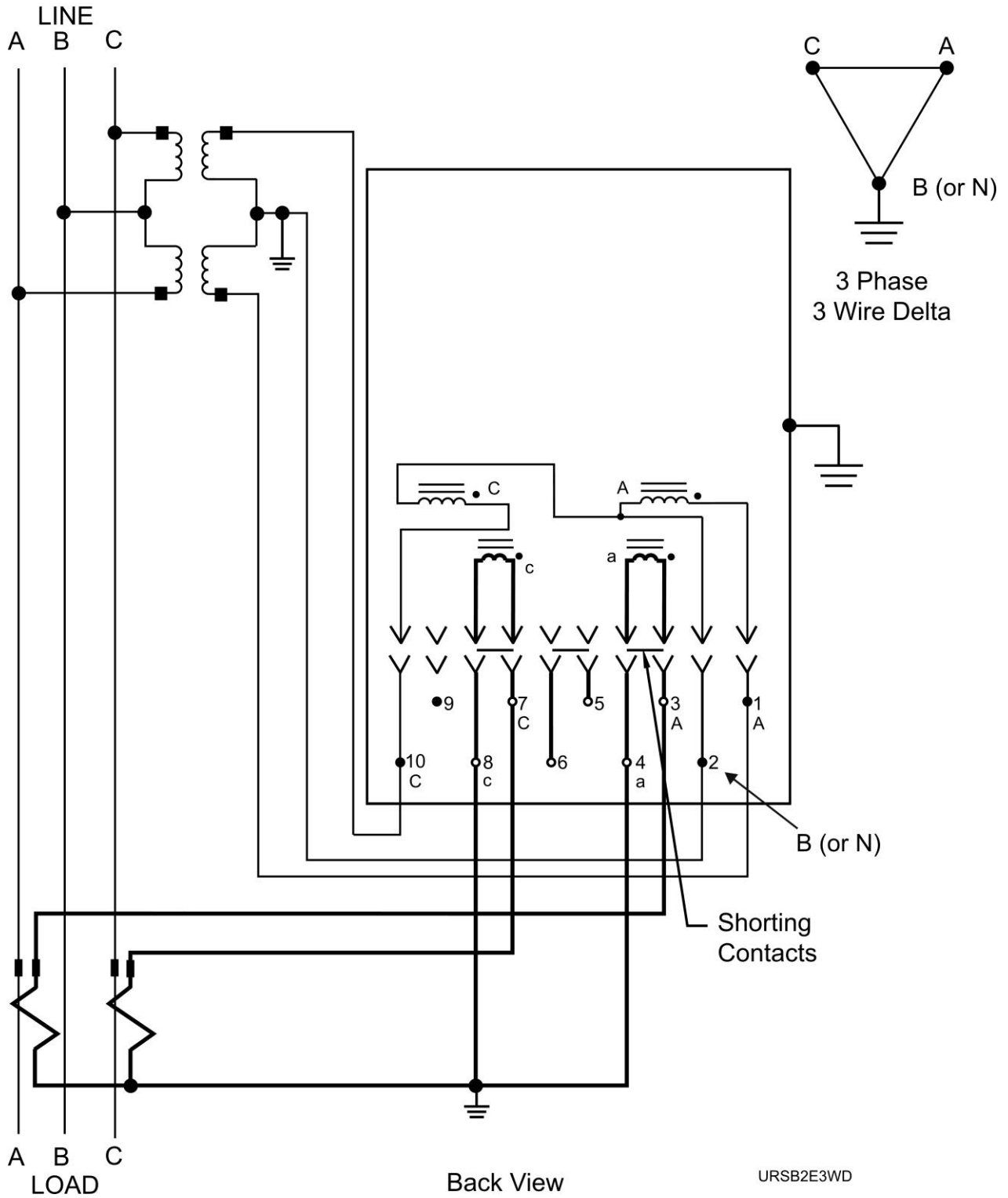
6R Switchboard 2½ Element 4 Wire Wye



9R/UR Switchboard 3 Element 4 Wire Wye



UR Switchboard 2 Element 3 Wire Delta



URSB2E3WD

EXTERNAL CONNECTIONS

JEMStar II uses industry-standard power connector configurations consistent with the standards listed in the Specifications section. JEMStar II Switchboard Case power connectors will accept 12 gauge solid wire or a ring or spade lug.

Connections that are intended to be made and broken during normal meter operation (e.g. temporary data connections, Test Pulse pickup, etc.) are accessible without exposing the operator to live power terminals or conductors.

Other JEMStar II electrical connections (e.g. Contact Outputs, Contact Inputs, Modem) are brought outside the meter as pigtail leads (S-base, A-base) of an appropriate wire gauge and insulation to maintain the electrical requirements of ANSI standards. The Switchboard model provides user connections on rear-mounted terminal blocks or connectors.

Grounding Recommendations

It is important to ensure that the JEMStar II meter is properly grounded. The S-base and A-base models are constructed per ANSI C12.10 standards and the ground tabs on the rear of the meter must be properly connected to earth ground through the socket. The Switchboard case is steel and must have a good protective ground to ensure that the entire housing is safe. The switchboard housing has an earth ground terminal at the rear of the housing. Supply an adequate, low-impedance ground to the JEMStar II case and verify with an ohmmeter. Be sure not to make grounding connections on painted surfaces. All signal inputs and outputs that will be wired for extended distances from the JEMStar II should be shielded cables, with the shield grounded at one end. The instrument PT and CT commons should be grounded consistent with your company's wiring procedures.

Signal Inputs

Voltage Inputs

The meter will operate continuously at any voltage within the nominal range of 55 – 530 volts while still meeting all operational specifications.

Refer to the Specifications section for input burden.

Current Inputs

The JEMStar II is configured at manufacture for one of the standard current Class ranges listed in the Specifications section. Each JEMStar II current input can withstand a continuous overload of 1.5 times the Class current, or 20 times the Class current for 0.5 second without damage or permanent change in registration. Refer to the Specifications section for input burden.

AUXILIARY POWER

For S-base and A-base models, the standard meter configuration is Self Powered via the Phase A, B & C voltage inputs. The power supply will operate from any phase. No separate connection is required. Refer to the Specifications section for burden.

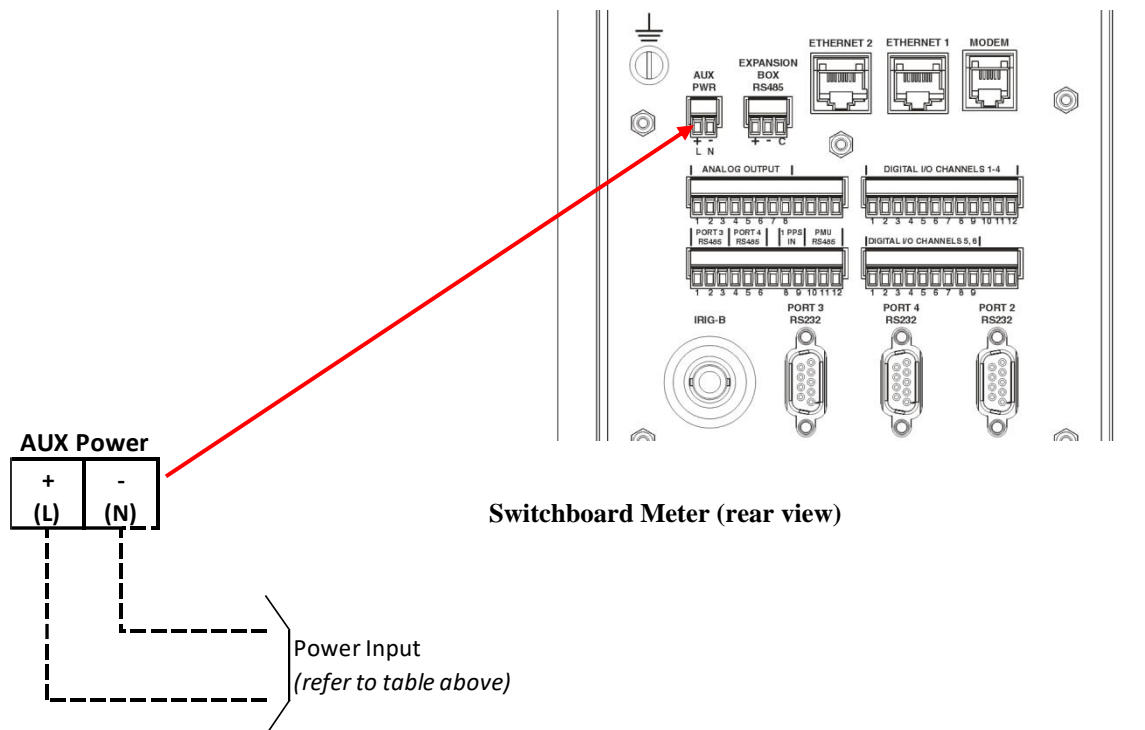
There are two options available for external auxiliary power on S-base and A-base models. Option EAP is for a universal AC/DC Power Input as shown below. Option DC is for a Low Voltage DC power supply. A two wire cable will be provided from the bottom of the meter socket for connection to power.

Wire Color	Function	Option EAP		Option DC
		AC Range	DC Range	DC Range
Red (White)	+ (L)	55-530 VAC	90-300VDC	19-58VDC
Black	- (N)			



The Switchboard models are designed to obtain Auxiliary Power from a separate terminal block connection. The Switchboard meter comes with a universal AC/DC power supply as shown below. As an option, the Switchboard models can be ordered with the Low Voltage DC Power, Option DC.

Terminal	Standard Power Input		Option DC
	AC Range	DC Range	DC Range
+ (L)	55-530 VAC	90-300VDC	19-58VDC
- (N)			



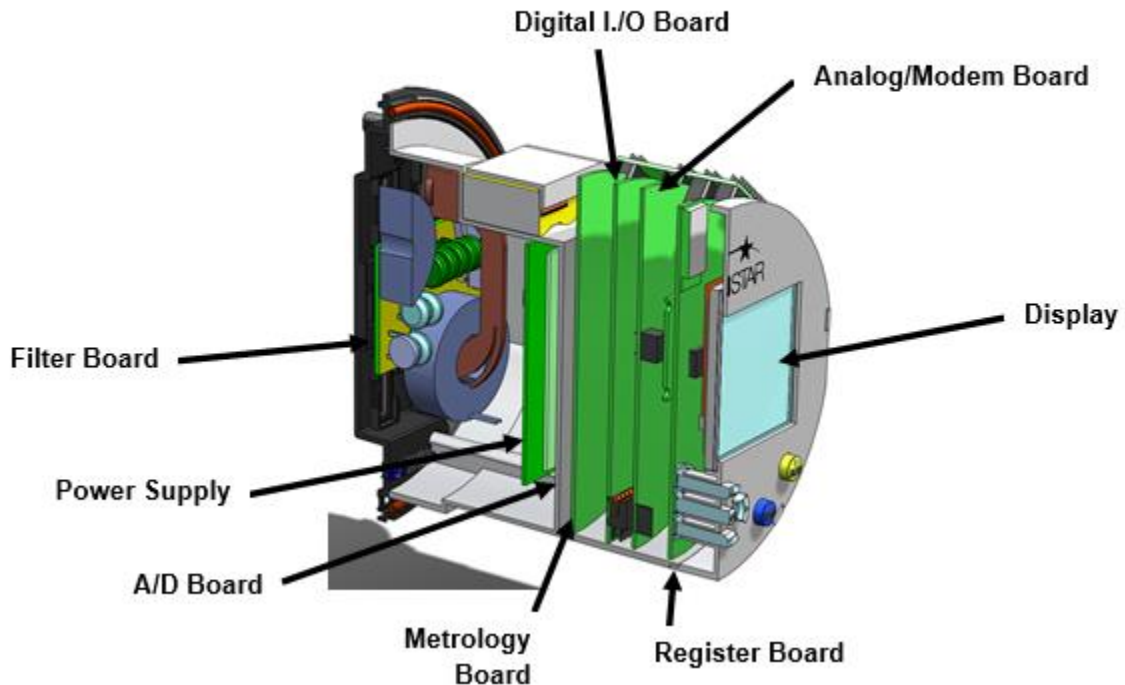
METER INPUTS AND OUTPUTS

The JEMStar II Meter has several options for digital I/O and analog outputs. You can combine both digital and analog options in the same meter as shown below.

I/O Options	
0	None
DIO	Internal Ch 6 D I/O
DIOP	Internal 6 Ch D I/O w/PS
AO1	Internal 4 Ch AO (0-1mA)
AO2	Internal 4 Ch AO (4-20mA)
You can select 1 each of Items: DIO or DIOP AO1 or AO2	

The Digital I/O and Analog Output options are contained on separate boards which are easily accessible. The drawing below shows where the boards are located on a socket meter. The same orientation is used for the switchboard meter.

JEMStar II Meter Architecture



Digital Input / Output Options

The JEMStar II Meter has an option for digital I/O which consists of 6 channels that can be individually configured as inputs or outputs using the JEMWARE Configuration Software. The Digital I/O option can be equipped with or without an isolated 24V power supply for supplying power to the digital inputs.

Contact Inputs

The Form A Contacts and can be configured to perform any one of the following functions:

- Pulse Counter: Each transition (make *or* break) is counted as a pulse.
- Interval synchronization pulse: Each "make" causes the Demand Interval and / or Load Profile (if so configured) to be re-synchronized.
- TOU Rate Override: Each "make" will cause the present Time Of Use rate to change to a user-configured "override" billing rate.
- Status Input: Each "make/break" of an external contact can be monitored by the meter
- Record Load Profile: This can be used to enable the recording of Load Profile when that channel is configured to record only during the presence of the digital input.
- Trigger Alarm: Used to trigger a power quality event.

JEMStar II can provide an internal 24 Vdc wetting voltage for the contact inputs (Option DIOP). If option DIO is specified, the user must provide an external wetting source. The external source must have the following characteristics:

- Minimum ON voltage 10Vdc
- Maximum ON voltage 40Vdc
- Current limited to 50 mA

JEMStar II will de-bounce both "make" and "break" transitions on each contact input for at least 20 milliseconds. The maximum detectable pulse rate is 100 *transitions* per second.

Contact Outputs

JEMStar II Outputs can be used as a Form A or KYZ.

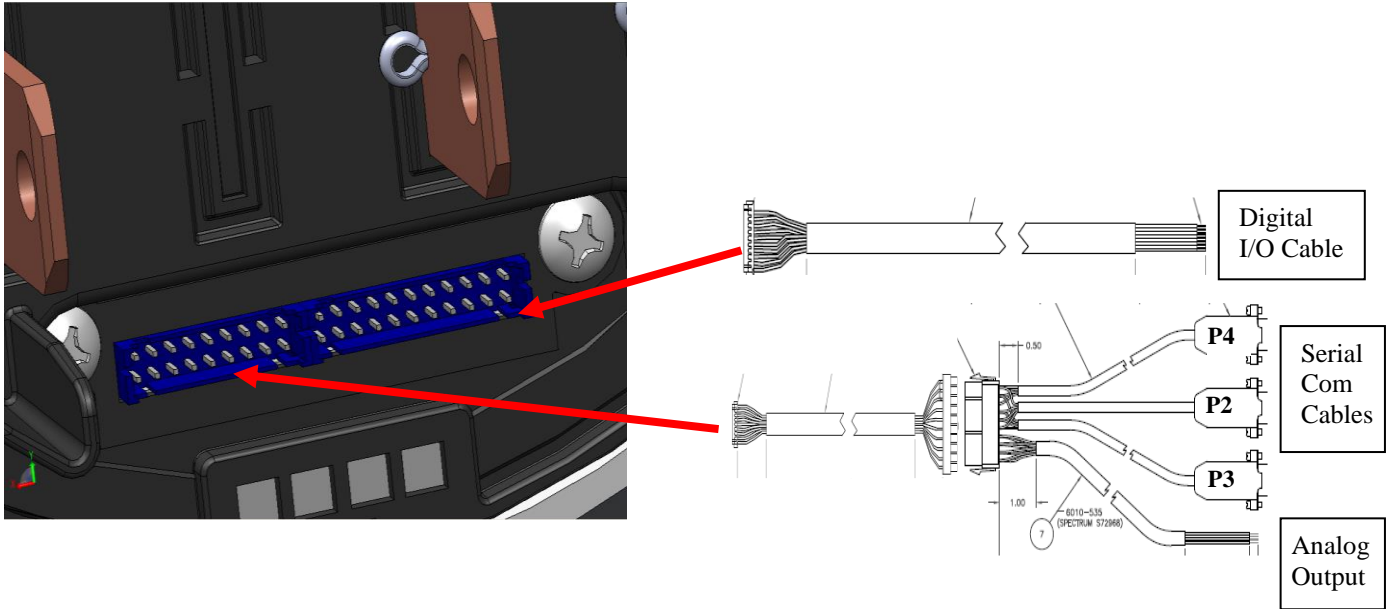
Outputs can be configured to perform any one of the following functions:

- Energy pulse output: KYZ Contact configurable for any consumption quantity or energy constant.
- End of Demand Interval Output: the Form A output will close for one second when a demand (sub) interval closes.
- Trigger Alarm: The Form A Output will close upon an alarm trigger if the trigger condition is set to activate a digital output.

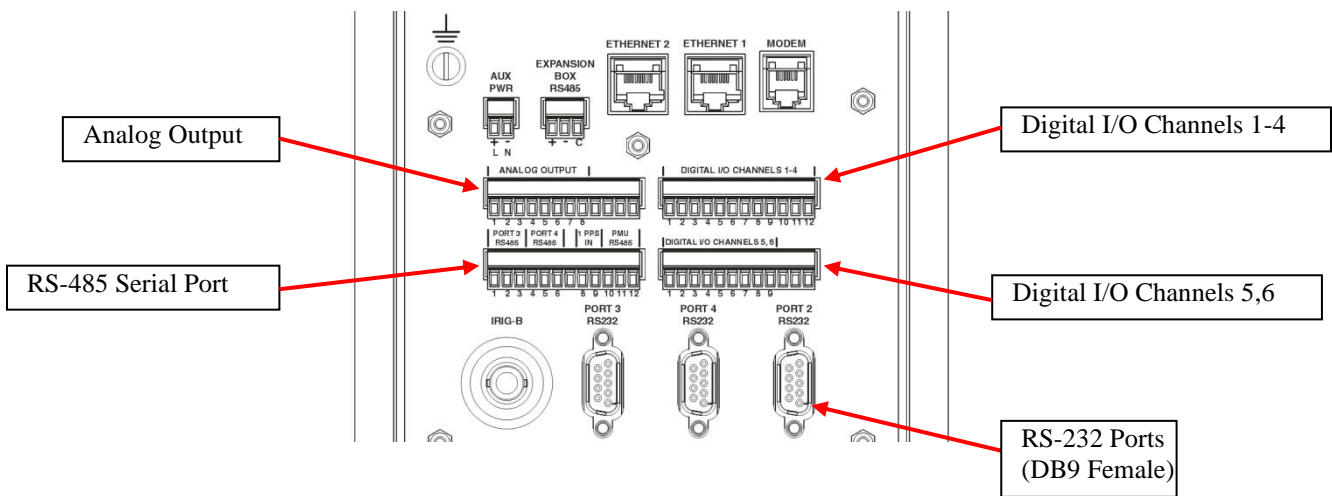
The JEMStar II contact closure outputs meet the following specifications:

- Maximum open-circuit voltage is 200 volts, DC or peak AC.
- Maximum closed-circuit voltage drop is 2.5 volts at 30 mA.
- In the closed state, the contact will conduct in either direction.
- The maximum current rating for a closed contact is 50 mA.
- The contact outputs are TTL-compatible when used with an external 4700 Ω pull-up resistor to an external +5Vdc source.
- Maximum output rate is 25 transitions per second. A transition is defined as a single change of state, either open-to-close or close-to-open. This equates to 10 complete pulse cycles per second

Socket Meter I/O Wiring Connections



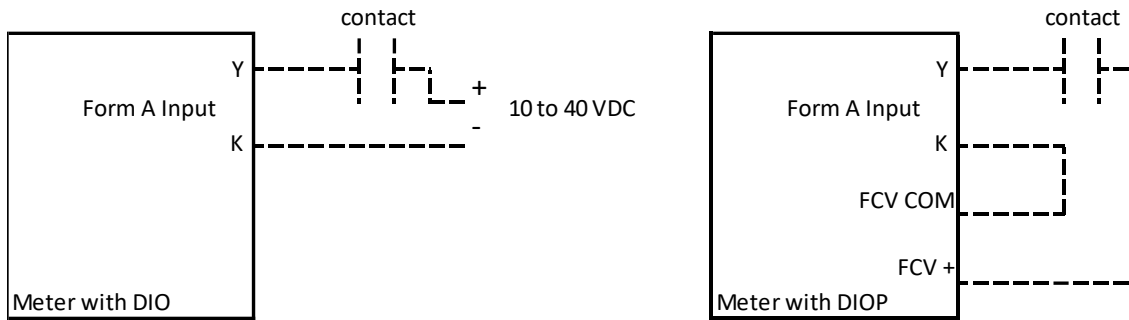
Switchboard Meter Connections



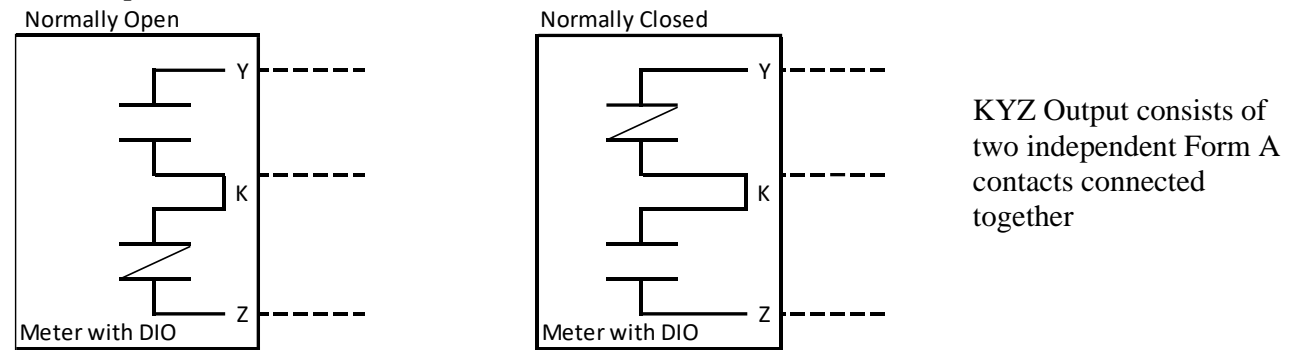
Typical Digital I/O Wiring:

The 6 Digital Inputs and Outputs use the same connection terminals(wires) and are selected via the JEMWARE Software Configuration. Digital Inputs use a Form A Contact and Digital Outputs use a Form A or KYZ Output. DIO Channel 1 shown below as a Form A Input, KYZ Output and Form A Output

Form A Input

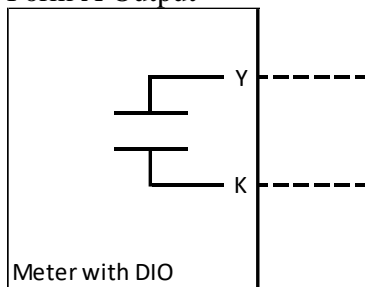


KYZ Output



Note: Normally Open/Closed refers to the power on normal state (no pulses)

Form A Output



Digital I/O Wiring

For the S-Base and A-Base meter styles, JEMStar II contact input connections are provided via a multi-conductor cable. The wire colors are as follows.

Digital I/O Connections -Socket and A-Base

Signal	Color	Signal	Color
DI/O #1 Y	WHT/RED	DI/O #4 Y	WHT/BLK
DI/O #1 K	WHT/ORG	DI/O #4 K	WHT/GRN
DI/O #1 Z	WHT/BRN	DI/O #4 Z	WHT/BLU
DI/O #2 Y	WHT/BLK/GRN	DI/O #5 Y	WHT/BLK/RED
DI/O #2 K	WHT/BLK/BLU	DI/O #5 K	WHT/BLK/ORG
DI/O #2 Z	WHT/RED/GRN	DI/O #5 Z	WHT/BLK/BRN
DI/O #3 Y	WHT/RED/BLU	DI/O #6 Y	WHT/RED/ORG
DI/O #3 K	WHT/GRN/ORG	DI/O #6 K	WHT/RED/BRN
DI/O #3 Z	WHT/GRN/BRN	DI/O #6 Z	WHT/GRN/BLU
FCV+	WHT/ORG/BRN	FCV COM	WHT/ORG/BLU

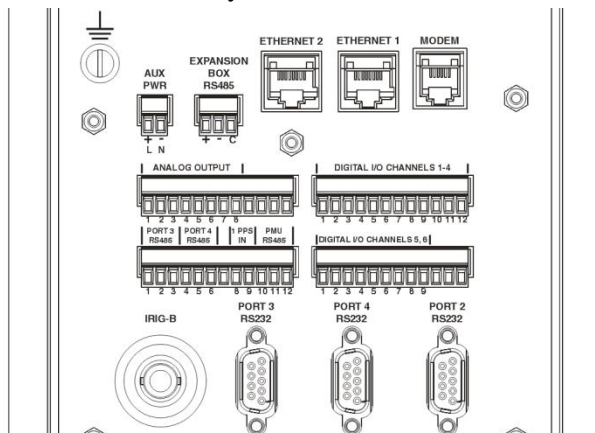


Digital I/O Connections - Switchboard

Digital I/O Channels 1–4		Digital I/O Channels 5, 6	
Signal	Terminal	Signal	Terminal
DI/O #1 Y	1	DI/O #5 Y	1
DI/O #1 K	2	DI/O #5 K	2
DI/O #1 Z	3	DI/O #5 Z	3
DI/O #2 Y	4	DI/O #6 Y	4
DI/O #2 K	5	DI/O #6 K	5
DI/O #2 Z	6	DI/O #6 Z	6
DI/O #3 Y	7	FCV +	7
DI/O #3 K	8	FCV Com	8
DI/O #3 Z	9	FCV = 24Vdc Field Contact Voltage for digital inputs (option DIOP)	
DI/O #4 Y	10		
DI/O #4 K	11		
DI/O #4 Z	12		



For Switchboard style meters, the connections are provided on rear-mounted terminal blocks.

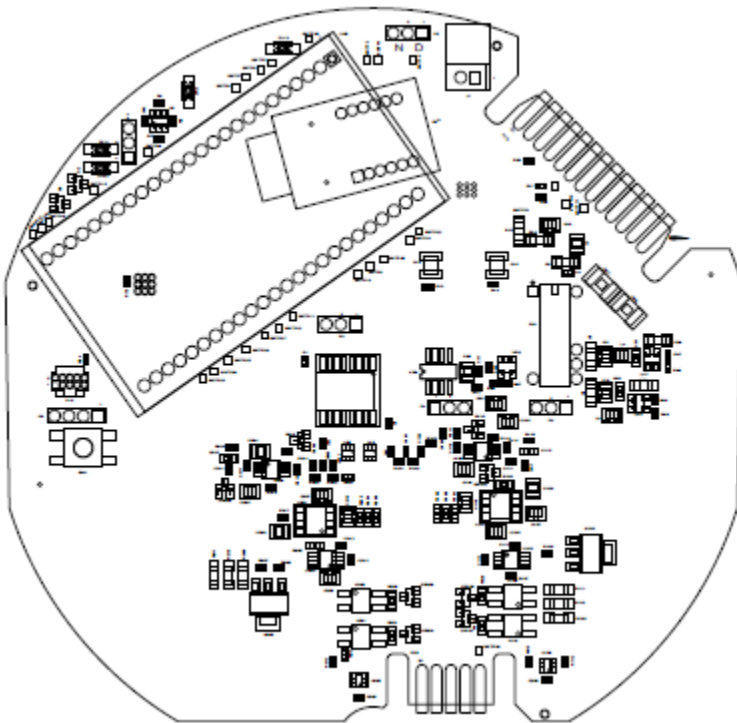


Analog Output / Internal Modem Options

The JEMStar II Meter has an option for analog outputs which can be combined with an internal modem. The option board can be equipped with any of these configurations:

- (4) 0-1mA Analog Outputs (no modem)
- (4) 4-20mA Analog Outputs (no modem)
- Analog Modem
- Analog Modem & (4) 0-1mA Analog Outputs
- Analog Modem & (4) 4-20mA Analog Outputs
- Cellular Modem
- Cellular Modem & (4) 0-1mA Analog Outputs
- Cellular Modem & (4) 4-20mA Analog Outputs

The option board can also be field installed if not ordered with the meter. (check with factory on compatibility for the cell modem option)



Analog Outputs

JEMStar II can include an optional feature that consists of four analog output channels. All channels are configured at the factory for either 0–1 mA or 4–20 mA output. Each of these channels may be configured for any instantaneous quantity. Loss Compensation can be utilized with any Analog Output that is based on Watts, VARs, VA, PF, or Q.

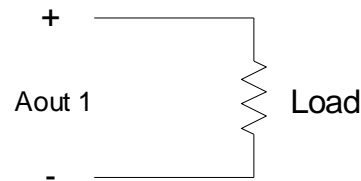
0–1 mA Outputs

A JEMStar II meter equipped with 0–1 mA analog outputs has the following characteristics:

- Each output channel will source and sink up to 2 mA.
- Each output channel will have a compliance voltage of at least 10 volts.
- Analog output accuracy is 0.15% of its full scale output, and is de-rated by an additional 75 ppm of Rated Output per degree C difference from nominal.
- The output can be configured to indicate bi-directional input quantities.

Example:

Input Range	Analog Output
- 1000 watts	-1 mA
0 watts	0 mA
+ 1000 watts	+1 mA



0 - 1 mA Output Connection

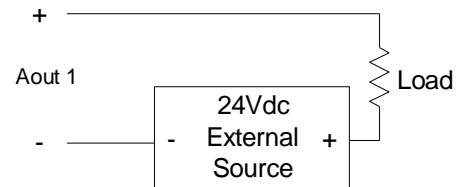
4–20 mA Outputs

A JEMStar II meter equipped with 4–20 mA analog outputs has the following characteristics:

- Each output channel requires a separate, external loop supply of up to 24 volts.
- Analog output accuracy is 0.15% of its full scale output, and is de-rated by an additional 50 ppm of span per degree C difference from nominal.
- The outputs can also be configured to indicate bi-directional input quantities.

Example of bi-directional input range:

Input Range	Analog Output
- 1000 watts	4 mA
0 watts	12 mA
+ 1000 watts	20 mA



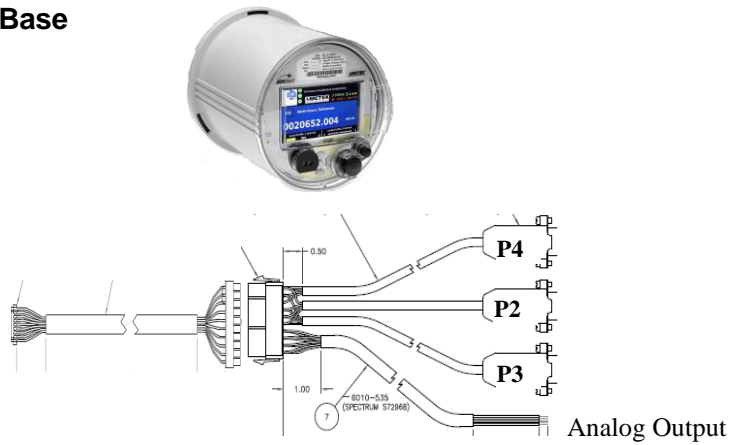
4 - 20 mA Output Connection

Analog Output Connections

For the S-Base and A-Base meter styles, JEMStar II analog output connections are provided via a 3-foot multi-conductor cable which plugs into an adaptor cable. The wire colors are as follows.

Analog Output Connections-Socket and A-Base

Signal	Color
AO #1 (-)	BLK
AO #1 (+)	WHT/VIO
AO #2 (-)	WHT/GRN/BLU
AO #2 (+)	WHT/RED/BLU
AO #3 (-)	WHT/ORG/GRN
AO #3 (+)	WHT/BRN/BLU
AO #4 (-)	WHT/ORG/BLU
AO #4 (+)	WHT/RED/ORG

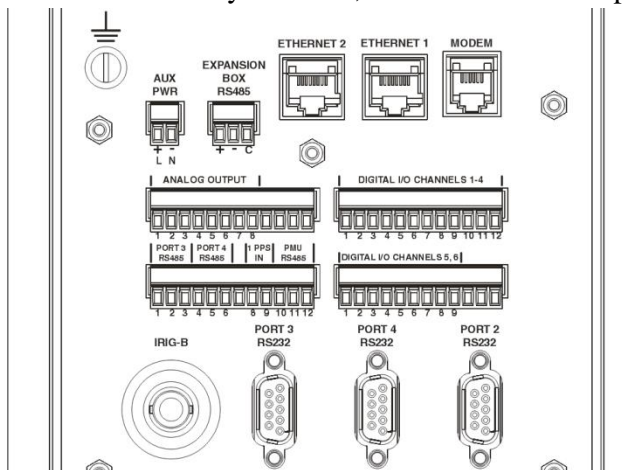


Analog Output Connections-Switchboard

Signal	Terminal
AO #1 (-)	1
AO #1 (+)	2
AO #2 (-)	3
AO #2 (+)	4
AO #3 (-)	5
AO #3 (+)	6
AO #4 (-)	7
AO #4 (+)	8



For Switchboard style meters, the connections are provided on the rear panel via terminal blocks.



COMMUNICATION PORTS

The meter has 8 communication ports available, consisting of Optical, Serial, Modem and Ethernet selections. Each port can support one or more communication protocols. All communication ports operate simultaneously and independently.

Com Port #	Port Type
1	Optical
2	RS-232
3	RS-232/485
4	RS-232/485
5	Modem (Analog or Cellular)
6	Ethernet 1
7	Ethernet 2
8	WIFI

Communication Options

The Communication ports are available in the following configurable options.

For each Port Type (Serial, Ethernet, Modem), you can select a single option. For example: Option 1A or 1B or 1C.

The Optical Port is included with every meter.

Port Type	Model Number Option	Communication Ports	Port Numbers
Serial	1A	(1) RS-232	Port 2
	1B	(2) RS-232/485	Port 3,4
	1C	(1) RS-232, (2) RS-232/485	Port 2,3,4
Ethernet	2A	(1) Ethernet	Port 6
	2B	(2) Ethernet	Port 6,7
Modem	3A	56K Analog Modem	Port 5

Communication Port Protocol Assignments

The communication ports support the following communication protocols. The quantity of simultaneous protocol sessions are shown for each port.

For Optical, Serial and Modem, only 1 protocol can be selected at a time per port. The Ethernet Port can support up to 12 simultaneous connections using the protocols shown.

Protocol	Port 1	Port 2	Port 3	Port 4	Port 5	Port 6	Port 7
	Optical	RS-232	RS-232/485	RS-232/485	Modem	Ethernet	Ethernet
JEM Binary	1	1	1	1	1	4	4
Modbus RTU		1	1	1	1		
Modbus TCP/IP						2	2
DNP		1	1	1	1	5	5
DLMS/COSEM	1	1	1	1		1	1
IEC 61850						1	1

Optical

JEMStar II uses a front panel mounted Type 2 Optical Port. A magnetic mating probe may be attached with the cover on the meter. With the cover removed, a wire retaining clip is required. The JEMStar II Optical Port incorporates JEM Binary Protocol, and may be configured for 300, 1200, 2400, 9600 or 19200 baud communications.



RS-232 and RS-232/RS-485

The JEMStar II can be optionally equipped with one, two or three serial ports. Port 2 is an RS-232 port. Ports 3 and 4 are software configurable for either RS-232 or RS-485. These ports are configurable for any valid communication address supported by the meter, and can be configured for 300, 1200, 2400, 9600, 19.2K, 38.4K or 115,200 bps communications. When configured for RS-232, the ports are operated in half-duplex mode using four signal wires: Common, Transmit Data (TX), Receive Data (RX), and Request To Send (RTS). For ports 3 and 4, the RS-232 option is mutually exclusive with the RS-485 option; that is, only one *or* the other can be configured.

When configured for RS-485, the port operates in half-duplex mode (e.g.: the Transmit and Receive signals share the same wires). It is configurable for any valid communication address supported by the meter, and can be configured for 300, 1200, 2400, 9600, 19.2K, 38.4K or 115,200 bps communications. The maximum reliable distance for RS-485 communications is approximately 4000 feet, however this length can vary depending on the type of cable used, external electrical interference, etc. The RS-485 option is mutually exclusive with the RS-232 option; that is, only one *or* the other can be configured.

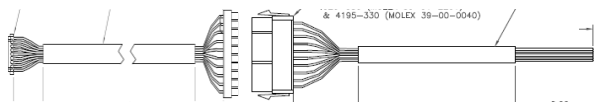
Any RS-485 network requires 120 Ω terminating resistors at each end to operate properly. The JEMStar II RS-485 communication option has a built in terminating resistor that may be enabled using the JEMWare II software. See the section "Communication Repeater," later in this manual, for details on when and how to enable the terminating resistor.

RS-232 Communications

For the S-Base and A-Base meter styles, JEMStar II serial output connections are provided via cables with pigtail wiring. There is an option to supply cables with DB-9 connectors. The connections are as follows.

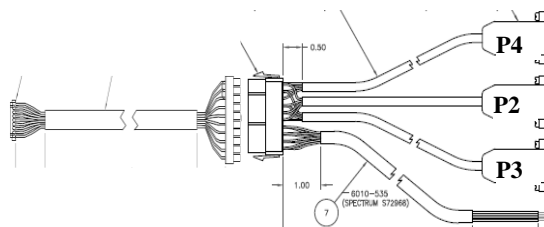
S-Base and A-Base RS-232 Connections (RS-232 Ports 2, 3 & 4) Pigtail Wiring

Signal	Port 2	Port 3	Port 4
RS-232 RX	Wht/Red/Blu	Wht/Red	Wht/Grn
RS-232 TX	Wht/Blu	Wht/Blk/Blu	Wht/Red/Grn
RS-232 RTS	Wht/Org	Wht/Blk/Brn	Wht/Red/Org
Serial Com	Wht/Org/Brn	Wht/Blk	Wht/Org/Blu



S-Base and A-Base RS-232 Connections (RS-232 Ports 2, 3 & 4) DB-9 Female Connector

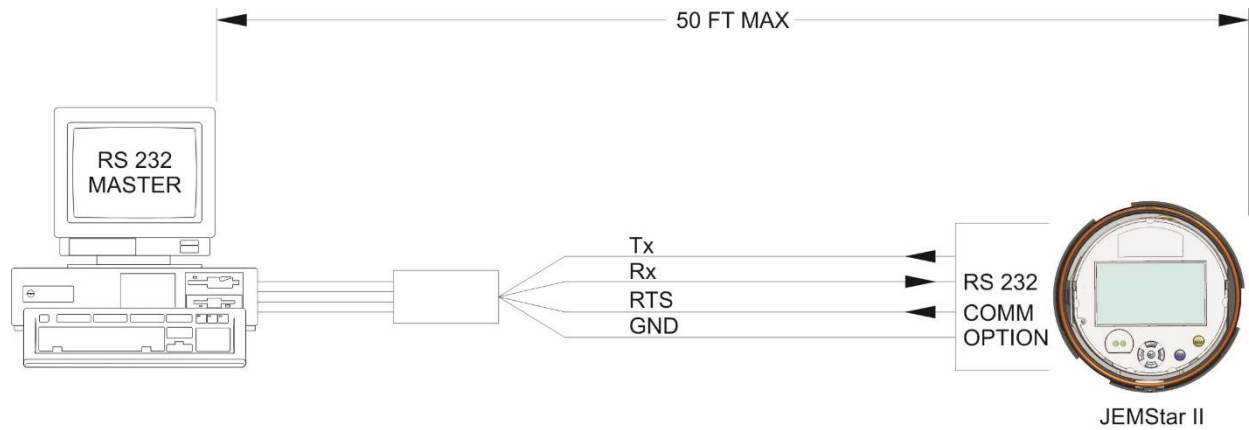
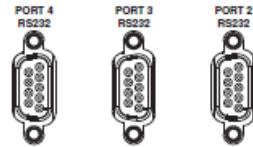
Signal	Port 2	Port 3	Port 4
RS-232 RX	P4-3	P2-3	P3-3
RS-232 TX	P4-2	P2-2	P3-2
RS-232 RTS	P4-7	P2-7	P3-7
Serial Com	P4-5	P2-5	P3-5



For Switchboard style meters, the connections are provided on the rear panel via 9-pin DB9 connectors.

Switchboard RS-232 Connections (RS-232 Ports 2, 3 & 4) DB-9 Female

Signal	Port 2, 3, 4
RS-232 RX	Pin 3
RS-232 TX	Pin 2
RS-232 RTS	Pin 7
Serial Com	Pin 5
Connections are the same for each DB-9 Connector	



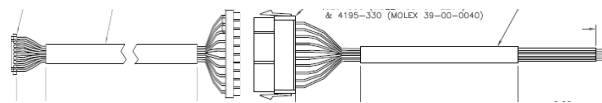
RS-232 CONNECTION DIAGRAM

RS-485 Communications

For the S-Base and A-Base meter styles, JEMStar II serial output connections are provided via cables with Pigtail Wiring. There is an option to supply cables with DB-9 connectors. The connections are as follows.

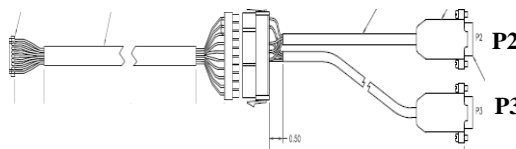
S-Base and A-Base RS-485 Connections (RS-485 Ports 3 & 4) Pigtail Wiring

Signal	Port 3	Port 4
RS-485 TX RX +	Wht/Blk/Blu	Wht/Red/Grn
RS-485 TX RX -	Wht/Blk/Brn	Wht/Red/Org
Serial Com	Wht/Blk	Wht/Org/Blu



S-Base and A-Base RS-485 Connections (RS-485 Ports 3 & 4) DB-9 Female

Signal	Port 3	Port 4
RS-485 TX RX +	P2-2	P3-2
RS-485 TX RX -	P2-7	P3-7
Serial Com	P2-5	P3-5

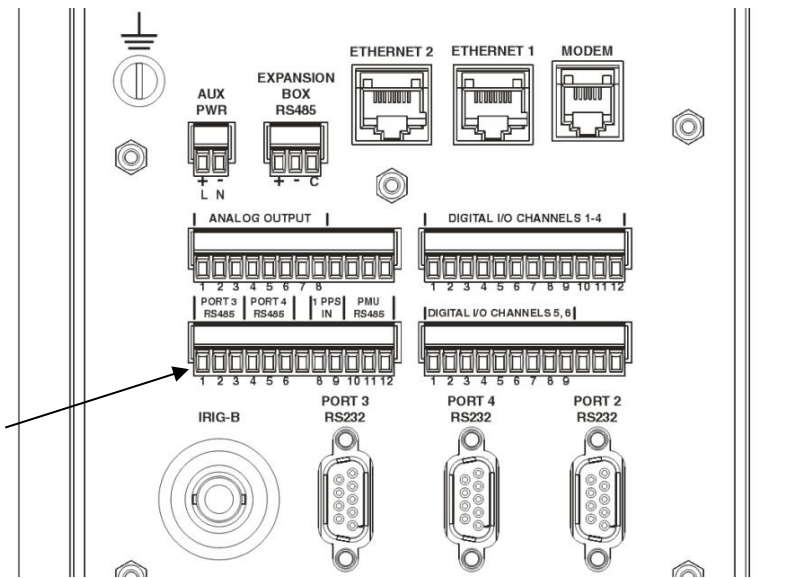


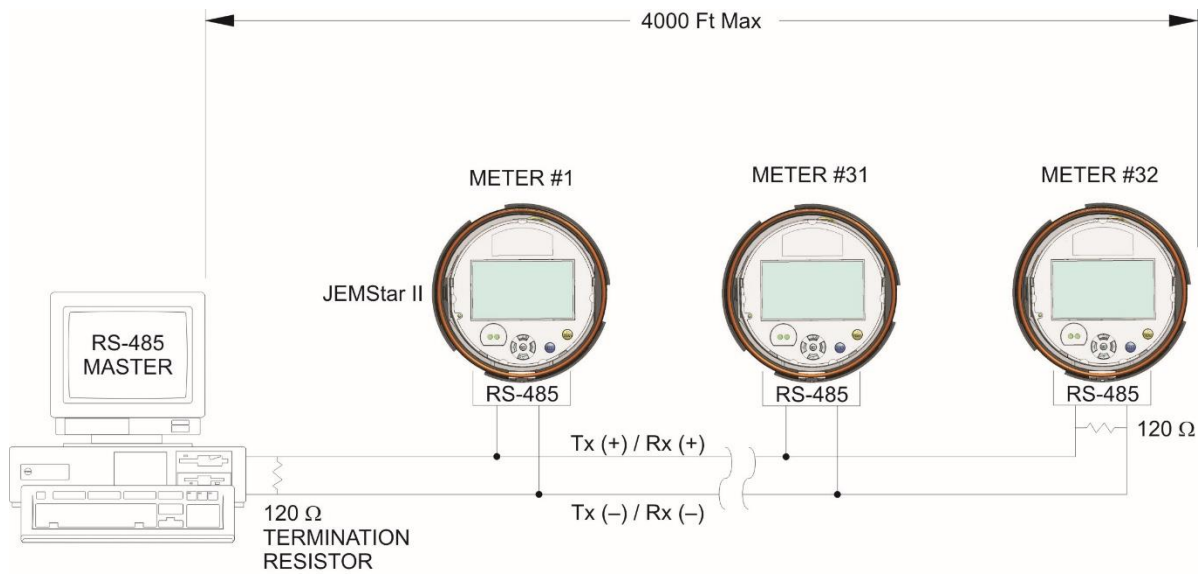
Switchboard RS-485 Communications Connections

RS-485 Serial Port		
Port #	Signal	Terminal
3	Serial Com	1
	RS-485 TX RX +	2
	RS-485 TX RX -	3
4	Serial Com	4
	RS-485 TX RX +	5
	RS-485 TX RX -	6



For Switchboard style meters, the connections are provided on the rear panel via terminal blocks.





