



Watthour Meters

Product Selection Guide

User Manual

Installation Manual



Dual 3-Wire, Single Phase Meter (Model A4231/3)

CAUTIONS

Serious injury can result from electric shock. Be sure to turn off the power before installing or servicing any meter.

Fire can result from loose electrical connections. Ensure that all connections are secure.

A loose or improperly connected neutral can damage equipment and cause fires. Most meters that count faster than they should are connected to a bad neutral.

Current transformers (CTs) should not be placed over wires with current flowing through them without connecting them to the meter or twisting the two wires coming from the CTs together. A very serious shock hazard exists if the wires are just left loose.

These meters should only be installed by experienced electricians. If you do not fully understand these instructions, call Customer Support at 1-805-688-9696 for clarification.

In most localities, a permit and inspection is required to install the meters. In some localities, it is illegal to use an unapproved meter for revenue billing. Check with your local Weights & Measures office or other regulatory agency.

Legends

These symbols appear on meter labels.

⚠ Caution, risk of Danger

G Equipment protected throughout by double insulation

H Alternating Current

Abbreviations & Glossary

Common abbreviations used in this manual include:

AMR - Automatic Meter Reading System

CT - Current transformer

KWH - Kilowatthour

Element - An input for measuring power, usually a current transformer (CT)

Contact Information

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Note: This manual applies to meters that have a letter (A-G) as the first character of the model number. Separate manuals are available for meters made prior to 2010 by Davidge Controls and for energy management meters that begin with the letter R.

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Contents

CAUTIONS	i
Legends	i
Abbreviations & Glossary	i
Safety Certification	Page 3
Accuracy Certification	Page 3
A Note for California Users	Page 3
Limited Warranty	Page 4
Product Selection Guide	Page 5
Automatic Meter Reading (AMR)	Page 5
Bi-directional Meters	Page 6
Voltage	Page 6
Maximum Current and Current Transformers	Page 7
Display and Resolution	Page 7
Enclosures	Page 8
Model Numbers	Page 8
Part Number Suffixes for Ordering	Page 11
EZ Meter Current Transformers	Page 12
Operating Instructions	Page 13
Understanding the Meter Electronics Module Label	Page 14
Installation Instructions	Page 16
Installing the NEMA4X Enclosure	Page 16
Installing the flush mount enclosure	Page 16
A note on different meter types:	Page 16
Installing the CTs	Page 16
Electrical Connections	Page 18
Surge Protection	Page 18
Display Connections	Page 18
Isolated Outputs	Page 19
RS-485 Connections	Page 19
I2C Port Connection	Page 20
Wiring Diagrams	Page 21
Testing the Installed Meter	Page 25

Trouble Shooting	Page 26
Installing a Grid Connect NET485 (Ethernet-RS422/485 Adapter).....	Page 27
Trouble Shooting the NET485	Page 29
Connecting Digi Radio Modems to EZ Meters	Page 30
Connecting Snap Link Radios to EZ Meters	Page 32
RS-485 Trouble Shooting	Page 33
Phantom Neutral Installation Guide	Page 37
Obvius AcquiSuite Connections.....	Page 38
Next Century Radio Module.....	Page 39
USConverters RS485 WIFI Converter	Page 40
Modbus Interface Description.....	Page 42
Modbus Registers & Summed Accumulator Registers.....	Page 45
EZ Meter Power Suite Quick Start Guide.....	Page 51
EZ Meter Access Tenant Billing Quick Start Guide.....	Page 53

Safety Certification

Underwriter's Laboratories (UL)

Most EZ Meters have been tested by UL to UL916 and carry the UL Recognized Component mark for the United States (UL916) and Canada (CAN/C22.2 No 1010.1-04). File number is E362606.

Accuracy Certification

All EZ Meters are guaranteed to meet the latest ANSI C12.1 accuracy standard for electric meters. This standard allows an error of up to 1% when new and 2% when field tested.

In California, Maryland and Canada, meters are regulated by the government when used for revenue billing. Contact the local Weights and Measures office. Only meters that have been Type Approved by the California Division of Measurement Standards may be used for revenue billing within California (all EZ Meters exceed California's accuracy requirements, but all are not type approved).

A Note for California Users

All meters used in California for which a charge is made for power must have been inspected by a Weights & Measures inspector and placed in service by a Licensed Service Agent or a Weights & Measures official. The meter must be reinspected by Weights and Measures every ten years. It is a misdemeanor to fail to do this. See the EZ Meter.com website for more on these requirements.

The only EZ Meters that have been certified for revenue billing in California are the 200 amp versions of the 120 volt to neutral meters when using the Model JD6W current transformer. Approved California meters are models

A31x3x/yzxxx

where x may be any digit, y may be 0 or 3 and z may be 0 or 1. 0 is assumed if x and y are not present. The CTEP certificate number is 5674(b)-18.

Limited Warranty

EZ Meter Technologies warrants its products, if used in accordance with all applicable instructions, to be free from original defects in material and workmanship for a period of five years from the date of manufacture. If the product should prove defective in material or workmanship within that period, EZ Meter Technologies will repair or replace the product, in its sole discretion. Service under this Warranty can only be obtained by your delivering or shipping the product (with all shipping or delivery charges prepaid) to: EZ Meter Technologies, 583 Refugio Road, Santa Ynez, CA 93460. EZ Meter Technologies will pay return shipping charges. Call EZ Meter Technologies at (805) 688-9696 for a Return Material Authorization (RMA) before sending any equipment back for repair.

THIS WARRANTY DOES NOT APPLY TO NORMAL WEAR OR DAMAGE RESULTING FROM ACT OF GOD, ACCIDENT, MISUSE, ABUSE, OR NEGLIGENCE. SELLER MAKES NO EXPRESS WARRANTIES OTHER THAN THE WARRANTY EXPRESSLY SET FORTH HEREIN, EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW. ALL IMPLIED WARRANTIES INCLUDING ALL WARRANTIES OF MERCHANTABILITY OR FITNESS ARE LIMITED IN DURATION TO THE WARRANTY PERIOD SET FORTH ABOVE AND THIS WARRANTY EXPRESSLY EXCLUDES ALL INCIDENTAL AND CONSEQUENTIAL DAMAGES. (Some states do not allow limitation on how long an implied warranty lasts, and some states do not allow the exclusion or limitation of incidental or consequential damages so the above limitations or exclusions may not apply to you. This Warranty gives you specific legal rights, and you may have other rights which vary from jurisdiction to jurisdiction).

Damage from lightning strikes, power surges, and improperly connecting the meter to the power source are not covered by the warranty.



Product Selection Guide

This chapter provides information to help you choose the best meter for your requirements.

Automatic Meter Reading (AMR). Every EZ Meter is available with one of four Automatic Meter Reading (AMR) capabilities: None, Pulse, EZ Plus, or ModBus.

No AMR requires someone to visit each meter periodically and manually write down the reading from the display.

A Pulse meter generates an isolated pulse, usually every kwh, which is detected by some type of data logger or pulse counting radio. EZ Meters are compatible with most type of pulse counting systems including Oscar, Inovonics and Hexagram. These systems are usually installed at the site and connected to a billing service via telephone modem or the internet. The pulse is generated by an optocoupler and mimics a dry-contact closure, except that it is polarity sensitive. Standard pulse duration is 50 milliseconds. Other pulse lengths are available. Contact the factory.

EZ Plus and Modbus are two separate software protocols used for addressing meters using a serial interface. Either one is available with an RS-232 or RS-485 interface.

RS-232 is a very common interface that is intended for a single device within about 30 feet. Because of the addressing scheme used in the EZ Plus and Modbus protocols, multiple meters can be addressed, but no tests have been conducted to see how many will work. RS-232 meters are not currently in production, but may be special ordered.

RS-485 is a protocol used commonly in building and industrial control systems. Up to 256 devices can be on one network, even more if repeaters or radio links are used. RS-485 is the most commonly used serial interface for meter reading. USB to RS-485 adapters are available at low cost from a number of vendors. TCP/IP to RS-485 adapters are also available allowing a network of power meters to be connected to the internet. Most telephone modems have an RS-232 port which requires an RS-232 to RS-485 adapter to connect the meter network to a phone line. Another option for extending an RS-485 network is to use two radios, something frequently done to avoid trenching between two buildings. More powerful radios have a range up to seven miles

The modular design of EZ Meter communications allows other modules to be developed and implemented fairly inexpensively. Expect a meter with a built-in radio shortly.

EZ Plus is a relatively easy to implement protocol that will provide all the information available by Modbus. The free EZ MeterReader billing program uses the EZ Plus protocol. The EZ Meter Power Suite package supports both EZ Plus and Modbus. Since it is a binary protocol, there is a chance it could conflict with an ASCII protocol if sharing the same network. The network must be 1200, 4800, 9600 or 19,200 baud, 8 data bits, 1 stop bit, no parity.

Modbus is an old protocol and the de facto standard for building and industrial automation. The register map is available on page 39. Several third party software vendors offer software already configured to the EZ Meter register map. Meters can be ordered for either big (default) or little endian and either signed (default) or unsigned integers.

Bi-directional Meters. All one, two and three element meters are available as bi-directional meters that measure the number of kwh that flow in each direction. These meters are most often used in conjunction with solar, wind or other alternative energy systems connected to the grid.

Voltage. Each EZ Meter must be ordered to match the electric system where it will be installed. The first character of the model number determines the voltage range the meter can handle.

Note: Each meter model is capable of handling a range of voltages. Select the meter with the voltage range that includes the voltage you want to measure.

A. 100-130 volts to neutral, 200-260 volts line to line, **single output:**

Single element: 100-130 volts to neutral, single phase.

Two element: 100-130 volts to neutral, 200-260 volts line to line, single phase or two phases of a three phase system.

Three element: 100-130 volts to neutral, four wire, three phase wye.

A. 100-130 volts to neutral, 200-260 volts line to line, **dual output:**

Two element: Two 100-130 volts to neutral, single phase services or

One bidirectional 100-130 volts to neutral, 200-260 volts line to line, single phase or two phases of a three phase system.

Three element: One 100-130 volts to neutral, single phase plus one 100-130 volts to neutral, 200-260 volts line to line, single phase or two phase of three phase system, or one bidirectional 100-130 volts to neutral, four wire, three phase wye.

Four Element: Two 100-130 volts to neutral, 200-260 volts line to line, single phase or two phases of three phase system.

B. Three element only: 100-130 volts to neutral on two legs, 200-260 volts to neutral on the third leg, 200-260 volts line to line, four wire, three phase delta. Can also be used in place of an A single output meter with a slight loss of accuracy at the low end on L3.

C. 200-260 volts to neutral, 400-500 volts line to line

Single element: 200-260 volts line to neutral, single phase

Two element: 200-260 volts to neutral, 400-500 volts line to line, or two phases of three phase.

Three element: 200-260 volts to neutral, 400-500 volts line to line, three phase wye

D. 240-300 volts to neutral, 430-500 volts line to line

Single element: 240-300 volts line to neutral, single phase

Two element: 240-300 volts to neutral, 430-500 volts line to line, or two phases of three phase.

Three element: 240-300 volts to neutral, 430-500 volts line to line, three phase wye

When used with the EZ Meter Technologies Phantom Neutral module, this meter will monitor a three-wire, three phase delta service.

E. Three element only: 240-300 volts to neutral on two legs, 430-500 volts to neutral on the third leg, 430-500 volts line to line, four wire, three phase delta.

F. Dual Element only: 200-260 volts line to line, three wire, three phase delta

G. Dual Element only: 440-500 volts line to line, three wire, three phase delta

Maximum Current and Current Transformers. Each EZ Meter is calibrated to work with a specific model current transformer (CT) at any current up to the maximum rating for the meter. Solid core CTs require that the power be turned off and the wire carrying the load to be measured must be disconnected, run through the CT, and reconnected. Split core CTs come apart and can be installed without disconnecting the wires.

Solid core CTs are available for current ranges up to 100, 150, 200, 250 or 400 amps. Split core CT ranges up to 60, 200, 400, 800, 1200 or 1600 amps.

CTs can be installed in parallel. If want to measure several circuits in a breaker panel and the circuits are on the same leg, but opposite sides of the breaker panel, you can use two CTs, one on each side, so you don't have to rewire the panel.

The wires on CTs can be extended a reasonable distance as long as the wire resistance does not exceed one ohm.

Display and Resolution. Each EZ Meter can be equipped with either an LCD display or an electro-mechanical counter that displays accumulated kilowatt hours. Some considerations:

An electro-mechanical counter costs less than an LCD display, but there are a few trade-offs. The standard counter is rated to work down to 10°C (14°F) and is not suitable for outdoor use in cold climates. An extended temperature range counter rated down to -30° (-22°F) is available at added cost. If the temperature drops below the counter's operating range, the counts will be lost forever unless you are using an automatic meter reading system. If you have a dual output meter, the LCD display will actually cost less than two counters. Counters are recommended when a local display is required, but the meters will be read by an AMR system. They are also recommended for locations in bright sunlight where an LCD display is difficult to read.

LCD displays have several advantages. Single output meters display accumulated kwh on the top line of the display while the bottom line cycles through volts, watts, amps, and power factor. The dual output meters display accumulated kwh for the second channel on the bottom line. If mounted in a location where the display stops working because of low temperature, the display will return to normal operation with no loss of kwh when it warms up.

Counters for meters with 0.1 kwh resolution have a red number on the right side to indicate tenths of kwh. The other numbers are all white. Counters for meters with 1.0 kwh or 0.01 kwh resolution have all numbers the same color. The LCD displays have a resolution of 0.01 kwh.

Enclosures. A variety of enclosures that hold different numbers of meters are available. Most are NEMA4X rated plastic enclosures with the meters mounted on a plastic panel inside. Use of plastic enclosures allows AMR radios to be mounted inside. Interior rated enclosures have a clear cover while exterior rated ones have a solid cover. The LCD displays are available only on the solid door version.

Available versions are:

5" x 6.9" x 3" enclosure holds one or two meters and one or two displays. An optional fixture allows the enclosure to be flush mounted in a wall.

6" x 6" x 4" enclosure holds one or two meters and two displays.

12" x 7" x 5" enclosure holds up to four meters and displays. It can hold six meters if two are mounted on the back of the enclosure with velcro.

13" x 13" x 6" enclosure holds up to eight meters and eight displays.

19" x 15" x 7" enclosure holds up to twelve meters and twelve displays.

Model Numbers. Each digit in a model number specifies a different feature or option. Use the table below to determine the options in the electronics module of your meter.

First Character - Voltage (see detailed description on page 6)

A = 100-130 volts to neutral, 200-260 line to line

B = 100-130 volts to neutral on two legs, 200-260 volts line to neutral on third leg, 200-260 volts line to line, four wire, three phase delta

C = 200-260 volts to neutral, 400-500 volts line to line

D = 240-300 volts to neutral, 430-500 volts line to line

E = 240-300 volts to neutral on two legs, 400-500 volts to neutral on the third leg, 400-500 volts line to line, four wire, three phase delta.

