Bulletin 1404 Powermonitor 3000

Allen-Bradley

Catalog Numbers 1404-M4, 1404-M5, 1404-M6, 1404-M8

User Manual

Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
SHOCK HAZARD	Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
BURN HAZARD	Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

Introduction

This release of this document contains new and updated information. To find new and updated information, look for change bars, as shown next to this paragraph.

Updated Information

The document contains these changes

Topic	Page
Added information about single-instance parameters	19
Single instance parameter for DeviceNet	77
Added Single Element Writes to the primary methods to communicate with a power monitor	80
Added information for writing single element data to a data table	86
Added information about floating-point word order	100
Added information for configuring protocol selections	103
Changed the placeholder from instance 99 to instance 255	110
Added information about changing the configuration of Instance 1 in the user configured table	122
Added information about setpoint output action logic	128
Added an example of sag alarm for setpoint operation	133
Changed element 3 range in the Discrete Data table to 0…7	193
Updated the Native Communication Configuration table, it has nine elements and the range for element 3 is 0…6	198
Updated the optional communication configuration table for Ethernet, adding protocol selection as element 13	199
Updated the optional communication configuration table for DeviceNet, adding floating point data format as element 4	202
Changed the element 4 range in the RS-232 table to 0…6	203

Topic	Page
Added Single Password Write data tables	266
Added Single Parameter Read data tables	267
Added sample applications: • Read and write power monitor tables by using an SLC 500 controller and a 1747-SCNR ControlNet scanner. • Read and write power monitor tables by using a MicroLogix controller over EtherNet/IP and Modbus RTU communication networks. • Read and write power monitor tables by using a Component HMI over an EtherNet/IP communication network.	Appendix C

Additioanl minor changes have been made throughout the document. Change bars mark all changes.

Using This User Manual

You should have a basic understanding of electrical circuitry and familiarity with relay logic. If you do not, obtain the proper training before using this product.

What This User Manual Contains

Review the table below to familiarize yourself with the topics contained in this User Manual.

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What This User Manual Does Not Contain

Topics related to installation and wiring are not covered in this manual. Refer to the Powermonitor 3000 Installation Instructions, publication 1404-IN007, for the following information:

- Selecting an enclosure for the Powermonitor 3000 unit and associated equipment.
- Mounting and wiring of the master module.
- Mounting and connection of the display module (refer to publication 1404-IN005).
- Selection and connection of current transformers (CTs) and potential transformers (PTs)
- Wiring to native and optional communication ports.

This manual does not provide information on functionality found in the Powermonitor 3000 master module, firmware revision 3.0 or earlier, Ethernet series A modules, all firmware revisions, or Ethernet series B modules, firmware revision 2.0 or earlier.

For this information, please refer to publications 1404-IN007D-EN-E and 1404-UM001D-EN-E, available as downloads from http://www.rockwellautomation.com/literature.

Additional Resources

Refer to these power and energy management documents for more information.

For this information	Refer to Publication
Powermonitor 3000 Installation Instructions (all communication options)	1404-IN007
Bulletin 1404 Powermonitor 3000 Display Module Installation Instructions	1404-IN005
Bulletin 1404 Series B Ethernet Communication Release Note	1404-RN008

You can view or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

Terms and Conventions

In this manual, the following terms and conventions are used.

Abbreviation	Term
AWG	American Wire Gage
BTR	Block Transfer Read
BTW	Block Transfer Write
CSA	Canadian Standards Association
CIP	Control and Information Protocol
CNET	ControlNet Industrial Control Network
CT	Current Transformer
DM	Display module
EMI	Electromagnetic Interference
HTML	Hyper-text Markup Language
ID	Identification
I/O	Inputs and Outputs
IEC	International Electrotechnical Commission
LED	Light Emitting Diode
NEMA	National Electrical Manufacturers Association
NAP	Network Access Port
NVS	Nonvolatile Storage
EtherNet/IP	Open Device Vendor’s Association’s Ethernet Industrial Protocol
PT	Potential Transformer (Also known as VT in some countries)
PM 3000	Powermonitor 3000 master module
PLC	Programmable Logic Controller
RFI	Radio Frequency Interference

Abbreviation	Term
RAM	Random Access Memory
RTOS	Real Time Operating System
R I/O	Remote Input/Output
PCCC	Rockwell Automation's proprietary Programmable Controller Communication Commands protocol
RMS	Root–mean–square
SNTP	Simple Network Time Protocol
SPDT	Single Pole Double Throw
SLC	Small Logic Controller
UL	Underwriters Laboratories
VA	Voltampere
VAR	Voltampere Reactive

Safety

Safety Considerations

Before installing and using this product, please read and understand the following precautions.

ATTENTION ⚠

Only qualified personnel, following accepted safety procedures, should install, wire and service the Powermonitor 3000 unit and its associated components. Before beginning any work, disconnect all sources of power and verify that they are de-energized and locked out. Failure to follow these instructions may result in personal injury or death, property damage, or economic loss.

ATTENTION ⚠

Never open a current transformer (CT) secondary circuit with primary current applied. Wiring between the CTs and the Powermonitor 3000 unit should include a shorting terminal block in the CT secondary circuit. Shorting the secondary with primary current present allows other connections to be removed if needed. An open CT secondary with primary current applied produces a hazardous voltage, which can lead to personal injury, death, property damage, or economic loss.

IMPORTANT

The Powermonitor 3000 unit is not designed for nor intended for use as a circuit protective device. Do not use this equipment in place of a motor overload relay or circuit protective relay.

IMPORTANT

The relay output contacts and solid-state KYZ output contacts on the Powermonitor 3000 unit may be used to control other devices through setpoint control or communication. You configure the response of these outputs to a communication failure. Be sure to evaluate the safety impact of the output configuration on your plant or process.

Other Precautions

ATTENTION

Electrostatic discharge can damage integrated circuits or semiconductors. Follow these guidelines when you handle the module.

- Touch a grounded object to discharge static potential.
- Wear an approved wrist strap-grounding device.
- Do not open the module or attempt to service internal components.
- Use a static safe workstation, if available.
- Keep the module in its static shield bag when not in use.

Product Description

The Bulletin 1404 Powermonitor 3000 unit is designed and developed to meet the needs of both producers of and users of electric power. A power monitor system consists of:

- a master module that provides metering, data logging, native RS-485 communication, and other advanced features depending on the model.
- an optional display module for configuration, entering commands, and displaying data.
- an optional communication port to serve data to other devices using a choice of networks.
- optional external devices and applications that display and utilize data for reporting, control, and management of power and energy usage.

The Powermonitor 3000 unit is a microprocessor-based monitoring and control device suited for a variety of applications including the following:

- Load Profiling – Using the configurable trending utility to log power parameters such as real power, apparent power, and demand, for analysis of power usage by loads over time
- Demand Management – Understanding when and why demand charges occur lets you to make informed decisions that reduce your electrical power costs
- Cost Allocation – Knowing your actual energy costs promotes manufacturing efficiencies
- Distribution System Monitoring – Using power parameters to show power flow, system topology, and distribution equipment status
- Emergency Load Shedding – Monitoring power usage to preserve system stability in the event of sudden utility outage
- Power System Control – Managing system voltage, harmonic distortion, and power factor

The power monitor is a sophisticated modern alternative to traditional electromechanical metering devices. A single Powermonitor 3000 unit can replace many individual transducers and meters. The power monitor is simple to install, configure, and operate, and provides you with accurate information in a compact economical package.

Master Module

The master module contains the main microprocessor-based monitoring functions, including terminations for power system connections, status inputs, control outputs, a native RS-485 communication port, and a port for the display module.

Configuration

Although the power monitor ships from the factory with default settings, you need to configure it for your particular requirements. You may configure the power monitor by using the optional display module. Alternately, you may use an external device or application to write configuration, operational parameters, and commands to the master module through its native or optional communication port.

Optional external applications that you may use for power monitor configuration include RSPower, RSPowerPlus, and RSEnergyMetrix software operating on a computer with a Microsoft Windows operating system.

Contact your local Rockwell Automation sales office or distributor, or visit http://www.software.rockwell.com/ for more information on available software packages.

Communication

Every power monitor comes with a native RS-485 communication port that supports the Allen-Bradley DF1 half- or full-duplex slave and Modbus RTU slave protocols. The native port is suitable for communicating to devices including the following:

- PLC-5, SLC 500, and ControlLogix processors
- RSLinx software with DDE/OPC server functionality
- Modbus RTU masters
- Other third-party devices
- Software that you develop

You may also specify power monitors with optional communication ports including the following:

- Serial RS-232 (DF1 half- or full-duplex or Modbus RTU slave)
- Remote I/O
- DeviceNet
- EtherNet/IP (CIP and/or CSP, Modbus TCP)
- ControlNet

You may integrate a power monitor into a programmable controller based control and monitoring system by using your choice of the native or optional communication methods.

Display Module

The Bulletin 1404 display module is an optional user interface device. The display module provides the most economical and simplest method for setting up and configuring the master module for operation.

The display module has a highly visible, two-line LED display and four operator buttons with tactile feedback. Use the buttons and display to navigate through a series of menus for configuration, commands, and data display.

The display module is shipped with a 3 m (10 ft) long, shielded four-pair cable that provides power and serial communication between the master module and the display module. The display module fits into a standard ANSI 4 in. analog meter cutout for panel mounting. Only one display module may connect to a master module, although you may use one display module to configure and monitor any number of master modules one at a time.

Performance Features

The power monitor is available in four basic models, designated M4, M5, M6, and M8. Each model offers specific functionality as indicated in this table. The M5 model offers M4 functionality and can be field-upgraded to an M6 or M8 model for an additional charge.

Product Features of Powermonitor 3000 Module

M4	M5	M6	M8	Master Module Features
•	•	•	•	Voltage, current, power measurements and display
•	•	•	•	Compatible with PLC-5, SLC 500, and ControlLogix controllers
•	•	•	•	Compatible with RSLinx, RSPower, RSPowerPlus, RSEnergyMetrix, and RSView32 software
•	•	•	•	Output control via control relays or PLC controllers
•	•	•	•	Demo mode for training
•	•	•	•	10 user configurable setpoints
•	•	•	•	Discrete condition monitoring via status inputs
•	•	•	•	Electronic KYZ pulse output
•	•	•	•	Form C ANSI C37.90-1989 rated relay for direct breaker tripping
•	•	•	•	Time stamped data logging of system measurements and events
•	•	•	•	Configurable trend log, up to 45,000 records deep
•	•	•	•	Event log 50 records deep
•	•	•	•	Firmware upgrades without removing module
•	•	•	•	Total harmonic distortion (THD) and Crest Factor
•	•	•	•	Automatic network-based time synchronization via SNTP
•	•	•	•	Daylight Saving Time
	•	•	•	ANSI C12.20 Class 0.5 revenue metering accuracy(1)
	•	•	•	EN60687 Class 0.5 revenue metering accuracy(1)
	•	•	•	Canadian Revenue Meter specification accuracy
	•	•		Field upgradeable to M6 or M8 (extra cost option)
		•	•	10 additional setpoints with more options
		•	•	Event Log an additional 50 records deep
		•	•	User configurable oscillography up to 400 cycles @ 60 Hz
		•	•	TIF, K-factor and IEEE-519 Pass/Fail
		•	•	Sag and swell detection with oscillogram capture
		•	•	Load factor log 12 records (months) deep
		•	•	Calculates amplitude and % distortion for harmonics 1…41
			•	Calculates amplitude and % distortion for harmonics 1…63
			•	Sub-cycle transient capture and metering
			•	Transducer and Energy Meter modes with improved update rate

(1) Class 0.2 revenue metering accuracy available as an extra-cost option.

Communication Options

In addition to the native RS-485 communication port, several factory-installed communication options are also available. These options make it possible for a user to select Powermonitor 3000 units to provide power and energy information into a variety of existing or new control systems and communication networks. Each communication option supports bi-directional data transfer with external devices or applications. Metering measurement, logging, configuration and status data may be accessed via communication.

Communication options are set in the master module. You may configure communication by using the display module or via communication to an external application such as RSPower, RSPowerPlus, or RSEnergyMetrix. Refer to the information later in this manual on configuration and operation of the communication options.

Refer to the Powermonitor 3000 Installation Manual, publication 1404-IN007, for installation and wiring information related to your selected communication options.

The last 3 characters of the catalog number specify the communication option of the Powermonitor 3000 unit.

RS-485 Native Communication

A catalog number ending in -000 specifies a power monitor equipped with only a native RS-485 communication port with the following performance features:

- Communication rates 1200, 2400, 4800, 9600, 19,200, 38,400, and 57,600 Kbps
- RS-485 cable length 1219 m (4000 ft)
- Cable type: two-wire shielded (Belden 9841)
- Multi-drop capabilities up to 32 nodes (half-duplex only)
- Update rate: 100 ms minimum
- Read/Write data table access to all data
- One user-configurable data table
- Supports DF1 half-duplex, DF1 full-duplex, and Modbus RTU communication protocol
- Used for field firmware upgrades

  The serial communication port operates as a responder on a full-duplex point-to-point link. You must verify that no more than one message is triggered simultaneously.

RS-232 Optional Communication

A catalog number ending in -232 specifies a power monitor with one RS-232 communication port in addition to the native RS-485 communication port. You select which of the two ports is active, as the two ports may not be used concurrently. The RS-232 port supports the same performance features as the RS-485 port, with the following exceptions:

- RS-232 cable length 15.24 m (50 ft) maximum
- Cable type: three-wire shielded (Belden 9608)
- Point-to-point wiring
- The RS-232 port operates as a responder. Unlike the RS-485 port, the RS-232 port supports overlapping messages.

Remote I/O Optional Communication

A catalog number ending in -RIO specifies a power monitor with a remote I/O communication port in addition to the native RS-485 communication port. The remote I/O option permits concurrent use of both communication ports. The remote I/O port has the following performance features:

- One-quarter rack slave device
- Three communication rate settings: 57.6, 115.2, and 230.4 Kbps
- Cable lengths up to 3048 m (10,000 ft)
- Node capacity up to 32 nodes
- Update rates for discrete I/O: 5 ms
- Update rates for block transfers: 50 ms minimum
- Two discrete inputs
- Eleven discrete outputs
- Read/Write block transfer data tables for access to all data

DeviceNet Optional Communication

A catalog number ending in -DNT specifies a power monitor with a DeviceNet port in addition to the native RS-485 port. The DeviceNet option permits concurrent use of both communication ports. The DeviceNet port has the following performance features:

- Adapter class device
- Four communication rate settings: 125, 250, 500 Kbps, and AutoBaud
- Remotely settable communication rate
- Cable length up to 500 m (1640 ft) maximum
- Node capacity up to 64 nodes including master
- Remotely settable node address
- Shielded twisted-pair media containing both signal and power conductors
- Update rates for I/O channel: 100 ms minimum
- Update rates for explicit messaging: 250 ms minimum
- Configurable I/O channel assembly instance: six parameters default, twenty-three maximum
- Configurable explicit assembly instance: seventeen parameters default, twenty-three parameters maximum
- Explicit assembly instances for access to all data
- Twenty-three single-instance parameters
- Two I/O assembly instances
- May be reset remotely through Identity Object
- Support for up to four concurrent clients
- Supports DeviceNet heartbeat facility

Ethernet Optional Communication

A catalog number ending in -ENT specifies a power monitor with one active 10/100BaseT Ethernet communication port in addition to the native RS-485 port. The Ethernet port has the following performance features:

- Connect to PLC-5E, SLC 5/05, ControlLogix Ethernet Bridge controllers, and the 1761-NET-ENI module products
- Built-in Internet Web page support
- Compatible with RSPower, RSPowerPlus, RSEnergyMetrix, and RSView32 software
- Ethernet communication rate: 10/100 Mbps

- Compatible with commercially available network bridges, routers, hubs and switches
- Fully software configurable
- Supports RSLinx software
- Supports Allen-Bradley Client Server Protocol (CSP)
- Supports EtherNet/IP (CIP) protocol
- Configurable I/O channel assembly instance: six parameters default, twenty-three maximum
- Configurable explicit assembly instance: seventeen parameters default, twenty-three parameters maximum
- Explicit assembly instances for access to all data
- Two I/O assembly instances
- Remotely resettable through Identity Object
- Supports up to 64 CIP/HTTP concurrent connections
- Data read latency: less than 10 ms
- Update rates for real-time metering data: 100 ms minimum
- Update rates for logged data: 250 ms minimum
- Supports network-based time synchronization via SNTP
- Supports networked demand period synchronization
- Supports Class 1 scheduled connection for I/O data

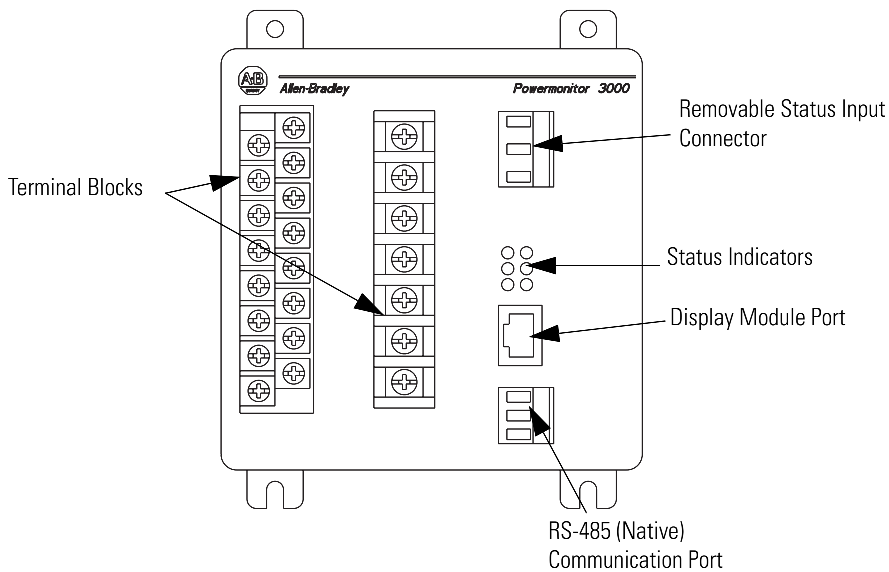
ControlNet Optional Communication

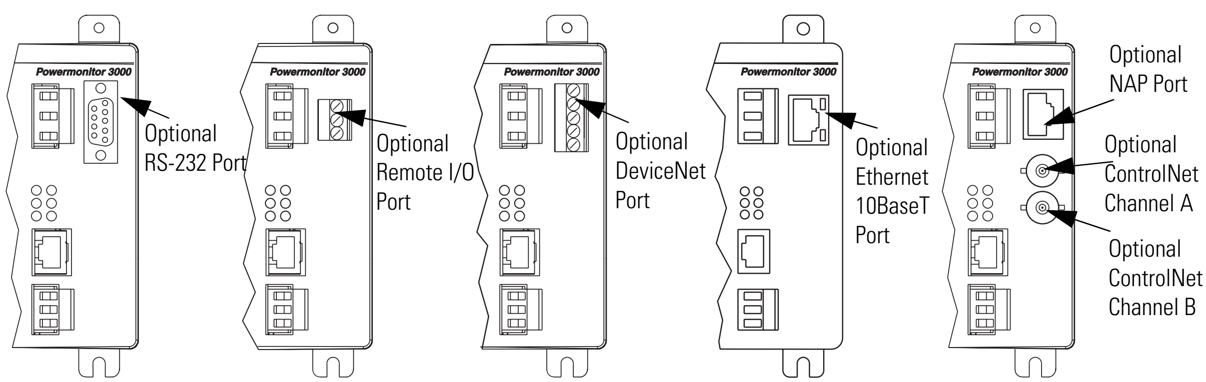
A catalog number ending in -CNT specifies a power monitor with a ControlNet communication interface in addition to the native RS-485 port. The ControlNet interface has the following features:

- Adapter class device
- Supports redundant media or single media applications; physical connections include NAP port and two BNC connectors
- ControlNet International conformace tested and approved
- Compatible with ControlLogix, PLC-5, and SLC controllers, PanelView units, RSEnergyMetrix, RSPower, and RSPowerPlus software, and more
- All power monitor data readable/writable via unscheduled (UCMM or Class 3) connection to Powermonitor assembly object instances 3…64
- Supports scheduled messaging (Class 1 connection); one assembly instance of configurable content from the power monitor and one assembly instance of fixed content to the power monitor

- Supports up to 64 concurrent Class 1 connections to instance 1 and one Class 1 connection to Instance 2.
- ControlFlash can be used to update ControlNet communication firmware
- Supports ControlLogix message types: CIP Generic, PLC-5 Typed
- Set power monitor node address (MAC ID) via display module, native comm port, or ControlNet assembly instance 12

Master Module with Various Communication Options

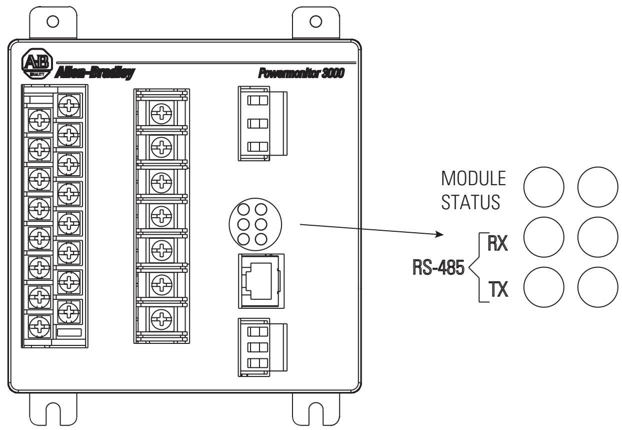




Status Indicators

The power monitor is equipped with six, two-color status indicators arranged as shown. Functions of the indicators differ among the various communication configurations.

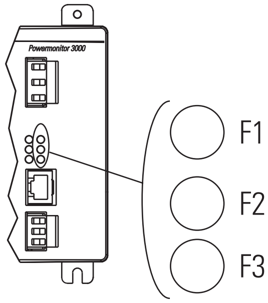
Status Indicators



The three indicators on the left, display the same information on Powermonitor 3000 units with any communication option including native RS-485 communication only. The three indicators on the right have different labels and different indications depending on the communication option selected, as shown in this table.

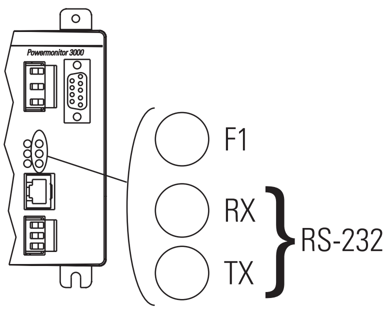
Status Indicators All Powermonitor 3000 Models

Status Indicator	Indicator Color	Indicator State and Communication Condition
Module Status	Off	Control power is off or insufficient
	Steady Red	Major fault; internal self-test has failed. If a power cycle does not correct the problem, call customer support
	Steady Green	Powermonitor 3000 unit is operating normally
RS-485 RX	Off	The RS-485 bus is idle; no active data is present
	Flashing Green	Active data is present on the RS-485 bus
RS-485 TX	Off	Powermonitor 3000 unit is not transmitting data onto the RS-485 bus
	Flashing Green	Powermonitor 3000 unit is transmitting data onto the RS-485 bus



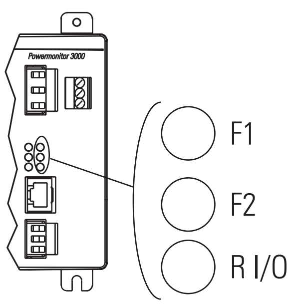
Native RS-485 Communication Only (catalog numbers ending in -000)

Status Indicator	Indicator Color	Indicator State and Communication Condition
F1	Off	Not Used
F2	Off	Not Used
F3	Off	Not Used



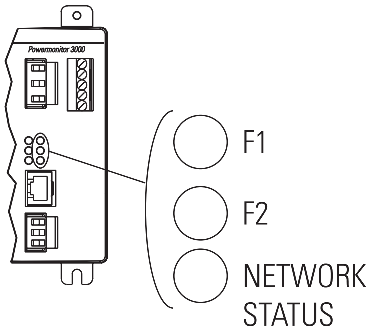
RS-232 Optional Communication (catalog numbers ending in -232)

Status Indicator	Indicator Color	Indicator State and Communication Condition
F1	Off	Not Used
RS-232 RX	Off	The RS-232 bus is idle; no active data is present
	Flashing Green	Power monitor is receiving data.
RS-232 TX	Off	The power monitor is not transmitting any data onto the RS-232 bus
	Flashing Green	The power monitor is transmitting data.



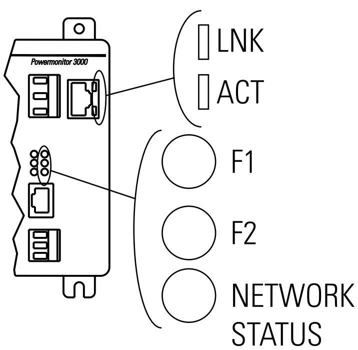
Remote I/O Optional Communication (catalog numbers ending in -RIO)

Status Indicator	Indicator Color	Indicator State and Communication Condition
F1	Off	Not Used
F2	Off	Not Used
R I/O	Off	Remote I/O communication has not been established
	Flashing Green	Remote I/O communication has been established but there are errors
	Steady Green	Remote I/O communication has been established



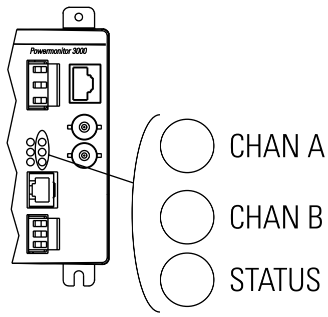
DeviceNet Optional Communication (catalog numbers ending in -DNT)

Status Indicator	Indicator Color	Indicator State and Communication Condition
F1	Off	Not Used
F2	Off	Not Used
Network Status	Off	Power is off or the power monitor is not online
	Flashing Green	Network status is OK, no connections established
	Steady Green	Network status is OK, connections established
	Flashing Red	Recoverable communication failure; port is restarting
	Steady Red	Non-recoverable communication error; check wiring and configuration parameters



EtherNet/IP Optional Communication (catalog numbers ending in -ENT)

Status Indicator	Indicator Color	Indicator State and Communication Condition
LNK	Off	No valid physical Ethernet connection
	Steady Green	Valid physical Ethernet connection
ACT	Strobing or Solid Yellow	Power monitor transmitting onto Ethernet
F1	Off	Not Used
F2	Off	Not Used
NETWORK STATUS	Off	No power
	Flashing Green	No established connections
	Steady Green	Connected; has at least one established connection
	Flashing Red	Connection timeout; one or more connections to this device has timed-out
	Steady Red	Duplicate IP; the IP address assigned to this device is already in use
	Flashing Green/Red	Selftest; this device is performing a power-up self test



ControlNet Optional Communication (catalog numbers ending in -CNT)

Status Indicator	Indicator Color	Indicator State and Communication Condition
CHAN A and CHAN B	Off	No power or Channel disabled
	Steady Red	Faulted unit
	Alternating red/green	Self-test
	Alternating red/off	Incorrect node configuration
	Steady green	Normal operation
	Flashing green/off	Temporary errors or node is not configured to go online
	Flashing red/off	Media fault or no other nodes present on network
	Flashing red/green	Incorrect network configuration
Status	Steady Green	Normal operation
	Flashing green/red	Communication card power-up self-test

Powermonitor 3000 Unit Operations

The Powermonitor 3000 unit is a microprocessor-based electrical power- and energy-measuring device. It connects to your three-phase or single-phase ac power system directly or through instrument transformers (PTs and CTs). It converts instantaneous voltage and current values to digital values, and uses the resulting digital values in calculations of things such as voltage, current, power, and energy. You may access the resulting metering values manually by using the display module or automatically by using communication with an external device or application.

The basic operations of the Powermonitor 3000 unit include the following:

- Metering functionality
- Operational and status indication
- Operation of the display module
- Display module menus and parameter structure
- Setup and configuration by using the display module
- Data monitoring by using the display module
- Issuing commands by using the display module

Other power monitor features such as communication, setpoint operations, I/O operations, data logging, oscillography, harmonics, sag/swell detection, load factor calculation, and transient detection are covered later in this manual.

Metering Functionality

The power monitor performs calculations on scaled, digital voltage and current values. Signals connected to the voltage and current inputs are sampled and their instantaneous values are converted to digital values in an analog-to-digital (A/D) converter section. These values are scaled according to configured PT Primary, PT Secondary, CT Primary, and CT Secondary parameters, and evaluated according to the configured Wiring Mode parameter. Metering results are available for display on the display module, in the communication data tables, and for use in setpoint programming and data logging.

The table on page 28 provides a summary of measurements produced in each Powermonitor 3000 unit, and notes which measurements you may view by using the display module.

Summary of Measurements

M4 M5	M6	M8	DM[(1)]	Measurement
•	•	•	•	Current, per phase and neutral
•	•	•	•	Average current
•	•	•	•	Positive sequence current
•	•	•	•	Negative sequence current
•	•	•	•	Percent current unbalance
•	•	•	•	Voltage per phase L-L, and L-N on four-wire systems
•	•	•	•	Average voltage per phase L-L, and L-N on four-wire systems
•	•	•	•	Positive sequence voltage
•	•	•	•	Negative sequence voltage
•	•	•	•	Percent voltage unbalance
•	•	•	•	Frequency
•	•	•	•	Phase rotation (ABC, ACB)
•	•	•	•	Real power (watts), total and per phase on four-wire systems
•	•	•	•	Reactive power (VARs), total and per phase on four-wire systems
•	•	•	•	Apparent power (VA), total and per phase on four-wire systems
•	•	•	•	True power factor (PF), total and per phase on four-wire systems
•	•	•	•	Displacement PF, total and per phase on four-wire systems
•	•	•	•	Distortion PF, total and per phase on four-wire systems
•	•	•	•	Energy consumption in kilowatt-hours (kWh), forward, reverse, and net
•	•	•	•	Reactive energy consumption in kVAR-hours, forward, reverse, and net
•	•	•	•	Apparent energy consumption in kVA-hours
•	•	•	•	Current consumption in ampere-hours
•	•	•	•	Demand (kA, kW, kVAR, and kVA)
•	•	•	•	Projected demand (kA, kW, kVAR, and kVA)
	•	•	•	Load factor calculation (amps, watts, VAR, and VA)
•	•	•	•	IEEE percent THD (total harmonic distortion)
•	•	•	•	IEC percent THD (Distortion Index) (DIN)
•	•	•	•	Crest Factor
	•	•	•	TIF (Telephone Interference Factor)
	•	•	•	K-factor
	•	•	•	IEEE 519 TDD (total demand distortion)
	•	•	•	IEEE 519 pass/fail calculation on voltage and current
	•	•		Individual percent and RMS magnitude, harmonics 1…41
		•		Individual percent and RMS magnitude, harmonics 42…63
	•	•		Oscillography capture data
		•		Transient voltage and current index
		•		RMS voltage and current per phase for each cycle of transient capture
		•		Transient capture wave form data

(1) If this box is checked, you may view the measurement by using display module. If not, you may access measurements by using communication only.

Metering Accuracy Class

In the Selftest/Diagnostic Results table, element 26 is a read-only parameter that indicates the revenue metering accuracy class of the master module. If this element contains the value 0, the master module meets ANSI C12.16 and EN61036 Class 1 requirements for accuracy. If this element contains the value 1, the master module meets ANSI C12.20 Class 0.5, EN60687 Class 0.5, and Canadian standard CAN3-C17-M84 requirements for accuracy. If this element contains the value 2, the master module meets ANSI C12.20 Class 0.2, EN60687 Class 0.2, and Canadian standard CAN3-C17-M84 requirements for accuracy. The revenue metering accuracy class is also indicated on the side of the master module and can be accessed via the display module
(DISPLAY > STATUS > ACCURACY CLASS).

Metering Accuracy Class

Model	Class 1	Class 0.5	Class 0.2
M4	Standard	Not Available	Not Available
M5		Standard	Optional
M6		Standard	Optional
M8		Standard	Optional

Expressing Metered Data on the Display Module

The display module displays scaled metered data in its basic units, such as volts, amps, watts. Prefixes such as K or M are used to denote multipliers of 1,000 (kilo-) and 1,000,000 (mega-). The display module expresses power factor as a percentage, with a positive value indicating leading and a negative value indicating lagging.

The display module displays values to a maximum precision of five significant digits.

Viewing Metered Data by Using the Display Module

The display module makes it easy to view the metering data produced by the power monitor.

Refer to display module functionality later in this chapter for information on use of the display module.

Voltage, Current, and Frequency Results

Line-to-line voltage results (L1-L2, L2-L3, and L3-L1) are calculated for all wiring modes. Line-to-neutral voltage results (L1-N, L2-N, and L3-N) are calculated in wye and single-phase wiring modes only. In delta wiring modes, line-to-neutral voltages return a zero value.

Average line-to-line (Avg. L-L) and line-to-neutral (Avg. L-N) voltage results return the mathematical average of the three line-to-line or line-to-neutral voltages, respectively. For single-phase wiring modes, the average line-to-neutral voltage is the mathematical average of phase 1 to neutral (L1-N) and phase 2 to neutral (L2-N) voltages. Voltage results return 999 if the line-to-neutral voltage exceeds 347 volts.

Current results include individual phase current (L1, L2, L3) and average three-phase current. L4 current returns neutral or zero-sequence current (refer to symmetrical component analysis discussion below).

Frequency results include Last cycle frequency and Average Frequency, calculated over your selection of either one or the last eight cycles. Frequency results return 0 if either the frequency is less than 40 Hz or if the voltage magnitude on all three voltage inputs is too low. Frequency results return 999 if the frequency is greater than 75 Hz. The power monitor selects one voltage phase input for frequency calculations and automatically switches to another in case of a phase loss. Frequency source indicates which phase is used to calculate frequency results.

Frequency source is accessible only via communication.

Phase rotation returns a value indicating forward (ABC), reverse (ACB) or no rotation.

RMS Resolution and Averaging

There are a number of configuration options in the power monitor that affect metering results.

- RMS Resolution – the high-resolution setting provides more accurate RMS results when significant levels of harmonics are present. You may also configure for nominal resolution if you require faster update rates but can accept lower accuracy as a trade-off. The M4 default is Nominal. The M5/M6/M8 default is High.
- RMS Result Averaging – the default setting provides a more steady result by averaging the results of the last eight calculations. You may also configure no averaging for the fastest response to a changing signal.

- Frequency Averaging – like the RMS result averaging, the default setting provides for a smoother response by averaging the frequency of each of the last eight cycles. You may select no averaging to return the frequency of only the last cycle

Refer to Advanced Device Configuration on page 50 for more information.

Symmetrical Component Analysis Results

The power monitor calculates sequence voltages and currents for use in symmetrical component analysis, a method of mathematically transforming a set of unbalanced three-phase vectors into three sets of balanced vectors. The positive sequence components are a set of vectors that rotate the same direction as the original power vectors, and represent that portion of the applied voltage or current capable of doing work. Negative sequence components rotate opposite to the original vectors, and represent the portion of the applied power that results in losses due to unbalance. The percent Unbalance value is the ratio between the negative and positive current sequence in a three-phase system and is the most accurate measurement of current unbalance because it takes into account the magnitude of the individual currents and the relative phase displacement. The zero sequence component is a single vector that does not rotate, and represents ground or neutral current or voltage. The component analysis results returned include the following:

- Positive Sequence Current
- Negative Sequence Current
- % Current Unbalance
- Positive Sequence Voltage
- Negative Sequence Voltage
- % Voltage Unbalance
- L4 current, which is the zero-sequence current on a wye system when neutral current is connected to the I4 current input or in delta systems when an external zero sequence transformer is connected to the I4 input

The Voltage, Current, and Frequency Metering table on page 32 summarizes the voltage and current metering information provided by the power monitor.

Voltage, Current, and Frequency Metering

Parameter	Description	Range	Units
Phase 1 L-N Voltage Phase 2 L-N Voltage Phase 3 L-N Voltage 3-Phase Average L-N Voltage	RMS line to neutral voltage of individual phase or three-phase average	0…999.9x10^{22}	Volts
Phase 1 L-L Voltage Phase 2 L-L Voltage Phase 3 L-L Voltage 3-Phase L-L Voltage	RMS line to line voltage of individual phase or three-phase average	0…999.9x10^{22}	Volts
Phase 1 Current Phase 2 Current Phase 3 Current 3-Phase Average Current	RMS line current in individual phase or three-phase average	0…999.9x10^{22}	Amps
Phase 4 (Neutral) Current	RMS current of phase 4, also known as neutral or zero-sequence current	0…999.9x10^{22}	Amps
Frequency	The frequency of the voltage	40.0…75.0	Hertz
Phase Rotation	The phase rotation of a three-phase system	None ABC ACB	N/A
Voltage Positive Sequence	Magnitude of positive sequence voltage in a three-phase system(1)	0…999.9x10^{22}	Volts
Voltage Negative Sequence	Magnitude of negative sequence voltage in a three-phase system(1)	0…999.9x10^{22}	Volts
Current Positive Sequence	Magnitude of positive sequence current in a three-phase system	0…999.9x10^{22}	Amps
Current Negative Sequence	Magnitude of negative sequence current in a three-phase system	0…999.9x10^{22}	Amps
Voltage Unbalance	The ratio between the negative and positive voltage sequence in a three-phase system	0…100	Percent
Current Unbalance	The ratio between the negative and positive current sequence in a three-phase system	0…100	Percent

(1) Expressed in line-to-neutral volts for Wye and line-to-line volts for Delta wiring modes.

Power Results

Real power, that is the portion of the voltage and current applied to a power system that is doing work, is calculated on a per-phase (L1 Real Power, L2 Real Power, L3 Real Power), and Total Real Power. L1 Reactive Power, L2 Reactive Power, L3 Reactive Power and Total Reactive Power similarly return that portion of the power used in capacitive or inductive reactance in the power system and doing no work. L1 Apparent Power, L2 Apparent Power, L3 Apparent Power and Total Apparent Power return the apparent power, which is the simple mathematical product of the system voltage and system current.

For single-phase wiring mode, all L3 power values remain at zero and are not included in the total power calculation.

Power Factor Results

The power monitor calculates true, displacement and distortion power factor, each on a per-phase and total three-phase basis. True power factor is the ratio between the total true power and total apparent power (in percent), and takes into account the effect of phase shift between the voltage and current as well as any harmonics present. Displacement power factor is the cosine of the difference between the phase angle of the fundamental voltage and current (in percent), and reflects the value a typical analog power factor meter would measure. The true power factor and displacement power factor are equal only if there are no harmonics present in either the voltage or current. These values are signed to show lead (+) or lag (-). Distortion power factor is the ratio between the magnitude of the fundamental and the sum of the magnitudes for all of the current harmonics (in percent).

The power quantities (kW, kWh, kVAR, kVARh, and power factor) are four-quadrant measurements. The power monitor measures and expresses these measurements in a way that allows you to determine the magnitude and direction of both the real power flow and the reactive power flow.

Explanation of Power Factor Values on page 34 indicates the relationship between these quantities and the numeric signs used by the power monitor to convey the information.