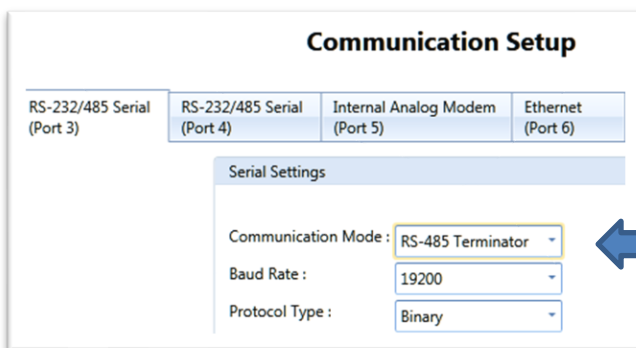
RS-485 CONNECTION DIAGRAM

The RS-485 protocol permits up to 32 transceiver pairs to share a party line. Because RS-485 communications are differential, much longer cable lengths are possible than RS-232C. The total length of the network wiring must not exceed 4000 feet. A single twisted-pair of wires can connect up to 32 drivers and receivers for half-duplex communications.

The signals labeled “TX(+)/RX(+)” and “TX(-)/RX(-)” are a half-duplex pair that carry Received Data to the meter and Transmitted Data to the master.

There are no restrictions on where the meters are connected to the wires, and it is not necessary to have the meters connected at the ends (you may have other devices connected in the same string). However, *the wire pair must be terminated at each end with a 120 Ω resistor*. If the JEMStar II meters are the end devices, this is accomplished via the JEMWare II software or meter front panel. If you have another type of device located at the end, refer to the instruction manual for that device; you may need to install the resistor externally. JEMStar II meters that are not at the ends of the RS-485 wiring should have their terminating resistors disabled via JEMWare II software or meter front panel.

The following shows how to enable the 120 Ω terminating resistor:



Termination in the JEMWare II software:

Using the drop-down menu select RS-485 Terminator for the end meter.

Analog Modem

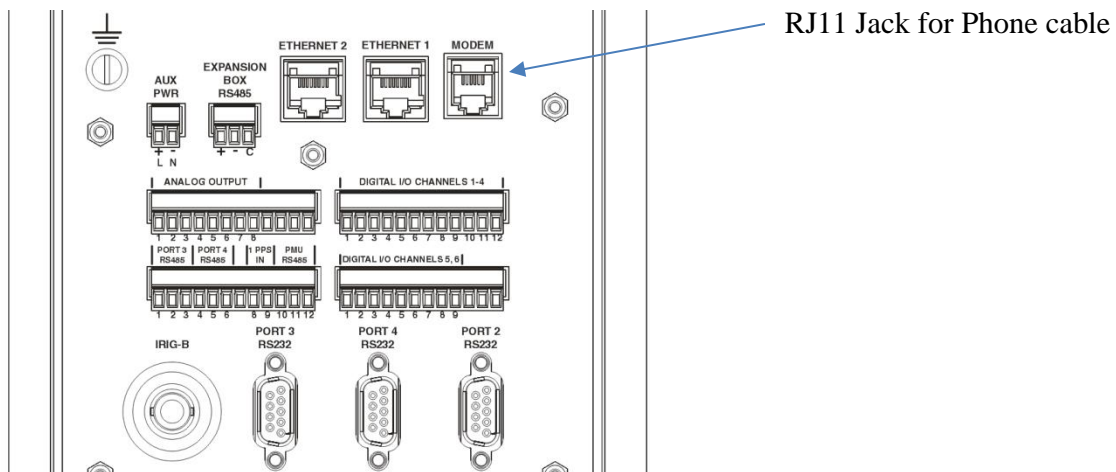
JEMStar II can be optionally equipped with an internal modem. The port is configurable via JEMWare II for any communication address supported by the meter and can be set for 300 – 56K bits per second. A custom initialization string can also be configured to adapt the modem to specific conditions (see Appendix A for the default AT command codes).

Modem tip and ring connections are made using a standard four-wire RJ-11 phone jack.

Socket Meter (RJ11 Cable provided)



Switchboard Meter (RJ11 Jack provided)



Rear View shown

Cellular Modem

JEMStar II can be optionally equipped with an internal cell modem using 4G LTE Cat 1 technology. The cell modems can support Verizon, Sprint and several GSM based carriers. The cell modem can be supplied with an internal antenna or external antenna.

Cell Modem and Antenna Options:

There are several options available for cell modems and antennas to satisfy a number of application needs. The cell modem and antenna options can be ordered in the model number of the meter. The options are shown below:

Option Code	Modem Options
3A	Internal Analog Modem
3B	Internal Cell Modem (GSM)
3C	Internal Cell Modem (Sprint)
3D	Internal Cell Modem (Verizon)
4A	Internal Antenna for Cell Modem
4B	External Antenna - Screw Mount
4C	External Antenna - Surface Mount
4D	Customer Supplied Antenna



For cell modems, you have a choice of option 3B, 3C or 3D. For antennas, you can select from a choice of option 4A, 4B, 4C or 4D.

For external antennas, we will supply an antenna cable from the meter with a standard SMA Female (RP) connector.



Cell Carrier Support:

There are three variations available to support Verizon, GSM (AT&T, T-Mobile, Rogers, Bell, Telus) and Sprint. The specific bands supported for these carriers is listed below:

- Verizon LTE Bands: B2(1900), B4(AWS 1700), B13(700)
- GSM LTE Bands: B2(1900), B4(AWS 1700), B5(850), B12/B13(700)
3G Bands: B2(1900), B5(850)
- Sprint LTE Bands B4(AWS 1700), B5(850), B12(700), B25(700), B26(850+)

The cell modems are IP Addressable and can support up to 8 simultaneous connections using the JEM Binary and DNP protocols. In addition, the cell modem can support the Alarm Notification messages using the JSON WEB message format.

The cell modems can be configured for up to 6 whitelisted IP addresses to prevent unauthorized access to the meter. Refer to the JEMWARE software manual for more details.

Support for APN's (Access Point Names) is provided and firmware updates are available over the air (FOTA).

Antennas

Several options are available for connecting both internal (under the glass) and external antennas to the internal Cell Modem. The selection and location of the antenna (internal vs external) is based on the signal strength at the meter location.

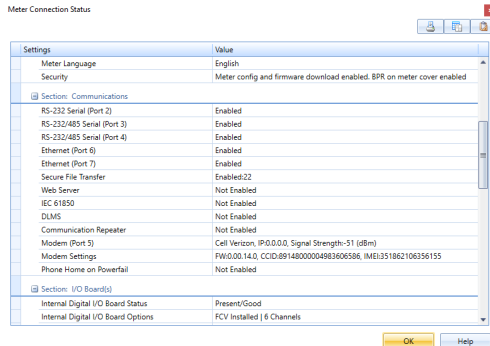
The Cell Modem supports the use of MIMO (Multiple In Multiple Out) diversity antennas which uses a dual antenna system to improve the quality and reliability of the wireless link. As such, two separate antenna cables are provided. The antennas we provide for options 4A, 4B and 4C have both antennas integrated into a single unit making it easier to install.

Signal Strength

It is recommended to have at least 3 bars of signal strength which is approximately -100dB or better. The JEMStar II Meter display will show the number of bars for signal strength and there is a User Menu display that shows the connection details and signal strength. There are other commercially available devices and applications that can provide your signal strength.



When connecting to the meter with the JEMWARE Software using any available communication option; the Meter Connection Status screen will also show the cell modem details and signal strength.



Internal Antenna (Option 4A)

Internal antennas work best when meters are installed outdoors or have enough signal strength indoors. If ordered with an internal antenna, it will come attached to the inside of the meter.



MIMO Dual Antenna style (Multiple In Multiple out)

Frequency: 698Mhz to 3Ghz

Gain: 2.9dBi @ 703 to 803Mhz

Efficiency: 50.48% @ 703 to 803MHz

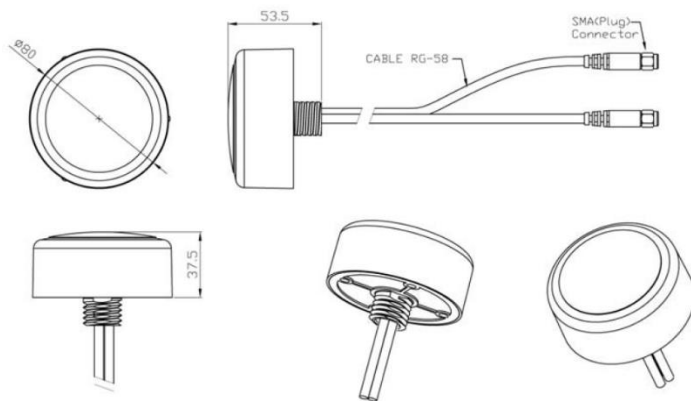
External Antennas

There are two external antenna options available (screw mount and surface mount).

Screw Mount (Option 4B)



MIMO Dual Antenna style (Multiple In Multiple out)
 Frequency: 704 to 960Mhz ; 1710 to 2,690Mhz (LTE)
 Gain: 6.1dBi @ 704 to 960Mhz
 5.47dBi @ 1710 to 2,690Mhz
 Bandwidth: 256MHz for 704MHZ~960MHz
 980MHz for 1710MHz~2690MHz
 Cable: 3 meter cable with SMA Connectors

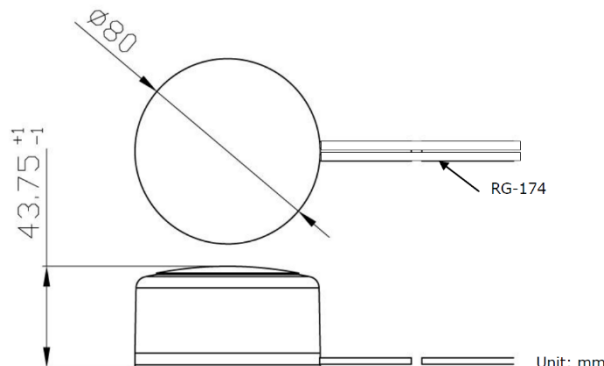


Unit: mm

Surface Mount (Option 4C)



MIMO Dual Antenna style (Multiple In Multiple out)
 Frequency: 704 to 960Mhz ; 1710 to 2,690Mhz (LTE)
 Gain: 2.79dBi @ 704 to 960Mhz
 3.22dBi @ 1710 to 2,690Mhz
 Bandwidth: 256MHz for 704MHZ~960MHz
 980MHz for 1710MHz~2690MHz
 Cable: 3 meter cable with SMA Connectors



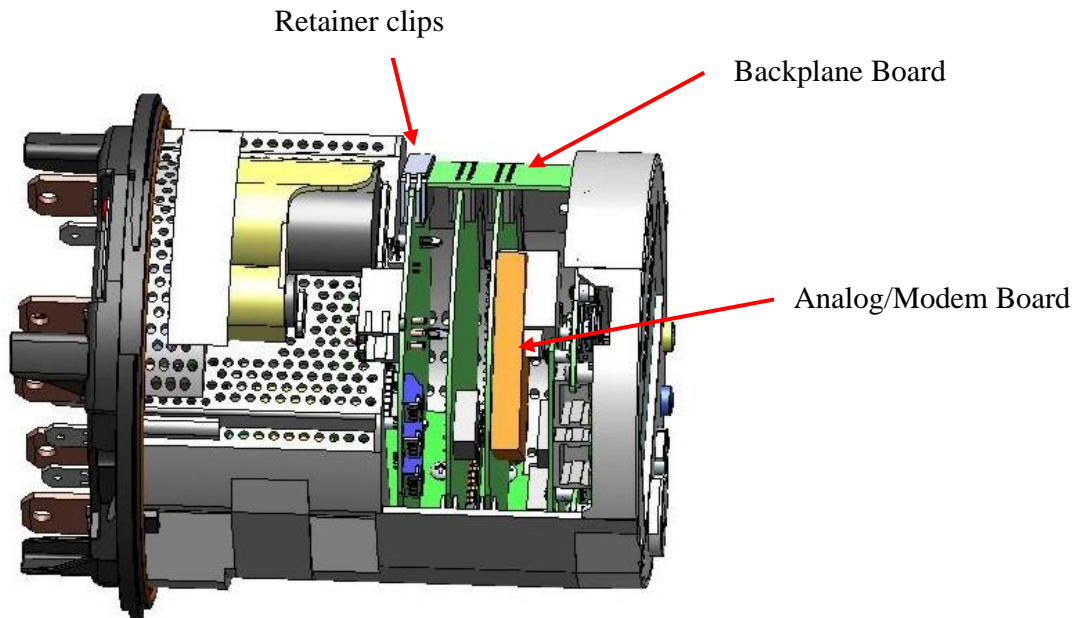
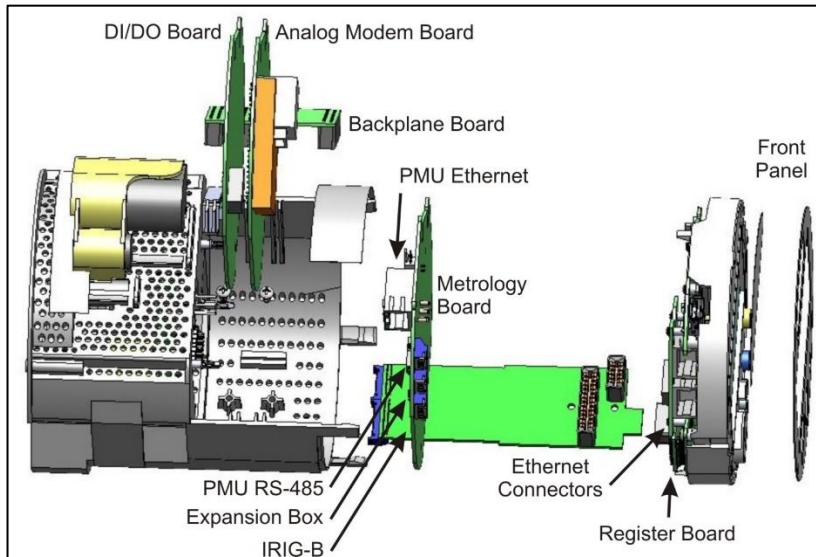
Unit: mm

SIM Cards

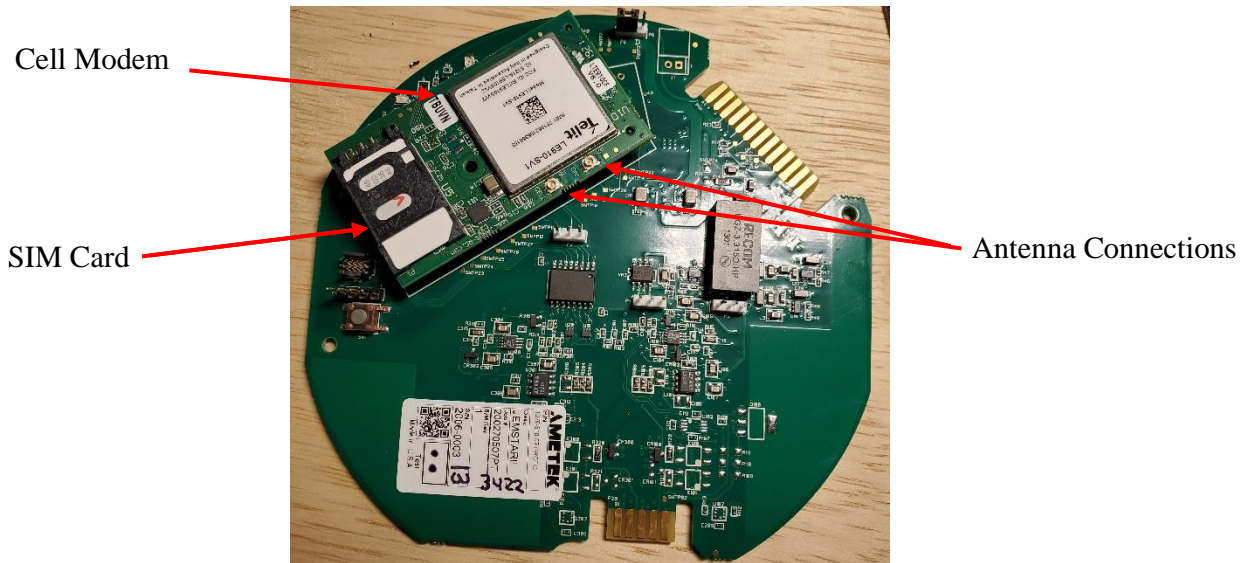
Customer supplied SIM Cards can be provided using the mini 2FF standard format. SIM cards can be activated according to normal practices.

The procedure for installing or replacing a SIM Card is shown below:

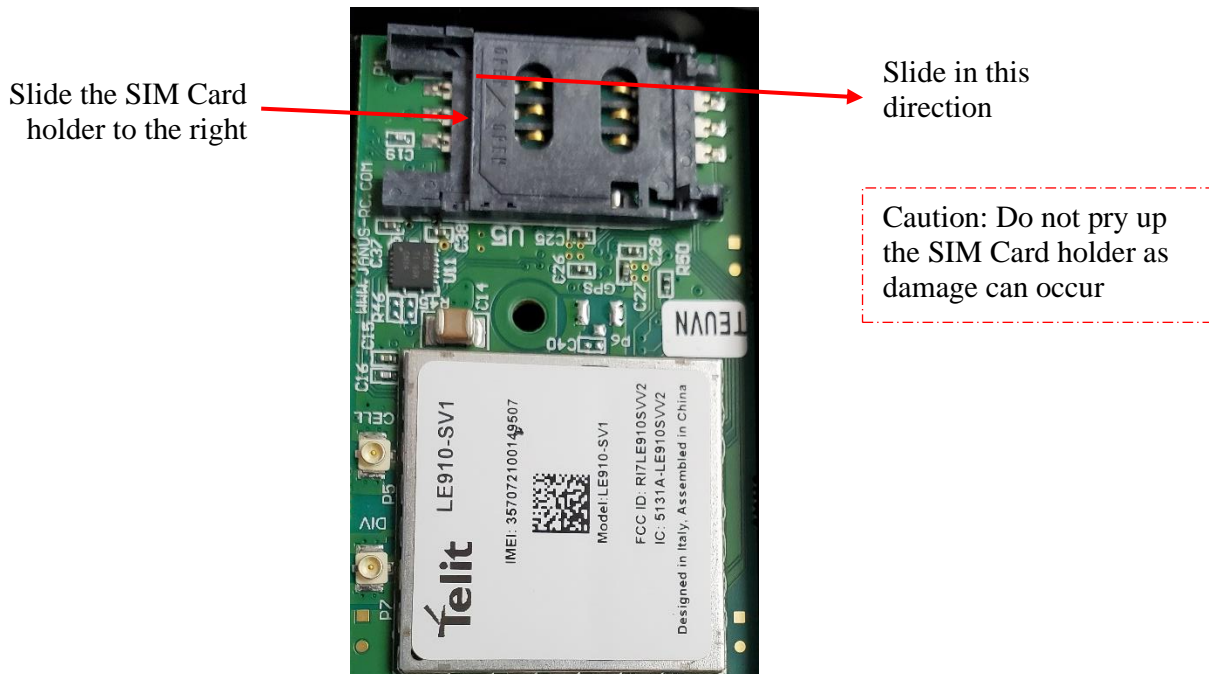
1. Remove power from the meter.
2. Remove the meter globe (or switchboard meter from the enclosure)
3. Remove the backplane board by removing any retaining clips first.



- Remove the Analog/Modem Board. Use caution for the antenna cables connected to the board.



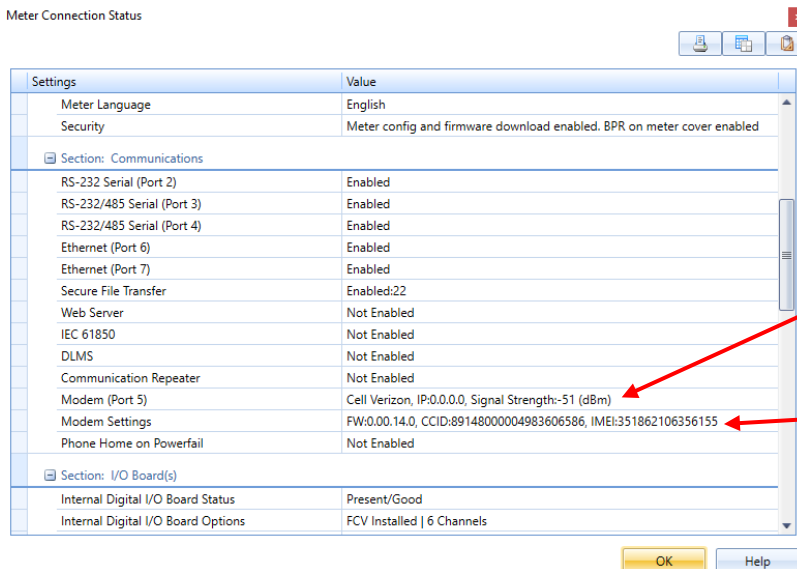
- The SIM Card holder can be opened for installation of the SIM Card. Slide the holder forward (do not pry up as damage will occur). You will feel it click into the unlatched position.



Once unlatched, you can open up the SIM card holder, install the SIM Card and then close it. (slide it back to latch)



6. Reinsert the Analog/Modem Board in the meter followed by the Backplane Board. (reconnect any antenna cables if removed)
7. Apply Power to the meter. To activate your SIM Card, you will need the IMEI and CCID numbers which are shown on the Meter User Menu Display or in the JEMWARE Software on the 'Connection Status Screen' shown below.
8. Connect to the meter using the JEMWARE Software on any communication port. The Meter Connection Status Screen will indicate that the modem is installed. It will not show an IP Address until the SIM is activated and the cell modem is configured in JEMWARE first.



Cell Modem installed in meter

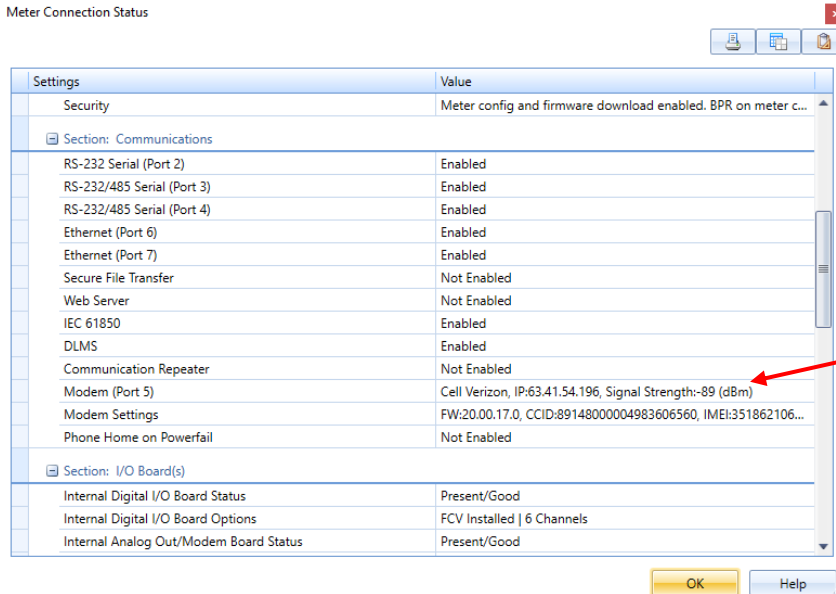
IMEI and CCID numbers

9. Configure the modem using the JEMWARE Software. Items to configure include:
 - a. Inactivity Timeout
 - b. APN (Access Point Name) provided by your cell phone carrier
 - c. List of whitelisted IP addresses

- d. List of protocols and connections (max 4 JEM Binary and 4 DNP)

10. After configuring the meter, wait about 5 minutes for the cell carrier to recognize the modem and then perform a Status Query in the JEMWARE Software.

The Meter Connection Status Screen will indicate that the modem is installed and it has an IP Address as assigned by your Carriers APN.

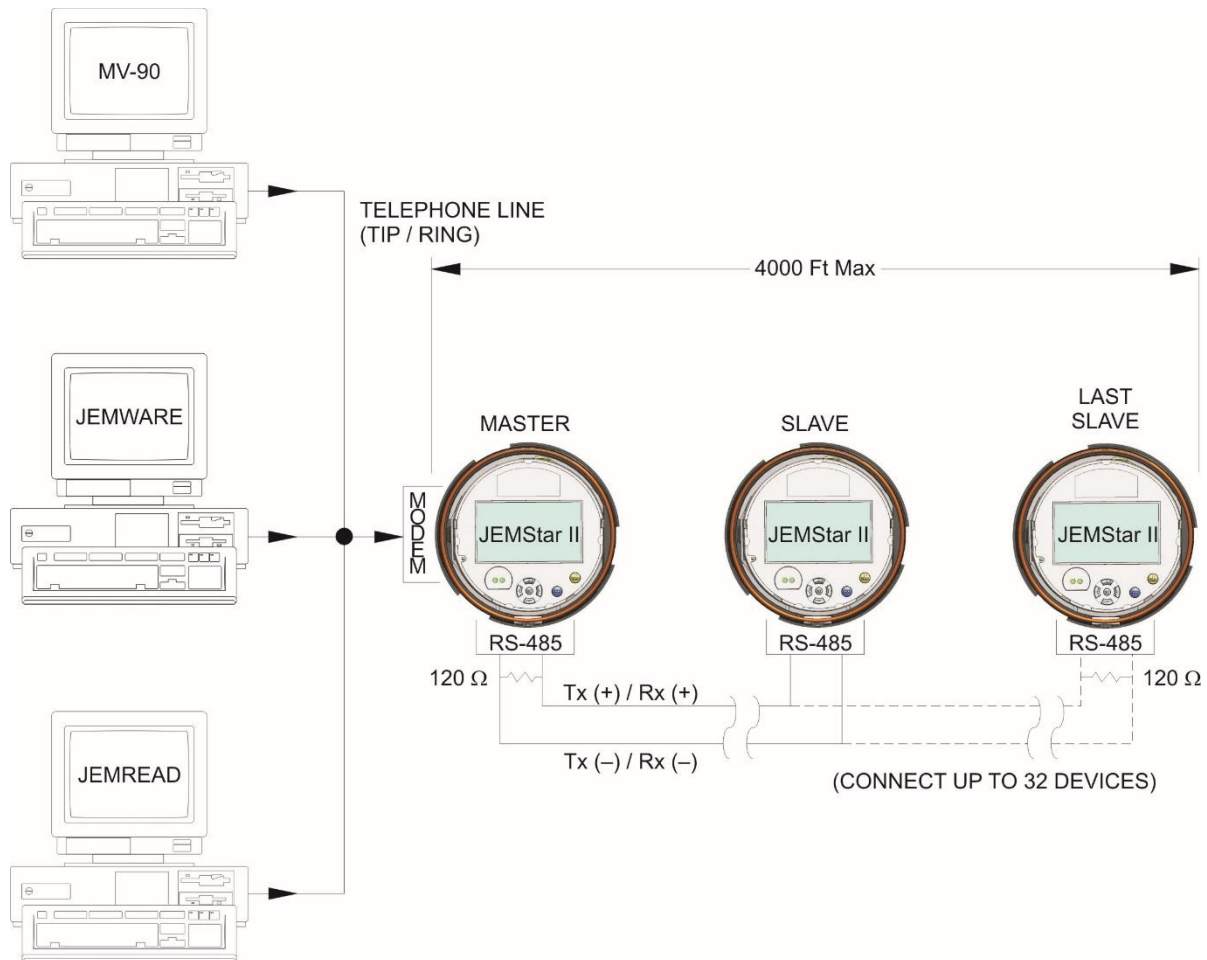


Cell Modem ready for use. IP Address shown

Communication Repeater (future)

JEMStar II can be optionally equipped with a Communication Repeater option that allows a network of meters to share a single internal modem. This feature requires the RS-485 option to be installed on all meters connected in the network. The JEMStar II CommRepeater operates as a master to slave configuration.

Each meter in the network must be assigned a unique communication address via JEMWare II configuration software. Multiple meter connectivity is obtained through one CommRepeater master meter and subsequent slave meters as shown in the diagram below.



TYPICAL COMMREPEATER DIAGRAM

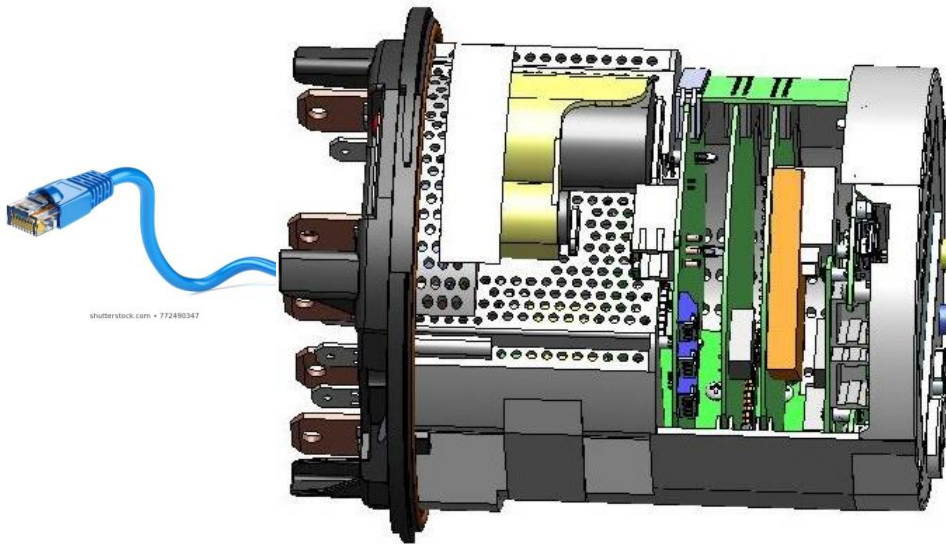
The interface to the master meter must be through a phone line that is connected to the internal JEMStar II modem. Note that the slave meters (those without an internal modem) in the network cannot cause the modem to originate a call. The daisy-chained slaves are connected in a standard RS-485 configuration. These signals are connected via the I/O cable (S and A-base), or rear-mounted terminal blocks (switchboard case). See the previous section titled “RS-485 Connections” for wiring details. The JEMStar II CommRepeater utilizes a half-duplex communications link.

Ethernet Port

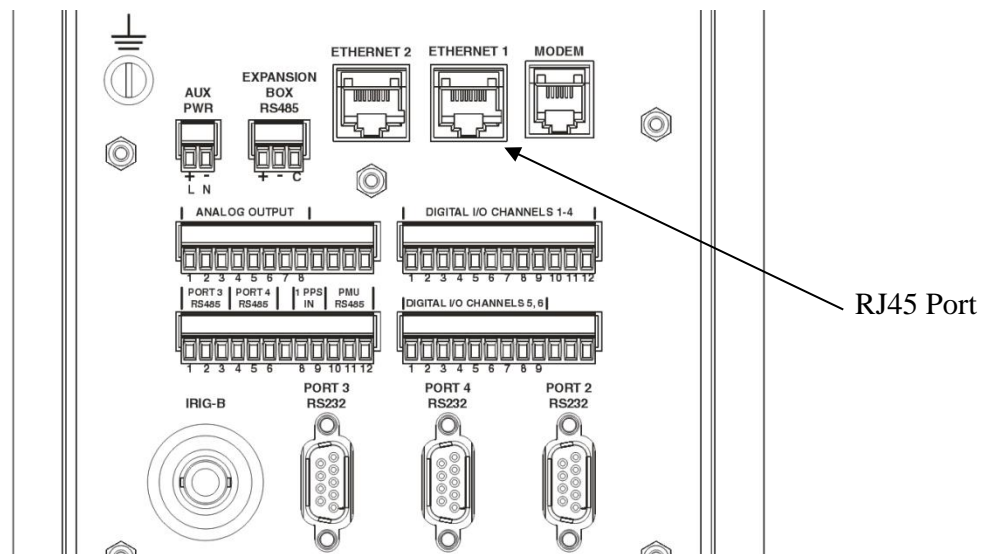
JEMStar II can be optionally equipped with a single or dual Ethernet port. The Ethernet port is configurable via JEMWare II for any IP address or it can obtain an IP address automatically using DHCP. The Ethernet port supports all JEMStar II protocols. (Modbus, DNP, ANSI Tables, Binary) Up to twelve simultaneous connections are possible, permitting each user to access whatever metering information is necessary. Up to ten passwords can be configured in the meter to restrict or allow certain functions per user. For example, one user can be granted access to display registers while a second user has access to load profile data and a third simultaneous user has access to all data and configuration settings.

Ethernet connections are provided through a standard RJ-45 jack.

S-base and A-base meters are supplied with a network cable and RJ45 (male) connector on the rear of the meter. Switchboard meters have a RJ45 jack on the rear.



JEMStar II Socket & A-Base Ethernet Cable (RJ-45)



JEMStar II Switchboard Ethernet Connectors (RJ-45)

EXTERNAL TIME SYNCHRONIZATION

External Time Synchronization options include IRIG-B, and NTP. NTP is connected to the meter via the Ethernet Port. IRIG-B is connected to the meter via a serial time cable.

S-Base and A-base models

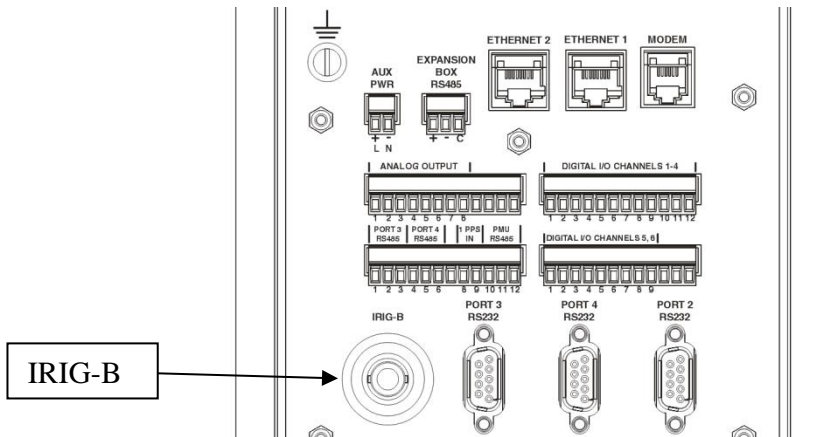
The IRIG-B and PPS will be provided via a cable from the bottom of the meter base. The connections for this are shown below:

Wire Color	Signal
Wht	IRIG-B (+)
Black	IRIG-B (-)
Red	PPS (+)
Green	PPS (-)



Switchboard Models

The IRIG-B will be available from a BNC connector on the rear of the unit. The connections for this are shown below:

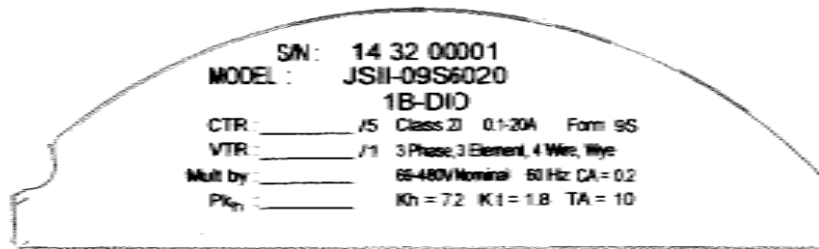


IRIG-B Time sync input (modulated or de-modulated - auto sensing) is accurate to +/- 1 ms UTC Time.
9.3K ohm input impedance

OPERATION

METER NAMEPLATE

The meter's nameplate provides general information about the meter including the Serial Number, model number, form, class, voltage, frequency, wiring configuration (3-Wire or 4-Wire), test amps, and the K_t (test pulse constant in WH/count). There is also an area for the user to write in the CTR (current transformer ratio), VTR (voltage transformer ratio), and a multiply-by field.



The Meter Serial Number format is: YY WW XXXXX

YY = Year

WW = Week of year

XXXXX = Unique number of production

In the Serial Tag above, the meter was produced the 32nd week of 2014.

The Model Number indicates all of the options as described in the General Information section of this manual.

METER POWER UP

When power is applied to the meter, it goes through a start up process that lasts about 4 ½ minutes. The display will come up immediately with a graphic image followed by a Display Register Screen. The values shown in the Display Register will either display the last value recorded by the meter or will display NOT SET, to indicate that the display has not completed the start up process. During this time, it is advisable to not use the display buttons (arrow buttons, Read, Reset, etc) as the meter hasn't fully started up.

Internally, the meter starts to register power within several seconds of power up and we start sending out test pulses from the Optical Port within 10 seconds. Once the display values change from NOT SET to actual values, this is an indication that the meter has completed the start-up process.

METER CONFIGURATION

All of the parameters that determine the meter's operation can be set by using the JEMWare II configuration software. JEMWare II includes a file-management system for storing configurations, configuration-editing screens for setting the various parameters, and communication channel setups to program the meter. JEMWare II provides the ability to read the existing configuration from the meter and to read the time on the meter through serial communications. The JEMWare II Instruction Manual 1079-699 describes each parameter that can be programmed.

NOTE: You may use the latest version of JEMWare II to open a configuration file saved with a prior version, or to read the configuration from a JEMStar II meter that was programmed with a prior version. If you do this, however, you must verify all settings in the configuration before saving it or programming it into a meter. Verify the settings by opening each item in the Meter Settings menu and reviewing the settings. This ensures confidence that the correct settings are in place and also allows JEMWare II to insert appropriate default settings for features that may not have been present in the older version of JEMWare II.

Changing Meter Configurations

Certain features of the JEMStar II meter are forced to be re-initialized when portions of the meter's configuration are changed. This section summarizes the changes that will force a re-initialization. Note that when a new configuration is loaded into a meter, the meter determines individually if each section has changed from the currently stored configuration. These features are re-initialized ONLY if the particular configuration sections are different. Re-initialization means that the data in that particular register is set to zero.

Display Registers

The Display Registers feature includes the following parts of the JEMStar II:

- Registers in the Normal display list
- Registers in the Alternate display list
- Registers in the Test display list
- Self Read registers
- Register Thresholds
- Site Monitor alarms
- Totalization registers

The following configuration sections, if modified, will cause the Display Registers feature to be re-initialized, erasing all previous data:

- Normal display list
- Alternate display list
- Test display list
- Demand settings
- Self Read settings
- Primary Scaling settings (including changing VT Ratio or CT Ratio from the meter front panel.)
- Register Threshold settings
- Demand, Load Profile Interval Timing settings
- Totalization channel setup

Load Profile

The Load Profile features (which does not include individual Event Logs) will be erased and re-initialized if these configuration sections are modified:

- Demand, Load Profile Interval Timing settings
- Load Profile channel assignments
- Primary Scaling settings (including changing VT Ratio or CT Ratio from the meter front panel)
- Totalization channels

Energy Pulses

The Energy Pulse feature will be re-initialized if these configuration sections are changed:

- Energy pulse channel assignments

DISPLAY FACEPLATE



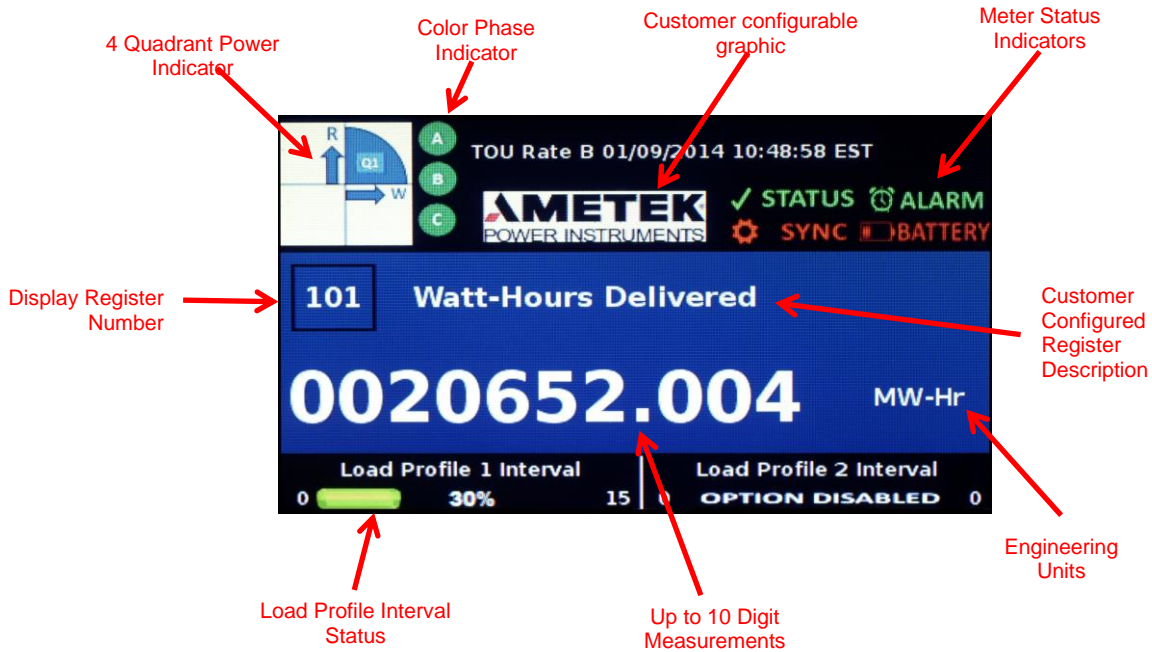
JEMStar II Front View; Globe Removed

Optical Port
 Navigation Keys
 Read Key
 Reset Key

Used for connecting an Optical Probe to read/write to the meter
 Up/Down/Left/Right/Set keys used to navigate the user menu
 Used to scroll through the register displays
 Used to perform a billing reset, peak demand reset and min/max reset. This button can be sealed from the outside cover to prevent unauthorized access. In addition, you can prevent access through the Security Key on the Register board. Refer to the Maintenance section for further information.

METER DISPLAY

The JEMStar II Meter includes a color graphic display. The display is used to scroll the meter measurements (Display Registers), special displays (Phasor Display) and a user menu system that will show various meter configuration settings. The different display screens will automatically scroll from one meter display to another. The scroll rate and display screen contents are configurable in the JEMWARE Software. The main register display functions are shown below.



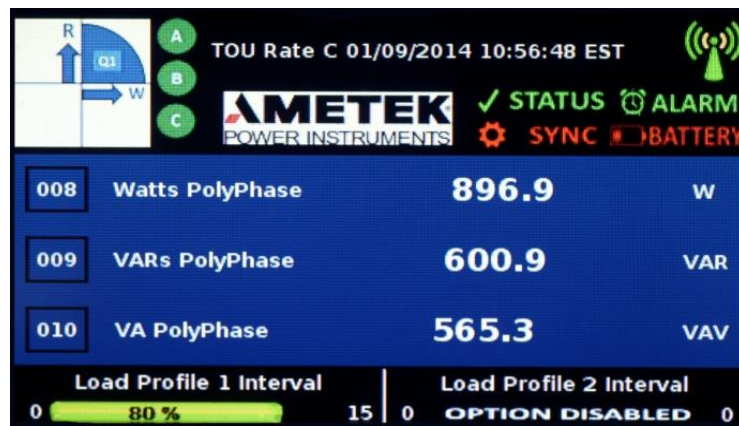
Single Register Display shown

Register Display Modes

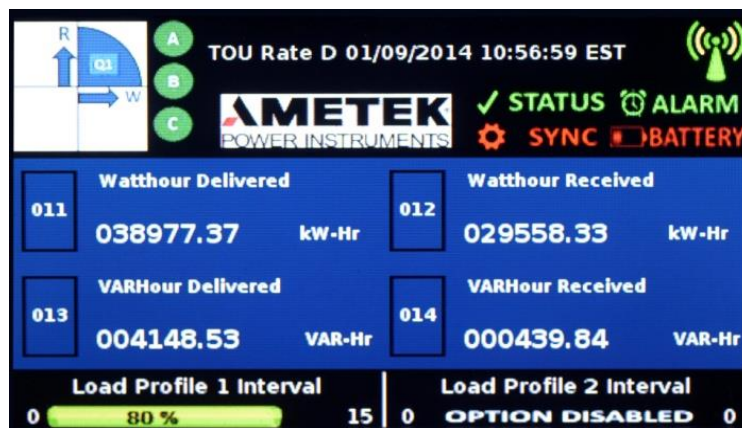
The meter can be configured to display a single register per screen or up to 4 registers per screen.



Dual Register Display



Triple Register Display



Quad Register Display

Navigating the Register Display

The meter registers can be grouped in three different display modes: Normal, Alternate, and Test. JEMStar II can display up to 50 Normal, 50 Alternate and 50 Test registers. Normal Registers are numbered 0-49, Alternate registers are numbered 100-149 and Test Registers are numbered 200-249. If display Scrolling is enabled (via JEMWare II), the display registers are sequentially displayed at a user-configurable rate. You can manually scroll through the registers by momentarily pressing the read button. If the meter cover is removed, you can press the Set Button to stop the meter display from scrolling.

Alternate Mode registers are a second group of registers that could be used as a convenient method to group Billing Period quantities, site monitor displays, or any other user purpose. They are accessible to the meter reader by pressing and holding the READ button for at least five seconds. To return to Normal registers, press and hold the READ button again for five seconds.

Test Mode is used for testing the accuracy of the meter. Refer to the Test & Calibration section for a complete explanation of Test Mode.

