"Electric Submetering with the ezeio"

Functions:

- Read power and energy from electric meter
- Access live readings from any web browser
- Store historic data for analysis

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About the ezeio

The ezeio is a programmable, communicating controller suitable for many applications. The ezeio is integrated with a Internet based service to facilitate easy set up, programming, monitoring, data logging and alarm functionality via secure and robust IP communications over Ethernet or GSM Cellular.

The ezeio controller has four discrete inputs for digital or analog sensors and two relay outputs. It can be expanded with digital temperature sensors or additional I/O over a MicroLAN low-speed sensor bus. The ezeio may also control ModBus slave devices through its built-in RS485 connection.

The ezeio is very suitable for data collection and supervision applications. The data from any input may be recorded and automatically sent to the cloud servers for storage and presentation. Each input can also be programmed with multiple alarm thresholds to send emails, control outputs or perform other actions via the easy to use web user interface.

Communications is very secure and is completely bidirectional. Control commands can be send directly from the user interface, from email, other web pages or systems.

Multiple ezeio controllers may be managed from a single login, and multiple users can access the controllers – even at the same time. Centralized user management also allow easy addition/removal of access rights.

Physical:	6.0 x 3.9 x 1.5 in 153 x 100 x 38 mm Approx 0.5lb (220g)
Power:	8-25VDC, <1W avg 12VDC adapter included
Environment:	32-120F / 0-50C, non condensing
Inputs:	4 inputs on screw terminal configurable for voltage, switches or current loop 0-10V, 10mV resolution 0-30mA, 32uA resolution
Outputs:	2 relay outputs on screw terminal Form C (1 pole switching) Max 2A / 50V
Expandability:	Up to 40 inputs, 40 outputs.
Network:	Standard Ethernet, TP 10/100, RJ45 DHCP address, preconfigured to communicate with cloud servers. Tri-band GSM/GPRS modem (optional) 128 bit encryption, typical <5MByte/month
Modbus:	RS485 @ 19200bps, Modbus RTU master. Compatible with wattmeters, thermostats, relay modules, VFD's.
Sensor network:	MicroLAN, up to 20 sensors, RJ12 jack Max 150ft/50m network length
Data logging:	Individual log interval per input. 5s - 4h. Automatically transferred to servers for access & backup.
Input triggers:	Up to 4 alarms per input with alarm/restore thresholds and holdoff timers. Each alarm can activate up to four actions (sending messages, controlling outputs or other local functions)
Schedules:	Up to 20 schedules each with four intervals and weekday flags.
Timers:	Up to 20 timers, hourly, daily or monthly with repeat counters.
Scripts:	C-like syntax. Support for events, floating point math, string manipulation and communication. Up to 64kB compiled code. Compiler/editor in web UI.

Objective

Electric submetering usually involves adding watt meters to an existing installation so that the energy use in different sections or functions of a complex can be measured accurately.

Reading those meters manually is labor intensive, and thus is only done with long intervals. If the meters could be read automatically, and the results pushed to the users in an email, the information from the meters would be much more valuable.

We will use the ezeio controller to read the meters and program the system to store data every 15 minutes and allow live access from standard web browsers – eliminating the need for manually reading the meters.

Background

In order to accurately measure the energy flowing through an AC circuit, one must measure both Voltage and Current simultaneously and calculate the real energy based on both amplitude and phase difference. Real watt meters do this, but be aware that some low grade “power monitors” only measure current and will not give an accurate reading. If the meter runs on battery, or is connected to high-voltage through a power adapter it's most likely not measuring real energy.

A Watt meter needs to be directly connected to the high-voltage as well as monitor the current with a current transformer that clips around each phase.

Meter types

The ezeio is directly compatible with several different watt meters from different manufacturers. There are two main types: Pulse meters and Modbus meters.

Pulse meters (a.k.a. S0 meters) gives a short pulse when a certain amount of energy has flowed through the meter. This type of meter only accurately provide information of energy. Power can be calculated by measuring the time between pulses, but may not be very accurate.

There is usually only a single pulse output even if the meter monitors multiple phases.

Modbus meters communicates with the ezeio through a data protocol (ModBus). These meters monitor each phase individually, as well as the voltage, current, phase and many other parameters. Modbus meters can also be daisy-chained so that we can monitor up to 10 wattmeters with a single controller.

