ELKOR

Technologies Inc.

WattsOn-MCM Installation & User Guide

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1. INTRODUCTION

1.1. Documentation

This document was last revised in December 2020 (rev. 2).

Revision History		
March 2020	Rev. 1	Initial revision
December 2020	Rev. 2	Corrected 2.6 to refer to "upper"/"lower" ports instead of "left"/"right"; added Appendix B

1.2. Disclosure

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1.3. Product Description

The WattsOn-MCM is a modular, internet-accessible metering solution for up to 60 independent circuits. It houses between one and twenty metering "nodes", which measure three independent circuits each. The device measures Volts, Amps, Real Power, Voltage Angle, Power Factor and Frequency, and Watt-Hours. These parameters can be read per-channel, or aggregated into user-defined groups.

The WattsOn-MCM may be purchased with as few or as many nodes as needed, and additional cards can be added at a later date if additional circuits are needed. Nodes are "hot-pluggable", meaning they can be added or removed without powering off the device, ensuring metering is not interrupted.

It provides a dynamic AJAX-enabled web-interface to configure the device and to display readings, and can also send its data to a web server via HTTP POST at regular intervals, using a highly configurable template-based format. The WattsOn-MCM will store a backlog of data in the event of short, temporary network outages to ensure any post information is not lost.

The unit accepts up to 600V (line-to-line) directly without needing potential transformers. It may be configured for use with 333mV output CTs or mA output CTs (such as Elkor's "safe" mA split and solid core CTs).

The WattsOn-MCM supports DHCP. A Windows® utility is used to detect and configure the network parameters from a Windows PC. In addition, the web interface allows for full device configuration.

For developers, custom web pages may be uploaded onto the device to create custom, highly integrated user interfaces.

1.4. Features

The following bullet points summarize the WattsOn-MCM's features:

- Metering for 3 to 60 independent circuits.
- Expandable after installation
- Uninterrupted metering: circuits can be added while powered
- Serial, Ethernet, or Wi-Fi communication
- Real-Time monitoring via web interface
- Highly customizable data posting via HTTP
- Communication via Modbus TCP and Modbus RTU
- Support for HTTP and HTTPS/SSL web posting
- Support for DHCP and static IP addresses
- Upgradable firmware

1.5. Visual Guide

The following image illustrates the different components and ports of the WattsOn-MCM, which are referred to in this section and throughout the document.
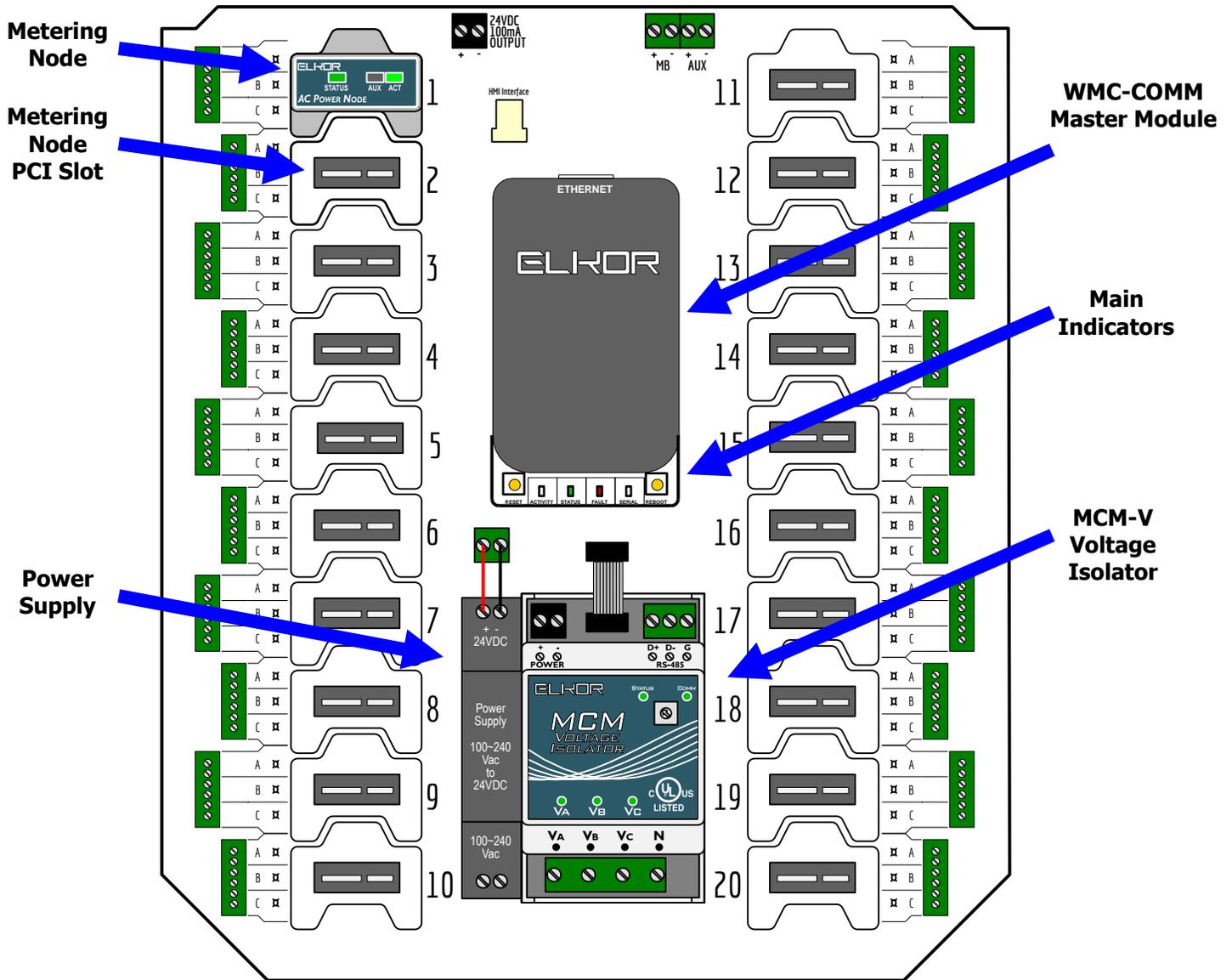
1.6. Connectors

Port	Description
N, L (Power Supply, bottom-left)	Neutral and 100-240V power supply inputs
24VDC Input (middle)	DC voltage input from Power Supply
MB (top-right)	Two-wire RS-485 serial connection for Modbus RTU communication
Aux (top-right)	Auxiliary Two-wire RS-485 serial connection for direction Modbus RTU communication with individual cards, intended for debugging and WattsOn compatibility purposes only
Ethernet (top)	RJ-45 (8P8C) 10/100mbit half/full duplex Ethernet (auto-sensing) connection
A, B, C (MCM Voltage Isolator, bottom-right)	Voltage channel inputs
N (MCM Voltage Isolator, bottom-right)	Neutral voltage input
A, B, C (left and right side)	CT channel inputs
PCI Slots 1 to 20	Metering node slot

1.7. Main Indicators

Name	Location	Color	Description
Status	Center	Green	Indicates the status of the device's network connectivity; see the following table for a detailed description of possible states.
Activity	Center	Green	Indicates communication between the master device and the individual nodes.
Fault	Center	Red	Indicates a problem. See the following table for a detailed description of possible states.
Serial	Bottom-left	Red/Green	Indicates activity over the "MB" RS-485 port. Red indicates data reception, and green indicates data transmission. Red flashes without corresponding green flashes may indicate a misconfiguration of the serial port parameters, if there are no other devices on the bus.

1.8. Node Indicators

Name	Location	Color	Description
Status	Left	Red/Green	Indicates the status of the node. Green indicates proper functioning, flashing green partial functioning (such as when a firmware update is taking place), and red indicates a problem (such as when the node is physically damaged or its firmware is corrupt).
ACT	Right	Green	Indicates communication between the master device and the individual nodes.
AUX	Center-Right	Red/Green	Indicates activity over the "AUX" RS-485 port. Red indicates data reception, and green indicates data transmission. All nodes on the bus receive all messages (flashing red), but only a single node will respond (flash green) at a time.

1.9. Voltage Isolator Indicators

Name	Location	Color	Description
Status	Center-Right	Red/Green	Indicates the status of the module. Green indicates proper functioning, flashing green partial functioning (such as when a firmware update is taking place), and red indicates a problem (such as when the node is physically damaged or its firmware is corrupt).
Comm	Right	Green	Indicates communication between the master device and the voltage isolator module.
Va, Vb, Vc	Bottom	Red/Green	Indicates a voltage on the voltage channel inputs above a minimum threshold (5% of the full-scale voltage).

1.10. Status Indicator Codes

Code	Description
STATUS (solid green)	Status solid green, with fault off indicates that the device is connected via Ethernet
STATUS STATUS (95% green, 5% off)	Status 95% green, 5% off, with fault off indicates that the device is connected via Wi-Fi.
STATUS STATUS (50% green, 50% off)	Status 50% green, 50% off, with fault off indicates that the device is in access-point mode. Connect to the device with a mobile phone or other wireless device to configure a wireless network, or plug in an Ethernet cable.
STATUS / FAULT	One periodic red flash indicates that networking is not working properly, but the device is otherwise functional. The RS-485 port may still be used in this state. Ensure that the Ethernet cable is connected, if used, and that there is a networked path from the WattsOn-MCM to the DHCP server (usually the router). If Wi-Fi is used, ensure that the wireless network is up and running and that the SSID and Password last programmed into the device are correct.
STATUS / FAULT FAULT	Two periodic red flashes indicates that the last web post has failed. This may be temporary, or indicate a configuration problem with the WattsOn-MCM or the server.
STATUS STATUS / FAULT (solid red)	Fault solid red with status flashing indicates that a fault with one or more of the installed nodes. A node may have failed, or may have been unexpectedly removed. The other non-faulted nodes continue to function normally. The Web Interface will show details about which node has faulted, if possible. The status LED on the faulted card may also be blinking green and red, or be off. Try re-seating this card in its PCI slot, or replacing it.
FAULT (solid red)	Fault solid red with status off indicates a fault that prevents the entire WattsOn-MCM from metering. The web interface is normally still functional, though metering data cannot be read in this state. This can happen when communication with the nodes has failed, or the voltage cannot be read. Ensure that the WattsOn-MCM-V is on and its status LED is green, and that the status LEDs of all of the installed cards are solid green. Try removing or re-seating any device with an off, red, or blinking green/red status LED. If all are green, try removing each card, one at a time, and waiting 15 seconds each time to see if the fault light clears; if the fault clears in this way, try re-seating or replacing that node.
▪ ▪ ▪ ▪▪ ▪▪ ▪▪ ▪ ▪ ▪ (red flashes)	Repeated red flashes in a "…---…" pattern with status off indicate that the WattsOn-MCM master device has suffered a fault is not functioning. The firmware may be corrupt, or the hardware may be damaged.