Note: When in Test Mode, only the Test Mode registers update. The standard metering registers and load-profile data do not accumulate. The normal metering functions are suspended until Test Mode is exited.

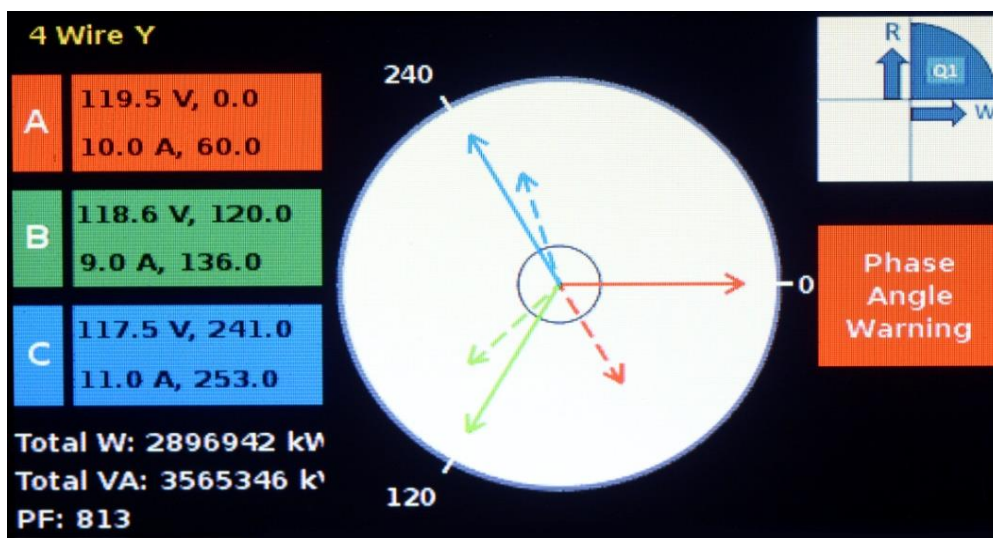
Special Displays

There are several custom displays that can be intermixed with the register displays including:

- Phasor Display
- Communication Status
- Alarm Display
- Graphical User Menu

Phasor Display

This display shows the current and voltage phase vectors graphically in real time. The display also shows the individual current and voltage magnitudes and phase angles. The solid line is for Voltage and the dashed line is for current.



Communication Status Display

The communication status display will provide the status of all communication ports and the protocols that are used with them. Any communication port not installed in the meter will be 'greyed' out. In the screenshot below, Serial 3, Ethernet 2 and WIFI are not installed. A matrix is provided to show the status of each installed port along with the protocol each port is configured for. The colors are described below:

- Light Blue** Indicates that the port and protocol have been configured and are ready for operation
- Green** Indicates that the port is currently being used (may be flashing)
- Yellow** Indicates that there may be a potential problem. For example, if the communication port is waiting for a poll from a master device, or the meter is waiting for a response from a device or receives an unrecognized response..
- Red** Indicates that the meter has detected a communication problem. For example; an Ethernet cable is unplugged, a port has timed out waiting for a response, no dial tone, etc

Communication Status		01/09/2014 10:52:59 EST							
Protocols	Optical	Serial1	Serial2	Serial3	Modem	Ethernet1	Ethernet2	WiFi	
JEM Binary	Green	Light Blue	Light Blue	Greyed	Yellow	Light Blue	Greyed	Greyed	
Modbus	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Green	Light Blue	Light Blue	
DNP	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Green	Light Blue	Light Blue	
DLMS	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	
ANSI	Light Blue	Red	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	
IEC 61850	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	
IEC 870-5-102	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	
PMU	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	
WEB	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	Light Blue	

Legend: Light Blue Ready, Green Active, Yellow Alert, Red Fault

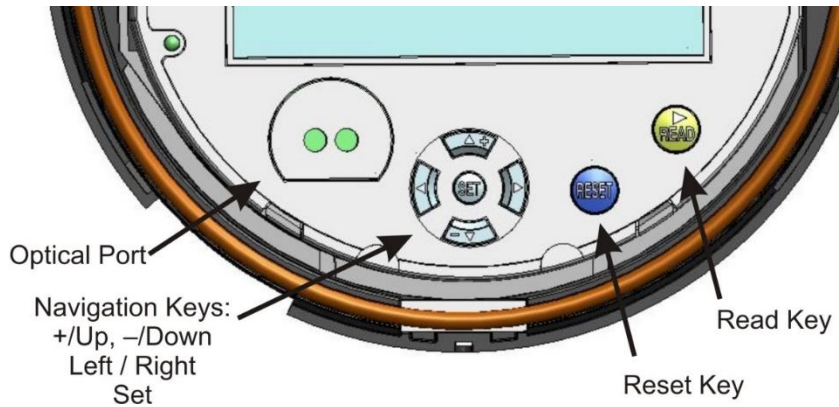
Alarm Display

The Alarm Display will show the status of all alarms as configured in the JEMWARE Software. The Alarm Display will show the alarm trigger and time and date when it went into alarm.

Site Alarm Display		08/11/2014 10:56:56 EST		1 of 1	
Trigger	Trigger Description	Value	Date/Time		
4	4,Inst,VLN:A,>,120,0,119	120.573	10:36:28	11-Aug-2014	
5	5,Inst,VLN:B,>,120,0,119	120.572	10:36:28	11-Aug-2014	
6	6,Inst,VLN:C,>,120,0,119	120.574	10:36:28	11-Aug-2014	

Graphical User Menu

JEMStar II includes a graphical user menu to show the meter status, configuration details and perform functions such as configuring select items, putting the meter in Test Mode and presetting display registers. With the meter cover (or globe) removed, all configuration buttons are accessible to the user.



Note: The hardware Security Key in the Register board can be set up to disable access the user interface of the meter. Refer to the Maintenance section for a complete description of the Security Key features.

Activating the User Menu

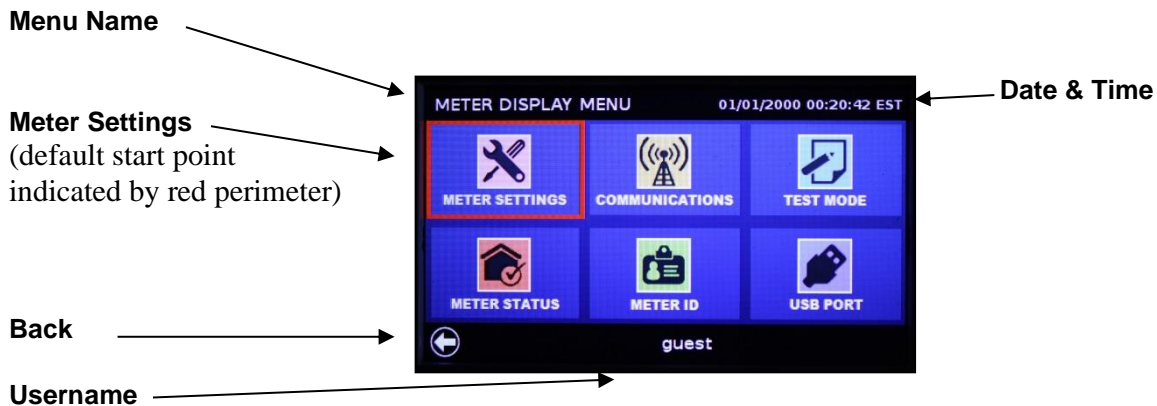
The User Menu is accessed after removing the meter cover. (this may require breaking a seal).

Press the left arrow button, and the display will immediately go to the Meter Display Menu.

Starting at the upper left corner, you will see Meter Settings highlighted. Highlighted areas (red perimeter) indicate the *selected* area. Using the UP and DOWN arrow buttons, you can scroll through the choices.

Use the right arrow button to move the cursor to the next menu item, Communications. In this manner, you can scroll up, down, left, or right, to place the selection on the specific function you want to view or edit. Familiarize yourself with this operation before proceeding. Press the READ button any time you want to return to the normal display.

Press SET to enter that menu. Once you have selected the desired menu feature, that menu will be displayed.



JEMStar II Display

Menu Name

Each menu's title/name is displayed in the top left corner.

The Meter Display Menu is the main starting point for navigating all the menus.

Meter Settings

This is the default starting point, indicated by the red perimeter. Items included in this menu:

- Date & Time
- PT/CT
- Digital I/O
- Analog I/O
- Normal Preset Registers
- Alternate Preset Registers

Back

In the lower left corner is the Back navigation button. From any menu, moving the selection point to this icon will revert the display back to the previous menu.

Username

Your log-in status is indicated at the bottom of the display.

NAVIGATING THE DISPLAY USER MENUS

In standard operation, the JEMStar II display is used to show the measured electrical quantities and other monitored parameters. However, the display can easily be switched into the User Menu mode, which uses a simple menu structure for access to the meter’s multiple features. Some menu items are “read-only” such as health status indicators, while others can be edited (time, date, communications, etc.). Through a series of front panel button presses, you can directly configure many of the simpler meter functions. Note: the front panel keypad may be “locked out”, depending on your company policy. See Section 5 – Maintenance for information on Security Keys.

The Display Menu is divided into logical groups of features and categories. The following shows all menu functions.

Meter Display Menu:

Pressing the Left front panel button will invoke the Meter Display Menu. The red perimeter around a menu item indicates it is selected. Meter Settings is the default starting location. To enter the menu item, press the Set button in the center of the navigation keys. To exit any menu, navigate to the Left arrow on the display and press Set. Or press the Read button.



Meter Settings:

To enter, press Set. Using this menu you can configure features such as: Date/Time, PT/CT, I/O and Register Presets.



Communications:

From the Meter Display Menu press the Right arrow once. And press Set. This will invoke the Communications menu where you can configure the ports.



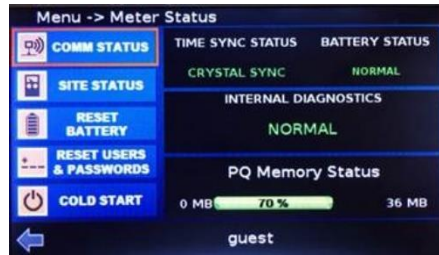
Test Mode:

From the Meter Display Menu press the Right arrow twice. Press Set. This will invoke the Test Mode menu where you can change the test pulse scaling, enable loss compensation and start Test Mode.



Meter Status:

From the Meter Display Menu press the Down arrow once. Press Set. This will invoke the Meter Status menu where you can check the Comm and Site Status, reset the battery status, reset users and passwords and do a cold start.



Meter ID:

From the Meter Display Menu, press the Down and Right arrow once each. Press Set. This will invoke the Meter ID menu where you can view the identification and firmware version.



USING DISPLAY MENUS

The following section details how to use the meter display menus. The categories are listed in the order they appear on the screen.

Some display menu features are read-only and some are directly editable. The meter settings that can be edited via the front panel are limited to the most common functions. ALL JEMStar II settings can be configured using JEMWare II software. Please refer to the JEMWare II instruction manual 1079-699 to configure a meter via software.

JEMStar II uses two security keys to limit access to the front panel pushbuttons. Depending upon your company's policy, you may need to "unlock" the keypad. Refer to Section 5 – Maintenance for instructions about Security Keys.

Unlocking the Meter

Before you can edit configuration parameters, the meter must be unlocked with the correct username and password. Once this entered, the User Menu configuration items will remain unlocked for a predetermined amount of time as configured in the JEMWARE software. Whenever you are on a User Menu configuration screen that allows editing, you will see a lock icon in the lower right corner. Tab to this Lock Icon and press the Set key. This will bring up a Security Log-In screen. The Username field will have a red box to highlight this selection. Use the Up and Down arrow keys to scroll through the different Usernames configured for this meter. Once you arrive at the correct one, press the Set button. The Password field will now have a red box highlighting this selection. Use the Up,Down, Left and Right arrow keys to select the letters, numbers and symbols that make up the correct password for the specified username, pressing the Set key after each entry. When done entering the password, move to the Enter tab and press the Set Key. If done correctly, the Lock symbol will open up showing that the meter is unlocked for configuration edits. Also, the User Menu screens will display the current username that you entered. If you need to exit from the password screen, press the Read button.



Meter Settings

This user menu will allow the viewing or editing of Date and Time, PT/CT Ratios, Digital and Analog I/O and Presetting Normal and Alternate Registers.



Time & Date:

The time and date can be set once the meter is unlocked. This will be evident when the lock is in the open position.

Press Set to enter the Set Time & Date menu shown here. Using the navigation keys, move around the fields to increase/decrease the numeric values. The time is displayed in the 24 hour format. Press SAVE once the time and date fields contain the desired value.



PT/CT Ratio

You can read and change the Power Transformer Ratio and the Current Transformer Ratio by going to the Meter Display Menu and selecting Meter Settings. Scroll right to PT/CT and press Set. Edit the existing setting by moving from field to field and using the arrow buttons to enter a new ratio and then pressing SET. Be sure to update the front panel label to correspond to the new ratio that you entered.



NOTE 1: Changing the meter's PT or CT Ratio will cause Load Profile pulse constants, Energy Pulse constants, Site Monitor thresholds, and Analog Output levels to be re-scaled **automatically** so that they will maintain the same settings in Primary units. It will also cause all numeric registers to be erased and re-initialized.

NOTE 2: Changing the meter's PT or CT Ratio from the front panel will invalidate any Loss Compensation settings that may already be configured. If you use the Loss Compensation feature, enter the PT and CT Ratios via JEMWare II configuration software to maintain your TLC settings.

Digital I/O

This is a view-only menu from the meter; all edits must be performed using JEMWare II software. If equipped with the DIO option, this screen will show whether the I/O channel is set up as an Input or Output, the function of the I/O and the current I/O state (ON or OFF)

CH	TYPE	FUNCTION	STATE
1	INPUT	INTERVAL SYNC, Scaling - None, TOU rate T, Form A	OFF
2	INPUT	INTERVAL SYNC, Scaling - None, TOU rate T, Form A	OFF
3	INPUT	INTERVAL SYNC, Scaling - None, TOU rate T, Form A	OFF
4	INPUT	INTERVAL SYNC, Scaling - None, TOU rate T, Form A	OFF
5	INPUT	INTERVAL SYNC, Scaling - None, TOU rate T, Form A	OFF
6	INPUT	INTERVAL SYNC, Scaling - None, TOU rate T, Form A	OFF

To view the input settings: from the Meter Settings menu press the right arrow twice and hit Set. Then select a Channel number that you want to view. The screen will display what each of the channels has been configured to monitor. To edit the configuration, you must use JEMWare II software.

Analog I/O

This is a view-only menu showing how the Analog Output option is configured. It will display whether the Analog Outputs are 0-1mA or 4-20mA, the measurement that was configured for each output and how the minimum and maximum scaling was configured. For example, if Channel 1 was configured as 0-1mA with a measurement of watts, 0mA could be 0 watts and 1mA could be 1500 watts.

CH	FUNCTION	MIN VALUE	MAX VALUE
1	Units - W Phase - A	0	0
2	Units - W Phase - A	0	0
3	Units - W Phase - A	0	0
4	Units - W Phase - A	0	0

To view how the analog outputs are configured:

From the Meter Settings menu, press the down arrow and hit Set. Then select a Channel number that you want to view. The screen will display how each of the analog channels has been configured. To edit the configuration, you must use JEMWare II software.

Preset Registers

Register Preset enables the user to set meter registers at a predetermined value. This option is often used when meters are replaced, allowing the user to set the new meter with the previous meter's register settings.

ID	DESCRIPTION	PRESET VALUE
001	Register Description	0000.00
002	Register Description	0000.00
003	Register Description	0000.00
004	Register Description	0000.00
005	Register Description	0000.00

The consumption (energy) measurements are the ones you typically preset. This function can be performed directly from the front panel of the meter, or with the JEMWare II configuration software. Since this may affect the correlation between Register and Load Profile readings, this session is logged as a Register Preset event.

To preset the meter registers from the front panel:

1. Press any arrow key to enter the Meter Display Menu press Set once.
2. From Meter Settings, press the down and right buttons once each, and press Set.
3. To increment the highlighted digit, press the +/up button; to decrement, press the -/down button. You may press the READ button at any time to cancel the operation.
4. To select the next digit, press the right arrow button.
5. Continue selecting and incrementing/decrementing digits until the desired quantity is shown on the display.
6. When the desired register value is reached, save that register value by pressing the SET button. The meter automatically returns to the menu.
7. Repeat Steps 3 – 7 to preset any other register quantities.
8. When all the necessary registers are preset, press SAVE, then the left arrow button repeatedly to exit out of the menu screen, or press READ.

Note: Pressing the READ button while editing a register will cancel the SET operation and restores the register to its' original value(s).

Communication Settings

There are a few methods of interfacing with JEMStar II: Optical port, Serial data (RS-232/485), modem, Ethernet & WiFi. The display menu allows reading and editing of basic communications port parameters such as:

- Type: For Serial ports, select whether communications are via RS-232 or RS-485
- Protocol: Use the arrow buttons to select a communication protocol, such as; Binary, DNP, Modbus (RTU or ASCII), or ANSI Tables
- Baud: Use the arrow buttons to scroll through the available choices
- Address: A unique address assigned to each meter.
- IP Address: Select this for Ethernet options



Press the Left navigation key to invoke the Meter Display Menu. Press the right arrow once and hit Set. From this menu you can configure the desired communication parameters. To change the meter’s IP Address, clear the existing IP Address and enter the new one. After pressing ‘Enter’, select the “Save” button.

Test Mode

This display is used for putting the meter into Test Mode which is used for checking the accuracy of the meter. More details on testing the meter are in the next section called Test and Calibration



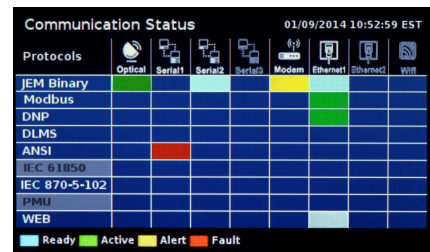
Meter Status

The meter has several internal safeguards that verify its own operation. You can check the status of these monitors from the display menus by going to Meter Display Menu, scroll down once to Meter Status and press Set. This will display a screen that shows: Comm Status, Site Status, Reset Battery, Reset Users and Passwords, and Cold Start.



Comm Status

The Comm Status is a special display that provides the status of all communication ports. This screen can be configured as a standard Display Register in JEMWARE or displayed manually with the User menu. The function of this display is described in the previous Display section.



Site Status

The Site Status display shows various screens on the current site conditions, such as the Phasor Display, Harmonics (future), Alarm Summary, etc. These screens can also be configured as a standard Display register in JEMWARE or displayed manually with the User Menu. The function of these displays is described in the previous Display section.



Reset Battery

The meter has a 10 year lithium ion battery to back up the time clock. If the battery needs replacement it will produce a Battery Warning indication. When the battery is replaced, you need to reset the Battery Monitor using the Reset Battery screen. Refer to the Maintenance section of the manual for battery replacement.



Reset Users & Passwords

This selection resets all user names and passwords back to factory defaults. You will be warned of the pending removal of user configurations, which you must accept by selecting Yes. You will then be prompted to remove power from the meter within 15 seconds or it will ignore the request.

Cold Start

A Cold Start returns the meter back to factory defaults. Refer to the Maintenance section of this manual for details on the Cold Start.



Meter Status Indicators

The Meter Status screen has indicators on the right side for the Time Sync Status, Battery Status, Internal Diagnostics and PQ Memory. The function of these indicators is shown below.

- Time Sync Status Indicates Crystal or Line sync.
- Battery Status Monitors the internal RAM battery and advises if OK.
- Internal Diagnostics Verifies if the meter’s configuration is acceptable. Note that this only checks for conflicts in the setup; individual settings could still be incorrect for your specific application.
- PQ Memory Status This provides a list of how much memory is currently used in MB and % along with the total memory allocated for the PQ Options enabled in the meter.



Meter ID, Firmware Version

You can read the following information about how the meter is configured by going to the Meter Display Menu. Press down and right once. And press Set to enter the Meter ID menu.

- ID This is the meter identification that will appear in the register list.
- Meter Set-up Available types are 4-Wire Wye, 4-Wire Delta, 3-Wire Delta, Network, Open Delta, 3-Wire Wye
- Firmware Versions This is the version number of the firmware installed in the meter.



TEST & CALIBRATION

The meter can provide test pulses from the Optical Port in Normal Mode or Test Mode. In Normal Mode, the meter operates normally, measuring and registering power in registers, Load Profile, etc. When the meter is put into Test Mode, it no longer registers power.

Normal Mode

Using JEMWARE Configuration Software, you can set up the Optical port to continuously output test pulses for either watt-hours or VAR-hours using your own scaling factors. The test pulses will be scaled to whatever the secondary meter input is. For example, if the meter secondary is registering 1,800 watt-hours and the scaling is set for 1.8, you will get 1,000 pulses per hour. This allows you to check the meter accuracy without removing the meter cover and without putting the meter into Test Mode.

Notes: When the meter is first powered up, the meter begins registering power within a few seconds and the test pulses begin within 10 seconds. (The meter continues to start up during this process, eventually scrolling measurements on the display and enabling the communication options.)

When the Optical Port is used for serial communications, the test pulses will stop and serial communications will be established. Once the Optical Port communications are finished, the meter will automatically resume sending test pulses within a few minutes.

Detailed Settings

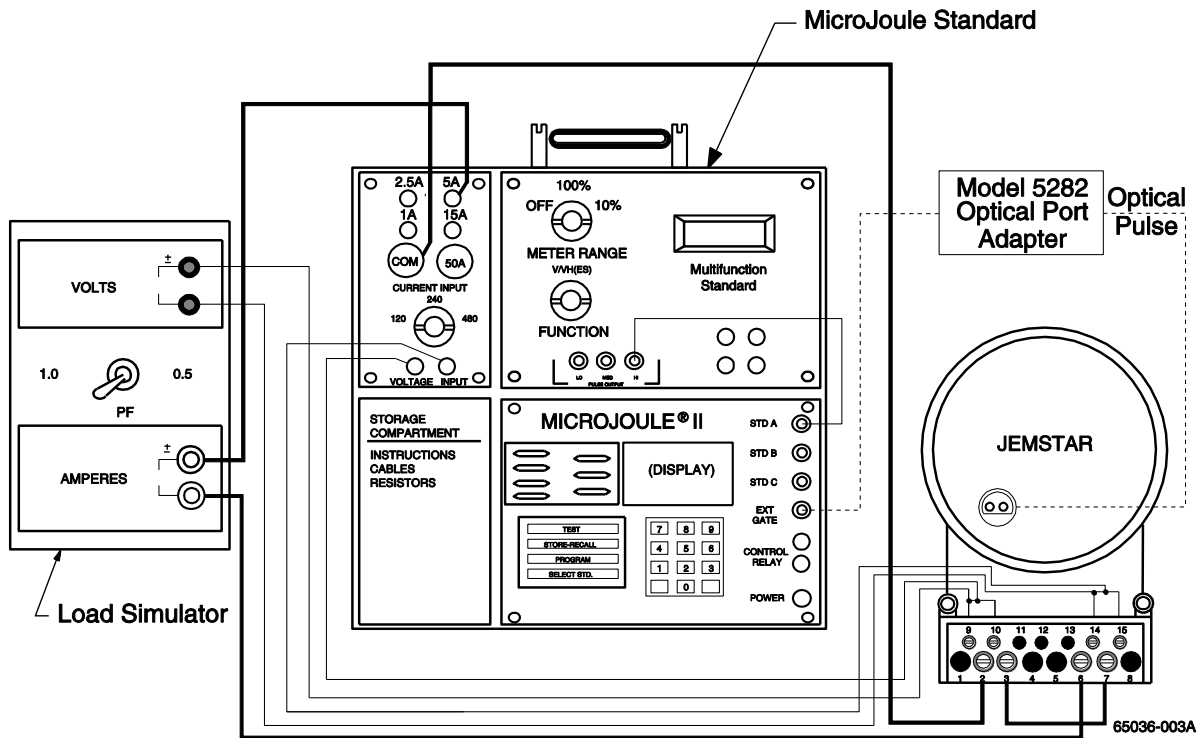
Device Address :	<input type="text" value="1"/>
Password Timeout :	<input type="text" value="5"/>
Continuous Test Pulse :	<input checked="" type="radio"/> Watt-hours <input type="radio"/> VAR-hours
Test Pulse Scaling :	<input type="text" value="1.8"/>

Test Mode

You can test meter functions and accuracy from the front panel. Since this may temporarily inhibit registration, this session is logged as a Test Mode event.

The JEMStar II optical port on the face of the meter performs two functions. During Standard Meter Mode it is used for serial communications. In Test Mode, the optical port on the face of the meter sends out test pulses consistent with the test register that is being displayed (e.g. Watthour, Varhour). The KYZ digital pulse outputs are available even when the meter is in Test Mode, operating at their programmed K_e value. You may use a Scientific Columbus Model 5282 Optical Port Adapter or equivalent that will convert the optical pulses to contact closures. This can then be interfaced to a Watt standard's (such as Scientific Columbus' MicroJoule®II) external gate input.

The JEMStar II is tested like any other electronic meter. It should be set up so the test standard sees the same voltage and current as the meter. This is done by connecting the JEMStar II voltage elements in parallel and the current elements in series. Refer to the following example that shows how to connect a JEMStar II and a Watt Standard to an external load source.



TYPICAL CONNECTION DIAGRAM FOR JEMSTAR II and MICROJOULE II TO AN EXTERNAL LOAD SOURCE

To use the Optical Test Pulse:

The Optical Test Pulse is an energy pulse output, similar to a KYZ pulse that repeats at a rate proportional to energy consumption. Each pulse is a brief (approximately 30 – 40 millisecond) burst of infrared light sent by the Optical Port transmitter.

Measurements that may be selected for output as a Test Pulse during Test Mode are:

- Consumption Measurements
Whr, VAhr, VARhr, etc
- Instantaneous Measurements
Watts, VA, VARs, etc

Any direction (Delivered, Received, per-quadrant) and element (phase A, B, C, or total) that may be selected for one of these measurements in a display test register may be output as a Test Pulse. The pulse weight (Kt) for each pulse is selectable by the user in JEMWARE via the Test Register setup or through the front panel user menu while in Test Mode.

The Optical Test Pulse may be picked up with any Optical Port receiver, although we recommend the Scientific Columbus Model 5282 Optical Port Adapter. The 5282 allows the Optical Port to be used for serial communication with a computer as well as directing the Test Pulse to an external counter for accuracy testing.

Test Mode Functionality

During Test Mode, the following conditions exist:

1. Normal and Alternate registers stop accumulating. Peak, Coincident, and Time/Date of Peak registers may continue to update, but they behave as if there is zero power applied to the meter.
2. Load Profile stops accumulating and storing interval records. Any partial interval counts accumulated before entering Test Mode will be retained, and will be stored with a Test Mode event record when Test Mode ends.
3. Test Registers accumulate power, and behave as expected for the type of register. (E.g. Time-of-Use registers respond only during the correct rate period, Demand registers update on normal demand interval timing, etc.)
Note: The Test Registers can be retrieved from the meter during or after the test is performed using JEMWARE or JEMREAD Software.
4. The Optical Port emits Test Pulses.
5. Analog Outputs continue to operate as before.
6. Energy output pulses continue to operate as before.

Test Mode ends on any of these conditions:

1. The user manually leaves Test Mode.
2. The meter detects a period of inactivity and exits Test Mode automatically. (Test Mode timeout.)
3. The meter loses power.

When Test Mode ends, the following occurs:

1. Normal and Alternate registers resume normal operation, accumulating power that is applied to the meter. Demand and TOU scheduling is unaffected.
2. Load Profile records a Test Mode event with partial interval counts from the interval before Test Mode began, then resumes normal operation.
3. The Optical Test Pulse returns to the 'Normal Mode'.
4. Loss Compensation is re-enabled if it had been disabled while in Test Mode.

Setting up Test Mode:

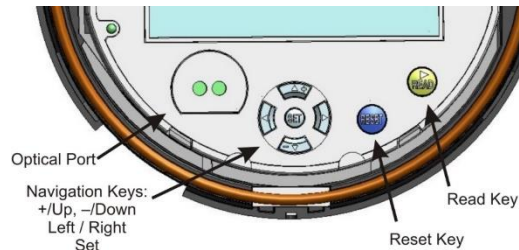
The JEMWARE Configuration Software lets you configure the Test Registers which will be used during your test. These Test Registers can be customized to suit your needs, letting you enter any measurement for testing purposes. Once you are in Test Mode, you can scroll from one measurement to the next based on what you configure in your list. The Test Register setup includes an entry for the pulse weight used for testing. The default is set for 1.8. This can be changed to whatever you want for each measurement and it can be over-riden while in test mode. *This scale factor is equal to the quantity of secondary Watts (Whr) per pulse. A setting of 1.8 is equal to a single pulse every 1.8 Watts (Whr).*

Display Registers

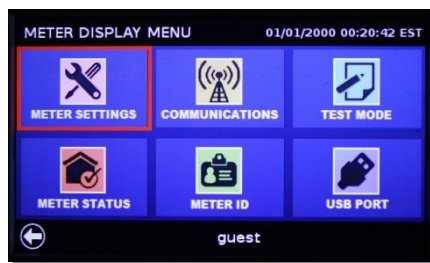
Normal Registers																	Alternate Registers																	Test Registers																
	ID	Register Category	Register Type	Quantity	Phase	Direction	Storage Type	Units	# of Digits	Decimal Point	Pulse Weight	TOU	TLC	Scaling Values	Display Screen	Description																																		
	200	Register	Consumption	WHr	Poly...	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	1	<input checked="" type="checkbox"/> Watthour Delivered																																		
	201	Register	Consumption	WHr	Poly...	Received	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	2	<input checked="" type="checkbox"/> Watthour Received																																		
	202	Register	Consumption	VARHr	Poly...	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	3	<input checked="" type="checkbox"/> VARhour Delivered																																		
	203	Register	Consumption	WHr	A	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	4	<input checked="" type="checkbox"/> Watthour Del Phase A																																		
	204	Register	Consumption	WHr	B	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	5	<input checked="" type="checkbox"/> Watthour Del Phase B																																		
	205	Register	Consumption	WHr	C	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	6	<input checked="" type="checkbox"/> Watthour Del Phase C																																		
	206	Register	Consumption	WHr	A	Received	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	7	<input checked="" type="checkbox"/> Watthour Rec Phase A																																		
	207	Register	Consumption	WHr	B	Received	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	8	<input checked="" type="checkbox"/> Watthour Rec Phase B																																		
	208	Register	Consumption	WHr	C	Received	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	9	<input checked="" type="checkbox"/> Watthour Rec Phase C																																		

To Enter Test Mode:

1. Press the left arrow key to enter the Meter Display User Menu.



2. This will open the User Menu Screen.



3. Press the right arrow key 2 times to select Test Mode. Press the Set Button to enter the Test Mode Screen. If you wish to change the test pulse scaling to something different than the Test Register settings programmed in JEMWARE, use the arrow buttons to enter a new scale factor. Press Enter when done. *This scale factor is equal to the quantity of secondary Watts (Whr) per pulse. A setting of 1.8 is equal to a single pulse every 1.8 Watts (Whr).* You can also choose to disable Loss Compensation during the test if the Test Registers were programmed to include TLC.



4. When you press the 'Start Test Mode' button, the Test Register Display will be shown. This looks like the Normal and Alternate Display Register except the Test Register ID numbers start at 200. You can scroll through your list of Test Registers (configured in JEMWARE) by using the 'Read' button on the front of the meter. The Optical Port will output test pulses based on the input to the meter and the Test Register Selected. To Exit Test Mode, press the left arrow button to return to the Test Mode Screen.



- When you return to the Test Mode Screen, the Test Pulses will stop. You have the option to Continue Test Mode, Stop Test Mode and exit this screen or make an adjustment to the Watt and VAR Gain. (see below)

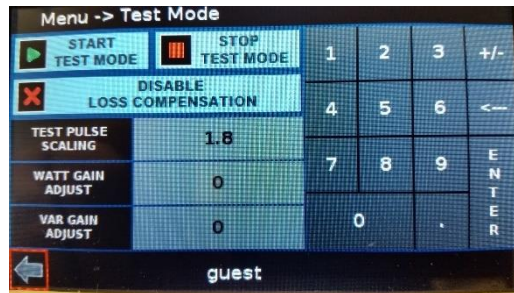
Watt/VAR Gain Adjust

If you need to make an adjustment to the meter after testing it for accuracy, the Watt/VAR Gain adjust will let you change the meter calibration.

Caution: Before doing this, make sure you have tested the meter accurately before making any changes.

Use the arrows to enter a gain adjustment in percent. There is a separate entry for Watts and VARs. When adjusting Watts, this will be applied to Watts, Whr, VA-vect, VAhr-vect, Q, Qhr, PF-vect. When adjusting VARs, this will be applied to VARs, VARhr, VA-vect, VAhr-vect, Q, Qhr , PF-vect.

The range available is +9.99% to -9.99%. This adjustment would be applied across the whole range from zero to full scale. When done, press the Enter key to save the change. It is recommended to retest the meter after the change has been made.



Note: This is not a replacement for the full meter calibration which examines multiple test points and measurement types. If a full re-calibration is required, send the meter to the factory.

MAINTENANCE

Damage to the instrument can be caused by Electrostatic Discharge (ESD). Appropriate precautions should be incorporated.

Any JEMStar II option, except for those noted as "factory configuration" or "configured at manufacture," can be installed by a user with the following capabilities:

- Intermediate skill as an electronic technician, including knowledge of electrostatic-protection and electrical safety techniques.
- Familiar with the proper use of common tools (e.g. screwdrivers, wire strippers or cutters, wrenches, etc.) and equipment (e.g. voltmeter) used in electronics, including static reduction equipment such as grounding straps or mats. Soldering equipment is NOT required.

The JEMStar II meter design, with its plug-together boards, requires few tools for maintenance.

Caution!

**All meter work must be performed at electrostatic-protected workstations
WITH POWER REMOVED.
The technician must follow properly prescribed electrostatic-control practices.
Refer to Appendix C for more information.**

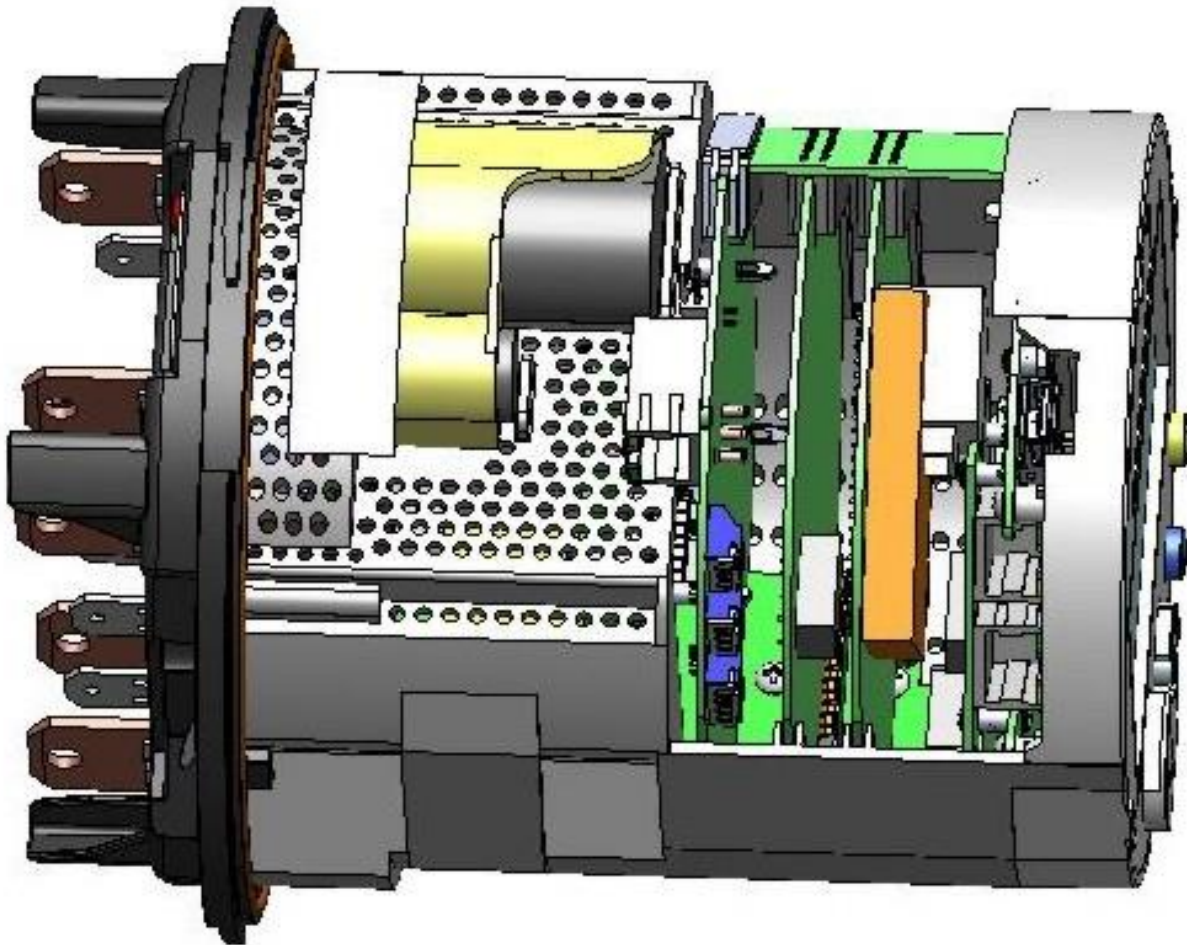
SERVICING

JEMStar II meters are available in socket-base (S- and A-base), and switchboard mounting packages. The disassembly procedure for each type is described as follows.

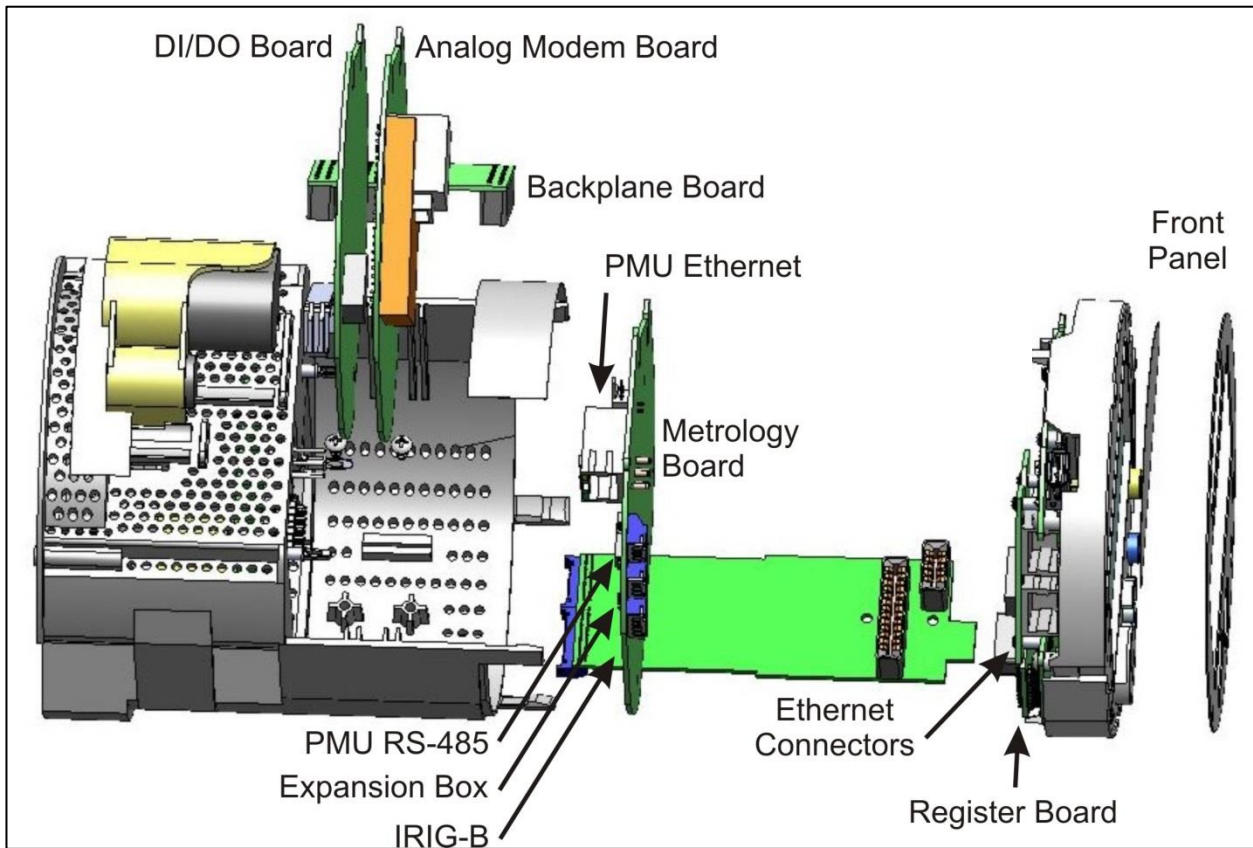
Socket-base meters (S- and A-base)

Globe Removal

1. Remove power from meter!
2. Remove all wire seals from the locking ring of the meter globe, and then remove the ring. You do NOT need to remove any seals from the RESET button.
3. Turn the globe counter-clockwise approximately 1 inch to disengage it from the base.
4. Carefully slide the globe forward away from the base and set it aside.



JEMStar II Boards Installed



JEMStar II Exploded view, Internal Case removed

Switchboard Meters

Cover Removal

1. Remove power from the meter, if possible. It is not mandatory that power is removed because the Switchboard meter has its' own disconnect device. However, *caution is advised since live terminations exist inside the housing even after the paddle is removed.*
2. Remove the wire seal on the thumbscrew at the bottom center of the meter cover.
3. Unfasten the thumbscrew and lift the cover slightly while pulling forward from the bottom.

Internal Chassis Removal

1. Locate the black plastic paddle at the bottom of the chassis. Grasp the protruding handle section and firmly pull it toward you. This will safely disconnect and bypass the CT circuits from the meter.
2. Locate the upper and lower metal locking latches. At the same time, pull both the upper and lower tabs towards you until the levers are pointed straight out (about 90° swing).
3. Grasping the levers, gently rock the chassis while pulling forward. When the chassis is loose, remove it from the housing. You can now take the entire chassis to your service shop.

When re-installing the meter, note that the thumbscrew on the front cover has a small indentation on the head. This indicates the orientation of the hole in the screw for inserting the sealing wire. Turn the screw until the dot is in a horizontal position, and the hole in the screw will line up with the hole in the plastic cover.

Serviceable Parts

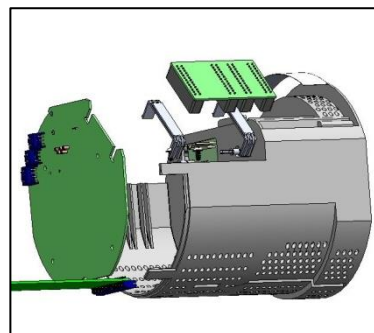
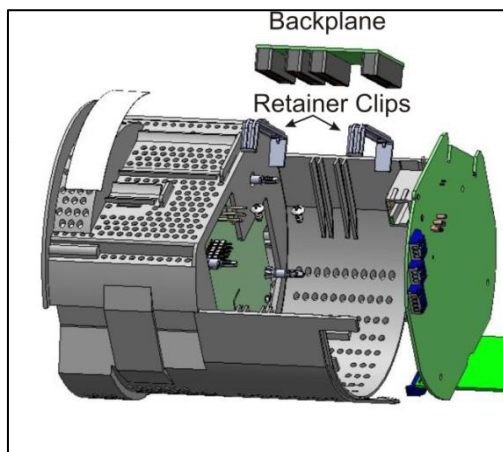
The JEMStar II's Ethernet, Serial Analog/Modem and Digital I/O boards can be changed in the meter shop with a few simple procedures.

The JEMStar II clock/RAM battery is designed to last 10 years under normal storage and usage conditions. If the battery needs replacement, or you would like more information on any JEMStar II components, call Ametek Power Instruments' Technical Support staff at 888-880-5361.

Option Boards Access

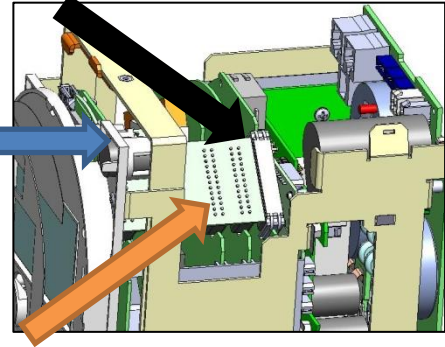
Socket-base Meters (S- & A-base):

To access option boards, the 2 backplane retainer clips must be removed as shown here. Press the ends of the clips and pull upward. After which the backplane board can be removed.