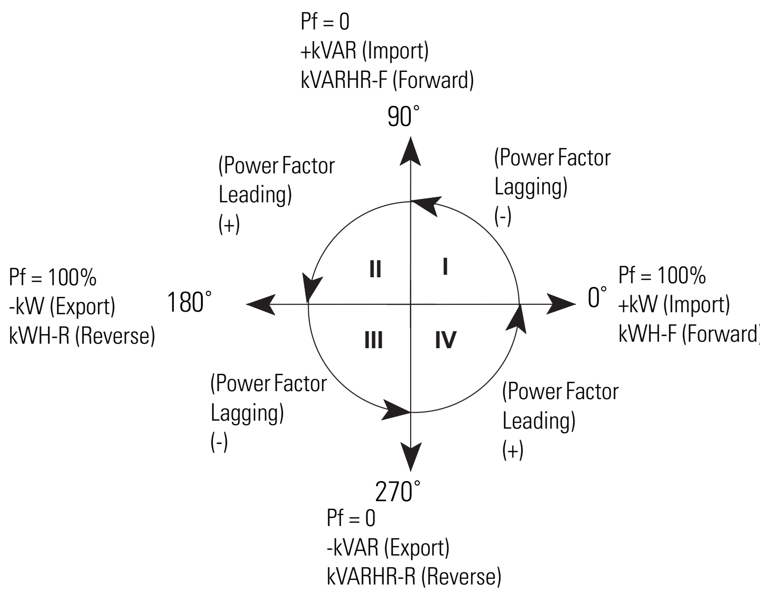
Power and Power Factor Results

Parameter	Description	Range	Units
Phase 1 Power	Power of individual phase or sum of phases; signed to show direction.	0…999.9x10^{22}	Watts
Phase 2 Power			
Phase 3 Power			
3-Phase Total Power			
Phase 1 Reactive Power	Reactive power of individual phase or sum of all phases; signed to show direction.	0…999.9x10^{22}	VARs (volt-amperes reactive)
Phase 2 Reactive Power			
Phase 3 Reactive Power			
3-Phase Total Reactive Power			
Phase 1 Apparent Power	Apparent power of individual phase or sum of all phases.	0…999.9x10^{22}	VA (volt-amperes)
Phase 2 Apparent Power			
Phase 3 Apparent Power			
3-Phase Total Apparent Power			

Power and Power Factor Results

Parameter	Description	Range	Units
Phase 1 True Power Factor	The ratio between the power and apparent power for an individual phase or all three phases; signed to show lead (+) or lag (-).	-100…100	Percent
Phase 2 True Power Factor			
Phase 3 True Power Factor			
Total True Power Factor			
Phase 1 Distortion Power Factor	The ratio between the magnitude of the fundamental and the sum of the magnitudes for all of the current harmonics for an individual phase or all three phases.	0…100	Percent
Phase 2 Distortion Power Factor			
Phase 3 Distortion Power Factor			
Total Distortion Power Factor			
Phase 1 Displacement Power Factor	The cosine of the phase angle between the fundamental voltage and current for an individual phase or all three phases; signed to show lead (+) or lag (-).	-100…100	Percent
Phase 2 Displacement Power Factor			
Phase 3 Displacement Power Factor			
Total Displacement Power Factor			

Explanation of Power Factor Values



Energy Results

The power monitor calculates energy values including kWh forward, reverse and net; kVAh; kVARh forward, reverse and net; and kAh. You may read these values by using the display module or via communication.

Configurable Energy Counter Rollover

You may configure the number of digits at which energy values roll over to zero. The parameter range is 4…15 digits.

Configure this setting in Advanced Device Configuration by using the display module or by writing to the Advanced Device Configuration table on page 196.

This setting lets you optimize the energy counter rollover for use with applications that support a limited number of significant digits. For instance, the display module supports a resolution of five significant digits. The Trend Log, which is used for automatic data re-population in some energy logging applications such as RSEnergyMetrix, supports twelve significant digits with eight digits of precision.

Demand Calculation

A typical industrial utility bill includes not only an energy (or kWh) charge but also a Demand charge. Demand is equal to the average power level during a predefined time interval. Some power providers may base demand on current, VA, or VARs instead of kW. This interval continuously repeats and is typically between five and 30 minutes in length. The formula for kW demand is shown below.

$$\text{Demand} = \frac{1}{T} \bullet \int_{t}^{t+T} P(t)dt$$

T = Demand interval duration
t = Time at beginning of interval
P(t) = Power as a function of time

Usually, a utility rate tariff includes a peak demand charge, determined by the peak demand that occurs during a specified period, which may be one month, one year, or some other duration. As a result, only one occurrence of a high demand level can have a long-term effect on your utility bill. The peak demand value indicates to the utility the reserve capacity they need to satisfy your short-term power requirements. The peak demand charge helps to pay the utility for maintaining this instantaneous capacity.

The power monitor computes demand levels for watts, VA, amps, and VARs, and provides three different methods for projecting demand.

The utility may provide a pulse that indicates the end of each demand interval. The utility updates the demand value at the end of each interval and maintains the highest value obtained during any interval. This method is known as thermal demand. You may set up a power monitor to determine its demand interval from the utility pulse. To accomplish this, connect the utility pulse to status input #2 and make the appropriate settings in the Advanced Device Configuration.

If the utility does not provide a demand interval pulse, you won't be able to synchronize with the utility to control your demand. In this case, you may use the sliding window method. This method breaks the demand interval into many sub-intervals and updates the demand value at the end of each sub-interval. For example a five-minute interval might be divided into five one-minute sub-intervals. The demand for each one-minute interval is calculated and at the end of five minutes the average value of the sub-intervals is computed to obtain a demand value. At the end of the sixth minute, the value for sub-interval one is discarded and a new demand value computed based on sub-intervals two through six. In this way a new five-minute demand value is obtained every minute. The maximum value is then maintained as the peak demand. This method approximates the actual demand the utility measures.

How can you minimize your peak demand in order to reduce your utility demand penalty charges? One way is to measure the power being used and project the demand level at the end of the interval. This method permits you to reduce power consumption when the projected demand reaches a predetermined threshold, thus preventing the final demand from exceeding the desired level.

Projected Demand Calculation

Select the best projection method for your system by comparing the projected values from each method with the actual demand at the end of the interval. The three methods of projecting demand are described below.

Instantaneous

The power monitor computes instantaneous demand by substituting the elapsed interval duration for the total interval duration (*T*) in the demand equation. It is therefore identical to the standard computation except it integrates the power only over the elapsed interval duration and calculates the average value over the elapsed duration. The modified equation thus becomes.

$$\text{Demand} = \frac{1}{t2 - t1} \bullet \int_{t1}^{t2} P(t)dt$$

(t2 - t1) = Elapsed interval duration and is less than T

First Order Projection

The first order demand projection does the following:

- Utilizes the instantaneous demand as a starting point
- Computes the trend of the instantaneous demand
- Computes the time remaining in the interval
- Performs a first order projection of what the final demand is at the end of the interval.

This method may be useful where your system has a significant base load with additional loads that are switched in and out during the interval.

Second Order Projection

The second order demand projection begins with the first order projection, then it does the following:

- Computes the rate of change of the first order trend
- Computes the time remaining in the interval
- Performs a second order projection of what the final demand is at the end of the interval

This method may be useful where your power system has little or no base load and a load profile that increases over the duration of the interval. A second order projection is more sensitive to rapid load changes than the other methods.

Energy and Demand Results

Parameter	Description	Range	Units
Kilo-Watt Hours Forward	The total real power consumed	$0 \ldots 1.0 \times 10^{12}$	kWh
Kilo-Watt Hours Reverse	The total real power produced		
Kilo-Watt Hours Net	The sum of forward and reverse power		
Kilo-VAR Hours Forward	The total reactive power consumed	$0 \ldots 1.0 \times 10^{12}$	kVARh
Kilo-VAR Hours Reverse	The total reactive power produced		
Kilo-VAR Hours Net	The sum of forward and reverse reactive power		
Kilo-VA Hours Net	The total apparent power consumed	$0 \ldots 1.0 \times 10^{12}$	kVAh
Amp Hours Net	Accumulated amp-hours consumed	$0 \ldots 1.0 \times 10^{12}$	Ah
Demand Current	The calculated demand for average current	$0 \ldots 999.9 \times 10^{21}$	Amps
Max Demand Current	The maximum (peak) demand for current. (included in Min/Max Log)		
Demand Kilo-Watts	The calculated demand for real power	$0 \ldots 999.9 \times 10^{21}$	kW
Max Demand Kilo-Watts	The maximum (peak) demand for real power (included in Min/Max Log)		
Demand Kilo-VARs	The calculated demand for reactive power	$0 \ldots 999.9 \times 10^{21}$	kVAR
Max Demand Kilo-VARs	The maximum (peak) demand for reactive power (included in Min/Max Log)		
Demand Kilo-VA	The calculated demand for apparent power	$0 \ldots 999.9 \times 10^{21}$	kVA
Max Demand Kilo-VA	The maximum (peak) demand for apparent power (included in Min/Max Log)		
Projected Current Demand[1]	The projected demand for average current	$0 \ldots 999.9 \times 10^{21}$	Amps
Projected Kilo-Watt Demand[1]	The projected demand for real power	$0 \ldots 999.9 \times 10^{21}$	kW
Projected Kilo-VAR Demand[1]	The projected demand for reactive power	$0 \ldots 999.9 \times 10^{21}$	kVARs
Projected Kilo-VA Demand[1]	The projected demand for apparent power	$0 \ldots 999.9 \times 10^{21}$	kVA

(1) Values returned depend on user selection of projected demand type in Advanced Configuration.

Display Module Functionality

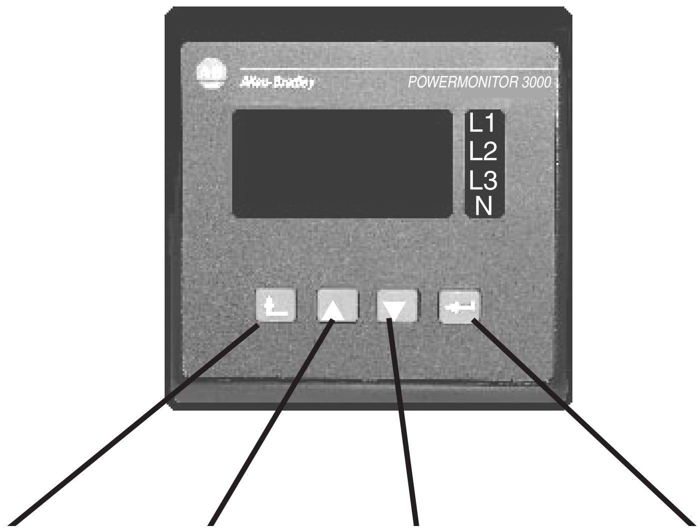
The display module is a simple terminal that allows you to easily view metering parameters or change configuration items. The display module uses three modes of operation.

- Display mode allows you to view power monitor parameters including metering, setpoint, min/max log, event log and self-test information. You may also select a default screen to be displayed at power-up or after 30 minutes without key activity.
- Program mode allows you to change configuration parameters, with security against unauthorized configuration changes. Each power monitor is password protected. In Program mode, the display module phase indicators (L1,L2,L3,N) flash.
- Edit mode allows you to modify the selected parameters. In Edit mode, the parameter being modified flashes, and the phase indicators (L1,L2,L3,N) remain solid.

Key Functions

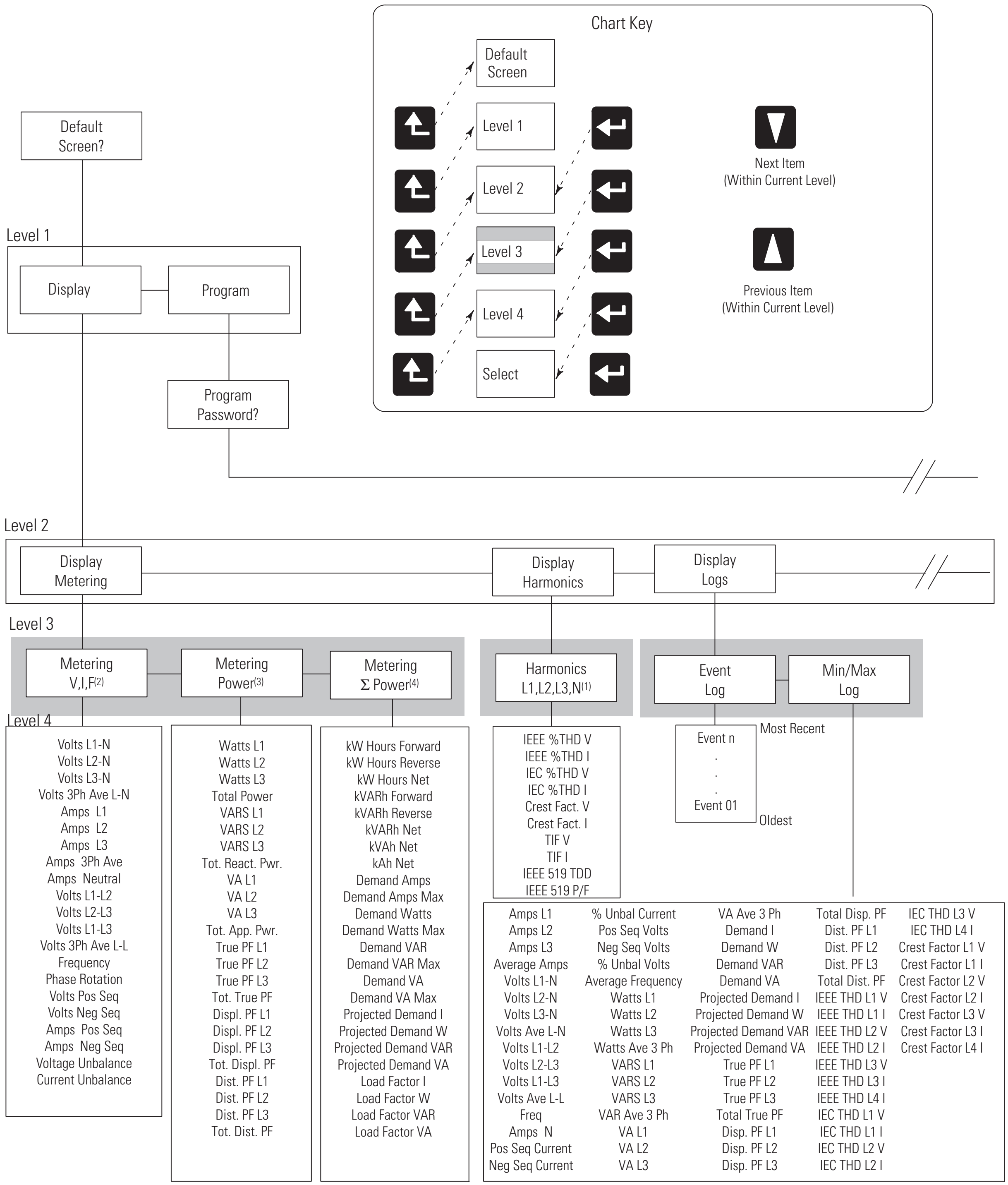
The display module has four keys located on its front bezel: an Escape key, Up Arrow key, Down Arrow key, and an Enter key. These keys differ slightly in how they function in each mode.

See Menu/Parameter Structure on page 40 for a description of their functionality.



	Escape Key	Up Arrow Key	Down Arrow Key	Enter Key
Display mode	Returns to parent menu	Steps back to the previous parameter/menu in the list	Steps forward to the next parameter/menu in the list	Steps into a sub-menu or sets as default screen
Program mode	Returns to parent menu	Steps back to the previous parameter/menu in the list	Steps forward to the next parameter/menu in the list	Steps into a sub-menu, selects the parameter to be modified or changes to Edit mode
Edit mode	Cancels changes to the parameter, restores the existing value, and returns to Program mode	Increments the parameter/menu value	Decrements the parameter value	Saves the parameter change to the master module and returns to Program mode

Menu/Parameter Structure

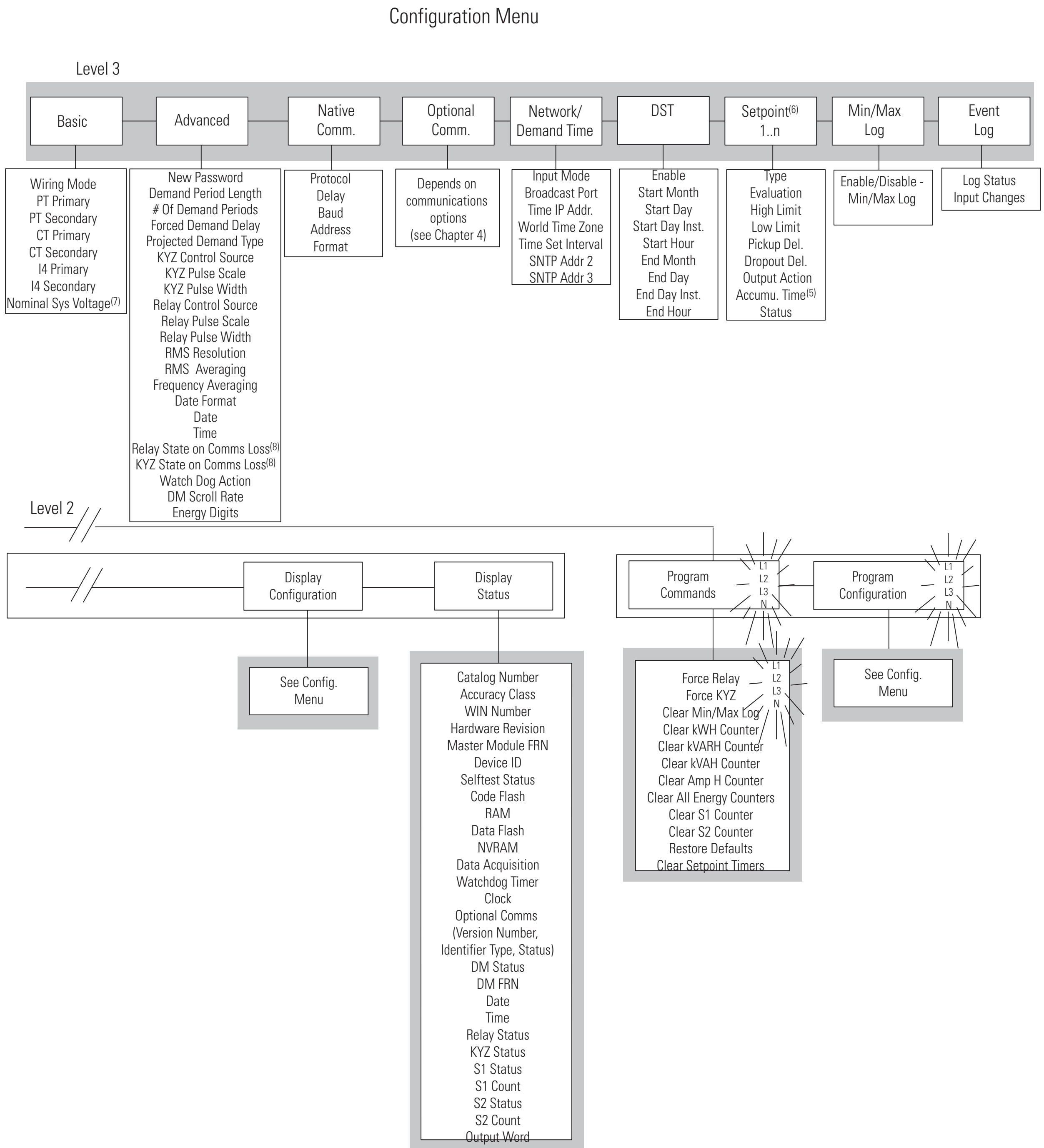


(1) Voltage THD and Crest Factor Voltage are omitted for neutral channel.

(2) Parameters displayed depend on the wiring mode.

(3) Individual phase parameters are omitted in delta wiring modes.

(4) Load factor parameters are available only on M6 and M8 modules.



(5) In Program Mode, this entry becomes Clear Accumulated Time.

(6) 1..10 (M4, M5) or 1..20 (M6, M8).

(7) Available on M6 and M8 only.

(8) Applies to EtherNet/IP, ControlNet, DeviceNet and remote I/O neworks only.

Displaying Information

The display screen consists of two rows of five alpha-numeric LED digits. At the right of this screen is a column of phase indicators: L1, L2, L3 and N. These indicators show which phase (or phases) is referred to by the information being displayed on the 2x5 screen. The phase indicators also indicate program mode by flashing.

Power Up

When the display module powers up, it first illuminates all of its LED indicators for approximately 2 seconds. It then displays its firmware revision number:

DM.FRN.
1.05

After about 2 seconds, the display waits for communication with the master module. If it doesn't receive any messages within 8 seconds, it displays:

Check
Rx

At any time, if the display module stops receiving information from the master module, it displays the Check Rx message. If it is receiving messages but not able to send messages (it determines this from a lack of response from the master module), the display module displays:

Check
Tx

Once the display module begins communicating with the master module, it displays it on the screen and the Check Rx or Check Tx messages disappear. No operator intervention is required to clear these messages.

Scrolling

When messages are too large to fit on the display, a scrolling mechanism is employed. The message scrolls horizontally. The default scroll rate was chosen to give you enough time to see the message but not take too much time to show the entire message. You may select from two different scroll rates by using the Advanced Configuration Menu on the display module. Take care to see the entire message before taking any action as some of the messages are very similar and differ only by a few characters.

Editing a Parameter

Follow these steps to edit a parameter by using the display module.

1. Using the display module keys, move into Program mode and display the parameter to be modified.

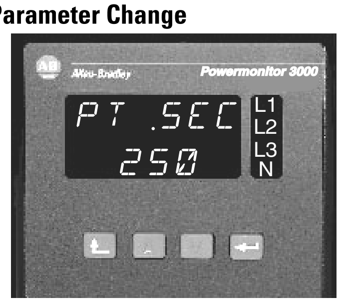
   Notice the flashing phase indicators on the right-hand side of the screen.

Edit Mode

2. Set the display module into Edit mode by pressing the Enter key.

   Notice that the phase indicators on the right side turn-on solid and the parameter being modified is now flashing.

Parameter Change



3. Change the value of the parameter by pressing the Up Arrow and Down Arrow keys until the desired parameter value is displayed.

   Notice the phase indicators on the right-hand side remain solid and the parameter being modified is still flashing.

4. After the desired parameter value is displayed, press the Enter key to write the new value to the master module and set the display module back to Program mode.

   Notice the phase indicators on the right-hand side are now flashing and the parameter being modified is now solid.

   If you begin to edit the wrong parameter, press the Escape key. This returns the original parameter value, does not modify the master module, and returns the display module to Program mode. Notice the phase indicators on the right-hand side are flashing again, and the parameter being modified is now solid.

Setting a Default Screen

To set the current display module view as the default screen, press the Enter key. The display reads Set Default with No flashing in the second line. Press the Down Arrow key to change No to Yes. Press the Enter key again to confirm your selection.

The display module now returns to the screen you have selected on power up or after 30 minutes of inactivity on the display module.

Issuing Commands

The display module allows you to issue commands to the power monitor. These commands include relay and KYZ output forcing; clearing the Min/Max Log; clearing energy and amp-hour counters, status input counters and setpoint counters, and restoring the factory defaults.

To issue a command, you must enter Program Mode and enter the correct unit Password.

ATTENTION

The relay and KYZ outputs may be connected to field devices. Before issuing a command to force an output, ensure that any devices connected to outputs cannot operate in an unsafe or undesired manner. Failure to follow these instructions may result in personal injury or death, property damage, or economic loss.

1. Using the four display module keys, move into Program mode and display the command to be issued.

   Notice the flashing phase indicators on the right-hand side.

Program Mode

2. Set the display module into Edit mode by pressing the Enter key.

   Notice that the phase indicators on the right-hand side are now solid and the command option prompt is now flashing.

Edit Mode

3. Choose the option of the command by pressing the Up Arrow and Down Arrow keys until the desired option is displayed.

   Notice the phase indicators on the right-hand side remain solid and the command option being selected is still flashing.

Command Option

4. After the desired command option is displayed, press the Enter key to execute the command.

   The selection prompt reappears and the display module is set back to Program mode. Notice the phase indicators on the right-hand side are flashing again and the option prompt is now solid.

Program Mode

To abort a command, press the Escape key. The display module returns to Program mode and the option prompt is displayed again. Notice the phase indicators on the right-hand side are now flashing and the option prompt is now solid.

Commands

Parameter	Description	Range
Force Relay	Forces relay to a known state in which the relay remains at that state until the force is removed.	De-energize Energize No Force
Force KYZ	Forces KYZ to a known state in which the relay remains at that state until the force is removed.	De-energize Energize No Force
Clear Min/Max Log	Resets the Min/Max log with the current real time metering information.	Yes No
Clear kWh Counter	Resets the kWh net counter to zero.	Yes No
Clear kVARh Counter	Resets the kVARh net counter to zero.	Yes No
Clear kVAh Counter	Resets the kVAh net counter to zero.	Yes No
Clear Ah Counter	Resets the Ah net counter to zero.	Yes No
Clear All Energy Counters	Resets all cumulative energy counter to zero.	Yes No
Clear S1 Counter	Resets Status 1 counter to zero.	Yes No
Clear S2 Counter	Resets Status 2 counter to zero.	Yes No
Restore Defaults Settings	Restores all settings to factory default.	Yes No
Clear Setpoint Timers	Clears the time accumulated in each setpoint timer.	Yes No

Configuration by Using the Display Module

The display module provides an inexpensive, easy-to-operate method for setting up power monitor parameters to adapt it to your power system and select the performance options you desire. You configure the power monitor by using Program mode and Edit mode of the display module.

You may also configure the power monitor via communication, and certain advanced features of the power monitor may be configured only via communication.

Please refer to the appropriate sections of the user manual for more information.

Refer to the Device Configurations Summary table on page 50 for a summary of basic and advanced device configuration settings. You may use a copy of this table to record your configuration settings.

Basic Device Configuration

The basic unit configuration sets the wiring mode, PT ratios and CT ratios to match your power system. Every power monitor requires basic configuration. To perform basic configuration by using the display module, navigate through these menus: **PROG.** > **PASS?** > **CONFIGURATION** > **BASIC**. You may also set the basic device configuration via communication by writing to the Basic Device Configuration Parameters table.

Wiring Mode

Select the wiring mode to match the physical configuration of your power system.

Your wiring mode choice must match the wiring diagrams found in the Powermonitor 3000 Unit Installation Instructions, publication 1404-IN007, for proper operation and accuracy.

Your choices include the following:

- Delta 3 CT
- Delta 2 CT
- Direct Delta 3 CT
- Direct Delta 2 CT
- Open Delta 3 CT
- Open Delta 2 CT
- Wye (default)
- Single Phase
- Demo

You may choose Demo mode for training or demonstration purposes. In Demo mode, the power monitor returns internally generated results.

PT and CT Ratios

You may directly connect the voltage inputs of the power monitor to power systems rated at 600V line-to-line or less. Above 600V, you need potential transformers (PTs) to step down the power system voltage to one that is measurable. Most commercially available PTs have a secondary rated voltage of 120V (150V full-scale).

Nearly every power monitor installation requires CTs to step down the power system current to a value of 5 A full-scale.

To perform basic configuration, set the primary and secondary voltage and current ratings of your PTs (if used) and CTs. If your system configuration includes a neutral current CT, you need to separately configure the I4 CT ratio.

- PT primary*:* range 1…10,000,000, default 480
- PT secondary*:* range 1…600, default 480
- CT primary*:* range 1…10,000,000, default 5
- CT Secondary*:* range 1…5, default 5
- I4 primary and I4 secondary*:* same as CT primary and secondary

For direct connection to power systems of 600V, set the PT ratio to 600:600. For a 480V system, set the PT ratio to 480:480.

Nominal system voltage (M6, M8 only)

The M6 and M8 models use the nominal voltage setting for calculating the default sag and swell setpoint high and low limits. For Wye and single-phase wiring modes, set this value to the PT primary-side nominal line-to-neutral. For all other wiring modes, set this parameter to the PT primary-side nominal line-to-line voltage.
Range 1…10,000,000, default 480.

TIP	When setting a parameter, you may press and hold the up arrow or down arrow key for a few seconds to increase the rate the value increments or decrements.

Refer to the Powermonitor 3000 Installation Instructions, publication 1404-IN007, for information on selecting and installing PTs and CTs.

Advanced Device Configuration

A number of parameters are grouped into Advanced Configuration, including the Password, demand and projected demand setup, relay and KYZ pulse operation setup, metering accuracy options, date/time and display module scrolling rate. To perform advanced configuration by using the display module, navigate through these menus: **PROG.** > **PASS?** > **CONFIGURATION** > **ADVANCED**. You may also set the advanced device configuration via communication by writing to the Advanced Device Configuration table.

Password

The password protects the unit against unauthorized commands or configuration changes. Be sure to write down the new password and keep it in a safe place. Range 0…9999, default 0000.

TIP If you forget or lose your password, contact Rockwell Automation Technical Support for assistance. Refer to Rockwell Automation Support on the back cover of this manual.

Device Configurations Summary

	Parameter	Range	Default	User Setting
Basic Configuration	Wiring Mode	0 = Delta 3 CT 1 = Delta 2 CT 2 = Direct Delta 3 CT 3 = Direct Delta 2 CT 4 = Open Delta 3 CT 5 = Open Delta 2 CT 6 = Wye 7 = Single Phase 8 = Demo	6 = Wye	
	PT Primary	1…10,000,000	480	
	PT Secondary	1…600	480	
	CT Primary	1…10,000,000	5	
	CT Secondary	1…5	5	
	I4 Primary	1…10,000,000	5	
	I4 Secondary	1…5	5	
	Nominal System Voltage (M6 and M8 only)	1…10,000,000	480	

Device Configurations Summary

	Parameter	Range	Default	User Setting
Advanced Configuration	New Password	-1…9999	0000	
	Demand Period Length	-99…99	15	
	Number of Demand Periods	1…15	1	
	Forced Demand Delay	0…900 s	10	
	Predicted Demand Type	Instantaneous 1st Order 2nd Order	Instantaneous	
	KYZ Control Source	0 = None 1 = Wh Forward 2 = Wh Reverse 3 = VARh Forward 4 = VARh Reverse 5 = Vah 6 = Ah 7 = Setpoint 8 = Comms	7 = Setpoint	
	KYZ Pulse Output Scale	1…30000	10	
	KYZ Pulse Output Width	0, 40…2000	0	
	Relay Control Source	Same as KYZ	7 = Setpoint	
	Relay Pulse Output Scale	1…30000	10	
	Relay Pulse Output Width	0, 40…2000	100	
	RMS Resolution	Nominal / High	High(2)	
	RMS Averaging	On / Off	On	
	Frequency Averaging	On / Off	On	
	Date Format	MM/DD/YYYY DD/MM/YYYY	MM/DD/YYYY	
	Date: Year	1998…2097	1998	
	Date: Month	1…12	1	
	Date: Day	1…31	1	
	Time: Hour	0…23	0	
	Time: Minutes	0…59	0	
	Time: Seconds	0…59	0	
	Default relay state on comms loss	0 = Last state/resume 1 = Last state/freeze 2 = De-energize/resume 3 = De-energize/freeze	0	
	Default KYZ state on comms loss		0	
	Wdog action	0 = Halt 1 = Continue	0 = Halt	
	Display Module Scroll Speed	Fast / Slow	Fast	
	Energy counter rollover point	4…15 digits	15	
	Metering Result Set (M8 only(1))	0 = All results 1 = Transducer mode 2 = Energy meter mode	0 = All results	

(1) Metering result set parameter may only be configured by using communication.

(2) Factory default for RMS Resolution is Nominal for the M4 and High for the M5, M6 and M8.

Demand Setup

You may configure the demand period length, the number of demand periods to average for demand calculation, the forced demand delay and the type of calculation used for projected demand.

Demand Period Length sets the length in minutes (1…99) of the demand period used for demand and projected demand calculation. Range –99…99, default 15.

- A positive value (other than 0) configures the power monitor to use its internal clock to measure the demand period.
- A setting of zero (0) configures the power monitor to use an external synchronizing method to synchronize the demand interval.
- A negative value configures the power monitor to use its internal clock for calculating projected demand and an external synchronizing method to calculate actual demand.

External synchronizing methods include:

- A dry contact end-of-interval pulse connected to status input #2
- For Ethernet network units, a network demand sync broadcast message from a network demand master power monitor or a controller command message from a PLC controller.

Refer to Network Demand / Time Configuration on page 55 for more informatin on network demand synchronization.

TIP	In RSEnergyMetrix RT software and RSPower software, a negative demand interval is set by checking a checkbox entitled 'Use Status Input #2' or 'Enable External Demand Sync'.

Number of Demand Periods specifies how many demand intervals are averaged together to a floating window demand calculation. For instance, to configure a 30 minute floating window, specify 2 as the demand period length and 15 as the number of demand periods. Range 1…15, default 1.

Forced Demand Delay is a timeout setting that waits for *x* number of seconds before ending a demand period when the external demand sync input function is being used. When a missed external demand sync is detected the unit:

- forces an end to the current demand period.
- records an event log record of the event.
- records a trend log record if the trend log interval is set to -1. (Sync with demand setting)

- sends out a demand sync broadcast when configured as a Master (Ethernet units).
- starts the projected demand calculations from the beginning again.

Entering a value of 0 disables this function.

For more information about this feature read the section Network Demand / Time Configuration on page 55.

Projected Demand Type specifies the type of calculation used for projected demand. Selections include the following:

- Instantaneous (default)
- First-order
- Second-order

Relay and KYZ Pulse Operation Setup

Use these configuration parameters to select how the relay and KYZ solid-state outputs are controlled. Relay control source controls the selection which includes the following:

- Disabled
- Wh forward
- Wh reverse
- VARh forward
- VARh reverse
- Vah
- Ah
- Setpoints (default)
- Remote I/O or DeviceNet discrete control

The Pulse output scale factor sets the number of measurement increments per pulse. Range 1…30,000, default 10. The Pulse output width parameter determines the pulse width in milliseconds. Range 40…2000 or 0 to transition the output KYZ-style. Default is 0.

Metering Options

Configuration parameters RMS Result Averaging, RMS Resolution and Frequency Averaging allow you to make choices to fit the power monitor more closely to your application needs. The default settings are to average 8 RMS and frequency calculations, providing a smoother result, and to sample at a high rate, providing greater accuracy where significant harmonics are present. Refer to the discussion of these parameters in Metering Functionality at the beginning of this chapter.

Configurable Energy Counter Rollover

You may configure the number of digits (range 4…15) at which energy values roll over to zero.

Configure this setting by using the display module or by writing to the Advanced Device Configuration Parameters table on page 196.

Advanced Metering Options

Some applications require very frequent updates of a limited set of metering data. In the M8 model, you may de-select certain metering functions to improve the update rate of the power monitor in its remaining metering and communication functions. With this feature selected, de-selected metering calculations return values of 0 in the appropriate data table elements.

You may set the advanced metering selection only through communication, by performing a table write to the Advanced Metering Configuration table.

The display module does not support this configuration. This table exists only in the M8 model and consists of 10 integer elements as follows:

- Password: A valid password is required
- Meter result set: 0 calculates all metering results (default); 1 is Transducer mode; 2 is Energy Meter mode
- Reserved elements: The remaining elements must be 0
- Transducer mode: The power monitor calculates only volts, amperes, watts, VARs, VA, true power factor (per phase and total) and frequency
- Energy Meter mode: The unit calculates only average voltage, average amperes, total watts, frequency and net kWh

Date and Time

You may use these parameters to set the power monitor's internal clock and calendar and configure the display format as MM/DD/YYYY (default) or DD/MM/YYYY. The power monitor uses its internal clock time-stamp entries in logs, oscillograms and transient captures.

Display Mode Scroll Speed

This parameter controls how fast text that doesn't fit in the window is scrolled on the display module. Default is fast scrolling.

Watchdog Timeout Action

Configure this parameter to determine how the power monitor responds if an internal watchdog timeout has occurred. This may occur due to extreme environmental condition or internal operational error. Choices include the following:

- Halt - Restart the firmware, log an event, stop metering and disable all functionality except display module and communication.
- Continue - Restart the firmware, log an event and resume operation.

Default is Continue.

Default Output Behavior on Communication Loss

Refer to Communication Loss Behavior on page 140.

Network Demand / Time Configuration

The Ethernet Powermonitor 3000 unit supports demand period synchronization via the Ethernet network. Demand period synchronization makes use of UDP (User Datagram Protocol) messaging, a simplified, low-level protocol that supports broadcasts. A power monitor may be configured as a Master or a Slave. A Master may be configured to receive an end-of-interval (EOI) signal either from a dry contact connected to its Status Input 2 or via a Controller Command write to the Controller Command table (see below). When a Master receives an EOI input, it broadcasts an EOI message to any units configured as Slaves.

Ethernet units also support synchronization of their internal clocks from up to three SNTP servers, at a configurable synchronization interval. Since SNTP servers operate in UTC (Universal Coordinated Time), a time zone for the power monitor must also be configured for the correct time to be set. The time zone is configured as an offset in hours from UTC (formerly known as GMT).

To enable network demand synchronization, the demand period parameter in the advanced configuration table must be set to zero or a negative number. Refer to page 52 for more information.

If using RSEnergyMetrix RT option or RSPower software for configuration, the checkbox 'Use Status Input #2' or 'Enable External Demand Sync' must be checked.

You may configure network demand and time synchronization options by using the display module, or by using communication, by writing to the Network Demand Sync and Time Configuration table.

Input Mode

Sets the unit network time sync mode. Range: 0 = Master command input, 1 = Master status 2 input, 2 = Slave broadcast input, 3 = Slave status 2 input (default)

Broadcast Port

Sets the UDP port number for the master slave configuration.
Range 300…400, default 300

Time IP Address

The IP address of the primary SNTP server, accessed as the 1st… 4th octet

World Time Zone

Sets the time zone of the power monitor. Range -12…12. For example -12 = GMT - 12:00 - Eniwetok, Kwajalein; -11 = GMT - 11:00 - Midway Island, Samoa; 12 = GMT 12:00; Fiji, Kamchatka, Marshall Island.

Time-set Interval

Determines how often the unit time is automatically set, in seconds.
Range: 0…32,766. 0 = Disables the time set function, Default = 60

SNTP Address 2

The IP address of the primary SNTP server, accessed as the 1st…4th octet.

SNTP Address 3

The IP address of a third SNTP server, accessed as the 1st…4th octet.

Network Demand/Time Configuration Summary

Parameter Name	Range	Default	User Setting
Input mode	0…3	3	
Broadcast port number	300…400	300	
Time server IP address-byte 1	0…255	0	
Time server IP address-byte 2	0…255	0	
Time server IP address-byte 3	0…255	0	
Time server IP address-byte 4	0…255	0	
Time zone	-12…12	0	
Time set update interval	0…32766	60	
SNTP IP address 2, octet 1	0…255	0	
SNTP IP address 2, octet 2	0…255	0	
SNTP IP address 2, octet 3	0…255	0	
SNTP IP address 2, octet 4	0…255	0	
SNTP IP address 3, octet 1	0…255	0	
SNTP IP address 3, octet 2	0…255	0	
SNTP IP address 3, octet 3	0…255	0	
SNTP IP address 3, octet 4	0…255	0	

Controller Command

The Controller Command table is a write table consisting of one integer element. A 1 written to bit 0 signals the end of a demand period. When this occurs, the master power monitor resets this bit to 0 and sends the end of demand broadcast to power monitor units configured as Slave broadcast input. Bits 1…15 are reserved.

DST (Daylight Saving Time) Configuration

The power monitor may be configured to automatically adjust its internal clock for daylight saving time.

You may configure the daylight saving time function by using the display module or via communication by writing to the Daylight Saving Time Configuration table.

DST Enable

Enables the daylight saving time function.
Range 0 = disable, 1 = enable

DST Start Month

Selects the calendar month when daylight saving time begins.
Range 1 = January, 2 = February, … , 12 = December

DST Start Day

Selects the day of the week when daylight saving time begins.
Range 0 = Sunday, 1 = Monday, … , 7 = Saturday

DST Start Day Instance

Selects which instance of the DST start day in the DST start month when DST begins.
Range 1 = first, 2 = second, 3 = third, 4 = fourth, 5 = last

DST Start Hour

Selects the hour of the day when DST begins. Range 0 = midnight, 1 = 1:00 a.m., … , 23 = 11:00 p.m.

DST End Month

This parameter and the following three determine when DST ends and are configured the same as the start parameters above.

- DST end day
- DST end day instance
- DST end hour

DST is disabled by default. When enabled, the default start time is 2:00 a.m. on the second Sunday in March, and the default end time is 2:00 a.m. on the first Sunday in November. This corresponds to US Daylight Saving Time beginning in 2007.