1.11. Buttons

Name	Location	Action	Description
RESET	Center-left	Hold for 10 seconds to restore factory default settings for the device.	
REBOOT	Center-right	Press to power-cycle the device.	

1.12. Default Settings

Ethernet	
IP Address	Automatically obtained via DHCP if available; Automatically configured via AutoIP if DHCP is unavailable
Subnet Mask	
Default Gateway	
Passwords	
Username	admin
Password (default)	admin
RS-485/Modbus	
Serial mode	Modbus/RTU
Baud rate	115200
Parity	None
Data bits	8
Stop bits	1

2. INSTALLATION

2.1. Overall Procedure

When working with the WattsOn-MCM device for the first time, especially if Wi-Fi is required, it is recommended to first setup and verify communication between the WattsOn-MCM and a PC or mobile device at a convenient location, before live voltages and current transformers are connected in their intended, final location.

See the visual guide in the previous section (p. 6) to locate ports and components. The following outlines the overall procedure. A section and page number following each step indicates where details can be found for each step.

1. Setup and test communication port(s) [see **2.2-2.3**, p. 10-11]
   – Three options exist: Ethernet, Wi-Fi, or RS-485 serial
   – Configuring Wi-Fi is simpler if an Ethernet cable can be used temporarily to program the Wi-Fi settings, though this is not required. If unavailable, a mobile device or PC with Wi-Fi capability can also be used.
   – Serial can be used simultaneously with Ethernet/Wi-Fi. Ethernet and Wi-Fi cannot be used simultaneously.

2. Setup communication software [see **3, The Web Interface**, p. 15 or **4, The Modbus Protocol**, p. 23]
   – Three options exist: the Web Interface or Modbus TCP (for Ethernet/Wi-Fi), or Modbus RTU (for serial).
   – For the Web Interface, any up-to-date standards-compliant browser on PC or mobile devices can be used.
   – For Modbus TCP/RTU, Elkor's free tool Modbus Commander, or software from other vendors, can be used.
   – Initial node setup can only be done using the Web Interface. Modbus is strictly read-only on the WattsOn-MCM.

3. Mount in intended location [see **2.4**, p. 13]
4. Install metering nodes into PCI slots [see **2.5**, p. 13]
   – Nodes can also be added later, even while the device is powered on.

5. Connect current transformers (CTs) to the terminal blocks corresponding to the installed nodes. [see **2.6**, p.14]
   – CT polarity is important for some node types.

6. Connect voltage inputs to the terminal blocks on the WattsOn-MCM-V, observing relevant safety practices. [see **2.7**, p. 14]
7. Connect power to the power supply N and L inputs, observing relevant safety procedures. [see **2.8**, p. 14]
8. Setup Nodes using the Web Interface [see **3.1**-**3.2**, p. 15]

2.2. Communication Setup

There are three options for communicating with the WattsOn-MCM: using the RS-485 serial port (with the Modbus RTU protocol), using the Ethernet port (with either the web interface, or the Modbus TCP protocol), or using Wi-Fi (with the same options as with the Ethernet port). Depending on which port you would like to use, following the instructions in the following sections. If desired, the RS-485 serial port can be used simultaneously with either Ethernet or Wi-Fi; however, Ethernet and Wi-Fi cannot be used at the same time.

> **Note that Wi-Fi mode will not activate if an Ethernet cable is connected to the device.**

2.2.1. RS-485 Port

Connect RS-485 wires to the D+ / D– terminal on the top-right RS-485 port, labelled "MB", of the WattsOn-MCM. Connect the other end to a Modbus master device (with D+ to D+, D– to D–), or to a PC via a USB-to-RS485 converter cable.

The RS-485 port comes factory-programmed with the indicated settings below. The baud rate, parity, and stop bit settings can be changed via the Web Interface; see **Section 0**,
The Web Interface (p. 15).

Parameter	Default Value
Device Address	Modbus Address 1
Baud rate	115200 bps
Parity	None
Data bits	8
Stop bits	1

2.2.2. Ethernet Port

Connect an Ethernet cable to the top RJ-45 (8P8C) jack. Connect the other end to your router, switch, hub, or directly to a PC. See the following section, Network Discovery, for details finding its IP address and viewing the Web Interface.

2.2.3. Wi-Fi

Note that Wi-Fi is **only available when the Ethernet port is disconnected**. To program the device with the settings for your wireless network, there are two options:
   (a) connecting to the WattsOn-MCM with an Ethernet port first, or
   (b) connecting to the WattsOn-MCM over Wi-Fi via a mobile phone or PC with Wi-Fi support.

The first method is considerably simpler, if possible at your location.

For method (a), connect an Ethernet cable to the top RJ-45 (8P8C) jack. Connect the other end to your router, switch, hub, or directly to a PC. See the following section, Network Discovery, for details finding its IP address and configuring Wi-Fi parameters.

For method (b), perform the following steps.
1. Connect a Wi-Fi enabled device, such as a mobile phone or a PC, to the wireless network created by the WattsOn-MCM. This network will have a name, or SSID, beginning with "MCM-" followed by the final four characters in its MAC address.
   – The mobile device or PC may issue a warning that the internet is not available on this network; this is normal.
2. Once connected, open a browser and direct it to the address http://192.168.1.1, which will load the device's Web Interface.
   – If you have already installed one or more metering new nodes, it may prompt you to configure the cards, which can safely be skipped temporarily by clicking "Finish Later."
   – Fore details about the device's Web Interface, see **Section 0,**
   – **The Web** Interface (p. 15).
3. Click on the "Network" menu item under the Gateway heading to open up the network settings.
   – On a small screen device, you may need to open the menu by first clicking on the menu button, ☰, in the top right.
4. Fill in the boxes labelled "Wifi SSID" and "Wifi Password" with the settings for your wireless network, and click "Submit". The device will reboot, and will attempt to connect with the given settings.
5. If the settings are incorrect, or the procedure cannot be performed with the available devices, try method (a), or clear the above settings and try again with this method by performing a Factory Reset (see **5.6, Factory Reset** (p. 30).

2.3. <u>Network Discovery and Network Settings</u>

By default, the WattsOn-MCM is configured to automatically obtain its IP address via DHCP if available, and with AutoIP otherwise. If you are the network administrator, you may be able to determine the device's IP address by consulting your router's user interface. Otherwise, you can use the Elkor Network Device Finder utility available for the Windows operating system.

2.3.1. <u>Network Discovery with the Elkor Network Device Finder</u>

The Elkor Network Device Finder is a stand-alone program that runs on Microsoft Windows operating systems to assist in discovering any WattsOn-MCM devices on the local area network when their IP addresses are not known. You can download the utility from Elkor's website, at http://www.elkor.net/bin/finder.exe.

To run the utility, simply double-click on the downloaded executable. The executable is "portable" – it does not require an installer, making it easy to take with you on a USB key or similar device if it must be used in a field location that does not have full internet access.

The utility will automatically search for any Elkor devices present on the network. If the device does not show up within a few seconds, you can have the program send subsequent broadcasts by clicking the *Find* button.
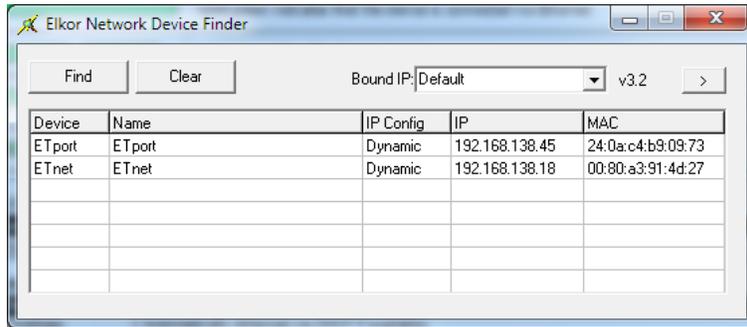
2.3.2. IP Configuration

If desired, the IP address, address assignment method can be changed, or wireless network settings can be assigned. Once you have found the WattsOn-MCM with the Elkor Network Device Finder (see the previous subsection), you can double-click on it to enter the IP address configuration dialog box.

You can choose to either use a static IP configuration (i.e. one that you provide manually), or the Dynamic Host Configuration Protocol (DHCP, a router or other device on the network automatically assigns the device an IP configuration when it starts up). By default, the WattsOn-MCM uses DHCP. If it has been configured to use a static IP configuration, you can set it back to DHCP by clicking the *DHCP* radio button and clicking *Apply*.

To enter a static IP configuration, click the *Static* radio button, and the other fields will be available for editing. You can enter an IP address, subnet mask, default gateway, primary and secondary DNS servers. If you are unsure as to how to configure IP address settings, consult your network administrator. If a static IP address is chosen, the network administrator must manually ensure that no other devices on the network are using this IP address, and that the router or other DHCP server does not include this IP address in its DHCP address pool.

The default gateway, primary and secondary DNS server IP addresses are either supplied by your internet service provider, or the same as the address of the device you use to connect to the network (i.e. your router). The secondary DNS server is optional, and may be left blank.

To configure Wi-Fi mode, enter an SSID and Password in the WiFi Settings (optional) area.

Note that Wi-Fi mode will not activate if an Ethernet cable is connected to the device.