Switchboard Meters

1. To access the option boards, the backplane retainer clip must be removed. Press the ends and pull upward. (Black arrow)
2. After removing the retainer clip, unplug the battery from the front of the backplane board. (Blue arrow)
3. Remove the backplane board. (Orange arrow)

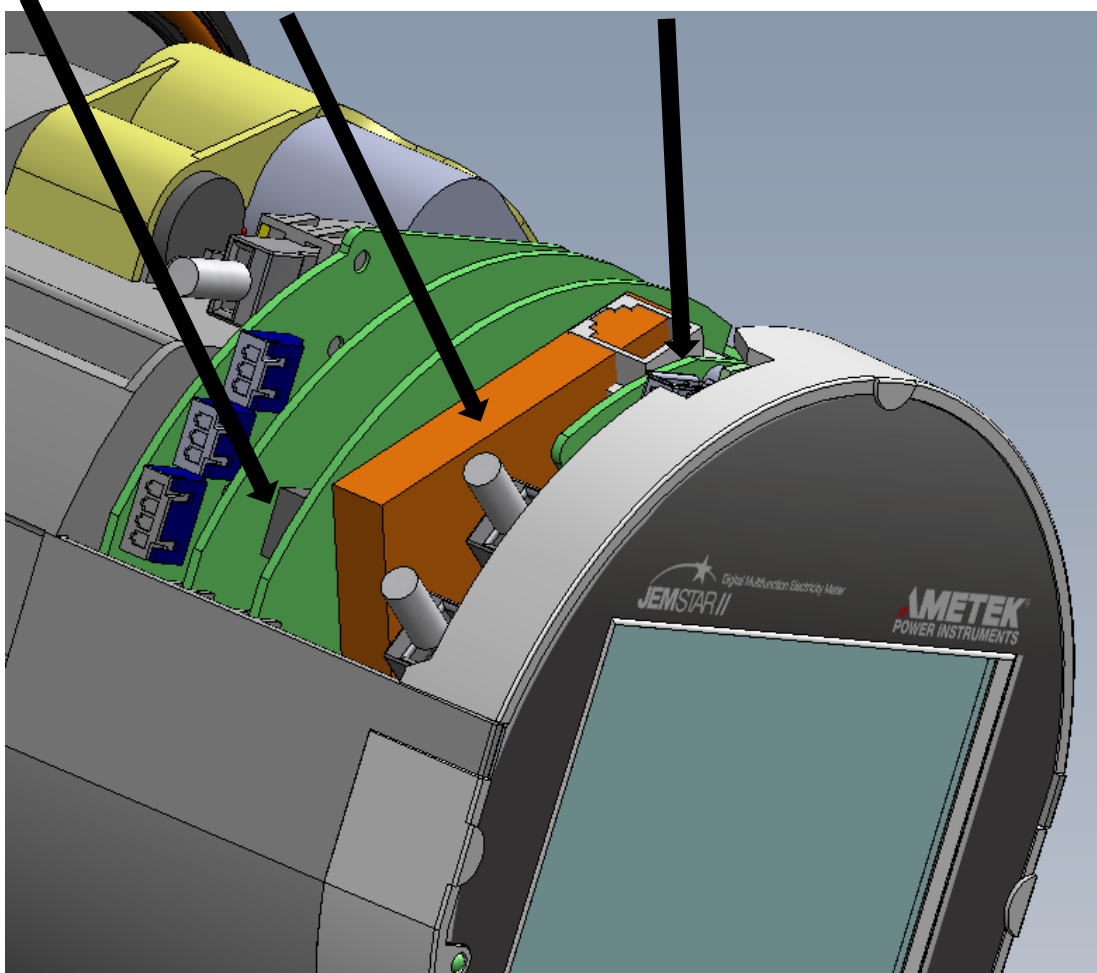


Note: for switchboard meters, the clock battery is disconnected to access any option boards. Removing a JEMStar II battery with the meter unpowered results in the Digital I/O, Analog Outputs, Display Registers and Load Profile reverting to default configurations when power is restored. After the meter has finished rebooting, the configuration will be restored but Register and Load Profile data will be erased. Also the real-time clock will be reset to 1/1/2000.

Option Boards Installation and Replacement

There are a total of 4 option boards that can be installed in the meter; Analog/Modem, Digital Input/Output, Ethernet and Serial. Locations are shown below.

Digital I/O Analog/Modem Ethernet

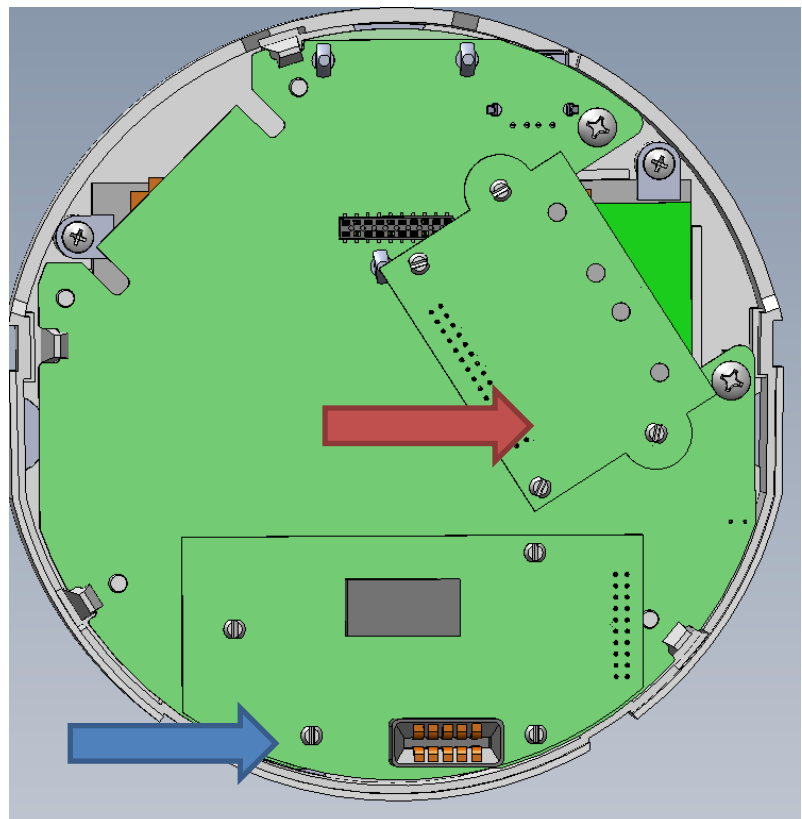
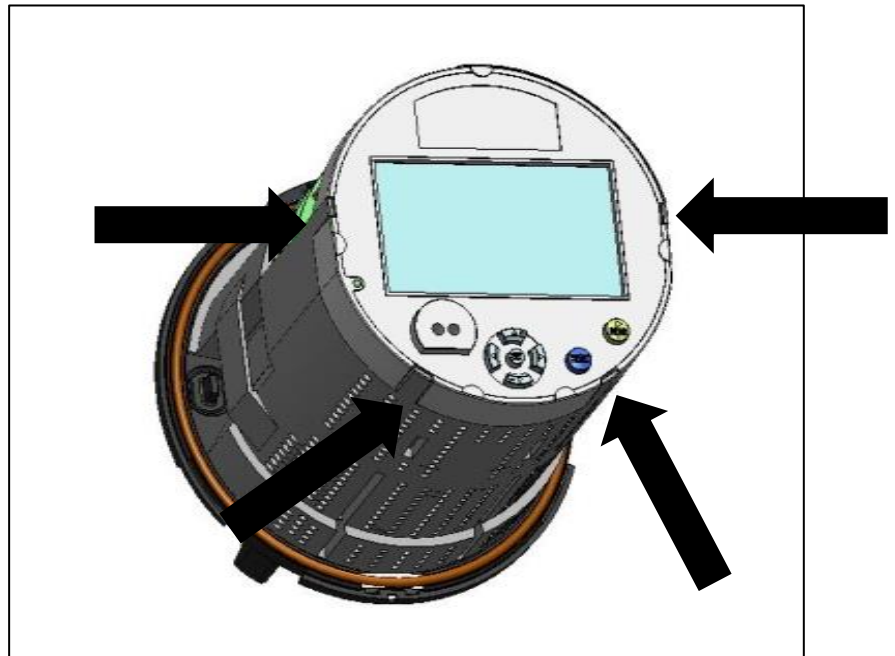


The Analog/Modem and Digital I/O boards slide into card guides on the inside walls of the meter.

The Ethernet and Serial boards mount to the rear of the Register assembly, behind the display. To remove the Register assembly, *gently* pry out each of the 4 plastic clips (Black arrows) around the outside of the front bezel and pull the front assembly away from the main housing.

The Ethernet board (Red arrow) mounts via 4 screws and a multi-position header. To remove it, take out the 4 screws and lift up on the board until it is free. To install it, line the header with the matching connector on the Register board and reinstall the 4 screws.

The Serial board (Blue arrow) mounts via 4 plastic spacers and a multi-position header. To remove the board, carefully lift up on each spacer until the board is free. To install a board, line the multi-position header with the matching connector on the Register board and push down on each board edge until the standoffs are full inserted.



Batteries

There is one standard battery (Blue arrow) and one optional battery (Black arrow) in the JEMStar II.

Socket-base Meter (S- & A-base) Battery

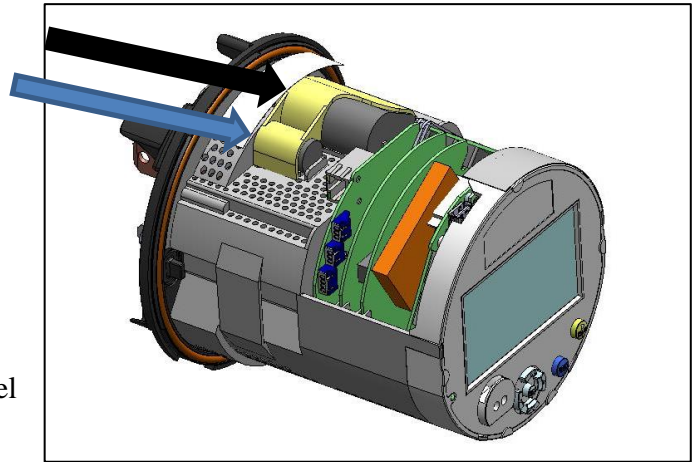
The standard battery is shipped with all JEMStar II meters. The optional battery is for the Call Home Power Fail option.

Clock Battery

The long life cell should provide support for 10 years, and its life can be checked from the front panel display.

1. Press the Left key to invoke the Meter Display Menu.
2. Press the –/Down key once to highlight the Meter Status menu.
3. Press Set.

Battery Status is displayed on the bottom right.



JEMStar II contains an easily replaceable battery that is used to power the internal clock. There is also a display register (Days on Battery) that can be read to determine how many days the battery has been used. If the meter is in service, the battery should be replaced while the meter is under power so that time is not lost (the battery is not used as long as service power is connected).

➔ **To replace the clock battery:**

1. If you remove the battery while the meter is under power, you will preserve the current time and date
2. Remove the outer globe from the S-base or A-base model.
3. This battery plugs into the top of the metrology board. Press on each side of the cover and lift off. Unplug the two-pin connector and lift the battery out of its holder.
4. Install a new, exact replacement battery, available from the factory. Specify part number 6005-254.
5. From the front panel menu, press the Left key to invoke the Meter Display Menu.
6. Press the down key once to highlight the Meter Status menu and press Set.
7. Using the navigation keys, move down to Reset Battery. And press Set. The Date and Time may also need to be set if the meter was taken out of service while changing the battery.

Call Home / Power Outage Battery Pack (future)

JEMStar II incorporates a replaceable battery pack that is used to power the internal Call Home modem during power outages. The battery will provide power to the modem for at least 8 hours of call time. It is recommended that the battery be changed every three years or sooner if you experience numerous power outages.

➔ **To replace the Power Outage battery pack:**

1. Remove power from the meter.
2. Ensure proper grounding.
3. Remove the outer globe from the S-base or A-base model. Remove the front cover from the switchboard model.
4. On an S-based or A-base meter, remove the top cover. The battery pack is the cylindrical assembly located in a holder directly under the cover. Unplug the two-pin connector and lift the battery up and out of its holder.

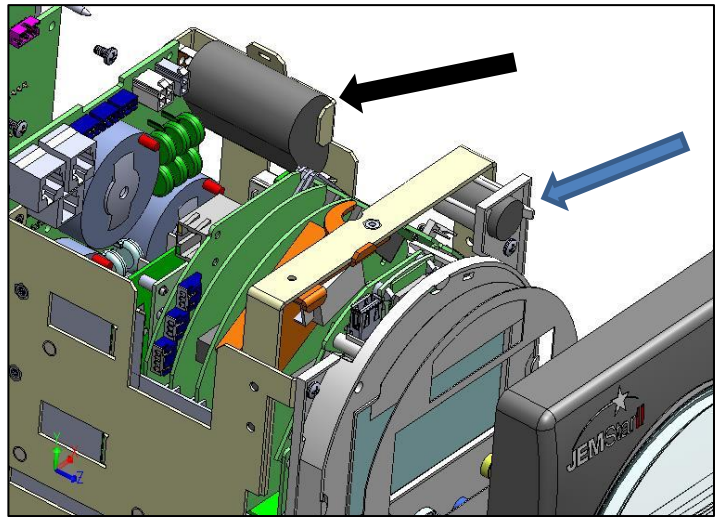
5. Install a new, exact replacement battery, available from the factory. Specify part number 1079-612.

Switchboard Meter Battery

The clock battery (Blue arrow) may be replaced after front panel removal. The meter does not need to be removed from service. This battery plugs into the backplane board.

➔ **To replace the clock battery:**

1. If you remove the battery while the meter is under power, you will preserve the current time and date.
2. Remove the front cover from the switchboard model.
3. The battery is located under a retainer bracket behind the front panel. Unplug the two-pin connector, loosen the bracket screws, and slide the battery out of its holder.
4. Repeat the previous steps in reverse order to complete the process.



The Call Home battery provides power to the optional Analog/Modem board on power fail, Communications Option 6. Refer to the Call Home Power Fail section for information on setup and operation. This battery connects to the top of the optional Analog/Modem board.

➔ **To replace the Call Home battery:** (Black arrow)

1. Cut the plastic tie-wrap that holds the battery to the chassis/frame.
2. Unplug the two-pin connector.
3. Install a new, exact replacement battery, available from the factory. Specify part number 1079-612.
4. Repeat the previous steps in reverse order to complete the process.

Removing a JEMStar II battery with the meter unpowered will result in the Digital I/O, Analog Outputs, Display Registers, and Load Profile reverting to default configurations when power is restored. After the meter has finished rebooting their configurations will be restored, but Register and Load Profile data will have been erased. Also, the real-time clock will be reset to 1/1/2000.

Security Keys

JEMStar II includes two security keys to protect the meter from tampering and unwanted access to certain meter functions. There are two removable jumpers (keys) located inside the meter on the rear of the Register board.

One security key is used to disable all functions that could impact meteorological measurements. This includes configuration changes from the front panel keypad menus, plus the following commands when accessing the meter via remote communications using JEMWare II.

- Configure Primary/PTCT Settings
- Configure Display Registers
- Configure Load Profile
- Configure Loss Compensation
- Configure TOU/DST settings
- Configure Input/Output Settings
- Configure Trigger Settings
- Configure Demand Settings
- Configure Totalization
- Configure Transformer Correction
- Firmware upgrade (via JEMWARE or WEB Browser)
- Option upgrade
- Activate Test Mode
- Preset Registers

The following commands will be allowed with the security key installed:

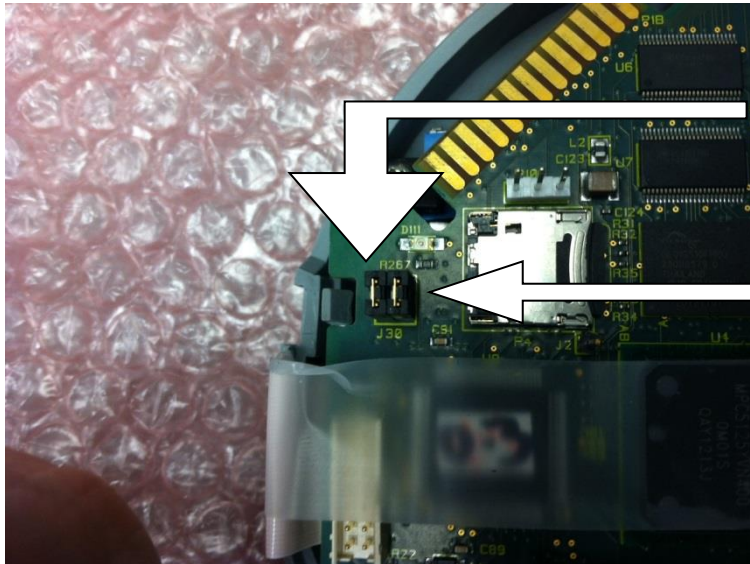
- Configure Meter Identification
- Configure Communication Settings
- Configure Protocol Settings
- Configure Display Settings
- Configure User Admin
- Change Password
- Set Time
- Freeze Registers
- Meter/Battery Status
- Read Triggered Alarms
- Read Display registers
- Read Load Profile
- Read Event/Diagnostic Logs
- Read Security Logs

The other key is used to disable just the meter's front panel RESET pushbutton. The RESET button is used to perform a Billing Period Reset (see the Glossary for definition). With the jumpers removed, access is enabled. Install the jumpers to restrict access.

The meter is provided with both keys factory removed. If you want to install the key(s) after proper configuration in your meter shop, follow this procedure.

1. Remove power from the meter.
2. Remove the outer globe of the meter.

Looking from rear of the meter, with top cover removed



Install this jumper to disable all configuration access from the meter keypad.

Install this jumper to disable the meter's RESET pushbutton.

The jumpers are a standard 0.1" center, two-pin female shorting connector commonly used on most PC motherboards. Contact AMETEK and specify part number 4195-263, or ask

your local computer shop for replacements.

Tip: You can “park” the jumper in a disconnected position by just plugging it onto one contact. This will keep the jumper in the meter for future use.

Firmware Upgrades

New meter firmware can be downloaded locally or remotely via the meter's communication ports. New firmware may be used to add optional features (like Power Quality), product enhancements, or program upgrades.

The firmware that can be upgraded on the meter consists of Register, Service and Metrology. When upgrading more than one version of firmware at one time, start with Service followed by Register and Metrology. The current versions of the firmware installed in the meter can be displayed on the User Menu, added to a Normal or Alternate register for scrolling on the display, or displayed on a WEB Browser when using that for a firmware upgrade.



A firmware upgrade will have no impact to the meter configuration, data saved, time and date. It is always a good idea to save the meter data and configuration file prior to the upgrade as some updates may require a Cold Start.

It is recommended to use the Ethernet port for these upgrades due to the size of the firmware file. On meters that do not have the Ethernet Option provided, the meter will still contain a built-in Ethernet port to be used for this purpose.

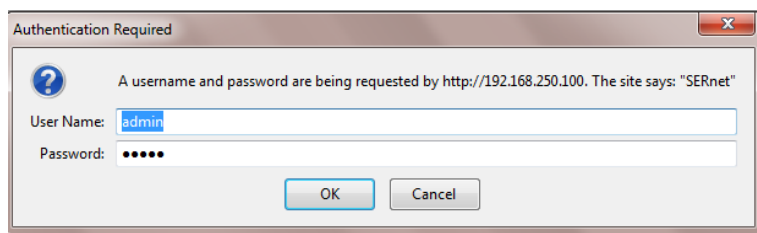
To perform a Firmware Upgrade, save the updated firmware file(s) you received from AMETEK to your computer. Connect your computer to the meter either locally or remotely via the Ethernet Port. Make sure the computer is set up to connect to the IP address assigned to the meter. The User Menu can be used to display the IP Address of the meter. The default setting from the factory is: 192.168.250.100

The upgrade can be performed through the JEMWARE II Software or through a standard WEB Browser.

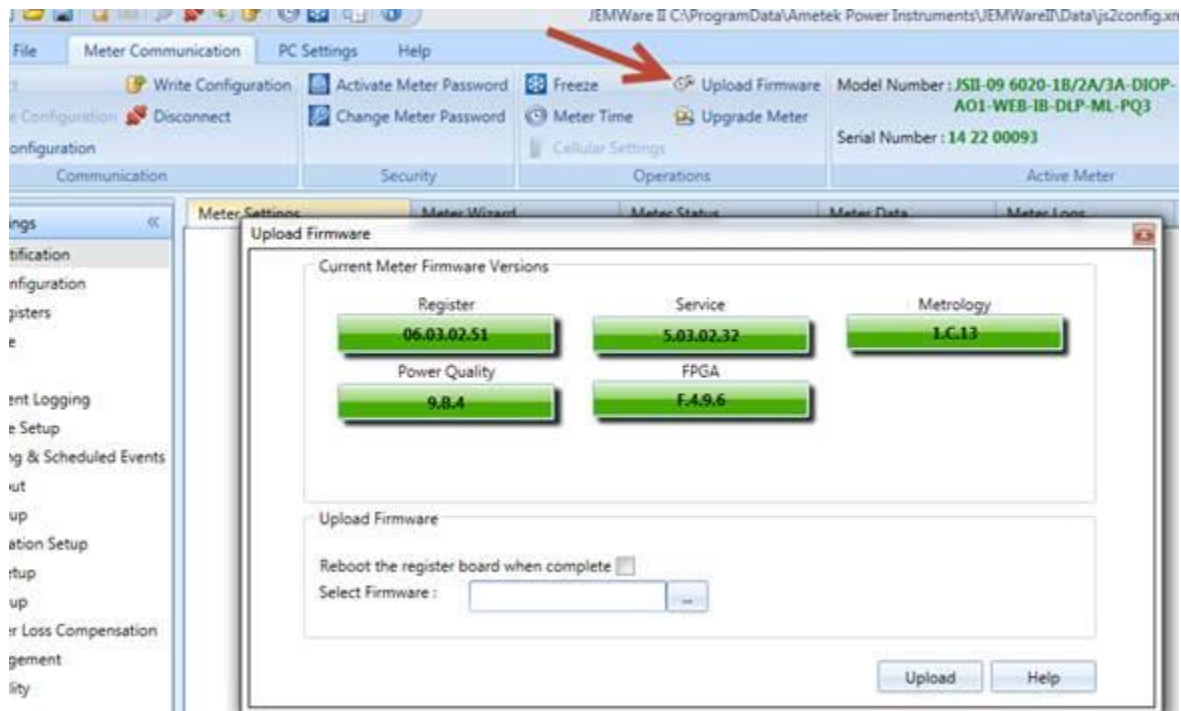
Using the WEB Browser for Firmware Upgrades

Connect the computer to the Meter's Ethernet Port. It is recommended to download the configuration file and meter data from the meter if you don't already have a copy of it. (Refer to the JEMWARE Software Manual for more details).

Using a standard web browser such as Internet Explorer, Mozilla Firefox, etc; enter the IP Address of the meter. (The factory default is 192.168.250.100) If successful, you will get a prompt for a Username and Password. The default is: *User Name: admin Password: admin* (The JEMWARE Software controls the setting of usernames and passwords. You must have the necessary permissions to update the meter firmware.)



Once the password is entered, you will get a browser window. Select the tab on the left for Firmware. This will open up a screen that will show you the current version of firmware. Select the Browse button to search your PC for the new firmware file. It is recommended to select the re-boot register board when complete. The browser screen will show you the status of the upgrade. When done, it will automatically disconnect from the web browser, so you will need to close out any warning messages that appear.



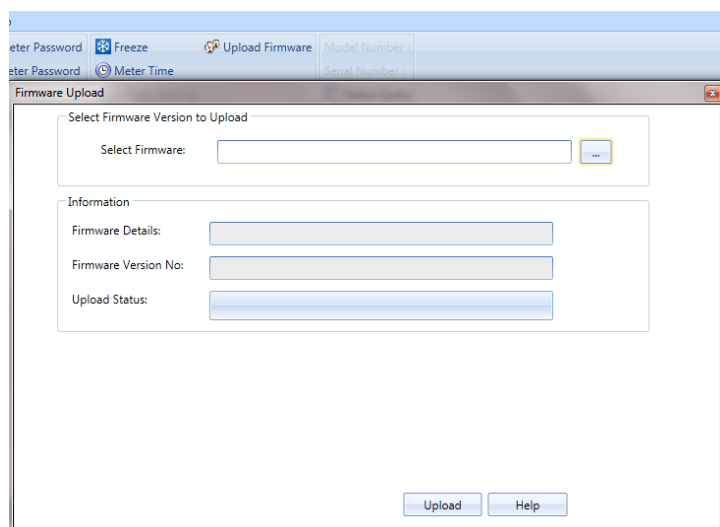
WEB Browser Firmware Upgrade Screen

Using JEMWARE for Firmware Upgrades

Connect the computer to the Meter. It is recommended to download the configuration file and meter data from the meter if you don't already have a copy of it. (Refer to the JEMWARE Software Manual for more details).

(The JEMWARE Software controls the setting of usernames and passwords. You must have the necessary permissions to update the meter firmware.)

Select the button labeled 'Upload Firmware'. This will open up a box that will let you select the firmware file. Once selected, select the Upload button. When completed, perform a cold start on the meter.



Tips for Upgrading Firmware:

1. Make a copy of the meter configuration and download data before upgrading firmware.
2. If upgrading multiple firmware versions, start twith Service followed by Register and Metrology.
3. Select re-boot register when downloading firmware
4. Some upgrades may require a Cold Start after installing new firmware (AMETEK will advise)
5. If you encounter issues after a firmware download, try disconnecting the battery, remove power and re-apply power. Plug in battery after the meter starts up. (This will reset the processors)

COLD START

A Cold Start will bring the meter back to factory defaults. Sometimes this is needed when upgrading much older firmware to newer firmware. The AMETEK Service group will always advise if this is necessary in the update instructions. Other times, if configuration data gets corrupted, communications are locked up or you have internal issues that can't be resolved; a cold start can start you back to factory defaults.

A 'Warm Start' can also be tried first, which consists of removing power from the meter for a few seconds. If the issue isn't resolved, a Cold Start may be required.

Before performing a Cold Start, it is recommended to download/back-up all meter data and configuration details.

Note: A cold start erases all register and load profile data. The configuration parameters are reset to factory defaults (see Appendix A).

Warning! Performing a Cold Start will cause a loss of data.

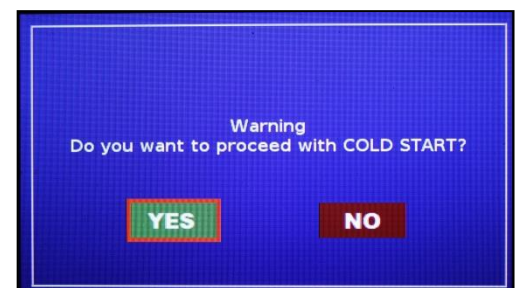
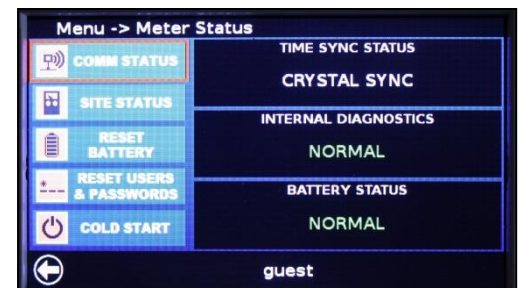
Performing a Cold Start

Pre-requisites:

- Requires the admin username and password
- Must un-seal the meter (remove globe on socket meter or front cover of switchboard meter)
- Will require removal of power from the meter
- Must be performed at the meter

Instructions:

1. From the Meter Display User Menu, press the down button once and press Set. This takes you to the Meter Status menu.
2. You will need to unlock the meter by moving to the 'lock' icon and press Set. This will bring up a keypad to select the admin username and password authorized to do this.
3. Using the navigation keys, move down to Cold Start and press the Set button.
4. Acknowledge the warning by selecting Yes.
5. The meter will prompt you to power down the meter within 15 seconds
6. The meter will take a little longer to start up. This is normal.
After a Cold Start is performed, the meter should be reconfigured using *JEMWare II* configuration software to program the meter for your specific application.



Note: If you still encounter issues after a Cold Start, try disconnecting the battery, remove power and re-apply power. Plug in battery after the meter starts up.

Default Time Displays

When a Cold Start is performed, certain time and date displays in the meter (for example, Date of Peak Demand) contain a default time/date until the meter records an actual value. This "non-value" displays as midnight, January 1, 1970. In other words, a time register will show 00.00.00 and a date register will show 01.01.70.

Note: When the meter is powered up, it will display the Jan 1, 1970 time and date until it completes the start-up process.

SITE DIAGNOSTICS

JEMStar II can be configured to monitor its operating environment and report suspicious conditions. This monitoring occurs in two forms: Meter Health & Status and Phasor Display.

Meter Health and Status

The Meter Health and Status display provides the current status of the meter. There is a selection on the right top of the Meter Health and Status display for printing this page

The screenshot shows the 'Meter Health and Status' window with the following data:

Trigger ID	Description	Value	Time\Date
1	1,Inst,VLL:A,<,100,0,105	1.475	11:16:30 06-Aug-2014
5	5,Inst,VLL:C,>,130,10,125	257.069	11:16:30 06-Aug-2014
6	6,Inst,PFV:P,<,0.7,10,0.75	0.000	15:52:25 07-Aug-2014

The following items are monitored in the Meter Health and Status display:

Meter Status:

This identifies the internal meter status. Green is normal. If red, you should be able to see additional detail by reading the Diagnostic Log from the meter. The meter status is also provided on the JEMStar Meter display.

Time Sync Status:

This is mainly used for external time sync options (IRIG-B and NTP). For IRIG-B, it will turn red when the IRIG-B time source is not detected. For NTP, it will display the status of the time server connected and will turn red when the signal is lost.

Battery Status:

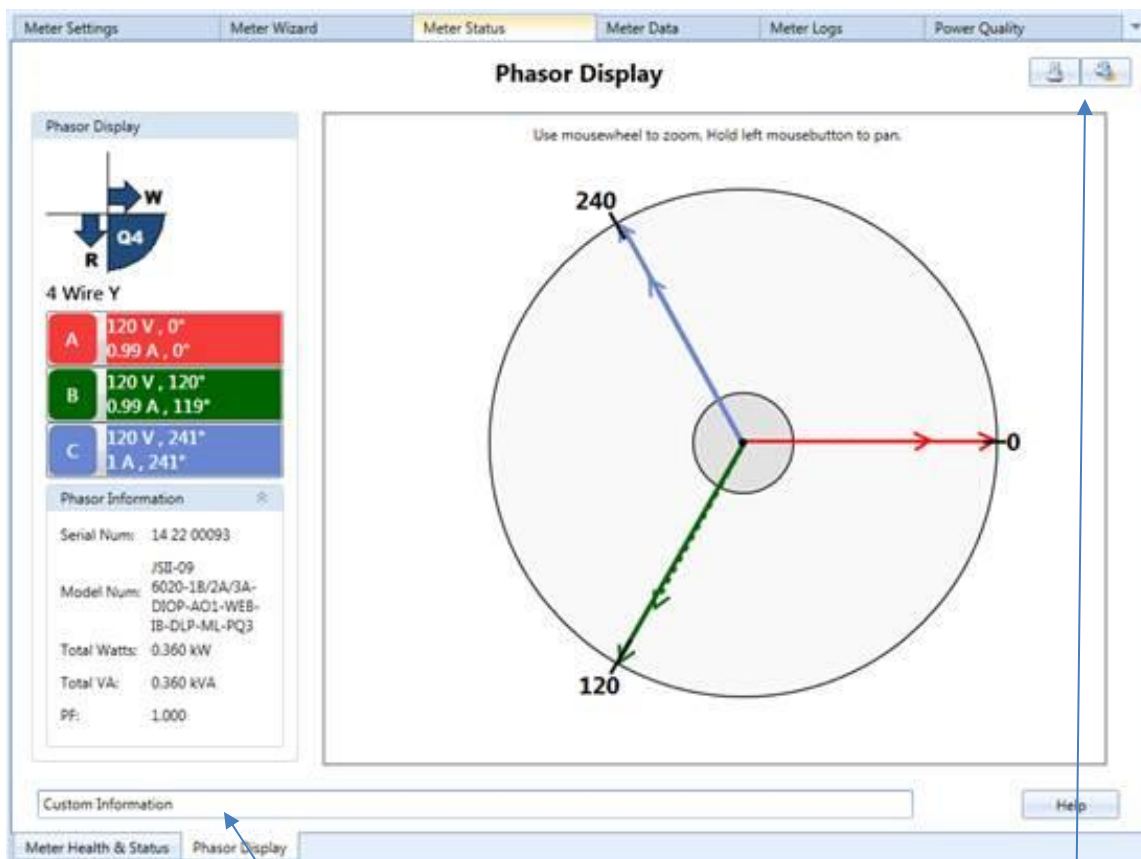
This indicates the status of the internal replaceable battery used to back up the time and date on the internal clock. Green indicates normal, yellow indicates that the battery should be replaced in 1-2 years and red indicates that you should replace the battery now. The same green/yellow/red indicator is provided on the meter display. The battery warning (red indicator) can be reset on the meter user menu display. Note: The internal battery is rated for 10 years under typical use. The battery monitor is conservative and assumes worse case where the battery is used almost continuously.

Triggered Alarms:

This is a display of all active alarms configured by a user trigger. The Alarm Log contains the history of all active alarms and previous alarms.

Phasor Display

The Phasor Display is available on the meter display and in JEMWARE Software as shown below. It provides quick verification of the site conditions and confirmation that it was wired correctly.



Phasor Display using JEMWare II

The Phasor display has a user field for entering custom information in case you wish to save or print this display. There is a selection on the right top of the phasor display for printing this page or saving it as a bitmap file.

ADVANCED FEATURES

TIME OF USE

JEMStar II maintains Time Of Use (TOU) information for Consumption, Average PF, Peak Demand, Time of Peak Demand, Coincident Demand, and Coincident PF registers.

The meter can differentiate among up to 9 possible TOU rates, with registers for each rate, as configured by the user. JEMStar II can have up to 8 rate changes per day. Each rate change is configured for the time of the change (resolved to 1 minute) and the rate code (A – H, or Total). Midnight is always assumed to be a rate change. The user must define the rate to begin at midnight of each day (midnight counts toward the limit of 8 changes per day).

JEMStar II will recognize up to 9 day types per season: each day of the week (Sunday through Saturday) plus two Holiday types (Type 1 and Type 2). A rate change schedule must be defined for each day type.

A given day is recognized as a particular day of the week based on the JEMStar II internal clock and calendar, unless that date is listed in the Holiday List. Any date in the Holiday List must be identified as a Type 1 or Type 2 Holiday. JEMStar II can store up to 200 holidays in the Holiday List.

JEMStar II is configurable for up to 4 season changes per year. The date (month, day, and year) of each season start, along with an indication of the season (Season 1, Season 2, Season 3, or Season 4) that starts on that date, is stored in the Season List. The Season List will hold up to 80 Season Start dates (4 per year for 20 years).

JEMStar II can be configured to force the present TOU rate in effect to any other programmed rate by triggering a contact closure input. The user must select a rate (1-8, or Total) to switch to when a closure is detected on the input. The rate then reverts to the normal scheduled rate when the contact opens.

To configure a meter for Time Of Use functions, consult the JEMWare II instruction manual 1079-699.

LOAD PROFILE

JEMStar II can record up to 16 Load Profile channels as a standard feature, or up to 32 channels as an added option. All Load Profile configurations are performed using JEMWare II software. Load Profile storage is such that if the available memory becomes full, the oldest record(s) are deleted from memory to make room for the most recent. Sometimes referred to as First In, First Out (FIFO). JEMStar II stores one single record at the end of each Load Profile interval. A Load Profile interval may end on any of the following conditions:

- On the hour (if configured for "internal Load Profile synchronization") and each multiple of the configured Load Profile interval length after the hour. Load Profile intervals may be configured to be 1, 5, 10, 15, 20, 30, or 60 minutes in length.
- On any time set, Daylight Saving Time adjustment, recognizable power outage, or other event that would cause a discontinuity in interval timing.
- On any event that may cause a discontinuity in registration so that register readings and equivalent Load Profile readings could not be reconciled. (E.g. Register Freeze, Billing Period Reset, Register Preset, etc.)

The Load Profile intervals resemble demand intervals, but can be set independently. The interval closures occur on even increments within the hour. For example, a 15-minute interval will begin on the hour and will close at 00:15; the next interval will close at 00:30; the next interval will close at 00:45; etc. At the end of each interval, the meter records the number of pulses accumulated since the last Load Profile interval closure or special event. When the Load Profile data storage memory is full, the meter will overwrite the oldest information. The number of days of storage available is determined by the Load Profile interval length and number of channels stored.

Each Load Profile interval contains one or more channels of data. The Load Profile Recording can be set up to record measurements in 16 bit (counts) with a scaling factor applied to the measurement (Km) or 32 bit values that can represent actual engineering values (no scaling required). When using 16 bit counts, each channel can store up to 16,383 counts per interval. When using 32 bit values, each channel can store measurements up to 1,073,741,824.

JEMStar II load profile storage will vary by the number of channels selected and the recording data interval. By configuring fewer channels and/or longer intervals, you can increase the number of days of storage.

Table 1 details the days available for the JEMStar II.

Each Load Profile channel can be configured to record one of the following:

- Any consumption quantity
- The number of pulses received in an interval on a contact closure input. Both make and break transitions are counted in the total.
- State of a contact input over the interval. If the contact was closed one or more times during the interval, the channel will record 1 count, otherwise zero.
- The average of any Instantaneous quantities over a Load Profile interval. In this case, the channel pulse count multiplied by the equivalent pulse constant shall give the average value, NOT the consumption in unit-hours, for the Load Profile interval.
- Accumulation in a Totalization channel.

For example, for a 3-element meter operating at 120 volts, 5 amps, 1.0 PF on every element, an equivalent pulse constant of 1.0 on all channels, and 15 minute Load Profile intervals, the Watthour Delivered channel will report 450 counts (120V x 5A x 3 elements / 4 intervals per hour). The Average Instantaneous Watt Delivered channel will report 1800.

Table 1: Approximate Number of Days of Load Profile Storage (16-Channel)

Interval Length	Number of Load Profile Channels															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	128	101	83	70	61	54	48	44	40	37	34	32	30	28	26	25
2	256	201	166	141	122	108	97	88	80	74	69	64	60	56	53	50
3	383	301	248	211	183	162	145	132	120	111	103	96	90	84	79	75
4	509	400	330	280	244	216	193	175	160	148	137	127	119	112	106	100
5	635	499	411	350	304	269	241	219	200	184	170	159	149	140	132	125
6	759	597	492	418	364	322	289	261	239	220	204	190	178	167	158	149
10	1095	981	809	688	599	530	475	431	394	363	336	314	294	276	260	246
12	1095	1095	956	821	714	632	567	514	470	433	401	374	350	329	311	294
15	1095	1095	1095	1016	885	783	702	637	583	537	498	464	434	408	385	365
20	1095	1095	1095	1095	1095	1029	923	837	766	705	654	610	571	537	506	479
30	1095	1095	1095	1095	1095	1095	1095	1095	1095	1029	954	889	833	783	739	700
60	1095	1095	1095	1095	1095	1095	1095	1095	1095	1095	1095	1095	1095	1095	1095	1095

JEMStar II will record certain events in the Load Profile system intermixed with regular interval data. Any event that would end a Load Profile interval will be recorded, including the following:

Power Fail

Indicates the meter has lost auxiliary power. If the meter does not have separate auxiliary power, Power Fail indicates the loss of all 3 phase inputs. The time of power failure & time of restoration are recorded.

Time Set

The beginning and end of a time set are recorded in load-profile memory. Time set can be performed at the meter or by use of serial communications.

Daylight-Saving Time

Adjustment events are stored. Changes are programmed via the JEMWare II program. The DST change start and stop times are recorded.

Test Mode

Entries and exits are recorded as events. No load-profile data is recorded during the Test Mode. Test Mode can be initiated at the meter or through serial communications.

Configuration Event

A configuration event is stored in the load-profile memory. Load-profile data is erased when any load-profile-related parameter is configured. The configuration event is executed only through serial communications.

Freeze Event

A freeze event will cause the meter to take a snapshot of the Normal- and Alternate-Mode registers. When the meter reads these registers via serial communications, the value stored at the time of the most recent freeze event is returned. This event is executed only via serial commands.

Demand Reset

Indicates the time of storage-register updates and register clearing. This command can be initiated from the meter or through serial communications.

Register Preset

Indicates the time of storage-register presetting when used. This command can be initiated from the meter or through serial communications.

Midnight

Indicates when midnight occurs in the Load Profile sequence of events.

All recorded events include the following information:

- The date and time at which the event occurred
- A description of the type of event
- The counts for each configured channel from the beginning of the interval until the event occurred
- If applicable, the time at which the event ended (such as for a Time Set or power outage).

Load-Profile Retrieval

Load Profile may be retrieved in any of the following segments:

- All complete Load Profile records in memory, oldest first.
- All complete Load Profile records since the last Load Profile read, oldest first.
- All Load Profile records for the last N days, for N = 0 through 60. For any number of days requested, the meter will send that number of complete day's records plus whatever records have been stored in the current day.

For example, requesting 0 days gives only today's records since midnight. Requesting 2 days gives all records for the preceding 2 days plus the present day's records. If the Load Profile memory does not contain enough days of records to fulfill the request, the meter will send all records presently stored.

Data can be retrieved with Ametek Power Instruments' JEMWARE II Software, *JEMRead* software or by Itron's MV-90 software. Connection to the meter can be via the optical port, RS-232 / RS-485 serial port, Ethernet or a modem.

External-Synchronized Load-Profile Interval Closures

External interval tracking in the meter affects the load-profile channels. For that reason, load-profile interval length should match demand-interval length.

When configured for external synchronization, the meter uses two time sources—one for determining interval closure and one for the meter's real-time clock. Data skewing is possible if a synchronization pulse occurs on the load-profile interval boundary.

External Control of Load Profile Recording

JEMStar II can be optionally configured to only record Load Profile data during externally triggered periods. This can be user-selected on a per channel basis, which means that some channels can record

constantly, and some can record upon command from an external source. JEMWare II can be used to configure any Load Profile channel to record when the TOU Rate Override contact input is ON.

STATUS WORD

The Status Word provides the current status of the meter. The Status Word can be configured as a Display Register and logged into Load Profile for each interval. The Status Word consists of two 16 Bit words: System Bit and Triggered Bit. Each individual bit provides the status of a particular item as listed below:

System Bit

This provides the current status of the meter with regards to internal diagnostics and external influences. The following items and their location within the 16 bit word are shown below:

Bit #	Status Indicator	Description
1	Battery Failure	Indicates that the internal battery needs replacing. Stays active until the battery reset is performed.
2	Auxiliary Power Loss	Future
3	General Failure	Indicates an internal error which could include a Service comm error, PQ Firmware CRC error, Metrology Firmware CRC error, Service Firmware CRC error, PQ Comm error, Metrology Comm error, CRC Error in Calibration Data, PQDIF Storage error, Config Update Request. (Note: all of these are reported separately in the Diagnostic Log)
4	Load Profile overflow	The Load Profile Counts have exceeded the maximum 16 bit storage range of
5	Pulse Output overflow	Pulse output rate has exceeded 10 pulses/sec
6	Loss of Time Sync	Indicates a loss of external time sync from NTP or IRIG-B
7	NTP Time Sync Drift	It shall go into alarm when the internal clock is more than the configurable tolerance Ts which is adjustable from 10ms to 10,000 msec. Default is 500msec
8	DST	Indicates when the meter is using Daylight Savings Time. DST time and dates are configured in JEMWARE.
9	Terminal / Service Cover Removed	Indicates that the terminal cover or service cover have been opened up.
10	Manual Time Change	The meter time was changed manually.
11	Configuration Change	The meter configuration was changed.
12	Firmware Changed	The meter firmware was changed.
13-16	Future	

Note: All of the above status indicators will stay active for the duration of the condition with a minimum duration equal to the current Load Profile Interval.

For example; if using a 15 minute Load Profile Interval, and the terminal cover was removed for 5 seconds, the 'Terminal Cover' bit would stay active during the 15 minute interval in which it occurred.

The system bit will be presented as a Hex word which can be converted into a 16 bit string with 1's or 0's representing the status of each item above. As shown below; a System Bit presented as: 00 21 hex (Binary: 0000 0000 0010 0001) would indicate a 'Battery Failure' and 'Loss of Time Sync'.

Example	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
Bit Position	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Trigger Bit

This provides the current status of the meter with regards to alarm triggers that you can configure in JEMWARE. A typical example of various triggered alarm bits is shown below:

Bit	Status Indicator	Description
1	Loss of voltage V1	$<0.4 \times V_n$
2	Loss of voltage V2	$<0.4 \times V_n$
3	Loss of voltage V3	$<0.4 \times V_n$
4	Overcurrent I1	$>1.3 \times I_n$
5	Overcurrent I2	$>1.3 \times I_n$
6	Overcurrent I3	$>1.3 \times I_n$
7	Loss of Voltage V1 with Current	$V1 < 0.4 \times V_n \ \& \ I1 > 0.05 \times I_n$
8	Loss of Voltage V2 with Current	$V2 < 0.4 \times V_n \ \& \ I2 > 0.05 \times I_n$
9	Loss of Voltage V3 with Current	$V3 < 0.4 \times V_n \ \& \ I2 > 0.05 \times I_n$
10	Phase Voltage Rotation Error	Angle between two phases < 90 and > 150 degrees apart
11	Phase Current Rotation Error	Angle between two phases < 60 and > 180 degrees apart
12	Voltage Unbalance	$>0.05 \times V_n$
13	Current Unbalance	$>0.05 \times I_n$
14	External Fault 1	Via Digital Input
15	External Fault 2	Via Digital Input
16	Future	

V1 = Voltage Phase A
I1 = Current Phase A
Vn = Nominal Voltage

V2 = Voltage Phase B
I2 = Current Phase B
In = Nominal Current

V3 = Voltage Phase C
I3 = Current Phase C

Some of the trigger bits can be a combination of alarm triggers as shown in Bits 6-8

Note: All of the above status indicators will stay active for the duration of the condition with a minimum duration equal to the current Load Profile Interval.