ABB DELTAplus

Continental Control WattNode

Modbus meters are usually preferred since they offer so much more information and flexibility for a relatively low extra cost, so that is what we are going to use in this example. The above two meters are excellent for use with the ezeio in submetering applications.

Internal or external current monitoring

Some watt meters monitor current internally. This type of meter is good for use in smaller installations where the current is low (less than ~50A). The downside with internal meters is that you will need to run the current through the meter, so the circuit wiring needs to be cut.

External current monitoring is done with a Current Transformer (CT). These come in many sizes and shapes to fit almost any application. Small CT's can be less than an inch in diameter and accurately measure currents in the single-Amp range. Large CT's can be as big as 15 inches in diameter and fit around bus bars or very thick conductors carrying thousands of Amperes. Some CT's can be opened (called Split Core), so that they can be placed around the conductor without breaking the circuit, making the installation much easier.

200A Split Core CT

Parts required

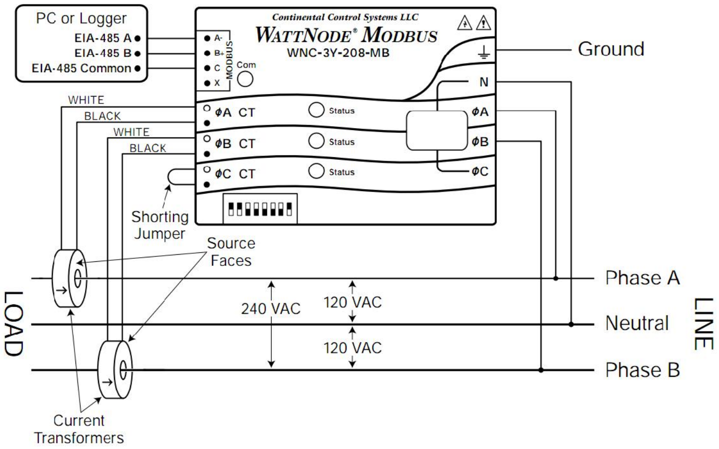
- ezeio controller
- Wattmeter
  In this example we will use a watt meter from Continental Controls
- Suitable Current Transformers
  The main fuses in this application is 150A on each phase, so we can use 200A split core CT's

Connections

High-voltage installation

We need to connect the watt meter to the line voltage and to the Current Transformers. The manual for the watt meter has excellent illustrations showing how the connections should be done in different situations. Our example installation is two-phase, which is common on residential applications in North America.

As always when working with high-voltage circuits, power should be turned off.



WattNode, 2-phase installation with neutral

Split-Core CT's installed

Note that the Neutral wire does not require a CT. For a three-phase system, three CT's are required.

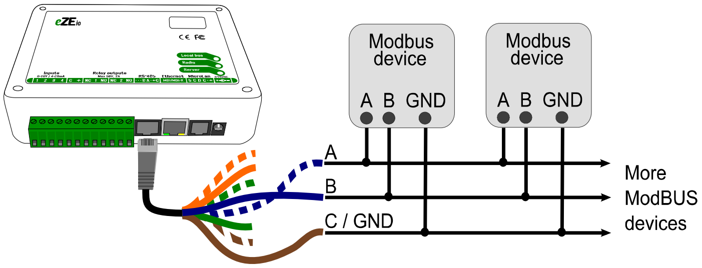
ModBus connection

ModBus requires three wires; A,B and ground. The A and B signals should be carried by a twisted pair.

Suitable type of wire is CAT5 or CAT3. With this type of wire correctly installed, the distance between the meter and the ezeio can be as much as 1000 meters (3000 feet). Standard Ethernet network patch cables (wired according to EIA 568B) are suitable. Just cut off the connector in one end if you do not have a RJ45 crimp tool available.

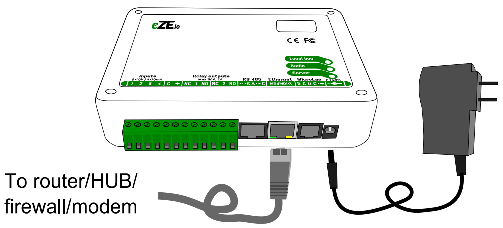
Multiple meters can be connected by daisy-chaining like shown in the diagram below:

RJ45 Pin	Modbus	EIA 568B Color
4	B	Blue
5	A	Blue/White
8	GND	Brown



Connecting ModBus devices to ezeio

ezeio installation



The final step in the physical installation is to connect power and network to the ezeio. Use the power adapter supplied with the ezeio, and also connect the ezeio to a network router or hub with Internet access.