F = Dual Element only: 200-260 volts line to line, three wire, three phase delta

G = Dual Element only: 430-500 volts line to line, three wire, three phase delta

Second Character - Number of elements supported

1 = One element

2 = Two element

3 = Three element

4 = Four element (dual two element meter)

Third Character - Display option

0 = No counter driver (AMR only)

1 = One counter (standard meter)

2 = Two counters (dual 2-in-1 meter)

3 = 2 line LCD display (standard meter)

4 = 2 line LCD display (dual 2-in-1 meter)

Fourth Character - Maximum rated current (Meter Class)

- 0 = 60 amps
- 1 = 100 amps
- 2 = 150 amps
- 3 = 200 amps
- 4 = 250 amps
- 5 = 400 amps
- 6 = 800 amps
- 7 = 1200 amps
- 8 = 1600 amps
- 9 = 2000 amps

Fifth Character - Automatic Meter Reading (AMR)

- 0 = No AMR or AMR through I2C port
- 1 = Isolated pulse output
- 2 = RS-485 EZ Plus protocol
- 3 = RS-485 Modbus protocol
- 4 = RS-232 EZ Plus protocol
- 5 = RS-232 Modbus protocol
- 6 = TinyMesh radio
- 7 = Next Century radio power/pulse interface

Valid meter model numbers contain at least five characters. The model number may contain up to five additional characters. If none of the additional characters are present, the "0" value is implied.

Sixth Character - Always a slash / unless there are no additional characters.

Seventh Character - The CT Model.

Additional CT models may be added at any time. Presently the models are:

- 0 = 4720/4 - 400:1, 250 max amps, solid core, 1" ID (discontinued)
- 1 = JC16F - 400:1, 100 max amps, split core, 0.6" ID
- 2 = S0140 - 3000:1, 1600 max amps, split core, 1.25" ID (discontinued)
- 3 = JD6W - 2500:1, 400 max amps, solid core, 0.7" ID
- 4 = S0160 or XH-SCT-2000/1600 - 3300:1, 1600 max amps, split core, 2.0" ID
- 5 = KFC-203-FD - 2000:1, 400 max amps, split core, 1.2" ID
- 6 = JC36S3 - 3000:1, 800 max amps, split core, 1.4" ID (special order)
- 7 = WC3-200 - 400:1, 400 max amps, split core, .94" x .75" inside
- 8 = WC4-800 - 800:1, 800 max amps, split core, 1.7" x 1.3" inside (special order)
- 9 = WC5-1600 - 1600:1, 1600 max amps. Split core, 3.5" x 2.0" inside (special order)
- A = XH-BCT-1000 - 1000:1, 250 max amps, solid core, 1.0" ID (special order)
- B = XH-SCT-T24/200 - 2500:1, 260 max amps, split core, 0.93" x 0.99" inside
- C = WC6-2000 - 2000:1, 2000 max amps, split core, 8.4" x 4.7" inside
- D = JD6WS - 417:1, 250 max amps, solid core, 0.7" ID
- E = EZ417 - 417:1, 250 max amps, solid core, 0.85" ID
- F = TS/200-417 200 max amps, split core

Eighth Character - Resolution

- 0 = Display: 1.0 kwh
Isolated: 1.0 kwh
- 1 = Display: 0.1 kwh
Isolated: 0.1 kwh
- 2 = Display: 0.01 kwh
Isolated: 0.01 kwh
- 3 = Display: 0.01 kwh
Isolated: 1.0 kwh

Ninth Character - Parity and Bidirectional

- 0 = Even parity, 1 stop bit, standard meter
- 1 = Even parity, 1 stop bit, bidirectional meter
- 2 = No parity, 2 stop bits, standard meter
- 3 = No parity, 2 stop bits, bidirectional meter
- 4 = Odd parity, 1 stop bit, standard meter
- 5 = Odd parity, 1 stop bit, bidirectional meter
- 6 = No parity, 1 stop bit, standard meter
- 7 = No parity, 1 stop bit, bidirectional meter

Tenth Character - Baud Rate (Modbus Configuration) or Isolated Pulse Timing.

For Serial Port meters (modbus configuration, EZPlus where noted)

- 0 = 9600 Baud (little endian, unsigned integers and EZPlus)
- 1 = 19,200 Baud (little endian, unsigned integers and EZPlus)
- 2 = 9600 Baud (little endian, signed integers)
- 3 = 19,200 Baud (little endian, signed integers)
- 4 = 9600 Baud (big endian, unsigned integers)
- 5 = 19,200 Baud (big endian, unsigned integer)s
- 6 = 9600 Baud (big endian, signed integers)
- 7 = 19,200 Baud (big endian, signed integers)
- 8 = 4800 Baud (EZPlus only)
- 9 = 1200 Baud (EZPlus only)

For Isolated Pulse Meters

- 0 = 50 ms pulse, 150 ms recovery
- A-Y = Pulse length is position of letter in alphabet times 129 ms, recovery time is 129 ms longer than pulse length
- Z = Custom pulse length

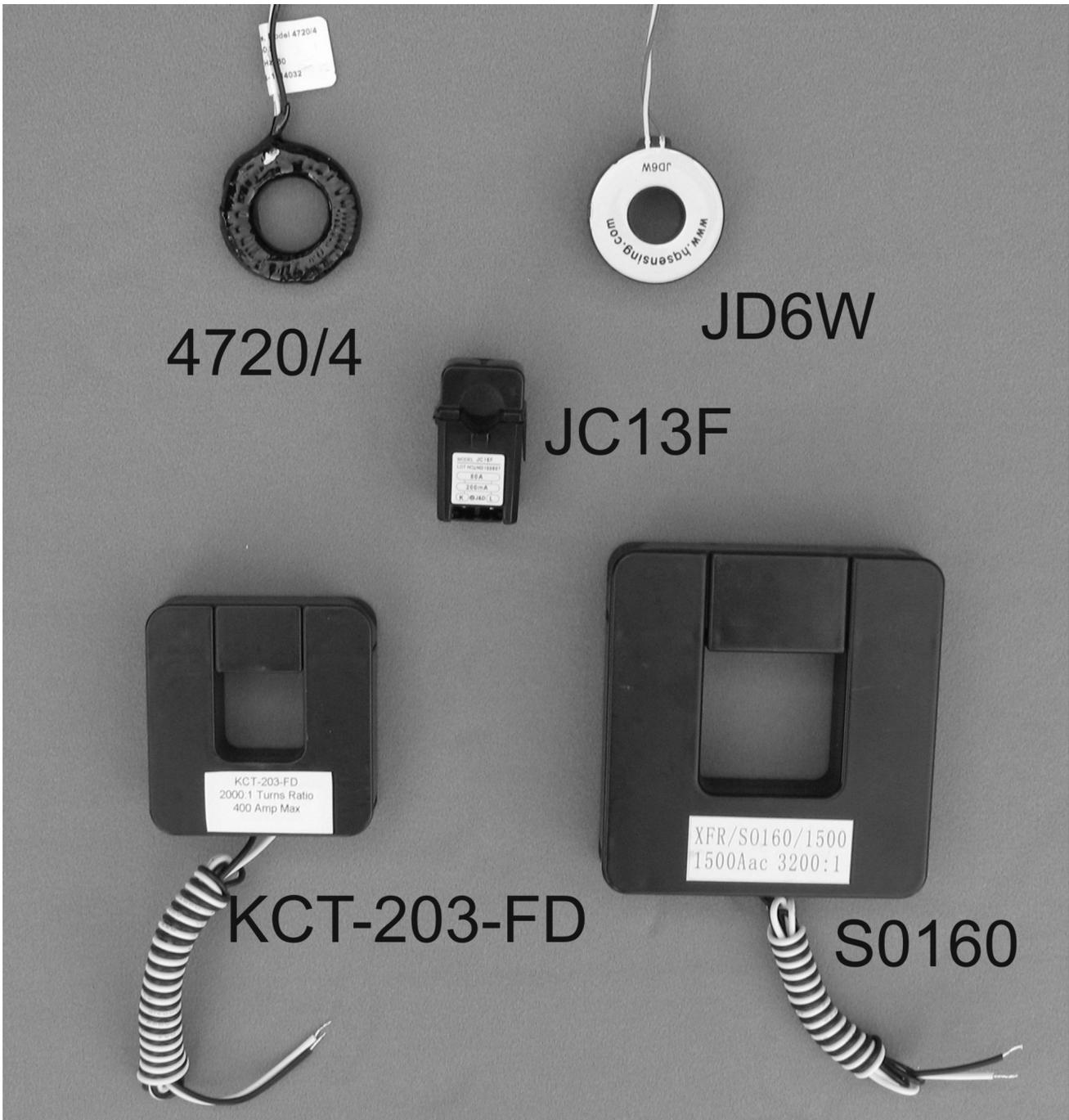
Eleventh Character - Stop Bits for no parity Modbus (legacy)

- 0 = 2 stop bits
- 1 = 1 stop bit

Part Number Suffixes for Ordering. The part numbers above are printed on the meter cases and enclosures. For ordering and invoicing, a part number suffix consisting of a hyphen (-) and two digits may be appended to the part number. The first digit is the number of CTs that go with the meter. The second digit represents the type of mechanical counter that goes with the meter. The codes are

- 5 = Counter for 0.1 kwh resolution, one red wheel, standard temperature range (4921/1)
- 6 = Counter for 1.0 or 0.01 kwh resolution, all white wheels, standard temperature (4921/0)
- 7 = Only one type 5 counter for dual meter with 4 CTs.
- 8 = Only one type 6 counter for dual meter with 4 CTs
- 9 = LCD Counter and ribbon cable

In addition, California approved meters require special marking on the current transformers. Append a letter "C" to the model number to be sure your meter will pass the state testing procedure.



EZ Meter Current Transformers. Each meter is manufactured to work with one model of current transformer (CT). While it is true that a CT with the same turns ratio can be substituted for another without causing a significant error, for best accuracy, use the CT specified on the meter label. The meter has been calibrated to account for variations in how the CT responds to different phase angles, a function of the core material rather than the turns ratio.

The seventh character of the meter model number specifies the CT that should be used. If there is no character in the seventh position the 4720/4 CT should be used. See the table on page 10.

Operating Instructions

After installation, the EZ Meter is simple to operate. You read the meter the same way you read the odometer in a car. The label on the front of the meter indicates the resolution of the display, either full kilowatt hours (kwh), tenths of kwh or hundredths of kwh. The label on the outside of the enclosure also states the resolution. The mechanical counters are available with all white digits or all white except the right hand digit being red which indicates tenths of kwh. Normally, the display reads in full kwh, except if the right most digit is a different color, it is reading in tenths. And except if someone did not use the correct display with the meter module. Look at the label to be sure.

To charge a tenant for power used, subtract the meter reading at the beginning of the billing cycle from the meter reading at the end of the cycle and multiply the difference by the rate per kilowatt hour.

Whenever power is applied to the L1 terminal, the red LED on the electronics module should light. The light will flash off then back on every time one of the legs measures 1/100 of a kwh (or whatever quantity is indicated by the Kt value on the meter label (see below).

For meters made in 2015 and earlier: (see the date code on the label. 4Q15 = Oct-Dec 2015)

If the red LED flashes on and off every second, the meter is detecting a high phase angle power factor is below .7 on one or more of the legs. This could indicate a piece of equipment is not operating properly or it could mean that the CTs and voltage references were not paired properly when using three phase power. See the installation instructions for curing this condition. To disable the high phase angle alarm (if you want to test the accuracy of the meter at a high phase angle), install a jumper between the two pins on the I2C connector closest to the display connector on the front row.



For meters made after 2015:

Beginning in January 2106, the low power factor warning is only active when reverse current is detected. This means that if the CTs were installed correctly, the continuous flashing of the red LED usually indicates that the voltage and current inputs to the meter were not properly matched during installation and the meter is only recording half (or 2/3) the power being consumed. This only occurs when the power is supplied from a three phase transformer.

Meters with electro-mechanical or LED displays have a green LED that will flash briefly every time the display counter advances.

Meters with an RS-485 interface have a bi-color LED that flashes red briefly every time the meter senses traffic from the serial port. It flashes green when it responds to a request over the serial port. Meters with an RS-232 interface, and the original RS-485 meters, have a yellow LED that flashes when the meter responds. If the bi-color LED comes on bright red and stays on, it indicates the serial connection was not properly installed or the isolated power has failed.

You can clean the outside of the meter enclosure with a general purpose cleanser such as 409 or Fantastic if necessary. Do not use harsh bathroom cleaners or alcohol.

If the meter appears to operate erratically, it is probably because it measures each phase separately and flashes the red LED when each phase accumulates 1/100 kwh (or other resolution). The resolution may be different for the red LED, the display and the isolated output. Check the meter label where the resolution of each will be noted.

If you believe the meter is not measuring correctly, perform the test on page 25 and see the troubleshooting suggestions on page 26.

Understanding the Meter Electronics Module Label

The center section on the meter label reveals a lot of data about the meter, but some of it is in the language used by the metering standards.

Display Units - The resolution of the meter display. Either 1.0, 0.1 or 0.01 KWH. Multiply by the value show on the display to get the total KWH the meter has recorded. Meters with 1.0 resolution have all digits the same color and the display shows KWH with no conversion needed. Meters with 0.1 resolution are usually sold with the right hand digit being a different color and is read as if there were a decimal point before the odd colored digit. Some older meters had the notation Kt: 1000 along with the display resolution. That confusing statement is no longer required by California Measurement Standards.

Red LED (Kt) - The Red LED serves two functions. If it is flashing about once a second, it indicates a low power factor on one or more legs. A slower flash indicates the meter has recorded the amount of energy shown on the label, usually .01 KWH (10 WH) for most meters. It may be as high as .5 KWH for high voltage, high current meters.

Depending on the type of meter, the next line will provide the isolated output resolution or the type of serial communication and the default baud rate.

Oper. Temp: - The operating temperature range applies to the electronics module only. The low temperature is usually lower than the low temperature for the electro-mechanical display.

Voltage - The range of voltages in which the meter will operate measured between line and neutral (L/N). If there is no neutral, it is the voltage line to line (L/L). For four wire delta meters, the voltage for the high leg is shown on the left for L3.

Max Amps (CL) - The maximum load (in amps) on each leg that the meter can handle. This is also referred to as the meter class.

Test Amps (TA) - This is another term from the standards and is set by the manufacturer, usually at 15% of the class rating (maximum amperage).

Max current draw: All EZ Meters use 2 watts or less for operation of the meter.

CT Ratio: The turns ratio of the current transformer that is intended for use with this meter. Vertically printed next to the labeling of the CT terminals is the model number of the current transformer the meter was calibrated against. Each model of CT has a slightly different phase angle adjustment which is programmed into the meter during calibration. Using a current transformer with a different model number, but the same turns ratio may cause an error of a few tenths of one percent. Using a current transformer with a different turns ratio, or a current transformer with an internal burden resistor, will cause a significant error.

Installation Instructions

These instructions are for meters whose model number begins with a letter, not a number.

The EZ Meter consists of an electronics module, one or more current transformers (CTs), a display of one or two electro-mechanical or LCD display counters, and an enclosure that holds from one to 12 meters. If the meter will be mounted outside in direct sunlight, be sure to order a UV resistant enclosure or paint the standard enclosure. The CTs and display may be mounted in the same enclosure or mounted in a remote location. A common practice is to mount the CTs in a breaker panel and mount everything else in a separate adjacent enclosure. A circuit breaker rated at 20 amps or less should be installed before the meter. Be sure no one will be able to turn off the breaker and defeat the meter. If a fuse is used to protect the meter, it should be a delayed-action fuse and the meter's power supply will short hot to neutral for half a cycle (1/120 second) on power up.

Installing the NEMA4X Enclosure: Use the metal brackets provided to mount the enclosure in a suitable location. Drill a hole anywhere in the side or back of the enclosure for a conduit to connect to a breaker panel or disconnect box in compliance with local electrical codes. After the meter has been installed and tested, secure the cover using the screws in the corners. You should also label each display counter with the unit name or number.