ID	Enabled	Trigger Measurement	Trigger On	Phase	Operator	Alarm	Trigger Delay	Reset	Reset Delay	Digital Output	Sag/Swell	High Speed RMS	Waveform Capture
1	<input checked="" type="checkbox"/>	Instantaneous	VoltsL-N	A	<	40	0	40.12	0	None	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Med
2	<input checked="" type="checkbox"/>	Instantaneous	VoltsL-N	B	<	40	0	40.12	0	None	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Med
3	<input checked="" type="checkbox"/>	Instantaneous	VoltsL-N	C	<	40	0	40.12	0	None	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Med
4	<input checked="" type="checkbox"/>	Instantaneous	AmpsRMS	A	>	1.3	0	1.2961	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No
5	<input checked="" type="checkbox"/>	Instantaneous	AmpsRMS	B	>	1.3	0	1.2961	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No
6	<input checked="" type="checkbox"/>	Instantaneous	AmpsRMS	C	>	1.3	0	1.2961	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No
7	<input checked="" type="checkbox"/>	Instantaneous	AmpsRMS	A	>	0.05	0	0.04985	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No
8	<input checked="" type="checkbox"/>	Instantaneous	AmpsRMS	B	>	0.05	0	0.04985	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No
9	<input checked="" type="checkbox"/>	Instantaneous	AmpsRMS	C	>	0.05	0	0.04985	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No
10	<input checked="" type="checkbox"/>	Instantaneous	Volts Imbal...	None	>	5	0	4.985	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No
11	<input checked="" type="checkbox"/>	Instantaneous	Amps Imba...	None	>	5	0	4.985	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No

Assignment of triggers to trigger bit number

Trigger bit #7 is a combination of trigger #1 and #7

Typical JEMWARE Config for the Status Word.

Displaying the Status Word

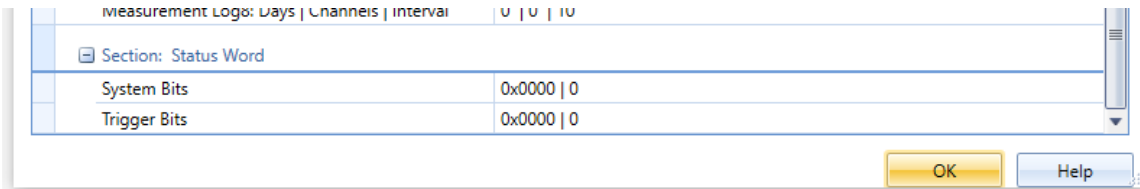
The Status Word can be presented when you connect to a meter in the Connection Status screen, as a display register, in load profile and in the communication protocols.

The value will be shown in Hex format which needs to be converted into Binary to determine the status of the 16 individual bit positions.

Some examples of this are shown below:

Meter Connection Status

When you connect to the meter, the Connection Status screen will indicate the current value for the Status Word System Bit and Trigger Bit, as shown below.



Display Register

If a display register is configured for the Status Word, the value will be shown when you read the register. Keep in mind that the current value for any register will be shown right after a meter freeze.

Category	Type	Description	Quantity	Phase	Direction	Value	Storage	Units
StatusWo...	TriggerBit	StatusWord,TBit	None	None	None	0x0070	None	None
StatusWo...	SystemBit	StatusWord,SBit	None	None	None	0x0400	None	None
Time	PresentTimean...	Time,PresTime&Date	None	None	None	05/14/2020 14:58:5		
Register	Instantaneous	C Phase Primary Volts	VoltsL-N	C	None	121.76		

Status Word
System BitsConfig Change;

Note: When you hold your mouse over the Status Word displayed in JEMWARE, it will indicate the individual bit status. As shown above, the mouse indicates that the System Bit result of 0x0400 is a configuration change.

The Trigger Bit Hex value of 0x0070 in binary is: 0000 0000 0111 0000. This reflects trigger bit numbers 5, 6 and 7 in alarm.

This is derived from the following Trigger Setup:

Trigger Setup

Advanced Trigger Configuration

Nominal % Calculations for Triggers

Nominal Voltage:
 PQ Voltage Measurement:

Threshold % Alarm Hysteresis % Reset

Sag:

Swell:

Interruption:

RVC:

Status Triggers

Bit	Enabled	Trigger/Combination
3	<input checked="" type="checkbox"/>	3
4	<input checked="" type="checkbox"/>	4
5	<input checked="" type="checkbox"/>	5
6	<input checked="" type="checkbox"/>	6
7	<input checked="" type="checkbox"/>	5 & 6

ID	Enabled	Trigger Measurement	Trigger On	Phase	Operator	Alarm	Trigger Delay	Reset	Reset Delay	Digital Output	Sag/Swell	High Speed RMS	Waveform Capture	Web
1	<input type="checkbox"/>	Instantaneous	VoltsL-N	Any	<	108	0	110.4	0	None	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	High	<input type="checkbox"/>
2	<input checked="" type="checkbox"/>	Instantaneous	VoltsL-N	Any	>	132	0	129.6	0	None	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	High	<input type="checkbox"/>
3	<input checked="" type="checkbox"/>	VoltageInterr...	VoltsL-N	All	<	24	0	25.2	0	None	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
4	<input checked="" type="checkbox"/>	RapidVoltage...	VoltsL-N	Any	>	6	0	1.8	0	None	<input type="checkbox"/>	<input checked="" type="checkbox"/>	No	<input type="checkbox"/>
5	<input type="checkbox"/>	Instantaneous	VoltsTHD	A	>=	2	0	1.994	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No	<input type="checkbox"/>
6	<input type="checkbox"/>	Instantaneous	AmpsTHD	A	>=	1	0	0.997	0	None	<input type="checkbox"/>	<input type="checkbox"/>	No	<input type="checkbox"/>

Load Profile

If a load profile channel is configured for the Status Word, it will show the current status for every interval. In the screenshot below, Load Profile Channel 5 is configured for the System Bit and Channel 6 is used for the Trigger Bit.

Record No	Event Type	Start Time	End Time	Channel 1 Type : Consumption, Quantity : Whr, Phase : Polyphase, Direction : Delivered, Km Value : 1, TLC : 0, Interval Length : 5	Channel 2 Type : Consumption, Quantity : Whr, Phase : Polyphase, Direction : Received, Km Value : 1, TLC : 0, Interval Length : 5	Channel 3 Type : Consumption, Quantity : VARHr, Phase : Polyphase, Direction : Delivered, Km Value : 1, TLC : 0, Interval Length : 5	Channel 4 Type : Consumption, Quantity : VARHr, Phase : Polyphase, Direction : Received, Km Value : 1, TLC : 0, Interval Length : 5	Channel 5 Type : StatusWord, Quantity : SystemBit, Phase : None, Direction : None, Km Value : 0, TLC : 0, Interval Length : 5	Channel 6 Type : StatusWord, Quantity : TriggerBit, Phase : None, Direction : None, Km Value : 0, TLC : 0, Interval Length : 5
0	Conf...	05/14/2020 15:28:4...	05/14/2020 15:28:4...	0.00	0.00	0.00	0.00	0x0400	0x0070

TriggerBit: Bit 5; Bit 6; Bit 7;

The Hex values displayed in Load Profile via JEMWARE will be identified by holding the mouse over them. As shown above, the trigger bit value in Hex 0x0070 is equal to trigger bits 5, 6 and 7.

POWER QUALITY

The JEMStar II can measure, capture and record power measurements related to power quality. The typical power quality issues include a variation of voltage above or below operating requirements and the presence of transients and harmonics. To capture these variations of the pure sine wave, there are several methods used including continuous recording of various power measurements and recording data after a pre-configured trigger. Once the data is collected, it needs to be analyzed so you can determine the type of issue, root cause and corrective action.

The JEMStar II meter has a variety of tools provided for your power quality applications:

- Sag/Swell/Outage Recording
- Waveform Capture
- High Speed RMS Recording
- Harmonic/Interharmonic Recording
- Flicker Measurement Recording
- Measurement Log (for saving recorded values)

Every JEMStar II meter includes the Sag/Swell/Outage Recording. When enabled, voltage sags and swells will record the time and date of the occurrence, number of cycles duration, phase that triggered the anomaly and the minimum/maximum/average current, voltage, power factor, THD and frequency during that event. For outages (interruptions), we record the start and end times/dates.

There are options available to enable the other power quality tools:

Option	Name	Description
PQ	PQ Ready	Meter can be upgraded in the field for a future PQ Option
PQ1	PQ Basic	High Speed RMS
PQ2	PQ Advanced	Waveform capture, Harmonic Recording, Flicker (includes Measurement Logging)
PQ3	PQ Max	PQ Basic and PQ Advanced (Option PQ1 and PQ2)

PQ Ready (Option PQ)

When meters are equipped with this option, they include all the hardware to support a future Power Quality Upgrade to option PQ1, PQ2 or PQ3. Once the specific option is purchased, the meter can be enabled with a software key provided by AMETEK. This option is useful when you may want a future PQ upgrade without having to change out the meter.

PQ Basic (Option PQ1)

This option provides the ability to record power quality anomalies with high speed RMS voltage and current measurements. The recording starts upon a pre-configured trigger which can be assigned to any instantaneous measurements.

With this option, the meter will record the following:

- Record RMS voltage, current and phase angle per phase
 - 100/120 Hz recording rate (2 measurements per cycle)
 - 0 to 0.5 second configurable pre-fault recording (recording prior to trigger)
 - 0 to 1.0 second configurable post-fault recording (recording after it returns to normal)
 - Maximum 60 second total recording time

PQ Advanced (Option PQ2)

This option provides the ability to record power quality anomalies with waveform capture, harmonic and flicker recording.

The waveform capture recording starts upon a pre-configured trigger which can be assigned to any instantaneous measurements. With this option, the meter will record the following:

- Voltage and current per phase
 - Three recording rates to choose from.
 - Low Resolution Recording
 - 900 Hz Recording rate (16 samples per cycle)
 - 0 to 30 cycle Pre-Fault/Post-Fault
 - 2 to 960 cycle Recording Time
 - Medium Resolution Recording
 - 7,680 Hz Recording rate (128 samples/cycle)
 - 0 to 10 cycle Pre-Fault/Post-Fault
 - 2 to 240 cycle Recording Time
 - High Resolution Recording
 - 30,720 Hz Recording rate (512 samples/cycle)
 - 0 to 5 cycle Pre-Fault/Post-Fault
 - 2 to 30 cycle Recording Time

Values shown for 60 Hz.

In addition to waveform capture, the PQ2 option provides the recording of harmonics and flicker. The measurements we can record include:

- Harmonics
 - Voltage and Current Magnitude per phase up to 64th
 - Voltage and Current Phase Angle per phase up to 64th
 - Voltage and Current THD to 128th
- Interharmonics
 - Voltage and Current Magnitude per phase up to 50th
- Flicker
 - Pst, Plt, Pinst

These measurements are recorded in the Measurement Log with selectable recording intervals from 150/180 cycles to 120 minutes. Refer to the next section on Measurement Log for more details.

PQ Max (Option PQ3)

This option combines options PQ1 and PQ2 together providing all features.

Power Quality Software

The JEMWARE Software used to configure the meter is also used to retrieve and display the power quality data. This software is included with every meter. Other third party software applications can be used to examine our power quality data saved in the PQDIF file format.

Power Quality Recording

The JEMStar II has several ways to measure and capture Power Quality data. There are options for short and long term recording and the data collected can range from low to high resolution. The JEMStar II can be used to collect all of the above simultaneously so that you can get a complete picture of the power quality event. The recording of power quality data can occur continuously or upon a trigger that you configure an alarm threshold with.

The methods used to record power quality data include a Measurement Log for trending, Sag/Swell Snapshot, High Speed RMS and Waveform Capture. The different modes are described below.

Measurement Log (option ML, PQ2, PQ3)

This is used for long term continuous trending of steady state values. Data can be recorded as minimum, maximum or average values. The recording rate can be configured from every 150/180 cycles to every 120 minutes. Typical measurements used for logging include voltage, current, harmonics, flicker, frequency, power factor and imbalance. This data can be used for analyzing power quality data from a high level. It's also useful for energy management studies and real time power analysis.

Sag/Swell/Outage Capture

This is a recording of voltage sags and swells upon a trigger. The recording is a snapshot of the event, recording min/max/avg values during the Sag or Swell. The measurements include volts, amps, THD, Power Factor and Frequency. This collection of data can provide a high-level overview of how the sag or swell occurred and what might have caused it. Outages (Interruptions) are logged with the time and date when you lose all three phases.

High Speed RMS (option PQ1, PQ3)

This is a recording of RMS voltages and current upon a trigger. The values are recorded every half cycle and can start prior to the trigger and end after the trigger returns to normal. The RMS values can simplify the analysis of sags and swells.

Waveform Capture (option PQ2, PQ3)

This is a recording of peak voltages and current upon a trigger. The values can be recorded at three different rates (16 samples/cycle, 128 samples/cycle or 512 samples/cycle). The recording can start prior to the trigger and end after the trigger returns to normal. The slower recording rates have lower resolution but with longer recording times. The faster recording rates have higher resolution but with a shorter recording time. The selection of recording rates is best matched with the type of power quality phenomena you wish to capture.

Power Quality Recording Modes

The JEMStar II Meter can record power quality data continuously or upon a trigger that you configure. For continuous recording, you select a measurement, recording interval duration and how the data is recorded. For triggered recording, you select a measurement, alarm threshold to start the recording and the type of recording methods.

Continuous Recording

The JEMStar II Meter uses the Measurement Log Option for continuously recording measurements over pre-selected time intervals.

Measurement Log

The Measurement Log is an option to record up to 100 channels, divided into two groups of 50. While similar to Load Profile, the Measurement Log includes a wider choice of measurements and recording intervals and it does not record the various metering events like meter freeze, midnight event, billing reset, etc. The measurement log allocates its non-volatile memory using FIFO storage (first in, first out) and all measurements are stored in 32 bit format.

The Measurement Log is included with option PQ2 and PQ3 but can be included on its own without either Power Quality Option. (Note: You need the PQ options to record items like harmonics and flicker) Measurements can be recorded as individual phases or the total polyphase quantities. An example of a single channel for the measurement log would be: Phase A Voltage Minimum
To record the min/max/avg for all 3 Phase voltages would require 9 channels.

Measurements:

The available measurements include:

- **Metering**
Instantaneous: Volts, Amps, Watts, VA, VARs, PF, Freq, Q, Volts², Amps², Unbalance
Integrated: Whr, VARhr, VAhr, Qhr, Amphr, Amp²hr, Volt²hr
- **Harmonics**
Magnitude and Phase Angle of harmonics 2-64, THD, TDD, Crest Factor
- **Interharmonics**
Magnitude of inter harmonics 2-50
- **Flicker**
Short term, long term, instantaneous
- **Digital Inputs**
Contact Inputs
- **Fault**
Positive, Negative, Zero Sequence Components

Note: Harmonic, Interharmonic, Flicker and Fault measurements are only available with options PQ2 and PQ3. For a full list of measurements, refer to the back of the manual.

Measurement Calculation Methods:

The measurement calculation method is based on whether the meter is equipped with a Power Quality Option (PQ1, PQ2, PQ3). Meters with a Power Quality Option will follow calculation methods per standard IEC-61000-4-30. Meters without Power Quality will use the calculation methods used for metrology (registers, load profile, etc).

Meters with PQ Options (PQ1, PQ2, PQ3)

For Watts, VARs, VA, Power Factor and other related measurements, we use the values that are calculated by our metrology every half cycle.

For measurements like Volts, Amps, Unbalance, Harmonics, Sequence Components, etc, we use the IEC-61000-4-30 standard which provides a common measurement method for all devices. Measurements are calculated over a 200 msec interval: 10/12 cycles (10 cycles for 50 Hz and 12 cycles for 60 Hz).

For a measurement selected as Average, we take the 200 msec measurements and average them over the total recording interval. (Note: IEC-61000-4-30 defines these recording intervals as 150/180 cycles, 10 minutes and 2 hours. For other selectable intervals, we do similar)

For a measurement selected as minimum or maximum, we examine each 200 msec interval and record the minimum and maximum value over the total recording interval. For example, if the Recording Interval was selected as 10 minutes, we would look at the qty (3000) 200 msec intervals to determine what the minimum and maximum value were.

Meters without Power Quality enabled (includes option PQ: PQ Ready)

On meters with no power quality enabled, we calculate the measurement log values similar to how we calculate metrology for registers and load profile. For Watts, VARs, VA, Power Factor and other related measurements, we use the values that are calculated by our metrology every half cycle. For Volts and Amps RMS, we use the values that are calculated by our metrology every full cycle with updates every half cycle.

For a Volts or Amps measurement selected as Average, we take the one cycle calculations updated every half cycle and average them over the total recording interval. For example, if the recording interval is 10 minutes, we will average 72,000 calculations for 60 Hz.

For a Volts or Amps measurement selected as minimum or maximum, we examine each calculation based on a full cycle with updates every half cycle. We then look for the minimum value across all of these calculations until we reach the total recording interval.

Unbalance and THD Measurements

In addition to above, the calculations for Unbalance and THD vary whether your meter is equipped with the PQ Options.

On meters equipped with power quality enabled, unbalance is calculated using the ratio of Negative Sequence and Zero Sequence Ratios. Percent THD is calculated per IEC61000-4-7, and includes harmonic content (up to and including the 128th harmonic).

On meters equipped with no power quality, unbalance is calculated using the ratio of the maximum deviation from average over the average. Percent THD is calculated using the Total RMS (over all harmonics) and the RMS over the Fundamental frequency. (typical for volts and amps)

Measurement Recording Methods:

For each of the above measurements, the measurement can be recorded as:

- **Minimum**
Lowest recorded value over the recording interval
- **Maximum**
Highest recorded value over the recording interval
- **Average**
Average value calculated over the recording interval
- **Total**
Total value recorded over the interval (used for integrated measurements)
- **Snapshot**
Value recorded at the end of that interval

For each measurement, you can select whether it is a primary or secondary value, engineering units for the value (units, kilo, mega, etc) and whether to include transformer compensation (if applicable).

Recording Interval

Each group of 50 measurement channels can have it's own recording interval. The available recording intervals are:

- 150/180 Cycles (150 cycles for 50 Hz, 180 cycles for 60 Hz)
- 1 minute
- 2 Minutes
- 3 Minutes
- 4 Minutes
- 5 Minutes
- 10 Minutes
- 15 Minutes
- 20 Minutes
- 30 Minutes
- 60 Minutes
- 120 Minutes

Measurement Log Storage:

The Measurement Log is stored inside the meter in an Internal Log and in PQDIF Format (if selected)
The Internal Log has a maximum storage of 1,095 days.

The meter memory will support approximately 1,460,000 measurements per 50 channel log.

Example:

If using all 50 channels with a recording interval every 10 minutes, that's 144 x 50 channels per day = 7,200 measurements per day. With a maximum of 1,460,000 measurements, that equates to approximately 203 days.

If the Power Quality configuration in JEMWARE includes the measurement log in the PQDIF file, the measurements will be stored in a daily file starting at midnight and ending in 24 hours.

Measurement Log Display:

The Measurement Log can be retrieved via JEMWARE and downloaded into Excel and CSV formats. The Measurement Log can be displayed in JEMWARE as shown below.

Retrieval Settings

Measurement Log 1 Measurement Log 2

Retrieval Selection

Days 1
 Date Range 2017-01-12 - 2017-01-12
 Read All

Recording Status

Days 2
Channels 28
Interval 10

Record No	Start Time	End Time	Channel : 1, VoltsL-N, Instantaneous, None, A	Channel : 2, VoltsL-N, Instantaneous, None, B	Channel : 3, VoltsL-N, Instantaneous, None, C	Channel : 4, VoltsL-N, Instantaneous, None, A	Channel : 5, VoltsL-N, Instantaneous, None, B	Channel : 6, VoltsL-N, Instantaneous, None, C	Channel : 7, VoltsL-N, Instantaneous, None, A
1	2017-01-12 00:00:00	2017-01-12 00:10:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
2	2017-01-12 00:10:00	2017-01-12 00:20:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
3	2017-01-12 00:20:00	2017-01-12 00:30:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
4	2017-01-12 00:30:00	2017-01-12 00:40:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
5	2017-01-12 00:40:00	2017-01-12 00:50:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
6	2017-01-12 00:50:00	2017-01-12 01:00:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
7	2017-01-12 01:00:00	2017-01-12 01:10:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
8	2017-01-12 01:10:00	2017-01-12 01:20:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
9	2017-01-12 01:20:00	2017-01-12 01:30:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
10	2017-01-12 01:30:00	2017-01-12 01:40:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
11	2017-01-12 01:40:00	2017-01-12 01:50:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
12	2017-01-12 01:50:00	2017-01-12 02:00:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000
13	2017-01-12 02:00:00	2017-01-12 02:10:00	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	144000.0000	143856.0000

When the measurement log is stored in PQDIF format, it can be displayed graphically in JEMWARE as shown below.

Observation

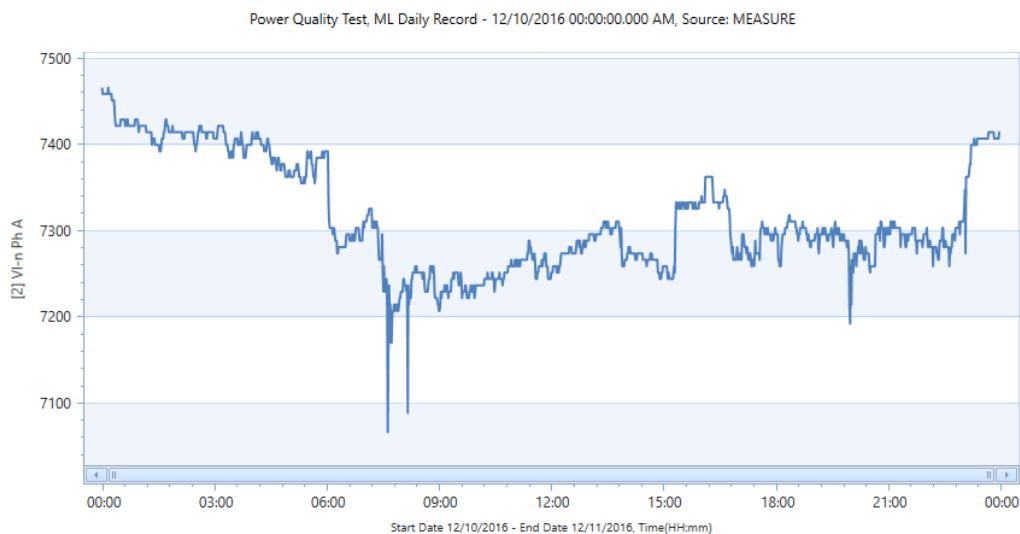
[0] 12/10/2016 00:00:00

Quantity

ID_QT_VALUELOG

Channel

- [0] Pst Ph A
- [1] Pit Ph A
- [2] VI-n Ph A
- [3] VI-n Ph B
- [4] VI-n Ph C



Triggered Recording

For the triggered recording, you set an alarm threshold for a measurement (Volts, THD, Power Factor, etc) and then you select the type of recording method, such as Sag/Swell snapshot, High Speed RMS or Waveform Capture.

Up to 64 triggers can be created; each one with it's own triggering criteria and recording modes.

Trigger Measurements

Category	Measurements			
Instantaneous	Volts	Frequency	Watt	Volt ²
	Amps	Power Factor	VAR	Amp ²
	Volts THD %	Volts Imbalance	VA	
	Amps THD%	Amps Imbalance	Q	
Power Quality	Flicker	TDD	Volts THD Odd %	Volts THD Even%
	Volts THD %	TDD Odd	Amps THD Odd%	Amps THD Even%
	Amps THD%	TDD Even	Crest Factor	
Fault	Negative Sequence, Positive Sequence, Zero Sequence			
Digital Input	On/Off			

Trigger Operation

The measurements used for triggers are calculated with a full cycle of sampled data updated every half cycle. The measurements are sampled at a fixed rate of 512 samples per cycle. Voltage Sag/Swell triggers have the option of using Class A or Class S triggers as described in the next section.

Note: When PQ is enabled in the meter, some measurements; like Sequence Components and Harmonics are calculated over 10/12 cycle intervals.

Digital Input Triggers have a resolution of 100 msec which means the 'ON State' must be at least 100 msec in duration. Since there could be a 100 msec delay to start the capture, make sure you have adequate pre-trigger settings >100 msec so that you don't miss the start of the anomaly.

Trigger settings can be filtered by adding delays in milliseconds. Trigger delays extend the time before a trigger is activated to help reduce nuisance alarms. A setting of 0 indicates no delay. There is a separate setting for the trigger reset (Hysteresis). This setting determines the level when the trigger returns to normal.

When a trigger is activated, it will turn the Alarm indicator on the meter to red and the trigger will be recorded in the Alarm Log which can be retrieved by JEMWARE. The Alarm Log indicates the trigger number, value of the trigger and time and date when it triggered. A separate log entry keeps track when the trigger returns to normal.

In addition to logging the alarm, you can select several items that can be activated by the triggered alarm such as:

- Digital Output (must have the DIO option)
- Sag/Swell Capture
- High Speed RMS Recording
- Waveform Capture Recording (low, medium, high resolution)

Note: *Some or all of these selections are available depending on the measurement and options installed in the meter. For example, The Sag/Swell capture only applies to Voltage triggers; High Speed RMS and Waveform capture require the power quality options.*

Voltage Sag/Swell Triggers:

Voltage Sag/Swell triggers can operate in accordance to IEC 61000-4-30 Class A or Class S. Both Class A and Class S use a sample rate of 256 samples per half cycle based on the fundamental period. Both use the same A/D data stream. In both cases, the calculation windows are exactly one cycle long, and are updated every half cycle. The difference is the placement of the calculation windows with respect to the waveform.

- Class A: The calculation windows are synchronized to fundamental zero crossings.
- Class S: The calculation windows are not synchronized to any zero crossings.

In most cases, the two methods will provide similar results. They could provide different results with the presence of transients and harmonics that could shift the zero crossover point.

The Class A triggers only apply to voltage triggers used for Sag/Swell detection.

The meter will only allow a single set of voltage triggers for Sag and Swell capture. The trigger setup needs to use a phase selection of ‘Any’ which provides a trigger from any one phase.

The top of the trigger screen provides a tool to set the voltage triggers for Sags and Swells using a % of nominal as opposed to specific magnitudes.

Once you adjust your settings, you select the ‘Apply to Sag/Swell Triggers’ button which will transfer the settings to your Voltage Sag/Swell triggers below.

Advanced Configuration

Sag/Swell Nominal % Calculations

Threshold %	Alarm	Hysteresis %	Reset	Nominal Voltage:
Sag 90	108.00	Sag 2.22	110.4	120.00
Swell 110	132.00	Swell 1.82	129.6	

[Apply to Sag/Swell Triggers](#)

Class A Sag/Swell Selection

Class A:

	ID	Enabled	Trigger Measurement	Trigger On	Phase	Operator	Alarm	Trigger Delay	Reset	Digital Output	Sag/Swell	High Speed RMS	Waveform Capture
	1	<input type="checkbox"/>	Instantaneous	VoltsL-N	Any	<	108	0	110.4	None	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	High
	2	<input type="checkbox"/>	Instantaneous	VoltsL-N	Any	>	132	0	129.6	None	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	High
	3	<input type="checkbox"/>	Instantaneous	VoltsTHD	Any	>=	10	100	9.97	None	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Med
	4	<input type="checkbox"/>	Instantaneous	AmpsTHD	Any	>=	10	100	9.97	None	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Med
	5	<input type="checkbox"/>	PowerQuality	Pst	A	>=	2	0	1.994	None	<input type="checkbox"/>	<input type="checkbox"/>	Low
	6	<input type="checkbox"/>	PowerQuality	Pst	B	>=	2	0	1.994	None	<input type="checkbox"/>	<input type="checkbox"/>	Low
	7	<input type="checkbox"/>	PowerQuality	Pst	C	>=	2	0	1.994	None	<input type="checkbox"/>	<input type="checkbox"/>	Low
	8	<input type="checkbox"/>	Instantaneous	FreqHz	A	>=	60.5	0	60.3185	None	<input type="checkbox"/>	<input type="checkbox"/>	No
	9	<input type="checkbox"/>	Instantaneous	Volts Imbalance	None	>=	1.5	0	1.4955	None	<input type="checkbox"/>	<input type="checkbox"/>	Low
	10	<input type="checkbox"/>	Instantaneous	Amps Imbalance	None	>=	50	0	49.85	None	<input type="checkbox"/>	<input type="checkbox"/>	Low

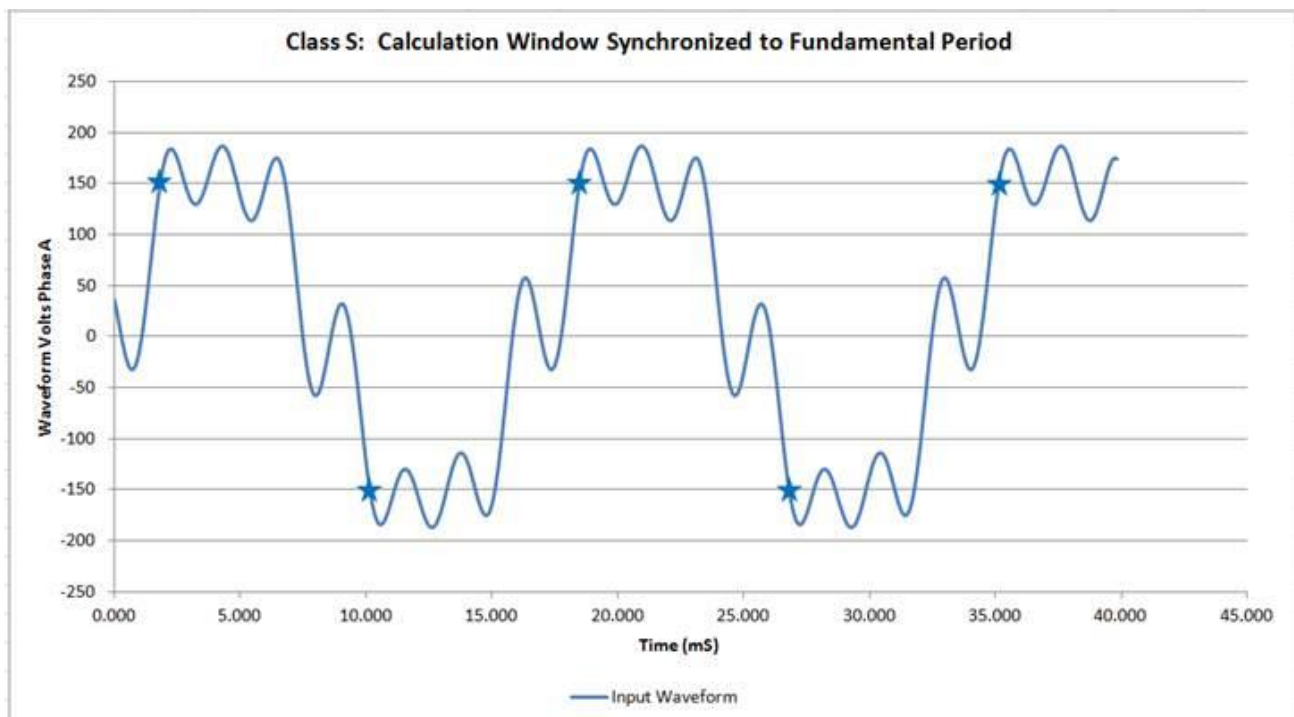
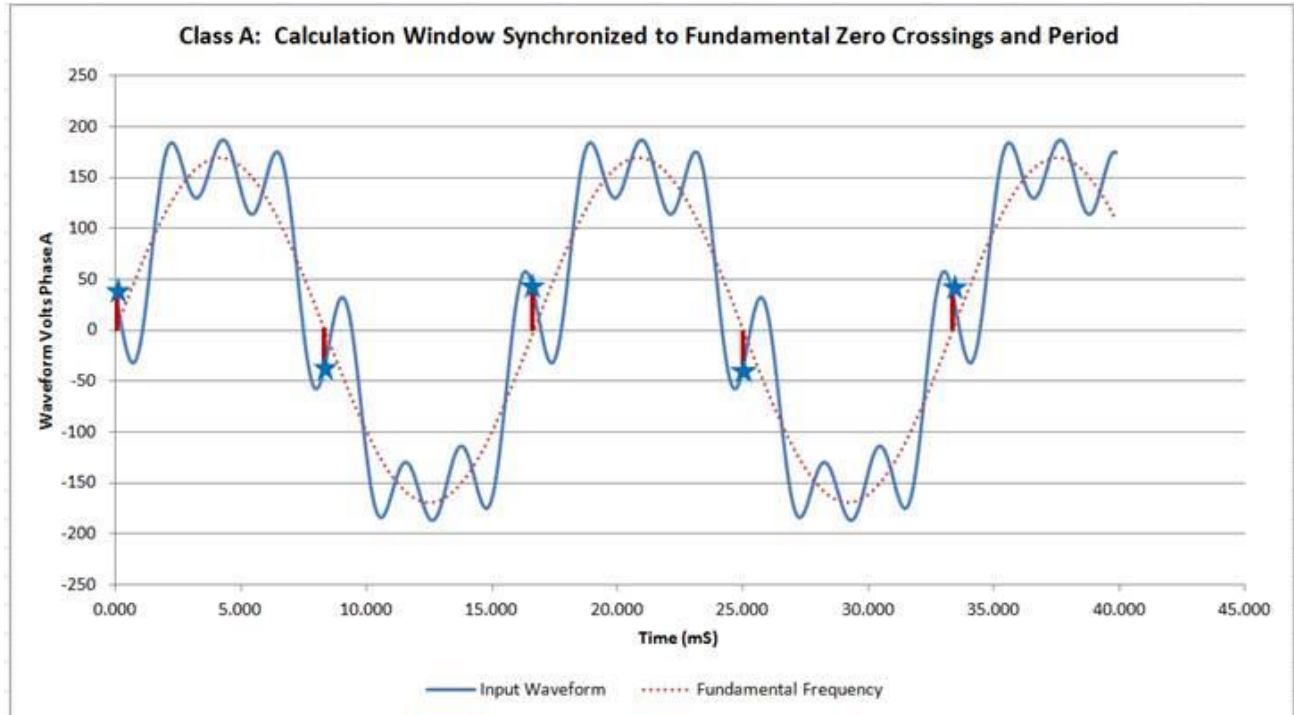
Note: You must have a voltage sag trigger pre-configured to make the ‘Apply’ button work. A voltage Sag/Swell trigger is the selection of Instantaneous Voltage
When configuring triggers, you can select to trigger based on IEC-61000-4-30 Class A for Sags and Swells.

When selecting High Speed RMS and Waveform Capture, you need to configure how these recordings will operate in the Power Quality Setup.

Comparison of Class A to Class S Voltage Sag/Swell Triggering

Class A triggering is synchronized to the zero crossings where Class S is synchronized to the fundamental period. In the example below, the waveform has multiple zero crossings.

Refer to the plots below to see how the calculation windows differ between Class A and Class S.



Voltage Sag / Swell / Outage Detection

The JEMStar II Meter comes equipped with Power Quality Sag/Swell Detection and Logging of Events. This is configured in the meter using our JEMWARE Configuration Software.

Sag / Swell /Outage Recording is used for capturing power quality events related to voltage. Voltage Sags occur when voltages drop below nominal levels for short periods of time. Voltage Swells occur when voltages rise above nominal levels. Outages are Voltage Sags that exceed 1 minute in time. The meter shall capture Sag/Swell/Outage events based on a power quality trigger. The meter will store up to 500 combined Sag/Swell/Outage events.

Sag/Swell Events

The Sag/Swell events are generated from configurable triggers and the duration can be as short as ½ cycle and as long as 1 minute. Events lasting longer than 1 minute on all 3 phases will be classified as an Outage.

The following information will be recorded during a Sag/Swell Event

- Time and date when it occurred (to the msec)
- Duration of the event in line cycles
- Trigger Setting and value that initiated the event
- Volts, Current, Power Factor, Frequency, Volts THD, Amps THD per phase (min/max/avg)

Event ID : 30	
Start:	12/14/2016 16:16:39.861 PM
End:	12/14/2016 16:16:40.136 PM
Cycles:	17
Event:	Phase A Voltage Line to Neutral SAG < 108.00, A
Volts A:	96.00 120.00 97.11
Volts B:	96.00 117.90 97.06
Volts C:	96.00 111.01 96.85
Amps A:	1.00 3.00 2.86
Amps B:	1.00 3.00 2.85
Amps C:	1.00 3.00 2.85
Vthd A:	0.00 0.72 0.37
Vthd B:	0.00 1.21 0.62
Vthd C:	0.00 0.91 0.47
Pf A:	-1.00 1.00 0.02
Pf B:	-1.00 1.00 -0.02
Pf C:	-1.00 1.00 -0.01
Athd A:	0.02 3.09 1.60
Athd B:	0.02 5.11 2.64
Athd C:	0.02 3.89 2.01
Fz:	60.00 60.00 60.00

Sample of the Sag/Swell data that is recorded

Voltage Interruption Events

The meter shall automatically record outages when the voltage is interrupted on all three phases. The JEMWARE Software has a configurable threshold for setting voltage interruption limits.

The Voltage Interruption Log is used to store all interruptions of power. A trigger for voltage interruptions must be configured and enabled in order to log these events. All three phases need to fall below the trigger setting before an interruption is recorded.

The log includes the start and end time of each interruption, duration in cycles, and value of the voltages that triggered the event. There are buttons on the top right to print or download the load profile data in Excel or CSV formats.

Read Voltage Interruption Log

Event ID	Start	End	Cycles	Phase A Voltage	Phase B Voltage	Phase C Voltage
20	03/20/2020 18:31:23.950 PM	03/20/2020 18:31:25.081 PM	68	12.162	12.153	12.146
19	03/20/2020 18:30:02.149 PM	03/20/2020 18:30:02.363 PM	13	10.134	10.127	10.12
18	03/20/2020 18:29:14.899 PM	03/20/2020 18:29:15.513 PM	37	15.202	15.191	15.185
17	03/20/2020 18:27:11.714 PM	03/20/2020 18:27:12.328 PM	37	15.202	15.191	15.185
16	03/17/2020 20:31:09.039 PM	03/17/2020 20:31:20.568 PM	648.5	15.397	15.465	15.413

Trigger settings used for the above events are shown below:

ID ▲	Enabled	Trigger Measurement	Trigger On	Phase	Operator	Alarm	Trigger Delay	Reset	Reset Delay
1	<input checked="" type="checkbox"/>	Instantaneous	VoltsL-N	Any	<	90	0	92	0
2	<input checked="" type="checkbox"/>	Instantaneous	VoltsL-N	Any	>	110	0	108	0
3	<input checked="" type="checkbox"/>	VoltageInterruption	VoltsL-N	All	<	20	0	20.4	0
4	<input checked="" type="checkbox"/>	RapidVoltageChange	VoltsL-N	Any	>	5	0	2.5	0

Trigger # 3 used for Voltage Interruptions.

High Speed RMS Recording


This recording is available with power quality options PQ1 and PQ3.

Upon a trigger, you can initiate the recording of RMS voltage and current at a rate of 2 measurements per cycle.

The meter will record the following:

- Record RMS voltage, current and phase angle per phase
 - 100/120 Hz recording rate (2 measurements per cycle)
 - 0 to 0.5 second configurable pre-fault recording (recording prior to trigger)
 - 0 to 1.0 second configurable post-fault recording (recording after it returns to normal)
 - Maximum 60 second total recording time

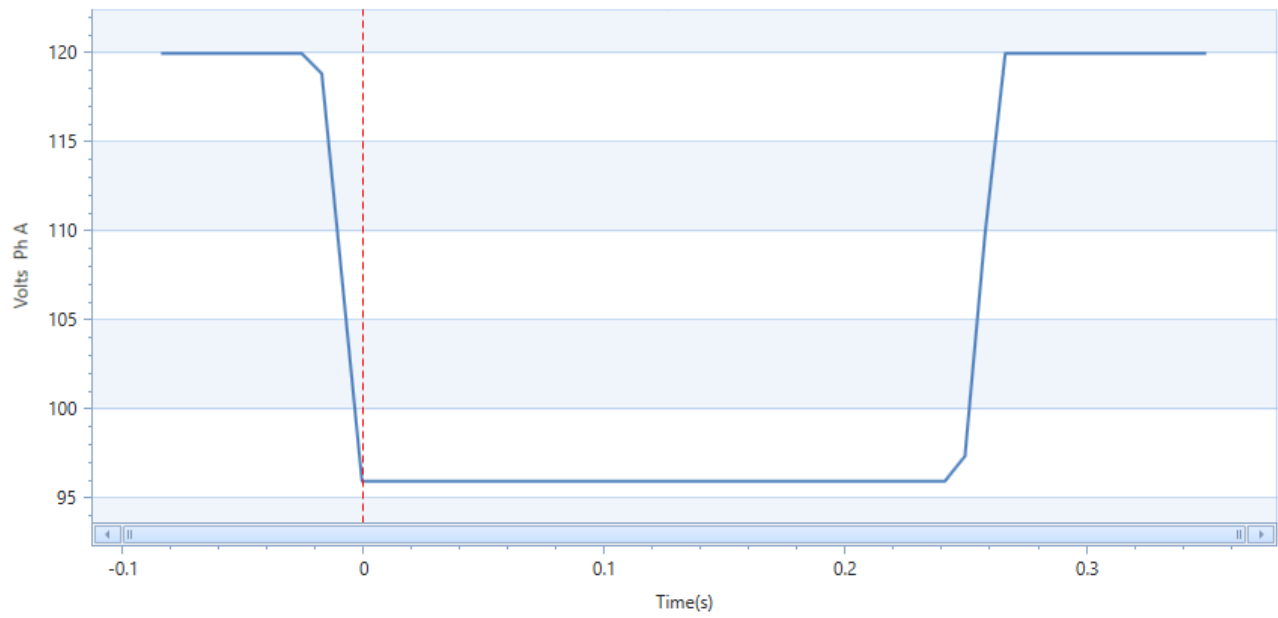
The settings for High Speed RMS Recording are in the JEMWARE Power Quality screen.

High Speed RMS	
	Cycle(s): Msec(s):
Pre-Fault Time:	15 250
Post Fault Time:	30 500
Max Recording Time:	1800 30006
	Record(s): Size in Kb:
Est # of Records:	3072 4

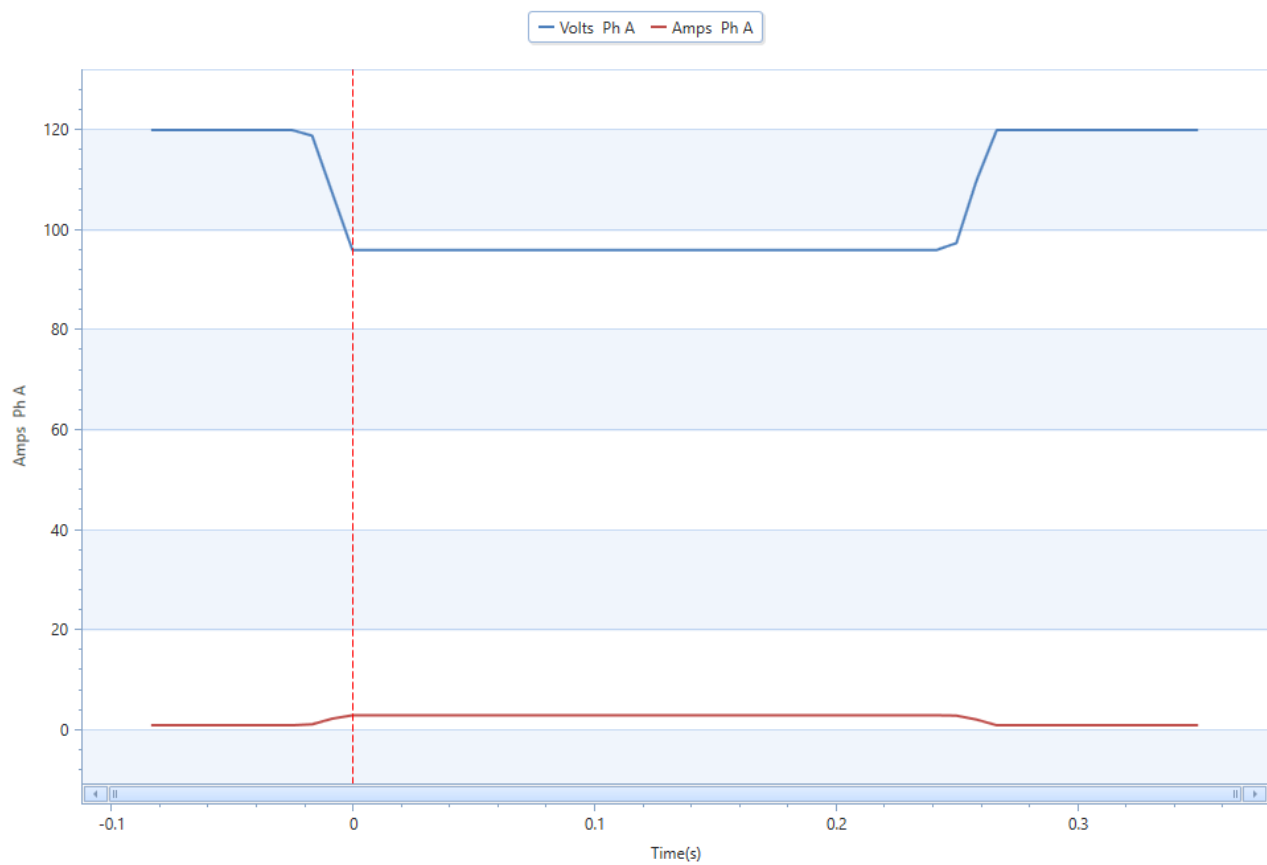
The entry is in cycles and the msec timing is automatically calculated in regards to your primary configuration setting of 50 or 60HZ frequency. The estimated quantity of records that can be stored in memory is displayed along with the file size for each record.