Daylight Saving Time Configuration Summary

Parameter Name	Range	Default	User Setting
DST Enable	0…1	0	
DST Start Month	1…12	3	
DST Start Day	0…6	0	
DST Start Day Instance	1…5	2	
DST Start Hour	0…23	2	
DST End Month	1…12	11	
DST End Day	0…6	0	
DST End Day Instance	1…5	1	
DST End Hour	0…23	2	

Metering Update Rate

The metering update rate is a measure of how often the power monitor calculates new metering results. The metering update rate is not significant in most applications, but can be important in some control applications. The metering update rate affects how quickly a setpoint can respond to an electrical event and affects how often new metering results are available for communication. The metering update rate is dependent on the power monitor model and device configuration.

The table below contains information that can be used to calculate the metering update rate for a specific model containing specific configuration selections.

Metering Update Rate Calculation Based on Model and Device Configuration

Model and Config Options	M4	M5	M6	M8	Update Rate
Base metering update rate	•	•	•	•	50 ms
If device is an M4	•				Add 10 ms
If RMS Resolution = High (see the Advanced Device Configuration table)	•	•	•	•	Add 10 ms
If catalog # contains ENT, CNT, or DNT	•	•	•	•	Add 5 ms
If the Min/Max log is enabled (see the Min/Max Log Configuration/Read-back Select table)	•	•	•	•	Add 5 ms
If more than 5 setpoints are configured	•	•	•	•	Add 5 ms
If Oscillography is enabled (see the Oscillograph Configuration/Read-back Data Select table)			•	•	Add 5 ms
If Transient detection is enabled (see the Transient Analysis Configuration/Read-back Select table)				•	Add 15 ms
If Meter Result Set is set to Tranducer mode or Emergy Meter Mode (see the Advanced Metering Configuration table)				•	Subtract 5 ms

This table lists the minimum and maximum possible metering update rate for each model based on information from the Metering Update Rate Calculation table.

Min and Max Metering Update Rate for Each Model

Model	Min and Max Metering Update Rate
M4	60…85 ms
M5	50…75 ms
M6	50…80 ms
M8	45…95 ms

Out-of-the-box metering update rates are based on factory-default configuration data and are listed in the Meter Update Rate with Factory Default Configuration table for all power monitor models and communication options.

Factory default settings for configuration parameters can be found in Appendix A.

Meter Update Rate with Factory Default Configuration

Model	Communication Option	
	000, 232, RIO	ENT, CNT, DNT
M4	60 ms	65 ms
M5	60 ms	65 ms
M6	65 ms	70 ms
M8	80 ms	85 ms

Communication

The communication features of the Powermonitor 3000 unit make it uniquely suited to integrate electric power usage information into your industrial control and information systems. Every power monitor is equipped with a native RS-485 communication port, and you can select optional communication that facilitate seamless integration with a variety of industrial networks. The optional communication choices include the following:

- Serial - an RS-232 communication port
- Remote I/O - allows you to connect your power monitor as a quarter rack to any remote I/O scanner device
- DeviceNet - a port with standard DeviceNet functionality lets your power monitor integrate into an open-standard, multi-vendor architecture
- Ethernet - a standard 10BaseT port allowing easy integration into factory-floor and office information systems
- ControlNet - with NAP port and two BNC connectors for connection to single or redundant media applications

This chapter covers configuration and operation of the native and optional communication ports.

Refer to the Installation Instructions, publication 1404-IN007, for installation, wiring and connection instructions.

Configuring Communication

The display module is the recommended way to configure communication on your power monitor. The display module includes setup menus for native and optional communication.

If you need to, review Configuration by Using the Display Module on page 47.

You may also configure communication parameters by using the native or optional communication ports. However, because this may lead to loss of communication with the port being configured, we recommend using the display module for initial communication configuration.

If you choose to configure communication parameters by using communication, please refer to the Native Communication Configuration table and the Optional Communication Configuration Parameters table in Appendix A.

Native RS-485 Communication

Your Powermonitor 3000 unit is set up to communicate via its native RS-485 port when you first power it up, except for units with an optional RS-232 communication port. The communication configuration includes the following parameters:

- Protocol: Allen-Bradley DF1 full-duplex, DF1 half-duplex slave, Modbus RTU slave, or auto-sense. Default auto-sense
- Data communication rate: Range 1.2, 2.4, 4.8, 9.6, 19.2, 38.4, and 57.6 Kbps. Default 9.6 Kbps
- Delay: Range 0…75 ms, 10 ms default
- Data Format: 8 data bits, 1 stop bit, no parity, odd parity or even parity. Default no parity
- Node address: Range 1…247, default is the same value as the unit ID listed on the nameplate
- Inter-character timeout: Range 0…6553 ms
  Default 0 (= 3.5 character times)
- Error checking: CRC (default), BCC

The Delay parameter is the time the power monitor waits before its response to an external request. Certain communication equipment requires such a delay for reliable operation.

With a half-duplex protocol selected, you may connect your power monitor into a multi-drop RS-485 network with up to 32 nodes. You must use a device configured as a master to communicate with this port. All devices on the RS-485 network must be set at the same data rate.

With the DF1 full-duplex protocol selected, the power monitor communicates with another DF1 full-duplex initiator device over a point-to-point link.

TIP	The native communication port does not support Data Highway 485 (DH-485) communication. Although DH-485 uses the RS-485 physical media, its protocol is not compatible with the DF1 protocol.

Native Communication Configuration Summary

Parameter	Description	Range	Default	User Setting
Protocol		DF1 Full-duplex DF1 Half-duplex Slave Modbus RTU Slave Auto-Sense	Auto-Sense	
Delay	Time between receiving a request and transmitting a response	0…75 ms	10 ms	
Communication Rate	RS-485 port communication bit rate	1.2 Kbps 2.4 Kbps 4.8 Kbps 9.6 Kbps 19.2 Kbps 38.4 Kbps 57.6 Kbps	9600 baud	
RS-485 Address	Uniquely identifies the Powermonitor device on a multi-drop network	1…247	Unit ID number	
Data Format	Data bits / Stop bits / Parity	8 / 1/ none 8 / 1/ even 8 / 1/ odd	8 / 1 / none	
Inter-Character Timeout	Mimimum delay between characters that indicates end of Modbus message packet	0…6553 ms	0 (= 3.5 character times)	
Error Checking		BCC, CRC	CRC	

Optional RS-232 Communication

Powermonitor 3000 units with a catalog number ending in -232 are equipped with an optional RS-232 serial port in addition to the native port. These units are set up at the factory to auto-sense the protocol used by the initiator or master device on the network. The configuration parameters are the same as the native RS-485 port with the following exception:

- Flow Control: Enables or disables hardware handshaking. Default disabled

The RS-232 communication standard supports point-to-point communication between TWO stations or nodes, with a maximum cable length of 15.24 m (50.0 ft). You may not use the optional RS-232 port and the native RS-485 port at the same time.

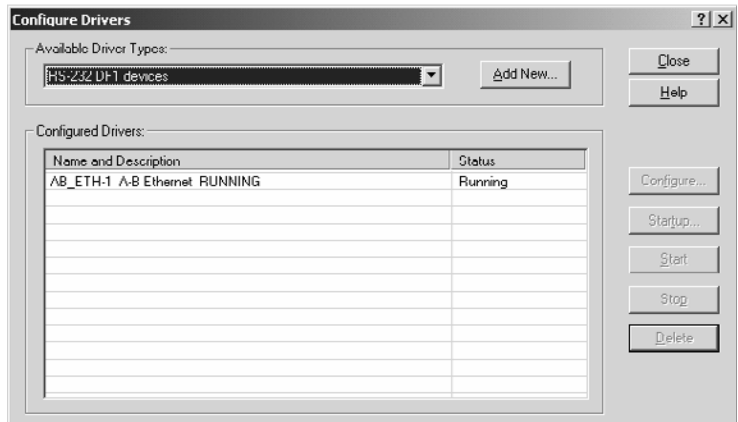
Optional RS-232 Communication Configuration Summary

Parameter	Description	Range	Default	User Setting
Port	Select active serial port	RS-232 RS-485	RS-232	
Protocol		DF1 Full-duplex DF1 Half-duplex Slave Modbus RTU Slave Auto-Sense	Auto-Sense	
Delay	Time between receiving a request and transmitting a response	0…75 ms	10 ms	
Communication Rate	RS-485 port communication bit rate	1.2 Kbps 2.4 Kbps 4.8 Kbps 9.6 Kbps 19.2 Kbps 38.4 Kbps 57.6 Kbps	9600 baud	
Node Address	Uniquely identifies the Powermonitor device on a multi-drop network	1…247	Unit ID number	
Data Format	Data bits / Stop bits / Parity	8 / 1/ none 8 / 1/ even 8 / 1/ odd	8 / 1 / none	
Flow Control (Handshaking)	RS-232 hardware flow control	0 - none 1 - RTS/CTS	0 - none	
Inter-Character Timeout	Mimimum delay between characters that indicates end of Modbus message packet	0 to 6553 ms	0 (= 3.5 character times)	
Error Checking		BCC, CRC	CRC	

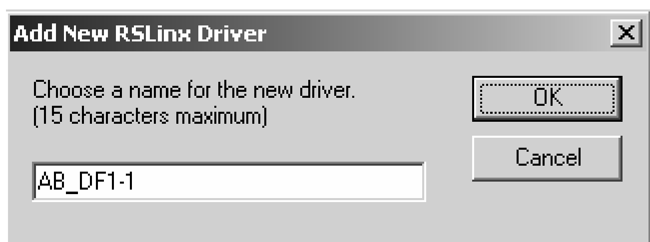
Auto Configure Instructions for DF1 Full-duplex

Verify that the latest EDS files have been installed for firmware revision 3. Follow these steps to configure DF1 full-duplex.

1. Select the serial DF1 driver from the selection menu and click Add New.



2. Select the default driver name or provide your own.

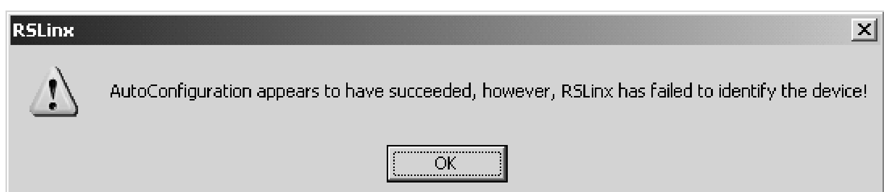


3. When presented with the configuration screen you may use the auto configure feature or enter your own configuration.

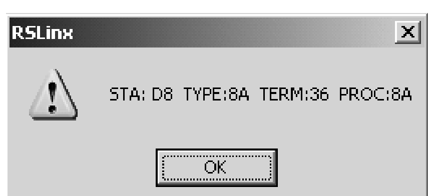
To use the auto configure you must first select the device as SLC-CH0/Micro/PanelView.

4. Click Auto Configure to start the process.

   The configuration returns with the following message. This message can be disregarded. Recognition of the device is provided after exiting the auto configuration routine.



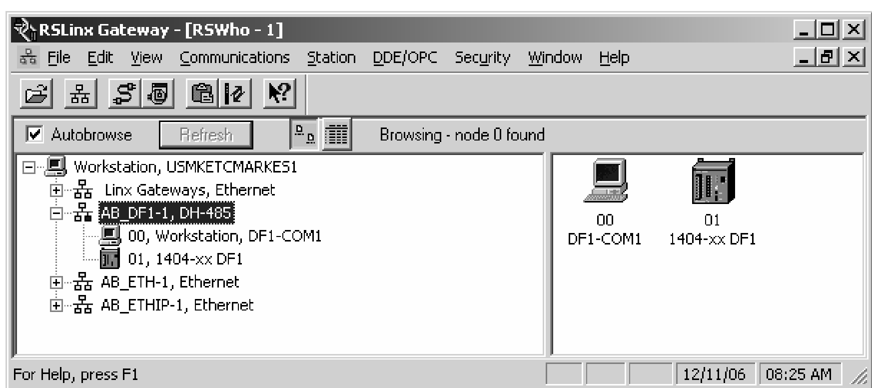
5. Click OK and disregard this message.



The successful configuration of DF1 full-duplex should look like this.

6. Return to the main browsing window of the RSLinx application and browse to the DF1 Driver for the Powermonitor 3000 unit.

   The result is an established communication link between the application and the powermonitor.



Optional Remote I/O Communication

Powermonitor 3000 units with a catalog number ending in -RIO are equipped with an optional remote I/O port in addition to the native port. This dual-port option allows the use of both ports simultaneously. The port emulates a logical quarter-rack of I/O. You must configure the rack address, group number, communication rate and last rack status. Configuration parameters are:

- RIO Rack Address: The logical rack address as configured in the remote I/O scanner module. Range 0…63 decimal, default 1
- RIO Group Number: Logical group number corresponding to the remote I/O port quarter rack. Range 0, 2, 4, or 6, default 0
- RIO Last Rack: If you are using a PLC-2 based system, set this flag for the highest-numbered rack / group addressed device on the channel. Range 0 or 1, default 0
- RIO Communication Rate: Sets the communication rate. Range: 57.6, 115 or 230 Kbps, default 57.6. All devices on the channel must be set to the same communication rate.

TIP For a logical rack address of 63 decimal, do not use group number 2, 4, or 6. Power monitor logical rack addresses are expressed in decimal. You may need to convert addresses to octal (range 0…77) for some PLC applications.

Optional Remote I/O Port Configuration Summary

Parameter	Description	Range	Default	User Setting
RIO Rack Address	Logical rack address as configured in the scanner	0…63 decimal	1	
RIO Group Number	Logical group number of quarter rack	0 = 1st quarter 2 = 2nd quarter 4 = 3rd quarter 6 = 4th quarter	0 = 1st quarter	
RIO Last Rack	Indicates highest-numbered logical rack / group address (PLC-2 based systems only)	0 = No 1 = Yes	0 = No	
RIO Communication Rate	Specifies the remote I/O communication rate	0 = 57.6 Kbps 1 = 115 Kbps 2 = 230 Kbps	0 = 57.6 Kbps	

Optional DeviceNet Communication

Powermonitor 3000 units with a catalog number ending in -DNT are equipped with an optional DeviceNet communication port in addition to the native port. Both may operate at the same time. You must configure the DeviceNet communication parameters before you connect the power monitor to a DeviceNet network. The DeviceNet configuration parameters include node address (or MAC ID), baud rate, and bus-off interrupt response.

- Node address: Range 0…64, default 63.
- Communication Rate: Range 125, 250, or 500 Kbps fixed rate, AutoBaud or Program Baud. Default 125 Kbps fixed rate
- Bus-off Interrupt: Specifies the response to a CAN bus-off interrupt.

Remotely settable node addressing (node address = 64) enables RSNetworx for DeviceNet to configure the node address of the power monitor. In addition, this allows client devices that support the DeviceNet Offline Connection Set to identify nodes with duplicate addresses and automatically reassign the addresses of the offending nodes.

AutoBaud allows the power monitor to automatically adjust to the prevailing baud rate of the DeviceNet network. Program Baud enables remote baud rate selection. With this option selected, you may use RSNetworx for DeviceNet to set the power monitor communication rate. Any change in communication rate takes place after power is cycled to the power monitor.

Bus-off Interrupt specifies the response of the power monitor to a CAN bus-off interrupt. The two options are Hold In Reset, which stops communication until power is cycled to the power monitor, and Reset and Continue, which resets communication and attempts to re-establish the communication link. Default is Hold in Reset.

You must configure each device on a DeviceNet network with a unique node address. Addresses 0 and 64 have special significance: 0 is most often used as a scanner address and 64 enables remotely settable node addressing as described above. You must also configure each device with the correct baud rate for the network. The DeviceNet network must be designed within its recognized design limitations of baud rate, trunk-line length, drop-line budget, and common-mode voltage drop for correct operation.

TIP

Some legacy power monitor units with optional DeviceNet communication do no support remotely settable node addressing, AutoBaud, or Program Baud. You can check whether your power monitor supports these functions by viewing the Optional Communication Card status by using your display module. Communication type 81 does not support these functions, type 88 does. You may also view this status item by a read of assembly instance 23, element 25.

Optional DeviceNet Communication Configuration Summary

Parameter	Description	Range	Default	User Setting
Node Address	DeviceNet node number (MAC ID)	0…64 decimal	63	
Baud Rate	DeviceNet Communication Rate	0 = 125 Kbps 1 = 250 Kbps 2 = 500 Kbps 3 = Autobaud 4 = Program Baud	0 = 125 Kbps	
Bus-off Interrupt	Specifies response to a CAN bus-off interrupt	0 = Hold CAN chip in reset 1 = Reset CAN chip and continue	0 = Hold in Reset	

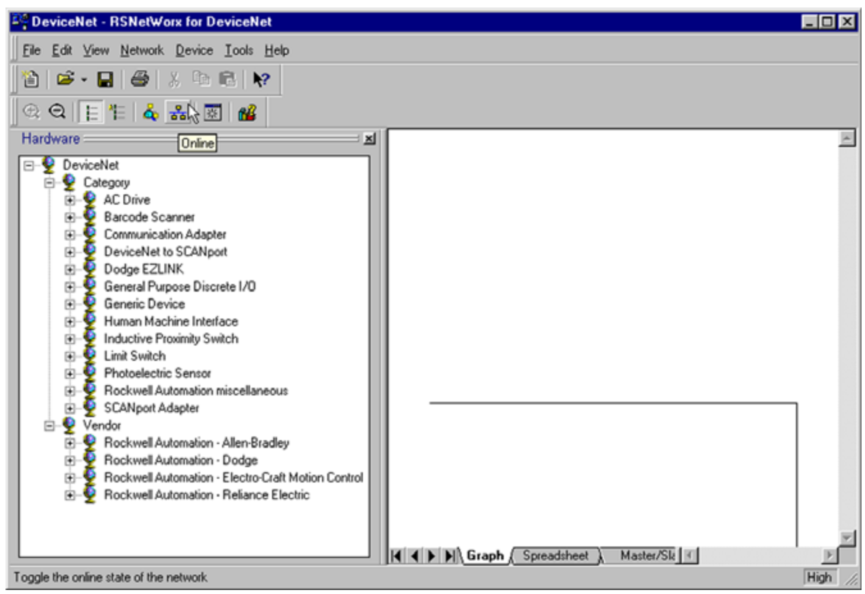
Configure the Powermonitor 3000 Unit by using RSNetworx for DeviceNet Software

TIP The DeviceNet network is an open-standard, multi-vendor communication network. Although other vendors offer DeviceNet configuration tools, all examples in this manual will depict the use of Rockwell Software RSNetWorx for DeviceNet software.

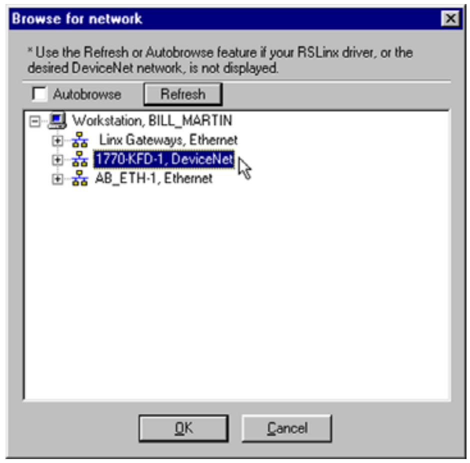
1. Launch RSNetWorx for DeviceNet software.

   At this point, the DeviceNet scanner module does not know what device to scan.

2. Click Online to list the available devices on the network.

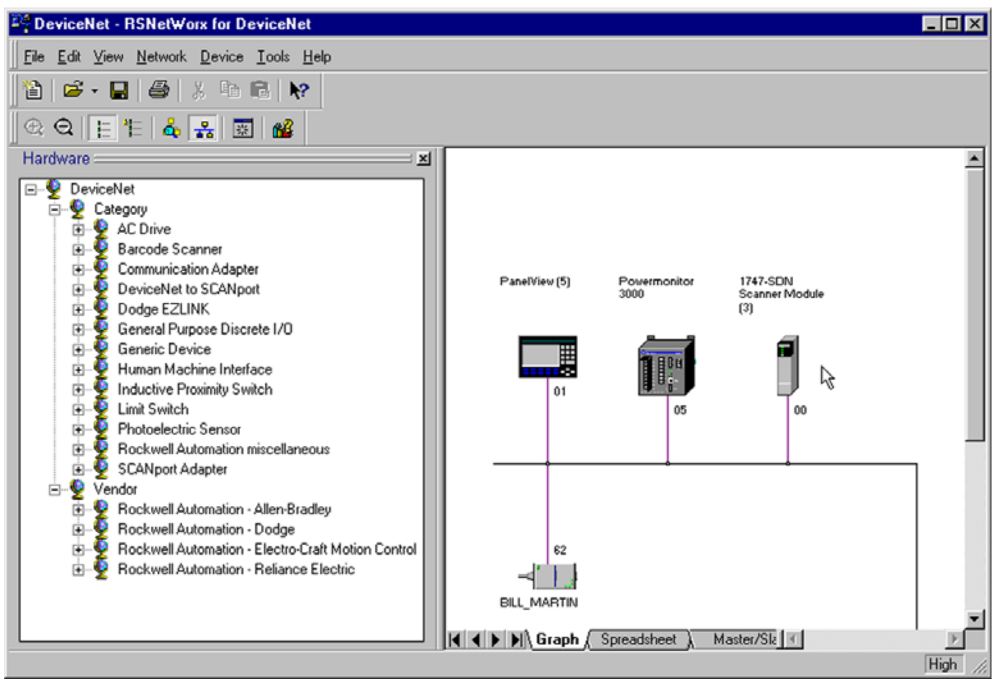


The available networks are displayed.



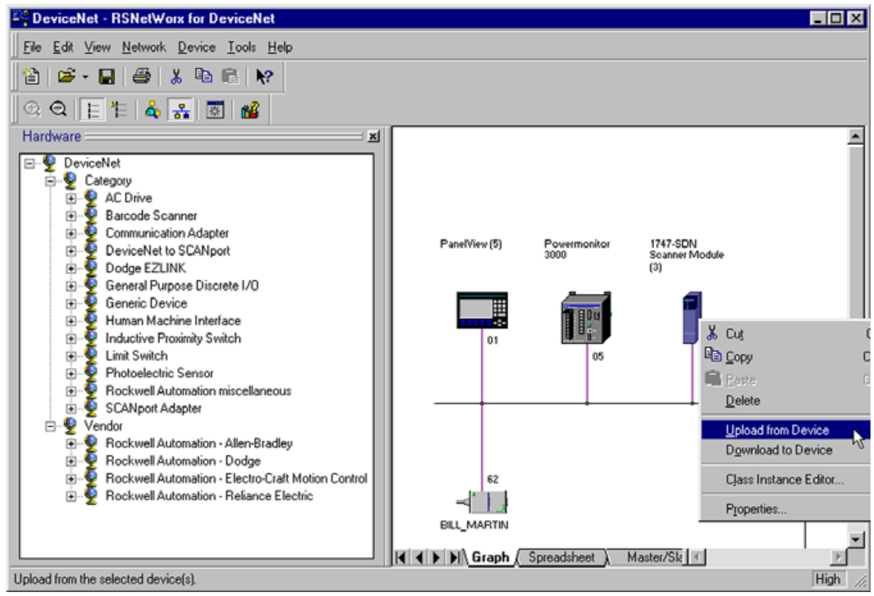
3. Click the network.

The network devices are displayed.



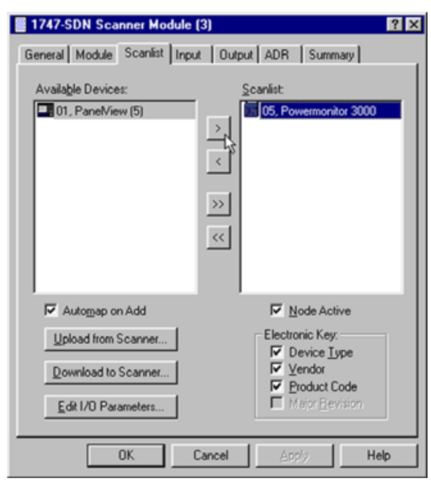
4. Read the scanner's configuration.

   Right-click on the DeviceNet scanner icon and upload the scanner's present configuration.



5. Edit the Scanner List.

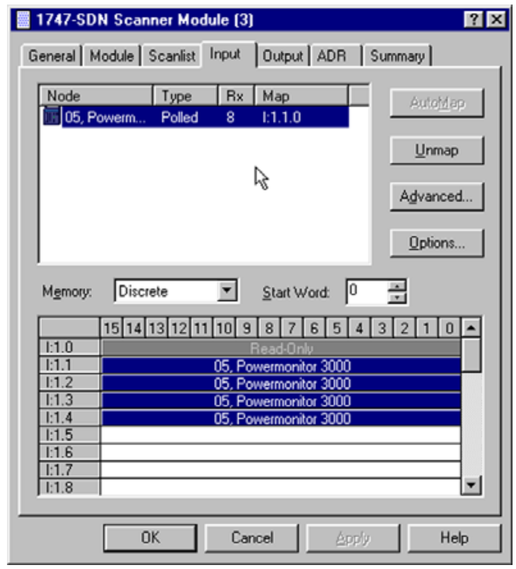
   The DeviceNet scanner needs to know how the information is coming from the Powermonitor 3000 unit. Select the Scan List tab and move the power monitor into the Scanlist set.



6. Edit the Data Table Map.

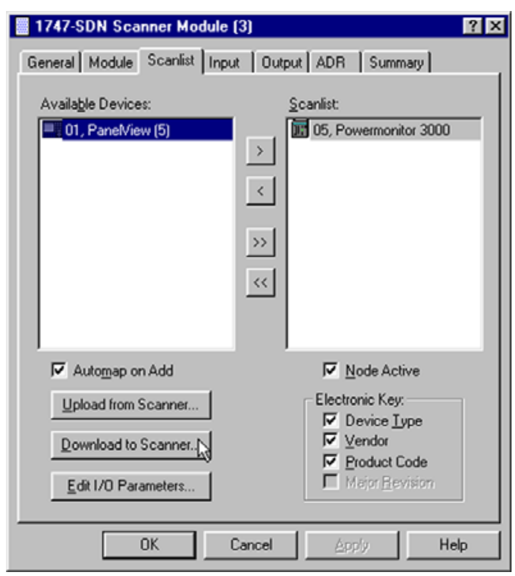
The DeviceNet scanner needs to know which bytes are scanned from the power monitor. Select the Input tab.

This lets you determine where the information is stored inside the scanner module. When finished configuring, click Apply.

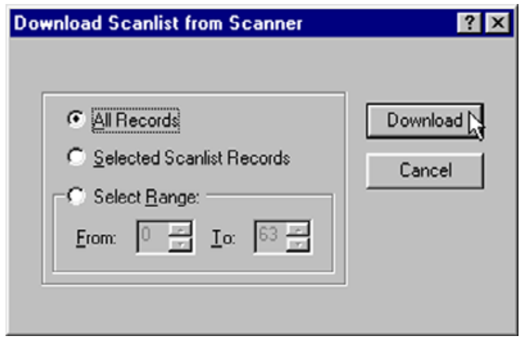


7. Click Download to Scanner.

All of the configuration data must be downloaded to the scanner module.



8. Download All Records, and allow the scanner to reset.



Afterwards, the DeviceNet scanner displays an 80, followed by a 00 when everything is configured properly.

TIP Powermonitor 3000 units Input parameters are Instance 1 and output parameters are Instance 2.

DeviceNet Single Instance Parameters

Powermonitor 3000 units with DeviceNet communication and master module firmware revision 4.*x* and later include 23 single-instance parameters. The data type for the single element parameters is little-Endian floating-point (identical to ControlLogix REAL). The configurable floating-point data format setting has no effect on the single element parameters.

Refer to Appendix A for a list of parameters included.

You may use RSNetWorx for DeviceNet to view the parameters and their values. You may need to update the DeviceNet power monitor eds files to view parameters.

Optional Ethernet Communication

Powermonitor 3000 units with a catalog number ending in -ENT are equipped with an optional Ethernet 10/100BaseT communication port and a native RS-485 port in a dual-port configuration that allows simultaneous operation of the ports. You must configure the communication parameters before you connect your power monitor to an Ethernet network. See your network administrator for assistance in setting the communication options.

Configuration parameters include the following:

- IP (Internet Protocol) address
- Subnet Mask
- Gateway IP address

The IP Address uniquely identifies your Powermonitor 3000 unit on the network. You configure the unit's IP address the way it is most commonly expressed, as four decimal numbers connected by decimal points: aaa.bbb.ccc.ddd. You may set each number (also called byte or octet) within the range of 0…255 decimal. The default IP address is 192.168.254*x*, where *x* is the factory-assigned Unit ID number. An IP address of 255.255.255.255 is not permitted.

IMPORTANT	The IP address for your power monitor must not conflict with the IP address of any other device on the network. Contact your network administrator to obtain a unique IP address for your unit.

The IP address is a 32-bit binary number, which consists of the network address (NetID) and the machine address (HostID). The Subnet Mask defines the boundary between the NetID and HostID in the IP address. Each 1 bit in the subnet mask represents the NetID and each 0 represents the HostID. Here is an example.

IP Address	(decimal):	192	.1	.1	.207
	(binary):	11000000	.00000001	.00000001	.11001111
Subnet Mask	(decimal):	255	.255	.255	.0
	(binary):	11111111	.11111111	.11111111	.00000000
		--------	Net ID	--------	-Host ID-

In this example, the NetID is 192.1.1.0 and the HostID is 0.0.0.207. The relationship between NetID and HostID depends on the IP address class, the discussion of which is beyond the scope of this document (the example uses a Class C IP address). Devices on the same subnet can communicate directly; devices on different subnets may communication with each other only through a gateway or router.

The Gateway IP Address defines the address of the gateway or router on the unit's subnet that is used to route messages to other subnets for wide-area networking. Default: 128.1.1.1.

Optional Ethernet Communication

Parameter	Description	Range	Default	User Setting
IP Address Bytes 1…4	Unit IP address in format aaa.bbb.ccc.ddd.	0…255 decimal, each byte	192.168.254.UnitID	
Subnet Mask Bytes 1…4	Subnet mask in format aaa.bbb.ccc.ddd	0…255 decimal, each byte	255.255.255.0	
Gateway IP Address Bytes 1…4	Gateway IP address in format aaa.bbb.ccc.ddd	0…255 decimal, each byte	128.1.1.1	

Optional ControlNet Communication

Powermonitor 3000 units with a catalog number ending in -CNT are equipped with an optional redundant ControlNet port and a native RS-485 port in a dual-port configuration that allows simultaneous operation of the ports. You must configure the communication parameters before you connect the power monitor to a ControlNet network.

The only configuration parameter is the ControlNet node number (also called MAC ID). The range of this parameter is 1…99 with a default of 99. A node number of 0 is typically used as the address of a ControlNet scanner.

Data Messaging Overview

Through communication, the power monitor becomes an effective source of power and energy data to enterprise information and automation systems. This section of the manual provides an overview of data messaging with the power monitor. Following the overview, discussions will focus on the details of messaging using specific communication types (for example, serial, remote I/O, DeviceNet, and Ethernet).

The power monitor is a read/write data server. It does not initiate data messages, but responds to messages from client devices. Its data is organized in data tables similar to those found in a SLC 5/03 programmable controller.

The primary methods to communicate with a power monitor include the following:

- Table Writes - A client may write a table of data to the power monitor. Generally, only full data tables may be written. Data writes may be performed to configure device features, set the date and time, reset or preset energy counters, and select records for subsequent reads.
- Single Element Writes - Beginning with version 4 master module firmware, a client may enable single-element writes by writing a valid password to the Single Element Password Write table. Single element writes are disabled again after 30 minutes of inactivity.
- Simple Data Reads - A client may read metering or configuration data. The client may read an entire data table or any number of consecutive data elements up to the table boundary.
- Indexed Data Reads - The power monitor parses large data structures such as logs, oscillograms, harmonics and transient captures into data blocks, records and/or channels. These records are transferred to an interface table. The client selects the read-back mode and/or record, reads the interface table and reassembles the original data structure.
- I/O Type Communication - The power monitor supports polled, change-of-state and/or cyclical implicit I/O messaging, depending on the communication options.

The specific communication setup depends on the communication port type and protocol, whether serial, Ethernet, or others, as well as the type of device controlling the communication. The following sections provide more detail.

Powermonitor 3000 Unit Data Table Attributes

Powermonitor 3000 unit data table attributes include their addressing, data access, number of elements, data type, and user-configurability.

Address - Data tables are addressed in a number of ways, depending on the type of communication and the protocol being used.

- For serial communication (native RS-485 and optional RS-232) and optional Ethernet CSP/PCCC communication, the CSP (Client Server Protocol) File Number identifies the table (and its data type) in message instructions, topic configuration or communication commands.

IMPORTANT	CSP file numbers are based on SLC 5/0x data table addressing. Because SLC 500 data tables 1…8 are assigned specific data types, file numbers lower than 9 are not used in the Powermonitor 3000 unit.

- For remote I/O communication, a unique Block Transfer Size identifies the data table to read or write using a Block Transfer instruction.
- For optional DeviceNet and EtherNet/IP communication, a CIP (Control and Information Protocol) Assembly Instance identifies the data table.

Data Access - Data tables may be read-only or read/write.

Number of Elements - the number of unique data values contained in the table. The number of words or bytes this represents depends on the data type.

Data Type - Specified as floating-point or integer. Each floating-point element consists of two 16-bit words or four 8-bit bytes of data. Each integer element consists of one word or two bytes.

User-configurability - This attribute determines whether you may configure the content and/or length of the data table.

Let's look at the Date and Time table as an example.

- CSP file number: N11
- Remote I/O BT length: 12
- CIP assembly instance: 6 (Write) or 7 (Read)
- Data table name: Date and Time
- Data access: Read/write
- Number of elements: 8
- Data type: Integer
- User-configurable: No

The power monitor data tables are listed in Appendix A. The table on page 188 shows a summary of all the data tables.

Expressing Data in Data Tables

The power monitor may express metering data in several formats in the communication data tables.

Floating-point data type is used to express most metering results. The trend log, min/max log and the user-defined data table also return values in floating-point format. The power monitor uses the IEEE 754, 32-bit floating-point format that is compatible with Allen-Bradley PLC-5 and SLC 500 controllers.

Modbus float data type returns IEEE 754 floating point values in a big-endian two-register array.

Integer data type (16 bit) is used in most configuration data tables and some results data tables.

Integer array format is used to express real, reactive and apparent energy results. Each of these values is expressed as an array of five integer values, each scaled by a different power of ten (10^9, 10^6, 10^3, 10^0, 10^{-3}).

Refer to Metering Real and Apparent Energy Results Parameters on page 210 for additional detail.

Integer/exponent format is used for some specific table entries such as IEEE-519 short-circuit current. The integer element is in the range of 0…999 or 9999 and a typical exponent element ranges from -4…21.

Timestamp format. The power monitor expresses timestamps in an array of four data table elements: Year, Month/Day, Hour/Minute, Second/ Hundredth of a second

Each timestamp parameter (except the Year) is a combination of its first and second element. For instance, the Month is the parameter value divided by 100 and the remainder is the Day.
Example: 1230 = December 30th. The timestamp data type may be integer or floating-point and depends on the data table.

Other Common Data Table Elements

The power monitor uses several common data table elements in a number of data tables. These include:

- Password: A valid password must be written to change configuration settings or issue commands. For selecting records to read back, you may write either a valid password or a value of -1. Default 0000, range 0000…9999.
- Record identifier: The power monitor assigns event log records, oscillography and transient captures and other items unique identification numbers. These numbers typically begin at 0, increment by 1 each time a new record is created, and roll over to 0 once they reach their maximum value, typically 32,767. The data client may use the record identifier to associate records in different data tables or to ensure that subsequent reads contain fresh data.
- DeviceNet unique write identifier: The DeviceNet communication port on Powermonitor 3000 models, with optional DeviceNet communicaitons, discards duplicate identical messages. For that reason, read-back selection tables include a DeviceNet unique write identifier element. The data client changes (usually, increments) the value of this element each time it writes an otherwise identical message.

Writing Data to Data Tables

The power monitor contains a number of writeable data tables. These tables have read/write access, so a client may read their current content or write new content.

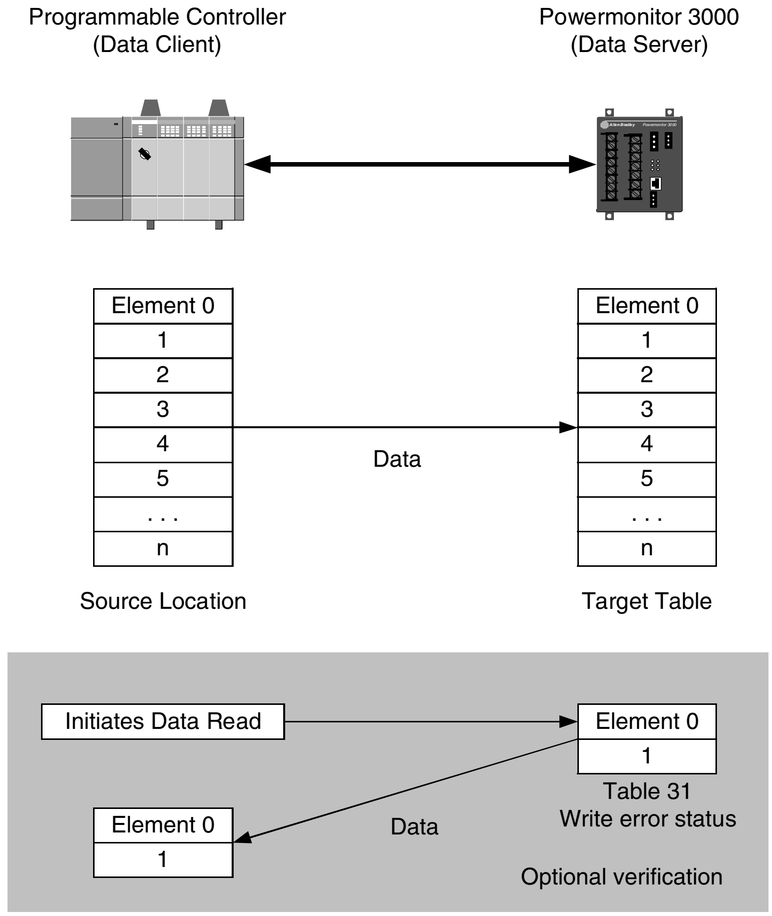
A valid write to a data table must meet the following general criteria:

- The length of the source data array must equal the data table length. Note that the same data table may have a different length in various power monitor models.
- The entire data table must be written in one pass.
- The first element in the source data array must generally contain the correct password (or a value of -1 for read-back data selection).
- The source and destination data type must match, for example, floating point or integer.
- Each element of the source data array must be within the legal range listed in the data table specification.
- Reserved elements must be the correct value, usually 0.
- For DeviceNet optional communication only, each consecutive write must be unique.

You may read the Write Error Status table after writing to a data table to verify that the write was valid and accepted by the power monitor. If there was an error in the last write, the Write Error Status indicates the CSP file or assembly instance (DeviceNet network only) number and the offending element number.

You may write data to the power monitor for basic and advanced device configuration, to set the time and date, to set up setpoints, logs, oscillography and transient analysis, and to select records to be read back from indexed data reads such as harmonics, oscillography and logs.