A valid username (always "**admin**" for the WattsOn-MCM) and password (default: "**admin**") are required to apply the changes.
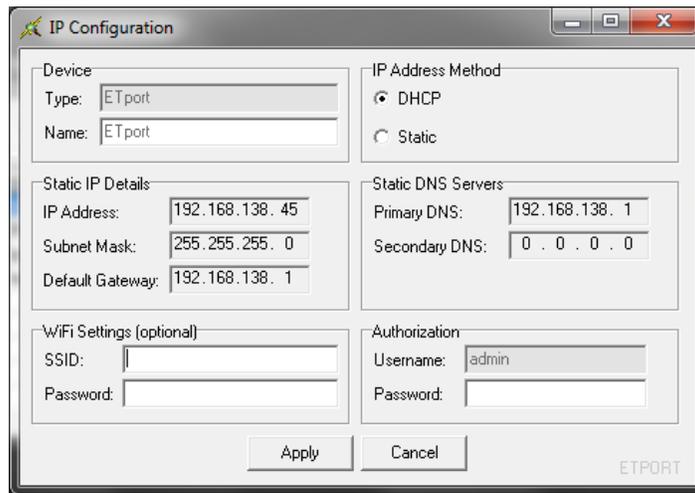
2.4. Enclosure Mounting

The WattsOn-MCM is intended to be installed indoors. While the enclosure is rated at NEMA4X, if equipped with the front panel HMI display, the enclosure is de-rated to NEMA1. Additionally, the enclosure openings must be properly sealed with rated grommets, glands or covers (not included).

The enclosure is designed for wall mounting using the attached feet. The below diagram shows the dimensions for the panel mounting feet.
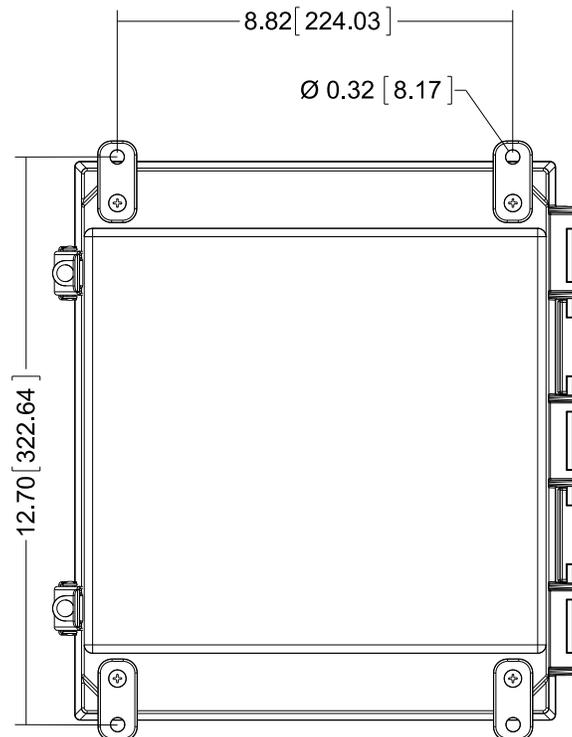
2.5. Node Installation

Each node can meter up to three independent circuits, and up to 20 can be installed in a single WattsOn-MCM, giving a total of 60 independent circuits. Each node plugs in to one of the 20 PCI slots on the WattsOn-MCM, numbered 1 through 10 on the left side, and 11 through 20 on the right side. The nodes do not need to be installed in any particular order – any node can be installed into any slot, left or right, according to convenience.

Nodes are "hot-pluggable," meaning that they can be installed or removed even while the device is powered, allowing for metering to continue un-interrupted even when the configuration is changed.

Each node corresponds to three current inputs. Each current input must be paired with a voltage input during setup. Any current channel on any node can be paired with any voltage channel.

2.6. Current Inputs

Standard wiring principles for electricity meters apply to the WattsOn-MCM, as for any other electricity meter. The polarity of interfacing transformers must be observed. The upper terminal of each current input connector is always associated with the 'X1' wire of the coresponding CT, with the lower terminal corresponding with the 'X2' wire. Please refer to **Appendix B, CT Wiring** (p. 39) for details.

All mV and mA CTs must be wired independently to the corresponding current inputs (two wires from each CT without shunts or jumpers). **mA and mV CTs must _NOT_ be grounded, or interconnected with each other (or any other components) in any way.**

A CT shorting mechanism is not required for mV and Elkor mA style CTs, since these are voltage clamped, however appropriate protection (fuse or breaker) for input line voltages is required.

2.7. Voltage Inputs

The four input terminals on the bottom of the WattsOn-MCM-V, on the bottom-right of the WattsOn-MCM, are voltage inputs, with the rightmost terminal being the neutral line. Line-to-line voltages of up to 600V may be present on these lines, so proper electrical safety procedures should be followed during installation and maintenance according to local codes.

Line voltages of up to 600V line-to-lne on the WattsOn-MCM-V terminals are isolated from the rest of the WattsOn-MCM's components, and from the output ports.

2.7.1. Fusing of Voltage Sensing Inputs

The input voltage lines should be protected as per electrical code requirements. This is also good practice to facilitate an easy disconnect means for servicing the meter. In some cases, the voltage may be tapped off of existing fuses or breakers. If this is not possible, Elkor recommends a 1A or lower fuse (fast acting) for protection of the installation wiring. The WattsOn-MCM voltage inputs are high impedance (> 1.5MΩ) and draw negligible current (less than 0.3mA max).

2.8. Power Supply

The WattsOn-MCM is powered by a 10W, 100-240VAC (input) power supply which is DIN rail mounted next to the isolator. This power supply outputs 24VDC to the motherboard, from which each component is powered. The power supply also provides 4kVAC isolation between the input (100-240VAC) and the output (24VDC). While this DIN rail power supply may be replaced with an external 24VDC source, considerations for grounding and power requirements should be observed.

The power supply inputs may be shared with the metering lines provided that the measurement voltage is within the 100-240VAC specification. If there is no voltage within the 100-240VAC range available at the installation location, contact Elkor Technologies Inc. for options.

3. THE WEB INTERFACE

3.1. Accessing the Web Interface

To access the web interface for the WattsOn-MCM, open a web browser and direct it to the device's IP address. (To discover the device's IP address for the first time, refer to **Section 2.3 Network Discovery and Network Settings,** p. 11). We recommend using Mozilla Firefox or Google Chrome to access the web interface, but other standards-compliant web browsers should work fine.
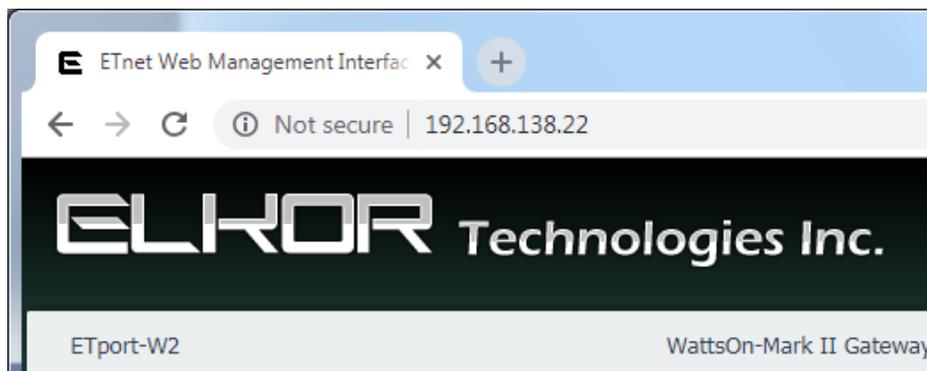
Figure 1. Accessing the Web Interface

The web interface provides a number of status indicators and configuration features.

> **Note — Default Password:** By default, the configuration pages are protected with a password. The first time you access the web interface, the default username and password will be **admin** and **admin**. This password can be changed, if desired; see **3.11, Changing the Administrator Password** (p. 19).

On large screens, the left-hand side of the web interface contains the different configuration pages available. They are divided into two sections, Connected Devices, which contains features related to the attached devices, and Gateway, which contains features that pertain to the Ethernet/Wi-Fi gateway itself. The center of the interface shows the current configuration/status page – Information, by default. On small screens, the menu opens via a button at the top-right of the screen, which is shown with this symbol: ≡

3.2. Node Setup

The first time the Web Interface is accessed, or after any new nodes are added or removed, the Configuration Wizard is displayed. If there were already some nodes installed previously, only the new or replaced nodes will be shown for configuration.

To access the wizard at any other time, or to re-configure previously-configured nodes, click on the "Card Setup Wizard" button in the menu.

Click "Next" to start configuring the cards. The web interface may issue a prompt for a username and password (the default is "admin" and "admin" on a new WattsOn-MCM).
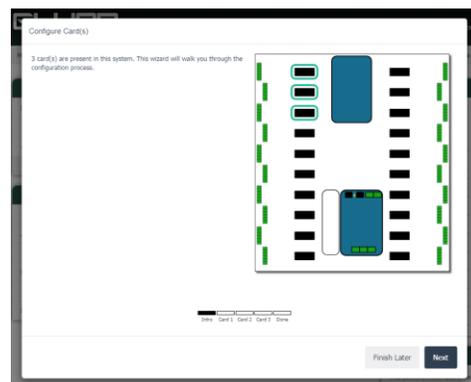
There are three steps for configuring each node:
1. Adding a name and note to each of its three channels (optional)
2. Setting the CT ratio, and depending on the CT type, its phase compensation
3. Pairing each current channel to a voltage channel

Click the "Next" button to move through each step on each node. Some or all of the nodes can be skipped with the "Skip Card" button, and it can be configured later. All remaining cards can be skipped with the "Skip to End" button. To skip

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configuration entirely, click "Finish Later," and the web interface will issue a prompt to configure the cards the next time it is visited.

After each "Next" button, the configuration is saved, so that it can be returned to at a later time. A node will continue to appear in the configuration wizard until the entire process has been completed, however previously entered values are saved.

3.2.1. Channel Names and Notes

For each channel, you can add a 16-character name and short note, for ease of identification later. This is entirely optional.

3.2.2. CT Ratios and Phase Compensation Values

For each channel, a CT ratio must be entered. Either find the CT model in the drop-down list (which will fill in the ratio automatically), or enter the ratio manually in the box. This information is generally found on the CT itself or in the CT's documentation.

Some CTs have a phase offset, which must be compensated for to provide accurate power and energy readings. Enter a phase compensation value in the final box, in degrees, with a precision of up to one hundredth of a degree.

3.2.3. Matching Current and Voltage Channels

Each current channel must be paired with a voltage channel in order to measure power and energy. Any current channel can be paired with any voltage channel — all channels on a card can use the same or different voltage channels.

To assist in preventing mistakes, the amps and volts of each current and voltage channel (respectively) are displayed, as well as the watts and power factor of the currently selected combination. Very broadly speaking, the correct combination usually has a relatively high power factor when compared to the incorrect combination, though this is just a generalization.

If a mistake was made, it can be corrected by reconfiguring the card at any time, however, previously accumulated energy measurements will not be valid. It is recommended to reset the energy accumulation in this case; an option to do so will be presented as the final step of the configuration process.