High Speed RMS measurements are calculated every cycle with updates on the half cycle. Two measurements are provided per cycle.

The High Speed RMS data is saved in non-volatile memory in a PQDIF File Format. It can be viewed in JEMWARE or other third party software that supports the PQDIF File Format.



High Speed RMS Plot in JEMWARE - Phase A Voltage Sag



High Speed RMS Plot in JEMWARE - Phase A Voltage Sag along with Phase A Current

Waveform Capture Recording

This recording is available with power quality options PQ2 and PQ3.

Upon a trigger, you can initiate the waveform recording of voltage and current at a low/medium/high resolution.

The meter will record the following:

- Voltage and current per phase
 - Three recording rates to choose from.
 - Low Resolution Recording
 - 900 Hz Recording rate (16 samples per cycle)
 - 0 to 30 cycle Pre-Fault/Post-Fault
 - 2 to 960 cycle Recording Time
 - Medium Resolution Recording
 - 7,680 Hz Recording rate (128 samples/cycle)
 - 0 to 10 cycle Pre-Fault/Post-Fault
 - 2 to 240 cycle Recording Time
 - High Resolution Recording
 - 30,720 Hz Recording rate (512 samples/cycle)
 - 0 to 5 cycle Pre-Fault/Post-Fault
 - 2 to 30 cycle Recording Time

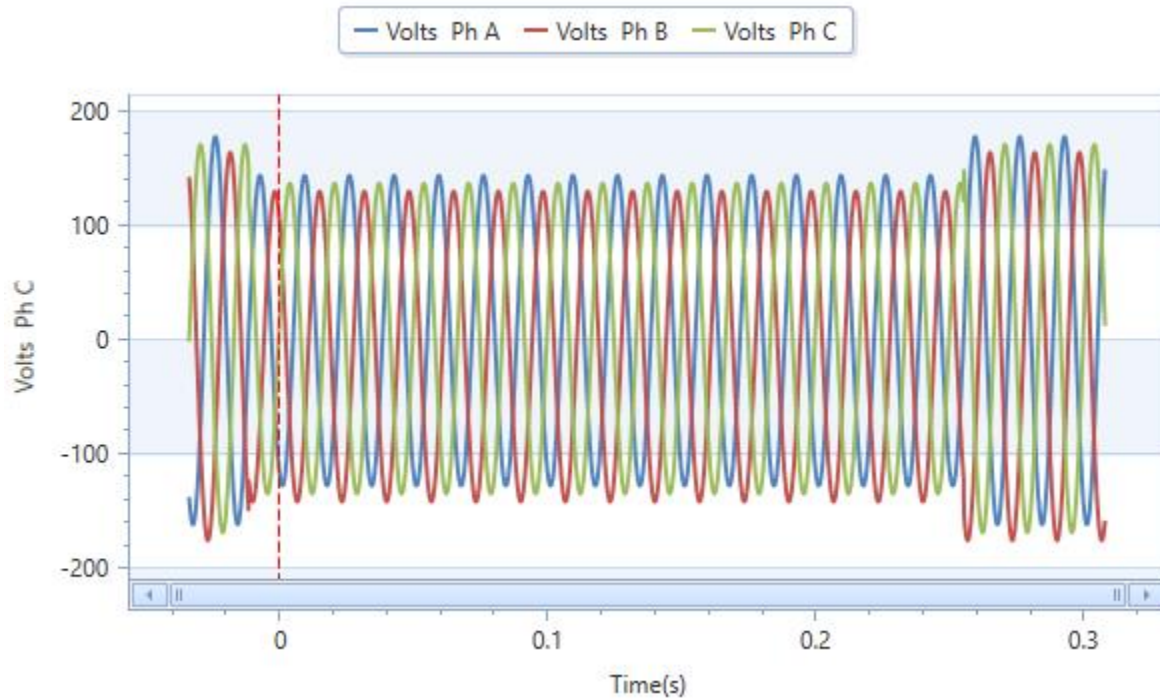
Values shown for 60 Hz.

The settings for Waveform Recording are in the JEMWARE Power Quality screen.

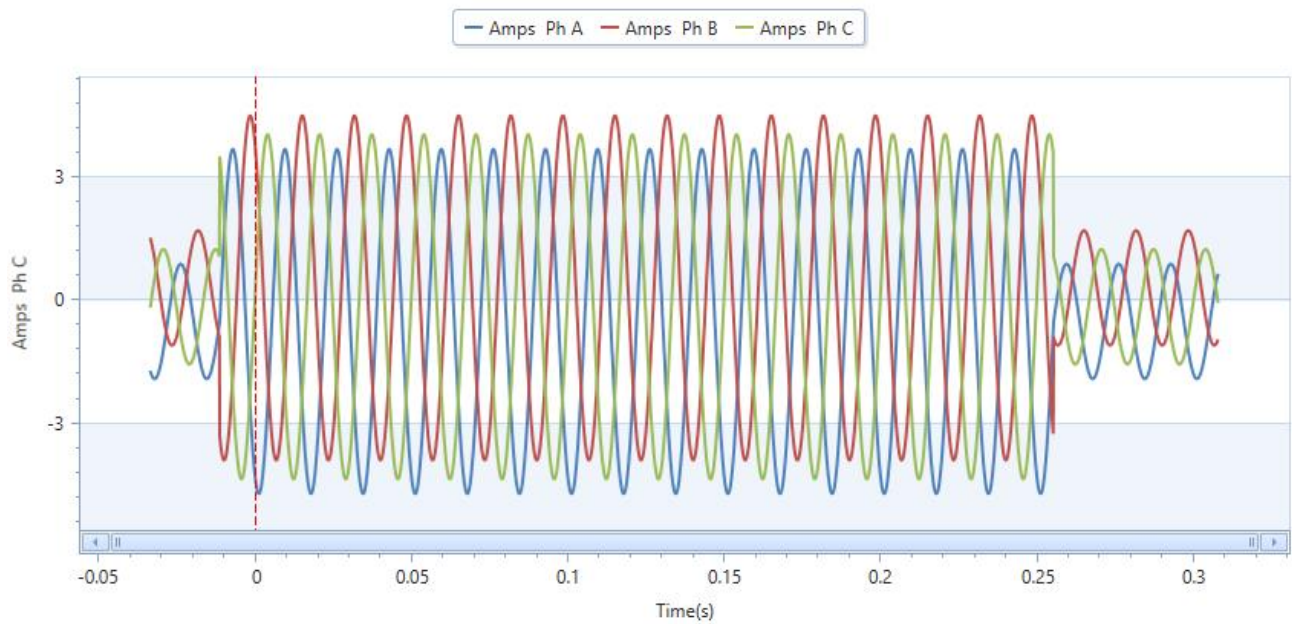
WaveForm Capture (LOW:16 samples/cycle)	WaveForm Capture (MEDIUM:128 samples/cycle)	WaveForm Capture (HIGH:512 samples/cycle)
Cycle(s): Msec(s): Pre-Fault Time: 15 250 Post Fault Time: 15 250 Max Recording Time: 480 8002 Record(s): Size in Kb: Est # of Records: 2458 5	Cycle(s): Msec(s): Pre-Fault Time: 5 83 Post Fault Time: 5 83 Max Recording Time: 120 2000 Record(s): Size in Kb: Est # of Records: 1365 9	Cycle(s): Msec(s): Pre-Fault Time: 2 33 Post Fault Time: 1 17 Max Recording Time: 15 250 Record(s): Size in Kb: Est # of Records: 585 21

The entry is in cycles and the msec timing is automatically calculated in regards to your primary configuration setting of 50 or 60HZ frequency. The estimated quantity of records that can be stored in memory is displayed along with the file size for each record.

The waveform capture data is saved in non-volatile memory in a PQDIF File Format. It can be viewed in JEMWARE or other third party software that supports the PQDIF File Format.



Waveform Capture Plot in JEMWARE - Phase ABC Voltage Sag



Waveform Capture Plot in JEMWARE - Phase ABC Current from above Voltage Sag

Power Quality Data Storage

Power quality data is stored in the meter in logs and in PQDIF File Format based on your configuration settings in JEMWARE. The following methods are available for power quality data storage:

PQ Data	Internal log	PQDIF
Sags and Swells	X	optional
Outages	X	
High Speed RMS		X
Waveform Capture		X
Measurement Log Harmonics InterHarmonics Flicker Metering	X	optional

X = always included optional = Configurable in JEMWARE

PQDIF File Format

PQDIF (Power Quality Data Interchange Format) IEEE 1159.3 is a non-proprietary file format used for storing power quality data. It uses a standardized format for saving power quality information so different manufactures can present the data in one common format. While similar to the concept of COMTRADE which is a common open format for saving fault data, PQDIF is specifically designed for the type of data collected for power quality applications. The power quality data collected by the JEMStar II meter consists of an Observation, Quantity and Channel.

Observation	Quantity	Channel
<u>PQ Data Type</u>	<u>Type of Recording</u>	<u>Individual Measurements</u>
-Triggered Recording -Measurement Log (24 hour period) Each one is labeled with the Time and Date of occurrence	XY = Sag/Swell Record Waveform = Waveform Capture Record Phasor = High Speed RMS Recording Value Log = Measurement Log	-Volts Phase A -Volts Phase B -Volts Phase C -AMPS Phase A -Volts Harmonic #3, Ph A

With the above structure, it is possible to have a single PQDIF File that contains multiple observations and multiple recording methods. It provides a complete picture of the power quality anomaly.

The JEMStar II meter saves the power quality data internally in PQDIF format, so there is no need to retrieve data and convert it. There are two options available for storing data in the PQDIF format.

- Single PQDIF File per day
This file will include any PQ recordings saved by the meter for the 24 hour period starting at midnight. If nothing is recorded, there will be no PQDIF file created. In this mode, a typical PQDIF File might include the 24 hour measurement log along with any power quality triggers

and associated data recordings.

Observation	Quantity	Channel
[0] 12/08/2016 09:22:51	ID_QT_WAVEFORM	[0] Volts Ph A
[1] 12/08/2016 00:00:01		[1] Volts Ph B
[2] 12/08/2016 00:00:03		[2] Volts Ph C
		[3] Amps Ph A
		[4] Amps Ph B

Example of a single PQDIF File displayed in JEMWARE Software. It has three observations over the 24 hour period. First observation at 12/08/2016 09:22:51 has a waveform capture.

Observation	Quantity	Channel
[0] 12/08/2016 09:22:51	ID_QT_VALUELOG	[0] VI-n Ph A
[1] 12/08/2016 00:00:01		[1] VI-n Ph B
[2] 12/08/2016 00:00:03		[2] VI-n Ph C
		[3] VI-n Ph A
		[4] VI-n Ph B

Same PQDIF File as above. The second observation at 12/08/2016 00:00:01 contains the 24 hr measurement log.

Note: The PQDIF File has a maximum size of 500K. In cases where the number of observations stored for this 24 hour period exceeds the 500K, a separate file(s) will be created to store the information.

- Single PQDIF File per observation

In this mode, the PQDIF file will be generated upon every observation. An observation could be a trigger and associated data recordings. If a single trigger initiated the recording of a Sag/Swell Record, Waveform Capture and High Speed RMS recording, all three would be included in the same observation. If the measurement log is included in the PQDIF file, it will be a separate PQDIF File generated at midnight and will contain the previous 24 hours of measurements.

Observation	Quantity	Channel
[0] 09/23/2016 14:14:36	ID_QT_XY ID_QT_WAVEFORM ID_QT_PHASOR	[0] SS Volts Phase A
		[1] SS Volts Phase B
		[2] SS Volts Phase C
		[3] SS Amps Phase A
		[4] SS Amps Phase B

Example of a single PQDIF File with a single observation that contains a Sag/Swell Record, Waveform Capture and High Speed RMS recording.

PQDIF File Naming Convention

The PQDIF files generated by the meter follow a naming convention that include the meter serial number, time and date of the event and type of data recorded.

The file name format used is: `YYMMXXXXX_TimeStamp_microsecond_DataType.pqd`

Where:

- **YYMMXXXXX**
Serial number of the meter; with spaces removed
- **TimeStamp**
10 digit time format (number of seconds elapsed since Jan 1, 1970) of when this file was created
- **Microsecond**
Variable length number 0->999,999 indicating the microsecond of the TimeStamp when the first event occurred
- **DataType**
A number representing the type of data stored in this file. See table below.

Single PQDIF File Generated by Observation	
01	Sag/Swell Recording
02	Waveform Capture
03	Sag/Swell and Waveform Capture
04	High Speed RMS
05	Sag/Swell and High Speed RMS
06	Waveform Capture and High Speed RMS
07	Sag/Swell, Waveform Capture and High Speed RMS
08	Measurement Log

PQDIF File Generated Daily	
128	Can contain any or all of the following: Sag/Swell, Waveform Capture, High Speed RMS, Measurement Log

Example file name: `142300003_1454408745_133724_07.pqd`

142300003	1454408745	133724	07
Meter Serial Number 14 23 00003 <i>23rd week of 2014</i> <i>Meter ID# 00003</i>	Febraury 02, 2016 10:25:45 GMT	133724 microseconds (when added to above, 02 Feb 2016 10:25:45:133724 GMT)	Sag/Swell, Waveform Capture, High Speed RMS Data

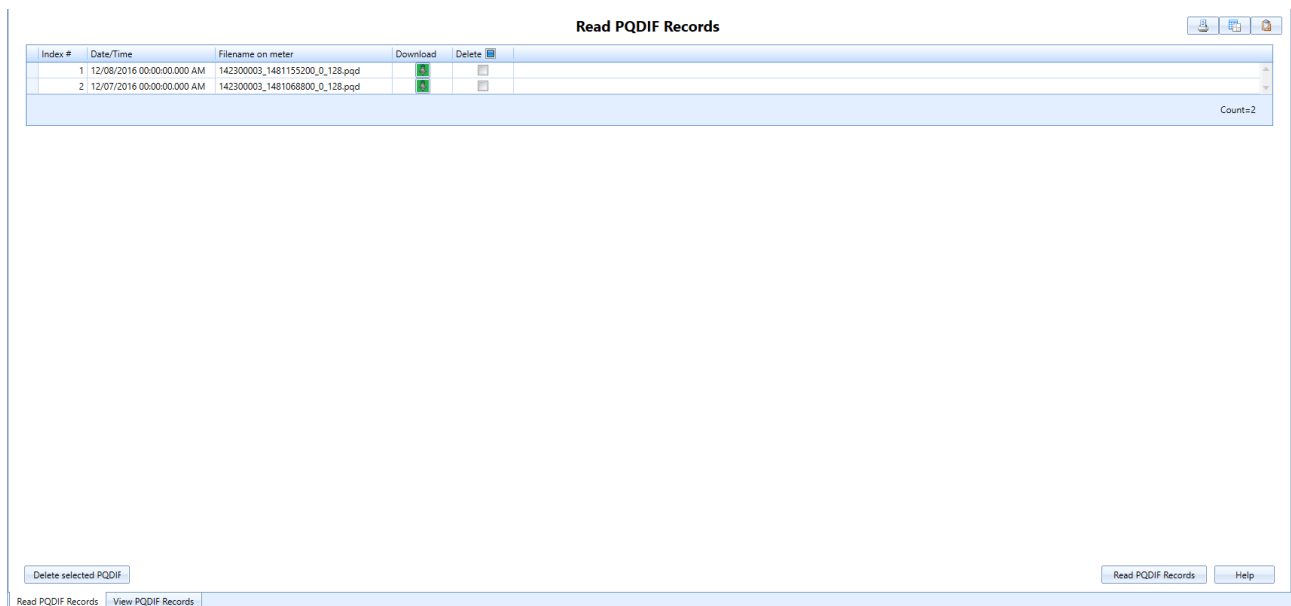
PQDIF File Retrieval

The PQDIF files generated by the meter can be retrieved in three different ways.

- Manual Retrieval via JEMWARE
- Scheduled Retrieval via JEMWARE
- Automatic Retrieval

Manual PQDIF Retrieval

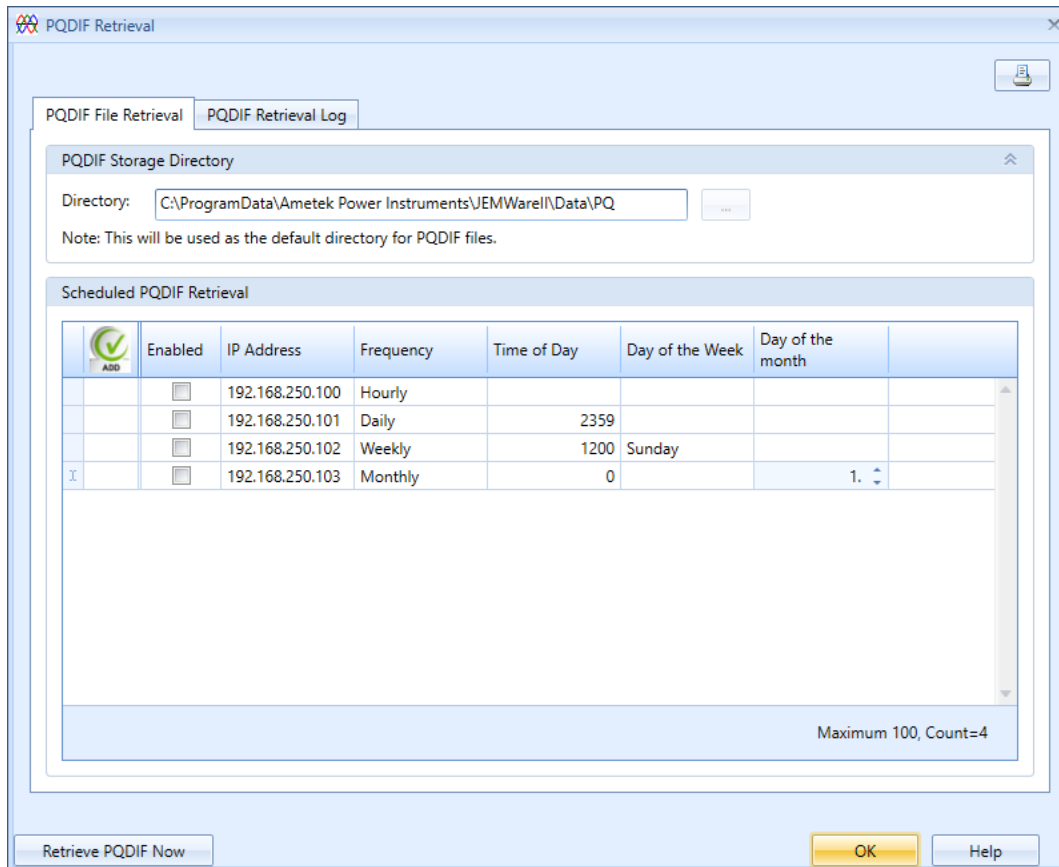
After connecting the meter to JEMWARE (see software manual), there is a Power Quality Screen that allows you to read the PQDIF Files from the meter. After pressing the 'Read PQDIF Records' button, you will see a list of all PQDIF files stored on the meter. To download a single file to the PC for viewing, select the download box next to the filename. To download multiple files, select all of the files with your mouse using the shift and control keys and right click the selection which will let you download all files selected. Once a file is downloaded to your PC, it will be shown in a green highlight.



Scheduled PQDIF Retrieval

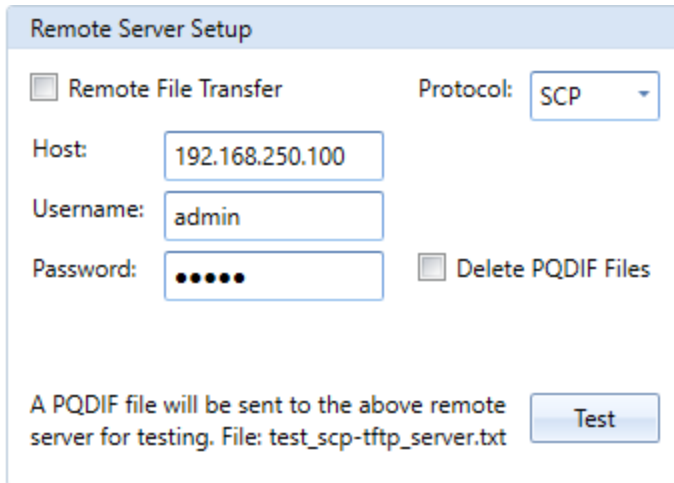
With the scheduled retrieval, you create a database of all the meters you wish to retrieve data from and the timing when you wish to retrieve the data. In JEMWARE, the setup screen for this is shown below. After setting up the group of meters and their IP Addresses, you can enter a folder on your PC where all the files will be saved.

Note: The JEMWARE Software will display all PQ files for viewing in the default directory location shown on this screen. If you change the location, the files will not be visible on the PQDIF File viewer.



Automatic PQDIF Retrieval

With the automatic retrieval, the meter will export the PQDIF Files from the meter as they are created using FTP or SCP protocol.



The screenshot shows a dialog box titled "Remote Server Setup". It contains the following elements:

- A checkbox labeled "Remote File Transfer" which is currently unchecked.
- A "Protocol:" dropdown menu set to "SCP".
- A "Host:" text input field containing "192.168.250.100".
- A "Username:" text input field containing "admin".
- A "Password:" text input field with six black dots.
- A checkbox labeled "Delete PQDIF Files" which is currently unchecked.
- A "Test" button.
- Below the fields, a message reads: "A PQDIF file will be sent to the above remote server for testing. File: test_scp-tftp_server.txt".

You enter the IP Address of the PC you wish to download files to and it will transfer them as soon as they are generated. If the meter is set up to generate a single PQDIF file per day; this transfer will occur shortly after midnight (assuming there was a file created). If the meter is set up to generate a single PQDIF file per observation; this transfer will occur after the PQDIF file is created.

Note: The PC must be equipped with a file server application that can support the transfer of FTP or SCP files.

On meters with the dual Ethernet Port Option, the files will be transferred from the Ethernet Port 6. If it is unable to transfer the files via this port, it will automatically switch to Ethernet Port 7.

IEC 61000-4-30 Compliance

The IEC-61000-4-30 Standard specifies methods of measuring and recording various power quality information. The JEMstar II follows this standard when it is equipped with one of the power quality options: PQ, PQ1, PQ2, PQ3. The JEMStar II meter complies to this IEC 61000-4-30; Edition 3.0 standard as follows:

- Class A for all measurements
- 10/12 cycle measurements, aggregated over 150/180 cycles, 10 minutes and 120 minutes

The following measurements will be provided in accordance to the standard:

- Frequency
- Magnitude of Supply Voltage and Current
- Flicker
- Voltage and Current Unbalance
- Voltage and Current Harmonics
- Voltage and Current Interharmonics
- Current Recording (included with Voltage Dips and Swell Recording)

These measurements are all available with the measurement log. The measurements are calculated over 200 msec (10/12 cycle). The measurement calculations are then aggregated in the following intervals:

- 150/180 cycles
- 1, 2, 3, 4, 5, 10, 15, 20, 30, 60, 120 minutes

Note: While the standard only specifies 150/180 cycles, 10 minutes and 120 minutes recording intervals, we apply the same 10/12 cycle measurement aggregation over the other intervals. Some measurements like flicker and harmonics require power quality options PQ2 or PQ3.

Voltage Dips and Swells

The detection of voltage dips and swells is in accordance to Class A with measurements synchronized to the zero crossing. The dip and swell threshold used is a percent of nominal as opposed to a sliding window. When we capture a voltage dip and swell, we record the start/stop time and date of the event, number of cycles duration, channel that triggered the dip or swell and we provide the min/max/avg measurements of voltage, current, THD, power factor and frequency.

We also support Class S for voltage dips and swells if the triggering is enabled for this.

Voltage Interruptions

We record Voltage Interruptions (Outage) when all three phases exceed the voltage dip threshold for > 60 seconds. Voltage Interruptions are recorded in the Outage Log and contain the start/stop time and date of the event.

DEMAND PREDICTION

JEMStar II can be purchased with an optional feature that will display a Demand Prediction for any measured Peak Demand quantity. This includes Watts delivered or received; VARs delivered, received, or per-quadrant; VA delivered or received; Q delivered or received; Amps; or Amps Squared.

A Demand Prediction is the Demand value that is expected at the end of the present demand interval. For example, if a level 1000 Watts is applied to the meter for a demand interval, the “predicted” demand at any time during that interval is 1000 Watts (See Example 1). At the end of the demand interval, the “actual” demand (which is based on actual measurements, not expected measurements) is 1000 watts. JEMStar II updates its internal Demand Prediction approximately every 50 milliseconds. Displayed Demand Predictions respond more slowly due to system and display timing constraints. Each update is based on the average of actual instantaneous readings taken in the current demand interval multiplied by the demand interval time that has already passed, plus the most recent instantaneous reading multiplied by the time remaining in the demand interval.

The result of this process is that a Demand Prediction register displays what will be the Demand at the end of the interval *if the load remains constant at its present value* until then. If the load does vary, the Demand Prediction register will reflect the new prediction and update the display within a second.

Demand Predictions may be used to monitor a load in order to prevent setting a new Peak Demand. If a Demand Prediction register shows a value that is higher than the existing Peak Demand, then a new Peak will occur at the end of the demand interval unless the load is reduced.

In the case of a sliding window (also known as rolling) demand, predictions are made in the last subinterval of the demand interval. In other words, JEMStar II will not try to predict the demand beyond the present subinterval.

Demand Prediction Algorithm:

The calculation is performed at a rate of once every three power line cycles (about 50 ms):

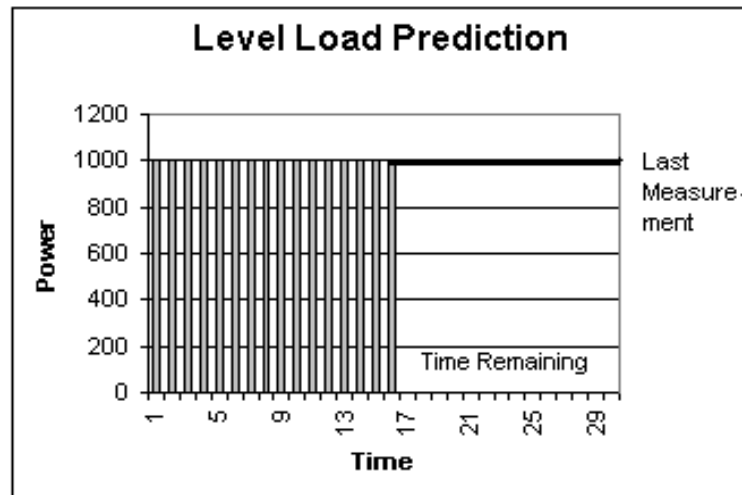
$$\text{PredDmd} = \frac{(\text{Avg} \times \text{Sec}) + (\text{Pres} \times \text{Rem})}{\text{Int}}$$

Where:

- PredDmd = Demand Prediction
- Avg = Average of Instantaneous Readings already taken in the present demand interval.
The average is updated just before the Prediction is made.
- Sec = Seconds that have already elapsed in the demand interval
- Pres = Most recent Instantaneous Reading
- Rem = Seconds remaining in Demand Interval
- Int = Total number of seconds in Demand Interval

Examples:

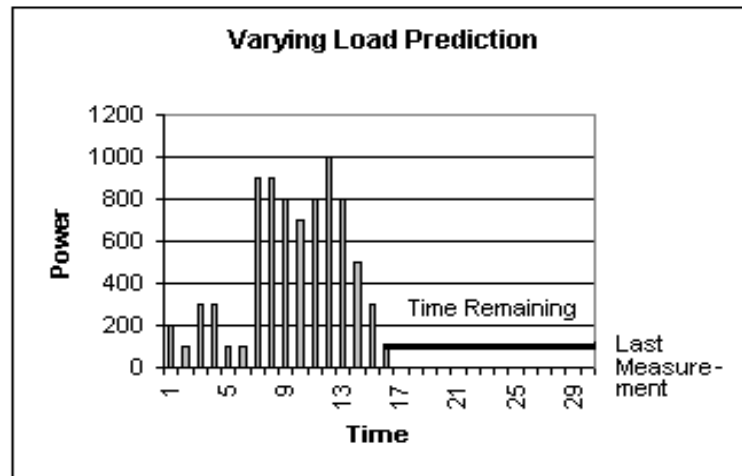
(Graphs are not to scale. Assume one Instantaneous measurement per minute for illustration purposes.)



Example 1: Predicted demand with level load

At 16 minutes into the demand interval, every measurement was 1000 W, which means the average power was also 1000 W. 1,000 W times 16 minutes = 16,000 watt-minutes.

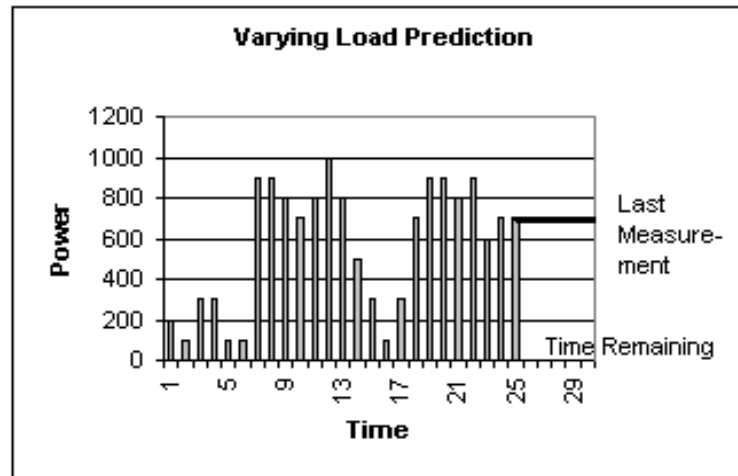
The most recent Instantaneous measurement (taken at 16 minutes into the interval) is 1000 W. Assume the average power of the remaining 14 (of 30) measurements is 1000 W. (I.e. a level load.) 1,000 W times 14 minutes = 14,000 watt minutes. Added to the 16,000 watt-minutes from before, the total is 30,000 watt-minutes. Divided by 30 total minutes, the Predicted Demand is 1000 W.



Example 2: Predicted demand with varying load

At 16 minutes into the demand interval the average of 16 Instantaneous measurements was 493.75 W. That average times 16 minutes equals 7900 watt-minutes.

The most recent Instantaneous measurement (taken at 16 minutes into the interval) is 100 W. Assume the average power of the remaining 14 (of 30) measurements is 100 W. (I.e. a level load.) 100W times 14 minutes = 1400 watt minutes. Added to the 7900 watt-minutes from before, the total is 9300 watt-minutes. Divided by 30 total minutes, the Predicted Demand is 310 W.



Example 3: Predicted demand with varying load – further update

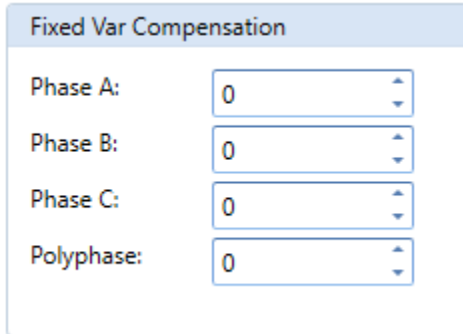
Continuing in the same demand interval from Example 2:

At 25 minutes into the demand interval the average of 25 Instantaneous measurements was 576 W. That average times 25 minutes equals 14,400 watt-minutes.

The most recent Instantaneous measurement (taken at 25 minutes into the interval) is 700 W. Assume the average power of the remaining 5 (of 30) measurements is 100 W. (I.e. a level load.) 700 W times 5 minutes = 3500 watt minutes. Added to the 14,400 watt-minutes from before, the total is 17,900 watt-minutes. Divided by 30 total minutes, the Predicted Demand is 596.67 W.

FIXED VAR CORRECTION

Fixed VAR correction is entered in JEMWare II from the Primary Configuration window (bottom right).



Fixed Var Compensation	
Phase A:	0
Phase B:	0
Phase C:	0
Polyphase:	0

The user may enter a separate amount of fixed VARs for each phase, or a polyphase total that will be distributed across all active phases in the meter.

Since VAR measurements contribute to a number of meter quantities, the fixed VAR compensation will affect other readings such as VA, Q, and PF.

The JEMStar II may be configured to add a fixed amount of VAR registration to all measurements in cases where a known amount of VAR compensation is required. This setting does not affect meter calibration; it simply adds a fixed offset to the meter's VAR readings.

Since the fixed VAR compensation is part of the meter configuration, it will be lost if the meter receives a Cold Start or firmware upgrade. Also, if the same configuration file is to be used in multiple meters, the compensation needs to be confirmed or modified before being programmed into each meter.

VOLTAGE AND CURRENT TRANSFORMER GAIN CORRECTION

The JEMStar II meter may be adjusted to compensate for gain and phase errors in external voltage and current circuitry; for example, ratio errors or phase shifts in external voltage or current transformers. This correction may be done without tampering with the actual meter calibration as established at the factory, or any local meter calibration adjustments made in Test Mode.

Transformer gain and phase corrections are set in JEMWare II Software from the Primary Configuration window.

Meter and Voltage Settings		Transformer Gain Correction		
Voltage Transformer				
	Ratio (+\-%)	Phase A 0.00	Phase B 0.00	Phase C 0.00
	Phase (+\ degrees)	0.00	0.00	0.00
Current Transformer				
Current Range	Ratio (+\-%)	Phase A	Phase B	Phase C
0 to 1,000	Phase (+\ degrees)	1.20	1.20	1.15
	Ratio (+\-%)	0.05	0.05	0.04
1,000 to 2,000	Phase (+\ degrees)	0.00	0.00	0.00
	Ratio (+\-%)	0.00	0.00	0.00
2,000 to 3,000	Phase (+\ degrees)	0.00	0.00	0.00
	Ratio (+\-%)	0.00	0.00	0.00
	Phase (+\ degrees)	0.00	0.00	0.00

The user may enter a gain correction (Ratio) from -10.00% to +10.00% in 0.01% increments for each voltage and current input. The user may also enter a phase correction from -5.00 to +5.00 degrees in 0.01 degree increments for each voltage and current. Furthermore, different current corrections may be entered for multiple user-defined current ranges. The gain correction is either added or subtracted from the transformer's ratio using the correction value entered. These corrections are applied directly to measured voltages and currents before any further computations are performed; therefore they affect virtually all quantities in the meter.

Because gain and phase errors may vary over the operating range of a current transformer, the user may specify up to eight different current ranges, each with its own gain and phase correction. For example, a current transformer may require -1% gain correction and -0.5 degree phase correction below 1 amp, but only 0.05% gain and 0.1 degree correction at 5 amps.

Changing the gain of a voltage or current input will cause any single-phase measurement using that input to increase or decrease by the amount of the change. For example, changing the Phase A Volts by +1.00% will cause all Phase A measurements to read 1% high (except for amp quantities).

Polyphase measurements will change by the average of the changes made to each individual phase. For example, if Phase A Volts is changed by +1.00%, Phase B Volts by +2.00% and Phase C Volts by +4.00%, the change to polyphase watts is $(1+2+4)/3=2.333\%$.

The mathematical formula used for Transformer Correction is detailed below:

$$\text{Corrected Ratio (result)} = \text{Transformer Ratio} + (\text{Transformer Ratio} * \text{Correction Factor} / 100)$$

Note: The value for Correction Factor is in percent, so we divide by 100

Example:

Transformer Ratio = 120:1

Correction Factor = -10

The Corrected Ratio or 'result' = $120 + (120 * -10/100) = 108$

This means that a 120VAC input to the Transformer will be seen by the meter as 108VAC.

Phase correction changes the apparent phase relationship between voltage and current, and its effects vary depending on the original phase relationship. For example, a 1 degree phase correction on a circuit at 1.000 PF will cause the displayed PF to read 0.999, while the same correction on a circuit at 0.866 PF will cause the displayed PF to read 0.857.

TOTALIZATION

The JEMStar II meter may be purchased with an optional Totalization system. Totalization is ability to sum the energy readings from several different instruments and display the result. JEMStar II has 12 totalization channels. Each channel may be displayed as a register in the Normal, Alternate, or Test lists and / or recorded as a Load Profile channel.

Each Totalization channel behaves as a Consumption register with several added features. Details on how to configure Totalization channels are contained in the JEMWare II User Manual, (document 1079-699). For each channel the user must configure the following:

- Measurement quantity: choice of Watthours, VARhours, VAhours, Qhours, Amphours, Volt Squared hours, Amp Squared hours* or Zero (which accumulates only external energy)
- Phase: A, B, C, or Polyphase*
- Direction: Delivered, Received, or a single quadrant for VARhours*
- Time of Use Rate: A through H or Total*
- Compensated or Uncompensated*
- Test Mode
- Enabled
- Load Profile Km in Primary (i.e. at VT and CT input) units
- Up to 2 external energy inputs (contact inputs)
- Pulse Weight in Primary units for each external energy input. Negative pulse weights will be deducted from the Totalization channel's reading, but it will never fall below zero.

* These settings are identical to those of a Consumption register.

Most of these settings are self-explanatory, but a few require further description.

The Test Mode setting causes the Totalization channel to operate only while the meter is in Test Mode. If a Totalization register is to be displayed in the meter's Test list, it must have the Test Mode selection enabled.

Enabled means the Totalization channel is active.

Load Profile Km is the pulse weight of counts recorded in Load Profile if a Profile channel is selected to record this Totalization channel's contents. This bypasses the normal Load Profile pulse constant configuration for that channel.

External energy inputs are pulse inputs on the JEMStar II configured to be Totalization inputs. Any transition (make or break) on one of these inputs can be detected by any Totalization channel and cause that channel to add the associated Pulse Weight to the Totalization's contents.

NOTE: Input Pulse Weights are configured independently for each Totalization channel. For example, Totalization Channel 1 may count each transition on input 1 as 1.0 MWh, while Totalization Channel 2 may count each transition on input 1 as -3.8 MWh.

A Totalization channel may be displayed, recorded as a Load Profile channel, or both. To display a Totalization channel, add a register to the desired Display List (Normal, Alternate, or Test) in JEMWare II with a Category of "Totalization" and select the desired Totalization channel number in the Type field. You may then set up the number of digits and decimal places, storage type, and label as for any other numeric register.

To record a Totalization channel in Load Profile, add a Profile channel in JEMWare II. In the Quantity field select the desired Totalization channel number. The Km, Direction, and Phase settings will be bypassed, but you may still select whether to record always or only during TOU Rate Override.

TIP: Normally Load Profile channels may not be associated with Time of Use rates other than Total. However, you may simulate a Load Profile channel that records only during a given rate period by assigning it to a Totalization channel with the correct rate. The Totalization channel need not record any external energy, making it essentially identical to an integrated Load Profile channel.

APPENDIX A

DEFAULT SETTINGS

The following is a list of the factory default settings that will be seen in a JEMStar II meter after a Cold Start is performed. Use JEMWare II software to program the meter with your custom configuration.

Meter Identification

ID String 1: (JEMStarII ID)
ID String 2: (Ametek Power)
ID String 3: (Rochester, New York)
ID String 4: (Factory Default)
ID String 5: (1-888-222-6282)
ID Label 1: MV90 Meter ID
ID Label 2: Administrator
ID Label 3: Location
ID Label 4: Configuration ID
ID Label 5: Account Number

Primary Configuration

Meter Settings:

Meter Form	9
Meter Class Amps	20
Voltage Range	69-480
Connection Type	4 Wire Y
Frequency	60hz

Primary and Secondary Settings:

PT:Primary	1
PT:Secondary	1
PT:Ratio	1
CT:Primary	1
CT:Secondary	1
CT:Ratio	1
Transformer Factor	1
Nominal Voltage	120
Nominal Current	0
Full Scale Watts	0

Register Scaling:

VARs, Q	Units
Watts, VA	Units
Amp, A ²	MilliAmps
Volt	Volts
V ²	KiloVolts

Display Registers

Normal Registers

Display Registers

Normal Registers	Alternate Registers	Test Registers													
	ID	Register Category	Register Type	Quantity	Phase	Direction	TOU	Storage Type	Units	# of Digits	Decimal Point	TLC	Scaling Values	Display Screen	Description
	0	IDStatus	MeterID	None	None	None	None	None	None	0	0	<input type="checkbox"/>	None	1	IDStatus,Meter ID
	1	Register	Consumption	WHr	Polyph...	Delivered	Total	Working	Units	6	2	<input type="checkbox"/>	Primary	2	Wattour Delivered
	2	Register	Consumption	WHr	Polyph...	Received	Total	Working	Units	6	2	<input type="checkbox"/>	Primary	3	Wattour Received
	3	Register	Consumption	VARHr	Polyph...	Delivered	Total	Working	Units	6	2	<input type="checkbox"/>	Primary	4	VARhour Delivered
	4	Register	Consumption	VARHr	Polyph...	Received	Total	Working	Units	6	2	<input type="checkbox"/>	Primary	5	VARhour Received

Alternate Registers

Display Registers

Normal Registers	Alternate Registers	Test Registers													
	ID	Register Category	Register Type	Quantity	Phase	Direction	TOU	Storage Type	Units	# of Digits	Decimal Point	TLC	Scaling Values	Display Screen	Description
	100	IDStatus	PhasorDisplay	None	None	None	None	None	None	0	0	<input type="checkbox"/>	None	1	IDStatus,Phasor Dis...
	101	IDStatus	Communicati...	None	None	None	None	None	None	0	0	<input type="checkbox"/>	None	2	IDStatus,Comm Sta...
	102	Time	LastBPRTTime...	None	None	None	None	None	None	0	0	<input type="checkbox"/>	None	3	Time,BPRTTime&Date
	103	Register	Consumption	WHr	Polyph...	Delivered	Total	BillingP...	Units	6	2	<input type="checkbox"/>	Primary	4	BPR Wattour Del
	104	Register	Consumption	WHr	Polyph...	Received	Total	BillingP...	Units	6	2	<input type="checkbox"/>	Primary	5	BPR Wattour Rec
	105	Register	Consumption	VARHr	Polyph...	Delivered	Total	BillingP...	Units	6	2	<input type="checkbox"/>	Primary	6	BPR VARhour Del
	106	Register	Consumption	VARHr	Polyph...	Received	Total	BillingP...	Units	6	2	<input type="checkbox"/>	Primary	7	BPR VARhour Rec

Test Registers

Display Registers

Normal Registers	Alternate Registers	Test Registers														
	ID	Register Category	Register Type	Quantity	Phase	Direction	Storage Type	Units	# of Digits	Decimal Point	Pulse Weight	TOU	TLC	Scaling Values	Display Screen	Description
	200	Register	Consumption	WHr	Pol...	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	1	Wattour Delivered
	201	Register	Consumption	WHr	Pol...	Received	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	2	Wattour Received
	202	Register	Consumption	VARHr	Pol...	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	3	VARhour Delivered
	203	Register	Consumption	WHr	A	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	4	Wattour Del Phas...
	204	Register	Consumption	WHr	B	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	5	Wattour Del Phas...
	205	Register	Consumption	WHr	C	Delivered	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	6	Wattour Del Phas...
	206	Register	Consumption	WHr	A	Received	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	7	Wattour Rec Phas...
	207	Register	Consumption	WHr	B	Received	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	8	Wattour Rec Phas...
	208	Register	Consumption	WHr	C	Received	Working	Units	6	2	1.80	Total	<input type="checkbox"/>	Primary	9	Wattour Rec Phas...

Load Profile

Channel ▲	Type	Quantity	Phase	Direction	Records	Primary Km Value	TLC
						Suggest Km	
1	Consumption	WHr	Polyphase	Delivered	Always	0.001	<input type="checkbox"/>
2	Consumption	WHr	Polyphase	Received	Always	0.001	<input type="checkbox"/>
3	Consumption	VARHr	Polyphase	Delivered	Always	0.001	<input type="checkbox"/>
4	Consumption	VARHr	Polyphase	Received	Always	0.001	<input type="checkbox"/>

Interval Length: 15 min
 External Interval Sync: No
 Freeze Markers: Yes
 Data Only: No
 Data and Events: Yes
 Data in Counts: Yes
 Data in Eng Units: No

Demand

Interval Length: 15 min
 Sub Interval Length: 5 min
 Enable Demand Sync: No
 Thermal Demand Time: 15 min
 Defer Demands for: 0 sec
 After Power Outage (secs): 1

Time of Use Setup

No Seasons or Time of Use schedules configured
 No Override Rate
 No Holidays schedules

Timekeeping and DST Changes

Meter Clock Sync: Internal
 Auto Register Freeze: none
 Auto Billing Period Reset: none
 DST: not enabled

Input/Output

Channel 1: Input Interval Sync
 Channel 2: Input Status Input
 Channel 3: Output Energy Pulse, 1 shot, Wh polyphase, ke=1
 Channel 4: Output Energy Pulse, 1 shot, VARh polyphase, pke=1
 Channel 5: Output End of Demand Interval
 Channel 6: Output Triggered Alarm

Analog Outputs

Analog Output 1: Watts Phase A, 0-0
 Analog Output 2: Watts Phase A, 0-0
 Analog Output 3: Watts Phase A, 0-0
 Analog Output 4: Watts Phase A, 0-0

Trigger Setup

Channel 1: Volts Line-Neutral, Phase A, >100, not enabled
 Channel 2: Volts Line-Neutral, Phase B, >100, not enabled
 Channel 3: Volts Line-Neutral, Phase C, >100, not enabled

Communication Setup

Optical (Port 1): 9600 baud
 Binary protocol
 Device Address = 01
 Password timeout 1 min.

RS-232 (Port 2) 19200 baud
 Binary protocol
 Device Address = 01
 Password timeout 5 min.
 TX Start Delay =0
 TX End Delay = 0
 Turnaround Delay = 0

RS-232/485 (Port 3) RS232
 19200 baud
 Binary protocol
 Device Address = 01
 Password timeout 5 min.
 TX Start Delay =0
 TX End Delay = 0
 Turnaround Delay = 0

RS-232/485 (Port 4) RS232
 19200 baud
 Binary protocol
 Device Address = 01
 Password timeout 5 min.
 TX Start Delay =0
 TX End Delay = 0
 Turnaround Delay = 0

Int Modem (Port 5) 9600 baud
 Binary protocol
 Device Address = 01
 Password timeout 10 min.