Installing the flush mount enclosure: A flush mount bezel is available for mounting a single meter in a sheet rock wall. Use the provided template to cut a hole in the wall.

A note on different meter types: All EZ Meters come with a 12 pin connector for voltage and CT inputs. There are three voltage inputs and three CT inputs (3&3) or two voltage inputs and four CT inputs (2&4). The 3&3 configuration must be used whenever a three phase wye or delta load is being measured. Either configuration can be used for measuring single phase loads, even if the load uses one or two legs of a three phase service. The 2&4 configuration is most commonly used in marinas and apartment buildings where two 3-wire 120/240V (or 120/208V) services are close enough to each other to be monitored by one meter.

Installing the CTs: (See the appropriate Figure on pages 22 and 23.) If you are using solid core CTs, you must turn off the power to begin your installation. Disconnect one end of the wire (or wires) with the load to be measured and pass it through the center of the CT and reconnect the wire(s) where it was attached before. Connect the two wires coming out of the CT to the appropriate terminals on the electronics module. Begin connecting CTs to CT #1 and continue until all the CTs for that meter are installed. The CT should be installed with the arrow facing the direction of current flow or the label facing the source.

CTs Are Directional (or Not)

If the meter is otherwise installed correctly, it will accurately record all the power that flows through the CTs. If you are working with three phase power, even if only one or two legs of it, you should be sure the arrows or labels are facing in the right direction (label faces the load if there is no arrow). The meter has a phase angle warning that flashes the red LED every second if power factor is below 0.7 and polarity is reversed. This will happen if the CTs are facing the proper direction, but the voltage and current sources are not properly matched. (L1 voltage and L1 CT should be on the same phase, etc).

If you want the phase angle warning (red LED flashes) to work all the time, simply install the CTs backwards. Doing so will cause Modbus and Plus meters to report watts as a negative number. Rather than physically turning the CTs around if needed, just reverse the black and white wires where they connect to the meter. This works on both single phase and three phase.

You can install more than one CT on each leg if you need to. You might need to if you were measuring several circuits in one breaker panel and the wires were not long enough for all to go through one CT or if you wanted to measure power being used in two separate breaker panels. Just be sure all the wires on each leg go through CTs that are connected to the same terminal on the meter and that the direction marks on the CTs are aligned the same. Multiple CTs should be connected in parallel.

If you run more than one wire through a CT, be sure that the current flow is the same direction for all wires and that all the wires are the same leg (phase). That means there should be no voltage variation between the wires (if you touched them together, they would not spark). Failure to do so will cause the power flowing in one wire to be subtracted from the power flowing in the other wire instead of being added to it.

The CT wires can be extended if needed. We have tested them at 500 feet and they can probably be extended even further. If the line resistance is much over one ohm, accuracy of the meter will be affected, especially at high phase angles. Be sure to install the CT wires in conduit. Connections should either be soldered or made with gel filled wire nuts. Any resistance in the connection will cause the meter to read lower than it should. The wire used should meet local codes for insulation. Any size wire from 22 AWG to 12 AWG may be used. #18 is suggested.

You can install split core CTs without disconnecting the load wire from the breaker. If you have to install them without turning off power, connect the wires to the meter before securing the two parts of the CT over the wire carrying the load. Be sure to secure the two parts of the CT so it cannot come apart. Note: Working in an electric panel that has power connected to it is an OSHA violation.

Do not mix CTs with different turns ratios on the same meter.

WARNING

Hazardous voltages exist in CT wires when they are not connected to a meter and current is flowing through wire passing through the CT. Wire nut the CT wires together if you must remove the meter and leave the CTs in place. Failure to do so may damage the CT or shock someone.

Electrical Connections: You need to provide a voltage reference for each phase of the power you are metering plus connect the neutral to the meter as well. The voltage ranges printed on the electronics module label (before L1, etc) refer to the voltage between neutral and that terminal and indicate what meter works with what electrical system. The voltage associated with the meter name is the most commonly used voltage in the range. See the diagrams on pages 19 and 20 for specific models. For meters that do not have a Neutral reference, the voltage ranges printed on the label are line to line voltages.

You can use any size wire from 28 AWG to 12 AWG. Be sure insulation meets local codes. Each phase should be protected by a circuit breaker or fuse of 20 amps or less. For safety, a switch or circuit breaker must be installed between the meter and the mains power source. It shall be in close proximity to the meter and within easy reach of the operator and shall be marked as the disconnecting device for the equipment. If a fuse is used, it should be a slow-blow type. Connecting the meter on the protected side of a GFCI may cause the GFCI to trip when power is applied to the meter.

IMPORTANT

You must ensure that the leg connected to the AC L1 terminal is the same leg which passes through CT L1, and the same for (AC L2 & CT L2) and (AC L3 & CT L3). This is especially important when connected to three phase power because the meter will only record 50% of the power used on legs that are not properly paired. After the installation is complete, turn on a 60 watt or greater load for each leg and observe the red LED. If it is flashing, you most likely did not wire the meter properly (The flashing LED indicates a power factor of 0.7 or less - optimum power factor is 1.0).

Surge Protection: Like computers, TVs and other electronic devices, EZ Meters are subject to damage from electrical surges. In fact they are particularly likely to be damaged because they are typically installed as the first piece of electronics that the surge hits when it enters the submetered electrical distribution system. Consider a whole-house surge protection device or other sacrificial protection device.

Display Connections: (See Fig 1 and Fig 7) The electro-mechanical counter comes already connected to the meter. If you purchased an OEM version of the product, connect as shown in the

diagrams. If you have a three element, dual output meter, DISP1 is matched with CT #1 and L1 while DISP2 is matched to L2, L3 and the remaining CT(s). If you have a four element, dual output meter, the power flowing through the CTs marked 'A' is displayed on DISPA while the CTs marked 'B' display on DISPB.

Isolated Outputs: (See Fig. 7) If you have a pulse output meter, connect the two wires from the pulse counting equipment to ISO- and ISO+ respecting polarities. The grounded terminal of the pulse counting device needs to be connected to the ISO- terminal on the meter. If you have a three element, dual output meter, connect one set to ISO- and ISO1 and the other set to ISO- and ISO2. They correspond with DISP1 and DISP2. On four element, dual meters, the terminals are labeled ISOA, DISPA, and ISOB and DISPB.

RS-485 Connections: (See Fig. 1 and Fig. 10) The serial connections are optically isolated from the electronics of the meter and require an external power source. Any power supply capable of delivering 5-18 volts DC and 50 mA per meter will work. Connect the power supply ground to the IGND terminal and the power supply hot wire to IPWR.

For RS-485, there does not appear to be a lot of consistency in pin labeling. Some are labeled Rx+ or Rx- and Tx- or Tx+. Others are labeled A and B. We have seen four-wire RS-422/485 adapters that work when Rx+ and Rx- were connected together and others where Rx+ and B- were connected together. We have also seen adapters that work when TX+ is connected to Tx on the adapter and others where TX+ is connected to Rx on the adapter. We suggest you find the proper configuration on your workbench before installing all the meters in the field.

Connecting a meter to an RS-485 connector can be a lot of hassle. To make the process easier EZ Meter Technologies resells USB to RS-485 adapters made by FTDI Chip. These adapters have a 1.8 meter wire bundle that can be connected directly to the meter.

The meters should be connected in daisy chain fashion (the wire should loop from one meter to the next) with a twisted pair of wires. CAT5 or CAT6 stranded cable is suggested, and telephone wire will work as long as the pairs are twisted.

It is important that twisted pairs be used for connecting the meter. That means use one twisted pair for both A and B. If you want redundancy, use two twisted pairs in parallel. Do not twist the solid and striped wires of one pair together for A and another pair for B. That defeats the purpose of using twisted pairs and will most likely not work unless you have a very short wire run to the meters.

If you have at least a two pair cable, you can run the power from the DC power supply on one of the pairs. Depending on the length of the cable and the impedance of the RS-485 adapter a 120 ohm resistor may need to be installed across the A and B pins on the last meter in the daisy chain. These resistors are built into the FTDI USB to RS-485 and Grid Connect NET485 adapters. Install a 120 ohm resistor on the first meter in the daisy chain. Some systems may require two 470 ohm resistors, one between +5 VDC and the B (TX+) terminals and the other between Ground and the A (RX-) terminals. See Fig. 10. All the resistors can be connected directly to the meter terminals. Experiment with different resistor combinations until communication is established. See the RS-485 troubleshooting section for more information.

Maxim Integrated Devices, manufacturer of the RS-485 drivers used in the meters, has a very helpful document titled *Guidelines for Proper Wiring of an RS-485 (TIA/EIA-485-A) Network* at <http://www.maximintegrated.com/an763>.

Be sure to write down the serial number and Modbus address of each meter and its location. The EZ Power Suite requires a unique serial number for every meter location.

Application Notes at the end of this document deal with troubleshooting an RS-485 installation, connecting Digi radios and the NET485 ethernet to RS-485 module.

I2C Port Connection: Contact the factory for details on using non-isolated pulses available on this connector.

Notes on Wiring Diagrams on following pages:

The voltages shown on most of the diagrams are for the allowable voltage range for meters made for 110-120 volt electric systems found in the USA. The voltage shown is for line-to-neutral or line-to-line for meters that do not use a neutral. Meters for higher voltages are configured the same way except a higher voltage range is specified. For instance, Figure 1 specifies Type A, C and D meters. Type A (the first letter of the model number) is for 110-120 volt to neutral systems, Type C for 220 or 240 volt systems and Type D for 277 volt systems.

Fig. 2 shows a 4 wire delta (hot leg, high leg, stinger leg). Be sure your L3 leg is the high voltage leg.

Fig 3 and Fig 6 show the same meter as in Fig 1, but with only two or one CTs connected. Be sure you have power on L1 or the meter won't work.

Fig 4 shows a 3 wire, 3 phase delta system. This meter only uses two CTs.

Fig 5 shows the same meter as in Fig 4, but with only 1 CT connected.

Fig 7 shows how to connect to the isolated pulse outputs. If you have a single output meter, ISO2 will be labeled ISO+ and ISO1 will be N/C (No Connect).

Fig 8 shows the special purpose dual two element meter with isolated pulse outputs. The RS232/RS485 versions connect as shown in Fig 1.

Fig 9 shows a three element, bidirectional meter. The power that flows in one direction is displayed on one counter and power that flows in the opposite direction is displayed on the other counter. This is the only installation where the direction of the CTs makes a difference.

Fig 10 shows the typical connections needed for an RS-485 network.



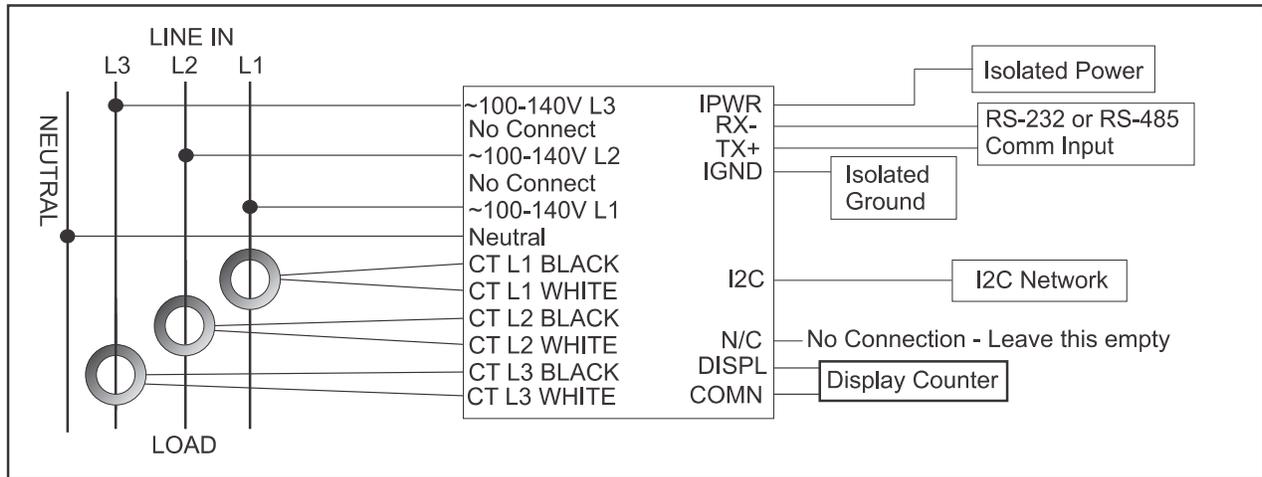


Fig 1. 4-wire, 3 Phase Wye Meter (Types A, C & D) with RS-232 or RS-485 Installation Diagram
Note: If used in 2- or 3-wire systems, power must be connected to L1. (Type A voltages shown)

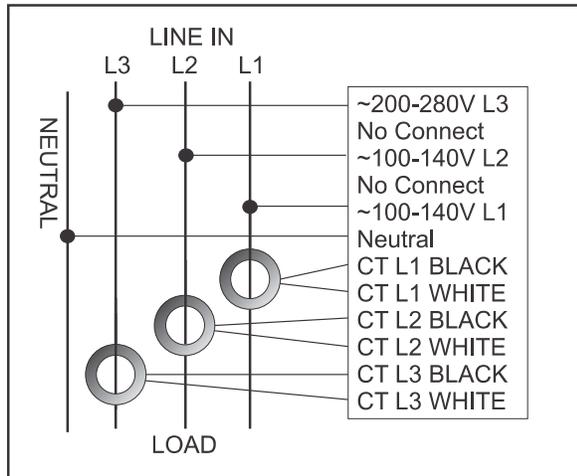


Fig 2. 4-wire, 3 Phase Delta Meter (Types B & E)
Note: High (stinger) leg must be connected to L3.

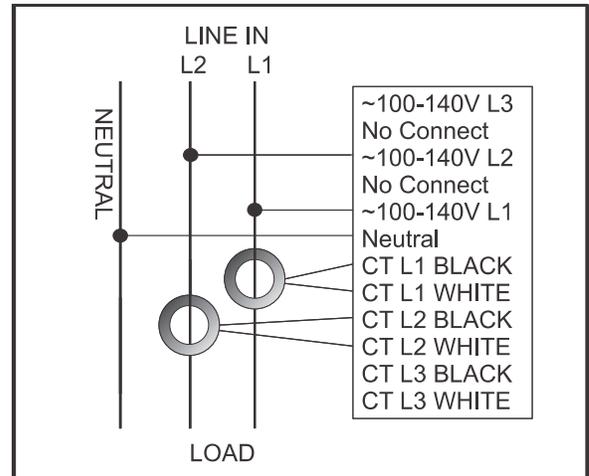


Fig 3. 3-Wire Single Phase Meter (Types A - E)
Note: Any one or two legs of 3 Φ power may be used as long as power is connected to L1 to power meter.