3.2.4. Resetting Energy Accumulation

At the end of the configuration process, the wizard will offer to reset the accumulated energy for each of the nodes. This is recommended so that all accumulated readings begin from exactly the same start time. However, this is not required, as energy readings are normally only used differentially.

3.3. Monitor Page

The monitor page displays many of the readings that the WattsOn-MCM collects. Hovering the mouse over a channel shows details.

3.4. User Registers Page

This page allows you to configure custom data points to display. These data points can include any reading that the WattsOn-MCM provides, or it can be a sum, average, or other mathematical combination of any of those points. For example, it may be convenient to display the total current in channels 1 through 5, or the average power consumption of channels 2, 4, and 6.

To add a new data point, or edit existing data points, click the button in the lower-right of the page to unlock the page for editing. Once unlocked, you can perform the following actions:
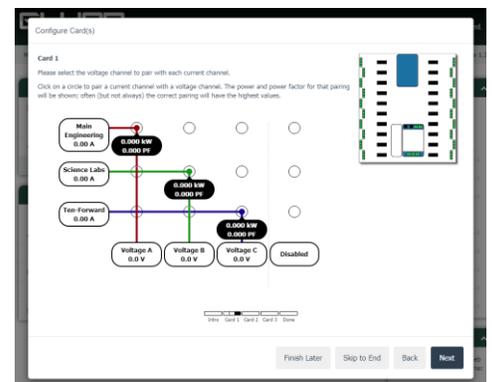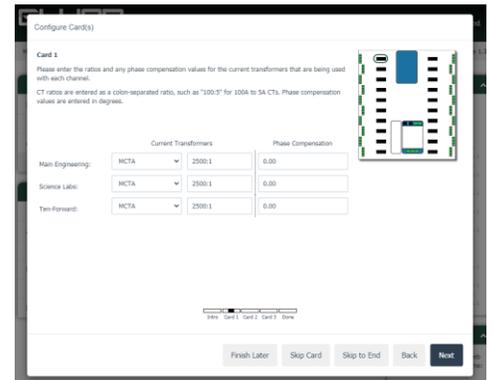
3.4.1. Adding a New Data Point

1. Click the "+" button to begin adding a new data point.
2. Give the point a name by filling in "Point Name".
3. The formula determines which data will be displayed. To add a new data point to the formula, select its data type, offset, and count from the "MB Point Generator" box at the bottom. The information for these boxes can be found in **Section 4, The Modbus Protocol** (p. 23), which contains a listing for all parameters measured by the WattsOn-MCM.

> For example, the register 0x2003 is a 16-bit register called the "Debug Registers", which always reads as 12345. To add this register, enter "unsigned short (16-bit)", "0x2003", and "1" into the "MB Point Generator" boxes and click "Add to Formula". The formula will now read "$ushort(0x2003)".

4. To add math operations, you can edit the formula to include the character "+", "-", "*", and "/" for addition, subtraction, multiplication, and division, respectively. Brackets, "(" and ")", can also be added to indicate order of operations.

> For example, to double the register we added above, the formula would be "$ushort(0x2003) * 2"

5. Multiple registers can be added using the MB Point Generator, for example, to add two or more registers together.
6. When finished, click "Apply".
7. For details on the formula language used by this device, see the separate document, **ETPORT API**.

3.4.2. Remove an Existing Point

Click the icon resembling a trash can to delete a data point.

3.4.3. Modify an Existing Point

Click on the icon resembling a gear to bring up the formula window. Follow the instructions for Adding a New Data Point from #2 to modify the data point.

3.5. Posting Status

Below the Connection Status box is the Posting Status box. If the Web Posting feature is enabled, this box shows the status of the most recent web post that has been made since the device was powered on. It will display the time of the most recent post attempt, in the local time zone of the accessing computer. It will also display whether or not the most recent post was successful or not, including (if applicable) the HTTP error code that was returned from the server. Any connection problems are shown in the top-right corner of the box.

For details on configuring the web posting feature, as well as getting a more detailed status response, see **3.14, Posting Data** (p. 20).

● **POSTING STATUS** ∧

The ETnet's most recent web post was at the following time:

1:05:21 PM (UTC-5)
2/5/2019

The result of the ETnet's most recent post was the following:

Successful
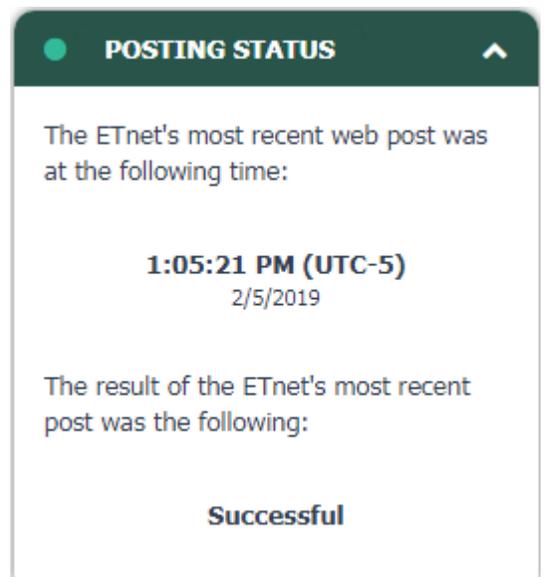
3.6. Information Page

By default, the web interface displays general information, including information about the device's firmware, and its current networking settings. The format differs slightly depending on the device model.

GATEWAY INFORMATION

Name:	WattsOn-Mark II Gateway
Device Name:	ETport-W2
Uptime:	01:38:46
Firmware Version:	0.83
Firmware Release Date:	Jan 3 2019 10:37:14
Operating System:	Platform v3.1.2e1 / Kernel V8.2.0

NETWORKING INFORMATION

Interface:	Ethernet
MAC Address:	24:0a:c4:17:cf:2b
IP Address:	192.168.138.22 (DHCP)
Subnet Mask:	255.255.255.0 (DHCP)
Default Gateway:	192.168.138.1 (DHCP)
Primary DNS:	192.168.138.1 (DHCP)
Secondary DNS:	0.0.0.0 (DHCP)

3.7. Diagnostics Page

Click "Diagnostics" to view the diagnostics page. On this page, several internal details about the device are viewable, including RAM details, and the processes that are currently running. Generally the diagnostics page does not need to be checked unless there is a problem.

3.8. Filesystem Page

Click "Filesystem" to view the filesystem page. On this page, files that are stored on the device's flash file system can be viewed, edited, or downloaded.

To view or download a file using the browser
1. Click "Filesystem" on the left-hand side of the web interface to access the filesystem configuration page.
2. In the Web File Explorer box, click on the name of the file desired.
3. Clicking on a file will either cause its contents will either be shown in the browser (if it is a text file), or the browser will ask if you wish to download the file to your computer.
4. To download a text file rather than view it, use the browser's "Save Page" function, which varies slightly depending on your browser:
    a. In recent versions of Mozilla Firefox, click on the Firefox button, and then click "Save Page As"
    b. In recent versions of Google Chrome, click on the wrench button, and then click "Save page as"
    c. In recent versions of Microsoft Internet Explorer, click on the gear button (tools), click on the File menu, and then click on "Save as"
    d. For other browsers, consult that browser's documentation for details on how to save a page.

3.8.1. To delete a file using the browser
1. Click "Filesystem" on the left-hand side of the web interface to access the filesystem configuration page.
2. In the Web File Explorer box, click on the red "X" next to the name of the desired file to delete.

3.8.2. To upload a file using the browser
1. Click "Filesystem" on the left-hand side of the web interface to access the filesystem configuration page.

2. In the Web File Explorer box, click the *Upload* button under the Operations heading.
3. Click on the *Browse* button (*Choose File* on Google Chrome) to select a file on the local computer to upload.
4. Click on the *Upload* button.
5. The file will appear in the directory tree shown above.

3.9. Network Page

The network page allows configuring how the device gets its IP address. The device supports automatic acquisition of an IP address using DHCP, as well as setting a static IP. The process for doing so is described below:

3.9.1. To set the IP address statically

1. Click "Network" on the left-hand side of the web interface to access the network configuration page.
2. Click in the *Static (Set Manually)* checkbox under the IP Configuration heading.
3. Enter the IP information. The values that are currently in use will be present in the text fields by default.
4. Click the *Submit* button to save changes. The device will reboot and then reload the web interface automatically.
   a. If the device acquires its IP address automatically using DHCP, it is possible that your router will assign a different IP address to the device after a reboot, and you will need to enter that IP Address manually in your browser to return to the web interface. For details on discovering the device's IP address, see **Section 2.3, Network Discovery and Network Settings** (p. 11)

3.9.2. To set the IP address automatically

1. Click "Network" on the left-hand side of the web interface to access the network configuration page.
2. Enter a hostname and/or domain into the corresponding text fields, if desired. (Optional)
3. Click in the *DHCP* checkbox under the IP Configuration heading.
4. Click the *Submit* button to save your changes. The device will reboot and reload the web interface automatically.
   a. If the device acquires its IP address automatically using DHCP, it is possible that your router will assign a different IP address to the device after a reboot, and you will need to enter that IP Address manually in your browser to return to the web interface. For details on discovering the device's IP address, see **Section 2.3, Network Discovery and Network Settings** (p. 11)

3.10. System Page

The system page allows you to reboot the device, restore its settings to the factory default configuration, or change the firmware that is installed.

> **Note — Not Recommended:** We do not generally recommend changing the firmware unless absolutely necessary, as a power failure during the process could corrupt the firmware, requiring a special procedure to recover the device. Use with caution.

3.11. Changing the Administrator Password

1. Click "System" on the left-hand side of the web interface to access the system configuration page.
2. Type the desired password twice, in each of the two boxes to the right of the *Admin Password* field.
3. Click the *Submit* button.

3.12. Reading Registers

To monitor real time sensor data from the meter, access the web interface, and click on *Monitor*. Data will begin to appear after a moment. In the first box, titled Reading Timestamp, a timestamp of when the data was last read is displayed. The timestamp is shown in your local time zone (as determined by your computer's system time).

The second box displays the current real-time parameters that are being measured, including instantaneous voltage, current, and power. The third box displays accumulated energy values. These values accumulate over time.

3.13. Posting Data to the Elkor Cloud

You can have your device post to the Elkor Cloud website to easily view graphs of data from any web browser anywhere in the world. A video tutorial on the Elkor Cloud is available at: https://www.youtube.com/watch?v=iW_6Wzvl1jE.