There is nothing to configure on the ezeio controller itself. If the Internet connection is working, the SERVER light will flash once every couple of seconds. If you get more flashes it means the ezeio can't communicate properly. It usually means the cabling is bad, or that there is a proxy/firewall that do not permit traffic to pass through. Refer to the installation manual for troubleshooting.

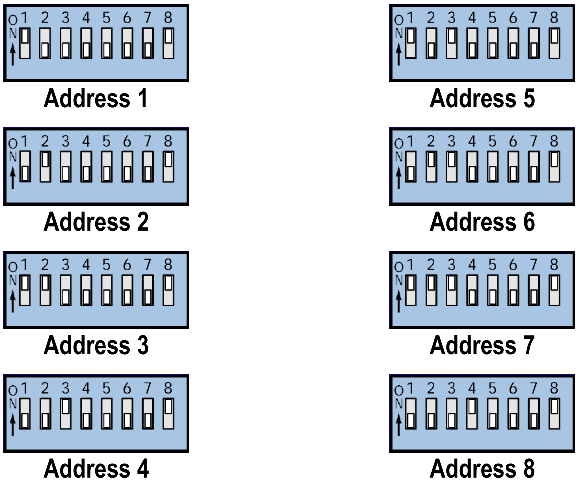
The ezeio optionally has a GSM Cell radio built-in that can be used as a backup should the Ethernet connection malfunction, or as a replacement for a physical connection. To use the GSM link you will need to insert a SIM-card inside the ezeio. Please refer to the installation manual for details.

Configuration

Setting the meter's ModBus Address

Each ModBus device must be configured with a unique address so that the master (the ezeio) can separate the information from each meter. The wattmeter in our example has eight small switches on the front that is used to set the address. Since we only have one meter here, we simply set the address to 1 (one) by setting switch 1 ON and switch 2 through 7 OFF.

Note that switch 8 should always be set to ON.



Address 1

Address 5

Address 2

Address 6

Address 3

Address 7

Address 4

Address 8

WattNode address settings, 1 through 8

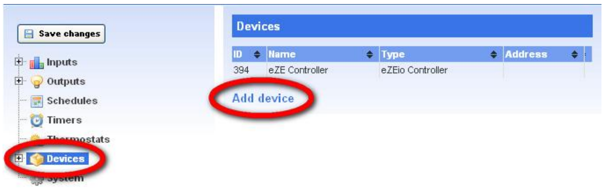
For other meters, the method of setting the ModBus addres may be different. Please refer to the manufacturer's installation manual for details.

There may be other settings in the meter depending on application. Most of these settings can be done from the ezecontrol web UI. Please contact us or the meter manufacturer if you need help with your meter.

Configuring the ezeio

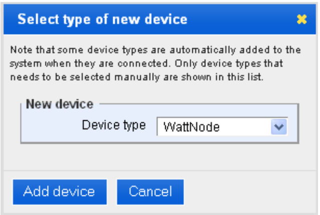
Navigate to **www.ezecontrol.com** and log in (or create a new account if you didn't already).
Click the Configure-tab. If the new ezeio is not already in the list of controllers to the left, add it by clicking Add Controller and enter the serial number and the registration code printed on the controllers label.

Click **Devices** in the object tree, then **Add Device** and select the type of meter you have.



Devices

ID	Name	Type	Address
394	eZE Controller	eZEio Controller	



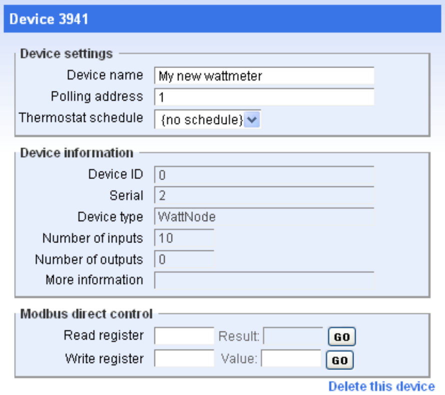
Select type of new device

Note that some device types are automatically added to the system when they are connected. Only device types that needs to be selected manually are shown in this list.