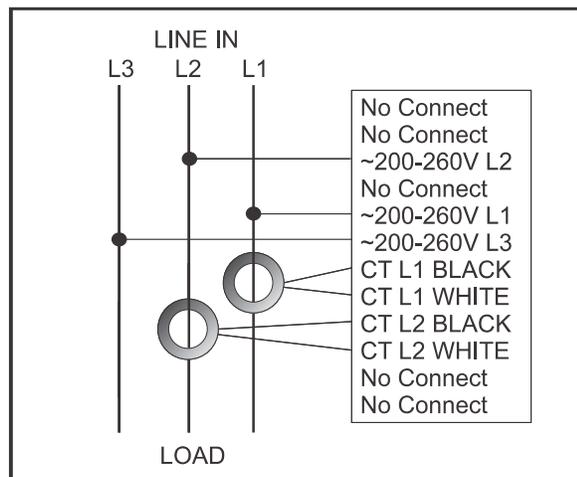


Fig 4. 3 Wire, 3 Phase Delta Meter (Types F & G)
 Type E meter with Phantom Neutral suggested for 480V

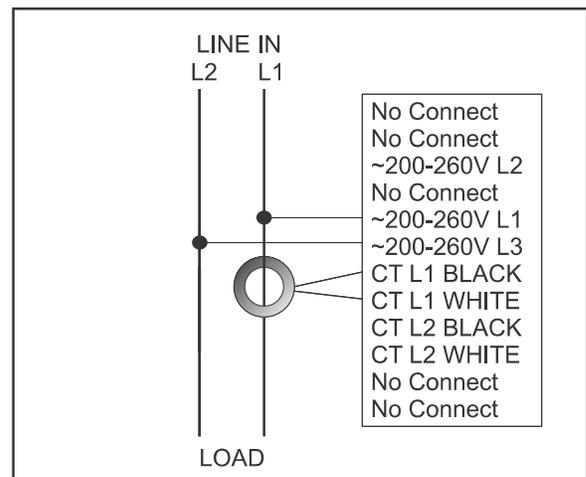


Fig 5. 2 Wire, Single Phase (Types F & G)

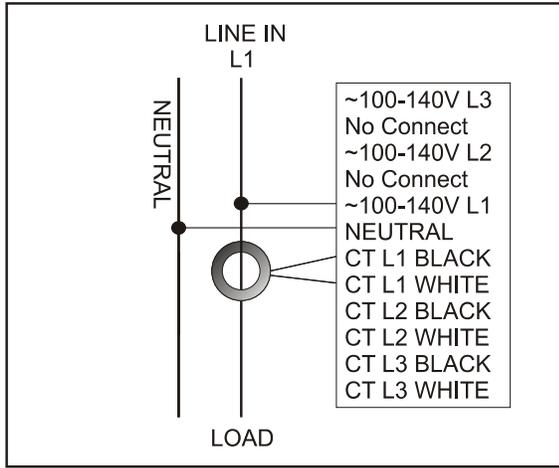


Figure 6. 2 Wire, Single Phase (Types A - E)

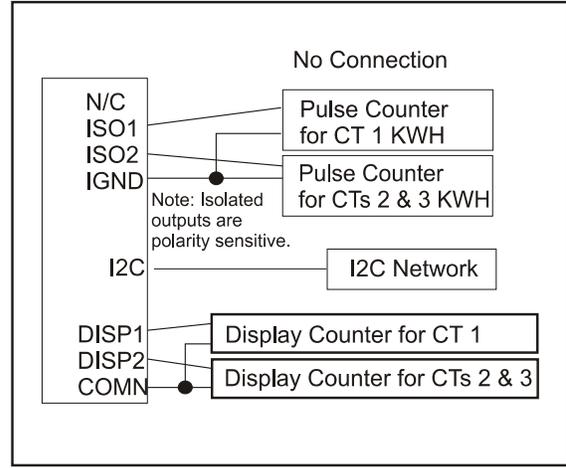


Fig 7. Display and Isolated Output configuration for dual output meters

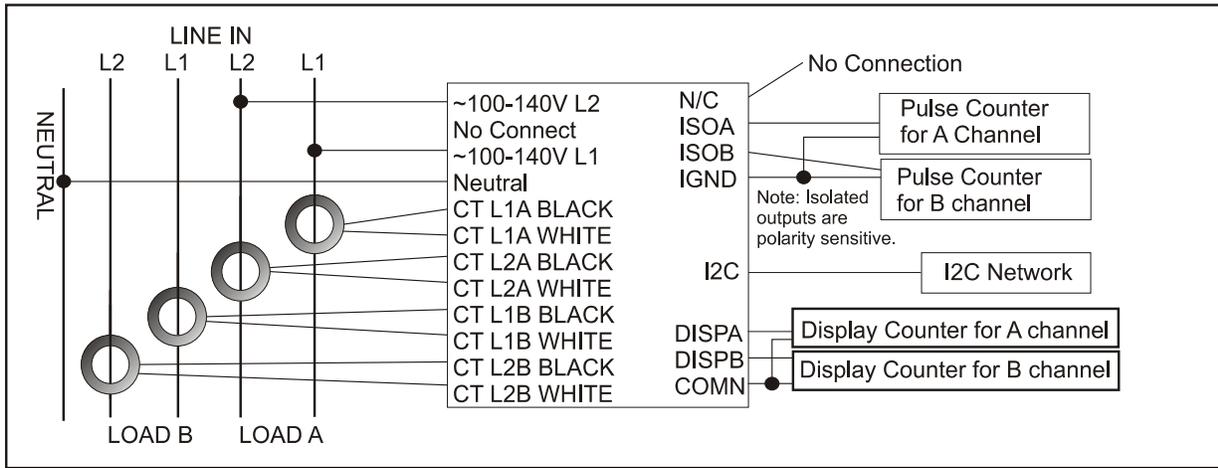


Fig 8. Dual 3-Wire, Dual Element, Single Phase Meter (Type A4)

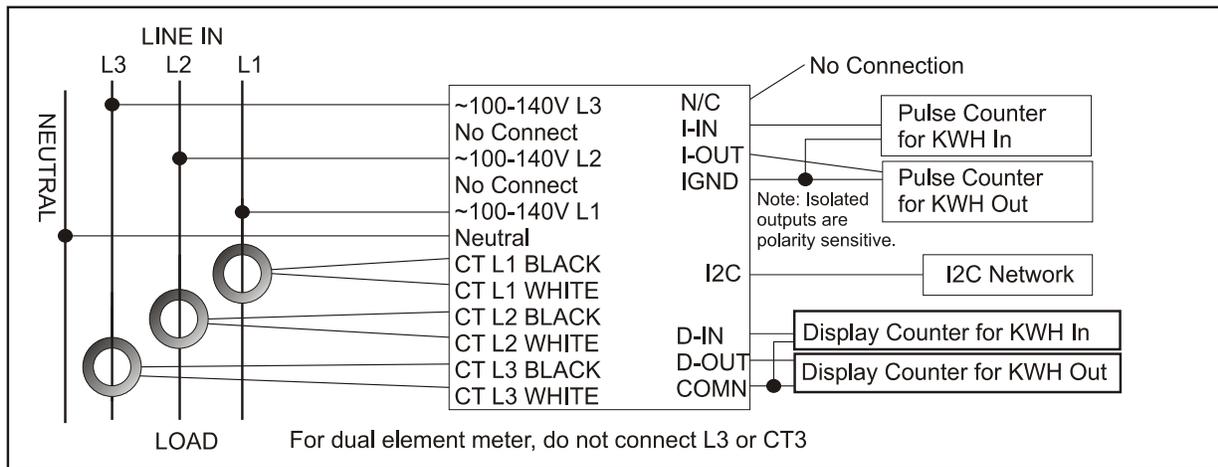


Fig 9. Bidirectional 2 or 3 Element Meter

Note:

Install a 120 ohm resistor (R1) across the TX- and RX+ lines if total length is over 50 feet, install a second 120 ohm resistor at R2 is line length exceeds 100 feet.

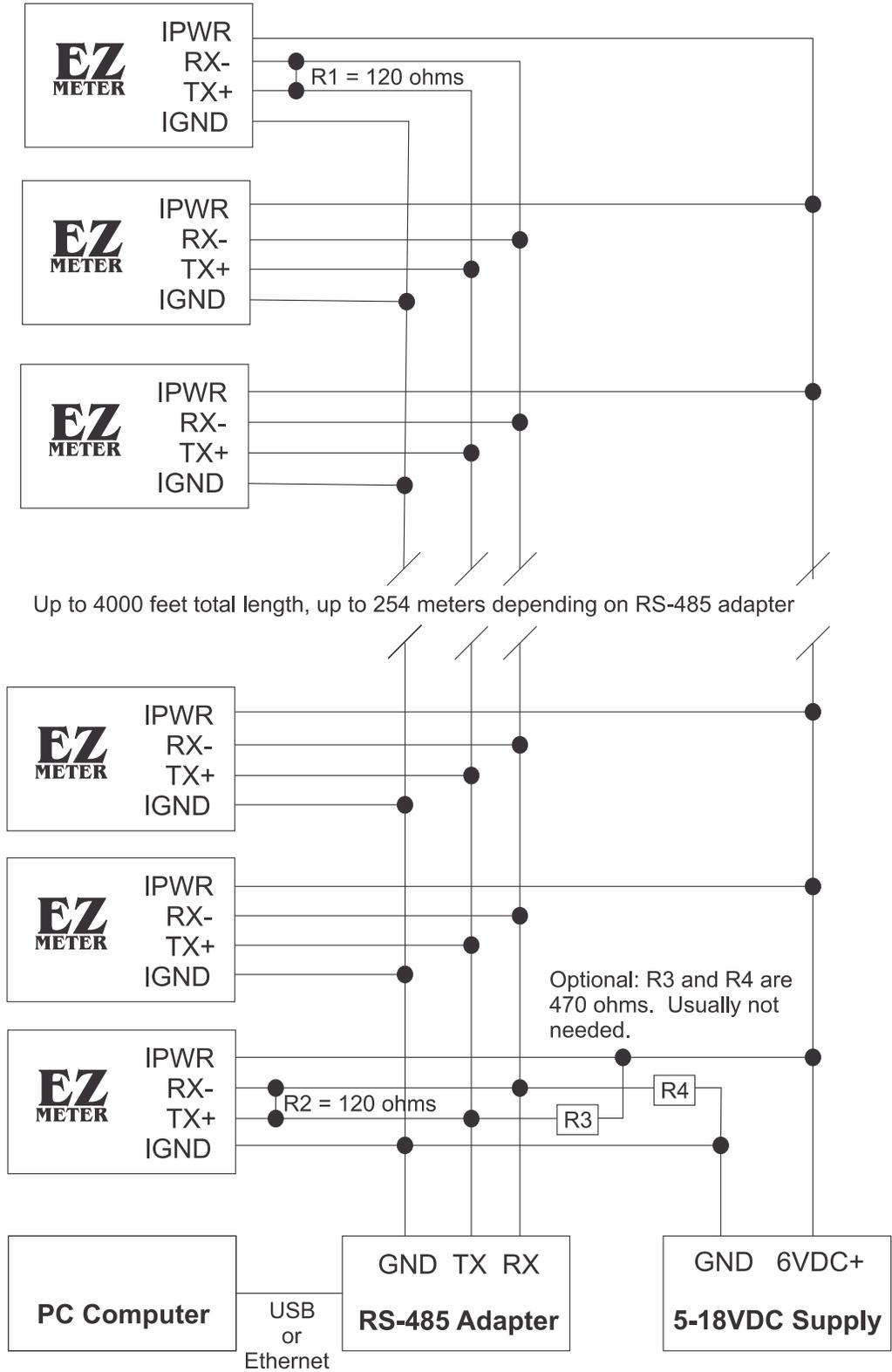


Fig.

10. RS-485 Network Layout

Testing the Installed Meter

After the meter has been installed, it is a good idea to turn power on the system and check to see that the meter was connected to the power line properly. This can be determined easily by looking at the red LED in the top, center portion of the label on the electronics module. This LED should glow a bright red whenever power is on. If it is flashing continuously, about one flash per second, it is indicating a high phase angle. This could be caused by the load on the system, but frequently indicates that the voltage and current inputs are not matched properly when using three phase power. This warning requires a current flow of approximately 60 watts on each leg.

If the meter is receiving power, the next step is to verify that the meter is operating properly. You will need a hair drier or other small appliance that uses approximately 1500 watts or more to be able to do the test in a reasonably short time. Since the meter measures each phase separately, you will need to test each phase individually.

You can get a rough idea of the accuracy of the meter with the following test. If you have a high voltage or high current meter, the red LED may flash at 0.5 kwh or 0.1 kwh instead of 0.01 kwh. Check the meter label. You will have to adjust the times for other resolutions.

Without getting into phase angle, resistance and impedance measurements, the following formula will tell you how many seconds it should take to count 0.01 kwh:

$$\text{SECONDS} = 4,320,000 / \text{VOLTS} / \text{WATTS}$$

where VOLTS is the AC voltage measured at the meter (it is important to measure this as variations up to 10% are common) and where

WATTS is the wattage shown on the nameplate of the appliance providing the load.

For example, a 1500 watt heat gun on 120 volts will use 0.01 kwh in $4,320,000 / 120 / 1500$ or 24 seconds. If you don't get this exact value, it does not mean the meter is defective. Many name plates are only approximate. The label on the EZ Meter itself states power consumption of 2 watts, but that only happens when the serial port is read or the mechanical counter advances. Another factor that influences the accuracy of this test is the power factor of the electricity being measured. If a big power factor exists, the test may take several more seconds than what is calculated, perhaps half again as much.

To check a 120 volt service, turn on your heater and begin timing when the red LED flashes the first time. The red LED should flash again about 24 seconds later (or whatever time you figured using the formula above for the load you are testing with).

If you have several meters but don't have a voltage meter, you can test several meters and if they all use the same number of seconds, you can assume the meters are working okay even if the time observed is different than the calculated time. This test will also correct for variation in the actual number of watts used by the appliance versus the number shown on the name plate.

Trouble Shooting

Try the following steps if the meter does not work. A simple AC voltmeter will make trouble shooting much easier.

No Red LED

Be sure that line and neutral wires are connected properly and that power is turned on. Check this with your voltmeter by measuring the voltage between the Neutral and L1 terminals. The voltage should fall in the range specified for the meter. If it does not, you have not connected it properly, the power is not turned on, or you have the wrong meter for your electrical system. Check the voltage between the neutral (usually white wire) and ground. This voltage should be close to zero.

No Green LED

The green LEDs are normally off. They flash briefly when the mechanical counter advances..

Green LED flashes but Counter does not change

The meter is correctly detecting the usage of power but the mechanical counter is not moving. Be sure the counter is connected properly with one wire going to COMN and one wire going to DISPL When the green LED flashes, the mechanical counter should advance. With 2-in-1 meters, when the top green LED flashes, the counter connected to DISP1 should advance indicating current measured with the transformer connected to the CT #1 terminals. When the bottom green LED flashes, the counter connected to DISP2 should advance.

If the counter is properly connected and does not advance when it should, replace the counter with a different one.

Green LED Flashes too often

The most common cause of inaccurate meters is a poor neutral connection, either at

the meter, at the panel, or where it connects to ground. Check your neutral. If a CT wire is shorted to neutral or ground, it will also cause a very high reading.

The time is wrong when doing the accuracy check.

Be sure all the terminals are wired correctly and screwed down tightly.

Be sure the hair dryer or other electrical load is plugged into the proper circuit and that it is the only thing drawing current through the meter.

Be sure the wire to the hair dryer only passes through the current transformer one time and that the neutral wire does not pass through it.

I have several meters and one appears to be reading lower than the others.

If you think one of the meters is reading low, swap the meter with one that appears to be reading right.

Communication problems

See the RS485 Troubleshooting Ap Note on page 33.

Still doesn't work

Check at www.EZ Meter.com for more trouble shooting suggestions or call Customer Support at 1-805-688-9696 between 9:00AM and 5:00PM Pacific Time, Monday through Friday. Each meter is covered by a five year limited warranty (see page 4). There is a charge for meters that are returned for repair that are not defective.