3.13.1. To configure your device to post to the Elkor Cloud

1. Click "Web Posting" on the left-hand side to access the web posting configuration page.

2. Click the *Change* button next to the *Posting* field.
3. Click the *Preconfigured Profiles* drop-down box, and select *Elkor Cloud*.
4. Check the *Enable Posting* checkbox.
5. Click the *Submit* button.
6. If you have not yet created an Elkor Cloud account, click the *create a new account* link.
7. Click the *Add this device* link to add your device to your Elkor Cloud account. The Elkor Cloud site will prompt you to login if necessary.

3.14. Posting Data to your own Web Server (Advanced Feature)

The device can periodically transmit data to a local or remote web site. This is done by sending an HTTP POST message to a given URL (website address, such as http://www.your-server.com/). This message can be interpreted by server-side scripts, such as those written in PHP, ASP, JSP, CGI, and similar technologies. Such scripts could log the information, upload it to a database, control some other device with the information, and so on.

The format of the HTTP POST is customizable using a template. By default, the device ships with a template that posts in JSON format, but by customizing the template, you could post in any other format, such as XML, CSV, or proprietary formats specific to your company or organization. Details for customizing your template are provided in **3.15, Customizing the Web Posting Format** (Advanced Feature).

While the details of server-side scripting are beyond the scope of this document, a sample script written in the PHP scripting language is provided below for reference. The script reads the data from the HTTP POST and appends that data to the end of the log file called "posts.log".

```php
<html>
<body>
<?php

    // Place the contents of the HTTP POST into a variable
    $postdata = file_get_contents("php://input");

    // Save the data to a log file
    $handle = fopen("posts.log", "a");
    fwrite($handle, $postdata);
    fclose($handle);

?>
</body>
</html>
```

3.14.1. Enabling Web Posting

To configure the web posting, you must access the web interface, and click on the *Web Posting* button on the left-hand side of the page.
1. In the Web Posting box, under the Current Posting Settings heading, click the *Change* button.
2. Check the *Enable Posting* box.
3. Choose how often the device will post its data to the server. To select, for instance, every 15 minutes, enter "15" into the text field, and select "minutes" from the drop-down box. You can enter times in minutes or hours.
4. Enter the URL (web address) of the web server to which posts should be made.

> **Note — Trailing Slashes:** If the URL you are entering does not end in a file extension (like .htm or .html), some web servers require that you end it with a trailing slash **/**. For instance, http://www.your-server.com/data**/**

5. Click the *Submit* button to save your changes.

If the device previously had web posting disabled, it will immediately make its first post after the settings are applied, and then make subsequent posts after the designated interval. You can test your configuration by clicking the *Post Now* button at the bottom of the Web Posting box.

3.14.2. Enabling HTTP Authentication

If your web server requires basic HTTP authentication, you can enable it by entering a username and password.

1. In the Web Posting box, under the HTTP Authentication heading, click the *Change* button.
2. Click the *Enable* check box.
3. Enter the username and password in the text fields
4. Click the *Submit* button to save your changes.

3.14.3. Testing the Configuration

You can test your configuration by clicking the *Post Now* button at the bottom of the Web Posting box. The Previous Post Response box will display the HTTP response, if any, of the previous posting attempt. You can use this to help debug connection or formatting problems with the post or posting template.

3.15. Customizing the Web Posting Format (Advanced Feature)

The format that the device uses to post data to the web server can be completely customized by editing a template. The template is stored on the device, and can be viewed or downloaded using the web interface. The default file is called *template.json*. For details on how to view or download a file using the web interface, see **3.8, Filesystem Page**.

3.15.1. Editing the Template

The template can be opened and edited in any simple text editor, such as *Notepad* on Microsoft Windows. The template contains both text that will be posted to the web server verbatim, and symbols which will be replaced with values read from the device when the data is posted.

Symbols are inserted into the template, which are replaced with real-time values each time the data is posted. Symbols start with a dollar sign $ to separate them from the text content of the template; if you need to use a literal $ in your template, enter it using two dollar signs $$, which will be replaced with a single $ when the data is posted.

See the separate **ETPORT API** guide for details in writing custom templates.

After you have modified the template (or created a new one) as desired, you can upload it by following the instructions in section **3.8, Filesystem Page**.

3.15.2. Template Modes

Only "global template mode" is available on this device.

3.15.3. Time Synchronization

The device does not have a battery-backed real time clock. To obtain the timestamps used in several of the web posting symbols, the device synchronizes the time over the internet. It attempts to synchronize the time when it first boots up, and will subsequently synchronize the time at least every 24 hours (by default). All time-related variables are replaced with the message "**Time Not Available**" if no time has been acquired since boot up.

The device acquires the time on a best-effort basis. Because it can not guarantee that it will be able to acquire the time from the internet due to any number of network problems, server software should not rely exclusively on its time-related variables. It is meant to be used as a cross-check against the server's local time, such as to identify buffered data (see the section below).

Changing the Default Time Servers (Advanced Feature)

The device supports two protocols for retrieving the time from the internet. It supports the Network Time Protocol (NTP). A list of public timeservers is built-in from which it will attempt to acquire the time. You can change these time servers by modifying the device's configuration file.

1. Click "System" on the left-hand side of the web interface to access the system configuration page.
2. Click the *Advanced Configuration* button.
3. Enter *ntp_server* in the *Search* field.
4. Up to three NTP servers can be entered in the *Value* column of the table, next to *ntp_server_0*, *ntp_server_1*, and *ntp_server_2*.

5. Click *Save Settings* at the top of the page to save the changes.

3.15.4. Buffering and Failure Handling

If the device cannot successfully post to the configured web server due to a connection problem, it will store failed posts in its internal memory and retry that post later on. Posts are retried at the same interval that is configured for making new posts. The device has four megabytes of internal storage available for buffered posts, with each post being approximately the size of the posting template.

Buffered posts can be viewed by exploring the /buffer directory in the Filesystem; see **3.8, Filesystem Page**.

4. THE MODBUS PROTOCOL

4.1. Protocol Overview

The WattsOn-MCM can communicate using Modbus, a communication protocol over either an RS-485 port or an Ethernet network. When using RS-485, the protocol is called Modbus RTU; over Ethernet, it is called Modbus TCP. These protocols are used by various PC applications, PLCs, data logging devices, and other Modbus "master" devices, which can can read data from the WattsOn-MCM. The WattsOn-MCM is defined as a Modbus "slave" device (sometimes called a "server" in Modbus TCP), meaning that it responds to queries sent by the Modbus "master" device (or "client" in Modbus TCP).

A Modbus slave device defines blocks of "registers" that contain information, each with a particular address. Each register contains a 16-byte field of data which can be read by the master device. The registers defined by the WattsOn-MCM are described later in this section.

> For technical details on the Modbus protocol, see **Appendix A, Modbus Protocol Details** (p. 32), or see the official Modbus Application Specification available for free from http://www.modbus.org/specs.php.

4.1.1. Modbus Functions

The MCM supports a number of different Modbus functions used to query the device or issue commands. Some Modbus software/devices require the user specify specific Modbus functions. Others are more sophisticated, and will automatically use the appropriate functions as needed, without requiring detailed knowledge of the Modbus protocol.

Supported Functions

The WattsOn-MCM supports the following Modbus functions:

Function Name	Function Code	Description
Read Holding Registers	03 (0x03)	Reads the data contained in one or more registers (identical to function 04 on this device).
Read Input Registers	04 (0x04)	Reads the data contained in one or more registers (identical to function 03 on this device).
Report Slave ID	17 (0x11)	Returns various information used to identify this device. See **Slave ID** (below).
Read Device ID	43 (0x2B)/14 (0x0E)	Reads various text strings giving device parameters. See **Device ID** (next page).

Slave ID

The MCM implements function 17, Report Slave ID, which returns three separate pieces of information. It returns an ID code identifying this particular device, a status code indicating if the device is running or not, and a null-terminated text string identifying this particular device.

Field	Data
ID Code	130
Status	0xFF (ON) when running normally, 0x00 (OFF) when in bootloader mode.
Text String	An ASCII text string containing the name of the product, its input configuration (mA, mV, or 5A), and its hardware and software version. The string is null-terminated, meaning a 0 is transmitted after the last character. For example, "Elkor Technologies W2-M1-mA Hardware 1.00 Firmware 1.00". While in bootloader mode, the string returned contains the bootloader version, for example, "Elkor Technologies Bootloader 1.00".

Device ID

The MCM implements the Read Device ID function, which provides access to various strings that identify various device properties. This is sub-function 14 (0x0E) of function 43 (0x2B), Encapsulated Interface Transport. The MCM implements this function at the highest Conformity Level of 0x83 (basic, regular, and extended identification, stream or individual access).

Each string, called an "object", is accessed with a number, called the object ID. The MCM defines the following objects, which can be read using this function.

Object	Object ID	Category	Value
VendorName	0 (0x00)	Standard (Basic)	Elkor Technologies
ProductCode	1 (0x01)	Standard (Basic)	WMC-COMM
MajorMinorRevision	2 (0x02)	Standard (Basic)	*1.00 (for example)*
VendorUrl	3 (0x03)	Standard (Regular)	http://www.elkor.net
ProductName	4 (0x04)	Standard (Regular)	WattsOn-MCM Communication Interface
ModelName	5 (0x05)	Standard (Regular)	WMC-COMM
UserApplicationName	6 (0x06)	Standard (Regular)	Elkor Firmware

4.1.2. Register Addressing Conventions

There are several different conventions for specifying the address of a particular register. Various conventions are used in different software programs, PLCs, and other devices. Three common conventions are described below.

- **Offsets:** Addresses are presented as hexadecimal numbers (shown with the "0x" prefix) with the first address starting at address 0. This is how addresses are transmitted digitally over the serial cable, and how many software packages describe Modbus addresses.

- **PLC-style addresses:** Addresses are presented as 5-digit decimal numbers, starting with a "3" or a "4" indicating whether they are considered "input registers" which are read-only, or "holding registers" which are read-write (respectively). The first input register is defined as 30001, and the first holding register is defined as 40001. For ease of integration, this device treats both Holding Registers and Input Registers as identical; therefore, either 30000-based addresses or 40000-based addresses will work with the MCM, though only 40000-based addresses can be written to. Some PLCs and other devices describe Modbus addresses in this manner.