Modem Init String =ATV0E0

Normal Answer Window

Answer Window Start: 00:00
 Duration: 1439
 Number of rings to answer: 2
 Frequency: Every Day

Delayed Answer Window

Number of rings to answer: 0

Ethernet (Port 6): DHCP: Not selected
 IP Address: 192.168.250.100
 Subnet Mask: 255.255.0.0
 Default Gateway: 192.168.250.10

Port 502: Modbus Slave, Device Address 1, disabled
 Port 2001: Binary, Device Address 1, enabled
 Port 20000: DNP, Device Address 1, disabled

Ethernet (Port 7): DHCP: Not selected
 IP Address: 192.168.250.101
 Subnet Mask: 255.255.0.0
 Default Gateway: 192.168.250.10

Port 502: Modbus Slave, Device Address 1, disabled
 Port 2001: Binary, Device Address 1, enabled
 Port 20000: DNP, Device Address 1, disabled

Protocol Setup

Modbus Slave

Modbus Counters: Start Address = 30001
 Point 1 Watthour Delivered 0.001 scaling
 Point 2 Watthour Received 0.001 scaling
 Point 3 VARhour Delivered 0.001 scaling
 Point 4 VARhour Received 0.001 scaling

Modbus Analogs: Start Address = 40001
 Point 1 Watts Phase A
 Point 2 Watts Phase B
 Point 3 Watts Phase C
 Point 4 Watts Polyphase
 Point 5 VARS Phase A
 Point 6 VARS Phase B
 Point 7 VARS Phase C

Point 8 VARS Polyphase
 Point 9 VA Phase A
 Point 10 VA Phase B
 Point 11 VA Phase C
 Point 12 VA Polyphase
 Point 13 Volts Phase A
 Point 14 Volts Phase B
 Point 15 Volts Phase C
 Point 16 Amps Phase A
 Point 17 Amps Phase B
 Point 18 Amps Phase C

Modbus Binary :

Read Output Coils
 Start Address = 1
 Point 1 Ch3
 Point 2 Ch4
 Read Input Status
 Start Address = 10001
 Point 1 Digital Input Ch 1
 Point 2 Digital Input Ch 2
 Point 3 Trigger Ch 1
 Point 4 Trigger Ch 2
 Point 5 Trigger Ch 3

DNP Slave

DNP Counters:

Write Time Interval = 1
 Data Link Timeout = 1
 Data Link Mode = never
 Application Timeout = 1
 Data Link Retries = 3
 Restrict Counter = any
 Time Set Tolerance = 2
 Analog Input Variation = 3
 Frozen Counter Events = yes
 Analog Scaling = 16 bit
 Class 0 Counter type = Running Object 20
 Class 0 Counter type = Frozen Object 21
 Global Time Set = enabled

Point 1 Watthour Delivered 0.001 scaling
 Point 2 Watthour Received 0.001 scaling
 Point 3 VARhour Delivered 0.001 scaling
 Point 4 VARhour Received 0.001 scaling

DNP Analogs:

Point 1 Watts Phase A
 Point 2 Watts Phase B
 Point 3 Watts Phase C
 Point 4 Watts Polyphase
 Point 5 VARS Phase A

Point 6 VARS Phase B
 Point 7 VARS Phase C
 Point 8 VARS Polyphase
 Point 9 VA Phase A
 Point 10 VA Phase B
 Point 11 VA Phase C
 Point 12 VA Polyphase
 Point 13 Volts Phase A
 Point 14 Volts Phase B
 Point 15 Volts Phase C
 Point 16 Amps Phase A
 Point 17 Amps Phase B
 Point 18 Amps Phase C

DNP Binary: Read Binary Output: Object 10
 Point 1 Ch3
 Point 2 Ch4
 Point 3 Ch5
 Point 4 Ch6
 Read Binary Inputs: Object 2
 Point 1 Digital Input Ch 1
 Point 2 Digital Input Ch 2

Display Setup

Display Scroll Rate: 7 sec
 Display Timeout: 15 sec
 Date Format: MM/DD/YYYY
 Preset mode timeout: 1 minutes
 Test Mode timeout: 30 minutes
 Demand Reset lockout: 5 minutes
 User Menu Timeout: 120 sec

TLC

Loss Compensation disabled

User Management

Username: admin Password: admin
 Access to all

Username: user1 Password: user1
 Set time, freeze registers, activate test mode, billing period reset, preset registers, meter/battery status

Username: user2 Password: user2
 Set time, billing period reset

APPENDIX B

ACCESSORIES

The following is a list of user replaceable parts. Please contact the factory for further information.

Description	Part Number
Phone Home Power Outage battery pack	1079-612
Non-Volatile RAM backup battery	6005-254
Security jumpers (for front panel lockout)	4195-263
S-base outer globe (w/pushbuttons)	1079-410
S-base to A-base adapter assembly	6002-656
A-base adapter locking ring	12648-001
Switchboard front cover assembly	1079-440
Switchboard case thumbscrew	1083-425
Optical Pickup Assembly	Consult factory
Replacement Circuit Boards*	Consult factory

*When ordering spare or replacement circuit boards, please have the meter's Model Number and Serial Number available.

APPENDIX C

ELECTROSTATIC DISCHARGE

ELECTROSTATIC DISCHARGE PREVENTION

Static, by definition, is designating or producing stationary electrical charges such as those resulting from friction. An electrostatic potential is produced by friction between nonconductive materials and can best be visualized as a field between two charged plates. The electrostatic potential will exist until the difference in the potential is overcome.

All meter shop work must be performed at static-protected work stations following properly prescribed static-control practices. Unless controlled, electrostatic discharge can destroy or weaken solid-state electronic components and assemblies.

Failure Mode

Failure of a solid-state component due to static discharge is characterized by partial or complete destruction of a semiconductor junction or a microscopic resistive or capacitive element within a circuit device. Failure is most common in CMOS, very low-energy devices.

Destruction of a circuit is immediately detectable and is remedied by normal troubleshooting and repair methods. However, the common condition of partial damage induced by low-level static discharge is not immediately detectable. Thus, the damaged component may continue to operate normally, but in a weakened state. Repeated exposure of the same component to similar low levels of static discharge may produce cumulative damage, ultimately leading to failure.

Static damage can be avoided by practical methods accessible to anyone handling solid-state components or assemblies.

Completely assembled products are only minimally vulnerable to static damage, and then only under the most severe of static-prone environments. Consequently, completely assembled products can usually be handled in normal work environments, indoors and outdoors, with little risk of static damage.

If a product is disassembled to any level, all exposed or removed electronic modules must be considered vulnerable to static damage and handled accordingly. There is no truly safe level of exposure to electrostatic discharge. However, the presence of a static charge or static field is not, in itself, damaging to electronic components.

Subassemblies from a dismantled product should not be considered static protected by design. In fact, depending on the design and conductive mass of the connected circuitry, components in subassemblies may be more vulnerable to static damage than loose components of the same type. Therefore, the objectives of static control cannot be met by indiscriminate handling of subassemblies or loose components.

Handling a printed-circuit-board assembly by its edges without employing static protection does not preclude the risk of static damage to its components. Effective static-control methods cannot be executed without proper tools and equipment.

All static-control methods relate to one simple principle: provide alternate, intentional paths for grounding electrostatic charges away from or around the devices to be protected. Static control is the employment of tools and equipment to predetermine the flow path of this current.

Any two physical bodies, conductive or nonconductive, can be the source of an electrostatic discharge if either is charged to a different level of electrostatic potential. As these two physical bodies come in contact or proximity, equilibrium is achieved by a sudden flow of current.

Most people associate a static discharge with a small blue arc and a sharp snapping noise. It is important to note that static charges of a level too low to produce a detectable arc can still damage unprotected electronic components.

Another important consideration is that even though a safe encounter has been achieved between two physical bodies, any subsequent encounter with a third, fourth, or more bodies must be protected in the same manner since a static potential difference may exist between the, now combined, first two bodies and any unknown new body.

Warning!

The first step in the above example is to de-energize the meter so that the meter is completely isolated from all service lines. Never dismantle an energized meter.

The following static-control equipment is required:

1. Conductive work mat
2. Ground cord attached to true earth ground
3. Conductive wrist strap
4. Electrically conductive bag

Caution!

Unless you are certain that the meter enclosure is properly earth bonded, do not attach the ground cord to the meter enclosure. Never attach a ground cord to the distribution system neutral or any other point inside the meter enclosure, as this can present a serious safety hazard.

Attach the conductive work mat and the conductive wrist strap to the ground cord. Put on the wrist strap and remove the assembly from the meter. If work is to be performed on the assembly at the metering site, perform it on the grounded work mat.

If the assembly is to be transported to the meter shop or other off-site location, insert the assembly into a conductive, antistatic bag for safe transportation. If the assembly has a battery installed, remove the battery before inserting into the bag for transportation. Conductive, antistatic bags can cause a battery to discharge during the transportation process.

If sensitive components are removed from the assembly at the meter site and are to be reused, insert the components—with all component leads piercing into a piece of conductive foam carrier—into an antistatic bag for safe transportation.

Static kits including mat, wrist strap, cord, and clip are available through your local electronics supplier.

APPENDIX D

DNP SERIAL COMMUNICATIONS

INTRODUCTION

Distributed Network Protocol (DNP 3.0) is an industry standard protocol for SCADA communications between Master Stations, Host computers, Remote Terminal Units, and Intelligent Electronics Devices (such as the JEMStar II meter). It is a public domain, non-proprietary protocol based on the IEC-870 standards, and is intended primarily for use in SCADA-like systems.

DNP as a protocol provides efficient, robust data communications through a system of 32-bit data link CRCs (Cyclical Redundancy Checks) and confirmation messages. However, DNP is much more than an error-detection-and-correction scheme. A DNP-compliant device, from the protocol's point of view, is considered a group of data "objects", each of which contains one or more "points". The DNP protocol specification defines the allowable object types and what constitutes a "point" for that object type.

DNP is *not* intended to be a general-purpose two-way communications link. Rather, it is highly optimized for SCADA and automation applications involving relatively small amounts of near-real-time data that is often read by the DNP master every few seconds. In the case of the JEMStar II, it is *not* used as a means of controlling or reconfiguring the meter.

DNP v3.00 DEVICE PROFILE

The purpose of this document is to describe the specific implementation of the Distributed Network Protocol (DNP) 3.0 within the JEMStar II meter. This document, in conjunction with the DNP 3.0 Basic 4 Document Set, and the DNP Subset Definitions Document, provides complete information on how to communicate with the JEMStar II meter via the DNP 3.0 protocol.

JEMStar II uses the Triangle MicroWorks™, Inc. DNP 3.0 Slave Source Code Library Version 3.12.0. This implementation of DNP 3.0 is fully compliant with DNP 3.0 Subset Definition Level 2, contains many Subset Level 3 features, and contains some functionality even beyond Subset Level 3.

The following sections, in conjunction with the Device Profile Document, provide a complete interoperability/configuration guide for the JEMStar II meter:

- the Implementation Table
- the Point List Tables
- Configuration methods

<h1 style="margin: 0;">DNP V3.00</h1> <h2 style="margin: 0;">DEVICE PROFILE DOCUMENT</h2>	
Vendor Name: AMETEK Power Instruments	
Device Name: JEMStar II, using the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library, Ver 3.12.0	
Highest DNP Level Supported: For Requests: Level 2 For Responses: Level 2	Device Function: <input type="checkbox"/> Master <input checked="" type="checkbox"/> Slave
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): For static (non-change-event) object requests, request qualifier codes 00 and 01 (start-stop), 07 and 08 (limited quantity), and 17 and 28 (index) are supported in addition to request qualifier code 06 (no range – or all points). Static object requests received with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Static object requests received with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event object requests, qualifiers 17 or 28 are always responded. The read and write function code for Object 50 (Time and Date), variation 1, is supported.	
Maximum Data Link Frame Size (octets): Transmitted: 292 Received 292	Maximum Application Fragment Size (octets): Transmitted: 2048 Received: 2048
Maximum Data Link Re-tries: Configurable from 0 to 255 – Via JEMWare II	Maximum Application Layer Re-tries: None
Requires Data Link Layer Confirmation: Configurable as: Never, Only for multi-frame messages, or Always via JEMWare II	
Requires Application Layer Confirmation: When sending multi-fragment responses Sometimes	
Timeouts while waiting for: Data Link Confirm: Configurable via JEMWare II Complete Appl. Fragment: None Application Confirm: Configurable via JEMWare II Complete Appl. Response: None Others: Transmission Delay: Configurable, via JEMWare II Inter-character Timeout: 1 sec. Need Time Delay: Configurable, via JEMWare II Frozen Counter Event scanning period: FIXED AT 5 seconds	

DNP V3.00	
DEVICE PROFILE DOCUMENT	
Sends/Executes Control Operations:	
WRITE Binary Outputs	Never
SELECT/OPERATE	Never
DIRECT OPERATE	Never
DIRECT OPERATE – NO ACK	Never
Count > 1	Never
Pulse On	Never
Pulse Off	Never
Latch On	Never
Latch Off	Never
Queue	Never
Clear Queue	Never
Reports Binary Input Change Events when no specific variation requested: Never	Reports time-tagged Binary Input Change Events when no specific variation requested: Never
Sends Unsolicited Responses: Never	Sends Static Data in Unsolicited Responses: Never No other options are permitted.
Default Counter Object/Variation: Default Object: 20 Default Variation: 5 Point-List is user-configurable via JEMWareII	Counters Roll Over at: 32 Bits: 999,999,999 or user-configurable from 3–8 digits. 16 Bits: 5 digits = 65535, or user-configurable 3–4 digits.
Sends Multi-Fragment Responses: Yes	

IMPLEMENTATION

The JEMStar II DNP implementation conforms to the standard for a Level II slave device, with some additions. Implementation consists of the following **static** objects:

- (6) Single-bit Binary Output (Object 10 Variations 0, 1, 2)
- (64) Single Bit Binary Inputs (Digital Input, Trigger Status, Meter Status (Object 1 Variations 0, 1, 2, Object 2 Variations 0,1, 2)
- (200) Analog Inputs, configurable with JEMWareII for either 32-bit analog input w/o flag points (Object 30 Variation 3), or 16-bit analog input w/o flag points (Object 30 Variation 4)
- A configurable number (up to 300) of 16 or 32-bit counters (Object 20 Variation 5) that can be assigned to any register in the Normal or Alternate display set
- A corresponding number of 32-bit frozen counter without flag (Object 21 variation 5) that represent the values of the counter points at the time of the last meter freeze

IMPLEMENTATION TABLE

The following table identifies the variations, function codes, and qualifiers supported by the meter in both request messages and in response messages.

For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

In the table below text shaded as **Subset Level 3** indicates Subset Level 3 functionality (beyond Subset Level 2), and text shaded as **beyond Subset Level 3** indicates functionality beyond Subset Level 3.

Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
1	0	Binary Input (Variation 0 is used to request default variation)	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
1	1	Binary Input	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
1	2	Binary Input Change with Time	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
2	0	Binary Input Change (Variation 0 is default)	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
2	1	Binary Input Change w/o Time	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)

Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
2	2	Binary Input Change with Time	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
10	0	Binary Output (Variation 0 is default)	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
10	1	Binary Output w/o Status	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
10	2	Binary Output with Status	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
20	0	Binary Counter (Variation 0 is used to request default variation)	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
20	1	32-Bit Binary Counter	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
20	2	16-Bit Binary Counter	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
20	5	32-Bit Binary Counter w/o Flag	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
20	6	16-Bit Binary Counter w/o Flag	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
21	0	Frozen Counter (Variation 0 is used to request default variation)	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)
21	1	32-Bit Frozen Counter	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07 , 08(limited qty) 17 , 28 (index)	129 (response)	00 , 01 (start-stop) 17 , 28 (index)

Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
21	2	16-Bit Frozen Counter	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
21	9	32-Bit Frozen Counter w/o Flag	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
21	10	16-Bit Frozen Counter w/o Flag	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
23	0	Frozen Counter Event (Variation 0 is used to request default variation)	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
23	1	32-Bit Frozen Counter Event w/o Time	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
23	2	16-Bit Frozen Counter Event w/o Time	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
23	5	32-Bit Frozen Counter Event with Time	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
23	6	16-Bit Frozen Counter Event with Time	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
30	0	Analog Input (Variation 0 is used to request default variation)	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
30	1	32-Bit Analog Input	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
30	2	16-Bit Analog Input	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)

Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
30	3	32-Bit Analog Input without Flag	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
30	4	16-Bit Analog Input without Flag	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
30	5	Short Floating Point Analog Input	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
50	0	Time and Date	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
50	1	Time and Date	1 (Read) 2 (Write)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
52	2	Time Delay Fine	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index)
60	0	Class 0, 1, 2, and 3 Data	1 (Read)	06 (no range , or all)	129 (response)	00, 01 (start-stop) 17, 28 (index)
60	1	Class 0 Data	1 (Read)	06 (no range , or all)	129 (response)	00, 01 (start-stop) 17, 28 (index)
60	2	Class 1 Data	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty)	129 (response)	00, 01 (start-stop) 17, 28 (index)
60	3	Class 2 Data	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty)	129 (response)	00, 01 (start-stop) 17, 28 (index)
60	4	Class 3 Data	1 (Read)	00, 01(start-stop) 06 (no range , or all) 07, 08(limited qty)	129 (response)	00, 01 (start-stop) 17, 28 (index)
No Object (function code only) –See Note 3			13 (cold restart)			
No Object (function code only)			14 (warm restart)			
No Object (function code only)			23 (delay meas.)			

NOTE 1: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. (For change-event objects, qualifiers 17 or 28 are always responded.)

NOTE 2: A cold restart is implemented as a warm restart – the meter is not restarted, but the DNP process is restarted.

DNP Mapping

The JEMStar II meter supports a flexible mapping scheme where you can select any data point in the location you want. The following categories of DNP objects are supported:

- Binary Inputs (Object 2)
- Binary Outputs (Object 10)
- Counters (Object 20, 21, 23)
- Analog Inputs (Object 30)
- Time and Date (Object 50)
- Class Polls (Object 60)

DNP Binary Objects

(Object 2, 10)

DNP Binary Objects support the Digital I/O with the following objects and variations:

Object	Variation	Description
2	1	Binary Input Change without time
	2	Binary Input Change with time
10	1	Binary Output without Status
	2	Binary Output with Status

We use DNP Object 10 to report the status of the Digital Outputs and we use DNP Object 2 to report the status of Digital Inputs and metering events as shown in the list below.

DNP Binary Objects		DNP Binary Objects	
Object 10	Variation 0,1,2	Object 2	Variation 0,1,2
DNP Index	Function		
1	Digital Out #1		
2	Digital Out #2		
3	Digital Out #3		
4	Digital Out #4		
5	Digital Out #5		
6	Digital Out #6		
7	Digital Out #7		
8	Digital Out #8		
9	Digital Out #9		
10	Digital Out #10		
11	Digital Out #11		
12	Digital Out #12		
13	Digital Out #13		
14	Digital Out #14		
DNP Index	Function		
1	Digital Input Status		
2	Ch. 1-14		
3	Trigger Status		
4	Ch. 1-64		
5	Meter Status		
6	Volts Ph A,B,C Status		
7	Clock Sync Status		
8	Battery Status		
9	Internal Comm Status		
	Calibration Status		
	Configuration Status		
99	Firmware Status		
100	Test Mode Status		

DNP Counters

(Object 20, 21, 23)

DNP Counters are implemented as 16 and 32-bit counter with the following objects and variations:

Object	Variation	Description
20	1	32-bit Counter with flag
	2	16-bit Counter with flag
	5	32-bit Counter without flag
	6	16-bit Counter without flag
21	1	32-bit Frozen Counter with flag
	2	16-bit Frozen Counter with flag
	9	32-bit Frozen Counter without flag
	10	16-bit Frozen Counter without flag
23	1	32-bit Counter without time
	2	16-bit Counter without time
	5	32-bit Counter with time
	6	16-bit Counter with time

The JEMStar II uses a flexible mapping system for DNP counters, with the ability to pick any Normal or Alternate Display register configured in the meter.

Normal Registers												
ID	Register Category	Register Type	Quantity	Phase	Direction	TOU	Storage Type	Units	# of Digits	Decimal Point	TLC	Scaling Values
0	IDStatus	MeterID	None	None	None	None	None	None	0	0	<input type="checkbox"/>	None
1	Register	Consumption	Whr	Polyphase	Delivered	Total	Working	KiloUnits	6	2	<input type="checkbox"/>	Primary
2	Register	Consumption	Whr	Polyphase	Received	Total	Working	KiloUnits	6	2	<input type="checkbox"/>	Primary
3	Register	Consumption	VARHr	Polyphase	Delivered	Total	Working	KiloUnits	6	2	<input type="checkbox"/>	Primary
4	Register	Consumption	VARHr	Polyphase	Received	Total	Working	KiloUnits	6	2	<input type="checkbox"/>	Primary
5	Register	Instantaneous	VoltsL-N	A	None	Total	Working	Units	6	2	<input type="checkbox"/>	Secondary
6	Register	Instantaneous	VoltsL-N	B	None	Total	Working	Units	6	2	<input type="checkbox"/>	Secondary
7	Register	Instantaneous	VoltsL-N	C	None	Total	Working	Units	6	2	<input type="checkbox"/>	Secondary
8	Register	PeakDemand	Watts	Polyphase	Delivered	Total	Working	KiloUnits	6	2	<input type="checkbox"/>	Primary
9	Register	TimeofPeakDemand	None	None	None	None	Working	None	0	0	<input type="checkbox"/>	None
10	Register	Instantaneous	Watts	Polyphase	Delivered	Total	Working	KiloUnits	6	2	<input type="checkbox"/>	Primary
11	Register	Instantaneous	Watts	Polyphase	Received	Total	Working	KiloUnits	6	2	<input type="checkbox"/>	Primary
12	Register	Instantaneous	VARs	Polyphase	Delivered	Total	Working	KiloUnits	6	2	<input type="checkbox"/>	Primary
13	Register	Instantaneous	VARs	Polyphase	Received	Total	Working	KiloUnits	6	2	<input type="checkbox"/>	Primary
14	Time	PresentTimeandDate	None	None	None	None	None	None	0	0	<input type="checkbox"/>	None

List of Normal Display Registers configured for meter

DNP Counters: Object 20, Variation 0-8, 16/32 Bit Counter, Object 21, Variation 0-12, 16/32 Bit Frozen Counter

Point #	Register Set	Register ID, Description	Scaling
1	Normal	0, IDStatus, Meter ID	1.
		1, Watthour Delivered	
		2, Watthour Received	
		3, VARhour Delivered	
		4, VARhour Received	
		5, Volts Phase A	
		6, Volts Phase B	
		7, Volts Phase C	
		8, Peak Demand	
		9, Time of Peak Demand	
		10, Watts Delivered	
		11, Watts Received	
		12, VARs Delivered	
		13, VARs Received	
		14, Time, PresTime&Date	
		15, IDStatus, Config ID	

Maximum 300, Count=1

When configuring DNP Counters, you will see the complete list of Normal and Alternate Registers to choose from

Note: Counters are typically used for integrated measurements like Watthours, VARhours, etc. but you can choose from any Display register configured in the meter, such as instantaneous or demand measurements.








Other data formats that may be assigned to display registers include:

- Time and Date registers are represented as seconds since midnight 1/1/70
- Diagnostic and String register types will be represented as 0
- Status registers will be represented as a direct 16 (32)-bit mask value.

The list of available measurements that can be configured for your DNP Counters is shown below:

Measurement Type	Measurement	Phase	Direction	TLC
Consumption	Whr, VARhr, Vahr(vect), Vahr(arith), Ahr, Qhr, A ² hr, V ² hr	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Instantaneous	Volt, Amp, Watt, VAR, VA(vect), VA(arith), Freq, PF(vect), PF(arith), Q, VoltTHD, AmpTHD, V ² , A ² , Volt Imbalance, Amp Imbalance	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Demand: Peak (Max) Present Past Thermal Peak Thermal	Volt, Amp, Watt, VAR, VA(vect), VA(arith), Freq, PF(vect), PF(arith), Q, VoltTHD, AmpTHD, V ² , A ² , Volt Imbalance, Amp Imbalance	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Minimum Maximum Average	Volt, Amp, Watt, VAR, VA(vect), VA(arith), Freq, PF(vect), PF(arith), Q, VoltTHD, AmpTHD, V ² , A ² , Volt Imbalance, Amp Imbalance	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Power Quality	Volt THD, Amp THD, VoltTHD odd, VoltTHD even, Volt Imbalance, Amp Imbalance, TDD, TDD odd, TDD even, Crest Factor, Pst, Plt, Pinst	A,B,C		n/a
Fault	Negative Sequence Ratio (current and voltage), Zero Sequence Ratio (current and voltage)	A,B,C		n/a

Typical Configuration of DNP Counters

	Point #	Register Set	Register ID, Description	Scaling
	1	Normal	1,Watthour Delivered	1. 
	2	Normal	2,Watthour Received	1. 
	3	Normal	3,VARhour Delivered	1. 
	4	Normal	4,VARhour Received	1. 
	5	Normal	8,Peak Demand	1. 
I	6	Normal	9,Time of Peak Demand	1. 

Maximum 300, Count=6

DNP Counter Scaling

A JEMStar II register configured as a DNP Counter point may contain a value as large as 999,999,999 (nine digits). Some DNP master devices cannot accept counter values this large. You may configure JEMStar II to restrict the reported value of counter points to 3, 4, 5, 6, 7, or 8 digits, or allow the full 9-digit precision to be reported. Restricting the number of digits reported affects only DNP counter points, not the actual display registers.

The DNP Counter will duplicate the settings in the display register, so if the display register measurement selected is 'Primary' with engineering units 'kilo', the corresponding counter point will match.

When configuring the DNP Counter, you can select your own scale factor from 1 to 1,000.

Note: The DNP Counter table must be configured after all Normal/Alternate display registers have been created for the configuration.

DNP Analogs

(Object 30)


DNP Analogs are implemented as 16 and 32-bit Analogs with the following objects and variations:

Object	Variation	Description
30	1	32-bit Analog with flag
	2	16-bit Analog with flag
	3	32-bit Analog without flag
	4	16-bit Analog without flag
	5	Short Floating Point Analog

The JEMStar II Meter supports a flexible DNP mapping system as you can select from any instantaneous, power quality and fault measurement. The list of available measurements that can be configured for your display registers is shown below:

Measurement Type	Measurement	Phase	Direction	TLC
Instantaneous	Volt, Amp, Watt, VAR, VA(vect), VA(arith), Freq, PF(vect), PF(arith), Q, Volt THD, Amp THD, V ² , A ² , Volt Imbalance, Amp Imbalance	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Power Quality	Volt & Current Harmonic magnitude (2-64th harmonic), Volt & Current Harmonic phase angle (2-64th harmonic), Volt & Current Inter-Harmonic magnitude (2-50th harmonic), Volt THD, Amp THD, VoltTHD odd, VoltTHD even, Volt Imbalance, Amp Imbalance, TDD, TDD odd, TDD even, Crest Factor, Pst, Plt, Pinst	A,B,C		n/a
Fault	Neagtive, Positive, Zero Sequence (voltage/current magnitude and phase, Negative Sequence Ratio (current and voltage), Zero Sequence Ratio (current and voltage)	A,B,C		n/a

Typical Configuration of DNP Analogs

	Point #	Category	Measurement Type	Quantity	Phase	Direction	TLC	Scaling
	1	Metering	Instantaneous	Watts	A	Delivered	<input type="checkbox"/>	1.
	2	Metering	Instantaneous	Watts	B	Delivered	<input type="checkbox"/>	1.
	3	Metering	Instantaneous	Watts	C	Delivered	<input type="checkbox"/>	1.
	4	Metering	Instantaneous	Watts	Polypha...	Bidirectional	<input type="checkbox"/>	1.
	5	Metering	Instantaneous	VARs	A	Bidirectional	<input type="checkbox"/>	1.
	6	Metering	Instantaneous	VARs	B	Bidirectional	<input type="checkbox"/>	1.
	7	Metering	Instantaneous	VARs	C	Bidirectional	<input type="checkbox"/>	1.
	8	Metering	Instantaneous	VARs	Polypha...	Bidirectional	<input type="checkbox"/>	1.

DNP Analog Scaling

DNP Analog measurements are in secondary values. Several methods of scaling are used depending if you are using 16 Bit or 32 Bit DNP Objects. When using 16 Bit DNP Objects, we offer two different methods.

32 Bit DNP Objects

All values are based on secondary values and include 3 places to the right of the decimal. For example; If the secondary value measured is 1825.438, it will be presented as 1825438. In addition, you can select an individual scaling factor from 0-1,000 to add more resolution. To convert the value into primary values, multiply it by the transformer factor/1000.

Example:

Secondary Measurement Value: 1,825.438 Watts
 Primary Measurement Value: 36,508.76 kWwatts
 Transformer Factor: 20,000
 Scale Factor Used: 20

$$\text{Measurement} \times 1,000 \times \text{Scale Factor} = \text{DNP Value}$$

$$1,825.438 \times 1000 \times 20 = 36508760$$

Note: The maximum value allowed for a 32 bit DNP Analog Object is: 2,147,483,647

16 Bit DNP Objects

If using a 16 Bit DNP Object and variations, you can select two different methods for scaling in the JEMWARE Software.

32 Bit Method

This is a similar approach to the 32 Bit, applying a straight scale factor from 0 to 1,000 to the measured value. Note: Keep in mind that the maximum 16 bit value that can be stored is 32,767, so make sure the scaling doesn't overflow the storage.

For Example; if the maximum secondary watts is 3,600 Watts, your maximum scale factor is 9.

16 Bit Method

This method optimizes the usage of 16 Bit storage by automatically scaling the measurement to fit the maximum secondary ranges. As an example, the measurement range for watts is 0 to 10600 which is scaled to 0 to 32767. A measurement of 10600 watts would provide a DNP value of 32767. A value 10% of that (1060 watts) would provide a DNP value that is 10% of the full scale, or 3277.

Measurement	Measurement Range	Scaled Range
Volts	0 to 530	0 to 32767
Amps	0 to 20	0 to 32767
Frequency	0 to 100	0 to 32767
Power Factor	-1.0 to 1.0	-32768 to 32768
Watts, VARS, VA (1 phase, del, rec, Q1-4, absolute)	0 to 10600	0 to 32767
Watts, VARS, VA (3 phase, del, rec, Q1-4, absolute)	0 to 31800	0 to 32767
Watts, VARS, VA (1 phase, bi-directional)	-10600 to 10600	-32768 to 32768
Watts, VARS, VA (3 phase, bi-directional)	-31800 to 31800	-32768 to 32768
Volts, Amps THD	0 to 100	0 to 32767
Volt ²	0 to 280900	0 to 32767
Amp ² (1 phase)	0 to 400	0 to 32767
Amp ² (3 phase)	0 to 1200	0 to 32767

These are some examples of how scaling can be applied to different measurements:

Scaling Example 1:

Amps 12.56
 Measurement Range 0 to 20
 Scaled Range 0 to 32767

Formula:

$$\frac{\text{Measurement}}{\text{Meas Range}} \times \text{Scaled Range} = \text{DNP Value}$$

$$\frac{12.56}{20} \times 32767 = 20578 \text{ DNP Value (The DNP value of 20578 represents 12.56 Amps)}$$

The DNP configuration also includes a user configurable scale factor of 1 to 100 selectable by measurement. A scale factor should be made so that the maximum value doesn't exceed the measurement range. For example, the 3-phase watt maximum is 31800. If your maximum watt value is less than 3180, you can use a scale factor of 10.

Scaling Example 2:

Polyphase Watts delivered 1825.438
 Measurement Range 0 to 31800
 Scaled Range 0 to 32767
 Scale Factor Used 10

Formula:

$$\frac{\text{Measurement}}{\text{Meas Range}} \times \text{Scaled Range} \times \text{Scale Factor} = \text{DNP Value}$$

$$\frac{1825.438}{31800} \times 32767 \times 10 = 18809 \text{ DNP Value} = 1825.438 \text{ Watts}$$

Events

The JEMStar II DNP implementation includes frozen counter event objects. These are implemented as Object 23 Variations 0, 1, 2, 5 and 6. These provide a time-stamped snapshot of the corresponding counters at the time of freeze. The JEMStar II has storage for up to 500 frozen event objects when all 300 points are configured. An event is generated at each register freeze. Each event includes all corresponding registers at the time the freeze occurred.

If event data is not desired, the generation of events can be disabled using JEMWare II.

In JEMStar II, all event data is permanently assigned to Class 1.

Time and Date

Time and Date (object 50) is supported both for read and write. Using JEMWare II, you can configure the "Write Time Interval", which is the interval after which the JEMStar II will set the "Need Time" bit in the Internal Indications.

Configuration

JEMWare II software must be used to set up the configurable parameters that relate to DNP 3.0 in the meter, as well as configurable point assignments for the various DNP Objects that the meter supports. Please refer to the section in this manual titled "Protocols" for detailed procedures.

APPENDIX E

MODBUS COMMUNICATIONS

INTRODUCTION

The MODBUS protocol defines a message structure that electronic communications equipment will recognize and use, regardless of the type of networks over which they communicate. It describes the procedure a host piece of equipment called the MASTER uses to request access to another device called the SLAVE, how it will respond to requests from other devices, and how errors will be detected and reported. A common format is defined for the layout and contents of message fields.

The MODBUS protocol has two distinct forms, RTU mode and ASCII mode, the JEMStarII supports MODBUS RTU protocol only.

RTU mode essentially means binary mode, where each byte of information is transmitted as an actual 8-bit binary byte.

Further information concerning MODBUS implementation standards can be found at the following website:

www.modicon.com/techpubs/toc7.html

The MODBUS Device Address, timeout, and communications parameters are configured via the JEMWare II software.

Communications

The following MODBUS serial communications parameters are configurable via JEMWare II:

- Baud Rate (1200, 2400, 9600, 19200, 38400)
- RS-232 (half duplex) or RS-485 (half duplex) signal levels

Note: MODBUS communications are always 8-bit, no parity.

Serial Port Connections

MODBUS Point-to-Point Connection Using RS-232 or RS-485

This method is used for connecting the JEMStar II MODBUS directly to a MODBUS Master device. The transmit and receive data pins on the MODBUS host system may vary between pin 2 and pin 3 according to the type of equipment used. Refer to the section Serial Communications for instructions on wiring/connecting serial ports.

Notes:

- For RS-485 mode communications, we suggest using RS-485 port *TX Start Delay* value to be set to 40ms initially, *TX End Delay* value must be set to 40ms initially and *Turnaround Delay* value set to 0ms.
- JEMStar II does not implement hardware handshaking signals with RS-232 or RS-485 serial data.
- The MODBUS port is connected via a pigtail I/O cable for S-base and A-Base meters. For Switchboard type meters, the MODBUS port is connected via the terminal block on the rear of the meter case.

Data Transfers using MODBUS RTU

The JEMStar II MODBUS implementation will fully support all data transfers with the following commands:

Read Output Status	(Function code 01)
Read Input Status	(Function code 02)
Read Holding Registers	(Function code 03)
Read Input Registers	(Function code 04)
Force Single Coil	(Function code 05)
Force Multiple Coils	(Function code 15)
Preset Multiple Registers	(Function code 16)

As implied by the **Read Holding Registers** command, all JEMStar II available data will be stored in 16-bit Holding Registers. However, these registers will either hold the High Order or Low Order 16 bits (word) of a 32-bit quantity or a single 16-bit register if *Analog Scaling = 16* in *JEMWareII Protocol Setup*. Whenever a 32-bit quantity is accessed, the registers containing both the High Order & Low Order words must be included in the request, or the command will be rejected.

The supported Register Sets and the MODBUS Function Codes (FC) used to retrieve the data are as follows.

<u>Function Code (FC)</u>	<u>Register Set</u>
01	Read Discrete Outputs
02	Read Discrete Inputs
03	Read Holding Registers (native data types)
04	Read Input Registers (Scaled and Cascaded)
05	Force Single Discrete Outputs
15	Force Multiple Discrete Outputs
16	Preset Multiple Holding Registers

CRC Calculation (RTU mode)

The MODBUS interface also operates in RTU mode and uses CRC for error checking. The CRC value is two bytes, containing a 16 bit binary value. The CRC value is calculated by the transmitting device that appends the CRC to the message. The receiving device recalculates the CRC and compares it to the value in the message. If the values are not the same, the receiver will not process the message.

The CRC value is calculated according to the following procedure.

1. Initialize a 16 bit *CRC register* to 0xFFFF
2. Place the first 8 bit character from the message and place it into a *test register*.
3. Exclusive OR the *test character* with the *CRC register*, leaving the result in the *CRC register*.
4. The *CRC register* is shifted one bit toward the least significant bit, the least significant bit is saved into a *carry register*, and the most significant bit is zero filled.
5. If the old least significant bit was zero, go to step 6, if it was one, the *CRC register* is exclusive Ored with 0xa001.
6. Repeat steps 4 and 5, seven times.
7. Using each successive character in the message, repeat steps 3 through 6.
8. The CRC is the value in the CRC register.
9. The CRC value is placed into the message in hexadecimal format with the most significant byte going into the first CRC byte and the least significant byte going into the last CRC byte.

RTU Message Framing

In RTU mode, messages start with a silence interval of at least 3.5 character times. If the SLAVE device can monitor the network bus continuously, this silence interval can be used to identify the beginning of a new message, with the first field of a new message being the Device Address. Devices that use the silence interval to detect a new message expect the entire message frame to be transmitted continuously, and do not allow a silent interval of more than 1.5 characters to occur before completion of the entire message.

The JEMStar II MODBUS implementation will not monitor the network bus continuously, and thus will not detect any silence interval. Consequently, the strict rules about silence intervals will not be enforced. The start of a new message will be detected using a synchronization algorithm.

Typical JEMStar II RTU Queries:

Query Field	Read Holding Regs	Force Single Coil
Device Address	05	05
Function	03	05
Register Address	00 04	00 01
# Regs/Preset Value	00 06	FF 00
Error Check (CRC)	XX XX	XX XX

Communication Errors

Communication errors, consisting of a Parity, LRC or CRC error, will result in the message causing the error to be ignored by the meter. The MASTER Device will timeout and retransmit the message.

Exception Responses

The JEMStar II MODBUS implementation can produce 1 of 3 possible exceptions:

- **Illegal Function** (Exception Code 01)
- **Illegal Data Address** (Exception Code 02)
- **Illegal Data Value** (Exception Code 03)

An **Illegal Function** is self-explanatory. If the meter receives a MODBUS query that contains a function that it does not support (anything other than 01, 02 03, 04, 05, 15 or 16), an Illegal Function (Exception 01) will be returned.

The **Data Address** is the *Holding Register* or *Input Register* address. For example, an Illegal Data Address for a Function 03 command would be either a register value greater than 0xE7 or a register value that begins at the second word (Lo Order Word) of a 32-bit quantity. An Illegal Data Address for a Function 06 command would be any register other than 0x16.

The meaning of the **Data Value** depends upon the command. The Data Value for a Function 03 command is the number of Holding registers requested, starting with the first (Data Address) register. If the sum of the first register and the number of registers is either greater than 0x3F, or results in the request of only one word of any 32-bit quantity, an Illegal Data Value exception is generated.

An Exception Response is the JEMStar II's Device Address, the function value with the High Order Bit set to 1, and the Exception Code followed by the CRC. For example, an **Illegal Data Address** exception to a function 03 request would be:

Exception Byte	Contents	Example
1	JEMStar II Device Address	5
2	Marked Function Code	83
3	Exception Code	02
4	High Order Byte CRC	XX
5	Low Order Byte CRC	XX

Timeouts

RTU

The timeout period from the reception of a matching Device Address until that message is completed is software assignable using JEMWare II software. If a timeout occurs, the portion of the message already processed is discarded and the meter will again look for a matching Device Address. The default timeout is 1 second, but can be configured for 100 – 65000ms.

Register Presets

In the JEMStar II Modbus implementation, meter registers (Normal and Alternate) may be cleared or set to a given value with the Preset Multiple Registers command (Function Code 16).

Note that the start register specified in the command must be the Hi-order register number of the appropriate register pair. There can not be more than 120 registers per request.

In addition, **“Allow Register Presets” must be specifically enabled in the meter with JEMWare II** (Use menu Meter Settings/Protocols/ Modbus). If not enabled, Modbus exception 01 (illegal function) will be returned if register presets are attempted.

Digital Output Control

The JEMStar II digital outputs may be forced to a high or low state via MODBUS using either the Force Single coil (Function 5) or Force Multiple Coils (Function 15) command. To use this feature, **“Allow Digital Output Control”** must be enabled in the meter with JEMWare II. If not enabled, Modbus exception 01 (illegal function) will be returned if this is attempted.

MODBUS REGISTER MAPS

The JEMStar II has a flexible map for the Modbus Protocol that you can customize in the JEMWARE Software. The following Modbus Functions are supported:

Function Code (FC)

- 03
- 04
- 03
- 04
- 05
- 17
- 18

Register Set

- Read Discrete Outputs
- Read Discrete Inputs
- Read Holding Registers (native data types)
- Read Input Registers (Scaled and Cascaded)
- Force Single Discrete Outputs
- Force Multiple Discrete Outputs
- Preset Multiple Holding Registers

Modbus Binary Objects

(Function 01 – Read Output Coils, Function 02 Read Input Status)

We use a single 16 bit register for multiple inputs and outputs. You can select from any of the digital I/O and metering events as shown in the list below.

Modbus Binary Objects	
Function 01 Read Output Coils	
Address	Function
00001	Digital Out #1
00002	Digital Out #2
00003	Digital Out #3
00004	Digital Out #4
00005	Digital Out #5
00006	Digital Out #6
00007	Digital Out #7
00008	Digital Out #8
00009	Digital Out #9
00010	Digital Out #10
00011	Digital Out #11
00012	Digital Out #12
00013	Digital Out #13
00014	Digital Out #14
Function 02 Read Input Status	
Address	Function
10001	Digital Input Status
10002	Ch. 1-14
10003	Trigger Status
10004	Ch. 1-64
10005	Meter Status
10006	Volts Ph A,B,C Status
10007	Clock Sync Status
10008	Battery Status
10009	Internal Comm Status
	Calibration Status
	Configuration Status
10099	Firmware Status
10100	Test Mode Status

Modbus Counters

(Function 03 – Read Holding Registers)

The JEMStar II uses a flexible mapping system for Modbus counters, with the ability to pick any Normal or Alternate Display register configured in the meter.

ID	Register Category	Register Type	Quantity	Phase	Direction	TOU	Storage Type	Units	# of Digits	Decimal Point	TLC	Scaling Values
0	IDStatus	MeterID	None	None	None	None	None	None	0	0		None
1	Register	Consumption	Whr	Polyphase	Delivered	Total	Working	KiloUnits	6	2		Primary
2	Register	Consumption	Whr	Polyphase	Received	Total	Working	KiloUnits	6	2		Primary
3	Register	Consumption	VARHr	Polyphase	Delivered	Total	Working	KiloUnits	6	2		Primary
4	Register	Consumption	VARHr	Polyphase	Received	Total	Working	KiloUnits	6	2		Primary
5	Register	Instantaneous	VoltsL-N	A	None	Total	Working	Units	6	2		Secondary
6	Register	Instantaneous	VoltsL-N	B	None	Total	Working	Units	6	2		Secondary
7	Register	Instantaneous	VoltsL-N	C	None	Total	Working	Units	6	2		Secondary
8	Register	PeakDemand	Watts	Polyphase	Delivered	Total	Working	KiloUnits	6	2		Primary
9	Register	TimeoffPeakDemand	None	None	None	None	Working	None	0	0		None
10	Register	Instantaneous	Watts	Polyphase	Delivered	Total	Working	KiloUnits	6	2		Primary
11	Register	Instantaneous	Watts	Polyphase	Received	Total	Working	KiloUnits	6	2		Primary
12	Register	Instantaneous	VARs	Polyphase	Delivered	Total	Working	KiloUnits	6	2		Primary
13	Register	Instantaneous	VARs	Polyphase	Received	Total	Working	KiloUnits	6	2		Primary
14	Time	PresentTimeandDate	None	None	None	None	None	None	0	0		None

List of Normal Display Registers configured for meter

Point #	Register Set	Register ID, Description	Scaling
1	Normal	1,Watthour Delivered	1,000.
2	Normal	0,IDStatus,Meter ID	1,000.
3	Normal	1,Watthour Delivered	1,000.
4	Normal	2,Watthour Received	1,000.
		3,VARhour Delivered	
		4,VARhour Received	
		5,Volts Phase A	
		6,Volts Phase B	
		7,Volts Phase C	
		8,Peak Demand	
		9,Time of Peak Demand	
		10,Watts Delivered	
		11,Watts Received	Maximum 300, Count=4
		12,VARs Delivered	
		13,VARs Received	
		14,Time,PresTime&Date	
		15,IDStatus,Config ID	
		16,PQ,Flkr,Pst:A	

When configuring Modbus Counters, you will see the complete list of Normal and Alternate Registers to choose from

You can specify a register starting address (ex: 40001) and you can select an individual scaling factor from 0-1000.

General Settings

Adjust Start Address : Register Presets Inactivity Timeout :

Frame Timeouts : Digital I/O Control


Modbus Counters: FN03, Read Holding Registers

ADD	Point #	Register Set	Register ID, Description	Scaling
	1	Normal	1,Watthour Delivered	1,000.
	2	Normal	2,Watthour Received	1,000.
	3	Normal	3,VARhour Delivered	1,000.
	4	Normal	4,VARhour Received	1,000.