Data Table Write Flow Diagram



Single Element Data Writes

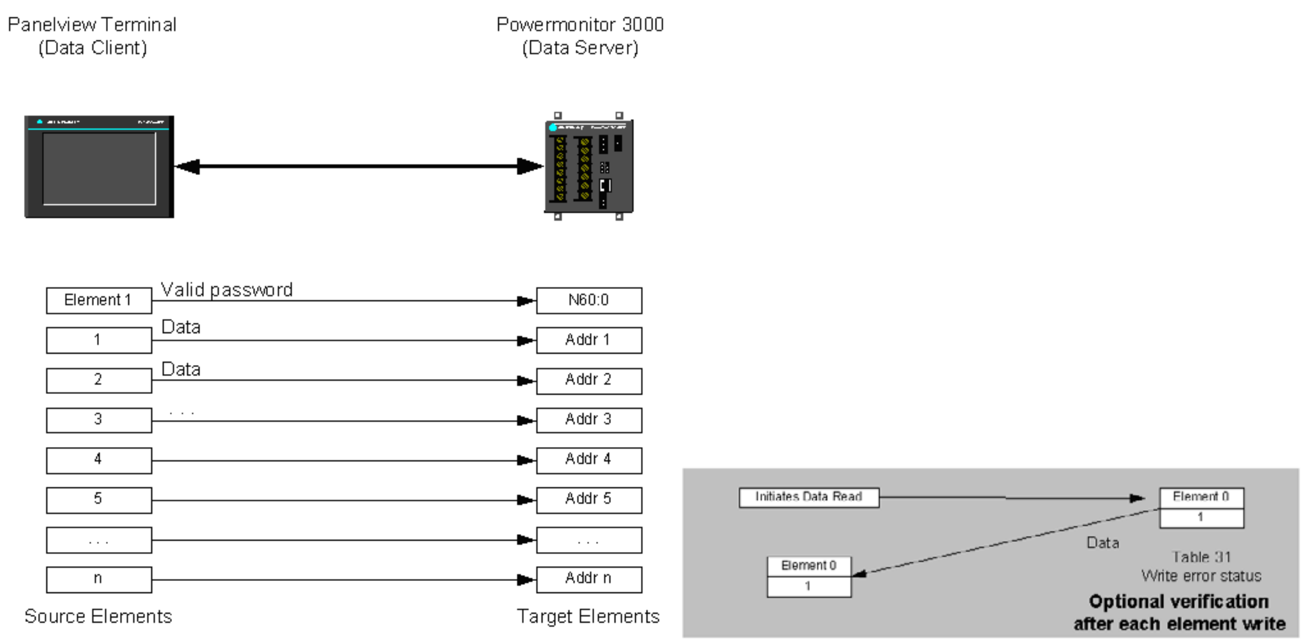
A single element write to a data table must meet the following general criteria:

- A valid password is written to Table 60, element 0 to enable single element writes.
- The source and destination data type and length must match, for example, floating point or integer, 4 bytes or 2 bytes.
- The source data element must be within the legal range listed in the data table specification.
- Reserved elements may not be written.
- For DeviceNet optional communication only, each consecutive write must be unique.
- After 30 minutes without a write, single element writes will be disabled.

You may read the Write Error Status table after writing an element to verify that the write was valid and accepted by the power monitor. If there was an error in the last write, the Write Error Status indicates the CSP file or assembly instance (DeviceNet network only) number and the offending element number.

You may write data to any writeable data table element in the power monitor.

Single Element Write Flow Diagram



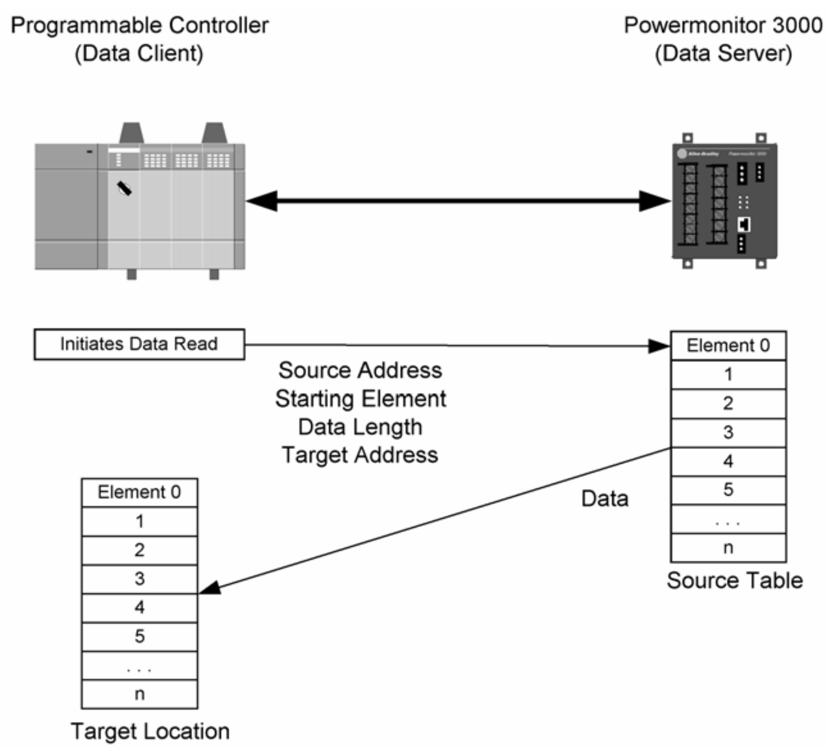
Simple Reads of Data Tables

The following considerations apply to simple power monitor data table reads:

- An entire data table or a contiguous portion (down to a single element) may be read, except for remote I/O and DeviceNet optional communication which require that an entire table be read
- The target data location should match the size and data type of the data requested

You may use simple reads to obtain basic metering data, configuration data, date and time, and the contents of the user-configured data table.

Simple Data Table Read Flow Diagram



Indexed Reads of Large Data Structures

Large data structures that require indexed reads are most often read into a computer-based application that performs further processing of the data. The power monitor parses logs, oscillograms, harmonic analysis results, setpoint status results, and other large data structures into individual records to be read by the client and reassembled into the original data structure.

You may select one of two modes for indexed table reads.

- Auto Increment - the power monitor automatically points to the next record following each read of the specified results table
- Manual Increment - the client specifies a record to be read during the next read of the results table by performing a write to the applicable read-back select table.

IMPORTANT	DeviceNet communication option supports only manual increment mode.

The client selects the read-back mode by writing to the Read-back Mode element in the appropriate read-back select table.

The Auto-increment mode provides the highest data throughput.

In Manual Increment mode, the client must alternate writes of the read-back select table with reads of the read-back table.

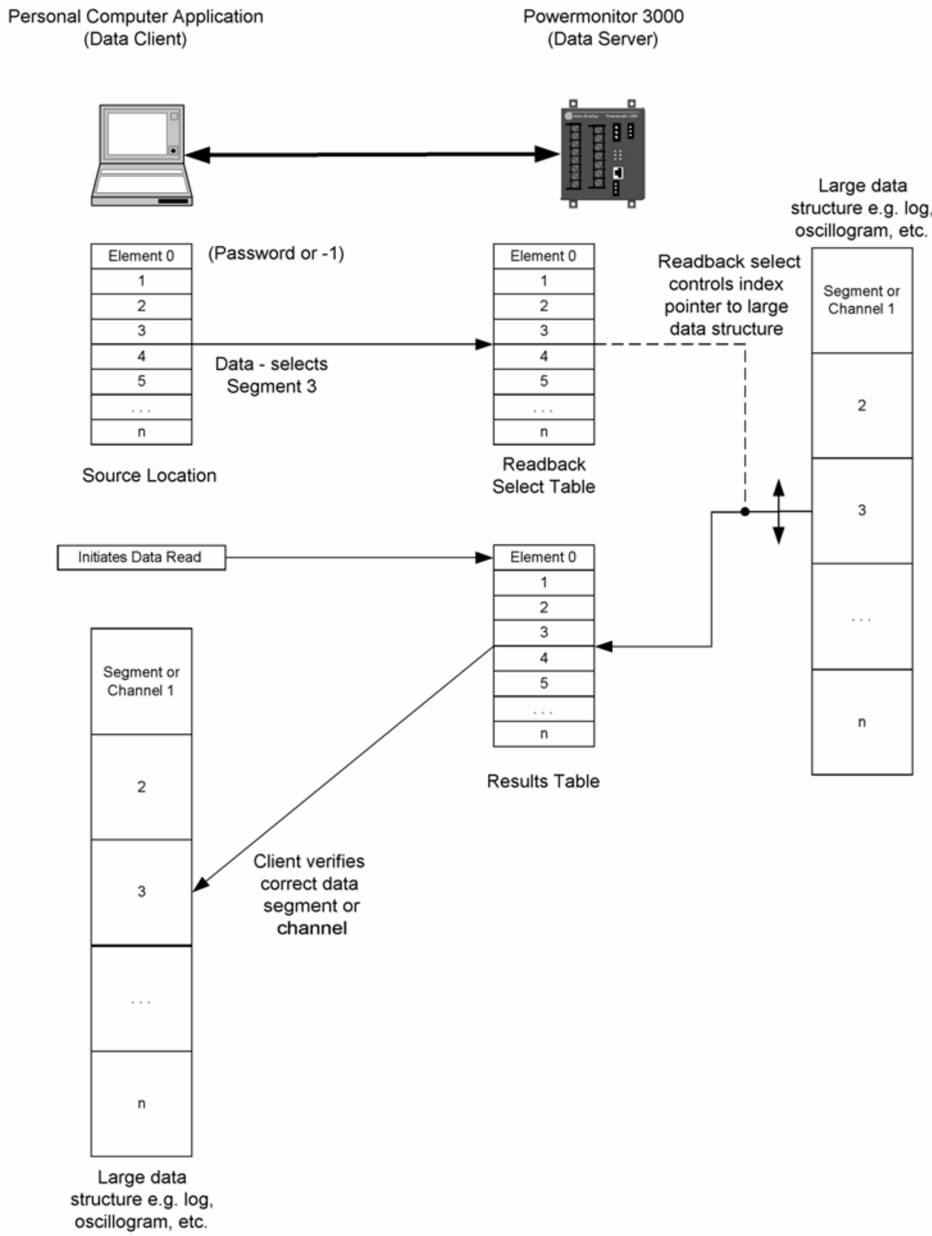
The Indexed Data Read, Manual Mode Flow Diagram shows the flow of alternating writes and reads required for the Manual Increment mode.

- First, the client writes to the appropriate read-back select table to identify the desired data block, record or channel.

  For selecting a read-back record, the client may write either a valid password or a value of -1 to the password element in the read-back select table

- After a short time delay, the client reads the results table, verifies that it is the desired record and adds it into the target data structure.
- The client repeats steps 1 and 2 until all the desired data is read.

Indexed Data Read, Manual Mode Flow Diagram



Refer to Chapter 5, Setpoint Programming and Operation; Chapter 7, Data Logging; and Chapter 8, Advanced Features for details of indexed mode data reads for each of these functions.

I/O Type Communication

Powermonitor 3000 units with optional remote I/O, EtherNet/IP, ControlNet, and DeviceNet communication provide I/O type (implicit) messaging.

Remote I/O units emulate a logical quarter rack on the I/O channel. The corresponding, two-word output and input image table elements are automatically scanned by the I/O scanner, and the data points they contain are available for use in the logic program of the controller associated with the I/O scanner.

In DeviceNet units, Instances 1 and 2 comprise the DeviceNet polled, change-of-state or cyclic connections. The default input table contains 6 integer typed elements and the output table contains two integer typed elements. You may configure instance 1.

Refer to the User-configured I/O Table discussion on page 122.

In EtherNet/IP and ControlNet units, Instances 1 and 2 comprise the Class 1 connection. As in DeviceNet units, Instance 1 contains 6 integer elements of input data and Instance 2 contains 2 integer elements of output data. You may configure Instance 1.

See the Remote I/O, DeviceNet, EtherNet/IP and ControlNet I/O Messaging Parameters table on page 191 for the content and format of the I/O messaging data tables.

Data Messaging-application Considerations

The power monitor supports a number of different communication networks and protocols. Each of these has unique characteristics and methods. The information in this section is provided to assist you in designing and implementing data messaging with the power monitor by discussing in detail the unique properties of the communication options.

Refer also to the Sample ladder diagrams in Appendix C.

Serial Communication Options

The native RS-485 and optional RS-232 communication ports provide basic serial asynchronous communication capabilities.

The RS-485 communication standard supports multi-drop communication between a master station and up to 31 slaves on a single network up to 1219 m (4000 ft) long. For satisfactory communication performance, however, we recommend connecting no more than 8…12 power monitors to an RS-485 multi-drop network.

The optional RS-232 communication port has several configuration settings that support the use of modems for point-to-point and point-to-multipoint communication. You may select Hardware Handshaking (CTS/RTS) and adjust the Delay parameter to match your choice of modem hardware. Please refer to Configuring Optional RS-232 Communication for detailed information on these settings.

The power monitor does not initiate messages nor does it support modem dial-out capabilities.

Allen-Bradley DF1 Half-duplex Protocol

The Allen-Bradley DF1 half-duplex slave protocol is supported by a number of Rockwell Automation and third party products.

Please refer to DF1 Protocol and Command Set Reference Manual, publication 1770-6.5.16, for further information.

The network master device must be configured as a DF1 polling master. All devices on the network must be set to the same baud rate. The node addresses of the power monitor must be listed in a permanent or temporary polling list of the master device, and the error checking must be set to CRC. When communication is established, the RS-485 or RS-232 RX and TX status LED indicators flashes alternately at a rapid rate. If you are using Rockwell Software RSLinx software as a polling master, the power monitor appears in RSWho if it is defined in the polling list. For best communication performance using RSLinx software, keep the number of concurrent clients to a minimum (for example, turn off the auto-browse function in RSWho).

To communicate with an Allen-Bradley PLC-5, SLC 500 or ControlLogix controllers, use message instructions that address the DF1 master port number, the power monitor node address, the power monitor data table address, (for example, F17:0 - Metering Power Results), and the length of the file in elements. The target file must be of the same data type as the power monitor data table, for example, integer or floating-point.

IMPORTANT	Because the floating-point word order in the ControlLogix controller is reversed from that in the power monitor, your ladder logic needs to reverse the word order so the data may be interpreted correctly. The swap byte (SWPB) instruction performs this function.

Because of the DF1 protocol's inherent handshaking, the completion of each message may be used to activate the next message, without any additional programmed delay.

Modbus RTU slave protocol

We assume that you are familiar with Modbus communication. The information provided in this section is general, rather than specific.

Refer to glossary at the end of this publication for definitions of unfamiliar terms.

For more information about the Modbus RTU Slave protocol, see the Modbus Protocol Specification (available from http://www.modbus.org).

Modbus is a half-duplex, master-slave communication protocol. The network master reads and writes coils and registers and obtains diagnostic information of the multiple slaves. The Modbus protocol allows a single master to communicate with a maximum of 247 slave devices (however no more than the physical limitations of the RS-485 or RS-232 ports permit). The master device on a Modbus network is not assigned an address.

Modbus messages are always initiated by the master. The slave nodes never transmit data without receiving a request from the master node. The slave nodes never communicate with each other. The master node initiates only one Modbus transaction at a time.

The power monitor supports Modbus RTU, the version of Modbus applied to serial communication in which each byte of data consists of two hexadecimal values. Modbus ASCII, Modbus Plus and Modbus TCP are not supported.

The power monitor does not initiate Modbus commands but responds to commands sent by the Modbus master. The following Modbus function codes are supported:

- 03 Read Holding Registers
- 04 Read Input Registers
- 16 Write Multiple Holding Registers
- 08 Diagnostics
  - 00 Echo Command Data
  - 02 Return Diagnostic Counters
  - 10 Clear Diagnostic Counters
- 06 Write Single Holding Register

Function 06, 16 and the sub function 10 of function 08 support Broadcast packets.

Refer to Appendix A for Modbus addresses of the power monitor data tables.

The power monitor supports zero-based addressing. The address ranges are arranged as follows (note that not all addresses in the range are used):

- 30,001…40,000 Modbus Input Register (Analog Input) Address Space
- 40,001…50,000 Modbus Holding Register (Analog Output) Address Space

The Modbus protocol supports four types of data: Discrete Input, Coil, Input Register and Holding Register. The power monitor supports Input Registers (read-only) and Holding Registers (read-write or write only).

Input Registers and Holding Registers are 16 bits long. Floating point values in the data tables are represented as big-Endian two-register arrays in IEEE-754 floating point format. The Modbus client application must be able to reassemble the two-word array into a valid floating-point value.

The power monitor returns the Modbus error codes shown in the table below when appropriate. In the event of an exception reply, not only is the exception code sent to the master device, but also the power monitor slave's diagnostic counter records the error code to further explain the error reason.

The data table number of error request and element offset of error request in the Write Error Status table is updated with the first Modbus address of the table and element offset that the incoming request packet attempts to write to.

Modbus Error Codes

Error Code	Description	Meaning	Response Exception Code
0	No error.		None
1	Function Code cannot Broadcast.	The function does not support Broadcast.	Nothing transmitted
2	Function Code not supported.	The controller does not support this Modbus function or sub-function.	1
3	Bad Command Length	The Modbus Command is the wrong size.	3
4	Bad Length	The function attempted to read/write past the end of a data file.	3
5	Bad Parameter	The function cannot be executed with these parameters.	3
6	Bad Table Number	The table number does not exist.	2
7	Bad Modbus Address	The function attempted to access an invalid Modbus address.	3
8	Table Write Protected	The function attempted to write to a read-only table.	3
9	Table Access Denied	Access to this table is not granted.	2

If a client device requests too large a data size, the power monitor returns the requested data padded with zeroes up to the requested data size rather than returning an error.

When the User-configured Table Setup table is used together with Modbus, the value for element 1 should be 1000.

The value for element 0 of the Write Error Status table is the first Modbus address of data table written to last.

For function code 03, 04, and 16, the number of words of user data is limited to 100. If it is over 100, exception code 3 will be returned to the master and error code 3 occurs.

For function code 16, if the data length is larger or less than the element number of the data table accessed, error code 4 occurs. It means the data length for function code 16 should be strictly the same as the size of the accessed data table.

If the data written to the power monitor by using function code 16 is outside of the legal range as shown in Appendix A, error code 5 occurs.

For function code 03, 04, and 16, if any undefined starting address is sent to the power monitor, exception code 2 is returned and error code 6 occurs. If the starting addresses other than the first Modbus address of the data tables are sent to the slave with function code 16, this error code also occurs.

For function codes 03 and 04, the starting address may be any address within the data table. However, for floating point data tables, one element occupies two Modbus addresses. Therefore, only odd Modbus address are allowed when accessing floating point data table. If the starting address is even, error code 7 occurs.

The Controller Command table is the only one table that has write only attribute. If you try to use function code 03 to read this table, error code 8 occurs and a 02 exception response packet is returned.

Auto-sense Protocol Selection

The primary purpose for auto-sense is to permit configuration by using RSPower or RSPowerPlus software on a point-to-point RS-485 connection by disabling the Modbus master station and enabling a DF-1 connection with RSLinx software. The port switches back to the Modbus protocol when it detects incoming Modbus data packets. Simultaneous use of Modbus and DF-1 master stations on the same network is not permitted or supported.

When auto-sense is selected, when a port configured as Modbus detects incoming DF-1 data packets, it automatically switches to the applicable DF-1 protocol at the same baud rate and other communication parameters. The port may return a communication error to the first non-selected packet and then switch protocols. The initiator should be set up to retry communication if it receives an error.

DeviceNet Communication Option

The Powermonitor 3000 units with optional DeviceNet communication operate as a slave device on a DeviceNet network. It serves data to a DeviceNet master station such as a PLC-5 or SLC 500 DeviceNet scanner module, a ControlLogix DeviceNet bridge module, a PanelView operator terminal and RSLinx direct and pass-thru DeviceNet drivers. It supports I/O (implicit) Messaging, Explicit Server Messaging and the explicit Unconnected Message Manager (UCMM) as discussed below.

I/O Messaging

The power monitor supports polled, change-of-state and cyclic I/O messaging by using assembly instances 1 for input data and 2 for output data. The default input messaging table size is 6 integer elements and the output table size is 2 integer elements. This corresponds to a DeviceNet scanner mapping of 12 Rx and 4 Tx bytes.

See the Remote I/O, DeviceNet, EtherNet/IP and ControlNet I/O Messaging Parameters table on page 191 for the contents of the default I/O messaging tables.

TIP

You may reconfigure the input messaging table (instance 1) by selecting up to 23 integer or 14 floating-point parameters through a table write to assembly instance 35.

Refer to User-configured I/O on page 122.

If you change the size of the input table, you must also re-map the inputs into the DeviceNet scanner by using RSNetworx for DeviceNet software.

Polled I/O messaging can automatically provide fresh data at update rates as fast as 100 ms. The power monitor supports both Every Scan and Background polled messaging. You select the poll type and polling rate by using RSNetworx for DeviceNet software.

- Every Scan: Polls the power monitor once per scan. Set the Interscan Delay to at least 100 ms. An Interscan Delay of less than 100 ms slows the power monitor's delivery of metering information.
- Background: Polls the power monitor at intervals you specify by using the Foreground to Background Poll Ratio. So long as the power monitor is polled no more frequently than every 100 ms, it operates and communicate at its optimal rate. You may calculate the total scan time with this formula.

$$\text{Total Scan Time} = (1 + R) \bullet D$$

Where:
R = Foreground to Background Poll Ratio
D = Interscan Delay

Change of State I/O messaging (COS) reports data only when the content of the I/O table changes. COS messaging can be more efficient for discrete applications because it tends to reduce the network traffic. If you have configured the input message table to include metering data, however, COS may reduce the network efficiency because the data constantly changes.

Cyclic I/O messaging reports data periodically according to a time increment you configure.

COS and Cyclic messaging typically reduce the network bandwidth loading compared with Polled messaging. To optimize explicit messaging performance, use a Background Polled I/O connection with a high foreground to background poll ratio.

To help obtain optimal network operation, verify the following settings by using RSNetworx for DeviceNet software, looking at the scanner Properties dialog:

- For Polled I/O messaging, verify that the effective polling rate (or scan time) is less than the expected packet rate (EPR) to prevent time-out errors. You may find the EPR on the Module by clicking Advanced.
- For COS or Cyclic I/O messaging, verify that the COS/Cyclic Inhibit Time is less than the EPR and that the ACK time out is set appropriately. You may find these parameters on the Scanlist by clicking Edit I/O Parameters.

Please contact Rockwell Automation technical support if you find that the default settings do not result in adequate network performance.

Explicit Messaging

Use explicit messaging to read and write all data tables other than the I/O messaging table. The specific details of explicit messaging depend upon the master device that initiates the message. The example in this section uses an Allen-Bradley SLC 500 controller and DeviceNet Scanner (1747-SDN) as the master.

Refer to the DeviceNet Scanner Module Installation Instructions, publication 1747-IN058, for a detailed description of explicit message programming in the SLC 500 controller.

Please refer to the Rockwell Automation KnowledgeBase for other examples of explicit messaging to a Powermonitor 3000 unit.

In the SLC 500 and PLC-5 controllers, you assemble the explicit message header in an integer file and transfer it to the scanner module. When the response is received, you transfer the response from the scanner to another integer file. The message header consists of 6 words organized as follows.

Explicit Messaging

Message	Word	High byte	Low byte
Header	0	Transmit ID	Command
	1	Port	Size
	2	Service	MAC ID
Body	3	Class	
	4	Instance	
	5	Attribute	
	6	Data to write if applicable	
	7		
	. . .		
	n		

Word 0 contains a transmit identifier (TXID) and command byte. Assign each explicit message a unique TXID in the range of 0…255 decimal (0 to FF hex). The TXID is used to identify the response to this message request. These are valid command codes:

- 1 hex = Execute transaction block. Use this command first to start the explicit message.
- 4 hex = Delete transaction from response queue. Use this command after you copy the response from the scanner to remove the response from the scanner and enable further explicit messages.

Word 1 contains the DeviceNet scanner port number and the transaction body size in bytes. The SLC 500 scanner module uses only port 0; a PLC-5 DeviceNet scanner module has two ports, 0 and 1. For a read request, the transaction body size is 3 words, therefore 6 bytes.

See the Explicit Messaging table on page 98 for more information.

For a write, the body size is the data size in bytes plus the 6-byte path (class/instance/attribute).

Word 2 contains the DeviceNet service code and the MAC ID or node number of the server device, in this case, the power monitor. Valid service codes for use on Class 4 assembly instances include the following:

- 0E hesx (14 decimal) = Get_Attribute_Single. Requests a read of the entire assembly instance defined in the transaction body.
- 10 hex (16 decimal) = Set_Attribute_Single. Writes the data contained in the message to the assembly instance defined in the transaction body.

TIP A convenient way to build Words 0, 1, and 2 is to multiply the high byte value by 256 and add the low byte value, using decimal values for each parameter. Example: TXID = 121; Command = 1. Word 0 = 121*256 + 1 = 30977.

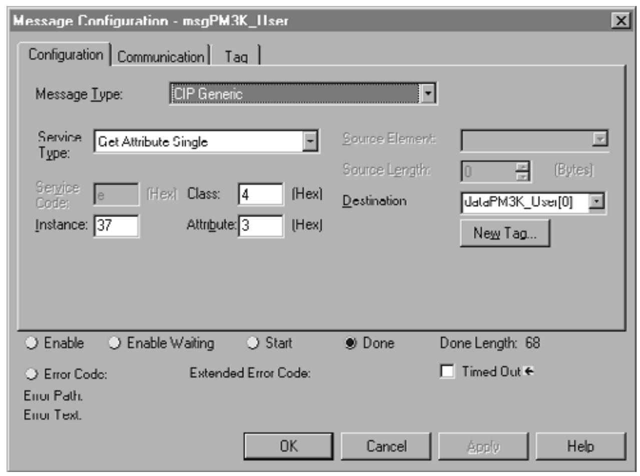
Words 3…5 comprise the DeviceNet path: Class, Instance, and Attribute. For the power monitor data tables, Class = 4, Assembly Objects; Attribute identifies the data table, and Attribute = 3, data.

Word 6 and following words contain data to write to the power monitor.

Once the message is assembled, your ladder program transfers the integer file to the scanner module M0 file starting at word 224 (SLC 500 controller) or block transfers the 64-word integer file to the scanner module (PLC-5 controller).

The ControlLogix controller includes in its instruction set a CIP Generic message instruction that builds the transaction header and path from information you enter into the message setup dialog in RSLogix 5000 software.

Message Setup



The example above is a ControlLogix message instruction to read the user-configured table, assembly instance 37.

TIP

Because the floating-point word order in the ControlLogix controller is reversed from the default DeviceNet floating-point word order setting in the Powermonitor 3000 unit, your ladder logic will need to reverse the word order so the data may be interpreted correctly. The SWPB instruction performs this function. You may also select little-Endian word order, however, this may be incompatible with RSPower and RSEnergyMetrix software.

Up to four concurrent explicit messaging connections are supported by the DeviceNet communication port.

DeviceNet Message Types

The power monitor supports the following DeviceNet message types.

DeviceNet Message Types

Group	CAN Identifier Field	Message Type
1	01101xxxxxx	Slave's I/O COS or Cyclic message
	01111xxxxxx	Slave's I/O poll response or COS / Cyclic ACK message
2	10xxxxxx010	Master's COS / Cyclic ACK message
	10yyyyyy011	Slave's explicit / unconnected response message
	10xxxxxx100	Master's explicit request message
	10xxxxxx101	Master's I/O poll command / COS / Cyclic message
	10xxxxxx110	Group 2 only unconnected explicit message request
	10xxxxxx111	Duplicate MAC ID check message
3	11101xxxxxx	Unconnected explicit response
	11110xxxxxx	Unconnected explicit request
4	Not used	

xxxxxx = Destination MAC ID / node no. (6-bit field)

yyyyyy = Source MAC ID / node no. (6-it field)

DeviceNet Class Services

As a group 2 slave device, the power monitor supports the following class and instance services.

DeviceNet Class Services

Service Name	Service Code (hex)	Service Code (decimal)
Reset	05	05
Get_Attribute_Single	0E	14
Set_Attribute_Single	10	16
Allocate_Group_2_Identifier_Set	4B	75
Release_Group_2_Identifier_Set	4C	76

DeviceNet Object Classes

The power monitor supports the following DeviceNet object classes.

DeviceNet Object Classes

Class (hex)	Object
01	Identity
02	Message Router
03	DeviceNet
04	Assembly
05	Connection
2B	Acknowledge handler

Indexed Data Table Reads by using DeviceNet Communication

Powermonitor 3000 units with optional DeviceNet communication support only manual-indexed mode for reading large data structures such as oscillograms, setpoint status, logs, and harmonics.

Refer to the appropriate sections of this manual for detailed information.

DeviceNet Unique Write Identifier

The communication interface used in the DeviceNet communication option is programmed to reject duplicate write messages. Because of this, all writeable data tables in the power monitor include an element called DeviceNet unique write identifier. In many cases, your client application may ignore this element because the message data is unique. However, where your client application performs repeated identical writes, it should increment the DeviceNet Unique Write Identifier with each new message. An example of this would be reading the Event Log or Trend Log.

Ethernet Communication Option

The Powermonitor 3000 units with optional Ethernet communication operates as a slave device on the Ethernet network. You can use your web browser and the unit's built-in web server to access metering and stats data.

Starting with Master Module firmware version 4 and Ethernet firmware version 3, the Ethernet port may be configured for the following protocol selections:

- CIP - This default selection maintains compatibility with prior firmware versions. It provides support for CIP generic messaging as well as PCCC encapsulated messaging. It must be selected for compatibility with RSEnergyMetrix, RSPower, and RSPowerPlus software.
- CSP - This optional selection supports legacy client/server protocol (CSP) messaging with older PLC and SLC controllers and certain 3rd-party 'A-B Ethernet' drivers.
- CIP/CSP - This dual stack protocol selection may be used when both third-party CSP drivers and CIP messaging are desired. This selection is incompatible with RSEnergyMetrix, RSPower, and RSPowerPlus software.

The following table summarizes the protocol selection options.

Protocol Selection Table

Protocol	RSLinx Connection Type	Pure CSP Client Compatibility(1)	RSEnergyMetrix and RSPower Compatibility	Logix and MicroLogix Compatibility	Implicit Messaging Compatibility
CIP (default)	EtherNet/IP	No	Yes	Yes	Yes
CSP	DF1 (CSP)	Yes	No	No	No
CIP/CSP	DF1 (CSP)	Yes	No	Yes	Yes

In addition to the selectable protocols listed above, the Ethernet port supports Modbus TCP beginning with Master Module firmware version 4 and Ethernet firmware version 3.

Refer to the description of the Modbus RTU protocol beginning on page 92 for further information.

The Ethernet port supports up to 64 concurrent connections.

The power monitor supports the following network requests.

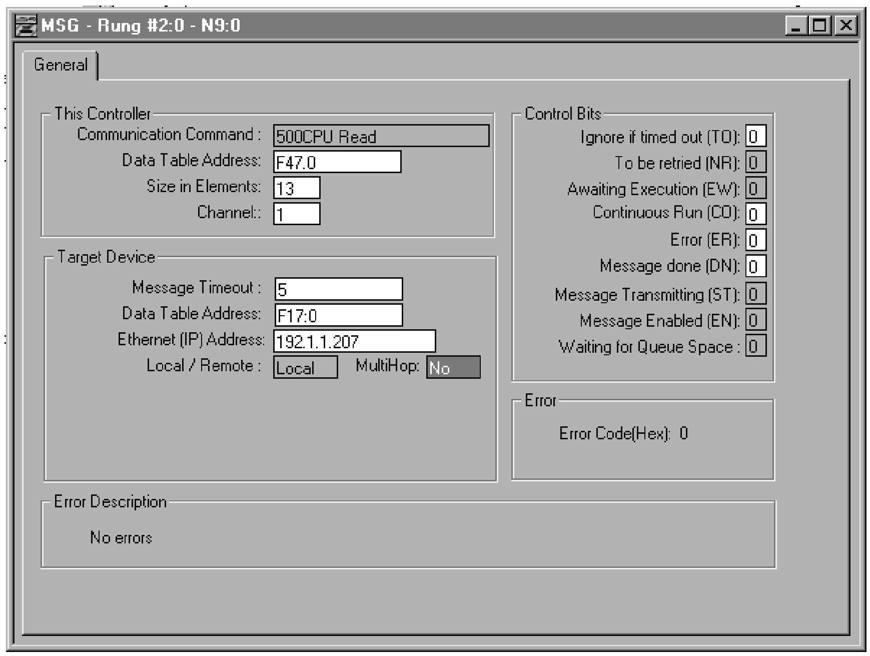
Ethernet Message Types

Message type
CIP PLC-5 Typed Write
CIP PLC-5 Typed Read
CIP Generic Assembly Object (class 04), Get & Set Attribute Single for Attribute 3 (data)
CIP Generic Assembly Object (class 04), Get Attribute Single for Attribute 3 (size)
CIP SLC 500 Typed Write
CIP SLC 500 Typed Read
CIP Data Table Read (using CSP/PCCC addressing for example F15:0)
CIP Data Table Write
CSP / PCCC PLC-5 Typed Write
CSP / PCCC PLC-5 Typed Read
CSP / PCCC Protected Typed Logical Read, 2 address fields
CSP / PCCC Protected Typed Logical Read, 3 address fields
CSP / PCCC Protected Typed Logical Write, 2 address fields
CSP / PCCC Protected Typed Logical Write, 3 address fields
CSP / PCCC Word Range Read
CSP / PCCC Word Range Write
CSP / PCCC Diagnostic Loopback

Ethernet PCCC/CSP protocol

You may set up messaging from legacy controllers such as PLC-5 and SLC 500 controllers, to a power monitor with optional Ethernet communication, by using peer-to-peer message instructions. In the message setup, specify the controller data table address, size of the data in elements and the channel the message instruction is to use. For the target device (power monitor), specify its IP address and data table address. In the example message setup dialog below, the SLC 500 controller is reading the Power table (F17:0) from a power monitor with IP address 192.1.1.207.

SLC 5/05 Controller to Power Monitor Message Detail Screen Example



If you want to execute a sequence of messages, condition each message in the sequence with the previous message's done or error status, and include a brief programmed time delay between messages so that each message receives fresh data and the communication port is not overloaded. As a starting point, program the inter-message time delay at 100 ms.

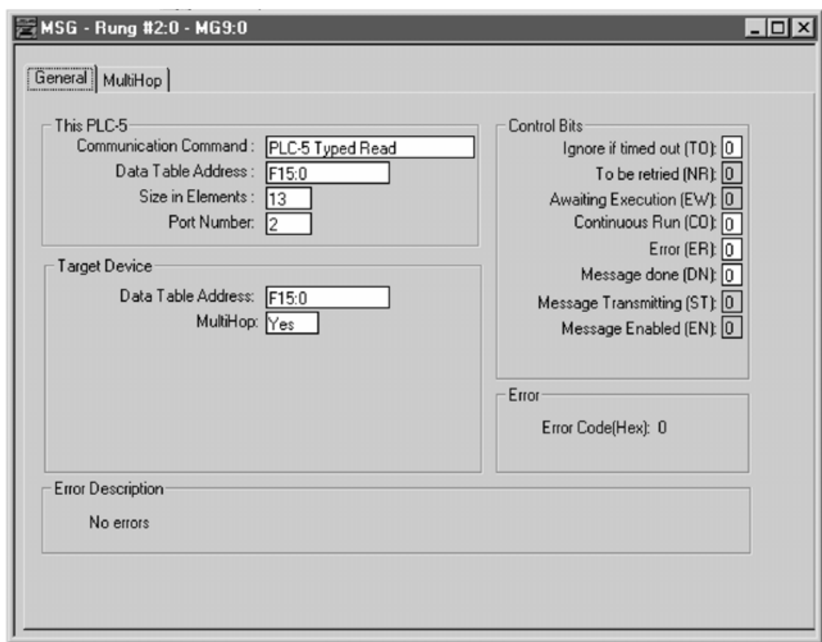
EtherNet/IP (CIP) Protocol

Allen-Bradley controllers since the release of the ControlLogix platform have used the EtherNet/IP or CIP protocol. In particular, PLC-5 and SLC 5/05 controllers at or later than the following series and revision levels support CIP communication:

- PLC-5/xxE Series C/ Rev. N
- PLC-5/xxE Series D/ Rev. E
- PLC-5/xxE Series E/ Rev. D
- SLC 5/05 Series A FRN 5 (OS 501)
- SLC 5/05 Series C

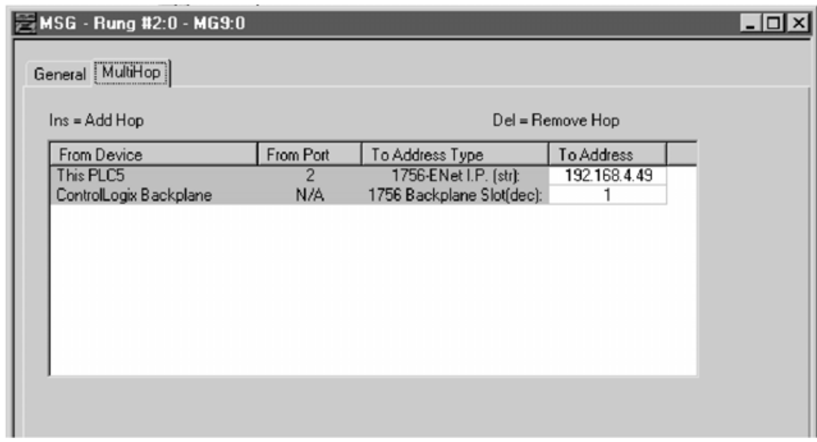
EtherNet/IP explicit messaging from a PLC-5E or SLC 5/05 controller to a Powermonitor 3000 unit uses a MultiHop message path. The client controller thinks it is communicating with a ControlLogix controller. The example message detail screens below indicate a PLC/5xxE reading the voltage and current table F15:0 from a power monitor to the controller's F15:0 data table.

PLC-5/xxE Controller Message Detail Screen Example



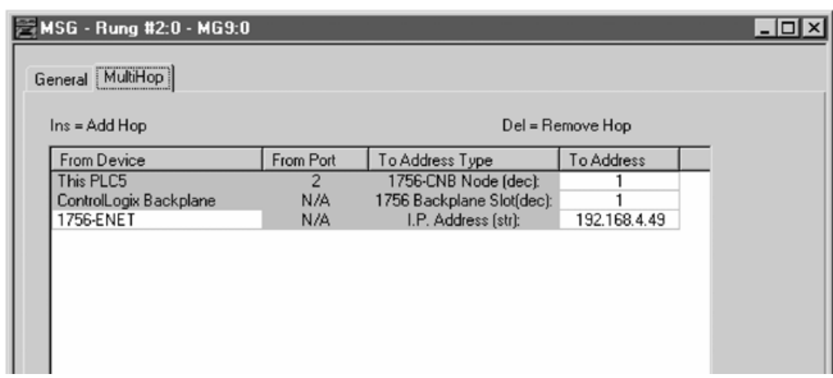
When you select Yes in the MultiHop field, the MultiHop tab appears in the dialog. Enter the IP address of the power monitor in the 1756-ENET I. P. field (192.168.4.49 is used here as an example) and any integer in the 1756 backplane Slot field.

PLC-5/xxE Controller MultiHop Configuration



The example below shows the MultiHop configuration for messaging from a PLC-5/xxC ControlNet processor through a ControlLogix Gateway to an Ethernet power monitor.

PLC-5/xxC Controller via ControlLogix Gateway MultiHop Configuration

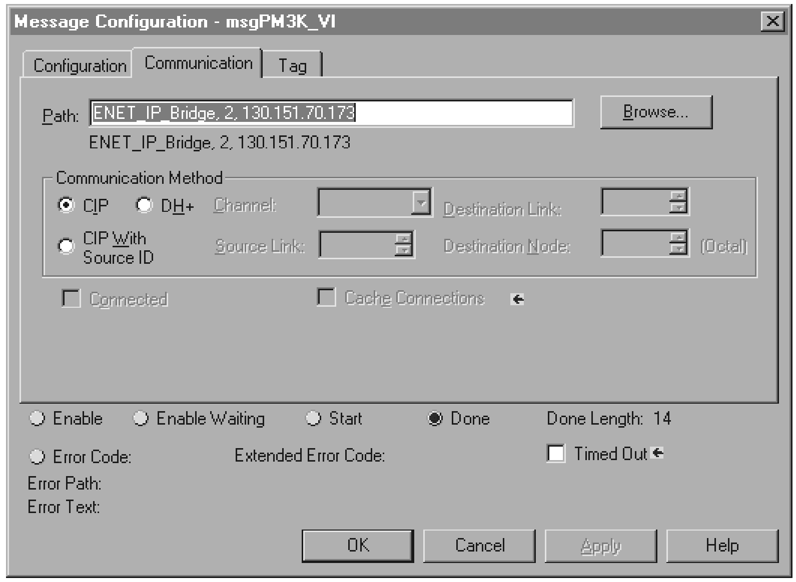


You may choose between two types of ControlLogix controller to power monitor messaging.