Examples

Offset:	0x0
PLC-style:	40001
Register No:	1
Offset:	0x10
PLC-style:	40017
Register No:	17
Offset:	0x200
PLC-style:	40513
Register No:	513

- **Register numbers:** Addresses are presented as decimal numbers, with the first register defined as register 1. These are similar to the PLC-style addresses described above, without "3" or "4" prefix. Some software packages describe Modbus addresses in this manner.

The address of each register is presented in the first style in this manual. The required convention that is used depends on the Modbus master software or device.

4.1.3. Register Length

Modbus registers are defined as each containing 2 bytes (16 bits) of information. In this document, some registers are described as being, for example, 4 bytes (32 bits) wide, rather than 2. In these cases, two consecutive registers are concatenated together in order to obtain the 4-byte value. Some registers in this document are described as being as many as 64 bytes wide, meaning that 32 consecutive registers must be concatenated together.

Example: Register **0x2000** is a 32-bit register. Suppose a read of register **0x2000** returns 0x0003, and a read of register **0x2001** returns 0x0D40. Concatenate these two registers together to get a hexadecimal value of 0x00030D40, or a decimal value of 200,000.

4.1.4. Register Count

Because of the nature of this device, which can provide metering information on up to 60 channels at once, each logical parameter such as "power" or "current" may contain 60 separate registers, one for each channel, and sometimes several per channel. Rather than listing such registers individually, registers are described in blocks with a "Register Count" field, indicating how many separate values there are in a block.

For example, the register block at offset 0x5000 contains information for the current on each channel. It has a register count of 60 and a register length of 4 bytes. This means that there are 60 separate four-byte values, each representing the current for one channel.

Because each Modbus operates on 2-byte words, each value is at an offset 2 higher than the previous one. The following table illustrates the addresses of the values for several specific channels in the block beginning at offset 0x5000, each with a length of 4 bytes (2 Modbus words).

Channel	Offset
Channel 1 (Card 1, Port A)	0x5000
Channel 2 (Card 1, Port B)	0x5002
Channel 3 (Card 1, Port C)	0x5004
Channel 4 (Card 2, Port A)	0x5006
Channel 5 (Card 2, Port B)	0x5008
Channel 6 (Card 2, Port C)	0x500A
⋮	
Channel 58 (Card 20, Port A)	0x5072
Channel 59 (Card 20, Port B)	0x5074
Channel 60 (Card 20, Port C)	0x5076

To compute the offset for a particular channel, you can use the following equation:

$$\textbf{\textit{Offset}}_{\textbf{channel}} = \textbf{\textit{Offset}}_{\textbf{1}} + [(\textbf{\textit{channel}} - \textbf{1}) \times \textbf{\textit{length}} \div \textbf{2}]$$

For example, as in the above table, the offset of the 58th channel for a block beginning at offset 0x5000, with a register length of 4 bytes, is calculated as follows:

$$
\begin{aligned}
\textit{Offset}_{58} &= 5000_{hex} + [(58{-}1) \times 4 \div 2] \\
\textit{Offset}_{58} &= 20480 + 114 \\
\textit{Offset}_{58} &= 20594 \\
\textit{Offset}_{58} &= 5072_{hex}
\end{aligned}
$$

4.1.5. Data Types

Registers contain data in one of four different types. Data types are given in the register tables with a single letter code in the "Type" column to indicate the type. The types are as follows.

Type	Code	Description
Unsigned Integer	U	Positive whole numbers (no sign). Can range from 0 to 65,535 for 16-bit registers, and 0 to 4,294,967,295 for 32-bit registers.
Signed Integer	S	Positive or negative whole numbers. Represented in 2's complement format. Can range from -32,768 to +32,767 for 16-bit registers and -2,147,483,648 to +2,147,483,647 for 32-bit registers.
Floating-Point	F	Positive or negative decimal numbers. Represented in IEEE 754 format. Can represent values from negative infinity to positive infinity, at decreasing levels of resolution as the number because larger.
Boolean	B	True or false. False is represented by the value 0, true is represented by the value 1.
String	Str	A sequence of ASCII characters. Each 16-bit register contains two characters; the upper 8 bits contain the first character, and the lower 8-bits contain the second. Only characters in the range 0x20-0x7E are used. Unused characters read as 0.
Bitmap	BM	Each binary digit (bit) or group of digits represents something described in the register's description.

4.2. Basic Information Registers

The following registers provide basic information about the overall WattsOn-MCM system.

Offset	Register Count	Register Length (bytes)	Type	Name	Description
0x2000	1	4	U	Serial Number	
0x2002	1	2	U	Firmware Version	Divide by 100 to get the proper decimal number.
0x2003	1	2	U	Debug Register	12345
0x2004	1	4	U	32-bit Debug Register	1234567
0x2006	1	4	F	Floating-Point Debug Register	12345.67
0x2008	1	2	U	Network Interface	Ethernet (0), Wi-Fi Client (1), or Wi-Fi Gateway (2)
0x2009	1	2	U	Network Ready	1 when connected to a network and ready for communication
0x200A	1	4	U	IP Address	The actual current network settings (i.e., from DHCP, Auto-IP, or the address that was set statically)
0x200C	1	4	U	Netmask	
0x200E	1	4	U	Default Gateway	
0x2010	1	4	U	DNS Server 1	
0x2012	1	4	U	DNS Server 2	
0x2014	1	32	Str	SSID	
0x2024	1	6	U	Ethernet MAC	
0x2027	1	6	U	WiFi MAC	
0x202A	1	8	U	Time	UNIX time, in seconds since 1/1/1970 GMT
0x202E	1	4	U	Uptime	Seconds since last boot
0x2030	1	2	U	Maximum Number of Cards	Always 20
0x2031	1	2	U	Maximum Number of Modules	Always 21 (20 cards plus the WattsOn-MCM-V)
0x2032	1	2	U	Number of Nodes	The current number of nodes (cards) installed
0x2033	1	2	U	Number of Modules	The current number of nodes (cards) installed, plus 1 for each of the Voltage Isolator and Display
0x2034	1	4	BM	Cards/Modules Present Bitmask	A 32-bit mask where the ith bit is set when the Card/Module at address i is present, and 0 otherwise
0x2036	1	4	BM	Fault Bitmask	A 32-bit mask, where each bit indicates a fault type (defined elsewhere)
0x2038	1	4	BM	Card Fault Bitmask	A 32-bit mask where the ith bit is set when the Card/Module at address i is reporting a hardware fault condition, and 0 otherwise
0x203A	1	4	BM	Voltage Fault Bitmask	A 32-bit mask where the ith bit is set when the Card/Module at address i is indicating a voltage that deviates from the majority by a significant amount
0x203C	1	4	BM	Card Missing Bitmask	A 32-bit mask where the ith bit is set when the Card/Module at address i is *unexpectedly* missing (i.e., it was previously configured, but is now not present)

4.3. Universal Card Parameters

The following registers provide basic information about each node/module installed. Most parameters contain 21 entries, with each entry corresponding to an installed node (entries 1 through 20) or module (entry 21 corresponds to the WattsOn-MCM-V). Most entries contain only 1 register, but some contain more than one. If a node is not installed, it will return 0 (for signed and unsigned integers), the null character (for strings), or QNaN (for floating-point values).

For example, to read the Card Serial Number of the node installed in slot 5, read registers 0x47C8 – 0x47C9, which is: Offset + ½RegisterLength * (NodeSlot − 1)), or 0x47C0 + (2 * (5 − 1)) in this case. Because it is a 2-byte register, both 0x47C8 and 0x47C9 must be read (0x47C8 is the most significant word).

Starting Offset	Register Count	Length (bytes)	Type	Description
0x4000	21	64	Str	Card Friendly Names
0x4400	21	16	Str	Card Class Names
0x4500	21	32	Str	Card Part Numbers
0x4700	21	26	U	Card Supported Parameter IDs
0x47A0	21	2	U	Card Types
0x47C0	21	4	U	Card Serial Numbers
0x4800	21	2	U	Card Hardware Versions
0x4820	21	2	U	Card Firmware Versions
0x4900	126	16	Str	Channel Strings. See the following table.

The final register block in the above table, Channel Strings, is broken down as follows:

Starting Offset	Length (bytes)	Type	Description
0x4900	16	Str	Card 1, Channel 1 Name
0x4908	16	Str	Card 1, Channel 1 Note
0x4910	16	Str	Card 1, Channel 2 Name
0x4918	16	Str	Card 1, Channel 2 Note
0x4920	16	Str	Card 1, Channel 3 Name
0x4928	16	Str	Card 1, Channel 3 Note
0x4930	16	Str	Card 2, Channel 1 Name
0x4938	16	Str	Card 2, Channel 1 Note
⋮			
0x4CB0	16	Str	Card 20, Channel 3 Name
0x4CB8	16	Str	Card 20, Channel 3 Note

4.4. Node Electrical Parameters

The following registers provide basic information about each node/module installed. Each parameter contains 60 entries, with each entry corresponding to a current input channel. If a node is not installed, or the parameter is not supported by the installed node type, it will return 0 (for signed and unsigned integers), the null character (for strings), or QNaN (for floating-point values).

For example, to read the Active Power of channel 5 (the second channel on the node in slot 2), read registers 0x5108 – 0x5109, which is Offset + (½RegisterLength * (ChannelNumber – 1)), or in this case, 0x5100 + (3 * (5 – 1)). Because it is a 2-byte register, both 0x5108 and 0x5109 must be read (0x5108 is the most significant word).

Starting Offset	Register Count	Length (bytes)	Type	Description
0x5000	60	4	F	Current (A)
0x5100	60	4	F	Active Power (kW)
0x5200	60	4	F	Power Factor
0x5300	60	4	F	Energy (kWh)
0x5600	60	2+2	U	Primary+Secondary CT Ratios. Each entry contains two values; a ratio primary and a ratio secondary
0x5700	60	2	U	Phase Compensation

4.5. Voltage Parameters

The following registers provide voltage and frequency information.