The list of available measurements that can be configured for your display registers is shown below:

Measurement Type	Measurement	Phase	Direction	TLC
Consumption	Whr, VARhr, Vahr(vect), Vahr(arith), Ahr, Qhr, A ² hr, V ² hr	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Instantaneous	Volt, Amp, Watt, VAR, VA(vect), VA(arith), Freq, PF(vect), PF(arith), Q, VoltTHD, AmpTHD, V ² , A ² , Volt Imbalance, Amp Imbalance	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Demand: Peak (Max) Present Past Thermal Peak Thermal	Volt, Amp, Watt, VAR, VA(vect), VA(arith), Freq, PF(vect), PF(arith), Q, VoltTHD, AmpTHD, V ² , A ² , Volt Imbalance, Amp Imbalance	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Minimum Maximum Average	Volt, Amp, Watt, VAR, VA(vect), VA(arith), Freq, PF(vect), PF(arith), Q, VoltTHD, AmpTHD, V ² , A ² , Volt Imbalance, Amp Imbalance	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Power Quality	Volt THD, Amp THD, VoltTHD odd, VoltTHD even, Volt Imbalance, Amp Imbalance, TDD, TDD odd, TDD even, Crest Factor, Pst, Plt, Pinst	A,B,C		n/a
Fault	Negative Sequence Ratio (current and voltage), Zero Sequence Ratio (current and voltage)	A,B,C		n/a

Typical Configuration of Modbus Counters

	Point #	Register Set	Register ID, Description	Scaling
	1	Normal	1,Watthour Delivered	1,000.
	2	Normal	2,Watthour Received	1,000.
	3	Normal	3,VARhour Delivered	1,000.
	4	Normal	4,VARhour Received	1,000.
	5	Normal	8,Peak Demand	1,000.
	6	Normal	9,Time of Peak Demand	1,000.
	7	Normal	10,Watts Delivered	1,000.
	8	Normal	11,Watts Received	1,000.
	9	Normal	12,VARs Delivered	1,000.
I	10	Normal	13,VARs Received	1,000.

Maximum 300, Count=10

Modbus Counter Scaling:

The Modbus Counter will duplicate the settings in the display register, so if the measurement is selected as ‘Primary’ with engineering units ‘kilo’, the corresponding counter point will match.

When configuring the MODBUS Counter, you can select your own scale factor from 1 to 1,000.

Note: The Modbus Counter table must be configured after all Normal/Alternate display registers have been created for the configuration.

The list of available measurements is based on what you have configured for your Normal and Alternate Display Registers.

Modbus Analogs

(Function 04 – Read Input Registers)


We use a single 16 bit register per measurement. You can select from any instantaneous measurement with selections for phase, direction, TLC and scaling. All values are based on secondary values. You can specify a register starting address (ex: 30001) and you can select an individual scaling factor from 0-100. The list of available measurements that can be configured for your display registers is shown below:

Address	Measurement
30001	Analog 1
30002	Analog 2
30003	Analog 3
30199	Analog 199
30200	Analog 200

Available Analog Measurements

Measurement Type	Measurement	Phase	Direction	TLC
Instantaneous	Volt, Amp, Watt, VAR, VA(vect), VA(arith), Freq, PF(vect), PF(arith), Q, VoltTHD, AmpTHD, V2, A2, Volt Imbalance, Amp Imbalance	A,B,C, Total	Del, Rec, Net, Abs, Q1-Q4	yes/no
Power Quality	Volt & Current Harmonic magnitude (2-64th harmonic), Volt & Current Harmonic phase angle (2-64th harmonic), Volt THD, Amp THD, VoltTHD odd, VoltTHD even, Volt Imbalance, Amp Imbalance, TDD, TDD odd, TDD even, Crest Factor	A,B,C		n/a
Fault	Neagtive, Positive, Zero Sequence (voltage/current magnitude and phase, Negative Sequence Ratio (current and voltage), Zero Sequence Ratio (current and voltage)	A,B,C		n/a

Typical Configuration of Modbus Analogs

	Point #	Category	Measurement Type	Quantity	Phase	Direction	TLC	Scaling
▶	1	Metering	Instantaneous	Watts	A	Delivered	<input type="checkbox"/>	1.
	2	Metering	Instantaneous	Watts	B	Delivered	<input type="checkbox"/>	1.
	3	Metering	Instantaneous	Watts	C	Delivered	<input type="checkbox"/>	1.
	4	Metering	Instantaneous	Watts	Polypha...	Delivered	<input type="checkbox"/>	1.
	5	Metering	Instantaneous	PFVectorial	Polypha...	Received	<input type="checkbox"/>	1.
	6	Metering	Instantaneous	VoltsL-N	B	None	<input type="checkbox"/>	1.
	7	Metering	Instantaneous	Amps ² Rms	C	None	<input type="checkbox"/>	1.
	8	Metering	Instantaneous	Amps Imbalance	Polypha...	None	<input type="checkbox"/>	1.

Modbus Analog Scaling:

Modbus Analog values are based on secondary values. Given the limitation of 16 bit storage of values, we automatically scale the measurements based on the measurement range.

This scaling method optimizes the usage of 16 Bit storage by automatically scaling the measurement to fit the maximum secondary ranges. *As an example, the measurement range for watts is 0 to 10600 which is scaled to 0 to 32767. A measurement of 10600 watts would provide a Modbus value of 32767. A value 10% of that (1060 watts) would provide a Modbus value that is 10% of the full scale, or 3277.*

Measurement	Measurement Range	Scaled Range
Volts	0 to 530	0 to 32767
Amps	0 to 20	0 to 32767
Frequency	0 to 100	0 to 32767
Power Factor	-1.0 to 1.0	-32768 to 32768
Watts, VARS, VA (1 phase, del, rec, Q1-4, absolute)	0 to 10600	0 to 32767
Watts, VARS, VA (3 phase, del, rec, Q1-4, absolute)	0 to 31800	0 to 32767
Watts, VARS, VA (1 phase, bi-directional)	-10600 to 10600	-32768 to 32768
Watts, VARS, VA (3 phase, bi-directional)	-31800 to 31800	-32768 to 32768
Volts, Amps THD	0 to 100	0 to 32767
Volt2	0 to 280900	0 to 32767
Amp2 (1 phase)	0 to 400	0 to 32767
Amp2 (3 phase)	0 to 1200	0 to 32767

These are some examples of how scaling can be applied to different measurements:

Scaling Example 1:

Amps 12.56
 Measurement Range 0 to 20
 Scaled Range 0 to 32767

Formula:

$$\frac{\text{Measurement}}{\text{Meas Range}} \times \text{Scaled Range} = \text{Modbus Value}$$

$$\frac{12.56}{20} \times 32767 = 20578 \text{ Modbus Value (The Modbus value of 20578 represents 12.56 Amps)}$$

The Modbus configuration also includes a user configurable scale factor of 1 to 100 selectable by measurement. A scale factor should be made so that the maximum value doesn't exceed the measurement range. For example, the 3-phase watt maximum is 31800. If your maximum watt value is less than 3180, you can use a scale factor of 10.

Scaling Example 2:

<i>Polyphase Watts delivered</i>	<i>1825.438</i>
<i>Measurement Range</i>	<i>0 to 31800</i>
<i>Scaled Range</i>	<i>0 to 32767</i>
<i>Scale Factor Used</i>	<i>10</i>

Formula:

$$\frac{\text{Measurement}}{\text{Meas Range}} \times \text{Scaled Range} \times \text{Scale Factor} = \text{Modbus Value}$$

$$\frac{1825.438}{31800} \times 32767 \times 10 = 18809 \text{ Modbus Value} = 1825.438 \text{ Watts}$$

APPENDIX F

IEC-61850 COMMUNICATION PROTOCOL

IEC 61850 is an optional communication protocol used over Ethernet. It is used to make the meter measurements and I/O status available for other IED's and applications.

In this implementation, the meter will be used as an IEC 61850 Server, publishing the status of the analog and digital I/O wired to the meter to other IEC 61850 enabled IED's.

It will support GOOSE messaging by transmitting the status of the digital inputs to other devices.

IED SETUP

ICD File

Each meter shall have an ICD file that describes all available options. The file will include information such as Internal I/O, External I/O and how it is configured for inputs or outputs. The ICD file shall also identify whether it is configured for power quality measurements and PMU.

CID File

The CID file shall be created using a software application (provided by Ametek) that allows you to take the ICD file and configure the various application requirements, including IED Properties, Goose Messaging, Buffered and Unbuffered Reports and definition of the Dataset. The Software shall allow the use of FTP to transfer the CID file into the meter.

IED Properties

The IED properties shall include the IED Name, Manufacture, Model Type, Station ID, Device ID, Firmware and Identification

LOGICAL NODES

The meter will support the following logical nodes:

Logical Node	IEC 61850 Name	Description	Measurements	Variations
Physical Device	LPHD	Contains physical information about our meter		
Logical	LLNO	Contains data about our meter		
Measuring- for operative purpose	MMXU1	Total Active Power Total Reactive Power Total Apparent Power Average Power factor Frequency Phase to phase voltages Phase to ground voltages Phase currents Phase active power Phase reactive power Phase apparent power Phase power factor	TotW TotVAR TotVA TotPF Hz PPV PhV A W VAr VA PF	phsAB, phsBC, phsCA phsA, phsB, phsC phsA, phsB, phsC phsA, phsB, phsC phsA, phsB, phsC phsA, phsB, phsC
Metering - for commercial purpose	MMTR1	Total Watt hours Total VAR hours Total VA hours Delivered Watt Hours Delivered VAR hours Received Watt hours Received VAR hours	TotWh TotVARh TotVAh SupWh SupVARh DmdWh DmsVARh	
Metering Statistics	MSTA	Average current Maximum current Minimum current Average voltage Maximum voltage Minimum voltage Average apparent power Maximum apparent power Minimum apparent power Average real power Maximum real power Minimum real power Average reactive power Maximum reactive power Minimum reactive power	AvAmps MaxAmps MinAmps AvVolts MaxVolts MinVolts AvVA MaxVA MinVA AvW MaxW MinW AvVAr MaxVAr MinVAr	
Digital Inputs	IN_GGIO1	Channel 1 Channel 2 Channel 3 Channel 4 Channel 5 Channel 6	Ind1 Ind2 Ind3 Ind4 Ind5 Ind6	
Digital Outputs	Out_GGIO2	Channel 1 Channel 2 Channel 3 Channel 4 Channel 5 Channel 6	Ind1 Ind2 Ind3 Ind4 Ind5 Ind6	

GOOSE MESSAGING

GOOSE messaging is supported to allow re-transmission of any of the JEMStar II hardwired digital inputs.

REPORTS

The IEC-61850 Protocol supports up to 12 Un-buffered reports and 12 Buffered Reports. The reports shall be configured using the IEC-61850 Software application.

The reports shall be triggered for retrieval from any of three methods:

- Configurable trigger based on a change in a value as selected by a deadband value
- Report retrieved at a configurable time interval
- Report requested for retrieval by a client device

Data Set	Report Type
Meter Status	Unbuffered
Instantaneous	Unbuffered
Energy	Unbuffered
Statistics	Unbuffered
I/O	Buffered

DATASET

The 61850 Configuration Software shall provide the ability to configure 8 Data Sets of meter data (max 50 measurements) which will become available for the buffered and unbuffered reports. They shall start as a default list of values which the user can add/edit/delete the entries.

The Data Sets shall consist of:

Meter Status	This shall contain various health check conditions of the meter
Instantaneous	Group of instantaneous measurements from MMXU node
Energy	Group of energy measurements from MMTR node
Statistics	Group of min/max/avg measurements from MSTA node
Sequence	Group of sequence components from MSQI node
<i>Power Quality</i>	<i>(Future) Group of power quality measurements from MHAI node</i>
<i>Disturbance</i>	<i>(Future) Group of disturbance measurements from RADR, RBDR, RDRE</i>
<i>I/O</i>	<i>(Future) Group of analog and digital I/O from GGIO node</i>

PERFORMANCE CLASS

The meter meets performance class M2 for revenue metering with accuracy class 0.2 (IEC 62053-22) and 0.1 (IEC 60044-8) and up to the 13th harmonic.

CONFIGURATION SOFTWARE

Configuration Software is provided for mapping the JEMStar II data items to other IED's using GOOSE Messaging and for selecting items in the Data set and Reports. The Software allows the import of other manufacture ICD files to assist with the mapping. The software creates a CID file that can be sent to the meter via FTP.

Refer to the 61850 Configuration Software manual for details

GLOSSARY

Apparent Power

The product of the applied voltage and current in an ac circuit. Apparent power, or volt-amperes, is not the real power of the circuit because the power factor is not considered in the calculation. JEMStar II

calculates Apparent Power = $\sqrt{\text{Watts}^2 + \text{VARs}^2}$

ARO

At Rated Output

Average Power Factor

The ratio of kilowatt-hour pulses to computed equivalent kVAh pulses for the billing period.

Billing Period

The period of time (commonly a month) between meter readings, when those readings are used for billing a power customer. Also, the period of time between two consecutive demand resets.

Billing Period Reset (BPR)

A task commonly associated with the Billing Read is the Billing Period Reset. The Reset causes a "snapshot" of register readings to be copied to storage as well as clearing Peak Demand readings and updating Cumulative and Continuous Cumulative readings. You must break a seal to perform a Billing Period Reset on the front panel. The Reset is recorded in the Billing Period Reset event buffer.

Billing Read

A Billing Read is the task of reading billing information from the meter front panel. If the billing information is required to be available to anyone, it can be programmed into the Normal display list (See "Casual" Read).

Burden

Load imposed by a device on an input circuit, expressed in ohms or VA.

Casual Read

A "casual" read is the ability to see measurements on a sealed, functioning meter without breaking a seal or otherwise violating the meter's security. The type and amount of information available during a casual read can be selected by the meter setup programmer using JEMWare II.

For example, any non-secure readings may be placed in the Normal display list. If nothing is to be displayed to unauthorized users, the programmer may place the Blank or Segment Check display items in the Normal list. Consult the JEMWare II user's manual for full configuration details.

Class; Class Amps

The maximum current for which a meter is specified to operate within its accuracy rating.

Daily Schedule

The daily schedule is an array of times and rates, and it determines the moment at which a TOU period changes.

Demand

The average of some measurement over a defined period of time, traditionally calculated by accumulating the integrated measurement over the defined period (the "demand interval") and dividing by the time.

Demand Deferral

A period immediately following a power outage during which demands are not calculated. It is determined by the number of demand-interval closures following the power outage.

Demand Prediction

An optional feature that calculates and displays the Demand value expected at the end of the present demand interval *before* the interval is completed. Demand Predictions may be used to monitor a load in order to prevent setting a new Peak Demand.

Demand Reset

A scheduled or user-initiated event that causes maximum demands to be zeroed and certain other calculations to occur.

DNP

Distributed Network Protocol: a serial communication protocol used in instrument networking. See Appendix D.

Element

A voltage and current input pair to a meter or transducer, typically from the same phase. A half element takes advantage of mathematical relationships present in a three phase power system to eliminate the need for one voltage measurement.

Full Scale

A reference condition corresponding to the highest rated value of a given measurement. For watts, this condition occurs at the user's input voltage, class current rating, and unity power factor. For VARs, full scale is at the user's input voltage, class current, and zero power factor.

Health / Status Read

A Health and Status Read is concerned with evaluating the correct operation of the meter and its installation, not its billing data. Health and Status display items may be programmed into either Normal or Alternate display lists at the user's discretion.

Holiday

For TOU purposes, a holiday is a date contained in the holiday schedule.

Holiday Schedule

A holiday schedule is an array of dates (in seconds time format at midnight) within the TOU schedule that enables the meter to identify holidays.

Instantaneous Quantities

Instantaneous quantities are short-term average or RMS measurements of electrical characteristics in a circuit. Instantaneous quantities are suitable for developing Instantaneous Register, Thermal Demand, or analog outputs.

Integrated Quantities

Integrated quantities are power measurement quantities that are integrated over time, and which may be accumulated. Integrated quantities are used for developing Consumption, Fixed or Sliding Window Demand (Peak or Coincident), Load Profile, or pulse outputs.

Interval

A period over which a demand is calculated consisting of one or more subintervals.

IRLED

Infrared light-emitting diode, such as the optical port on the JEMStar II meter.

KYZ

A meter output that indicates energy by toggling a Form-C contact output at a frequency proportional to power flow. Each transition represents some constant amount of energy (typically referred to as K_e , "energy constant") that has been consumed. *JEMStar II* mimics this function by allowing the user to configure two solid-state contact outputs into a similar arrangement.

Leading Zero(es)

The main section of the meter's LCD readout can be configured (with JEMWare II) to fill in unused display digits with either blanks or zeros. "Leading Zeroes" inserts "0" digits to the left of the most significant digit until all display positions are filled (there can be 6 or 8 digit positions, depending upon user-configuration).

LLC

Line Loss Compensation: the ability of an instrument to measure or calculate the power lost in an imperfect conductor and to use that figure to modify its power or energy readings.

Liquid Crystal Display (LCD)

Display area on the meter face that contains alpha-numeric characters for data readout.

Load Linearity

Specifies the maximum deviation of performance in percent registration over a range of current (load) assuming all other conditions at nominal reference conditions.

Load Profile

A record of energy consumption stored periodically (typically every 1 to 60 minutes) and sequentially. Each stored "interval" (one record) contains one or more "channels" (a single integrated quantity accumulated during the interval just ended).

(Load Profile) Periodic Special Event

The meter stores pulses accumulated since the time of the previous LP interval closure.

Load Profile Interval

An LP interval is the period between two consecutive LP interval closures.

Load Profile Record

An LP record is the data in a segment of load-profile memory where the accumulated pulses from a single LP interval are stored.

Loss Compensation

A generic term used to include both TLC and LLC.

Measurement Quantity

A single measurable characteristic of power flow in a circuit, or a commonly used combination of measurement quantities. E.g. Volts Phase A, Watthours Delivered Total.

MODBUS™

A standard serial communication protocol used by programmable controllers.

Null Modem

Cable that emulates a modem to enable the connection of two DTE (data terminal equipment) devices such as any two devices that would communicate with a modem (DCE) device.

Partial Load Profile Count

The total accumulated counts within an interval after the last special event or load-profile interval closure.

Past Interval Demand

The demand for the most recently ended demand interval.

Peak Demand

(a.k.a. Maximum Demand) The highest demand reading in a Billing Period.

Phase

The timing relationship between two signals of the same frequency, expressed as an angle. E.g. the delay between voltage and current waveforms in an AC circuit, or between voltage waveforms in different circuits.

One of (usually) three circuits in a polyphase power distribution system. Each phase may be treated as an individual power source that is synchronized to the other phases in the system.

Polyphase

The sum, average, or combination (as appropriate) of measurements from all phases input to a meter.

Power Factor (PF)

The ratio of the real power (watts) to the apparent power (volt-amperes). PF is equal to the cosine of the phase angle between voltage and current.

Present TOU Period

The one Time Of Use period that the meter determines to be active at the present time. This is determined by the present date and time of the meter and the TOU schedule.

Pulse

A state change in either direction of a binary metering signal.

Register

Used to refer to specific quantities to be displayed or retrieved.

Register Assembly

The term used to refer to the hardware implementation of the display or control of the I/O functions of the meter.

RMS

Root Mean Square: the equivalent DC value of a periodic (AC) signal. 5 amps RMS delivers the same amount of power to a given load as 5 amps DC.

Rolling Interval/Sliding Window

A demand measurement consisting of the summation of values calculated over multiple consecutive subintervals. A calculation is updated at the completion of each subinterval, but includes a defined number of previous subintervals.

Season

A season is a range of dates whose start date is contained in the season schedule in seconds time format.

Season Schedule

A season schedule is an array of dates within the TOU schedule that enables the meter to identify the seasons.

Seconds Time Format

A 32-bit number in units of seconds referenced from January 1, 1990.

Special Event

An event stored in load-profile data such as a register freeze, power fail, time set, etc.

Storage Register

A copy of a quantity which could be a displayable register and is saved when triggered by a demand reset.

Subinterval

The increment of time in which demand calculations are updated.

T_A

Test Amperes; equal to ½ Class Amps

THD

Total Harmonic Distortion: a measure of the amount of harmonic content in a periodic signal, expressed as a percentage. A pure sine wave at the fundamental frequency has 0% THD.

Thermal Demand

A measurement filtered through a time delay such that step changes in the measurement are reflected slowly in the output. Commonly used to simulate the effects of current heating on power distribution equipment.

Thermal Time Characteristic

The time required for a Thermal Demand Register to reflect 90% of a step change in input. Similar to the time characteristic of mechanical thermal demand meters.

Threshold Alarms

JEMStar II can be configured to monitor any Register and (if the proper option module is installed) generate a contact closure output based on the register's value. JEMStar II compares the selected Register against the setpoints once per second.

The user can configure these characteristics:

- The register to compare against the thresholds
- The upper threshold (set point)
- The lower threshold (reset point)

Time

Time indicates hours, minutes, and seconds.

TLC

Transformer Loss Compensation: the ability of an instrument to measure or calculate the power lost in an imperfect transformer and to use that figure to modify its power or energy readings.

Total Registers

Those JEMStar II registers that are not TOU registers are called total registers. The total registers always are active.

TOU Period

A selected duration of time during which the consumption, demand, and other information are assigned to a set of Time Of Use registers.

TOU Rate Indicator Output

A display segment that indicates the present TOU rate in effect.

TOU Register

A TOU register is a register of the JEMStar II meter that, for a designated TOU period, accumulates and may display amounts of electrical energy, demand, or other quantities measured or calculated.

TOU Schedule

The TOU schedule is a static, externally configured database within the meter. The data base contains information that allows the meter to determine the present TOU period based upon the real date and time of the meter.

VA

Volt Amperes or Volt Amps: the product of voltage and current in a circuit regardless of phase. Typically expressed in RMS units, this is also called "apparent" power. JEMStar II calculates VA vectorially.

$$VA = \sqrt{Watts^2 + VARs^2}$$

VAh

VA hour: VA integrated over time to produce a measurement that may be accumulated.

VAR

Volt Amps Reactive: the product of voltage and current in a circuit, times the sine of the phase shift between the two. Typically expressed in RMS units. The unit of "reactive" or "imaginary" power.

VARh

VAR hour: VAR integrated over time to produce a measurement that may be accumulated.

W

Watt: the product of voltage and current in a circuit, times the cosine of the phase shift between the two. Typically expressed in RMS units. The unit of "real" power.

Wh

Watt-hour: W integrated over time to produce a measurement that may be accumulated.

METER MEASUREMENTS

Display Registers

The meter has provisions to display and store up to 50 Normal, 50 Alternate and 50 Test Registers. The measurement selections available are shown below.

Meas Type	Measurement	Phase	Direction	Meas. Type
Instantaneous	Volts	A,B,C,Polyphase	Bi-Directional	Primary Secondary
	Amps	A,B,C,Polyphase, Neutral, Average	Bi-Directional	
	Frequency	Phase A	N/A	
	Volts THD	A,B,C,Polyphase	Bi-Directional	
	Amps THD	A,B,C,Polyphase	Bi-Directional	
	Volts ²	A,B,C,Polyphase	Bi-Directional	
	Amps ²	A,B,C,Polyphase	Bi-Directional	
	Watts	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute	
	VARS	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute, Q1,2,3,4	
	VA (Arithmetic)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute	
	VA (Vectorial)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute	
	Q	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute	
	PF (Arithmetic)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute	
	PF (Vectorial)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute	
	Volts Imbalance	Polyphase	N/A	
Amps Imbalance	Polyphase	N/A		

Meas Type	Measurement	Phase	Direction	Meas Type	Storage Type
Energy	WHR	A,B,C,Polyphase	Delivered, Received, Net, Absolute	Primary Secondary	Working Billing Period Reset Season Change Previous Hour Previous Day
	VARHr	A,B,C,Polyphase	Delivered, Received, Net, Absolute, Q1,2,3,4		
	VAHr (Arithmetic)	A,B,C,Polyphase	Delivered, Received, Net, Absolute		
	VAHr (Vectorial)	A,B,C,Polyphase	Delivered, Received, Net, Absolute		
	QHr	A,B,C,Polyphase	Delivered, Received, Net, Absolute		
	AMPHr	A,B,C,Polyphase, Average	Bi-Directional		
	Volts ² Hr	A,B,C,Polyphase	Bi-Directional		
	AMP ² Hr	A,B,C,Polyphase, Average	Bi-Directional		
Integrated Values (Consumption)					

Meas Type	Measurement	Phase	Direction	Meas Type	Storage Type
Minimum Maximum Average	Volts	A,B,C,Polyphase	Bi-Directional	Primary Secondary	Working Billing Period Reset Season Change Previous Hour Previous Day
	Amps	A,B,C,Polyphase, Neutral, Average	Bi-Directional		
	Frequency	Phase A	N/A		
	Volts THD	A,B,C,Polyphase	Bi-Directional		
	Amps THD	A,B,C,Polyphase	Bi-Directional		
	Volts ²	A,B,C,Polyphase	Bi-Directional		
	Amps ²	A,B,C,Polyphase	Bi-Directional		
	Watts	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	VARS	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute, Q1,2,3,4		
	VA (Arithmetic)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	VA (Vectorial)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	Q	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	PF (Arithmetic)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	PF (Vectorial)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	Volts Imbalance	Polyphase	N/A		
Amps Imbalance	Polyphase	N/A			

Each of the above measurements can be selected as Compensated or Un-Compensated.

Min/Max/Avg Registers are reset after a BPR (Billing Period Reset)

Demand Registers

Demand Meas	Measurement	Phase	Direction	Meas Type	Storage Type
Peak (Max)	Watts	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute	Primary Secondary	Working Billing Period Reset Season Change Cumulative Continuous Cumulative Previous Hour Previous Day
Present	VARs	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute, Q1,2,3,4		
Past	VA	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
Thermal	Q	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
Peak Thermal	Amps	A,B,C,Polyphase, Neutral, Average	Delivered, Received, Bi-Directional, Absolute		
Demand	Amps ²	A,B,C,Polyphase, Average	Delivered, Received, Bi-Directional, Absolute		
	Time	Time when demand measurement above is recorded			
Coincident Demand (coincides with a peak demand measurement)	Watts	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute	Primary Secondary	Working Billing Period Reset Season Change Previous Hour Previous Day
	VARs	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute, Q1,2,3,4		
	VA	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	Q	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	PF	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	Amps	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		
	Amps ²	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute		

Storage Types are defined as:

A *Working Register* will store the selected data in real time and update the displayed quantity on a continual basis. When a BPR is performed, the contents of the working register are transferred to the BPR storage register. All peak demand registers will reset to zero when a BPR is performed. All other register types will continue to increment.

A *Billing Period Reset* register will update the selected quantity only when a BPR occurs. The quantity in this register will be saved until the next BPR command, at which time the old quantity is overwritten.

A *Season Change* register stores the selected quantity only when a Season Change command occurs. The quantity in the register is saved until the next Season Change command, at which time the data is overwritten.

A *Cumulative* register will store the selected peak demand quantity when a BPR occurs. The quantity in the register is saved until the next BPR command, at which time the quantity is added to the existing quantity.

A *Continuous Cumulative* register will sum the selected peak demand quantity read at BPR plus the quantity from the Working register. The sum is continuously updated. Note that any alteration to the BPR configuration will reset these registers.

A *Previous Hour* register will store the selected energy measurement that occurred in the last hour. It starts accumulating at the top of the hour and the value is replaced every hour with the previous hour's data.

A *Previous Day* register will store the selected energy measurement that occurred in the last day. It starts accumulating at midnight and the value is replaced every day with the previous day's data.

Load Profile

The meter comes with 16 channels of Load Profile that can be selected with any of the measurements below. There is an option to add a second group of 16 Channels Load Profile. The recording interval for each measurement is selectable from 1 to 60 minutes.

Measurement	Phase	Direction	Meas Type	Storage Type	
Volts	A,B,C,Polyphase	Bi-Directional	16 Bit Counts (scaled)	Selectable Storage Intervals (minutes)	
Amps	A,B,C,Polyphase, Neutral, Average	Bi-Directional			
Frequency	Phase A	N/A			
Volts THD	A,B,C,Polyphase	Bi-Directional			
Amps THD	A,B,C,Polyphase	Bi-Directional			
Volts ²	A,B,C,Polyphase	Bi-Directional			
Amps ²	A,B,C,Polyphase	Bi-Directional			
Watts	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute			
VARs	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute, Q1,2,3,4			
VA (Arithmetic)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute			
VA (Vectorial)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute			
Q	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute			
PF (Arithmetic)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute			
PF (Vectorial)	A,B,C,Polyphase	Delivered, Received, Bi-Directional, Absolute			
Volts Imbalance	Polyphase	N/A			32 Bit (eng units)
Amps Imbalance	Polyphase	N/A			
WHR	A,B,C,Polyphase	Delivered, Received, Net, Absolute			
VARHr	A,B,C,Polyphase	Delivered, Received, Net, Absolute, Q1,2,3,4			
VAHr (Arithmetic)	A,B,C,Polyphase	Delivered, Received, Net, Absolute			
VAHr (Vectorial)	A,B,C,Polyphase	Delivered, Received, Net, Absolute			
QHr	A,B,C,Polyphase	Delivered, Received, Net, Absolute			
AMPHr	A,B,C,Polyphase, Average	Bi-Directional			
Volts ² Hr	A,B,C,Polyphase	Bi-Directional			
AMP ² Hr	A,B,C,Polyphase, Average	Bi-Directional			

Each of the above measurements can be selected as Compensated or Un-Compensated

Instantaneous measurements such as Volts, Amps, Frequency, THD, Volts2, AMPS2, Watts, VARs, VA, Q and PF will store the average value over the selected time interval, selectable from 1-60 minutes. The remaining energy measurements will store the accumulated consumption for that interval and start again from 0 for the next interval.

The Load Profile Data is stored in either 32 bit engineering units or 16 bit counts.

When 32 bit engineering units are used, we store the value as a 32 bit floating point with a maximum value of 4,294,967,296 per recording interval.

When 16 bit counts are used, you have a maximum 16,383 counts per recording interval. To avoid exceeding this number of counts, the measurements can be scaled by a factor called Km.

The number of counts for a given measurement is shown below:

$$\frac{\text{Total Measurement}}{\text{Km}} = \# \text{ of Counts in Load Profile}$$

Note: In order to increase your measurement resolution when using 16 bit counts, it is best to pick a Km scale factor to maximize the total number of 16,383 counts available per interval. You don't want to exceed the 16,383 counts per interval, so try to get at least 13,000 counts for your full scale input, allowing some room for exceeding full scale.

Measurement Log (option ML)

This continuous recording option provides 100 channels divided into two groups of 50, each with their own recording interval. The following measurements are available in the measurement log.

Meas Type	Measurement	Phase	Direction	Recording	Storage Type
Measurement Logging 50 Channels x 2 Groups	Volts L-N	A,B,C,Polyphase (average)	N/A	Min/Max/Avg/Snap	Selectable Storage Intervals
	Volts L-L	A,B,C,Polyphase (average)	N/A	Min/Max/Avg/Snap	
	Amps	A,B,C,Polyphase (total)	N/A	Min/Max/Avg/Snap	
	Frequency	A,B,C,Polyphase	N/A	Min/Max/Avg/Snap	
	Volts ² L-N	A,B,C,Polyphase (average)	N/A	Min/Max/Avg/Snap	
	Volts ² L-L	A,B,C,Polyphase (average)	N/A	Min/Max/Avg/Snap	
	Amps ²	A,B,C,Polyphase (total)	N/A	Min/Max/Avg/Snap	
	Watts	A,B,C,Polyphase	Del. Rec. Bi-Dir, Abs	Min/Max/Avg/Snap	
	VARs	A,B,C,Polyphase	Del. Rec. Bi-Dir, Abs, Q1-Q4	Min/Max/Avg/Snap	
	VA (Arithmetic)	A,B,C,Polyphase	Del. Rec. Bi-Dir, Abs	Min/Max/Avg/Snap	
	VA (Vectorial)	A,B,C,Polyphase	Del. Rec. Bi-Dir, Abs	Min/Max/Avg/Snap	
	Q	A,B,C,Polyphase	Del. Rec. Bi-Dir, Abs	Min/Max/Avg/Snap	
	PF (Arithmetic)	A,B,C,Polyphase	Del. Rec. Bi-Dir	Min/Max/Avg/Snap	
	PF (Vectorial)	A,B,C,Polyphase	Del. Rec. Bi-Dir	Min/Max/Avg/Snap	
	Volts Imbalance	Polyphase	N/A	Min/Max/Avg/Snap	
	Amps Imbalance	Polyphase	N/A	Min/Max/Avg/Snap	
	WHR	A,B,C,Polyphase	Delivered, Received, Net, Absolute	Total	
	VARHr	A,B,C,Polyphase	Delivered, Received, Net, Absolute, Q1,2,3,4	Total	
	VAHr (Arithmetic)	A,B,C,Polyphase	Delivered, Received, Net, Absolute	Total	
	VAHr (Vectorial)	A,B,C,Polyphase	Delivered, Received, Net, Absolute	Total	
	QHR	A,B,C,Polyphase	Delivered, Received, Net, Absolute	Total	
	AMPHr	A,B,C,Polyphase, Average	N/A	Total	
	Volts ² Hr	A,B,C,Polyphase	N/A	Total	
	AMP ² Hr	A,B,C,Polyphase, Average	N/A	Total	
	Harmonic Volts L-N	A,B,C	Magnitude: Harmonics 2 thru 64	Min/Max/Avg/Snap	
	Harmonic Volts L-N	A,B,C	Phase Angle: Harmonics 2 thru 64	Min/Max/Avg/Snap	
	Harmonic Volts L-L	A,B,C	Magnitude: Harmonics 2 thru 64	Min/Max/Avg/Snap	
	Harmonic Volts L-L	A,B,C	Phase Angle: Harmonics 2 thru 64	Min/Max/Avg/Snap	
	Harmonic Amps	A,B,C	Magnitude: Harmonics 2 thru 64	Min/Max/Avg/Snap	
	Harmonic Amps	A,B,C	Phase Angle: Harmonics 2 thru 64	Min/Max/Avg/Snap	
	Volts THD	A,B,C	N/A	Min/Max/Avg/Snap	
	Amps THD	A,B,C	N/A	Min/Max/Avg/Snap	
	Volts THD even	A,B,C	N/A	Min/Max/Avg/Snap	
	Volts THD odd	A,B,C	N/A	Min/Max/Avg/Snap	
	Amps THD even	A,B,C	N/A	Min/Max/Avg/Snap	
	Amps THD odd	A,B,C	N/A	Min/Max/Avg/Snap	
	TDD	A,B,C	N/A	Min/Max/Avg/Snap	
	TDD even	A,B,C	N/A	Min/Max/Avg/Snap	
	TDD odd	A,B,C	N/A	Min/Max/Avg/Snap	
	Crest Factor	A,B,C	N/A	Min/Max/Avg/Snap	
	InterHarmonic Volts L-N	A,B,C	Magnitude: InterHarmonics 2 thru 40	Min/Max/Avg/Snap	
	InterHarmonic Volts L-L	A,B,C	Magnitude: InterHarmonics 2 thru 40	Min/Max/Avg/Snap	
	InterHarmonic Amps	A,B,C	Magnitude: InterHarmonics 2 thru 40	Min/Max/Avg/Snap	
	Flicker Pinst	A,B,C	N/A	Min/Max/Avg/Snap	
	Flicker Pst	A,B,C	N/A	Average	
	Flicker Plt	A,B,C	N/A	Average	
	Negative Sequence	Polyphase	Current Magnitude	Snapshot	
	Negative Sequence	Polyphase	Current Phase Angle	Snapshot	
	Negative Sequence	Polyphase	Voltage Magnitude	Snapshot	
	Negative Sequence	Polyphase	Voltage Phase Angle	Snapshot	
Positive Sequence	Polyphase	Current Magnitude	Snapshot		
Positive Sequence	Polyphase	Current Phase Angle	Snapshot		
Positive Sequence	Polyphase	Voltage Magnitude	Snapshot		
Positive Sequence	Polyphase	Voltage Phase Angle	Snapshot		
Zero Sequence	Polyphase	Current Magnitude	Snapshot		
Zero Sequence	Polyphase	Current Phase Angle	Snapshot		
Zero Sequence	Polyphase	Voltage Magnitude	Snapshot		
Zero Sequence	Polyphase	Voltage Phase Angle	Snapshot		
Digital Input	Digital Input Ch 1-6	Status Input	Total		
Digital Input	Digital Input Ch 1-6	Pulse Counter	Total		

Storage Types for Measurement Logging is defined as:

Min – Minimum value over that interval.

Max – Maximum value over that interval

Avg – Average value computed over that interval

Total – Total quantity computed over that interval (similar to Load Profile)

Snapshot – Value recorded at the end of the interval

MEASUREMENT FORMULAS

Volts_{RMS}

Volts_{RMS} is calculated using the square root of the sum of the squares over one cycle which is sampled 512 times.

$$V_{\text{RMS}} = \sqrt{\frac{1}{N} \sum_n V_n^2} \quad 3\text{Phase} \sqrt{\frac{1}{N} \sum_n V_a^2 + \sum_n V_b^2 + \sum_n V_c^2}$$

Amps_{RMS}

Amps_{RMS} is calculated using the square root of the sum of the squares over one cycle which is sampled 512 times.

$$I_{\text{RMS}} = \sqrt{\frac{1}{N} \sum_n I_n^2} \quad \sum_n I_n^2 = \sum_n I_a^2 + \sum_n I_b^2 + \sum_n I_c^2$$

Amps_{Neutral}

Amps_{RMS} is calculated using the square root of the sum of the squares over one cycle which is sampled 512 times.

$$I_{\text{Neutral}} = \sqrt{\frac{1}{N} \sum_n (I_{an} + I_{bn} + I_{cn})^2}$$

Watts

Watts is calculated using the product of voltage and current updated every half cycle

$$\text{Watts} = \frac{1}{N} \sum_n V_n I_n$$

VARs

VARs is calculated using the product of voltage and current updated every half cycle

$$\text{VARs} = \frac{1}{N} \sum_n V_n I_{Sn} \quad I_{Sn} = I_n \text{ advanced } 90^\circ \text{ with respect to fundamental frequency}$$

Apparent Power

Apparent Power is calculated both Vectorially and Aritmetically every half cycle.

$$VA \text{ Vectorial} = \sqrt{Watts^2 + VARS^2} \quad (\text{same sign as Watts})$$

$$VA \text{ Arithmetic} = V_{RMS} * I_{RMS} \quad (\text{same sign as Watts})$$

Vectorial Versus Arithmetic kVA Calculation

The vectorial method (or phasor method) uses the square root of the sum of the squares for Watts and VARS. This does not take into effect the impact of harmonics on the voltage and current inputs.

The arithmetic method uses the product of RMS Voltage and Current which does reflect the added impact of harmonics on the voltage and current inputs.

In the case of no harmonics outside of the fundamental, the two results will be the same. When additional harmonics are introduced, the arithmetic calculation will end up with a higher result.

In all cases, the arithmetic method will result in the same or higher result as compared to the vectorial method.

The end result depends on what you are using the value for. The arithmetic method may be more physically appropriate to reflect utility capacity while the vectorial method is more indicative of actual customer load.

Q

Q is calculated using the sum of Watts and VARs as shown every half cycle.

$$Q = \frac{Watts}{2} + \frac{VARS \sqrt{3}}{2}$$

PF Arithmetic

PF Arithmetic is calculated using the ratio of Watts over the Apparent Power calculated arithmetically every half cycle.

$$PF_{\text{ARITH}} = \frac{\text{Watts}}{VA_{\text{Arithmetic}}} \quad \text{Sign positive for Lag (Quad I \& III), Negative for Lead (Quad II\&IV)}$$

PF Vectorial

PF Arithmetic is calculated using the ratio of Watts over the Apparent Power calculated vectorially every half cycle.

$$PF_{\text{VECT}} = \frac{\text{Watts}}{VA_{\text{Vectorial}}} \quad \text{Sign positive for Lag (Quad I \& III), Negative for Lead (Quad II\&IV)}$$

Unbalance

Unbalance is calculated using the ratio of the maximum deviation from average over the average.

$$\text{Unbalance} = 100 * V_{\text{rmsMaxDev}} / V_{\text{rmsAvg}}$$

(Voltage shown. Typical for current)

Unbalance (with PQ Options installed)

Unbalance is calculated using the ratio of Negative Sequence and Zero Sequence Ratios.

$$\text{Unbalance} = 100 * \text{Negative Sequence} / \text{Zero Sequence}$$

Percent THD

PercentTHD is calculated using the Total RMS (over all harmonics) and the RMS over the Fundamental frequency. (typical for volts and amps)

$$\% \text{ THD} = \frac{\sqrt{\text{Total RMS}^2 - \text{Fundamental RMS}^2}}{\text{Fundamental RMS}} \times 100$$

Percent THD (with PQ Options installed)

With PQ enabled, Percent THD is calculated per IEC61000-4-7, and includes harmonic content (up to and including the 128th harmonic).

$$\% \text{ THD} = \sqrt{\sum_2^{128} \left(\frac{\text{Total RMS}_{H 2-128}}{\text{Total RMS}_{H 1}} \right)^2} \times 100$$

Harmonics, Interharmonics

Voltage/Current magnitudes and phase angles are calculated per IEC61000-4-7

Individual harmonics are calculated up to the 64th. Individual interharmonics are calculated up to the 50th.

Flicker

Pinst (instantaneous), Pst (10 minute), Plt (2 hour) are calculated per IEC61000-4-15

TDD

Total demand distortion as defined in the IEEE 519 standard is the total root-sum-square harmonic current distortion, in percent of the maximum demand load current and can be calculated using the following formula

$$\text{Total Demand distortion (TDD)} = \frac{\sqrt{\sum_{h=2}^{h=63} I_h^2}}{I_L}$$

Crest Factor

Crest factor is defined as the ratio of peak value to rms value of a current waveform: The crest factor for a sinusoidal current waveform, such as that which a pure resistive load would draw, is 1.414 since the peak of a true sinusoid is 1.414 times the rms value.

Sequence Components

Sequences are calculated by the Method of Symmetrical Components as required by IEC61000-4-30

Zero Sequence:

$$\text{Zero Sequence Vector} = \mathbf{V0} = 1/3(\mathbf{Va} + \mathbf{Vb} + \mathbf{Vc})$$

$$\text{Zero Sequence Magnitude} = \sqrt{\text{real}(\mathbf{V0})^2 + \text{imag}(\mathbf{V0})^2}$$

$$\text{Zero Sequence Phase} = \arctan(\text{imag}(\mathbf{V0}) / \text{real}(\mathbf{V0}))$$

Positive Sequence:

$$\text{Positive Sequence Vector} = \mathbf{V1} = 1/3(\mathbf{Va} + n\mathbf{Vb} + m\mathbf{Vc})$$

(where n = vector rotation 120 deg counter-clockwise, m = vector rotation 240 deg counter-clockwise)

$$\text{Positive Sequence Magnitude} = \sqrt{\text{real}(\mathbf{V1})^2 + \text{imag}(\mathbf{V1})^2}$$

$$\text{Positive Sequence Phase} = \arctan(\text{imag}(\mathbf{V1}) / \text{real}(\mathbf{V1}))$$

Negative Sequence:

$$\text{Negative Sequence Vector} = \mathbf{V2} = 1/3(\mathbf{Va} + m\mathbf{Vb} + n\mathbf{Vc})$$

(where n = vector rotation 120 deg counter-clockwise, m = vector rotation 240 deg counter-clockwise)

$$\text{Negative Sequence Magnitude} = \sqrt{\text{real}(\mathbf{V2})^2 + \text{imag}(\mathbf{V2})^2}$$

$$\text{Negative Sequence Phase} = \arctan(\text{imag}(\mathbf{V2}) / \text{real}(\mathbf{V2}))$$

Zero Sequence Ratio

$$= 100 \times (\text{Zero Sequence Magnitude} / \text{Positive Sequence Magnitude})$$

Negative Sequence Ratio

$$= 100 \times (\text{Negative Sequence Magnitude} / \text{Positive Sequence Magnitude})$$

PROCEDURES FOR FACTORY REPAIR AND RETURN

- A. Obtain a Returned Material Authorization (RMA) number by calling the AMETEK Repair Department and giving the following information:
1. **Model** and **Serial Number** of the equipment.
 2. Failure Symptom - **Be Specific**
 3. Approximate date of installation.
 4. The site name and address of the failed equipment.
 5. Complete shipping information for the return of the equipment if other than the operating site.
 6. Name and telephone number of person to contact if questions arise.
- B. Enclose the information with the equipment and pack in a commercially accepted shipping container with sufficient packing material to insure that no shipping damage will occur. Mark the outside of the container with the RMA number.
Ship to the appropriate location:
- Attention:** Repair Department
- AMETEK Power Instruments**
255 North Union Street
Rochester, New York 14605 USA
Telephone: (888) 222-6282
Fax: (585) 238-4945
- C. Your equipment will be tested, repaired, and inspected at the factory. Normal factory turn-around is ten working days or less (excluding shipping time).

WARRANTY — AMETEK warrants equipment of its own manufacture to be free from defects in material and workmanship, under normal conditions of use and service. AMETEK will replace any component found to be defective, upon its return, transportation charges prepaid, within five years of its original purchase. AMETEK will extend the same warranty protection on accessories that is extended to AMETEK by the original manufacturer. AMETEK assumes no responsibility, expressed or implied, beyond its obligation to replace any component involved. Such warranty is in lieu of all other warranties expressed or implied.