- PLC-5 Typed read or write, that encapsulates a PCCC message within a CIP wrapper
- CIP Generic messaging which uses the CIP class/instance/attribute object model common to DeviceNet network

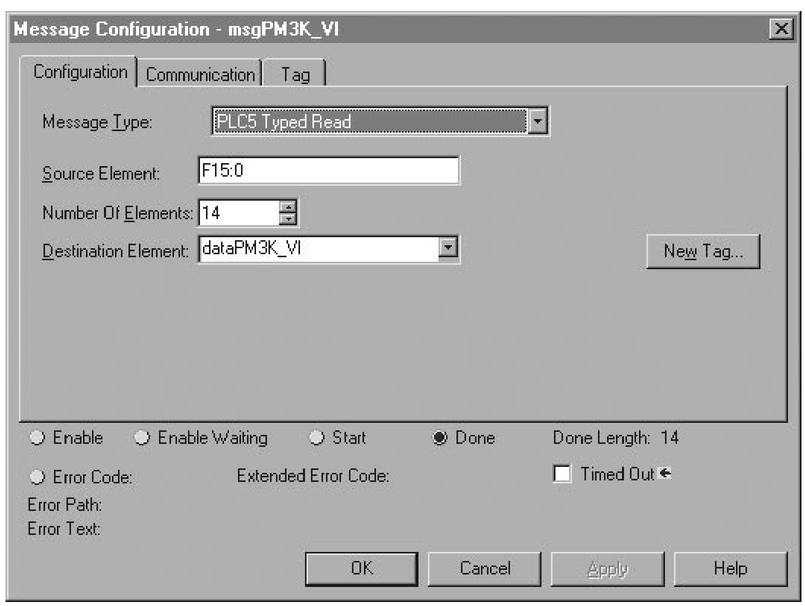
Set up the Communication tab in the ControlLogix message instruction the same for each messaging type.

ControlLogix Controller to Powermonitor 3000 Unit Communication Tab Example



The first example below reads the Voltage and Current table from a power monitor into the ControlLogix controller tag dataPM3K_VI(0) by using a PLC-5 Typed Read, configured as an array of 14 elements of type Real. You would configure a CIP Data Table Read the same way except for the message type.

ControlLogix PLC-5 Controller Typed Read Example

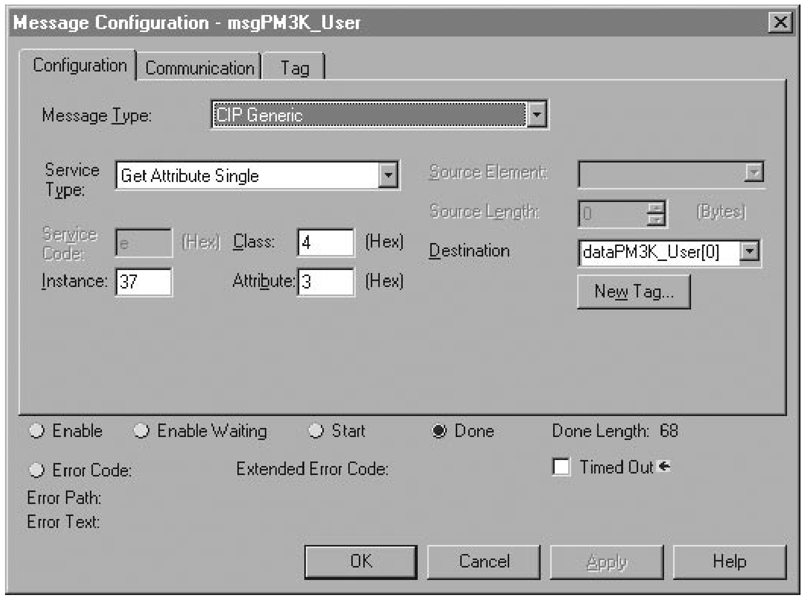


The next example shows the message configuration for a CIP Generic message type. A CIP Generic message can read or write data, depending on the Service Type you specify.

Refer to DeviceNet Class Services on page 102.

In this example, the ControlLogix reads the User-configured Data Table into tag dataPM3K_User(0), configured as an array of 23 elements of Real type.

ControlLogix Controller CIP Generic Messaging Example



This example uses the following message parameter values:

- Service Type: Get_Attribute_Single, (service code oe hex)
- Object class: 4 (hex), Assembly
- Instance: 37 (decimal), User configured table results
- Attribute: 3 (hex), Data

Set EtherNet/IP I/O Connection

Ethernet Powermonitor 3000 units support a Class 1 connection to Instance 1 and 2.

1. To utilize this scheduled connection to a ControlLogix controller, open the controller program offline in RSLogix 5000 software.

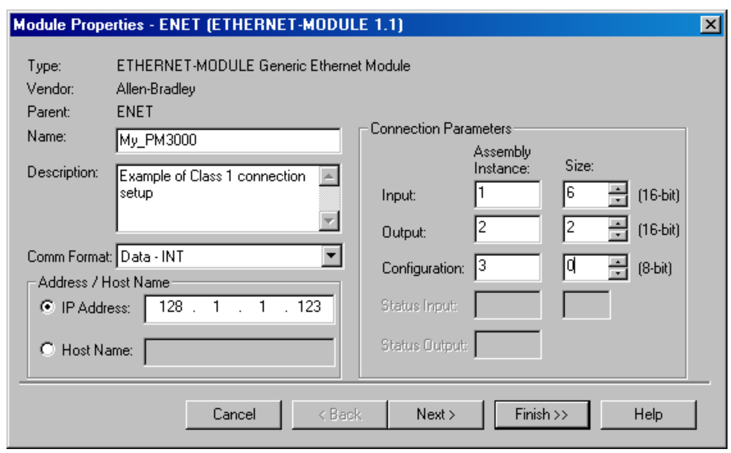
2. Select the 1756-ENET/B or 1756-ENBT/A module in the I/O configuration.

3. Add the power monitor as a Generic Ethernet Module.

   I/O Connection Setup shows a typical configuration.

TIP If you wish to establish a Class 1 connection with more than one controller to the same power monitor, use instance 1 and 2 for the first controller and use instance 1 and 255 for all remaining controllers (instance 255 is a placeholder instance since instance 2 only supports one connection). If the controller loses its connection to instance 1 and 2, the instance 255 connection is also lost.

I/O Connection Setup



4. Select Data – INT as the Communication Format.

5. Enter the IP address of the power monitor.

6. Set the Connection Parameters as shown for the default configuration.

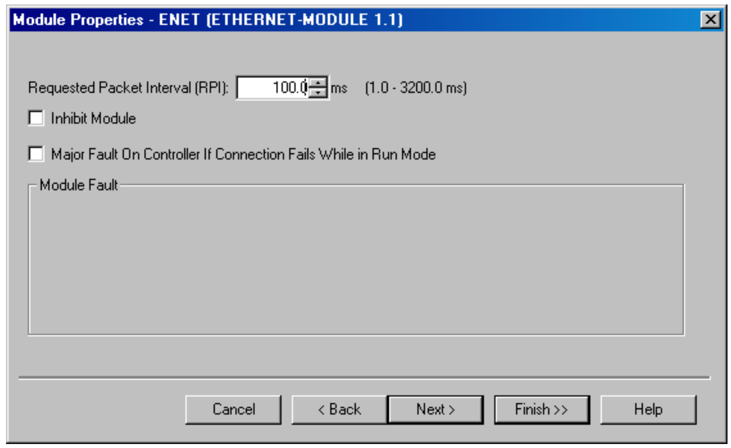
   If you change the configuration of the input assembly instance, enter its new size in Instance 1 here.

7. Select 3 as the Configuration instance and leave its Size set to 0 bytes and click the Next.

8. Set the Requested Packet Interval to 100 ms or greater.

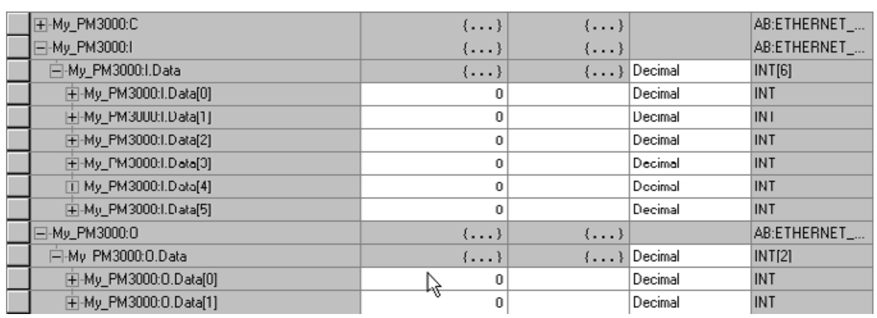
   The power monitor does not respond reliably to an RPI of less than 100 ms.

Requested Packet Interval Setup



The power monitor data is found in controller tags.

Power Monitor I/O Tags



My_PM3000:C	{...}	{...}		AB:ETHERNET_...
My_PM3000:I	{...}	{...}		AB:ETHERNET_...
My_PM3000:I.Data	{...}	{...}	Decimal	INT[6]
My_PM3000:I.Data[0]	0		Decimal	INT
My_PM3000:I.Data[1]	0		Decimal	INT
My_PM3000:I.Data[2]	0		Decimal	INT
My_PM3000:I.Data[3]	0		Decimal	INT
My_PM3000:I.Data[4]	0		Decimal	INT
My_PM3000:I.Data[5]	0		Decimal	INT
My_PM3000:O	{...}	{...}		AB:ETHERNET_...
My_PM3000:O.Data	{...}	{...}	Decimal	INT[2]
My_PM3000:O.Data[0]	0		Decimal	INT
My_PM3000:O.Data[1]	0		Decimal	INT

Powermonitor 3000 Web Access

You may view a number of data tables by simply pointing your web browser to the IP address of your power monitor from a computer with access to the unit's subnet. Example: http://192.1.1.207.

On the left side of the web page is a list of data table that you may view. Each list entry is a hyperlink that takes you to the selected table with a single mouse click. Each table appears as a tabular display with value descriptions and values. To return to the main page, click Refresh on your browser.

Powermonitor 3000 Web Page

Additional Ethernet Information

The power monitor utilizes the following fixed Ethernet port numbers:

- HTML: Port 80
- CSP: Port 2222
- CIP: Port 44818
- Modbus TCP: TCP port 502

ControlNet Communication Option

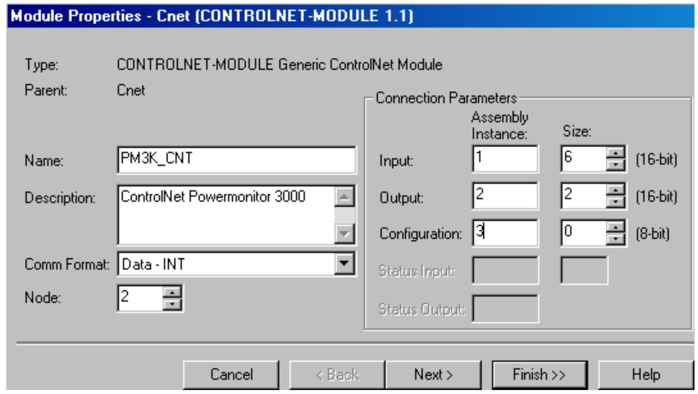
Powermonitor 3000 ControlNet units support a Class 1 connection to Instance 1 and 2.

1. To utilize this scheduled connection to a ControlLogix controller, open the controller program offline in RSLogix 5000 software.

2. Select the ControlNet bridge module (1756-CNB or 1756-CNBR) in the I/O configuration.

3. Add the power monitor as a Generic ControlNet module.

Typical ControlNet Configuration



4. Select Data-INT as the Communication Format.

5. Enter the ControlNet address of the power monitor.

6. Set the Connection Parameters as shown for the default configuration.

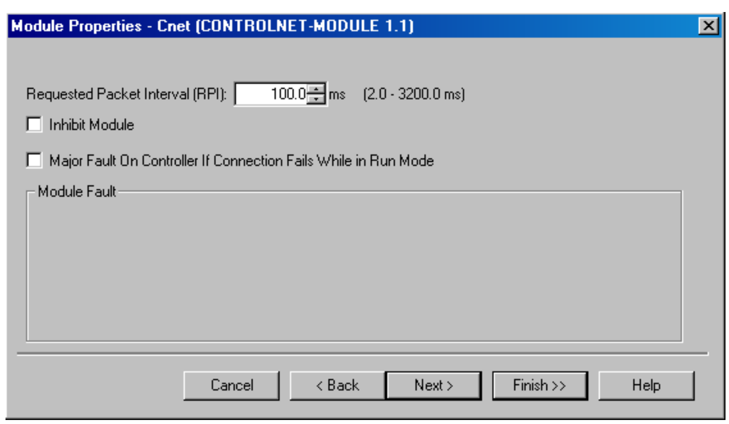
   If you change the configuration of the input assembly instance, enter its new size in Instance 1 here.

7. Select 3 as the Configuration instance and leave its Size set to 0 bytes and click Next.

8. Set the Requested Packet Interval to a binary multiple of the network update time (NUT) greater than 100 ms.

   The power monitor update rate is typically 100 ms.

Requested Packet



The power monitor data is found in controller tags.

Controller Tags

⊟-PM3K_CNT:I.Data	{...}	{...}	Decimal	INT[6]
⊞-PM3K_CNT:I.Data[0]	0		Decimal	INT
⊞-PM3K_CNT:I.Data[1]	0		Decimal	INT
⊞-PM3K_CNT:I.Data[2]	0		Decimal	INT
⊞-PM3K_CNT:I.Data[3]	0		Decimal	INT
⊞-PM3K_CNT:I.Data[4]	0		Decimal	INT
⊞-PM3K_CNT:I.Data[5]	0		Decimal	INT
⊞-PM3K_CNT:O	{...}	{...}		AB:CONTROLNE...
⊞-PM3K_CNT:C	{...}	{...}		AB:CONTROLNE...

9. Download the revised program to the controller.

10. Run RSNetworx for ControlNet software to schedule the connection between the controller and the power monitor.

    Refer to the RSNetWorx for ControlNet documentation for assistance.

The ControlNet power monitor supports up to 64 concurrent Class 1 connections to instance 1 and one concurrent connection to instance 2.

Communicating to a Powermonitor 3000 Unit from an SLC Controller through 1747-KFC15 ControlNet Module

Connect the 1747-KFC15 module according to your instruction manual documentation. There should be a connection from the KFC15 RS232 port to Channel 0 of the SLC controller. For this example, the communication and configuration of the channel 0 and the KFC15 module were the following:

- KFC15 – DF1 station address - 7
- KFC15 and SLC baud rate at - 19200
- KFC15 and SLC - Full-duplex
- KFC15 and SLC Parity - None
- KFC15 and SLC Handshaking - None
- KFC15 Diagnostic Command Execution - Disabled
- KFC15 Duplicate detect - Off
- KFC15 and SLC Error Detect - CRC
- KFC15 Number of Retries - 3
- KFC15 DF1 ACK Time Out - 3.2

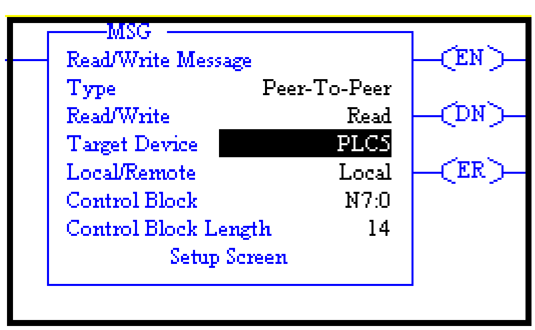
TIP Since it is easier to configure and much faster to run, full-duplex mode is the preferred mode of operation. Use half-duplex mode only if you do not have a choice.

Reading Files From the Power Monitor

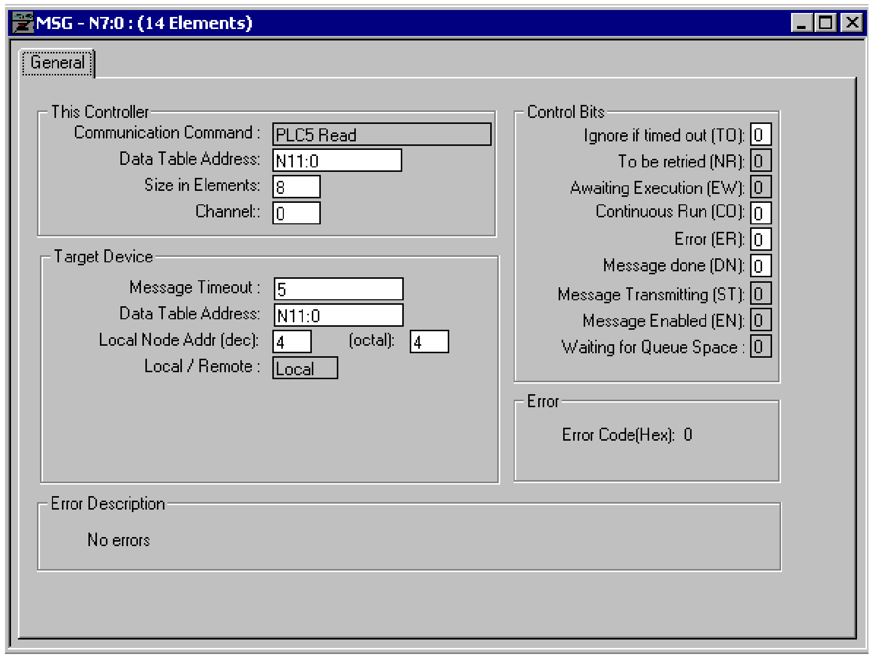
Both integer and float files can be read from the power monitor. This example reads the Date and Time table. Floats can be read by using this same process but destination file should be of type float.

1. Select a PLC-5 controller for your Target Device, Local Network, and Control Block.

Date and Time Message Read



2. Fill out the Setup dialog as shown.

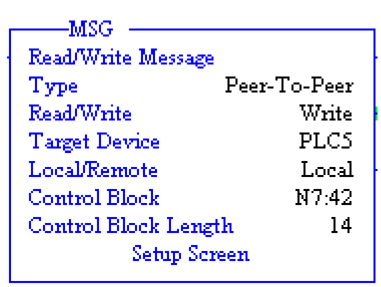


Notice that under target device that power monitor data table N11 (Date and Time) was selected. The Local Node Address is the address of the power monitor Controlnet Node Address 4.

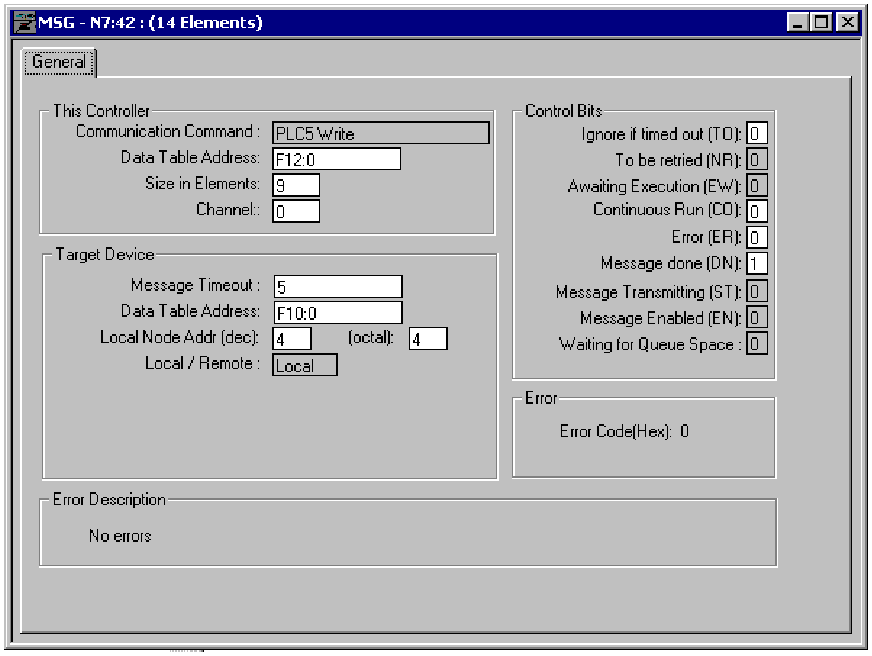
Writing Files to the Power Monitor

Writing data to the power monitor is done with the same method. It is recommended that 1 integer file and 1 float file be set aside in the SLC controller for use when writing to the power monitor. Data to be written to the power monitor is loaded in one of these files according to data type before the transaction is started. The following example writes data to the power monitor.

1. Select PLC5 for your Target Device, Local Network, and Control Block.



2. Fill out the Setup dialog as shown.



Notice that under target device that power monitor data table F10 (Basic Configuration) was selected. The Local Node Address is the address of the power monitor Controlnet Node Address 4. The information to write was loaded into file F12:0 of the SLC controller and is 9 elements long.

Communicating to a Powermonitor 3000 Unit from a PLC-5 ControlNet Processor

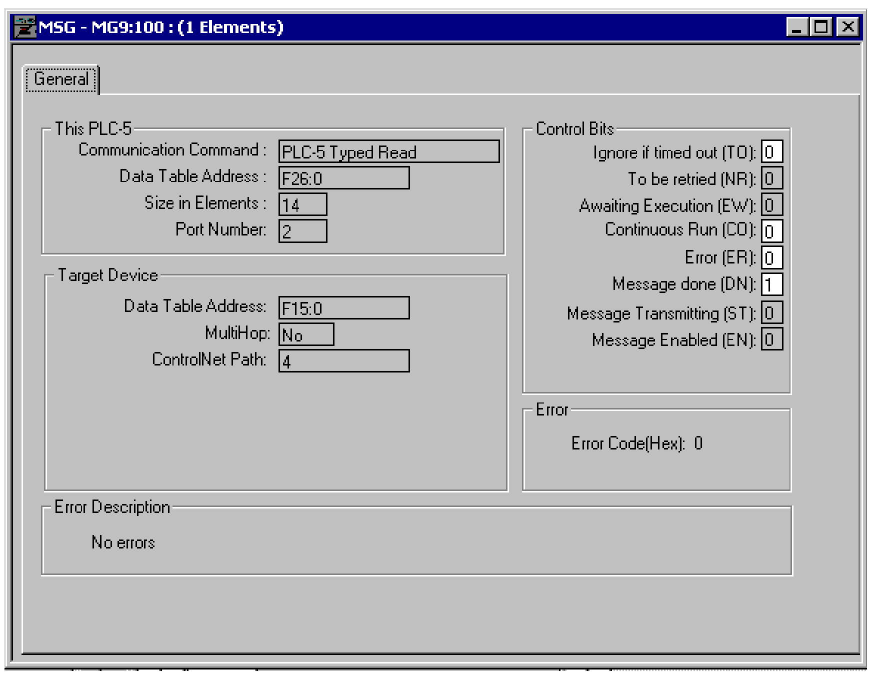
The power monitor is capable of communicating over ControlNet by using PLC-5 typed reads and writes. When using ladder to communicate unscheduled messages to and from the power monitor the following example applies.

Create a PLC-5 Typed Read

You can message integer and float files to and from the power monitor using PLC-5 typed message instructions by using the following steps.

Insert a MSG Instruction to the ladder rung and assign a control.

This example reads the Voltage, Current and Frequency table, File F15 from the power monitor.

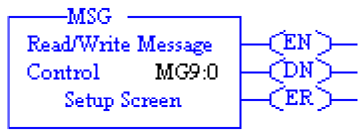


Notice that when using an unscheduled message directly to the power monitor, in this case node 4, that the message format is local, multi-hop selection is no.

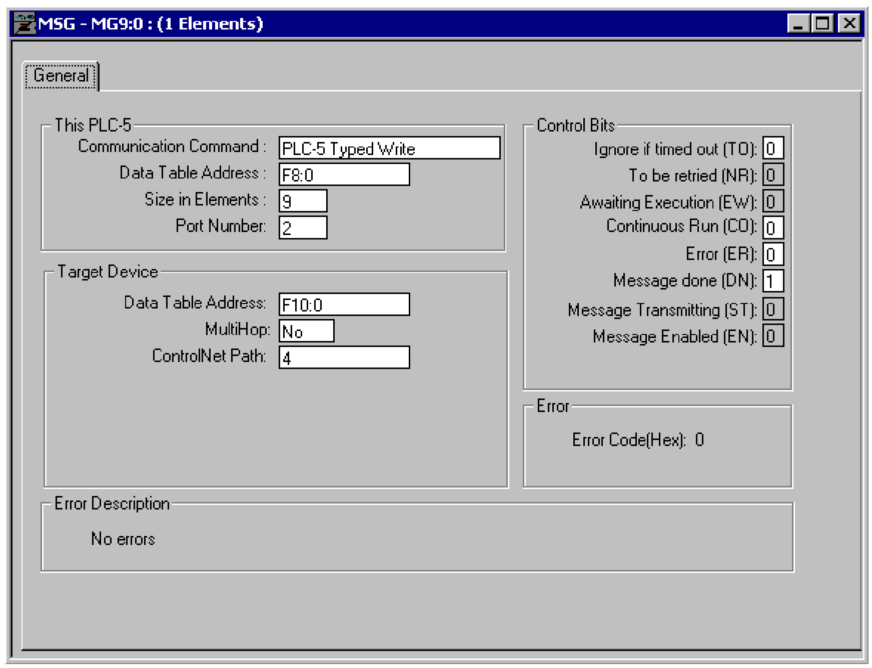
Create a PLC-5 Typed Writes

The following selection performs a write operation to the basic configuration table F10 of the power monitor.

Insert a MSG Instruction to the ladder rung and assign a control.



This example writes configuration to the Basic Configuration table, File F10 in the power monitor.



This message transfers 9 floats from table F8:0 to the power monitor table F10. The power monitor address is at node 4, local message.

How to Clear or Preset Energy Counters by Using Communication

You may clear or preset the energy counters by performing a table write to the Metering Real and Apparent Energy Results table or the Metering Reactive Energy and Amp-hour Results table. These read/write tables each contain 23 integer elements.

- Password: required to clear or preset an energy counter, returns -1
- Parameter select: bitfield used to select parameter for clearing or presetting

  See below.

- Energy counter values: expressed in integer-array format, see page 82
- Metering iteration: increments by 1 with each new set of results, rolls to 0 at 32,767

The Parameter select bitfield value selects the parameter or parameters to be cleared or preset during the current write, as shown in the table below.

Parameter Selection Bitfield Value

Bitfield Value		Parameter	
Binary	**Decimal**	**Table 14**	**Table 15**
000	0	-	-
001	1	kWh forward	kVARh forward
010	2	kWh reverse	kVARh reverse
100	4	kVAh	kAh
111	7	All	All

You may select the value at which the energy counters roll over to 0 in the Advanced Device Configuration table.

User-configured Data Table

If your application requires monitoring a small number of parameters normally found in different data tables, and you need to conserve communication bandwidth, then the power monitor user-configured data table may be an ideal solution. To use this table, your data client application performs a write to the User-configured Table Setup table, containing the desired parameters that you select from the Parameters for Trend Log and Configurable Table. To read the user-configured table, perform a table read of the User-configured Table Results.

The user-configured table setup includes the following elements:

- Password: needed to change the configuration
- Table identifier: a number that identifies the results table. For DF1 Ethernet CSP, and Ethernet PCCC/CSP, this is file number 31; for Remote I/O, file number (BT length) 62; for EtherNet/IP, DeviceNet, and ControlNet networks, instance 37 or 1 (see the User-configured I/O table)
- Parameter selections: from the Parameters for Trend Log and Configurable Table. The first zero ends the list of parameters

The User-configured Table Results table returns 14 elements (DeviceNet units) or 23 elements (all other communication options) containing the parameters you specified. You may specify more than 14 elements in DeviceNet units but it will return only 14. The results table data is in floating-point format. The first zero-valued element in the configuration write determines how many meaningful elements are returned in a read of the results table.

Refer to User-configured Data Table Setup by Using ControlLogix and EtherNet/IP Networks on page 314 for a sample ladder diagram and messages used to configure and read the user-configured data table.

Optionally, you may purchase and use RSPower or RSPowerPlus software to configure and view the configuration of the user-configured data and input tables.

User-configured I/O Table

You may configure Input Messaging Instance 1 in Powermonitor 3000 units with optional DeviceNet, EtherNet/IP, or ControlNet communication in the same way as the user-configured data table above. You have one additional option for Instance 1: you may select the data type of Instance 1 as integer (0) or floating-point (1).

If you change the configuration of Instance 1, an existing Class 1 connection will fault. You need to edit the properties of the connection with the parent controller to reflect the new size of Instance 1.

TIP	Refer to the Rockwell Automation KnowledgeBase (http://www.ab.com) for additional information on setting up a user-configured I/O instance.

Setpoint Programming and Operation

Setpoint operation provides a method other than communication for the power monitor to be used in and interact with power and energy applications. Some examples of setpoint applications include the following:

- Turning on an output relay when predicted demand exceeds a preset level, for simple demand management
- Turning off an output relay if phase rotation is accidentally reversed, helping to assure that loads rotate in the correct direction
- Capturing an oscillogram when a status input is energized

Theory of Setpoint Operation

Setpoint operation permits the power monitor to simultaneously monitor a number of parameters and take action when specified conditions are met. The M4 and M5 models support 10 setpoints while the M6 and M8 support 20.

There are eight parameters to configure for each setpoint: *S*etpoint Number, Type, Evaluation Condition, High Limit, Low Limit, Action Delay, Release Delay, and Action Type. These parameters are described in the Setpoint Configuration table on page 128.

In the M6 and M8 models, setpoints 19 and 20 have special significance and are preset at the factory.

Refer to Sag and Swell in Chapter 8.

When a setpoint activates, it takes the action defined in Setpoint Action Type and writes a time-stamped entry to the Event Log. Setpoint action types that energize a relay or KYZ output or set an alarm flag are maintained until the setpoint releases. Other setpoint actions such as capturing an oscillograph or clearing a counter occur when the setpoint activates. The power monitor also writes a time-stamped entry in the Event Log when the setpoint releases.

The event log record contains the maximum over-voltage or under-voltage recorded during a swell or sag condition, respectively. This applies only to models M6 and M8.

TIP If more than one setpoint is used to control the relay and/or KYZ output, the individual setpoints are evaluated in a logical and to determine the output state.

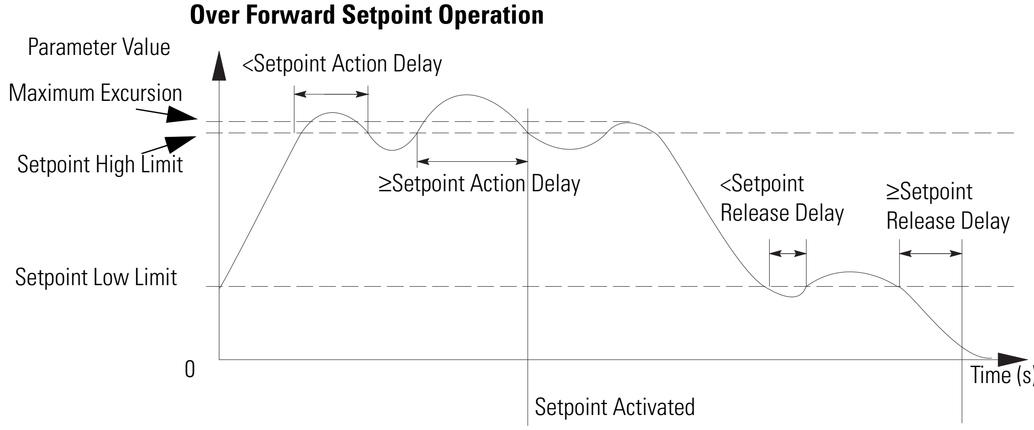
You may read setpoint output flags in the Discrete Data table on page 193 and the Remote I/O, DeviceNet, EtherNet/IP and ControlNet I/O Messaging Parameters on page 191. You may read only the first 8 setpoint output flags in the discrete input table with optional remote I/O communication.

Setpoints evaluate data based on six different conditions: over forward, over reverse, under forward, under reverse, equal, and not equal. Over and under setpoint evaluation conditions may only be used with analog values such as voltages, currents, power, etc. Reverse setpoints are typically used to monitor power and energy when on-site generation is present. Equal and not equal evaluation conditions are for use with discrete conditions such as phase rotation, status inputs and transient detection.

Over Forward Setpoint

An over forward setpoint activates when the magnitude of the parameter being monitored (defined by the Setpoint Type) increases beyond the Setpoint High Limit and remains over the limit for a time greater than the Setpoint Action Delay. The setpoint releases when the magnitude of the parameter being monitored decreases below the Setpoint Low Limit and stays below the limit for a time greater than the Setpoint Release Delay.

Over Forward Setpoint Operation

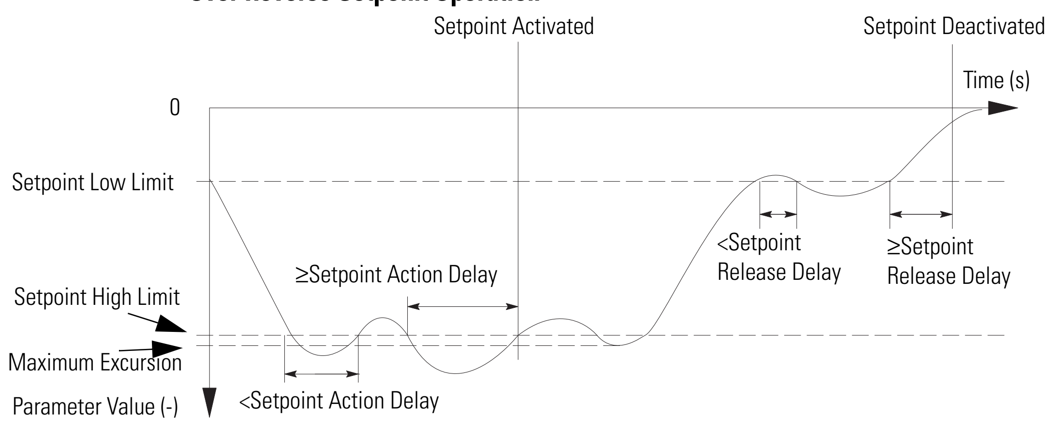


Over Reverse Setpoint

An over reverse setpoint is the mirror image of an over forward setpoint. For reverse setpoints, all the magnitudes and limits are negative.

An over reverse setpoint activates when the magnitude of the parameter being monitored (defined by the Setpoint Type) increases beyond the Setpoint High Limit in the negative direction and remains over the limit for a time greater than the Setpoint Action Delay. The setpoint releases when the magnitude of the parameter being monitored decreases below the Setpoint Low Limit and stays below the limit for a time greater than the Setpoint Release Delay.

Over Reverse Setpoint Operation

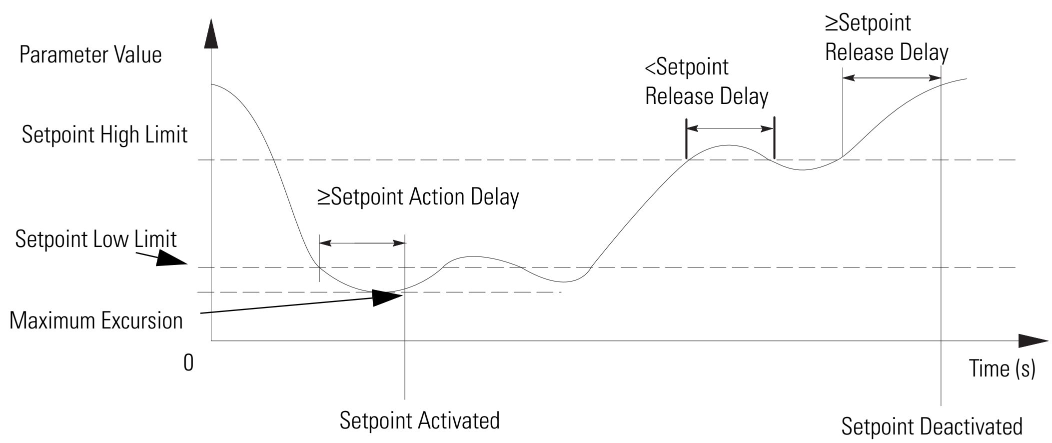


Under Forward Setpoint

An under forward setpoint is similar to an over forward setpoint, except the Setpoint High Limit and the Setpoint Low Limit are reversed.

An under forward setpoint activates when the magnitude of the parameter being monitored (defined by the Setpoint Type) decreases below the Setpoint Low Limit and remains below the limit for a time greater than the Setpoint Action Delay. The setpoint releases when the magnitude of the parameter being monitored increases above the Setpoint High Limit and stays above the limit for a time greater than the Setpoint Release Delay.

Under Forward Setpoint Operation

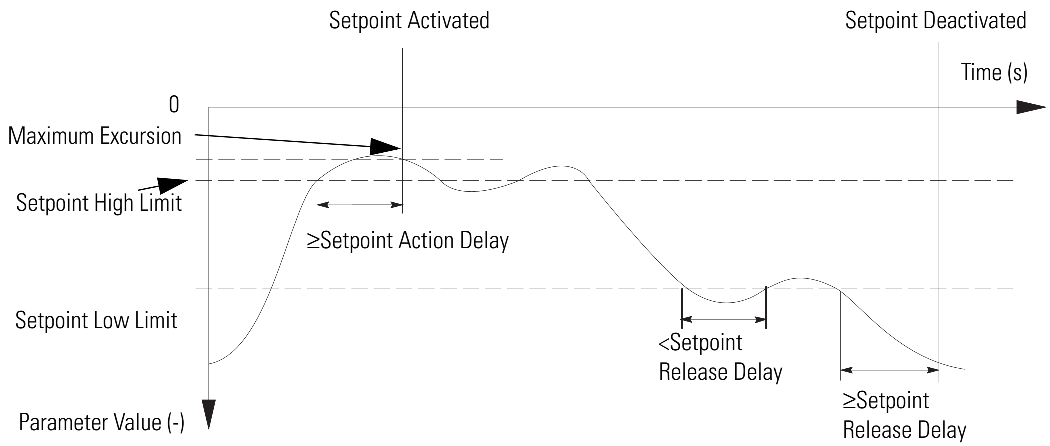


Under Reverse Setpoint

An under reverse setpoint is the mirror image of an under forward setpoint. The magnitude and all limits are negative numbers.

An under reverse setpoint activates when the magnitude of the parameter being monitored (defined by the Setpoint Type) decreases below the Setpoint Low Limit in the negative direction and remains below the limit for a time greater than the Setpoint Action Delay. The setpoint releases when the magnitude of the parameter being monitored increases above the Setpoint High Limit and stays above the limit for a time greater than the Setpoint Release Delay.

Under Reverse Setpoint Operation



Equal Setpoint

An equal setpoint activates when the monitored parameter equals the Setpoint High Limit for a time greater than the Setpoint Action Delay. An equal setpoint releases when the monitored parameter does not equal the Setpoint High Limit for a period of time greater than the Setpoint Release Delay. The Setpoint Low Limit is not used for equal and not equal setpoints.

Not Equal Setpoint

A not equal setpoint is the opposite of an equal setpoint, activating when monitored parameter does not equal the Setpoint High Limit for a time greater than the Setpoint Action Delay. It releases when the monitored parameter equals the Setpoint High Limit for a period of time greater than the Setpoint Release Delay.

Setpoint Output Action Logic

When more than one setpoint is configured to control a single setpoint output action, the following logic applies:

Setpoint output action = Setpoint 1 output action OR Setpoint 2 output action OR ... Setpoint n output action

Configuring Setpoints

You may configure setpoints by using the display module or by writing the setpoint configuration table through communication. The following tables describe setpoint configuration parameters.