EZ Meter Technologies Application Note

Installing a Grid Connect NET485 (Ethernet-RS422/485 Adapter)

Several companies make Ethernet to RS485 adapters that are suitable for connecting EZ Meters to the internet or a local area network (LAN). Most come with a fixed IP address and setting one up is both time consuming and difficult. EZ Meter Technologies recommends the Grid Connect NET485 for its ease of setup.

Physical Connections to meter. The NET485 module must be mounted in a location where a hard-wired LAN connection meets the end of the RS485 network. The A pins must be wired together and the B pins must also be wired together. The two termination resistor jumpers next to the green connector should be removed unless you have very long wires for your RS485 network.

NET485	EZ Meter	DC POWER SUPPLY
TXD A & RXD A	A or RX-	
TXD B & RXD B	B or TX+	
SGND & GND	IGND	GND
8-24VDC	IPWR	8-16VDC

Firmware Setup. An active ethernet cord must be plugged into the NET485 and DC power must be supplied to the GND and 8-24VDC pins on the green connector before setting up the firmware.

Step 1. Determine and set the IP address. Install the Lantronix DeviceInstaller software on your computer from the CD that came with the NET485 or download it from the Grad Connect website. Run the program. It will search your network for your adapter and may take several seconds to find it. Your device should show up in the main part of the screen with an icon labeled Xport. Double click on the icon and a list of the devices properties will be displayed. You are looking for the IP address which is about a third of the way down the page. For subsequent steps, you can use either an internet browser (Internet Explorer, Firefox, Safari, etc) or you can click on the Web Configuration tab in the program.

Step 2. If you clicked on the Web Configuration tab, the IP address and port (80) will be showing in the address box. Click the white arrow with the green background to the right of the address. If you are using a browser, continue to the next step.

Step 3. Enter 'admin' as the user name and leave the password box empty, then click 'OK'.

Step 4. Set up the Serial Port. Click 'Serial Settings' under Channel 1 in the menu on the left side of the screen. Change the Protocol to 'RS485 - 2 wire'. Set the baud rate to match whatever is printed on the label of the EZ Meter (They all have to be the same or you won't be able to communicate with some of them.) Flow Control should be 'None', Data Bits '8', Parity 'None', and Stop Bits '1' for EZPlus meters. Refer to the label for Modbus meters as they may require different settings. Under Pack Control, the 'Enable Packing' box should be unchecked. There should be a green dot in No for everything under 'Flush Mode'. Click the 'OK' button at the bottom of the page when you are done.

Step 5. Set up the connection data. Click 'Connection' on the menu on the left side of the screen.

Under Connect Mode: Protocol = 'Yes', Accept Incoming = 'Yes', Password Required = 'No', Active Connect = 'No'

Under Endpoint Configuration. Local Port is one of the values you will enter into the EZ MeterReader software package to connect to this device. The default is 10001 which is fine unless you have multiple devices that use this port and you want to be able to access the device over the internet. Then it will need its own port. Be sure to note the number you assign. Remote Port = '0', Remote Host = '0.0.0.0' and Auto increment for active content is unchecked.

Do not make any changes to Common Options.

If the NET485 will be accessed through the internet, in the Disconnect Mode section, enter 1 minute, 0 seconds in the Inactivity Timeout fields.

Click 'OK' to save any changes you made.

Step 6. Select 'Network' on the main menu. Set a DHCP Host Name or Fixed IP Address. A fixed IP is suggested if your network does not support DHCP host names. Click "Network" on the menu. Under IP Configuration, either:

(a) Select 'Obtain IP address automatically' and all the 'Enable's below it. Enter a name in the 'DHCP Host Name' box. This is the name that you will enter in the IP Address field in the EZ Meter Reader program. Or

(b) Select 'Use the following IP configuration' and enter the desired IP address. Change the other values only if your network requires.

Under 'Ethernet Configuration' be sure the 'Auto Negotiate' box is checked.

Click 'OK' to save any changes you made.

Step 7. Setting passwords. This step is optional, but highly recommended if the NET485 device will be exposed to incoming messages from the internet.

Select 'Server' from the menu. Under 'Server Configuration' enter a password in the 'Telnet Password' box and again in the box below it.

Click 'OK' to save any changes you made.

Note: If you ever come back and change any of the settings in the 'Advanced' section, be sure to re-enter the password before you click the 'OK' button. Otherwise the password will be reset to a blank (empty) password.

Step 8. Apply Settings (Very Important). Click 'Apply Settings' on the menu. If you fail to do this, everything you have done up to this point will not be loaded into the NET 485 device and you will have wasted your time.

The Grid Connect NET485 can be ordered from <https://gridconnect.com/rs485-ethernet.html> or pre-configured from EZ Meter Technologies. When ordered from EZ Meter Technologies, a 9 vdc power supply is included.

Trouble Shooting the NET485

Problem: The meters are no longer read after upgrading from DSL to a cable modem.

Solution: This is a problem because the IP addresses in the NET485 are fixed and the subnet changed from something like 192.168.1.* to something like 10.0.10.*.

One solution is to have the installer change the subnet back to the same as it was for the DSL service. If that is not an option, this procedure should work:

1. Run the Lantronix Device Installer program, search for devices and make a note of the MAC addresses for each one of the NET485s and correlate that with the connection in the EZ Meter Access Setup page. This data will be needed once the IP addresses are reassigned.
2. Disconnect the computer from the router.
3. Go to the Control Panel and navigate to Network Settings, Change Adapter Settings. Right click on the network adapter that is connected to the NET485 and select Properties. Select the Internet Protocol Version 4 (TCP/IPv4) item and click Properties. Select Use the following IP address and enter an address in the old subnet (perhaps 192.168.1.10) Click OK to save, then reboot the computer.
4. Connect the computer to one or more of the NET485s. If you have an ethernet switch other than the one that assigns the IP addresses, its real easy. If you don't, you may have to get an ethernet cross-over cable so you can plug the computer directly into the NET485.
5. Start Internet Explorer or another browser and type the IP address for the NET 485. The addresses are in the Configuration tab in Setup in the EZ Meter Access program. Unless you have changed the password, just hit Enter when it asks for user name and password. Click Network from the menu in the left column. Under IP Configuration, Select Obtain IP address automatically. Click OK then Click Apply Settings in the menu on the left.
6. Repeat steps 4, 5, and 6 for each NET485.
7. Repeat step 3, but set it back to Get IP address automatically.
8. Reconnect the network to the way it was before you started step 2.
9. Reboot the computer and restart each of the NET485s (Disconnect the green connector, wait 10 seconds, then reconnect it)
10. Run the Lantronix Device Installer, search for devices and make a note of the new IP addresses along with the MAC addresses.
11. Using either Device Installer or a browser, follow the procedure in step 6, except set a fixed IP address for each NET485. Use the same address that was dynamically assigned. If you don't do this, the next time the router restarts, it may assign different IP addresses and the meter reading will fail.
12. Start EZ Meter Access and update the Configuration tab in the Setup window with the new IP address for each NET485

EZ Meter Technologies Application Note 2

Connecting FTDI Chip Model USB-RS485-WE-1800-BT

Connect the orange and brown wires to the A (RX-) terminal, the yellow and green wires to the B (TX+) terminal, the black wire to the IGND terminal and the red wire to IPWR (Be sure to check that there is at least 4.8 VDC between IGND and IPWR if there are multiple meters installed). The brown and green wires install a 120 ohm termination resistor. If a separate DC power supply is required for isolated power for the meters, connect it to the IGND and IPWR terminals and do not connect the red wire from the FTDI Chip device. Instructions and drivers for Windows, Linux and OS-X are at www.ftdichip.com.

EZ Meter Technologies Application Note 3

Connecting Digi Radio Modems to EZ Meters

The MaxStream division of Digi Corporation makes several radio modems that work as wireless RS-485 network extenders. The three series, XCite, XStream and XTend all have the same function with XCite having the shortest, and Xtend being the most powerful. Maximum range for the different models (from the Digi specifications) are:

Model	Indoor/Urban Range	Line of Sight Range
Xcite	300 feet	1000 feet
XStream	1500 feet	up to 20 miles
XTend	3000 feet	up to 40 miles

Choosing the right radio. Adequate range is the most important consideration in choosing a radio. The range figures above should be considered ballpark figures and not relied on completely. Interference from other radios and physical objects can severely affect the actual range of the radios. To get the maximum ranges shown, expensive, directional antennas are required. Each radio comes with software for configuring the radio and testing communication between two radios. Before a radio is permanently installed, be sure to use the provided test program to be sure the radios will communicate with each other.

The other important consideration is the operating temperature rating. For indoor use, Commercial (0°C to 70°C) is adequate. Outdoor installations generally require the Industrial (-40°C to 85°C) rating.

Testing the Range. Follow the instructions in the Quick Start Guide to establish communication. If your computer has an RS-232 port, use it and the included cable for this test. If your computer does not have an RS-232 port, you will need to configure the radio connected to the computer for RS-485 and connect it as described below. The radio with the loopback connector must remain configured for RS-232 during the test.

Connecting a Radio to Your Computer. If the radio will be installed near the computer, it is usually simpler and cheaper to connect to the radio using RS-232 rather than RS-485. Simply use the RS-232 cable provided with the radio or purchase a USB to RS-232 adapter. Plug it into the connector on the radio, set the DIP switch for RS-232 (switch 1 on, the others off) and plug in the power supply.

If the cable from the computer to the radio will be more than thirty feet long, use RS-485. We suggest the FTDIChip USB to RS-485 Adapter (Model USB-RS485-WE-1800). Connect the yellow wire to Pin 2 on the L-COM DB9MT1 adapter, the orange wire to Pin 8, and the black wire to Pin 5. Set the DIP switch for 2-wire RS-485 by turning all the wires off.

If some meters will be connected directly to a USB to RS-485 adapter (or an ethernet to RS-485 adapter) and other meters need the radio link, both radios may be connected as described in the next section.

Connecting a Radio to the Meters. Before connecting a radio to the meter network, it is a good

idea to connect a portable computer to the network to determine that everything is working properly. It is easier to troubleshoot if you know the problem is in the wiring rather than with the radios.

These instructions assume the RS-485 network has already been installed and is working. Connect the B- wire from the meters to Pin 2 on the L-COM BD9MT1 adapter, the A+ wire to Pin 8, the IGND wire to Pin 5 and the IPWR wire to Pin 9. Be sure to set all the switches on the DIP switch off for 2-wire RS-485.

Troubleshooting. Troubleshooting is best accomplished by separating the RS-485 network from the radios and checking each system separately. To test the radios, remove the DB9 adapter from the radio connected to the meters and install the loopback connector furnished with the radio. Move switch 1 on the DIP switch to on and be sure there is power to the radio. You will need to provide power to the radio if it was powered from the same source as the isolated power connected to the RS-485 connector on the meter. The radio comes with a plug in power supply as well as a short cord that will connect to a 9 volt battery. Use the software provided with the radio to test the communication.

EZ Meter Technologies Application Note

Connecting Snap Link Radios to EZ Meters

Snap Link radios produced by Synapse are another cable replacement option for creating an RS485 network. Product information is available on their website at:
<http://www.synapse-wireless.com/iot-development/hardware-products/snaplink>

One downside to using Snap Link is that a separate USB to RS485 adapter is required. The USB port built into each radio is only for providing power, not communications.

The default communication setup for the radios is two-wire RS485, 9600 baud, no parity, one stop bit. Ordering EZ Meters in this configuration makes setting up the system easy right out of the box. Synapse has configuration programs available on their website for changing any of the parameters if needed.

A lot of the material in the previous app note regarding Digi radios applies to Snap Link as well. If you are not familiar with setting up radio networks, read that section.

Connecting to a USB Adapter: Use of the FTDIChip USB-RS485-WE-1800-BT adapter described earlier is suggested. Connect the orange and brown wires to the left-most pin (TX+) on the connector on the SnapLink radio. The yellow and green wires go to the next pin (TX-). The black wire connects to the right-most pin (GND). Install the antenna and connect the provided USB cable to power and this module is ready to go.

Connecting to a NET485 Ethernet Adapter: See the app note above about installing a NET485 device. The two A pins are jumpered together and connected to the left most pin (TX+) while the two B pins are connected to the adjacent pin (TX-). GND and SGND on the NET485 should be connected to the right hand pin on the radio (GND) and the ground of the power supply. Put a jumper on the TX TERM pin of the NET485.

Connecting to one or more EZ Meters. Connect the left-most pin (TX+) on the radio connector to A or RX- on the meter. Connect the adjacent pin (TX-) to B or TX+ on the meter. Connect the meter IGND to the right-most pin (GND) of the radio's connector. Be sure to also connect the isolated power supply to IPWR and IGND. Test the polarity before making the connection.

The default connection will work in most situations. If there are a lot of radios or long distances involved, programs available on the Synapse website will configure the radios into a mesh network with some acting as repeaters and others as simple end points. Consult Synapse's technical support for assistance configuring a network.

EZ Meter Technologies Application Note

RS-485 Trouble Shooting

Ideally, you will hook up your system and it will work the first time. If that doesn't happen, you have a few options.

1. Use the EZ Meter Access program to communicate with the meters through the EZServer meter reading and logging utility that is part of the EZ Meter Power Suite. This is a little cumbersome as the program was not designed for troubleshooting.
2. Use the EZServerTester program that was installed in the EZ Meter folder on your main drive. Start the program by double clicking on it. Be sure the EZServer is running (Comm Server in the main menu of EZ Meter Access). You will probably connect to the server using Localhost (on the same computer) and pushing the Connect button. The program reads the unit information from the Access database. Click the buttons to get various data stored in the meter.
3. Use the EZ Meter Configuration Tool program. If it was not installed with the Power Suite (versions 0.3.0 and earlier), download it from <http://www.EZ Meter.net/downloads/Setup-EZ MeterConfigTool.exe>. This program communicates directly with the meters so make sure the EZServer program will not interfere by trying to read a meter at the same time. The online help system will get you started and walk you through it. Be sure the communication server for EZ Meter Access is stopped before using this program. Select *CommServer* in the EZ Meter Access menu to start and stop the server.
4. Read *Guidelines for Proper Wiring of an RS-485 (TIA/EIA-485-A) Network*, an app note (763) published by Maxim Integrated Devices, manufacturer of the RS-485 drivers used in the meters. It is at <http://www.maximintegrated.com/an763>.