Starting Offset	Register Count	Length (bytes)	Type	Description
0x60F0	1	4	F	Voltage A
0x60F2	1	4	F	Voltage B
0x60F4	1	4	F	Voltage C
0x60F6	1	4	F	Voltage AB
0x60F8	1	4	F	Voltage BC
0x60FA	1	4	F	Voltage CA
0x61A8	1	4	F	Frequency
0x6278	1	2	U	PT Ratio A Primary
0x6279	1	2	U	PT Ratio A Secondary
0x627A	1	2	U	PT Ratio B Primary
0x627B	1	2	U	PT Ratio B Secondary
0x627C	1	2	U	PT Ratio C Primary
0x627D	1	2	U	PT Ratio C Secondary
0x6378	1	4	F	Voltage Angle AB
0x637A	1	4	F	Voltage Angle BC
0x637C	1	4	F	Voltage Angle CA

5. UPGRADES AND OTHER PROCEDURES

5.1. <u>Adding a New Node</u>

1. Plug in the new node into a free PCI slot.
    a. Note that power does not need to be disconnected first, nor does the device need to be rebooted.
2. Visit the device's Web Interface.
3. The Web Interface should issue a prompt to configure the new node. If it does not, click on the "Card Configuration Wizard" button.
4. Configure the new node as described in **3.2, Node Setup** (p. 15)

5.2. <u>Replacing a Node</u>

1. Remove the desired node from a PCI slot.
    a. Note that power does not need to be disconnected first, nor does the device need to be rebooted.
    b. If the node has previous been configured, as described in **3.2, Node Setup** (p. 15), the red fault light will turn on, indicating that a card is unexpectedly missing.
2. Plug in the new node into the same PCI slot as the old node was removed from.
    a. Note that power does not need to be disconnected first, nor does the device need to be rebooted.
3. Visit the device's Web Interface.
4. The Web Interface should issue a prompt to configure the new node. If it does not, click on the "Card Configuration Wizard" button.
5. Configure the new node as described in **3.2, Node Setup** (p. 15).
    a. Because the card was replaced, the Web Interface fills out the Wizard with the same values used with the previous card, however, they can still be changed if necessary.
    b. The red fault light will turn off when the new card is configured.

5.3. <u>Reconfiguring a Node</u>

1. Visit the device's Web Interface.
2. Click on the "Card Configuration Wizard" button.
3. Configure the new node as described in **3.2, Node Setup** (p. 15).
    a. You can safely skip any nodes that do not need to be reconfigured using the "Skip Card" button.

5.4. <u>Removing a Previously Configured Node</u>

1. Remove the desired node from a PCI slot.
    a. Note that power does not need to be disconnected first, nor does the device need to be rebooted.
    b. The red fault light will turn on, indicating that a card is unexpectedly missing.
2. Visit the device's Web Interface.
3. A warning will be issued at the top of the Web Interface indicating that a card is unexpectedly missing. Click the "Dismiss" button to clear the message
    a. The red fault light will turn off.

5.5. <u>Moving a Node to a New Slot</u>

Follow the procedure for Removing a Previously Configured Node, followed by the procedure for Adding a New Node.

5.6. <u>Factory Reset</u>

1. Hold down the Reset button for 10 seconds.
    a. While the Reset button is depressed, the red fault light will turn on.
    b. After 10 seconds have elapsed, the red fault light will begin to blink.
2. Release the button

5.7. <u>Changing the Firmware</u>

The WattsOn-MCM master device, each node, and the WattsOn-MCM-V all have upgradable firmware.

5.7.1. Changing the Firmware of the WattsOn-MCM Master Device

The firmware of the master device can be upgraded without interrupting the metering. Although data from the nodes will not be viewable while the upgrade procedure is taking place, energy will continue to accumulate uninterrupted.

1. Visit the device's Web Interface
2. Click on "System", the last option in the menu.
   a. A prompt may be issued for a username and password. The default username/password is "admin" and "admin" for a new WattsOn-MCM device.
3. Next to "Change Firmware", choose a firmware file and upload it.
   a. The exact appearance of this field may vary depending on your Browser (for example, on Google Chrome, a "Choose File" button followed by an "Upload" button will be shown).
   b. The filename must begin with the text "etport". This is to deter an incorrect file being chosen by accident.
4. The device will apply the new firmware and reboot. This may take several minutes.

5.7.2. Changing the Firmware of a Node or the WattsOn-MCM-V

For this procedure, to free Elkor tool Modbus Commander must be used. It can be downloaded from Elkor's web site, http://elkor.net/bin/mbcmdr_lite.exe. Note that energy accumulation will be paused on any node being updated while this process completes. Cards that are not being updated will continue to accumulate energy uninterrupted.

1. Open Modbus Commander.
2. Go to Setup, Ethernet Settings, and enter the device's IP address, and click OK.
3. Click on Setup, Ethernet to switch to Ethernet mode, if necessary.
4. Click on Devices, Elkor WattsOn-MCM, Card Firmware Update.
5. Click "Browse…" and select the firmware file.
6. Check/Uncheck the boxes next to each device that you want to update/ignore, respectively.
   a. Device 21 is the WattsOn-MCM-V. The same firmware file contains firmware for both the nodes and the WattsOn-MCM-V, so they can be updated simultaneously.
7. Click "Start Update". The procedure will take some time to complete.

6. APPENDIX A, MODBUS PROTOCOL DETAILS

Modbus RTU is a protocol used to read and write information from a variety of devices such as the WattsOn-MCM. Generally, the details of the protocol are handled by the Modbus master software or device, so that the user need not be familiar with their implementation. For full details regarding the Modbus protocol, see the official Modbus specification available for free from http://www.modbus.org/specs.php. This section summaries the Modbus RTU protocol as it pertains to the WattsOn-MCM device.

6.1. Modbus Frames on RS-485 Networks

Modbus messages are represented as frames of no more than 256 bytes each. The start of a frame is defined as no transmissions for at least 3.5 character periods, followed by the Modbus address (a one-byte number between 1 and 247) and the Modbus function code (a one-byte number). The contents of the frame vary between different function codes. At the end of the frame, comes a 2-byte checksum value used to verify that the frame was not corrupted during reception. Fields of 2 bytes or more, including the checksum, are transmitted with the most-significant byte first (big-endian order).

The Modbus master device sends "request" messages to a slave device, which responds with a "response" message. Both request and response messages share the same basic format:

Start	Modbus Address	Function Code	Frame Contents	CRC
3.5 character times	(1 byte)	(1 byte)	(up to 252 bytes)	(2 bytes)

Start: No transmission for 3.5 character times. This is about 3.65 milliseconds with default serial settings.

> **Example:** At a baud rate of 9600 bits per second, with one stop bit, one character requires 10 bits to transmit (one start bit, eight data bits, and one stop bit). Each bit takes 1/9600 seconds to transmit. Transmitting 3.5 characters of 10 bits each, therefore, takes 35/9600 seconds, or about 3.65 milliseconds.

Modbus Address: This should match the address indicated on the hardware address switch, or match the software-configured value if the switch is set to "F".
Function Code: Available function codes are described in subsequent sections.
Frame Contents: Varies with the function code, as described in subsequent sections.
CRC: Modbus 16-bit cyclic redundancy checksum. This value is described in the following section.

6.2. Modbus Frames on Ethernet/Wi-Fi Networks

Modbus TCP works similarly to Modbus RTU, but without the 2 byte CRC (as TCP already contains an error correction mechanism), and with an additional 6 byte header. This Modbus TCP frame is sent as the payload of a TCP packet.

Transaction ID	Protocol ID	Length	Modbus Address	Function Code	Frame Contents
(2 bytes)	(2 bytes)	(2 bytes)	(1 byte)	(1 byte)	(up to 252 bytes)

The transaction ID may be any number; the Transaction ID of the request will be repeated in the response. The Protocol ID must be 0. The length is the number of bytes that follow in this frame, to a maximum of 254 (despite being a 2-byte field, the upper byte is not used). These header fields are transmitted in big-endian format.

The following pages show frames assuming that Modbus RTU is used; for Modbus TCP, omit the final CRC, and add the above three header fields.

6.3. Cyclic Redundancy Checksum

Each Modbus RTU frame (but not Modbus TCP frames) ends in a cyclic redundancy checksum. This is computed from the other bytes in the message when transmitting the message. When the message is received, the checksum is computed again, and checked against the checksum found in the message. If the results differ, the message was corrupted during transmission. Below is a simple algorithm for calculating the CRC value, shown in pseudo-code. The variable $d[i]$ is defined as the ith byte of the message, and the variable *size* denotes the number of bytes in the message. The result of

each bit of a *XOR* (exclusive or) operation is 0 if the corresponding bits of each input are the same, or 1 if the corresponding bits of each input are different.

```
crc ← 0xFFFF

loop i from 0 to size - 1
   crc ← crc XOR d[i]

   loop j from 0 to 7
      lsb ← crc AND 0x0001
      crc ← crc LEFT-SHIFT 1

      if lsb = 1 then
         crc ← crc XOR 0xA001
```

6.4. Read Holding Registers

This is the basic command used to read information from the device. The structure of its frames is as follows.

Request:

Modbus Address	Function Code	Starting Address	Register Count	CRC
1-63	3	0-65535	1-125	(CRC)
(1 byte)	(1 byte)	(2 bytes)	(2 bytes)	(2 bytes)

Response:

Modbus Address	Function Code	Byte Count	First Value			CRC
1-63	3	2-250	Hi-byte	Lo-byte	…	(CRC)
(1 byte)	(1 byte)	(1 byte)	(2 bytes)			(2 bytes)

6.5. Read Input Registers

On this device, this command is identical to Read Holding Registers, above, but uses function code 4 instead of 3.

6.6. Write Single Register

This is the basic command used to write data to a single configuration register. The structure of its frames is as follows:

Request:

Modbus Address	Function Code	Address	Value		CRC
1-63	6	0-65535	Hi-byte	Lo-byte	(CRC)
(1 byte)	(1 byte)	(2 bytes)	(2 bytes)		(2 bytes)

Response (identical to the response):

Modbus Address	Function Code	Address	Value		CRC
1-63	6	0-65535	Hi-byte	Lo-byte	(CRC)
(1 byte)	(1 byte)	(2 bytes)	(2 bytes)		(2 bytes)

6.7. Write Multiple Registers

This command writes data to multiple configuration registers. The structure of its frames is as follows:

Request:

Modbus Address	Function Code	Starting Address	Register Count	Byte Count	First Value			CRC
1-63	16	0-65535	1-123	2-246	Hi-byte	Lo-byte	…	(CRC)
(1 byte)	(1 byte)	(2 bytes)	(2 bytes)	(1 byte)	(2 bytes)			(2 bytes)

Response:

Modbus Address	Function Code	Starting Address	Register Count	CRC
1-63	16	0-65535	1-123	(CRC)
(1 byte)	(1 byte)	(2 bytes)	(2 bytes)	(2 bytes)

6.8. <u>Mask Write Register</u>

This command is used to modify bits in an individual register, based on an AND mask and an OR mask. The register is written to based on the result of the following expression:

$$Result = (Current\ Contents\ AND\ AndMask)\ OR\ (OrMask\ AND\ (NOT\ AndMask))$$

Example 1: To clear the 1st bit of a register to 0, use an AND mask of 0xFFFE and an OR mask of 0x0000.
Example 2: To set the 1st bit of a register to 1, use an AND mask of 0xFFFE and an OR mask of 0x0001.
Example 3: To AND the value of a register with 0x5555, use an AND mask of 0x5555 and an OR mask of 0.