Setpoint Configuration

Parameter Name	Parameter Description	Range	Units	Default
Setpoint Number	The number of the setpoint being configured.	1…10 (M4, M5) 1…20 (M6, M8)	-	N/A
Setpoint Type	The parameter value to be evaluated by the setpoint.	0…52 (Refer to List of Setpoint Types on page 216)	-	0
Setpoint Evaluation Condition	The operator used to evaluate the parameter value.	0 = Over forward (+) 1 = Over reverse (-) 2 = Under forward (+) 3 = Under reverse (-) 4 = Equal (=) 5 = Not equal (<>)	-	0
Setpoint High Limit	The value being used as a reference to activate the setpoint for over comparisons, or to deactivate the setpoint for under comparisons. Note: This parameter is non-numeric when viewed via the display module, and the Setpoint Type is Phase Rotation or Status input.	0…10,000,000	Depends on type	0

Setpoint Configuration

Parameter Name	Parameter Description	Range	Units	Default
Setpoint Low Limit	The value being used as a reference to deactivate the setpoint for over comparisons, or to activate the setpoint for under comparisons.	0…10,000,000	Depends on type	0
Setpoint Action Delay	The minimum time in seconds that the setpoint limit must be exceeded continuously before the setpoint will trigger.	0…3600	Sec (M4, M5)	0
		0…30,000	0.1 Sec (M6, M8)	
Setpoint Release Delay	The minimum time in seconds that the setpoint limit must not be exceeded continuously before the setpoint releases.	0…3600	Sec (M4, M5)	0
		0…30,000	0.1 Sec (M6, M8)	
Setpoint Action Type	The action that occurs when the setpoint is triggered.	0…32 (see details in the Setpoint Action Type table on page 131)		0
Clear Accumulated Time	Clear the time accumulator for this setpoint	Yes No		N/A

Setpoint Types

Setpoint Type	Description	Units	M4, M5	M6	M8
0	Not used	-	•	•	•
1	Voltage[1]	Volts	•	•	•
2	Current[1]	Amps	•	•	•
3	Voltage unbalance	Percent	•	•	•
4	Current unbalance		•	•	•
5	Neutral current	Amps	•	•	•
6	W	Watts	•	•	•
7	VAR	VARs	•	•	•
8	VA	VA	•	•	•
9	Total true PF	Percent	•	•	•
10	Total disp PF		•	•	•
11	Total dist PF		•	•	•
12	W demand	Watts	•	•	•
13	VAR demand	VARs	•	•	•
14	VA demand	VA	•	•	•
15	Amp demand	Amps	•	•	•
16	Projected amp demand	Amps	•	•	•
17	Projected W Demand	Watts	•	•	•
18	Projected VAR Demand	VARs	•	•	•
19	Projected VA Demand	VA	•	•	•
20	Frequency	Hz	•	•	•
21	Phase rotation	-	•	•	•
22	Crest factor voltage	Volts	•	•	•
23	Crest factor current	Amps	•	•	•

Setpoint Types

Setpoint Type	Description	Units	M4, M5	M6	M8
24	Crest factor I4	Amps	•	•	•
25	IEEE THD voltage[(1)]	Volts	•	•	•
26	IEEE THD current[(1)]	Amps	•	•	•
27	IEEE THD I4	Amps	•	•	•
28	IEC THD voltage[(1)]	Volts	•	•	•
29	IEC THD current[(1)]	Amps	•	•	•
30	IEC THD I4	Amps	•	•	•
31	Status input 1	-	•	•	•
32	Status input 2		•	•	•
33	Any status input[(1)]		•	•	•
34	Setpoint #1 time accumulator	Seconds	•	•	•
35	Setpoint #2 time accumulator		•	•	•
36	Setpoint #3 time accumulator		•	•	•
37	Setpoint #4 time accumulator		•	•	•
38	Setpoint #5 time accumulator		•	•	•
39	Setpoint #6 time accumulator		•	•	•
40	Setpoint #7 time accumulator		•	•	•
41	Setpoint #8 time accumulator		•	•	•
42	Setpoint #9 time accumulator		•	•	•
43	Setpoint #10 time accumulator		•	•	•
44	Voltage Sag[(1) (2)]	Volts		•	•
45	Voltage Swell[(1) (2)]			•	•
46	Transient detected[(2)]	-			•
47	Avg IEEE THD V	%	•	•	•
48	Avg IEEE THD I		•	•	•
49	Avg IEC THD V		•	•	•
50	Avg IEC THD I		•	•	•
51	Avg Crest Factor V	-	•	•	•
52	Avg Crest Factor I		•	•	•

(1) A setpoint activates when the magnitude of any phase passes the activation limit and releases when all phases pass the release limit in the appropriate direction for the setpoint evaluation condition.

(2) These setpoint types apply only to the applicable Powermonitor 3000 models and will appear as inactive on other models.

Setpoint Action Type

Setpoint Action type	Description	M4 M5	M6	M8	Setpoint Action type	Description	M4 M5	M 6	M 8
0	None	•	•	•	22	Clear all energy results	•	•	•
1	Energize relay (and alarm flag 1)	•	•	•	23	Clear setpoint #1 time	•	•	•
2	Energize KYZ (and alarm flag 2)	•	•	•	24	Clear setpoint #2 time	•	•	•
3	Set alarm flag 3	•	•	•	25	Clear setpoint #3 time	•	•	•
4	Set alarm flag 4	•	•	•	26	Clear setpoint #4 time	•	•	•
5	Set alarm flag 5	•	•	•	27	Clear setpoint #5 time	•	•	•
6	Set alarm flag 6	•	•	•	28	Clear setpoint #6 time	•	•	•
7	Set alarm flag 7	•	•	•	29	Clear setpoint #7 time	•	•	•
8	Set alarm flag 8	•	•	•	30	Clear setpoint #8 time	•	•	•
9	Set alarm flag 9	•	•	•	31	Clear setpoint #9 time	•	•	•
10	Set alarm flag 10	•	•	•	32	Clear setpoint #10 time	•	•	•
11	Set alarm flag 11	•	•	•	33	Clear setpoint #11 time		•	•
12	Set alarm flag 12	•	•	•	34	Clear setpoint #12 time		•	•
13	Set alarm flag 13	•	•	•	35	Clear setpoint #13 time		•	•
14	Set alarm flag 14	•	•	•	36	Clear setpoint #14 time		•	•
15	Set alarm flag 15	•	•	•	37	Clear setpoint #15 time		•	•
16	Set alarm flag 16	•	•	•	38	Clear setpoint #16 time		•	•
17	Save a trend log record	•	•	•	39	Clear setpoint #17 time		•	•
18	Clear kWh result	•	•	•	40	Clear setpoint #18 time		•	•
19	Clear kVARh result	•	•	•	41	Clear setpoint #19 time		•	•
20	Clear kVAh result	•	•	•	42	Clear setpoint #20 time		•	•
21	Clear Ah result	•	•	•	43	Capture oscillograph		•	•

Examples of Setpoint Operation

Let us look again at the setpoint applications mentioned at the beginning of this chapter.

ATTENTION

These examples are intended to demonstrate setpoint configuration only. They should not be used as sample application programming references. Carefully consider all control, operational and safety issues when designing and implementing setpoint operations.

Example 1 – Simple demand management: To configure setpoint 1 to energize output relay 1 when projected demand exceeds 100 kW for more than one second and de-energize relay 1 when projected demand falls below 90 kW for more than two seconds, you could use the following settings.

Simple Demand Management Settings

Parameter	Value
Setpoint number	1
Setpoint type	17 - Projected Watt Demand
Setpoint evaluation condition	0 - Over forward
Setpoint high limit	100,000 watts
Setpoint low limit	90,000 watts
Setpoint action delay	1 second (M4, M5) 10 tenths of a second (M6, M8)
Setpoint release delay	2 seconds (M4, M5) 20 tenths of a second (M6, M8)
Setpoint action type	1 - Energize relay 1 and set alarm flag 1

Example 2 – Phase reversal relay: To use setpoint 2 to energize the output relay as a permissive for starting a three-phase motor, you could use the following settings.

Phase Reversal Relay Settings

Parameter	Value
Setpoint number	2
Setpoint type	21 - Phase rotation
Setpoint evaluation condition	4 - Equal
Setpoint high limit	1 - ABC
Setpoint low limit	Not used

Phase Reversal Relay Settings

Parameter	Value
Setpoint action delay	0 second (M4, M5) 0 tenths of a second (M6, M8)
Setpoint release delay	0 seconds (M4, M5) 0 tenths of a second (M6, M8)
Setpoint action type	1 - Energize relay 1 and set alarm flag 1

Example 3 – Sag alarm. To set an alarm flag on a sag condition so that RSEnergyMetrix software can log it and take action, use the following settings.

Sag Alarm Settings

Parameter	Suggested Value
Setpoint number	3
Setpoint type	1 - Voltage
Setpoint evaluation condition	2 - Under forward
Setpoint high limit	110% of nominal system voltage
Setpoint low limit	110% of nominal system voltage
Setpoint action delay	0
Setpoint release delay	90 seconds
Setpoint action type	3 - Set alarm flag 3

Nominal system voltage is the nominal line to neutral voltage in Wye and single-phase systems and nominal line to line voltage in Delta systems. In 1404-M6 and 1404-M8 units, the high and low limits would be the same as those found in setpoint 19, the built-in sag setpoint. Setpoint release delay of 90 seconds sets alarm flag 3 long enough that RSEnergyMetrix software can reliably log the alarm with a one-minute log rate. Alarm flag 3 is selected because alarm flags 1 and 2 are tied to physical relay and KYZ outputs.

Configuring Setpoints by Using the Display Module

You may configure setpoint operations by navigating through the **PROG > PASS? > CONFIGURATION > SETPOINT** menus, selecting a setpoint number and programming the appropriate parameters.

Viewing Setpoint Data by Using the Display Module

You may view setpoint setup parameters and status by navigating through these menus: **DISP** > **CONFIGURATION** > **SETPOINT**, selecting the setpoint number and scrolling through the setpoint setup parameters, status and accumulated activated time.

Writing Setpoint Configuration by Using Communication

To configure setpoint operations by using communication, the client performs a table write to the Setpoint Setup/Read-back Select and Status table. This read/write data table of 16 integer elements includes the following:

- Password: A valid password is required to enable, disable or clear the min/max log. Write a value of –1 when simply selecting a setpoint
- Setpoint number: Selects a setpoint for configuration or read-back; or indicates the currently selected setpoint on a read.
- Read-back mode: 0 selects auto-increment; 1 selects manual-increment (only mode supported by DeviceNet and Ethernet units)
- Setpoint type: See Setpoint Types on page 129
- Evaluation condition: 0 = Over forward; 1 = over reverse; 2 = under forward; 3 = under reverse; 4 = equal, 5 = not equal (see above)
- High and low limits: Expressed in integer/exponent format
- Action and release delays: Expressed in seconds (M4, M5) or tenths of a second (M6, M8)
- Output action: See Setpoint Action Type on page 131
- Status: 0 indicates released; 1 indicates activated; this read-only element is ignored on a write
- Accumulated time: Expressed in integer/exponent format
- Clear time accumulator command: 0 performs no action; 1 clears the accumulated time for selected setpoint

Reading Setpoint Status Data by Using Communication

To read the setpoint status by using communication, the client uses the indexed read method. The power monitor uses the Setpoint Setup/Read-back Select and Status table both to select the setpoint to be read on the next read, and to return the status of the selected setpoint. In auto-increment mode (0), the first read returns the status of setpoint 1, the second read setpoint 2, and so on. In manual mode (1) the client alternates writes selecting the desired setpoint with reads of the setpoint status. See the list just above for the content of this data table.

I/O Operations

The power monitor is equipped with two relay outputs and two status inputs designed to provide a discrete interface with your application.

Relay and KYZ Output Operations

The Relay output is an electromechanical Form C relay with contacts rated at 10 amperes at 240V ac or 250V dc. This set of contacts is also rated to meet IEEE C37.90 requirements for power circuit breaker tripping duty. The KYZ output is a solid-state relay rated at 80 mA at 240V ac or 250V dc that provides higher reliability and long life for low-power signaling duty such as a kWh pulse output.

The two outputs operate independently and you may configure each output's operation individually. You may use the display module or communication to set the output configuration parameters in the Advanced Device Configuration table. The output configuration options for the relay and KYZ outputs include the following:

- Control source: specifies what controls the selected output. Options are 0= none; 1 through 6= pulsed output; 7= setpoint control; 8 discrete I/O control. Default = 7
- Output scale: specifies the scaling factor for pulsed operation. Range 1…30,000; default = 10
- Output width: specifies the pulse width for pulsed operation. Range 0 or 40…2,000 ms
- Force command: overrides setpoint, communication, discrete or pulsed control until the force is released. Options are: 0 = no change; 1 = force the output energized; 2 = forced the output de-energized; 3 = release the force
- Default output state on communication loss: specifies response to a loss of communication. Options are 0= last state/ resume; 1= last state/ freeze; 2= de-energize/ resume; 3= de-energize/ freeze. See below.

Pulsed Control

Many electric energy meters provide a dry contact output that changes state at intervals determined by a metered parameter. Pulsed control lets the power monitor emulate this function. You may select the following options for the Control source parameter:

1 = Watt-hours forward
2 = Watt-hours reverse
3 = VAR-hours forward
4 = VAR-hours reverse
5 = VA-hours
6 = Ampere-hours

Set the Output width to the desired pulse duration in milliseconds. Set this parameter to zero (0) if you want the output to toggle instead of pulse. This operation emulates the KYZ operation of electromechanical energy meters. For a two-wire KYZ connection, use only one side of the relay. For a three-wire KYZ connection, use both sides of the Form C output.

In a two-wire interface, (KY connection), an output event occurs only when the output contact closes. In a three-wire connection, an event occurs when either the KY or KZ contact closes. Therefore twice as many output events occur in a three-wire connection as in a two-wire connection for the same number of relay transitions.

Calculate Output Scale

Set the Output scale for the number of increments of the Control source parameter it takes to pulse or toggle the selected output. Follow these steps to calculate the output scale.

1. Determine the maximum value of the selected parameter expected in an hour period.

   This is related to the feeder capacity. For example, a 480V, 1200 A, three-phase feeder can supply approximately 1000 kW or 1000 kWh per hour.

2. Divide this maximum parameter value by 3600 to determine the maximum value expected per second.

   In our example, we round this to 280 Wh per second.

3. Select a maximum pulse rate.

   This should be between 2 and 5 pulses per second for a two-wire KYZ connection and between 2 and 10 pulses per second for a three-wire connection. Let's use a three-wire KYZ connection and a pulse rate of 4 pps.

4. Compute the output scale by dividing the result of step 2 by the result of step 3 and rounding to the nearest integer.

   For our example, we'll set the output scale to 70.

Setpoint Control

Set the Control source to a value of 7 to enable setpoints to control the selected output.

Discrete I/O Control

Set the Control Source to a value of 8 to enable Ethernet, ControlNet, DeviceNet, or remote I/O networks to have exclusive control over the power monitor output via I/O messaging.

Forced Operation

You may over-ride automatic output control by issuing a force command by using the display module or by writing the appropriate force command parameter in the Advanced Device Configuration table. Forces override all other output control sources. If you force an output either energized or de-energized, be sure to release the force to re-establish your selected control source.

TIP	If you cycle power to the power monitor, all output forces are released.

No Control Operation

You may also select no output control by selecting a value of zero (0) for the Control source parameter. This mode enables only output forcing.

Communication Loss Behavior

IMPORTANT The relay output contacts and solid-state KYZ output contacts on the power monitor may be used to control other devices through setpoint control or communication. You configure the response of these outputs to a communication failure. Be sure to evaluate the safety impact of the output configuration on your plant or process.

The Default output state on communication loss defines the behavior of the output if the power monitor experiences a loss of communication. What constitutes a communication loss depends on the protocol. A remote I/O unit declares a communication loss if it has detected more than 100 ms between valid frames or more than 255 consecutive valid frames not addressed to it. A DeviceNet unit declares a communication loss when the network master (scanner) has not polled it within the Expected Packet Rate that you configured when setting up the I/O connection.

You may select one of the following behaviors for each output.

- Last-state / resume: holds the output in its last state during a communication loss and resume the output control when communication recovers.
- Last-state / freeze: holds the output in its last state during a communication loss and freezes the output in this state when communication recovers. You may clear the freeze by placing the logic controller into Program mode, changing the behavior to last state / resume, or cycling power to the power monitor.
- De-energize / resume: de-energizes the output during communication loss and resume output control when communication recovers.
- De-energize / freeze: de-energizes the output during communication loss and freezes the output de-energized when communication recovers. You may clear the freeze by placing the logic controller into Program mode, changing the behavior to last state / resume, or cycling power to the power monitor.

Status Input Operations

The power monitor's two self-powered status inputs provide a number of flexible configuration options that help customize the power monitor operation to meet the requirements of your specific application.

Counters

You may use the power monitor to monitor discrete events such as circuit breaker status or kWh pulses from a legacy electrical energy, steam, gas or other type of meter. Each status input has associated with it an independent counter, which increments with every false-to-true transition of its input. The counter rolls over to 0 when it reaches its maximum value of 29,999. The counter value may be read by using the display module or communication to provide a value proportional to the accumulated value of the meter connected to the status input. You may select the input counter values as Trend Log parameters.

You may clear either or both status input counters by using the display module or by writing the appropriate command to the Advanced Device Configuration table.

Demand Period Synchronization

You may synchronize the Powermonitor 3000 demand period with a utility end-of-interval (EOI) pulse by wiring a dry contact controlled by the EOI pulse into Status Input 2 and setting the appropriate demand configuration parameters.

Refer to Chapter 3 for more information about demand.

Setpoint Inputs

You may use one or both status inputs to activate setpoint control. Use an equal or not equal setpoint evaluation condition with status inputs.

Event Logging of Status Inputs

You may choose whether or not to record status input transitions in the Event Log. If you were using a status input to read a KYZ meter pulse, for example, recording transitions into the Event Log would quickly fill the log and overwrite potentially important event information. On the other hand, you may use the status input to detect a discrete condition that you want logged.

Refer to Event Log Configuration Options on page 144.

Data Logging

Its inherent data logging capability makes the power monitor a versatile component in a number of power and energy applications. Cost allocation applications can read billing variables like energy usage and demand from the configurable Trend Log, making the accuracy of reports less dependent on a continuous network connection. The Event Log captures time-stamped records of important power system occurrences that can be aligned with corresponding production or environmental effects to better understand and optimize your energy use and costs. This chapter describes in detail the data logging functions in the power monitor.

Event Log

The Event Log contains records stored in nonvolatile memory of the 50 (M4 and M5) or 100 (M6 and M8) most recent events that occurred in the power monitor. Event records may include the following:

- changes in the unit configuration.
- setpoint activation and release.
- relay or KYZ output forcing.
- status input change of state.
- power-up and power-down.
- clearing or presetting of an energy counter.
- setting the unit time and date.
- clearing of the trend or min/max log.
- clearing of setpoint timers.
- detection of a sag, swell, or transient.

Event Log Configuration Options

There are two options in the Event Log setup.

- You may choose to log or ignore (ignore is default) status input change-of-state.
- You may choose to log or ignore (log is default) changes to the date and time setting.

These choices provide you with the flexibility to ignore routine occurrences, thereby increasing the time that important events are stored. For example, a status input may count pulses from a water or gas meter. Or, the unit may be connected to an energy logging system, such as RSEnergyMetrix software, that synchronizes the time every night at midnight. In either case, important events would likely be overwritten by routine, nuisance events.

Viewing the Event Log by Using the Display Module

The event number shows up in the top line, and in the bottom line an event description followed by the event time stamp scrolls across the display. The Event Codes table lists the event codes as shown on the display module.

Event Codes

Event Type Name	Event Type Shown by DM	Event Type Number	Event Command Code
No Event	No Evnt	0	0
Setpoint Activated	Set##A[1]	1	Setpoint Number (1…10)
Setpoint Deactivated	Set##D[1]	2	Setpoint Number (1…10)
Relay Forced Energized	Rly# F1[1]	3	Relay Number (1…2)
Relay Forced De-energized	Rly# F0[1]	4	Relay Number (1…2)
Relay No Force Option	Rly# NF[1]	5	Relay Number (1…2)
Status Input Set	S# On[1]	6	Status Input Number(1…2)
Status Input Cleared	S# Off[1]	7	Status Input Number(1…2)
kWh Counter Set	Wh Set	8	1
kVARh Counter Set	Varh Set	8	2
kVAh Counter Set	kVAh Set	8	3
Ah Counter Set	kAh Set	8	4

Event Codes

Event Type Name	Event Type Shown by DM	Event Type Number	Event Command Code
All Energy Counters Set	All Power Set	8	5
Trend Log Clear	Trend Clr	8	6
Min/Max Log Set	M/M Clr	8	7
Factory Defaults Restored	FactCfg	8	8
Status Input Counter 1 Cleared	S1 Clr	8	9
Status Input Counter 2 Cleared	S2 Clr	8	10
Reserved for Future Enhancement			11
Single Setpoint Timer Clear	Single SP Set		12
All Setpoint Timers Clear	All SP Set		13
Power Up	Pwr On	9	0
Power Down	Pwr Off	10	0
Self-test Error	ST ####(1)	11	Hexadecimal Status Error Code (See Status Error Codes on page 146)
Time Set	TimeSet	12	0
Device Reconfigured	New Cfg	13	0
Setpoint Reconfigured	Set Cfg	14	0
NVRAM Set	NVRAM Set	15	0
Transient Detected	TRN Det	16	M8 only

(1) Number indicates a numeric digit.

Status Error Codes

Bits	Hex	Description
bit 0	0001h	Master module code flash status
bit 1	0002h	Master module data flash status
bit 2	0004h	Master module RAM Status
bit 3	0008h	Reserved for factory use
bit 4	0010h	Master module NVRAM status
bit 5	0020h	Master module data acquisition status
bit 6	0040h	Master module real time clock status
bit 7	0080h	Reserved for factory use
bit 8	0100h	Reserved for factory use
bit 9	0200h	Display module status
bit 10	0400h	Master module watchdog timer status
bit 11	0800h	Master module optional communication status
bit 12…15	1000h -8000h	Reserved for factory use

Configuring the Event Log by Using Communication

You may configure the Event Log by performing a valid table write to the Event Log Configuration/Read-back Record Select table. This read/write data table contains these six integer elements:

- Password: A valid password is required to set configuration options or -1 to select a record for read-back
- DeviceNet unique write identifier
- Read-back mode: see below
- Status input logging: 0 disables; 1 enables
- Number of events logged: this read-only element is ignored on a write
- Time/date set logging: 0 disables; 1 enables

Reading Data from the Event Log by Using Communication

The Event Log uses the indexed read method. The Event Log Configuration/Read-back Record Select table is the Read-back Select table and the Event Log Results table is the Results table. You may select among a number of read-back options for the Event Log.

0 = Auto-increment / start at beginning of log

1 = Auto-increment / start at end of log

2 = Auto-decrement / start at end of log

3 = Point to the beginning of log

4 = Point to the end of log

5 = Index to the next record

6 = Index to the previous record

Indexing occurs after each read of the Results table.
Only mode 0, 1, and 2 are supported by DF1 and remote I/O communication.

The Event Log Results table is a read-only data table containing 14 (M4, M5), 17 (M6) or 18 (M8 only) integer elements as follows:

- Reserved: returns 0
- Event record internal identifier: An incremental number assigned to each new event. See below
- Timestamp: event timestamp expressed in four-element timestamp format (see below)
- Event type: see Event Codes on page 144
- Event command code: see Event Codes on page 144 and Status Error Codes on page 146
- Setpoint type, evaluation condition, level, action/release delay, and action: if event is a setpoint, these elements return additional information about the setpoint. The Setpoint level, expressed in integer/exponent format, records the worst-case value of the setpoint parameter
- Sustain limit timer (M6, M8 only): time the setpoint parameter exceeded the limit, expressed in integer/exponent format
- Capture identifier (M6, M8 only): identifies oscillograph or transient capture number if applicable

TIP

The power monitor expresses timestamps in an array of four data table elements:

Year
Month/day
Hour/minute
Second/hundredth of a second

Each timestamp parameter (except the *Year*) is a combination of its first and second element. For instance, the Month = the parameter value divided by 100 with the remainder = the Day.

Example: 1230 = December 30th.

Configurable Trend Log

You can learn a great deal about, and learn how to reduce, your enterprise's energy costs by keeping a historical record of power and energy usage. The Configurable Trend Log allows you to set up automatic logging of up to 16 parameters at intervals between 1 second and 1 hour. It can store over 45,000 individual records in nonvolatile memory.

You must use communication to configure and read the Trend Log. There is no display module interface for either configuration or monitoring.

Trend Log Modes of Operation

The Trend Log operates in one of these two modes:

- Fill and Hold - record logging continues until the log is full. You must clear the log for logging to continue.
- Overwrite - logging operates in first-in, first-out mode whereby each new record overwrites the oldest record. The trend log always contains the most recent records.

Default Configuration

As shipped from the factory, a power monitor logs net kilowatt-hours (kWh), net kVAR-hours (kVarh) and demand watts, at 15-minute intervals, in overwrite mode.

TIP

If you use the power monitor with RSEnergyMetrix energy logging software, you should coordinate the parameters selected for the Trend Log with those logged by the software. This allows for the energy logging software to poll the Trend Log data, allowing for automatic data repopulation of the energy database.

Calculating Trend Log Depth

How long the Trend Log takes to fill may be as little as 90 minutes or as long as 2 years depending on how you configure the log. These formulas will help you configure the trend log to obtain the results you want. Round off any results to the next lower integer.

Trend Log Depth Formula

This formula returns the number of records in the trend log for the number of parameters logged. To determine the length of time this represents, multiply the result by the trend log interval.

Where:

D = Depth of the trend log in records
F = Fill mode (0 = fill and hold, 1 = overwrite)
P = Parameters per record (1…16)
INT (x) = The integer portion of x

EXAMPLE

For example, if P=3 and F=0, we will get this result.

$$7 \times INT\left(\frac{65536}{12 + 6 + 16}\right) = INT(1927.53) = 7 \times 1927 = 13489$$

Parameters per Record Formula

If your application requires a certain number of records or time to preserve logged information, this formula returns the number of parameters per record allowed.

$$P = INT\left(\frac{16384}{CEIL\left(\frac{D}{7-F}\right)} - 5.5\right)$$

Where:

CEIL (x) = the smallest integer greater than x.

EXAMPLE

For example, CEIL (1914.28) = 1915.

Suppose D = 13400 and F = 0, we will get

$$P = INT\left(\frac{16384}{CEIL(1914.28)} - 5.5\right) = INT(3.05) = 3$$

Suppose D = 13500 and F = 0, we will get

$$P = INT\left(\frac{16384}{CEIL(1928.57)} - 5.5\right) = INT(2.99) = 2$$

Examples

Example 1: You want to log kWh every 15 minutes and you want to know how many records the log contains and how long a time that covers. The Trend Log Depth Formula applies to this example.

Fill and hold mode allows logging the most records. Logging only 1 parameter per record, the formula results in a total of 17,640 records after rounding down. Logging every 15 minutes, this log configuration will log 6.1 months of kW data.

Example 2: Another user wants to log several parameters every 5 minutes indefinitely, retrieving the records within one week after the end of each month. He saves the retrieved data and creates trend graphs on his PC. The question is how many parameters may be monitored. The Parameters per Record Formula applies to this example.

The total log depth of 10,944 is based on the log duration and interval: (31 days per month + 7 days) * (24 hours per day) * (60 minutes per hour) / 5 minute logging interval. Overwrite mode (F = 1) allows you to read the log any time without losing any data.

In this example, P, the number of parameters that may be recorded, is 3.

From this example, you can see that the trend log can log 3 parameters every 5 minutes in a 38-day sliding window.

Setting up the Trend Log

You configure the Trend Log by performing a table write to the Trend Log Configuration/Read-back Record Select table with the desired configuration settings. This read/write data table contains 26 integer elements including the following:

- Password: Required to configure logging, you may use -1 for read-back selection
- DeviceNet unique write identifier
- Read-back mode: See below; must be a valid entry even if read-back is not being selected at this time
- Logging interval: Interval in seconds (1…3600). 0 disables logging but does not disable setpoint-triggered logging; -1 synchronizes logging with demand interval.
- Logging mode: 0 selects overwrite mode; 1 selects fill and hold.
- Clear log command: 0 takes no action; 1 clears the trend log.
- Parameter selections: You may select up to 16 parameters from the list in the Parameters for Trend Log and Configurable Table table to be logged. An entry of 0 selects no parameter; only parameters preceding the first 0 in the table is logged.
- Reserved elements: Must be 0
- Total records logged: These read-only elements are ignored during a write

TIP Although you may configure up to 16 Trend Log parameters on units with optional DeviceNet communication, the results table will return only the first 8.

The power monitor clears the trend log when you change any parameter or the logging interval.

You may perform a simple table read of the Trend Log Configuration/Read-back Record Select table to view the existing Trend Log configuration.

When you read this table, the password element returns a value of -1 and the reserved and command elements return a value of 0. Elements 7 and 8 return the Total Records Logged * 1000 and * 1 respectively.

Reading Data from the Trend Log

To read the Trend Log, use the indexed read method.

A write to the Trend Log Configuration/Read-back Record Select table selects which trend log record is read next.

There are a number of auto-increment and manual-increment options that may be selected by writing to the Read-back Mode element in the Trend Log Configuration/Read-back Record Select Parameters table.

You can select from the following options:

0 - Auto-increment / start at beginning: Start at the oldest log record and index to the next record after each read of the results table

1 - Auto-increment / start at end: Start at the newest log record and index to the next record after each read

2 - Auto-decrement / start at end: Start at the newest log record and index to the previous record after each read

3 - Point to the oldest log record

4 - Point to the newest log record

5 - Index to the next record after each read of the results table

6 - Index to the previous record after each read

Only mode 0, 1, and 2 are supported by DF1 and remote I/O communication. In modes 0, 1, and 2 the client need only read the results table repeatedly until the entire Trend Log is read. In modes 3…6 the client must alternate writes to select the next read-back record with reads of the results table.

You may obtain the number of records in the Trend Log by reading the Trend Log Configuration/Read-back Record Select table, elements 7 and 8.

The number of records is (element 7) * 1000 + (element 8).

Only the following elements are needed during a record-selection write:

- Password: -1
- DeviceNet unique write identifier: as applicable
- Reserved words: must be 0
- Read-back mode: see above

The Trend Log Results table is a read-only table of 14 (DeviceNet network) or 22 (all other communication options) floating-point elements as follows:

- Reserved element: returns 0
- Internal identifier: increments by 1 to 15 for each trend log record then rolls over to 0
- Time stamp: in 4-element timestamp format. See page 55.
- User-selected parameters: parameters you selected when you configured the Trend Log.

Min/Max Log

The Min/max Log maintains a time-stamped record of the minimum and maximum values of up to 74 metering parameters. You can monitor values over a day, a week, a month or any period to record the highest and lowest values of voltage, current, or power factor.

Most industrial utility bills include a charge based on the maximum demand recorded during the billing period. You could use the Min/max log to provide that piece of data for generating an internal or shadow billing report.

Accessing the Min/Max Log by Using the Display Module

You may view, enable, disable, or clear the min/max log by using the display module.

Interfacing with the Min/Max Log by Using Communication

Write Min/max Log configuration settings and command by using a table write to the Min/Max Log Configuration/Read-back Select table.

Access data in the Min/max Log by using the indexed read method. Write to the Min/Max Log Configuration/Read-back Select table to select the read-back mode and/or which of 74 min/max records to return on the next read of the Min/Max Log Results table.

The Min/Max Log Configuration/Read-back Select table contains these nine integer elements:

- Password: Required to enable, disable or clear the min/max log; -1 for selecting a record
- Parameter to read: The record number to read next, or the starting record for auto-increment read-back mode
- Read-back mode: 0 selects auto-increment mode; returns the next min/max record after each read of the results table, 1 selects manual indexed mode (only mode 0, 1 and 2 are supported by DF1 and remote I/O communication)
- Enable/disable Min/max Log: 0 disables, 1 enables
- Clear Min/max Log command: 0 takes no action, 1 clears the log and writes a time stamp
- Timestamp of last Min/max clear: the last four elements store the last-clear timestamp (read-only; these elements ignored on a write)

Min/Max Log Parameter Listing

Param. Number	Parameter Name	Param. Number	Parameter Name
0	L1 Current	37	Projected Demand I
1	L2 Current	38	Projected Demand W
2	L3 Current	39	Projected Demand VAR
3	Avg Current	40	Projected Demand VA
4	L1-N Voltage	41	L1 True Power Factor
5	L2-N Voltage	42	L2 True Power Factor
6	L3-N Voltage	43	L3 True Power Factor
7	Avg L-N Voltage	44	Three-phase True PF
8	L1-L2 Voltage	45	L1 Displacement Power Factor
9	L2-L3 Voltage	46	L2 Displacement Power Factor
10	L3-L1 Voltage	47	L3 Displacement Power Factor
11	Avg L-L Voltage	48	Three-phase Displacement PF
12	Frequency, last cycle	49	L1 Distortion Power Factor
13	L4 Current	50	L2 Distortion Power Factor
14	Positive Sequence Current	51	L3 Distortion Power Factor
15	Negative Sequence Current	52	Three-phase Distortion PF
16	% Current unbalance	53	V1% IEEE THD
17	Positive Sequence Voltage	54	I1% IEEE THD
18	Negative Sequence Voltage	55	V2% IEEE THD
19	% Voltage unbalance	56	I2% IEEE THD
20	Average frequency	57	V3% IEEE THD
21	L1 Real Power	58	I3% IEEE THD
22	L2 Real Power	59	I4% IEEE THD
23	L3 Real Power	60	V1% IEC thd (DIN)
24	Total Real Power	61	I1% IEC thd (DIN)
25	L1 Reactive Power	62	V2% IEC thd (DIN)
26	L2 Reactive Power	63	I2% IEC thd (DIN)
27	L3 Reactive Power	64	V3% IEC thd (DIN)
28	Total Reactive Power	65	I3% IEC thd (DIN)
29	L1 Apparent Power	66	I4% IEC thd (DIN)
30	L2 Apparent Power	67	V1 Crest Factor
31	L3 Apparent Power	68	I1 Crest Factor
32	Total Apparent Power	69	V2 Crest Factor
33	Demand Current	70	I2 Crest Factor
34	Demand Power	71	V3 Crest Factor
35	Demand Reactive Power	72	I3 Crest Factor
36	Demand Apparent Power	73	I4 Crest Factor

The Min/Max Log Results table is a read-only data table consisting of 11 floating-point elements containing the following information:

- Parameter #: See the Min/Max Log Parameter Listing table above
- Min and max values
- Timestamps: for Min and Max values in four-element timestamp format

Time-of-use

The power monitor provides a Time-of-Use Log. Also called the TOU log, it provides a one-year time-of-use history of energy usage and demand. The time-of-use log provides the following:

- User-selectable on-peak, mid-peak and off-peak hours
- User-selectable off-peak days of the week
- Real, reactive and apparent energy usage records
- Real, reactive and apparent power demand records
- Month-to-date record for the current month
- Monthly history for the past year
- User-selectable day of month to begin time-of-use logs

The time-of-use log is designed to support simple billing and cost allocation applications that apply different rates to energy and demand used at different times.

Time-of-use Hours Selection

Off peak hours are those which occur on off peak days or during hours not selected as either mid peak or on peak. Hours selected as both mid peak and on peak will be evaluated as on peak hours.

RSEnergyMetrix software selects the appropriate time-of-use logs to store energy and demand values based on the time-of-use hours selection and the off peak day selection.

Time-of-use selection elements are bit mapped parameters. The bits are mapped as shown in the table below, which depicts the default values as an example. The default time-of-use periods include the following:

- Mid peak AM – 8:00…10:59
- Mid peak PM – 3:00…6:59
- Peak AM – 10:00…11:59
- Peak PM – 12:00 noon…2:59

TOU Period	AM												PM											
	12:00 – 12:59	1:00 – 1:59	2:00 – 2:59	3:00 – 3:59	4:00 – 4:59	5:00 – 5:59	6:00 – 6:59	7:00 – 7:59	8:00 – 8:59	9:00 – 9:59	10:00 – 10:59	11:00 – 11:59	12:00 – 12:59	1:00 – 1:59	2:00 – 2:59	3:00 – 3:59	4:00 – 4:59	5:00 – 5:59	6:00 – 6:59	7:00 – 7:59	8:00 – 8:59	9:00 – 9:59	10:00 – 10:59	11:00 – 11:59
Peak	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
Mid peak	0	0	0	0	0	0	0	0	1	1	1	X[1]	X	X	X	1	1	1	1	0	0	0	0	0

(1) x = Don't care.

Configuring the Time-of-use Log

Perform a table write to the Time of Use Register Configuration table to set up the user-selectable options.

This read/write table of 10 integer elements contains the following configuration and read-back selection parameters.

- Password – required for configuration. Use a valid password or -1 for read-back select. Range 0…9999, default 0, returns -1
- Record to read back – selects the record to be returned in the next read of the Tables Time of Use Records – Real Energy and Demand, Time of Use Records – Reactive Energy and Demand, and Time of Use Records – Apparent Energy and Demand. Range 0…12, default 0
- Write command – stores record 0 to record 1 and shifts remaining records down. Range 0 (no action), 1 (execute write command), default 0
- Log day – selects the day of the month to automatically store the in-process record and shift the remaining records down. Range 0 to 31. 0 disables automatic store. 1…28 select the day of month, 29…31 select last day of month
- Off-peak day – selects day(s) of week during which all hours are off-peak. Bitfield, bit 0 = Sunday, bit 1 = Monday and so on. Range 0…127 (0…FF Hex), default 65 (41 Hex, Saturday and Sunday)
- Mid peak AM – selects morning mid peak time-of-use hours. Bitfield, range 0…4095 (0 to 0FFF hex). See Time-of-use selection above. Default 1792 (700 Hex, 8:00 to 10:59 a.m.)

- Mid peak PM – selects afternoon mid peak time-of-use hours. Default 120 (78 Hex, 3:00…6:59 p.m.)
- Peak AM – selects morning peak time-of-use hours. Default 2048 (800 Hex, 11:00…11:59 a.m.)
- Peak PM – selects afternoon peak time-of-use hours. Default 7 (7 Hex, 12:00 noon…2:59 p.m.)

Reading Time-of-use Log Data

The power monitor stores the TOU log in three sets of 13 records each, one set for real energy and demand, a second for reactive energy and demand, and the last for apparent energy and demand. For each set, record 0 contains the in-process records for the current month. Records are stored to non-volatile memory every 2 minutes. Records 1…12 contain the monthly records for the previous 12 months. When the log day occurs, the records are shifted down, with the record 0 moving into record 1 and the oldest record being deleted.

The Time of Use Records – Real Energy and Demand table contains the real energy and demand time-of-use data from the record selected during the most recent write to the Time of Use Register Configuration table. This read-only table of 12 floating-point elements contains the following data:

- Off-peak MWh
- Off-peak kWh
- Off-peak demand Watts
- Mid-peak MWh
- Mid-peak kWh
- Mid-peak demand Watts
- Peak MWh
- Peak kWh
- Peak demand Watts
- Start date in YY/MM/DD format
- End date in YY/MM/DD format
- Record number 0…12

The Time of Use Records – Reactive Energy and Demand and Time of Use Records – Apparent Energy and Demand tables are identical except that one contains reactive energy and demand TOU data and the other contains apparent energy and demand TOU data.

Advanced Features

In this chapter we discuss major features that, for the most part, are found only in the Powermonitor 3000 M6 and M8 models. The exception is that basic harmonic analysis is supported in the M4 and M5 models.