On all systems:

Problem: No communication

1. Verify that the meter is powered up and the red LED is on steady. If it is flashing, it could indicate that the meter does not have a steady source of power. It can also mean that there is a high phase angle on one or more of the legs.
2. Verify that there is DC power between the IPWR and IGND terminals on the meter. You should have between 5 and 18 volts.
3. Verify that there is a DC voltage difference of more than 0.1 volts (100 millivolts) between the B- and A+ terminals. The voltage between IGND and B- should be over 1 volt and between IGND and A+ should be higher by at least 0.1 volts.
4. If you are using the FTDI Chip USB to RS-485 dongle, be sure the orange wire is connected to the A+ terminal, the yellow wire is connected to B- and the black wire is connected to IGRND. If you are using a different RS-485 device, the Tx and Rx wires may need to be reversed. Be sure the signal ground from the device is connected to IGRND.
5. Verify there are no shorts or opens in the wiring. Disconnect the A and B wires at the adapter (USB to RS-485 or Ethernet to RS-485) then use an ohmmeter to verify the resistance is about 120 ohms (or the value of the termination resistor at the end of the line).
6. If you have no communication with any meter on your system, isolate one meter from the others and work through this guide until you can communicate with that one meter before

- connecting to the others. Be sure to check with and without a termination resistor at the meter.
7. Be sure the label on the meter specifies that it is for RS-485.
 8. Be sure your computer program (EZ Meter Reader or EZ Meter Access) is configured properly.
 - a. Be sure that at least one connection has been set up and that all the parameters match what is printed on the meter label.
 - b. Be sure you have added the meter you are trying to communicate with to the system and that the serial number (EZ Plus) or Modbus address (Modbus) is entered in the appropriate space without any hyphens or commas.
 - c. If you have set up more than one connection for your system, make sure that the meter under test is part of the meters served by the active connection.
 - d. Make sure the baud rate for your connection is the same as the baud rate printed on the front of the meter label. For Modbus meters, also check parity and stop bit settings.
 - e. EZ Meter Reader - Click on the meter you want to read in the list of meters, then click then Read This Meter button. If you get a reply, the right part of the screen will be refreshed with new numbers. If you do not get a good reply a window will pop up and tell you what the problem is.
 - f. EZ Meter Plus - Be sure the server is running (Comm Server in the menu bar). Go to the Units tab in the Setup window, select a unit and click the Read Now button at the bottom of the window. The Last Reading data will be updated with the current reading, date and time if the reading is successful.
 9. Be sure you do not have too many devices on the network. Up to 255 meters can be installed on one network as long as there is nothing else. Each device you add to the network adds impedance to the line. The original RS485 specification allowed up to 32 devices. Mixing old, high impedance devices with EZ Meters will reduce the maximum number of meters that can be on one network. Repeaters and radio links can be used to increase the number of meters.
 10. Line termination is important and best discovered by trial and error. It sometimes is not needed at all and other times is required on very short runs. The first step is to install a 120 ohm resistor across the Tx and Rx terminals on the last meter in the chain. If this does not solve the problem, add a second 120 ohm resistor across Tx and Rx at the adapter. The NET485 Ethernet adapters have jumper selectable terminating resistors built in.

Using the FTDI Chip USB to RS485 Dongle:

Note: 120 ohm termination is usually required at the last meter, even if there is only one.

Problem: Lights in Dongle do not flash.

1. Be sure you have installed the latest driver for the device from the FTDI Chip website.
2. Verify the COM port to which the USB device is mapped and that the COM port in the program are set to same value.
3. Try a different Dongle

Problem: The red light in the Dongle flashes but the green one does not.

1. Verify that the meter is powered up and the red LED is on steady. If it is flashing, it could indicate that the meter does not have a steady source of power. It can also mean that there is a high phase angle on one or more of the legs.

2. Verify that the orange wire from the Dongle is connected to the TX- terminal on the meter, the yellow wire is connected to the RX+ terminal and the black wire is connected to the IGND terminal.
3. Be sure the serial number (EZ Plus) or Modbus address is correct.
4. Watch the white, bicolor LED on the meter (the one above the two green LEDs). It will flash red when it receives a signal from the Dongle. If it does not flash, there is a problem with the wiring somewhere. If it flashes red, it did not recognize its address so it did not respond. The address may have been for another meter or the message received may have been corrupted. Corrupted messages are usually caused by improper termination.

Problem: Both lights in Dongle flash, but there is no reply.

1. Watch the white, bicolor LED. If it flashes red it is not replying. If the meter replies, the LED will flash red then green so fast that it looks sort of orange. If the meter has replied, but the program is not recognizing the response, it is most likely a termination problem.
2. If you have multiple meters, try a different one. Something may have happened to the first one.
3. Try to isolate the meter from electronic noise. If the yellow LED on the meter never flashes, but you get an error message indicating Checksum error, noise on the line is probably the main problem. This can affect both the Dongle and the wiring. A shielded CAT5 or better wire or rerouting the wiring away from the source of the noise is suggested.
4. Bench test a meter without the all the wire. Connect a meter directly to the RS-485 output. Connect your DC power to the IGND and IPWR terminals. Connect AC power to the neutral and L1 terminals on the meter. Cutting the end off a short extension cord works well for this. Be sure to make sure the neutral is not connected to the L1 terminal. In North America, the wide blade of your plug is the neutral. If you cannot communicate at this distance, it indicates the either the meter is bad, the RS-485 adapter is bad, the wiring is not configured properly or the software is not configured properly (wrong COM port or baud rate).
5. If the meter bench tests OK, reinstall it in the field without connecting the other meters to it. Connect successive meters until communication fails. Then check the wiring at that location.
6. Customers have reported no communication even with both lights flashing correctly and fixed the problem by using a different Dongle.

Using Other RS485 Adapters

There does not appear to be a standard for the labeling Tx and Rx among manufacturers. We have tested various adapters and found that we connect Tx on the adapter to Tx on the meter on some and on others we have to connect Tx on the adapter to Rx on the meter. It can be very confusing with adapters that can be configured for two-wire RS485 or four-wire RS422. If you are having trouble, it may be cost effective to get one of the FTDI dongles referred to above.

Mfg Part No: USB-RS485-WE-1800-BT

Digi-Key Part No: 768-1041-ND, \$30.00, www.digikey.com

Mouser Electronics Part No: 895-USBRS485WE1800BT, \$30.00, www.mouser.com

Also on Amazon, usually at a lower price and perhaps not as reliable

The Gearmo model USA-482422 is also a good USB to RS-485 adapter.

Using an Ethernet to RS485 Adapter (such as the NET485)

Problem: No response from meter

1. Verify IP address is correct. Suggest setting a fixed IP rather than relying on DHCP. Log into the web server in the adapter. This will verify the IP address. While there:
2. Verify adapter is configured properly for serial communication.
3. Check to be sure firewall is not blocking communication with adapter.
4. Restart the adapter.
5. Verify wiring between adapter and meters is correct. Cat5 or CAT6 twisted pair is suggested. Twisted pair is a must. TXD A and RXD A should be jumpered together and connected to A+ on the meter, TXD B and RXD B should be connected to B-, SGND and GND must both be connect to IGND on the meter.
6. Verify there is 6-18VDC across the IGND and IPWR terminals on the meter.
7. Experiment with termination resistors, either built into the adapter or separate.
8. If not using a NET485, see note above on *Using Other RS485 Adapters*
9. Read the section above about the FTDI Chip USB to RS485 Dongle. It has a description of how the LEDs on the meter respond that can be helpful and the discussions about addressing, wiring problems and termination apply here as well.



EZ Meter Technologies Application Note Phantom Neutral Installation Guide

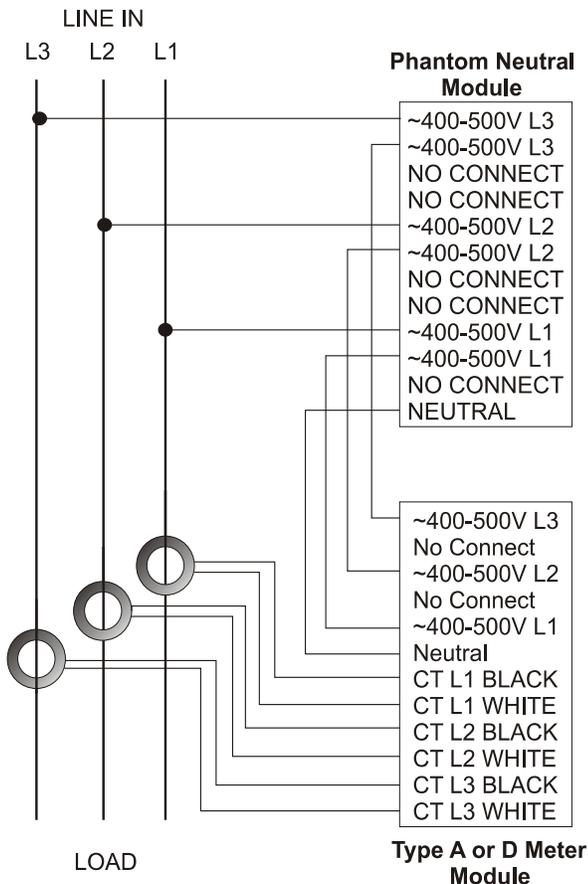
Usage: The EZ Meter Technologies Phantom Neutral devices may be used in conjunction with a standard three phase wye EZ Meter to allow connection to a three-wire, three-phase delta electrical service. It should be used whenever a neutral is not available.

Models: For a 440 to 480 volt, line to line, three wire delta, use a model PN277 in conjunction with an EZ Meters with a model number that begins with the letter D (or E if you already have one). The PN277 may also be used with EZ Meters whose model begins with C for line to line voltages between 400 and 440 volts.

For 200 to 250 volt, line to line, three wire delta systems, use the PN120 phantom neutral in conjunction with an EZ Meter whose model number begins with A (or B if you already have one).

Note: The phantom neutral and meter should be ordered together. If you are ordering a phantom neutral to use with a meter that you already have, contact Customer Support for information about determining the proper match. Failure to properly match the phantom neutral can lead to a meter error of five percent or more.

Installation: The meter/phantom neutral combination should be installed as close together as is practical. Connect the three hot wires coming from the electrical service to the L1-A, L2-A, and L3-A terminals on the phantom neutral. Connect L3-B on the phantom neutral to the L3 terminal on the meter. Similarly, connect L2-B to the meter L2 terminal and L1-B to the meter L1. Connect the Neutral terminals on the phantom neutral and the meter together.



Connect the current transformers (CTs) as shown in the meter installation instructions being certain to properly match the L1 CT with the L1 on the phantom neutral and the meter.

Note: Failure to connect the L1 terminal on the phantom neutral to the L1 voltage input on the meter will cause an error of 50% or more and will very likely will produce voltages inside the meter that would damage it so badly that it can not be repaired.

The terminals labeled “NO CONNECT” are not connected to anything internally.

Testing: After the phantom neutral and meter are installed and powered on, verify the unit is working properly. The red LED on the meter should be illuminated (or flashing). Use a voltmeter to verify that the voltages between neutral and each of the hot legs is within 1.5 volts. Variations over that amount can lead to a meter error over 1%.

EZ Meter Technologies Application Note Obvius AcquiSuite Connections

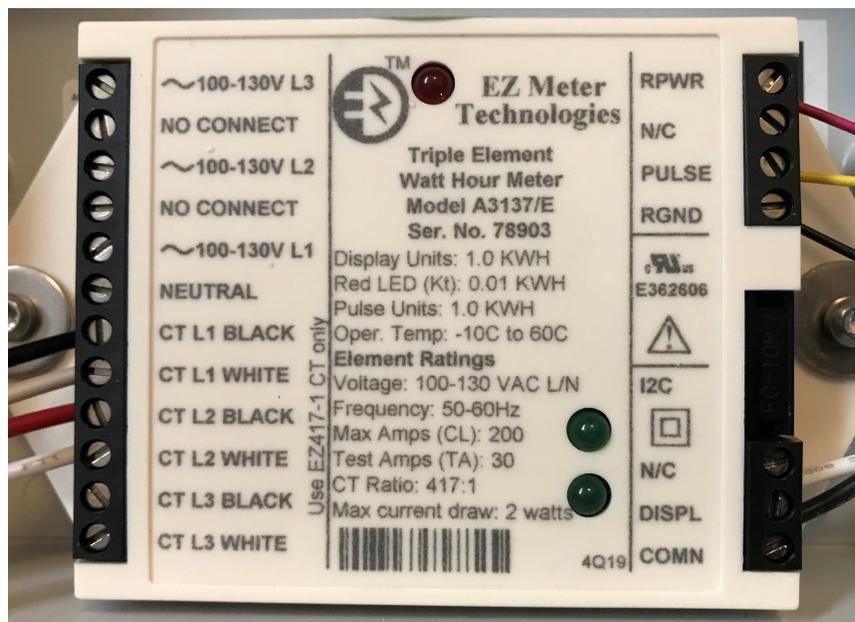
The Obvius AcquiSuite can be used with the EZ Meter Modbus meters. While not listed on the Obvius website as a supported meter, it can be used in conjunction with the EMZMeter.mbt format file (www.EZ Meter.net/downloads/EZ Meter.mbt).

To connect an EZ Meter to an AcquiSuite, you need to provide isolated DC power to IPWR and IGND; 5-18 VDC will work. Connect RX- (A) on the meter to + on the AcquiSuite and TX+ (B) connects to -. Connect iGND to Shield. Load the EZ Meter.mbt file into the AcquiSuite, set the AcquiSuite Modbus Setup parameters to match what is printed on the meter label and add the Modbus Address to the Modbus Device List and link it to EZ Meter.mbt.

EZ Meter Technologies Application Note Next Century Radio Module

Next Century offers a special version of their pulse counting radios that get power from an EZ Meter rather than using a battery that must be replaced on regular intervals. The fifth character of the EZ Meter model number should be a 7 which indicates a special module has been installed in the meter to provide the regulated 3.3 volts needed to power the radio.

WARNING: The module was engineered to provide enough power to replace the battery in the Next Century radio. Connecting it to a device that requires more power will cause the meter to fail.



Connecting the meter to the radio

Connect: RPWR terminal to the 3.3V input on the radio module (red wire)
PULSE to the pulse input on the radio (yellow wire)
RGMD to the ground pin on the radio. This is ground for both the power and the pulse.
(black wire)

Note

Each radio must have been programmed prior to installation and a label with the unit number must have been affixed to the radio case. Care must be taken during installation to assure the radio and its meter are installed on the panel for the appropriate unit.

EZ Meter Technologies Application Note USConverters RS485 WIFI Converter

See the setup guide provided on the manufacturer's website

http://www.usconverters.com/downloads/wf485/WF5000B_WF485-setup-guide.pdf

These instructions will get you started.

Connect the meter to the RS485 WIFI Adapter. Connect D+ to RX- (A), D- to TX+ (B) and G to IGND. Install a 120 ohm resistor across RX- (A) and TX+ (B) on the last meter in the daisy chain. Be sure 5-18VDC are provided to the IPWR and IGND terminals on the meter and that power is also supplied to the WIFI device.

Set up the WIFI device. Once logged into its web server:

10. Mode Selection. Choose AP Mode and Transparent Mode. Click Apply. You want it in AP mode to start with so you can get back into it to make changes.
11. AP Interface Setting. Ignore
12. STA Interface Setting.
 - a. AP1's SSID. Click Search and choose one of available networks
 - b. Security mode. Choose access point's security method
 - c. Encryption Type. Choose access point's encryption
 - d. Pass Phrases. Enter the password needed to connect
 - e. Repeat two more access points if desired
 - f. Click Apply

 - g. DHCP Mode. Choose either DHCP or static IP. Not all access points support DNS to let you access the Hostname you enter. If you use a static IP, make sure it is not in the range the DHCP server will use when assigning IP addresses. Use the Windows PowerShell and type "PING " followed by the IP address you want to use. If it does not respond, that IP address can be used for your WIFI device. Subnet mask is usually 255.255.255.0 and Default Gateway is usually the address you use to set up your router or access point. Click Apply.
13. Application Setting
 - a. Uart Setting. Set the values shown on the meter's label. Flow control and Baudrate adaptive should both be disabled. Then click Apply.
 - b. Disable Uart AutoFrame and Registered Package Settings
 - c. Network A Setting. Mode:Server. Protocol: TCP. Port - use default or other value that does not conflict on the network
14. Skip down to Device Management and restart the module.
15. Log into the network again, then use the EZ Meter Configuration Tool to read the meter.
16. If reading the meters was successful, log into the device's control panel again and reset it to a STA and connect it to the regular wifi network where it will operate.