The structure of its frames is as follows:

Request:

Modbus Address	Function Code	Address	And Mask		Or Mask		CRC
1-63	22	0-65535	Hi-byte	Lo-byte	Hi-byte	Lo-byte	(CRC)
(1 byte)	(1 byte)	(2 bytes)	(2 bytes)		(2 bytes)		(2 bytes)

Response (identical to the request):

Modbus Address	Function Code	Address	And Mask		Or Mask		CRC
1-63	22	0-65535	Hi-byte	Lo-byte	Hi-byte	Lo-byte	(CRC)
(1 byte)	(1 byte)	(2 bytes)	(2 bytes)		(2 bytes)		(2 bytes)

6.9. <u>Read/Write Multiple Registers</u>

This function performs reads and writes in a single command. The writes occur before the reads. The structure of its frames is as follows:

Request:

Modbus Address	Function Code	Read Starting Address	Read Count	Write Starting Address	Write Count	Write Byte Count	First Value		…	CRC
1-63	23	0-65535	1-125	0-65535	1-121	2-246	Hi-byte	Lo-byte		(CRC)
(1 byte)	(1 byte)	(2 bytes)	(2 bytes)	(2 bytes)	(2 bytes)	(1 byte)	(2 bytes)			(2 bytes)

Response:

Modbus Address	Function Code	Byte Count	First Value		…	CRC
1-63	23	2-250	Hi-byte	Lo-byte		(CRC)
(1 byte)	(1 byte)	(1 byte)	(2 bytes)			(2 bytes)

Note: The response format for Read/Write Multiple Registers is identical to that of Read Holding Registers, aside from the function code.

6.10. <u>Diagnostic Functions</u>

This function contains a series of sub-functions used to perform diagnostic operations on the device and the communication line. The sub-functions are described below.

6.10.1. Echo Query Data

This function simply returns the data sent to it, for testing purposes.

Request:

Modbus Address	Function Code	Sub-function Code	Data	CRC
1-63	8	0	Any value	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

Response (identical to the request):

Modbus Address	Function Code	Sub-function Code	Data	CRC
1-63	8	0	The sent value	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

6.10.2. Clear Counters

This function clears the device's count of all messages, slave messages, communication errors, and exceptions since power-up.

Request:

Modbus Address	Function Code	Sub-function Code	Data (always 0)	CRC
1-63	8	10	0	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

Response (identical to the request):

Modbus Address	Function Code	Sub-function Code	Data (always 0)	CRC
1-63	8	10	0	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

6.10.3. Return Bus Message Count

This function returns a count of all Modbus message this device has seen on the bus since power-up, regardless of whether they were addressed to this device or another device on the line.

Request:

Modbus Address	Function Code	Sub-function Code	Data (always 0)	CRC
1-63	8	11	0	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

Response:

Modbus Address	Function Code	Sub-function Code	Data	CRC
1-63	8	11	Counter value	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

6.10.4. Return Slave Message Count

This function returns a count of all Modbus messages addressed to this device that it has received since power-up.

Request:

Modbus Address	Function Code	Sub-function Code	Data (always 0)	CRC
1-63	8	14	0	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

Response:

Modbus Address	Function Code	Sub-function Code	Data	CRC
1-63	8	14	Counter value	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

6.10.5. Return Communication Error Count

This function returns a count of all Modbus messages that failed the CRC check upon reception.

Request:

Modbus Address	Function Code	Sub-function Code	Data (always 0)	CRC
1-63	8	12	0	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

Response:

Modbus Address	Function Code	Sub-function Code	Data	CRC
1-63	8	12	Counter value	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

6.10.6. Return Exception Count

This function returns a count of all Modbus messages that this device responded with an exception response.

Modbus Address	Function Code	Sub-function Code	Data (always 0)	CRC
1-63	8	13	0	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

Response:

Modbus Address	Function Code	Sub-function Code	Data	CRC
1-63	8	13	Counter value	(CRC)
(1 byte)	(1 byte)	(1 bytes)	(2 bytes)	(2 bytes)

6.11. Get Comm Event Counter

This function returns a count of all Modbus messages that were successfully completed without error or exception. The structure of its frames is as follows:

Request:

Modbus Address	Function Code	CRC
1-63	11	(CRC)
(1 byte)	(1 byte)	(2 bytes)

Response:

Modbus Address	Function Code	Status (always 0)	Event Count	CRC
1-63	8	0	Counter value	(CRC)
(1 byte)	(1 byte)	(2 bytes)	(2 bytes)	(2 bytes)

6.12. Report Slave ID

This function returns an ID number, a status code, and a text string identifying the device. The status code is 0x00 when the device is in bootloader mode, and 0xFF otherwise. The text string is an ASCII text string containing the name of the product, its input configuration (mA, mV, or 5A), and its hardware and software version. The string is null-terminated, meaning a 0 is transmitted after the last character.

Example String: "Elkor Technologies W2-M1-mA Hardware 1.00 Firmware 1.00".

While in bootloader mode, the string returned contains the bootloader version, for example, "Elkor Technologies Bootloader 1.00".

The structure of its frames is as follows:

Request:

Modbus Address	Function Code	CRC
1-63	17	(CRC)
(1 byte)	(1 byte)	(2 bytes)

Response:

Modbus Address	Function Code	Byte Count	Slave ID	Status	String identifier	CRC
1-63	17	3-249	130	0x00 or 0xFF	A null-terminated string identifying the device.	(CRC)
(1 byte)	(1 byte)	(1 byte)	(1 byte)	(1 byte)	(Up to 250 bytes)	(2 bytes)

7. APPENDIX B, CT WIRING

7.1. Single Phase Installation

7.2. Two / Split Phase Installation
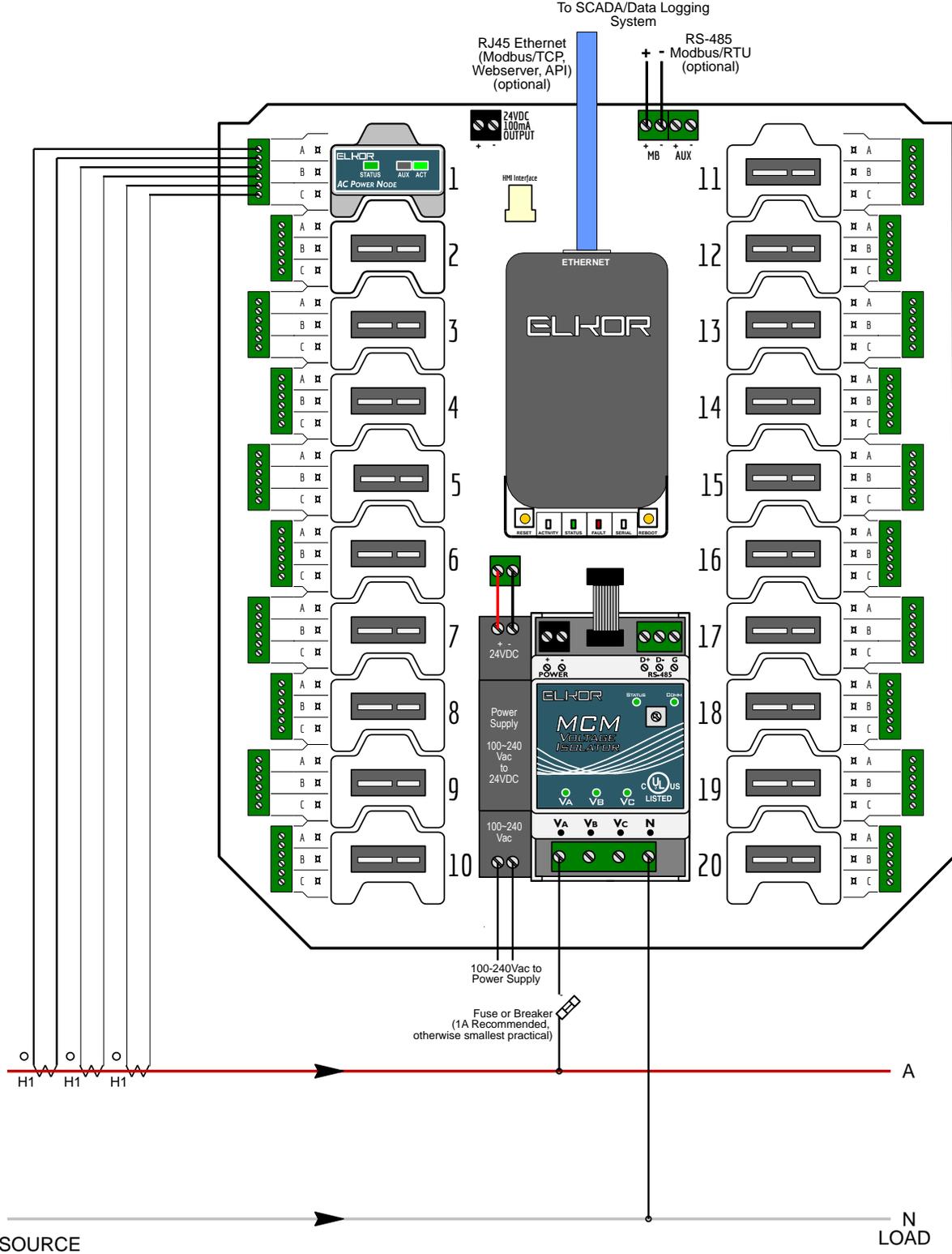
7.3. Three Phase Installation

Location of CT depends on circuit being measured Note of circuit phase must be maintained.

Fuses or Breaker(s) (1A Recommended, otherwise smallest practical)

100-240Vac to Power Supply

SOURCE

LOAD