Oscillography

Oscillography captures waveforms of the voltage and current present at the power monitor input terminals. A client application reads oscillography records by using the indexed read method. The main features of oscillography include the following:

- Simultaneous capture of all seven voltage and current channels
- Non-volatile storage of up to 8 (M6) or 2 (M8) captures
- Configurable sampling rate up to 5.4 kHz or 90 samples per cycle at 60 Hz
- Captures may hold up to 408 cycles of data per channel at 60 Hz
- Configurable data resolution of 13 bit w/ sign or 7 bit w/sign
- Configurable pre-trigger means the capture includes waveform information prior to the triggering event
- Setpoints or communication may trigger oscillogram captures
- All communication options support oscillography

You may choose to use RSPower, RSPowerPlus, or RSEnergyMetrix software, or create a custom application, to configure oscillography and read waveform data. RSPower software may be configured to automatically download and save waveforms to a disk file, and then clear the oscillography buffers.

Configuring Oscillography

You may configure oscillography only via communication. The display module does not support an interface to oscillography. Configure oscillography by performing a table write to the Oscillograph Configuration/Read-back Data Select. This read/write table of 11 integer elements comprises the following configuration and command parameters.

- Password: needed to configure the capture type or pre-trigger, or execute a command to trigger or clear a capture. Not needed for read-back select, use -1. Default 0000.
- Capture number: selects a capture for read-back or returns the last capture selected. Range 1…8 (M6) or 1…2 (M8). Default 1.
- Channel number: selects a channel number or returns the last channel number selected. Range: 1 = V1, 2 = I1, 3 = V2, 4 = I2, 5 = V3, 6 = I3, 7 = I4. Default 1.
- Block number: selects a data block for the next read or returns the last block selected. Range depends on communication type. See below. Default 1.
- Read-back mode: selects a read-back mode or returns the last mode selected. Range 0…2, default 0. See below.
- Clear / trigger command: clears one or all captures or triggers a new capture. Always returns 0. In the M8 model, values of 3…8 have same meaning as 0. These are the options:

  0 - no action
  1 - clear capture 1
  2 - clear capture 2
  3 - clear capture 3 (M6 only)
  4 - clear capture 4 (M6 only)
  5 - clear capture 5 (M6 only)
  6 - clear capture 6 (M6 only)
  7 - clear capture 7 (M6 only)
  8 - clear capture 8 (M6 only)
  9 - clear all captures
  10 - initiate a new capture

- Capture type: selects sample rate and data resolution or indicates selected sample rate and resolution. Range -1…5, default 0. -1 disables oscillography.

  See the Capture Type Properties table on page 161.

- Pre-trigger: specifies how much of the captured waveform occurred before the triggering event. Range 0…100 per cent, default 90%.
- Reserved: must be zero (0) on a write, returns 0.

- Capture clear status: Read-only bitfield that indicates which capture numbers are clear. Bit 0 (LSB) corresponds to capture 1, bit 1 to capture 2 and so on. For each bit, 1 indicates clear, 0 indicates not clear.
- Capture ready status: read-only bitfield that indicates which capture numbers contain captures that are ready to read. Same bit correspondence as above. For each bit, 1 indicates the capture is ready, 0 indicates no capture or not yet ready. If a client reads a capture that is not ready, -1 is returned for all data points.

Block Number

The block number and the total number of data reads required to read an entire capture depend on the communication option and the capture type.

See the Capture Type Properties table.

The block number range is 1 to the number of Data reads required listed in the table.

Capture Type

The properties associated with the capture type options are listed in the Capture Type Properties table.

You may select a capture type that best suits your application requirements. A higher sample rate provides a more accurate representation of the waveform when higher-order harmonics and transients are present. Higher data resolution provides more accuracy of each data point. Capture type 5 combines low sampling rate and low resolution, but captures almost 7 seconds of waveform at 60 Hz.

Capture Type Properties

Capture Type	Sampling Rate	Data Resolution	Samples per Cycle at 60 / 50 Hz	Total Cycles per Channel at 60 / 50 Hz	Capture Duration (seconds)	Data Reads Required	
						DeviceNet	Other Comms
0	5.4 kHz	13-bit w/sign	90 / 108	51.1 / 42.6	0.85	230	92
1	2.7 kHz		45 / 54	102.2 / 85.2	1.70		
2	1.35 kHz		22.5 / 27	204.4 / 170.3	3.40		
3	5.4 kHz	7-bit w/sign	90 / 108	102.2 / 85.2	1.70	460	184
4	2.7 kHz		45 / 54	204.4 / 170.3	3.40		
5	1.35 kHz		22.5 / 27	408.8 / 340.7	6.81		

Read-back Mode

The data client uses the indexed read method to read oscillogram capture data. The readback mode options include the following:

- Auto-increment all channels: successive reads of the Oscillograph Results table increment through all remaining blocks of the current channel, increment through all remaining channels and wrap back to the original channel.
- Auto-increment current channel: successive reads of the results table will increment through all remaining blocks of the current channel only.
- Manual increment: each write of the Oscillograph Configuration/Read-back Data Select table specifies the channel and block to be read in the next read of the Oscillograph Results table. Successive reads of the results table returns the same block of data each time if no read-back select write is done.

Reading Oscillograph Data

Read oscillograph data from the Oscillograph Results table by using the indexed read method. Oscillograph data is not available via Modbus communication. This read-only table comprises these 29 (DeviceNet network) or 59 (all other communication options) integer elements:

- Capture timestamp: in three elements using the standard timestamp format except the year is omitted
- Capture number: in the range 1…8 (M6) or 1…2 (M8)
- Channel number: in the range 1…7 (see above)
- Block number: block number of the data contained in the table (see above)
- Capture type: in the range of 1…5 (see table above)
- Trigger statistics: see below. Range 0…22,999.
- Trigger position: data point corresponding with the trigger position. See below.
- Oscillograph data points: See below.

The data client sets up the read-back configuration with a table write to the Oscillograph Configuration/Read-back Data Select table, the content of which is described above. As with other indexed reads, DeviceNet and Ethernet optional communication support only manual increment read-back mode so that the client must write a read-back select message before each read of the results table. For all other communication options, auto-increment all channels or auto-increment current channel read-back mode provides the highest communication throughput.

Waveform Data Points

The results table contains 20 data points for optional DeviceNet communication or 50 data points for all other communication options. Data points are numbered 1…20 or 1…50 in each read. The client calculates each data point's place in the waveform by using the following formula:

$$N_{\text{datapoint\_oscillogram}} = (N_{\text{block}} - 1) + N_{\text{datapoint\_this\_read}}$$

$N_{\text{datapoint\_oscillogram}}$ = the sequence number of the data point in the oscillogram channel
N_{block} = the block number
$N_{\text{datapoint\_this\_read}}$ = the data point number (1…20 or 1…50) in the current read

The total number of data points is 4600 for capture type 0, 1, and 2 and 9200 for capture types 3, 4, and 5.

Each data point is expressed in calibrated analog-to-digital (A/D) converter counts with a resolution of 8192 (13-bit w/sign) or 128 (7-bit w/sign). A client may calculate the primary-side instantaneous voltage or current magnitude of each data point by using the following formula:

$$M_i = \frac{M_{(\text{max rms})} \bullet \sqrt{2}}{R_{max}} \bullet N_t \bullet M_{data}$$

Where:

- M_i = instantaneous value of the voltage or current data point
- $M_{(\text{max rms})}$ = max rms magnitude
  = 399.0 line-to-neutral volts for channels 1, 3, and 5
  = 691.1 line-to-line volts for channels 1, 3, and 5
  = 10.6 amperes for channels 2, 4, 6, and 7
- R_{max} = maximum resolution
  = 8192 for 13-bit w/sign, capture types 0, 1, and 2
  = 128 for 7-bit w/sign, capture types 3, 4, and 5
- N_t = PT or CT ratio
  = PT or CT primary / PT or CT secondary
- M_{data} = value of the data point from the Oscillograph Configuration/Read-back Data Select table

For example, consider the following capture:

- PT primary = 13.8 kV
- PT secondary = 120 V
- CT primary = 100 A
- CT secondary = 5 A
- Delta voltage mode (line-to-line)
- Capture type = 2

You would multiply each data point by the following factor to correctly display the waveform:

$$Factor = (691.1 \bullet 1.414) / 8192 \bullet (13800 / 120) = 13.72$$

Trigger Statistics

The trigger source and capture identifier are combined in one element, and indicate what triggered the capture and a unique capture identifier or serial number. The value divided by 1000 gives the trigger source: 0 = none; 1…20 = setpoint number; 21 = native communication; 22 = optional communication. The remainder of this calculation is the unique capture identifier which increments by 1 from 0…999 and rolls back to 0. A client application may use the identifier to associate with an event log entry and determine chronological order of captures. Example: a parameter value of 15,347 indicates that setpoint 15 triggered the capture and its serial number or identifier is 347.

The trigger position returns the number of the data point corresponding with the time the capture was triggered. A client application may use this to place a marker on the displayed waveform. The maximum trigger position is the same as the total number of oscillogram data points. The power monitor configuration may affect the accuracy of the trigger position statistic with respect to the pre-trigger setting. For best results, set RMS resolution to 0 (nominal) and RMS results averaging to 0 (none) in the Advanced Device Configuration table.

The capture timestamp and capture type are also important statistics that identify the capture and enable a client application to correctly display the waveform.

Harmonic Analysis

The power monitor provides harmonic data to help you understand this important element of power quality in your facility. Each model provides a different level of harmonic information.

The Harmonic Analysis Functionality table provides an overview of the harmonic analysis available in each model. You may access all harmonic data by using communication. The display module can access average values of the parameters as indicated in the DM column.

Harmonic Analysis Functionality

Harmonic data	DM (Avg.)	M4 M5	M6	M8	Per Current Channel	Per Voltage Channel	Avg. Of Current Channels	Avg. Of Voltage Channels
IEEE Total Harmonic Distortion (THD)	•	•	•	•	•	•	•	•
IEC Distortion Index (DIN)	•	•	•	•	•	•	•	•
Crest Factor	•	•	•	•	•	•	•	•
Telephone Interference Factor (TIF)			•	•	•	•	•	•
K-factor			•	•	•	•	•	•
IEEE-519 Total Demand Distortion (TDD)			•	•	•			
IEEE 519 Pass / Fail			•	•	•	•		
Harmonic distortion, harmonics 1…41			•	•	•	•		
Harmonic magnitude, harmonics 1…41			•	•	•	•		
Harmonic distortion, harmonics 42…63				•	•	•		
Harmonic magnitude, harmonics 42…63				•	•	•		

IEEE THD and DIN

Both of these total harmonic distortion calculation methods provide a summary indication of the amount of distortion due to harmonics present in a system. The standard IEEE definition of harmonic distortion is Total Harmonic Distortion (THD) and is computed for each channel as follows:

$$THD = \frac{\sqrt{\sum_{n=2}^{\infty}(H_n)^2}}{H_1}$$

Where:

- H_n = magnitude of the n^{th} harmonic ($n \leq 41$ or 63)
- H_1 = magnitude of fundamental

The standard IEC definition of harmonic distortion is the Distortion Index (DIN) and is computed for each channel as follows:

$$\text{DIN} = \sqrt{\frac{\sum_{n=2}^{\infty} (H_n)^2}{\sum_{n=1}^{\infty} (H_n)^2}}$$

Where:

- H_n = magnitude of the n^{th} harmonic (n ≤41 or 63)
- DIN is equivalent to IEC THD

Crest Factor

This is another quantity that is sometimes used to describe the amount of distortion present in a waveform. It can also be used to express the dynamic range of a measurement device. Crest Factor is the ratio of the peak to the RMS.

$$\text{Crest Factor} = \text{Peak Value} / \text{RMS Value}$$

A pure sinusoid Crest Factor equals $\sqrt{2}$.

TIF

Another method of measuring signal distortion is the Telephone Influence Factor, sometimes called the Telephone Interference Factor. This measurement is used to estimate the effect that the power line harmonics have on nearby analog telephone conductors. This method weighs each of the harmonics based on the physiological and audiological characteristics of the human ear. The harmonics are additionally weighted to reflect the relationship of harmonic frequency and degree of coupling to the phone lines. These weights are called single frequency TIF weights. The 1404-M6 uses the most recent TIF weights (updated in 1960). The single frequency factors are used to compute the total TIF. You multiply the TIF numbers by the RMS magnitude of the power lines voltage or current to obtain an index for estimating the amount of interfering energy that is coupled to the telephone system. The formula for total TIF is:

$$\text{TIF} = \frac{\sqrt{\sum_{i=1}^{\infty} (w_i X_i)^2}}{\sqrt{\sum_{i=1}^{\infty} (X_i)^2}}$$

Where:

- X_i = single frequency RMS current or voltage at harmonic *i*.
- w_i= single frequency TIF weighting factor at harmonic *i*.

K-Factor

K-Factor measures additional heating in a power transformer due to the harmonics in the power signal. These harmonics cause additional heating due to increased core losses that occur at higher frequencies. The increased losses are related to the square of the harmonic frequency. Therefore, a slight harmonic content can significantly increase the heat rise in a power transformer. The additional harmonic heating may cause a transformer to exceed designed temperature limits even though the RMS current is less than the transformer rating. The K-Factor is used as justification to oversize a power transformer to allow extra margin for harmonic losses or to select an appropriate K-Factor rated transformer. A K-Factor rated transformer is the preferred choice since it has known performance in the presence of harmonics. The formula for K-Factor is as follows:

$$\text{K-Factor} = \frac{\sum_{n=1}^{\infty}\left(H_n^2 \bullet n^2\right)}{\sum_{n=1}^{\infty}(H_n)^2}$$

Where:

- H_n = magnitude of the n^{th} harmonic ($n \leq 41$ or 63).

IEEE-519 TDD and IEEE-519 Pass/Fail

IEEE-519 is the IEEE standard for Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems. The 1404-M6 refers to the 1992 version of this standard. IEEE-519 provides recommended limits for the level of harmonic current injection at the Point of Common Coupling (PCC) between the utility and your setup. The PCC is typically defined as the location in the power distribution system where the utility meters are connected. The standard provides recommended limits for individual harmonic components as well as a limit for Total Demand Distortion (TDD). Total Demand Distortion is defined as the root sum square of the current distortion expressed as a percent of the maximum fundamental demand load current (based on the maximum demand over the applicable demand interval). The formula for computing TDD is the same as the IEEE THD formula except the configured value for maximum fundamental load current is substituted for the magnitude of the measured fundamental load current.

$$\mathrm{TDD} = \frac{\sqrt{\sum_{n=2}^{\infty}(H_n)^2}}{H_1}$$

Where:

- H_n = magnitude of the n^{th} harmonic ($n \le 41$ or 63)
- H_1 = maximum fundamental load current

Table 10.3 of the IEEE standard specifies the limits. The appropriate limits are selected by computing the ratio of the available short circuit current to the maximum fundamental demand load current. The row of the table that corresponds to the ratio is then used to determine the proper limits for each of the individual harmonics and the TDD specified in the table columns. IEEE-519 also recommends maximum voltage distortion levels that the utility should remain below.

Table 11.1 of the IEEE standard specifies these limits based on the magnitude of the line to line voltage at the PCC. Once configured, the 1404-M6 will automatically monitor the system voltage and current for IEEE-519 compliance.

Harmonic Magnitude

The powe rmonitor calculates the RMS magnitude of each individual harmonic. Results are calculated for harmonics 1…41 (M6) or 1…63 (M8) for all 7 voltage and current channels. Each result is expressed in RMS volts or amps.

Harmonic Distortion

The power monitor calculates the magnitude of each individual harmonic with respect to the fundamental. Results are calculated for harmonics 1…41 (M6) or 1…63 (M8) for all 7 voltage and current channels. Each result is expressed as a percentage of the fundamental.

Configuring Harmonic Analysis

You may configure harmonic analysis only via communication. The display module does not support harmonic analysis configuration. Configure harmonic analysis by performing a table write to the Harmonic Analysis Configuration/Read-back Select table. This read/write table of nine integer elements comprises the following configuration parameters.

- Password: needed to enable or disable harmonic analysis or write the maximum short-circuit and demand current parameters. Not needed for read-back select, use -1. Default 0000
- Channel: Specifies the channel of harmonic data to obtain in the next read of Table 33. 1 = V1, 2 = I1, 3 = V2, 4 = I2, 5 = V3, 6 = I3, 7 = I4, 8 = avg. of voltage channels, 9 = avg. of current channels. On a read, indicates the last selection made. Default 1
- Read-back mode: selects read-back mode for the Harmonic Results; THD, Crest Factor, and More table. Range 0…1, default 0. See below

TIP The remaining elements listed below are reserved in the M4 and M5 models, return 0 on a read and must be 0 on a write.

- Individual harmonic data type: selects% distortion (0) or magnitude (1) on subsequent reads of the individual results tables. Default 0
- Enable disable harmonic analysis: 0 disables, 1 enables calculation of TIF, K-factor, IEEE-519 and individual harmonics results. Default 1
- IEEE-519 maximum short-circuit current: used for IEEE-519 pass/fail calculation, expressed in integer/exponent format. Range 0…9999 (integer), -4 to 21 (exponent), defaults are 0.
- … used for IEEE-519 TDD calculation, expressed in integer/exponent format. Range 0…9999 (integer), -4… 21 (exponent), defaults are 0.

Readback Mode

The data client uses the indexed read method to read harmonic analysis and individual harmonic data. The options include the following:

- Auto-increment (0): increments the channel after each read of the Harmonic Results; THD, Crest Factor, and More table. This also controls the read-back channel for individual harmonics results tables. If you use the auto-increment mode, read any desired individual harmonic data for the current channel before the next read of the Harmonic Results; THD, Crest Factor, and More table.
- Manual-increment (1): successive reads of the Harmonic Results; THD, Crest Factor, and More table return harmonic results from the current channel.

As with other indexed reads, DeviceNet and Ethernet networks optional communication support only manual increment read-back mode so that the client must write a read-back select message to change the channel returned in the results table. For all other communication options, auto-increment Read-back mode provides the highest communication throughput.

Reading Harmonic Analysis Data

The power monitor presents harmonic analysis results in the Harmonic Results; THD, Crest Factor, and More table. This read-only table contains 9 floating-point elements in the M4 and M5 models and 10 floating-point elements in the M6 and M8 models. The table contains the following parameters.

- Channel number: the voltage or current channel being returned. See above
- % IEEE THD: Total harmonic distortion in per cent based on the IEEE definition. Range 0.0…1000.0
- % IEC THD (DIN): Total harmonic distortion in per cent based on the IEC definition. Range 0.0…1000.0
- Crest factor: Range 0…10
- THD & Crest iteration: each new calculation increments by one from 0…32,767 and rolls back to 0

TIP The remaining elements are reserved in the M4 and M5 models and return values of 0.

- TIF: Telephone influence factor. Range 0.0…999.9*10^{22}
- K-factor: Range 0.0…999.9*10^{22}
- IEEE-519 TDD: Total demand distortion. Range 0.0…999.9*10^{22}
- IEEE-519 Pass/fail: -1 = unknown, 0 = fail, 1 = pass
- FFT iteration: each new FFT calculation (used in the previous four parameters) increments by one from 0…32,767 and rolls back to 0

A data client may determine the relative freshness of data by comparing the THD & crest iteration or FFT iteration parameters in repeated reads of this table.

Reading Individual Harmonic Values

The M6 and M8 models provide several data tables containing individual harmonic results. Individual harmonic value data is not available via Modbus communication. Write to the Harmonic Analysis Configuration/Read-back Select table to select the Read-back mode, data type (magnitude or distortion per cent) and/or channel number of harmonic data. A data client reads the tables listed below in indexed Read-back mode to obtain individual harmonic data. In Auto-increment mode, read the Harmonic Results; THD, Crest Factor, and More table to index the channel.

- Harmonic Results; Odd Harmonics 1…21 Table (M6 and M8)
- Harmonic Results; Odd Harmonics 23…41 Table (M6 and M8)
- Harmonic Results; Even Harmonics 2…20 Table (M6 and M8)
- Harmonic Results; Even Harmonics 22…40 Table (M6 and M8)
- Harmonic Results; Odd Harmonics 43…63 Table (M8 only)
- Harmonic Results; Even Harmonics 42…62 Table (M8 only)

Each of these tables consists of 14 floating-point elements containing the following parameters:

- Channel: 1 = V1, 2 = I1, 3 = V2, 4 = I2, 5 = V3, 6 = I3, 7 = I4 (no averages)
- Type of harmonic data: 0 = per cent harmonic distortion, 1 = magnitude
- Nth harmonic: expressed according to the *type* parameter. Magnitude type is referenced to the primary side of PTs and CTs. Range: 0.0…999.9 * 10^{22}
- FFT iteration: each new FFT calculation (used in the previous four parameters) increments by one from 0…32,767 and rolls back to 0

In the Harmonic Results; Odd Harmonics 23…41, Harmonic Results; Even Harmonics 2…20 and Harmonic Results; Even Harmonics 22…40 tables the first nth harmonic element is reserved and returns a value of 0.

Sag and Swell

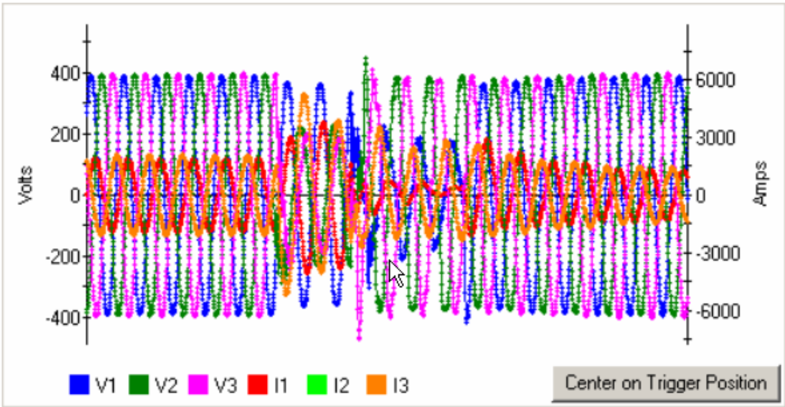
The Powermonitor 3000 M6 and M8 models are capable of detecting voltage sags and swells. There are many definitions for sag and swell. IEEE 1159[1] defines sag as:

> a decrease to between 0.1…0.9 pu in rms voltage or current at the power frequency for durations of 0.5 cycle to 1 minute.

IEEE 1159[1] defines swell as:

> an increase in rms voltage or current at the power frequency for durations from 0.5 cycles to 1 minute. Typical values are 1.1…1.8 pu.

Sag and Swell



The pre-defined setpoint configuration for the detection of sag and swell is based on the IEEE-1159 standard. Although the default setpoint configuration is applicable as-is for many sag and swell applications, it may be necessary to alter the setpoint configuration to adjust the unit's sensitivity to sags and swells for your particular application.

Setpoint #19 is setup to detect voltage sag and has the following configuration data:

- Type = Voltage Sag
- Evaluation condition = Under forward
- High Limit = 90% Nominal System Voltage
- Low Limit = 90% Nominal System Voltage
- Action delay = 0
- Release delay = 0
- Output action = Capture oscillograph

Setpoint #20 is setup to detect voltage swell and has the following configuration data:

- Type = Voltage Swell
- Evaluation condition = Over forward
- High Limit = 110% Nominal System Voltage
- Low Limit = 110% Nominal System Voltage
- Action delay = 0
- Release delay = 0
- Output action = Capture oscillograph

TIP	The setpoint limits reference the nominal line-to-line voltage for Delta modes and the nominal line-to-neutral voltage for Wye and single-phase modes.

If the nominal system voltage setting is changed, the high and low limits for setpoint #19 and #20 are automatically adjusted to 90% and 110% of the nominal system voltage.

Using Sag and Swell Detection

Follow these steps to effectively use sag and/or swell detection.

1. Set RMS result averaging to 0 (no averaging) for the quickest setpoint response to changes in input voltage.

2. Alter setpoint configuration if necessary to adjust the sensitivity to sags and/or swells.

   If using the setpoint to trigger an oscillograph capture, make sure there is at least one capture location that is clear and ready to accept a new capture.

3. Periodically check the event log or capture ready status for an indication that a sag or swell has occurred.

4. Read the event log to get the timestamp, duration of the disturbance, the worst case magnitude, and the identifier of the capture.

5. Find the capture that has the same identifier as the one found in the event log record by reading the first block from each capture location.

   Read the entire capture from the power monitor. Depending on the duration of the disturbance, the capture may contain additional information prior to and during the sag or swell event.

The sag or swell duration reported in the event log has a tolerance of ± 2x the metering update rate.

Refer to Metering Update Rate on page 60 for more information.

For sag and swell durations less than 500 milliseconds, examining the oscillograph data can result in a more accurate determination of sag or swell duration.

References:

IEEE Std 1159-1995, “IEEE Recommended Practice for Monitoring Electric Power Quality”, page 5,6,12.
The Institute of Electrical & Electronics Engineers Inc,
345 East 47th Street,
New York, NY 10017-2394,
ISBN 1-55937-549-3

Load Factor

The Powermonitor 3000 M6 and M8 models provide a Load Factor Log which calculates and stores a group of plant demand metrics that indicates how stable (or, conversely, how dynamic) a load is over a period of time, usually one month. Use communication to configure load factor operation and read the results. The display module does not support an interface to the load factor log.

Load factor is the average demand divided by the peak demand for the month. If the load is constant, load factor is 100%. The power monitor calculates load factor for real, reactive and apparent power and current, and stores the last 12 results in the Load Factor Log in non-volatile memory. You may configure the power monitor to automatically calculate and store load factor on a particular day each month, or you may manually generate a command by using communication to save the load factor result and reset the calculation. This information is useful in reducing peak demand when you look at load factor and peak demand values. The peak demand period is stored in the Mix/Max Log, which has a date and time stamp that indicates when the peak occurred. Using this information, you may be able to identify plant activities that caused the peak. You may be able to prevent or reschedule activities, or install a demand management system. Either option may realize significant savings in demand charges. You can use the load factor values to estimate demand cost savings potential. The lower the load factor, the higher the potential for savings by managing your electric power demand.

The power monitor stores the load factor in 13 records. Record 0 stores in-progress calculations and is cleared on a power cycle. Records 1…12 are a first-in, first-out array saved in non-volatile memory, with the highest record number containing the most recent record. In manual clear/reset mode, when you issue a clear/reset command, the contents of record 0 is written to the highest-numbered record and (if necessary) the remaining records are shifted down, with the oldest being deleted. In auto clear/reset mode, you select a day of the month for this process to occur automatically.

Within each record, the power monitor stores peak, average and load factor values for real power (watts), reactive power (VARs) apparent power (VA) and average current (amps). Peak values are the largest such value that has occurred since the last automatic or manual clear/reset occurrence. The in-process record (record 0) is updated at the end of each demand interval. If no demand interval has expired since the last unit power-up, the record will return all zeroes.

Reading the Load Factor Log

To select the Read-back mode or record, an auto reset/store day of the month, or issuing a manual reset/store command, perform a table write to the Load Factor Log Configuration/Read-back Select table. Load factor log data is not available via Modbus communication. This read/write table contains six integer elements as follow:

- Password: required for changing the auto clear/reset day or manual clear/reset command. Use -1 if only selecting read-back mode or record. Range 0000…9999, default 0000. Returns -1
- Record select: selects the next read-back record
- Read-back mode: 0 = auto-increment record number after each read, 1 = manual increment. Auto-increment not supported in DeviceNet and Ethernet optional communication.
- Manual clear/reset command: 0 = do nothing, 1 = manual clear/reset command (see above)
- Auto clear/reset day: Selects the day of month for automatically storing and clearing the current in-process record. Range 0…31; 0 disables automatic clear/reset, 1…28 selects day of month, 29…31 selects last day of month
- Reserved: reserved element must be 0 on a write, returns 0

The results table is the Load Factor Log Results table. You may read the in-process Record 0 or one of the 12 logged records. This table contains the following 14 floating-point elements:

- Peak demand power: expressed in watts. Range 0.0…$999.9*10^{21}$
- *A*verage demand power: expressed in watts. Range 0.0…$999.9*10^{21}$
- Load factor power: expressed in per cent. Range 0.0…100.0
- Peak demand reactive power: expressed in VARs. Range 0.0…$999.9*10^{21}$
- Average demand reactive power: expressed in VARs. Range 0.0…$999.9*10^{21}$
- Load factor reactive power: expressed in per cent. Range 0.0…100.0
- Peak demand apparent power: expressed in VARs. Range 0.0…$999.9*10^{21}$
- Average demand apparent power: expressed in VARs. Range 0.0…$999.9*10^{21}$
- Load factor apparent power: expressed in per cent. Range 0.0…100.0
- Peak demand current: expressed in VARs. Range 0.0…$999.9*10^{21}$

- Average demand current: expressed in VARs.
  Range 0.0…999.9*10^{21}
- Load factor current: expressed in per cent. Range 0.0…100.0
- Elapsed time: hours that have elapsed since the last automatic or manual clear/reset operation
- Ending date: for this load factor record. Range 0…123199 (mmddyy). 0 if the selected record is blank

Transient Detection, Metering and Capture

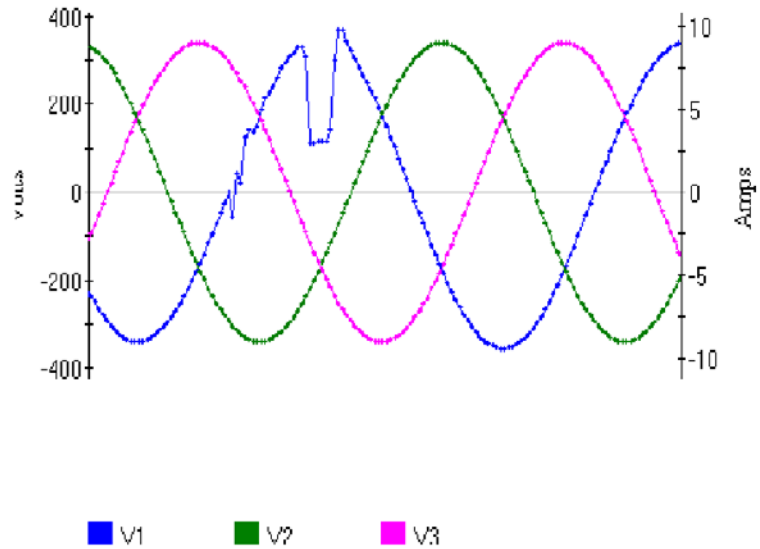
Transient detection functionality, available only in the M8 model, continuously monitors your choice of voltage or current inputs for the occurrence of a transient. Transients such as voltage spikes and momentary dropouts can disrupt equipment connected to the power source, but can be difficult to detect. Use communication to configure transient capture parameters and retrieve the data for display and/or processing. The display module does not support an interface for transient detection. Transient detection includes the following:

- Continuously monitors all six voltage or six current channels
- Identifies transients at least 200 microseconds in duration
- Triggers a transient oscillogram capture when it detects a transient
- Records captures each containing 12 cycles; 6 cycles preceding and 6 cycles following the transient
- Stores up to six transient captures of all seven voltage and current channels in non-volatile memory
- Calculates RMS voltage and current values for each cycle in each capture
- Stores each data point in the capture with 13-bit plus sign resolution
- Monitors for transients on your choice of voltage channels or current channels
- Automatically or manually adjusts transient detection thresholds

You may configure a detected transient to trigger a setpoint, which may then trigger an oscillogram capture, providing zoom capability. All communication options support transient configuration, metering and capture.

Use RSPower, RSPowerPlus, or RSEnergyMetrix software, or create a custom application, to configure and read transient data. The following information provides details of the data table interface for transient detection.

Transient Capture



Transient Analysis Configuration

Perform a table write to the Transient Analysis Configuration/Read-back Select to configure transient analysis. This read/write table of 13 floating-point elements contains the following configuration, command and read-back select parameters:

- Password: required for configuration and command. Use a valid password or -1 for read-back select. Range 0000…9999, default 0, returns -1
- DeviceNet unique write identifier: range -32,768…32,767, default 0
- Capture number: selects a capture for read-back. Range 0…6, default 1
- Cycle number: selects a cycle for read-back. Range 1…12, default 1
- Read-back mode: 0 = Auto-increment mode; cycle number increments after each read of the Transient Analysis Metering Results table. 1 = Manual-increment mode; only mode supported by DeviceNet and Ethernet communication. Default 0
- Detection mode: selects channels to monitor. 0 disables transient detection, 1 = voltage channels only, 2 = current channels. Default 1
- Auto-threshold set command: 0 = do nothing, 1 = set threshold. Default 0
- Auto-threshold set duration: range: 1…3600 seconds, default 10

- Auto-threshold set margin: range 1.0…100.0 per cent, default 20.0
- Voltage trigger threshold: range 0.1…1000.0, default 10.0
- Current trigger threshold: range 0.1…1000.0, default 10.0

Threshold Configuration

The power monitor compares voltage or current transients against a threshold that you may set manually or command to be set automatically. You select either voltage channels or current channels with the Detection mode parameter.

When you issue the Auto-threshold set command, the power monitor first determines if there is sufficient signal amplitude on the selected voltage or current channels to set the threshold. If the signal amplitude is greater than 10% of full-scale, the power monitor begins timing the Auto-threshold set duration. During this time, it monitors the selected channels, calculates an average transient index, and decrements the Auto-threshold duration time remaining parameter. At the end of this time, it combines the average transient index with the Auto-threshold set margin and stores the result as the Voltage trigger threshold or Current trigger threshold.

Threshold settings relate to both magnitude and duration of a transient, so they are representative of the energy contained in a transient. In most cases, use the automatic threshold calculation as a starting point, by issuing an Auto-threshold set command. Then manually adjust the selected threshold if you want to increase or decrease the sensitivity.

The power monitor does not monitor for or capture transient data until a threshold setting has been configured.

Reading Transient Analysis Metering Data

The Powermonitor 3000 M8 model presents 12 cycles of transient metering results for each of up to 6 transient captures in the Transient Analysis Metering Results Parameters table. Transient analysis metering data is not available via Modbus communication. This read-only table of 14 floating-point elements contains the following metering results and capture statistics:

- Capture number: transient capture number associated with the metering results. Range 1…6
- Cycle number: which cycle in the capture is returned in this read. Range 1…12

- Voltage: three RMS voltage results that express line-to-line (delta wiring modes) or line-to-neutral (all other wiring modes) for the current Cycle number. Range 0.0…999.0 * 10^{21}
- Current: four RMS current results (L1, L2, L3, L4) for the current Cycle number. Range 0.0…999.0 * 10^{21}
- Trigger channel: indicates which channel caused the transient capture. 1=V1, 2=I1, 3=V2, 4=I2, 5=V3, 6=I3, 7=I4
- Index at trigger: the value of the transient index at the time of the capture. Range -999.0 * 10^3…999.0 * 10^3
- Voltage and Current trigger thresholds: at the time of the transient capture. Range 0.0…999.0 * 10^3
- Capture ID: unique identifier that increments by 1 s to 30,000 and then rolls over to 0

Read this data table by using an indexed read method. Select the Read-back Mode, Capture and Cycle by writing to the Transient Analysis Configuration/Read-back Select table.

Reading Transient Capture Data

The data client sets up the read-back configuration with a table write to the Transient Capture Clear/Read-back Data Select. Transient capture data is not available via Modbus communication. This read/write table of 13 integer elements contains the following:

- Password: required for Clear command, use -1 for read-back selections
- DeviceNet unique write identifier
- Capture number: selects one of six captures or returns the last capture number selected. Range: 0 = most recent capture initiated via communication, 1…6 = capture #1…#6, default 1.
- Channel number: selects a channel number or returns the last channel number selected. Range: 1 = V1, 2 = I1, 3 = V2, 4 = I2, 5 = V3, 6 = I3, 7 = I4, default 1.
- Block number: selects a data block for the next read or returns the last block selected. Range depends on communication type. See below. Default 1.
- Read-back mode: selects a read-back mode or returns the last mode selected. Range 0…2, default 0. See below.
- Clear command: clears one or all captures. Always returns 0. See below
- Reserved elements: must be zero (0) on a write, returns 0.

- Capture clear status: Read-only bitfield that indicates which capture numbers are clear. Bit 0 (LSB) corresponds to capture 1, bit 1 to capture 2 and so on. For each bit, 1 indicates clear, 0 indicates not clear.
- Capture ready status: read-only bitfield that indicates which capture numbers contain captures that are ready to read. Same bit correspondence as above. For each bit, 1 indicates the capture is ready, 0 indicates no capture or not yet ready.

Block Number

The block number and the total number of data reads required to read an entire capture depend on the communication option. The range is 1…70 for the DeviceNet network and 1…28 for all other communication options.

Read-back Mode

The data client uses the indexed read method to read transient capture data. The Read-back mode options include the following:

- Auto-increment all channels: successive reads of Transient Capture Clear/Read-back Data Select table increment through all remaining blocks of the current channel, increment through all remaining channels and wrap back to the original channel.
- Auto-increment current channel: successive reads of the results table will increment through all remaining blocks of the current channel only.
- Manual increment: each write of the Transient Capture Clear/Read-back Data Select table specifies the channel and block to be read in the next read of the Transient Capture Results table. Successive reads of the results table return the same block of data each time if no read-back select write is done.

As with other indexed reads, DeviceNet and Ethernet optional communication support only manual increment read-back mode so that the client must write a read-back select message before each read of the results table. For all other communication options, auto-increment all channels or auto-increment current channel read-back mode provides the highest communication throughput.

The Transient Capture Results table comprises the transient capture results. This read-only table comprises these 29 (DeviceNet network) or 59 (all other communication options) integer elements:

- Capture timestamp: in three elements using the standard timestamp format except the year is omitted
- Capture number*:* in the range 1…6
- Channel number: in the range 1…7 (1=V1, 2=I1, 3=V2, 4=I2, 5=V3, 6=I3, 7=I4)
- Block number: block number of the data contained in the table. See above.
- Transient capture identifier: range 0…30,000, rolls over to 0
- Transient capture data points: see below

Transient Capture Data Points

The results table contains 20 data points for optional DeviceNet communication or 50 data points for all other communication options. Data points are numbered 1…20 or 1…50 in each block. The block number ranges from 1…70 for the DeviceNet network and 1…28 for all other communication options. The client calculates each data point's place in the transient capture by using the following formula:

$$N_{\text{datapoint\_capture}} = (N_{\text{block}} - 1) + N_{\text{datapoint\_this\_read}}$$

$N_{datapoint\_capture}$ = the sequence number of the data point in the capture channel

N_{block} = the block number

$N_{datapoint\_this\_read}$ = the data point number (1… 20 or 1…50) in the current read

The total number of data points is 1400. Each data point is expressed in calibrated analog-to-digital (A/D) converter counts with a resolution of 8192 (13-bit w/sign). A client may calculate the primary-side instantaneous voltage or current magnitude of each data point by using the following formula:

$$M_i = \frac{M_{(\text{max rms})} \bullet \sqrt{2}}{R_{max}} \bullet N_t \bullet M_{data}$$

M_i = instantaneous value of the voltage or current data point

$M_{(max\ rms)}$ = max rms magnitude

= 399.0 line-to-neutral volts for channels 1, 3 and 5

= 691.1 line-to-line volts for channels 1, 3 and 5

=10.6 amperes for channels 2, 4, 6 and 7

R_{max} = maximum resolution

= 8192 for 13-bit w/sign

N_t = PT or CT ratio

= PT or CT primary / PT or CT secondary

M_{data} = value of the data point from Transient Capture Results Parameters, page 252

For example, consider the following capture:

- PT primary = 13.8 kV
- PT secondary = 120V
- CT primary = 100 A
- CT secondary = 5 A
- Delta voltage mode (line-to-line)

You would multiply each data point by the following factor to correctly display the waveform:

$$Factor = (691.1 \bullet 1.414) / 8192 \bullet (13800 / 120) = 13.7$$

Capture Statistics

The Capture timestamp and Capture identifier are important statistics that identify the capture. A data client may use the Capture identifier to associate the transient capture with corresponding metering data and event log data.

Clear Command

Issue the Clear command parameter to clear transient captures from non-volatile memory and provide space for new captures. Write the correct Password for the power monitor to accept the command. The command parameter options include the following:

-1 - Clear all transient captures
0 - No action
1 - Clear capture #1
2 - Clear capture #2
3 - Clear capture #3
4 - Clear capture #4
5 - Clear capture #5
6 - Clear capture #6

At least one capture location must be clear for a transient detect event to be processed. If no captures are clear, the power monitor ignores any new transient detection events.