New device

Device type: WattNode

After clicking the Add Device button in the dialog box, the settings screen for your new device will show. Enter the ModBus address in the “Polling Address” box, and also give your new meter a name so you can identify it later.



Device 3941

Device settings

Device name: My new wattmeter
Polling address: 1
Thermostat schedule: {no schedule}

Device information

Device ID: 0
Serial: 2
Device type: WattNode
Number of inputs: 10
Number of outputs: 0
More information:

Modbus direct control

Read register: Result:
Write register: Value:

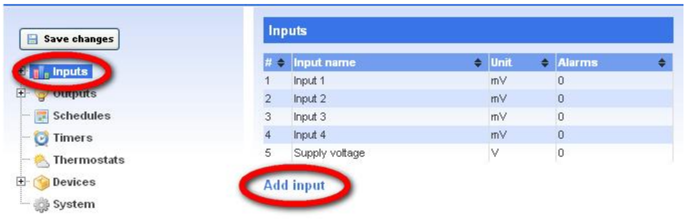
Important: Click Save changes to update your controller with the new settings.

The ezeio is now aware of the meter, and will start reading values from it.

Selecting and displaying data

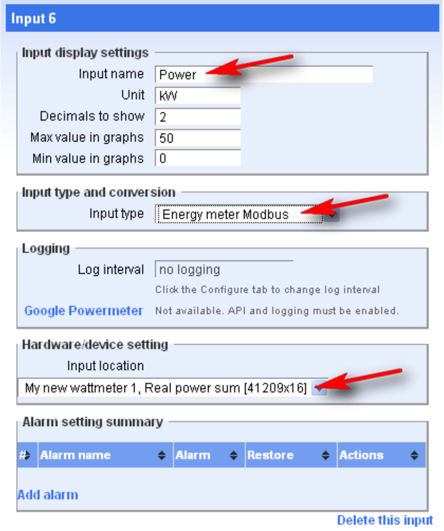
We need to configure the ezeio controller with what information we want to read from the watt meter. In this example we are interested in the total power and the total energy.

Click the **Inputs** node in the object tree, and click Add input. This brings up the input settings screen for a new input



Inputs

#	Input name	Unit	Alarms
1	Input 1	mV	0
2	Input 2	mV	0
3	Input 3	mV	0
4	Input 4	mV	0
5	Supply voltage	V	0



Input 6

Input display settings

Input name: Power
Unit: kW
Decimals to show: 2
Max value in graphs: 50
Min value in graphs: 0

Input type and conversion

Input type: Energy meter Modbus

Logging

Log interval: no logging
Click the Configure tab to change log interval
Google Powermeter: Not available. API and logging must be enabled.

Hardware/device setting

Input location
My new wattmeter 1, Real power sum [41209x16]

Alarm setting summary

#	Alarm name	Alarm	Restore	Actions

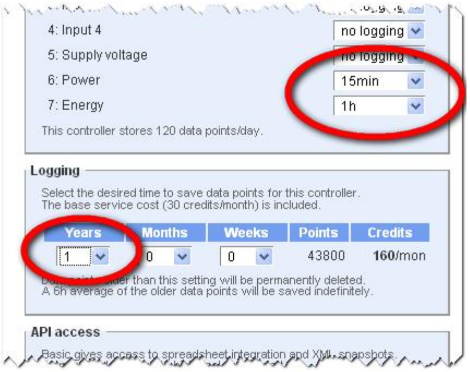
On the **Input Settings** screen, give the new input a name, and select the type **Energy meter Modbus**.
Also select where the data for this input shall come from in the Hardware/device setting box. For our first input we select the **Real Power Sum** register.

Repeat the process for a second input, but select the **Total Net Energy** register and change the unit to “kW h” instead of the default “kW”.

Don't forget to click **Save changes.**

Data storage settings

When the inputs are added configured, click on the **Configure** tab, and select the desired log interval for the two new inputs. Also select for how long the data will be stored – in our case a full year.



4: Input 4 — no logging
5: Supply voltage — no logging
6: Power — 15min
7: Energy — 1h
This controller stores 120 data points/day.

Logging

Select the desired time to save data points for this controller.
The base service cost (30 credits/month) is included.

Years	Months	Weeks	Points	Credits
1	0	0	43800	**160**/mon

Data points older than this setting will be permanently deleted.
A 6h average of the older data points will be saved indefinitely.