TROUBLE SHOOTING

17. Check Modbus Address is correct and that WIFI device settings were properly stored.
18. Check wiring and voltages. Try moving the termination resistor (120 to 1K ohms should work) to other places and try without it.
19. Look at the device. Are the Pwr, Ready and Link lights on. If not, you have not set up the device properly. If the TX light fails to flash when you try to read the meter, you may be connected to the wrong network or you have specified the wrong port. If TX flashes but RX does not, see the next item.
20. Does the yellow reply light on the meter flash when you attempt to read the meter? If so, a signal is getting to the meter and the meter is either not responding because the Modbus address is wrong or one or more of the serial (baud, parity, data and stop bits) is set wrong. If the yellow light does not flash, it means the signal is not getting to the meter. Look at the device when you try to read the meter
21. If there is a question as to whether or not the meters are working properly, disconnect the WIFI device from the meter and connect a USB-RS485 device and verify the meters work properly
There are separate instructions in the manual for connecting the FTDI Chip USB-RS485 device.

EZ Meter Technologies Application Note Modbus Interface Description

This information is included for anyone writing their own meter reading application. It is not needed for normal installation of the system.

The data space for the meter consists of two blocks of registers that may be selectively accessed using the standard Modbus Functions listed below. Paragraph references are to the document “MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b”.

- 6.3 03 (0x03) Read Holding Registers
- 6.4 04 (0x04) Read Input Registers
- 6.6 06 (0x06) Write Single Register
- 6.12 16 (0x10) Write Multiple registers

The blocks of registers are:

- 1) Metered Values
- 2) Device Control Registers

Each block of registers may be located anywhere in the Modbus Register Space by changing selected registers in the device control block. Default register addresses are:

- Metered Values - Registers 1000 to 1047
- Control Registers - Registers 2000 to 2024

The above listed instructions all access the same data space so that, for instance, Function 03 (Read Holding Registers) and Function 04 (Read Input Registers) both address the same register blocks. Most of the write instructions are restricted and their successful use depends in some cases upon the successful entering of passwords, etc. Restrictions will be listed in the section which describes the registers. For details of the correct byte sequence for the Modbus functions and responses, see the above referenced Modbus Specification.

The following functions are also partially supported:

- 6.7 07 (0x07) Read Exception Status (Serial Line only)
- 6.8 08 (0x08) Diagnostics (Serial Line only)
- 6.8.1 Sub-function codes supported by the serial line devices
- 6.9 11 (0x0B) Get Comm Event Counter (Serial Line only)
- 6.10 12 (0x0C) Get Comm Event Log (Serial Line only)
- 6.13 17 (0x11) Report Slave ID (Serial Line only)

Read Functions 03 and 04.

These read functions may be used to access all defined registers. Registers that are defined but

restricted (such as the current value of passwords) will read back as zeros (0x00). Attempts to read beyond the defined data blocks will result in the appropriate Modbus exception message.

Write Single Register Function 06

This command may be used to write single register values only. It may not be used to write individual registers in a defined array of registers except that individual pairs of bytes of the Customer Identification Array may be written with this command as long as the correct priority level has been established by the previous entry of the appropriate password. In every case where the use of this function is appropriate, the same action may be achieved using a single register write with Function 10.

Write Multiple Register Function 10

Within the data block of Metered Value registers, this command is usable only to enter new values into the sets of registers that carry the values of the resettable Summed Accumulation registers. Not all meters use all four of these registers and not all meters allow the entry of new data into the SA registers.

Meter Configuration

The basic metering engine measures the amount of power flowing into or out of each of the (up to) four current inputs, each cycle of the associated voltage input. The power flowing is accumulated until a unit of 10 watt hours is reached, and then a count is injected into the associated Accumulated Power register. There is one register for power flowing into the load and another for power flowing in the reverse direction. The voltage input associated with each current input varies by meter model. For instance, a meter that measured the power flowing to four separate loads from a single phase would use the same voltage input for each of the four power measurement channels, while a three phase meter would use separate voltage inputs for each of the (in this case) three power measuring channels. The counts that increment the Accumulated Power registers are also routed to one or more of a set of four Summed Accumulation (SA) Registers. Depending on the meter configuration, these SA registers may count up or down in response to input counts, and Registers 2-4 may be resettable by the user. These registers are intended to accumulate the values that are used by the customer for total power monitoring. For instance, a three phase, unidirectional meter would accumulate counts from all six registers associated with its active inputs into the same SA register. A second register may accumulate the same counts but be resettable via a Modbus or EZNet command to keep track of the power associated with a particular job. All 12 of the possible meter registers are readable using Modbus or EZNet communications.

On LCD versions of the meter, the contents of the SA registers are displayed on the LCD. Meters that have mechanical counters instead of LCDs generally display total power on the mechanical counter(s), but the meaning of the counts and the units accumulated vary by meter type and reference must be made to the individual meter data sheet.

The meter also monitors voltage, current, power, frequency and power factor for each input. These values are averaged for 64 cycles of the input voltage and the values made available via communications commands. It should be noted that the calculations involved in measuring RMS values of voltage and current assume that the voltage and current waveforms are sinusoidal. The measurement of consumed and instantaneous power do not rely on such assumptions.

Reg Offset	Reg Address		Size	Default Value			DM	GP
Dec	Dec	Hex	Regs		Description	Units	Used	Used
Metered Values								
0	0	0	2	0	Acc. Pwr. Ph. 1 10Wh (Imp - Pos)	10 watt hr.		
2	2	2	2	0	Acc. Pwr. Ph. 2 10Wh (Imp - Pos)	10 watt hr.		
4	4	4	2	0	Acc. Pwr. Ph. 3 10Wh (Imp - Pos)	10 watt hr.		
6	6	6	2	0	Acc. Pwr. Ph. 4 10Wh (Imp - Pos)	10 watt hr.		
8	8	8	2	0	Acc. Pwr. Ph. 1 10Wh (Exp - Neg)	10 watt hr.		
10	10	0A	2	0	Acc. Pwr. Ph. 2 10Wh (Exp - Neg)	10 watt hr.		
12	12	0C	2	0	Acc. Pwr. Ph. 3 10Wh (Exp - Neg)	10 watt hr.		
14	14	0E	2	0	Acc. Pwr. Ph. 4 10Wh (Exp - Neg)	10 watt hr.		
16	16	10	2	0	Summed accumulation Counter 1	10 watt hr.		
18	18	12	2	0	Summed accumulation Counter 2	10 watt hr.		
20	20	14	2	0	Summed accumulation Counter 3	10 watt hr.		
22	22	16	2	0	Summed accumulation Counter 4	10 watt hr.		
24	24	18	1	0	Phase 1 Voltage	0.1 Volt		
25	25	19	1	0	Phase 1 Current	0.1 Amp		
26	26	1A	2	0	Phase 1 Power	0.1 Watt		
28	28	1C	1	0	Phase 1 Frequency	0.1 Hz.		
29	29	1D	1	0	Phase 1 Power Factor	x 0.01		
30	30	1E	1	0	Phase 2 Voltage	0.1 Volt		
31	31	1F	1	0	Phase 2 Current	0.1 Amp		
32	32	20	2	0	Phase 2 Power	0.1 Watt		
34	34	22	1	0	Phase 2 Frequency	0.1 Hz.		
35	35	23	1	0	Phase 2 Power Factor	x 0.01		
36	36	24	1	0	Phase 3 Voltage	0.1 Volt		
37	37	25	1	0	Phase 3 Current	0.1 Amp		
38	38	26	2	0	Phase 3 Power	0.1 Watt		
40	40	28	1	0	Phase 3 Frequency	0.1 Hz.		
41	41	29	1	0	Phase 3 Power Factor	x 0.01		
42	42	2A	1	0	Phase 4 Voltage	0.1 Volt		
43	43	2B	1	0	Phase 4 Current	0.1 Amp		
44	44	2C	2	0	Phase 4 Power	0.1 Watt		
46	46	2E	1	0	Phase 4 Frequency	0.1 Hz.		
47	47	2F	1	0	Phase 4 Power Factor	x 0.01		
Device Control Registers								
0	1000	3E8	4	"operator"	Enter Supervisor Password	ASCII		
4	1004	3EC	4	"password"	Enter Master pasword	ASCII		
8	1008	3F0	1	hidden	Enter OEM Password	Hex		
9	1009	3F1	1	hidden	Davidge Password	Hex		
10	1010	3F2	1	0	Protection Level	Hex		
11	1011	3F3	2	Ser No+01H	Serial number/address	Hex		
13	1013	3F5	1	0	Modbus Data register base address	Hex		
14	1014	3F6	1	03E8H	Modbus Control register base address	Hex		
15	1015	3F7	1	DFH	Modbus copy of CCMODE	Hex		
16	1016	3F8	1	0	Response Delay	12.91 msec		
17	1017	3F9	5	Varies	Modbus Copy of Option Bytes	ASCII		
22	1022	3FE	1	0	Reset Meter	N/A		
23	1023	3FF	10	Varies	Customer Identification array	ASCII		
24	1033	409	1	1	Format Av. Pwr and Power Factor signed int	Hex		

Summed Accumulators by Meter Type					
	3 ph Unidirectional	3 ph Bidirectional	3 ph Independent	4 Element Dual Meter	3 Element Dual Meter
SA#1	Total Power	Total Positive	L1 Total	A Total	L1 Total
SA#2	not used	Total Negative	L2 Total	B Total	L2 + L3 Total
SA#3	not used	Net, #1 - #1	L3 Total	A Resettable	#1 Resettable
SA#4	#1 Resettable	#3 Resettable	Total Power	B Resettable	#2 Resettable

Table 1: Modbus Registers & Summed Accumulator Registers

The configuration of the Modbus registers is listed in Table 1, above. Details of individual registers are as follows:

The first 12 pairs of registers register the power flowing through the monitored circuits. Each set of registers contains 4 bytes, counting power in units of 10 watt hours. The counters are arranged so that they reset to zero when the maximum count of the binary equivalent of 99,999,999 decimal (corresponding to 999,999.99 KWHrs) is exceeded. Byte order follows Modbus convention with the least significant byte occupying the low end (right hand side) of the highest number register. The registers are Read Only. Positive power is defined as when the current phase is within +/- 90 degrees of the voltage vector. An option is provided to change the order in which the four bytes that report a register are read out from the meter in response to an 03 or a 04 command. If Big Endian is not selected (See Modbus Operating Modes below), the two Modbus registers are read out in reverse order to the register containing the lower two bytes of the register number are reported before the upper two bytes. Under this option the bytes are reported in order 2,1,4,3, where 4 is the most significant and 1 the least significant.

Acc. Pwr. Ph. 1 10Wh (Imp - Pos)

Acc. Pwr. Ph. 2 10Wh (Imp - Pos)

Acc. Pwr. Ph. 3 10Wh (Imp - Pos)

. Acc. Pwr. Ph. 4 10Wh (Imp - Pos)

These three four of 2 registers each, accumulate positive power on the corresponding phase inputs. The fourth registers is used only in the DM versions of the meter and accumulates positive power for input 4.

Acc. Pwr. Ph. 1 10Wh (Exp - Neg)

Acc. Pwr. Ph. 2 10Wh (Exp - Neg)

Acc. Pwr. Ph. 3 10Wh (Exp - Neg)

Acc. Pwr. Ph. 4 10Wh (Exp - Neg)

These four pairs of registers work the same as the corresponding positive power registers. They accumulate power only when the current vector is more than 90 degrees from the voltage vector. Phases 1 - 3 are used for bidirectional meters, or when a meter is wired incorrectly. The DM currently meters all power as positive and does not use these four registers.

Summed Accumulation Counter 1**Summed Accumulation Counter 2****Summed Accumulation Counter 3****Summed Accumulation Counter 4**

These four pairs of registers form counters that accumulate totals of the power increments that feed the individual phases. Detailed functioning of these counters varies depending on the meter model. For instance, on a standard 3 phase meter, SA counters 1 and 2 are both incremented every time any of the phase input registers are incremented and provide a total power reading. SA Counter 2 is settable and resettable with a 2 register write to the applicable Modbus register address, if a correct supervisor password has been entered (see below for entry of passwords). SA Register 1 is never resettable. On the 3 phase meter mentioned SA registers 3 and 4 are not used.

The next four blocks of six registers contain blocks of data that represent the average readings of voltage, current, power, frequency and power factor for the preceding block of 64 ac line cycles on each input. The registers are thus updated every 1.07 seconds. The first 6 registers report Channel 1. The values for Ch4 are only significant on a DM meter.

Phase 1 Voltage

This 2 byte number reads the RMS value of the voltage on voltage input 1 in units of 0.1 volts. The accuracy of the reading is dependent on the voltage waveform and may differ significantly from the true RMS reading for wave shapes that differ significantly from sinusoidal.

Phase 1 Current

This 2 byte number reads the RMS value of the current on current input 1 in units of 0.1 amps. The accuracy of the reading is dependent on the current waveform and may differ significantly from the true RMS reading for wave shapes that differ significantly from sinusoidal.

Phase 1 Power

This pair of Modbus registers should be read as a sign digit followed by a three byte number (high byte first). For meters configured for unsigned integers, the first digit is either 0 representing positive power or -1 (0FFH) representing negative power. The next three digits read out the average true RMS power over the preceding 64 cycle interval in units of 0.1 watts.

Phase 1 Frequency

This register (2 bytes) gives the frequency of the voltage 1 input in units of 0.1 Hz. Note that each phase is metered and monitored separately and there is no assumption or requirement for each phase to be the same frequency.

Phase 1 Power Factor

For meters configured for unsigned integers, this register should be read as two separate bytes. The high byte encodes the Lead or Lag of the current waveform with respect to the voltage. A value of -1 (0FFH) indicates a LAG condition. A value of zero indicates a power factor of 1 and a value of +1 indicates a LEAD power factor. The second byte carries the power factor in units of 0.01. Meters with signed integers report power factor times 100. This value is subject to the same accuracy considerations as voltage and current.

The next three blocks of registers follow the same pattern.

Phase 2 Voltage
Phase 2 Current
Phase 2 Power
Phase 2 Frequency
Phase 2 Power Factor
Phase 3 Voltage
Phase 3 Current
Phase 3 Power
Phase 3 Frequency
Phase 3 Power Factor
Phase 4 Voltage
Phase 4 Current
Phase 4 Power
Phase 4 Frequency
Phase 4 Power Factor

The remainder of the registers are concerned with the control and registration of the meter and generally will occupy a separate piece of Modbus address space from the above block of power measurement registers. The first five sets of registers are concerned with establishing priority levels to permit or inhibit various meter control functions. There are five levels of protected access to the registers protected by four passwords.

Supervisor Password

This password defaults to “operator” unless changed during meter configuration. Unless a higher level password has been previously entered correctly, the supervisor password must be written to the appropriate series of registers (7D0 in default configuration) in a 4 register write, to raise the security level to 1. If a higher level of password has already been entered, then entering a password into the supervisor password address resets that password to the one entered. At or above security level 1, the resettable SA counters may be set by writing all zeros to them in a 2 register write.

Master Password

This works the same way as the supervisor password but raises the security level to 2. At this level, the Modbus base address registers the baud rate, parity and communications mode of the meter and the Customer Identification Array may be changed. The OEM password is required to change the master password from its default value of “password”.

OEM Password

This is a 16 bit value that is related to the serial number of the meter and is thus varies from meter to meter. The value of the password is to be obtained from EZ Meter on a need to know basis. It provides a method of changing the Master Password and the Response Delay, and enables a Hard Reset which clears the memory of the meter.

Note that the same OEM password is used in EZPlus mode to condition certain functions.

EZ Meter Password.