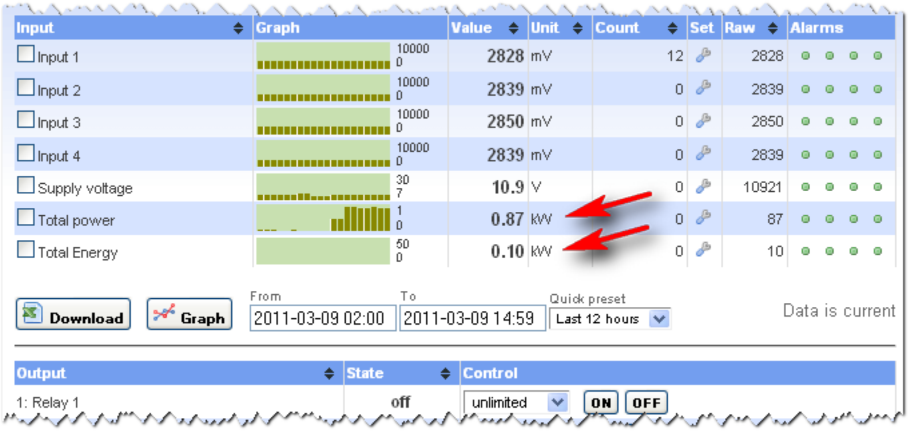
API access

Basic gives access to spreadsheet integration and XML snapshots.

Click **Save Changes** and accept the change in service.

Viewing live data

Click the Status tab to view the live status of the system. If everything was done right you should have a reading on the Power and Energy inputs now. The Energy value should (slowly) count up, while the Power should show the actual load right now. The status page updated every few seconds automatically.



Input	Graph	Value	Unit	Count	Set	Raw	Alarms
□ Input 1	10000 0	2828	mV	12	🔧	2828	● ● ● ●
□ Input 2	10000 0	2839	mV	0	🔧	2839	● ● ● ●
□ Input 3	10000 0	2850	mV	0	🔧	2850	● ● ● ●
□ Input 4	10000 0	2839	mV	0	🔧	2839	● ● ● ●
□ Supply voltage	30 7	10.9	V	0	🔧	10921	● ● ● ●
□ Total power	1 0	0.87	kW	0	🔧	87	● ● ● ●
□ Total Energy	50 0	0.10	kW	0	🔧	10	● ● ● ●

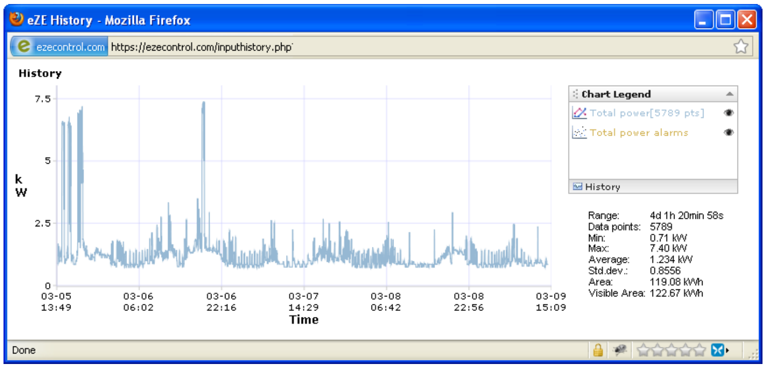
From: 2011-03-09 02:00
To: 2011-03-09 14:59
Quick preset: Last 12 hours

Data is current

Output	State	Control
1: Relay 1	off	unlimited

Viewing historic data

To view the recorded data for an input, select the input by checking the checkbox on the status page, pick the desired interval and click the Graph button. A popup window will show the data recorded in graphical form.



eZE History - Mozilla Firefox

https://ezecontrol.com/inputhistory.php

Range: 4d 1h 20min 58s
Data points: 5789
Min: 0.71 kW
Max: 7.40 kW
Average: 1.234 kW
Std.dev.: 0.8556
Area: 119.08 kWh
Visible Area: 122.67 kWh

This graph window allows zooming with the mouse scroll wheel, panning by holding the right mouse key and shows some statistics automatically.

Summary

This application note has illustrated how to install a watt meter and connect it to the ezeio. We have also gone through the basic steps to configure the system and accessing the information from the meter via the web user interface.