The EZ Meter password is used during meter configuration only. The password is tied to the assigned serial number for the meter and so is different from meter to meter, and is generated within the factory calibration system. It is one register (16 bits) long.

Protection Level

A read of this register gives a single numeric digit in the range 0 to 4 and indicates the current security level. 0 indicates no passwords successfully entered, 1 the supervisor password, 2 the master password, 3 the OEM password and 4 the EZ Meter Configuration password. A write to this register sets the priority to 0.

Serial Number/Address

These 2 registers contain four bytes. The first three are the serial number of the meter expressed per Modbus convention, high byte first. The fourth byte is the current Modbus address of the meter. The modbus address may be changed by addressing a 2 register write to this register pair. The write must be a broadcast (to Modbus address 0) with the first three bytes matching the meter serial number and the fourth byte the new modbus address byte in the range 1 to 247.

Modbus Data Register Base Address

Modbus Control Register Base Address

These two registers are provided as a means of relocating the data register address anywhere within the Modbus address space. They may be changed only in master protection level and above and *extreme care is advised*. They should be written as a two register write and the effect takes place immediately. The control register base address should always occupy a numerically higher block of address than that of the data registers. These locations are best changed by means of the configuration option to change them.

Modbus Operating Mode

The lower byte of this register contains a copy of the communications mode byte for the meter. The baud rate, parity (in Modbus only) and operating mode (Modbus or EZPlus protocol) are encoded herein and may be changed by writing the new configuration to this register in OEM protection level or above, and then executing a “Reset Meter” command.

Bit allocations are:-

bit	2 - 1	Baud Rate
0 - 0		1200
0 - 1		4800
1 - 0		9600
1 - 1		19200

bit 3 - NOT Modbus 8 bit no parity mode. Only effective when bit 5 = 0, Modbus mode

bit 4 - Modbus Registers BIG Endian

bit 5 - not Modbus mode (0 = Modbus)

- bit 6 - even parity (0 = odd parity)
- bit 7 - enable parity (0 = no parity)

Note that for EZProtocol, the parity bits and endian are ignored. It is always 8 data bits, no parity and Big Endian.

The value of 0FF corresponds to 19,200 baud using EZPlus Protocol. The default value for Modbus is 0DF (19,200 baud using 8 data bits and a 9th even parity bit).

Response Delay

The lower byte of this register controls the incremental delay (over and above the minimum inter-data delay specified in the document "MODBUS Over Serial Line Specification and Implementation Guide V1.02"), between the end of the data block received from the host and the time the meter starts to transmit its reply. The number programmed is the incremental delay in units of 12.91 msec. 0 corresponds to no incremental delay. The maximum delay is 255 x 12.91 msec = 3.3 seconds. The byte may be written only with OEM priority level and above. The change takes place immediately.

Option Bytes

This nine byte string identifies the Meter Type and its operating mode. The registers may be written only with EZ Meter protection level (config priority).

Reset Meter

The meter may be reset by writing a pair of null characters (00H, 00H) using a single register write with at least Master priority. This is used to complete changes in communications configuration (change in baud rate, parity or protocol). It does not change the power accumulation registers, but it does interrupt the metering operation for approximately 3 seconds.

If 0FFH,0FFH is written with OEM or Config priority, a hard reset is executed. This is a drastic reset that clears out all the power accumulation registers and restores the meter to its default settings (as entered during configuration).

Customer Identification Array

This is a 20 byte array of meter memory that may be written to by the customer to record the location of the meter. It is readable at any level of priority but may be written only with the use of the Master password.

Summed Accumulators by Meter Type Description

Meter types can be determined by the model number *abcde/fg*

- 4 Element Dual Meter - First two numbers (*bc*) are 42
- 3 Element dual Meter - First two numbers (*bc*) are 32
- 3 Phase Bidirectional - The second character after the slash (*g*) is an odd number
- 3 Phase Unidirectional - All others
- 3 Phase Independent - Special order and identified by serial number

Configuration Tool Program

A utility program that exercises most of the features described is available free of charge. The hex values of the byte streams sent and received are shown on the screen making it useful for anyone configuring another meter to work with EZ Meters. It is included with the EZ Meter Power suite.

EZ Meter Power Suite Quick Start Guide

Plan and Test. Reading the installation instructions before installing the meters can save a lot of time later. Similarly, setting up the software and connecting one or two meters in the shop can save a lot of time and anxiety later if you have trouble communicating with the meters after they have been installed.

Download the Program. Visit www.EZ Meter.net/cgi-bin/ezdownloader/ezdownloader.cgi to obtain a license for the program. Enter your email address, leave the password space empty and click Send. Check your email (look in the spam folder if you don't see it) and copy the password into the space on the original site. Click Send again, then fill out the rest of the form. You can change the password if you want to. The facility name you enter will be hard coded into your database and will appear on all printed reports and invoices. Click the Download button. Be sure to write down the license number as you will need that the first time you log in.

Installing the Program. Launch the downloaded program and follow the prompts on the screen. Run the EZ Meter Access program when the installer completes.

Logging in the First Time. You will be asked for your license number the first time you log in. You also need to enter the email address you used to download the software. You can use a different password also. After the first time, just your email address and password are required. There is a box to check to automatically fill in the log in info and another to recover your password by email. The computer must be connected to the internet to validate the license to use the billing and web based features.

System Set Up. It is important to set up the meter reading system in the proper order. Not doing so means that you have to revisit areas that were partially configured earlier. Click the Setup icon or Configuration | Main Setup from the menu bar. The tabs are arranged in the order the data should be entered.

Connections. Connections tell the computer how to connect to the meter. Click the New button to add a new connection and give it a descriptive name. The [EZ Meter User Manual](#) has specific info on setting up different types of serial and ethernet connections.

Units. Units can be apartments, offices, slips in a marina or spaces in an RV park. Each unit has a meter associated with it. For facilities that use the dual single phase meters, two units can be associated with one meter, either the A or B channel. Each unit needs a descriptive and unique name. Usually these have already been assigned (Apt A-4, Slip 109, etc). If a large unit has multiple meters, multiple unit names must be assigned (Slip 109-A, Slip 109-B). When lists of units are sorted, they are sorted alphabetically, not numerically so A01, A02 ... A10, A1, etc will sort as expected. Without the zero, it sorts A1, A10, A11, ... A2, A20, etc.

Modbus addresses are related to the serial number. If the serial number is an even number of 100s, the Modbus address is the last two digits of the serial number. For odd number of 100s, the Modbus address is 100 plus the last two digits. The exception is that if the Modbus address would be 0 or 1, it is 200 or 201. This rule is not always true as Modbus addresses can be reprogrammed in the field.

The Location field is not required. It is to direct service people to the meter's location. Selected units are selected for billing or for inclusion in a report. Active meters are read on schedule. The graph color is used in the web based program. Large facilities need to group units together without repeating colors in the group.

Logging/Schedule. The meters are read by a separate program that runs as a Windows service. The service gets the schedule for readings from the data entered on this screen. The system will read the meters on whatever

schedule you enter in the center of the screen. Every time you change any of the values here, you must stop and restart the server as it only reads the schedule when it starts up. Click Comm Server in the menu bar and the program will tell you whether the server is running or not.

EZServer Meter Communication Server Setup. This section controls the service that reads the meters. While the program can be run as a regular Windows program, that option is advisable only for users who want occasional readings, perhaps once a month for billing purposes. Running as a service that starts when the computer starts is the preferred method of operation.

The programs communicate between each other via TCP/IP sockets. The default port for this communication is 15571. If you cannot connect with the server's socket, the port can be changed. Both programs use the value entered here.

Users. The Users tab manages different people who use the program with either Administrator, Supervisor, Operator or Visitor privileges for the power management features of the EZ Meter Access program, the billing features and the Power Watch web application. New users get their password by leaving the password field empty the first time they log in. This also works if they forget their passwords or just want to change them.

Facility. The Facility tab shows information about the facility. The information appears on some reports. Use of the program is licensed to the facility and the facility name cannot be changed without contacting EZ Meter Technologies at 805-688-9696.

The program is often run on a dedicated computer and provision is made for the EZServer communication server to reboot the computer once a week if desired. Choose the day of the week and time of day for the reboot if desired.

Billing. There is a separate Billing Quick Start Guide. A free trial of the billing feature is included with the initial license. The trial ends 90 days after the program is first downloaded. Call EZ Meter Technologies at 805-688-9696 to renew the enhanced license. To set up billing, Rates (tariffs), Tenants, and Invoice Setup must first be run from the Billing menu. The program also supports adding a monthly rent or condominium fee to each invoice. Billing reports are accessed from the Reports menu.

Web Server. A free 90 day trial of the EZ Meter Power Watch web server is also included with in the EZ Meter Power Suite. The server allows anyone with a web browser who is connected to the same network to access the meter data. The server can also be exposed to the internet by configuring the network router to forward port 80 communication to the computer running the Power Suite. It cannot run on the same computer with another web server such as Apache or IIS.

Reports. Click the Reports icon or select Reports in the menu bar. A summary of month to date power usage will appear on the screen with a list of different reports available on the left. Date ranges and summaries can also be selected. The Save as TSV button at the bottom of the left column will create a tab separated variable file that can be opened with Microsoft Excel or similar programs.

The View/Print as PDF button on the Reports page will generate a pdf file of whatever is on the screen. PDF files are opened in the computer's default pdf viewer which can be used to view, print or rename the file. All reports are initially saved on the EZ Meter/PDFs folder in your Documents folder with the file named for the subject and date. The pdf viewer must be closed or the file must be renamed before another pdf report can be generated. On some of the reports, clicking one of the lines will open another window. This feature allows single invoices to be generated and saved as a pdf file.

EZ Meter Access Tenant Billing Quick Start Guide

This document assumes that the procedures described in the [EZ Meter Power Suite Quick Start Guide](#) have already been accomplished and that the system is reading all the installed meters reliably. What follows are step-by-step instructions for implementing the billing features which are available to subscribers of the enhanced edition of the program (paid subscribers and beta testers).

Billing System Overview. The purpose of the billing system is to prepare invoices for tenants for the power they have used. The invoices are presented to the operator in PDF format meaning they can be printed and distributed to tenants the old fashioned way or they can be sent by email. The program has no capability for tracking payments. It does have the capability to export the invoices to spreadsheets or other programs that can accept tab or comma delimited variable text files.

Initial Setup. Select *Billing* from the main menu bar in the EZ Meter Access program. The bottom four items should be completed in this order to prevent having to go back and update items you have done before: Tariffs (rates), Rents, Tenants, Invoice Setup. Actually, you can do Invoice Setup any time. Usually, it is done once and never touched again whereas the other three have items that will change from time to time.

Tariffs. A tariff tells how much money the program should charge for a kilowatt hour of electricity. It can be anything from one fixed rate that stays the same no matter what or it can change with the season or the average daily amount of power used in the billing period. It can include a fixed demand charge, a minimum daily charge or a service charge. Metered demand charges will be incorporated in future versions if enough users want those features. Another alternative is to divide a utility company bills amongst the tenants in proportion to the amount of power each tenant used.

The program supports multiple tariffs which might be used to adjust the rates to make up for transformer loss if some power is metered at a lower voltage than other. They also might be used to compensate for solar heat loads or lack of insulation in some units. Perhaps a lower rate for non-profits. Most users stick with one tariff, but multiple tariffs are possible for those who need them. If your state regulations require that you charge your tenants what they would pay if they had a power company meter, you may find yourself with multiple tariffs.

Tariffs can be seasonal or year-round. There can be any number of seasons in a tariff. Simply enter a season name and the beginning date, month and day only. The last one in the year will continue until the start of the next season in the following year. When the power company rates change (other than a seasonal change), click the *Copy Tariff to New Effective Date* button, enter the new effective date and any rate changes. The program will prorate the invoices for the period that includes the change-over date without you having to do anything else.

To get started, click the *Add New Tariff* button, then enter the *Tariff Name* which can be anything. We suggest you do not use terms like 'Summer Rate' since that would be confusing if it is a multi-seasonal tariff.

When you first start the program, the exact date for *Effective Date* is not important as long as it is before the first day of the first billing period. If you are entering a seasonal tariff, click the Add Season button, enter the *Season Name* and *Start Date* and all the other information about that tariff. Click the *Save* button which will make the tariff appear in the list of tariffs. Click the tariff name in the list, then click *Add Season* and continue as before.

Rate types can be *Single Rate*, *Multi-Level Rate* or *Time of Use*. For *Single Rate*, enter a price in the *Single Rate Price per KWH* box. For *Multi-Level*, enter the upper limit of the first price break point in the top *Daily KWH Usage up to* box and enter the price in the box to the right. Repeat on subsequent rows until all are entered. Enter the price for all power above the highest bracket on the bottom row. For *Time of Use*, click twice on one of the items in the box to edit it. Click *New* to add a new row. The first period begins when the last one ends so if *Off-Peak* starts at 9:00pm and ends at 8:00am, the first entry would be *Off-Peak - 0800* and the last one would be *Semi-Peak - 2100*. Version 0.3.0a will print a report of time of use consumption, but it has not been implemented in the invoicing routine yet.

Each tariff, except *Time of Use* tariffs, can include a demand element. There are several ways the demand can be calculated. The built-in help system has the details.

Once a tariff is complete and saved, you need to assign it to the units that will be affected. You can assign a tariff to a single unit or all units at once.

Rents. The rent charge can actually be any charge that will be the same for every billing period. Select *Billing | Invoice Setup* on the main menu to change how the description appears on the invoice. To change the amount to be charged, click twice on the amount next to one of the units and edit the amount. Be sure to *Save* before exiting.

Tenants. Click *New Tenant* to add another tenant. The *Tenant ID* field can be anything you want. We suggest the company name for companies and last name, comma, first name for individuals. The buttons in the upper left corner determine what is shown in the tenant list. Click on a tenant in the tenant list to edit that tenant's data.

To assign a unit to a tenant, click on one of the *Available Units* list, then click the left arrow < to move it to the *Rented Unit(s)* list. When you do that, another window will open for you to enter the starting meter reading for that tenant's unit. You can either use one of the readings already in the system or enter another value.

Invoice Setup. The *Heading Lines* box contains the information about your company that will be printed on the invoice. The first row is the name of the company you entered when you created the license for the software prior to downloading it. The *Available Lines* come from the *Facility* tab of the *Setup* window. Click *Edit Available Lines* if you need to change anything. Use the left arrow < button to move data to the *Heading Lines* box.

The *Meter/Demand Charge* in the *Tariff* will override the value entered in *Service charge to be added to each invoice*.

The *Rent Charge* feature is not restricted to rent. Homeowner association fees or other fixed monthly fees can be substituted. Just enter the description in the *Text for rent charge line* box.

NORMAL OPERATIONS

Manual Data Entry. This feature can be used if the automatic meter reading system is not working or installed. When the window launches, the first unit in the list will be shown in the *Add New Meter Readings* section on the right. Change the date if necessary, then enter the *Current Reading*. Click *Save* to save the reading and load the next unit. Click *Skip* to ignore that unit and go to the next unit.

Create Invoices. The first step of preparing invoices is verifying that the meter readings are current. Mark all the units that need an invoice by putting a check next to their names. Choose one of the options in the *Select One* section and click *Continue*.

Once the readings are OK and you have clicked *Continue*, the program will display all the units and the charges that will be on the invoice. You can uncheck any units that do not appear correct and create invoices for the remainder or abort to fix everything and do all at once.

Click *Continue* again to generate the invoices. The program will take you to the Reports window where you can get a variety of reports including invoices and summaries.

Reports. Click *Billing* in the top left corner of the Reports window to show the available reports.