Powermonitor 3000 Data Tables

This section provides the detailed data table definitions you may use for setting up communication with a Powermonitor 3000 unit. One set of data tables covers all the Powermonitor 3000 models (M4, M5, M6, and M8) and communication options (-000, -232, -RIO, -DNT, -ENT, and -CNT). The individual tables include notes regarding their applicability to various models and communication options. Please note carefully these designations.

The table on page 188 summarizes the purpose and general attributes of each data table and lists each data table's access method (read-only or read/write), addressing options, number of elements and Powermonitor 3000 model applicability.

The tables on pages 191…268 provide comprehensive details of the individual data tables along with application notes.

For your convenience, summary information from the Summary of Powermonitor 3000 Data Tables for all Communication Options on page 188 is repeated at the top of each individual table.

Summary of Powermonitor 3000 Data Tables for all Communication Options

Data Table Name and Description[1]	Data Access	Indexed Reads[3]	File No.[4] (DF1, CSP)	Remote I/O BT Size	Assy Instance (CIP, DNet)	Modbus Starting Address[6]	No. of Elements	Applies to M4, M5	Applies to M6	Applies to M8	Configur-able	Refer to Page
Remote I/O, DeviceNet, EtherNet/IP and ControlNet I/O Messaging Parameters	R/W	-	-	I/O	1,2	-	-[7]	•	•	•	•[7]	191
Discrete Data Parameters	R		N9	10	3	30001	6	•	•	•		193
Basic Device Configuration Parameters	R/W		F10	20	4,5	40001	8 or 9[8]	•	•	•		194
Date and Time Parameters	R/W		N11	12	6,7	40101	8	•	•	•		195
Advanced Device Configuration Parameters	R/W		N12	26	8,9	40201	26	•	•	•		196
Native Communication Configuration Parameters	R/W		N13	11	10,11	40301	10[9]	•	•	•		198
Optional Communication Configuration Parameters	R/W		N14	24	12,13	40401	20	•	•	•		199
Metering Voltage, Current, and Frequency Result Parameters	R		F15	38	14	30101	14	•	•	•		205
Metering Sequence Voltage, and Current Results Parameters	R		F16	27	15	30201	11	•	•	•		206
Metering Power Results Parameters	R		F17	31	16	30301	13	•	•	•		207
Metering Demand Results Parameters	R		F18	25	17	30401	10	•	•	•		208
Metering Power Factor Results Parameters	R		F19	33	18	30501	13	•	•	•		209
Metering Real and Apparent Energy Results Parameters	R/W		N20	29	19,20	40501	23	•	•	•		210
Metering Reactive Energy and Amp-hour Results Parameters	R/W		N21	30	21,22	40601	23	•	•	•		211
Selftest/Diagnostic Results Parameters	R		N22	36	23	30601	27	•	•	•		212
DF1 PCCC Diagnostic Status Reply Parameters	R		[5]	-	-	-	-	•	•	•		213
Setpoint Setup/Read-back Select and Status Parameters	R/W	•	N23	22	24,25	40701	16	•	•	•		215
Trend Log Configuration/Read-back Record Select Parameters	R/W		N24	34	26,27	40801	26	•	•	•		220
Trend Log Results Parameters	R	•	F25	48	28	30701	14 or 22[10]	•	•	•	•	221
Min/Max Log Configuration/Read-back Select Parameters	R/W		N26	13	29,30	40901	9	•	•	•		223
Min/Max Log Results Parameters	R	•	F27	28	31	30801	11	•	•	•		227
Event Log Configuration/Read-back Record Select Parameters	R/W		N28	9	32,33	41001	6	•	•	•		228
Event Log Results Parameters	R	•	N29	21	34	30901	14,17,18 [11]	•	•	•		229
User-configured Table Setup Parameters	R/W		N30	35	35,36	41101	26	•	•	•		233
User-configured Table Results Parameters	R		F31	62	37	31001	14 or 23[12]	•	•	•	•	235
Write Error Status Parameters	R		N32	4	38	31101	2	•	•	•		236
Harmonic Analysis Configuration/Read-back Select Parameters	R/W		N33	14	39,40	41201	9	•	•	•		237
Harmonic Results; THD, Crest Factor, and More Parameters	R	•	F34	23	41	31201	9 or 10[13]	•	•	•		238
Harmonic Results; Odd Harmonics 1…21 Parameters	R	•	F35	39	42	-	14		•	•		239
Harmonic Results; Odd Harmonics 23…41 Parameters	R	•	F36	40	43	-	14		•	•		240
Harmonic Results; Even Harmonics 2…20 Parameters	R	•	F37	41	44	-	14		•	•		241
Harmonic Results; Even Harmonics 22…40 Parameters	R	•	F38	42	45	-	14		•	•		242
Oscillograph Configuration/Read-back Data Select Parameters	R/W		N39	15	46,47	-	11		•	•		243

Summary of Powermonitor 3000 Data Tables for all Communication Options

Data Table Name and Description[1]	**Data Access**	**Indexed Reads**[3]	**File No.**[4] **(DF1, CSP)**	**Remote I/O BT Size**	**Assy Instance (CIP, DNet)**	**Modbus Starting Address**[6]	**No. of Elements**	**Applies to**			**Configur-able**	**Refer to Page**
								M4, M5	**M6**	**M8**		
Oscillograph Results Parameters	R	•	N40	61	48	-	29 or 59[14]		•	•		244
Load Factor Log Configuration/Read-back Select Parameters	R/W		N41	16	49,50	-	6		•	•		247
Load Factor Log Results Parameters	R	•	F42	43	51	-	14		•	•		248
Transient Analysis Configuration/Read-back Select Parameters	R/W		F43	44	52,53	-	13			•		249
Transient Analysis Metering Results Parameters	R	•	F44	32	54	-	14			•		250
Transient Capture Clear/Read-back Data Select Parameters	R/W		N45	17	55,56	-	13			•		251
Transient Capture Results Parameters	R	•	N46	60	57	-	29 or 59[14]			•		252
Advanced Metering Configuration Parameters	R/W		N47	19	58,59	-	10			•		255
Harmonic Results; Odd Harmonics 43…63 Parameters	R	•	F48	45	60	-	14			•		256
Harmonic Results; Even Harmonics 42…62 Parameters	R	•	F49	46	61	-	14			•		257
Catalog Number and WIN Parameters	R		N51	50	64	32301	29	•	•	•		258
Network Demand Sync and Time Configuration Parameters[2]	R/W		N52	-	65, 66	41901	20	•	•	•		260
Controller Command Parameters[2]	W		N53	-	67	42001	1	•	•	•		261
Daylight Saving Time Configuration Parameters	R/W		N54	47	68,69	42101	10	•	•	•		261
Time of Use Register Configuration Parameters	R/W		N55	49	70,71	42201	10	•	•	•		262
Time of Use Records – Real Energy and Demand Parameters	R		F56	51	72	32401	12	•	•	•		263
Time of Use Records – Reactive Energy and Demand Parameters	R		F57	52	73	32501	12	•	•	•		264
Time of Use Records – Apparent Energy and Demand Parameters	R		F58	53	74	32601	12	•	•	•		265
Single Password Write Parameters	R/W		N60	-	75,76	42701	1	•	•	•		266
Single Parameter Read Parameters	R		-	-	80…103	-	1	•	•	•		267

(1) Event log user comment feature has been removed from master firmware revision 3.1 and later.

(2) Supported only on 1404-*xxxxx*-ENT-*xx*.

(3) Data is most commonly read from this table by using the Indexed read method.

(4) Powermonitor 3000 unit starts with file 9 to avoid any data-type incompatibility with SLC file numbers 1…8, which are of a fixed data type.

(5) This is a reply to a PCCC diagnostic status request, used by RSWho to display text and an icon for the product.

(6) Listed Modbus address is one-based. For zero-based addressing, subtract a value of one (1) from the listed address.

(7) The default size is 2 input words and 2 output words for remote I/O. The input table (instance 1) default size is 6 words and is user configurable for DeviceNet, EtherNet/IP, and ControlNet networks. Remote I/O tables and the default DeviceNet input channel are PLC/SLC controllers compatible, but if you reconfigure the DeviceNet input channel (Instance 1), it may or may not be PLC/SLC controllers compatible (depending on the number of parameters configured).

(8) Basic device configuration data table size is 8 elements for the M4 and M5, and 9 elements for the M6 and M8.

(9) Table size increased in revision 3.1*x* of the master module firmware.

(10) The size of the Trend log results table is 28 elements for the DeviceNet network and 44 elements for all other communication protocols.

(11) The size of the Event log results table is 14 elements for M4/M5, 17 elements for M6 and 18 elements for the M8.

(12) The User-configured table results table is populated from the bottom up with the number of parameters you configured. The DeviceNet table must contain 14 elements or less to remain PLC/SLC controllers compatible.

(13) Harmonic results; THD, crest factor, and more data table size is 18 elements for the M4 and M5 and 20 elements for the M6 and M8.

(14) The Oscillograph results and Transient capture results tables are 29 elements for the DeviceNet network and 59 elements for all other communication protocols.

Remote I/O, DeviceNet, EtherNet/IP and ControlNet I/O Messaging Parameters

CSP File No.	N/A
Remote I/O BT	N/A
CIP Assy. Inst.	1 (Read), 2 (Write)
No. of Elements	2 (Default)
User Configurable	Yes (DeviceNet, EtherNet/IP and ControlNet)
Data Type	Integer (Selectable as Floating Point with DeviceNet, EtherNet/IP and ControlNet)
Data Access	Read/Write
PM3000 Type	All

Remote I/O Discrete Data Provided by Powermonitor (Remote I/O Input Data)

Element No.	Element name	Range	Comment	
1	Relay, KYZ, and alarm bits	-	Bit	Description
			00…07	Reserved, used internally for BT information
			08	Form C relay state (setpoint output flag 1) 0 = De-energized and not forced 1 = Energized and not forced
			09	KYZ output state (setpoint output flag 2) 0 = De-energized and not forced 1 = Energized and not forced
			10	Setpoint output flag 3 state
			11	Setpoint output flag 4 state
			12	Setpoint output flag 5 state
			13	Setpoint output flag 6 state
			14	Setpoint output flag 7 state
			15	Setpoint output flag 8 state
2	Status input bits		Bit	Description
			00	Status input 1 state
			01	Status input 2 state
			02…05	Reserved, returns 0
			06	New oscillograph (M6, M8 only) Indicates at least one capture has been triggered, saved, and is ready to be read. This bit is cleared when all captures are cleared.
			07…11	Reserved, returns 0
			12…14	Reserved, used internally for BT information
			15	Reserved, returns 0

TIP Data appears in the first two words of the input image table corresponding to the Powermonitor 3000 logical rack. For example, with the unit configured as Rack 1, Group 1 in a 1747-SN scanner residing in Slot 2, the data will appear in words I:2.8 and I:2.9 of the data table.

Remote I/O Discrete Data Accepted by Powermonitor Units (Master Output Data)

Element No.	Element name	Range	Comment
1	Relay control	0 or 128	0 (Bit 8 = 0): De-energize 128 (Bit 8 = 1): Energize Must be enabled by Control source parameter
2	KYZ control		

DeviceNet, EtherNet/IP, and ControlNet I/O Data Provided by Powermonitor Units (Scanner Input Data; Instance 1)

Element No.	Element name	Range	Comment
0	Relay output status	0…3	0 = De-energized & not forced 1 = Energized & not forced 2 = Forced de-energized 3 = Forced energized
1	Solid-state KYZ output status		
2	Alarm output word	0…FFFF	Bitfield indicates state of 16 alarm output flags; 0 = released, 1 = asserted Bit 0 = relay/setpoint output flag 1 Bit 1 = KYZ/setpoint output flag 2 Bit 2 = setpoint output flag 3 … Bit 15 = setpoint output flag 16
3	Status inputs state	0…7	Bit 0 = status input 1; 0 = open, 1 = contact closure detected Bit 1 = status input 2; 0 = open, 1 = contact closure detected Bit 2 = demand sync timeout; 1 = the demand delay expired before the next expected external demand sync. This bit clears when the next external demand sync occurs. Refer to Advanced Device Configuration Parameters element 23. Bits 3…15 = unused (always 0)
4	Status input #1 counter	0…29,999	Counts to 29,999, rolls over to 0.
5	Status input #2 counter		

TIP Size and content of Instance 1 may vary depending on user configuration. Refer to User-configured Data Table on page 121 for more information.

DeviceNet, EtherNet/IP, and ControlNet I/O Data Accepted by Powermonitor Units (Scanner Output Data; Instance 2)

Element No.	Element name	Range	Default Value	Comment
0	Relay output	0…1	-	0 (Bit 8 = 0): De-energize 256 (Bit 8 = 1): Energize Must be enabled by Control source parameter
1	Solid-state KYZ output	0…1		

Discrete Data Parameters

CSP File No.	N9
Remote I/O BT	10
CIP Assy. Inst.	3
No. of Elements	6
User Configurable	No
Data Type	Integer
Data Access	Read Only
PM3000 Type	All

Discrete Data

Element No.	Modbus Address	Element name	Range	Comment
0	30001	Relay output status	0…3	0 = De-energized and not forced 1 = Energized and not forced 2 = Force De-energized 3 = Force Energized
1	30002	Solid-state KYZ output status		
2	30003	Alarm output word	0…FFFF	Bitfield indicating state of the 16 alarm output flags; 0 = released, 1 = asserted. Bit 0 = relay/setpoint output flag 1 Bit 1 = KYZ/setpoint output flag 2 Bit 2 = setpoint output flag 3 … Bit 15 = setpoint output flag 16
3	30004	Status inputs state	0…7	Bit 0 = status input #1; 0 = open, 1 = contact closure detected Bit 1 = status input #2; 0 = open, 1 = contact closure detected Bit 2 = demand sync timeout; 1 = the demand delay expired before the next expected external demand sync. This bit clears when the next external demand sync occurs. Refer to Advanced Device Configuration Parameters element 23. Bits 3…15 = unused (always 0)
4	30005	Status input #1 counter	0…29,999	Counts to 29,999, rolls over to 0
5	30006	Status input #2 counter		

Basic Device Configuration Parameters

CSP File No.	F10
Remote I/O BT	20
CIP Assy. Inst.	4 (Write), 5 (Read)
No. of Elements	8 (M4, M5), 9 (M6, M8)
User Configurable	No
Data Type	Floating point
Data Access	Read / Write
PM3000 Type	See table

Basic Device Configuration

Element No.	Modbus Address	Element name	M4 M5	M 6	M 8	Range	Units	Defaul t Value	Comment
0	40001-2	Password	•	•	•	0…9999	-	0	Valid password required to change configuration. Returns -1
1	40003-4	Wiring mode	•	•	•	0…8	-	6	0 = Delta 3 CT 1 = Delta 2 CT 2 = Direct Delta 3 CT 3 = Direct Delta 2 CT 4 = Open Delta 3 CT 5 = Open Delta 2 CT 6 = Wye 7 = Single Phase 8 = Demo
2	40005-6	Potential transformer (PT) primary	•	•	•	1.0… 10,000,000.0	Volts	480.0	The high side of the PT ratio (**xxx**:xxx)
3	40007-8	PT secondary	•	•	•	1.0…600.0	Volts	480.0	The low side of the PT ratio (xxx:**xxx**)
4	40009-10	I1/I2/I3 current transformer (CT) Primary	•	•	•	1.0… 10,000,000.0	Amps	5.0	The high side of the CT ratio (**xxx**:xxx)
5	40011-12	I1/I2/I3 CT secondary	•	•	•	1.0…5.0	Amps	5.0	The low side of the CT ratio (xxx:**xxx**)
6	40013-14	I4 CT primary	•	•	•	1.0… 10,000,000.0	Amps	5.0	The high side of the I4 CT ratio (**xxx**:xxx)
7	40015-16	I4 CT secondary	•	•	•	1.0…5.0	Amps	5.0	The low side of the I4 CT ratio (xxx:**xxx**)
8	40017-18	Nominal system voltage		•	•	1.0… 10,000,000.0	Volts	480.0	Value is used in the default Sag and Swell setpoints. (M6 and M8 only) Nominal line-to-line voltage for Delta mode and line-to-neutral for Wye and single-phase modes

Date and Time Parameters

CSP File No.	N11
Remote I/O BT	12
CIP Assy. Inst.	6 (Write), 7 (Read)
No. of Elements	8
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Date and Time

Element No.	Modbus Address	Element name	Range	Default Value(2)	Comment
0	40101	Password	0…9999	0	Valid password required to change the date and time. Returns -1
1	40102	Date: year	1998… 2097	1998	1 = January, 2 = February,…12 = December The internal clock adjusts the date for leap year.
2	40103	Date: month	1…12	1	
3	40104	Date: day	1…31(1)	1	
4	40105	Time: hour	0…23	0	0 = 12am, 1 = 1am,…23 = 11pm The internal clock does not adjust for daylight saving time.
5	40106	Time: minute	0…59	0	
6	40107	Time: seconds	0…59	0	
7	40108	Time: hundredths of seconds	0…99	0	

(1) On a write, the maximum value for day depends on the values written to month and the year.

(2) The data and time default values are set if one of the following three conditions occur:
- When the device is first powered-up at the factory.
- A device power-up following the depletion of the real-time clock power source.
- In the event of an abnormal condition which may cause the real-time clock to contain values which are not in the valid range.

The date and time are not set to the default values when Restore Factory Defaults is performed via the display module or communication port.

Advanced Device Configuration Parameters

CSP File No.	N12
Remote I/O BT	26
CIP Assy. Inst.	8 (Write), 9 (Read)
No. of Elements	25
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Advanced Device Configuration

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40201	Password	0…9999	-	0	Required to change configuration data. Returns -1
1	40202	New password	0…9999	-	-1	-1 = no action; 0…9999 = new password; returns -1
2	40203	Demand period length	-99…+99	Min	15	Zero or negative demand period length enables external demand synch. Refer to Demand Calculation on page 35
3	40204	Number of demand periods	1…15	-	1	
4	40205	Predicted demand type	0…2	-	0	0 = instantaneous; 1 = 1st order; 2 = 2nd order
5	40206	KYZ control source	0…8	-	7	0 = None (forcing only) 1 = Wh Forward 2 = Wh Reverse 3 = VARh Forward 4 = VARh Reverse 5 = Vah 6 = Ah 7 = Setpoints 8 = Discrete control (RIO, DeviceNet)
6	40207	KYZ pulse output scale	1…30,000	-	10	Refer to Relay and KYZ Output Operations on page 137
7	40208	KYZ pulse output width	0, 40…2000	ms	0	0 = KYZ-style transition 40…2000 = pulse duration
8	40209	Relay control source	0…8	-	7	Same choices as KYZ control source
9	40210	Relay pulse output scale	1…30,000	-	10	Refer to Relay and KYZ Output Operations on page 137
10	40211	Relay pulse output width	0, 40…2000	ms	100	0 = KYZ-style transition 40…2000 = pulse duration
11	40212	RMS resolution	0…1	-	0 (M4) 1 (M5, 6 or 8)	0 = Nominal 1 = High
12	40213	RMS result averaging	0…1	-	0 (M4) 1 (M5, 6 or 8)	0 = No averaging. 1 = Average of the last 8 results
13	40214	Frequency averaging	0…1	-	1	0 = none; 1 = last 8 cycles

Advanced Device Configuration

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
14	40215	Restore factory default config	0…1	-	0	0 = No action 1 = Restore factory default settings
15	40216	Clear status input counters	0…3	-	0	0 = No action 2 = Clear counter #2 1 = Clear counter #1 3 = Clear both
16	40217	Wdog action	0…1	-	1	0 = Restart, log an event and halt operation 1 = Restart, log an event and resume Refer to Watchdog Timeout Action on page 55
17	40218	Force relay output	0…3	-	0	0 = No change 1 = Force energize the relay 2 = Force de-energize the relay 3 = Release force of relay output Overrides setpoint or pulse output control
18	40219	Force solid-state KYZ output	0…3	-	0	
19	40220	Default relay state in event of communication loss	0…3	-	0	0 = Last state / resume 1 = Last state / freeze 2 = De-energize / resume 3 = De-energize / freeze Refer to Communication Loss Behavior on page 140
20	40221	Default KYZ state in event of communication loss				
21	40222	DM text scroll rate	0…1	-	1	0 = Slow; 1 = Fast
22	40223	Energy counter rollover	4…15	Digits	15	Refer to Configurable Energy Counter Rollover on page 35
23	40224	Forced demand sync delay	0…900	s	10	0 = Disable, 1…900 = number of seconds delay
24	40225	Reserved	0	-	0	Reserved. Must be 0 on a write, returns 0
25	40226	Reserved	0	-	0	Reserved. Must be 0 on a write, returns 0

Native Communication Configuration Parameters

CSP File No.	N13
Remote I/O BT	11
CIP Assy. Inst.	10 (Write), 11 (Read)
No. of Elements	10
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Native Communication Configuration

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40301	Password	0…9999	-	0	Valid password required to change configuration data. Returns -1
1	40302	Protocol	0…3	-	0	Communication protocol for the native communication port. 0 = DF1 half-duplex slave 1 = Modbus RTU slave 2 = Auto Sense - Selects the protocol based on the incoming communication packets 3 = DF1 full-duplex
2	40303	Delay	0…15	5 ms	2 (10ms)	Specifies the delay before responding to an external request, useful with slow external devices (such as RF modems)
3	40304	Baud rate	0…6	-	3	0 = 1.2 Kbps 1 = 2.4 Kbps 2 = 4.8 Kbps 3 = 9.6 Kbps 4 = 19.2 Kbps 5 = 38.4 Kbps 6 = 57.6 Kbps
4	40305	Device address	1…247	-	(1)	Identifies the device on a multi-drop network. DF1 master typically uses 0. The broadcast address is 255
5	40306	Data format	0…2	-	0	Parity, number of data bits, number of stop bits 0 = No parity, 8 data bits, 1 stop bit 1 = Odd parity, 8 data bits, 1 stop bit 2 = Even parity, 8 data bits, 1 stop bit
6	40307	Inter-Character Timeout	0…6553	ms	0	Specifies the minimum delay between characters that indicates the end of a message packet. 0 = 3.5 character times
7	40308	Error checking	0…1	-	0	0 = CRC 1 = BCC
8	40309	Reserved	0	-	0	Returns 0
9	40310					

(1) The default address is the Device ID, which is factory assigned and is found on the label on the side of the master module. The device ID is incremented for each device.

Optional Communication Configuration Parameters

CSP File No.	N14
Remote I/O BT	24
CIP Assy. Inst.	12 (Write), 13 (Read)
No. of Elements	20
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

TIP Select the table that applies to your Powermontior 3000 unit.

Ethernet

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40401	Password	0…9999	-	0	Valid password required to change configuration data. Returns -1
1	40402	IP address byte a	0…255	-	192	Format: aaa.bbb.ccc.ddd. Static IP address of this device (for example 130.151.32.86). If connected to a network, IP address must be unique. (255.255.255.255 is not permitted.)
2	40403	IP address byte b			168	
3	40404	IP address byte c			254	
4	40405	IP address byte d			Device ID	Factory-assigned device ID
5	40406	Subnet mask byte a	0…255	-	255	Format aaa.bbb.ccc.ddd.
6	40407	Subnet mask byte b			255	
7	40408	Subnet mask byte c			0	
8	40409	Subnet mask byte d			0	
9	40410	Gateway IP address byte a	0…255	-	128	IP address of the gateway on this subnet used to route messages to other subnets (wide area networking).
10	40411	Gateway IP address byte b			1	
11	40412	Gateway IP address byte c			1	
12	40413	Gateway IP address byte d			1	
13	40414	Protocol selection[(1)]	0…2	-	0	0 = CIP, 1 = CSP, 2 = CIP/CSP
14	40415	Reserved	0	-	0	Reserved. Must be 0 on a write, returns 0
15	40416					
16	40417					
17	40418					
18	40419					
19	40420					

(1) Master module version 4 or later, Ethernet firmware version 3 or later.

ControlNet

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40401	Password	0…9999	-	0	Valid password required to change configuration data. Returns -1
1	40402	MAC ID	0…99	-	99	On a write, sets MAC ID (node address) of Powermonitor 3000 unit on ControlNet network
2	40403	Reserved	0	-	0	Reserved. Must be 0 on a write, returns 0
3	40404					
4	40405					
5	40406					
6	40407					
7	40408					
8	40409					
9	40410					
10	40411					
11	40412					
12	40413					
13	40414					
14	40415					
15	40416					
16	40417					
17	40418					
18	40419					
19	40420					

Remote I/O

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	40401	Password	0…9999	0	Valid password required to change configuration data. Returns -1
1	40402	Logical rack address	1…63	1	The scanner uses rack address 0
2	40403	Module group	0,2,4,6	0	0 = Group 0 (acts like the first 2 rack slots) 2 = Group 2 4 = Group 4 6 = Group 6
3	40404	Last rack	0…1	0	0 = No 1 = Yes
4	40405	Baud rate	0…2	0	0 = 57.6 Kbps 1 = 115.2 Kbps 2 = 230.4 Kbps
5	40406	Reserved	0	0	Reserved. Must be 0 on a write, returns 0
6	40407				
7	40408				
8	40409				
9	40410				
10	40411				
11	40412				
12	40413				
13	40414				
14	40415				
15	40416				
16	40417				
17	40418				
18	40419				
19	40420				

DeviceNet

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	40401	Password	0…9999	0	Valid password required to change configuration data. Returns -1
1	40402	Node address (MAC ID)	0…64	63	Address 64 enables remote node address programming; there is no actual node address of 64 defined for the DeviceNet network
2	40403	Baud rate	0…4	0	0 = 125 Kbps 1 = 250 Kbps 2 = 500 Kbps 3 = Auto 4 = Programmable
3	40404	Bus Off Interrupt Action	0…1	0	0 = hold CAN chip in reset 1 = reset CAN chip and continue communication
4	40405	Floating point data format	0…1	0	0 = Compliant with prior versions, word order swapped 1 = CIP compliant, little Endian
5	40406	Reserved	0	0	Reserved. Must be 0 on a write, returns 0
6	40407				
7	40408				
8	40409				
9	40410				
10	40411				
11	40412				
12	40413				
13	40414				
14	40415				
15	40416				
16	40417				
17	40418				
18	40419				
19	40420				

RS-232

Element No.	Modbus Address	Element name	Range	Default Value	Comment
0	40401	Password	0…9999	0	Required to change configuration data. Returns -1
1	40402	Hardware port	0…1	0	Select active port 0 = RS-232 port 1 = Native RS-485 port
2	40403	Protocol	0…3	0	Communication protocol for the native communication port. 0 = DF1 half-duplex slave 1 = Modbus RTU slave 2 = Auto Sense - Selects the protocol based on the incoming communication packets 3 = DF1 full-duplex
3	40404	Delay	0…15	2 (10 ms)	Specifies the delay before responding to an external request., useful with slow external devices (such as RF modems)
4	40405	Baud rate	0… 6	3	0 = 1.2 Kbps 1 = 2.4 Kbps 2 = 4.8 Kbps 3 = 9.6 Kbps 4 = 19.2 Kbps 5 = 38.4 Kbps 6 = 57.6 Kbps
5	40406	RS-232 address	1…247	(1)	Identifies the device on the link. 0 is typically used by the DF1 master. 255 is the broadcast address
6	40407	Data format	0…2	0	Parity, number of data bits, number of stop bits 0 = No parity, 8 data bits, 1 stop bit 1 = Even parity, 8 data bits, 1 stop bit 2 = Odd parity, 8 data bits, 1 stop bit
7	40408	Flow Control (Handshaking)	0…1	0	Data flow control for RS-232/RS-485 port. 0 = None 1 = Hardware RTS/CTS
8	40409	RTS On Delay	0…9995 ms	0	
9	40410				
10	40411	Inter-character timeout			Specifies the minimum delay between characters that indicates the end of a message packet. 0 = 3.5 character times.
11	40412	Error checking	0…1	0	0 = CRC 1 = BCC

RS-232

Element No.	Modbus Address	Element name	Range	Default Value	Comment
12	40413	Reserved	0	0	Reserved. Must be 0 on a write, returns 0
13	40414				
14	40415				
15	40416				
16	40417				
17	40418				
18	40419				
19	40420				

(1) The default address is the same as the Device ID, which is assigned at the factory and can be found printed on the white label on the side of the master module. The device ID is incremented for each device.

Metering Voltage, Current, and Frequency Result Parameters

CSP File No.	F15
Remote I/O BT	38
CIP Assy. Inst.	14
No. of Elements	14
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Metering Voltage, Current, and Frequency Result

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30101-2	L1 Current	Amps (A)	0.0…999.9x10^{21}	Refer to Voltage, Current, and Frequency Results on page 30.
1	30103-4	L2 Current		0.0…999.9x10^{21}	
2	30105-6	L3 Current		0.0…999.9x10^{21}	
3	30107-8	Avg. Current		0.0…999.9x10^{21}	
4	30109-10	L1-N Voltage	Volts (V)	0.0…999.9x10^{21}	
5	30111-12	L2-N Voltage		0.0…999.9x10^{21}	
6	30113-14	L3-N Voltage		0.0…999.9x10^{21}	
7	30115-16	Avg. L-N Voltage		0.0…999.9x10^{21}	
8	30117-18	L1-L2 Voltage		0.0 …999.9x10^{21}	
9	30119-20	L2-L3 Voltage		0.0 …999.9x10^{21}	
10	30121-22	L3-L1 Voltage		0.0…999.9x10^{21}	
11	30123-24	Avg L-L Voltage		0.0…999.9x10^{21}	
12	30125-26	Frequency, last cycle	Hertz (Hz)	40.0…75.0	Returns 0 or 999.0 if out of range.
13	30127-28	Metering iteration	-	0…32,767	Increments by 1…32,767, rolls over to 0.

Metering Sequence Voltage, and Current Results Parameters

CSP File No.	F16
Remote I/O BT	27
CIP Assy. Inst.	15
No. of Elements	11
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Metering Sequence Voltage, and Current Results

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30201-02	L4 (Zero sequence) Current	Amps (A)	0.0…999.9x10^{21}	Refer to Symmetrical Component Analysis Results on page 31.
1	30203-04	Positive Sequence Current		0.0…999.9x10^{21}	
2	30205-06	Negative Sequence Current		0.0…999.9x10^{21}	
3	30207-08	% Current unbalance	Per Cent	0.0…100.0	
4	30209-10	Positive Sequence Voltage	Volts (V)	0.0…999.9x10^{21}	
5	30211-12	Negative Sequence Voltage		0.0…999.9x10^{21}	
6	30213-14	% Voltage unbalance	Per Cent	0.0…100.0	
7	30215-16	Phase rotation	-	0…2	0 = No rotation. 1 = ABC rotation. 2 = ACB rotation.
8	30217-18	Average frequency	Hertz (Hz)	40.0…75.0	Average of the last 1 or 8 cycles. Returns 0 or 999.0 if out of range.
9	30219-20	Frequency source	-	0… 2	0 = V1, 1 = V2, 2 = V3.
10	30221-22	Metering iteration	-	0…32,767	Increments by 1…32,767, rolls over to 0.

Metering Power Results Parameters

CSP File No.	F17
Remote I/O BT	31
CIP Assy. Inst.	16
No. of Elements	13
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Metering Power Results

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30301-02	L1 Real Power	Watts (W)	0.0…999.9x10^{22}	Real power per phase, signed to show direction. Refer to Power Results on page 32.
1	30303-04	L2 Real Power		0.0…999.9x10^{22}	
2	30305-06	L3 Real Power		0.0…999.9x10^{22}	
3	30307-08	Total Real Power		0.0 …999.9x10^{22}	Total power signed to show direction.
4	30309-10	L1 Reactive Power	Volt-amps reactive (VAR)	0.0…999.9x10^{22}	Reactive power per phase, signed to show direction.
5	30311-12	L2 Reactive Power		0.0 …999.9x10^{22}	
6	30313-14	L3 Reactive Power		0.0…999.9x10^{22}	
7	30315-16	Total Reactive Power		0.0…999.9x10^{22}	Total reactive power, signed to show direction.
8	30317-18	L1 Apparent Power	Volt-amps (VA)	0.0…999.9x10^{22}	Apparent power per phase.
9	30319-20	L2 Apparent Power		0.0…999.9x10^{22}	
10	30321-22	L3 Apparent Power		0.0…999.9x10^{22}	
11	30323-24	Total Apparent Power		0.0…999.9x10^{22}	Total apparent power.
12	30325-26	Metering iteration	-	0…32,767	Increments by 1…32,767, rolls over to 0.

Metering Demand Results Parameters

CSP File No.	F18
Remote I/O BT	25
CIP Assy. Inst.	17
No. of Elements	10
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Metering Demand Results

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30401-02	Demand Current	Amps (A)	$0.0...999.9x10^{21}$	Refer to Energy Results on page 34.
1	30403-04	Demand Power	Watts (W)	$0.0...999.9x10^{21}$	
2	30405-06	Demand Reactive Power	VAR	$0.0...999.9x10^{21}$	
3	30407-08	Demand Apparent Power	VA	$0.0...999.9x10^{21}$	
4	30409-10	Projected Demand I	Amps	$0.0...999.9x10^{21}$	Refer to Projected Demand Calculation on page 36.
5	30411-12	Projected Demand W	Watts	$0.0...999.9x10^{21}$	
6	30413-14	Projected Demand VAR	VAR	$0.0...999.9x10^{21}$	
7	30415-16	Projected Demand VA	VA	$0.0...999.9x10^{21}$	
8	30417-18	Elapsed demand period time	Minutes	$0.0...999.9x10^{21}$	The time elapsed within the current demand period.
9	30419-20	Metering iteration	-	0…32,767	Increments by 1…32,767, rolls over to 0.

Metering Power Factor Results Parameters

CSP File No.	F19
Remote I/O BT	33
CIP Assy. Inst.	18
No. of Elements	13
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Metering Power Factor Results

Element No.	Modbus Address	Element name	Units	Range	Comment
0	30501-02	L1 True Power Factor	Percent	-100…100	Ratio between power and apparent power. + = Lead - = Lag
1	30503-04	L2 True Power Factor		-100…100	
2	30505-06	L3 True Power Factor		-100…100	
3	30507-08	Three-phase True PF		-100…100	
4	30509-10	L1 Displacement Power Factor		-100…100	Cosine of the phase angle between the fundamental voltage and current. + = Lead - = Lag
5	30511-12	L2 Displacement Power Factor		-100…100	
6	30513-14	L3 Displacement Power Factor		-100…100	
7	30515-16	Three-phase Displacement PF		-100…100	
8	30517-18	L1 Distortion Power Factor		0…100	The ratio between the magnitude of the fundamental and the sum of the magnitudes for all of the current harmonics.
9	30519-20	L2 Distortion Power Factor		0…100	
10	30521-22	L3 Distortion Power Factor		0…100	
11	30523-24	Three-phase Distortion PF		0…100	
12	30525-26	Metering iteration	-	0…32,767	Increments by 1…32,767, rolls over to 0.

Metering Real and Apparent Energy Results Parameters

CSP File No.	N20
Remote I/O BT	29
CIP Assy. Inst.	19 (Write), 20 (Read)
No. of Elements	23
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Metering Real and Apparent Energy Results

Element No.	Modbus Address	Element Name		Range	Units	Default Value	Comment
0	40501	Password		0…9999	-	0	Required to clear or preset energy counters. Returns -1.
1	40502	Parameter select		0 to 7 (bitfield)	-		Refer to How to Clear or Preset Energy Counters by Using Communication on page 120.
2	40503	kWh forward	### x 10^9	-999…999	kWh		
3	40504		### x 10^6				
4	40505		### x 10^3				
5	40506		### x 10^0				
6	40507		### x 10^{-3}				
7	40508	kWh reverse	### x 10^9	-999…999			
8	40509		### x 10^6				
9	40510		### x 10^3				
10	40511		### x 10^0				
11	40512		### x 10^{-3}				
12	40513	kWh net	### x 10^9	-999…999			
13	40514		### x 10^6				
14	40515		### x 10^3				
15	40516		### x 10^0				
16	40517		### x 10^{-3}				
17	40518	kVAh	### x 10^9	-999…999	KVAh		
18	40519		### x 10^6				
19	40520		### x 10^3				
20	40521		### x 10^0				
21	40522		### x 10^{-3}				
22	40523	Metering iteration		0…32,767	-		Increments by 1…32,767, rolls over to 0.

Metering Reactive Energy and Amp-hour Results Parameters

CSP File No.	N21
Remote I/O BT	30
CIP Assy. Inst.	21 (Write), 22 (Read)
No. of Elements	23
User Configurable	No
Data Type	Integer
Data Access	Read/Write
PM3000 Type	All

Metering Reactive Energy and Amp-hour Results

Element No.	Modbus Address	Element name		Range	Units	Default Value	Comment
0	40601	Password		0…9999	-	0	Required to clear or preset energy counters. Returns -1.
1	40602	Parameter select		0…7	-		Refer to How to Clear or Preset Energy Counters by Using Communication on page 120.
2	40603	kVARh forward	### x 10^9	-999…999	kVARh		
3	40604		### x 10^6				
4	40605		### x 10^3				
5	40606		### x 10^0				
6	40607		### x 10^{-3}				
7	40608	kVARh reverse	### x 10^9	-999…999			
8	40609		### x 10^6				
9	40610		### x 10^3				
10	40611		### x 10^0				
11	40612		### x 10^{-3}				
12	40613	kVARh net	### x 10^9	-999…999			
13	40614		### x 10^6				
14	40615		### x 10^3				
15	40616		### x 10^0				
16	40617		### x 10^{-3}				
17	40618	kAh	### x 10^9	-999…999	kAh		
18	40619		### x 10^6				
19	40620		### x 10^3				
20	40621		### x 10^0				
21	40622		### x 10^{-3}				
22	40623	Metering iteration		0…32,767	-		Increments by 1…32,767, rolls over to 0.

Selftest/Diagnostic Results Parameters

CSP File No.	N22
Remote I/O BT	36
CIP Assy. Inst.	23
No. of Elements	27
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	All

Selftest/Diagnostic Results

Element No.	Modbus Address	Element name	Range	Comment
0	30601	Bulletin number	1404	
1	30602	Series	0…8	0 = A, 1 = B
2	30603	Overall status	-	0 = OK
3	30604	Data Acquisition status	-	0 = OK bit 0 = overall status; 0 = pass, 1 = fail bit 1 = reserved bit 2 = data bus connection failure bit 3 = address test failure
4	30605	Data FLASH status	-	0 = OK
5	30606	Real-time clock status	-	0 = OK
6	30607	RTC NVRAM status	-	0 = OK Non-zero indicates corruption of nonvolatile memory. This does not cause product to shutdown. The error is cleared on a reset/power cycle. If this error is detected, date/time, and energy values are reset.
7	30608	Option communication status	-	0 = OK or no optional communication present
8	30609	Display module status	-	0 = OK or no DM connected
9	30610	Watchdog status	-	0 = OK
10	30611	Code FLASH status	-	0 = OK bit 0 = overall status; 0 = pass, 1 = fail bit 1 = boot code checksum failure bit 2 = application code checksum failure bit 3 = calibration CRC failure bit 4 = no calibration data bit 5 = wrong application firmware loaded
11	30612	RAM status	-	0 = OK bit 0 = read/write test failure
12	30613	Application FRN	0…9999	100 indicates version 1.00, 103 indicates version 1.03…
13	30614	Boot code FRN	0…9999	100 indicates version 1.00, 101 indicates version 1.01…

Selftest/Diagnostic Results

Element No.	Modbus Address	Element name	Range	Comment
14	30615	ASIC build #	0…9999	Revision number of the code that was used to fabricate the ASIC.
15	30616	Option communication FRN	0…9999	100 indicates version 1.00, 103 indicates version 1.03… 0 = none (catalog numbers ending in -000, -232)
16	30617	Display module FRN	0…9999	104 indicates version 1.04, 105 indicates version 1.05… Returns 0 if no DM connected
17	30618	Reserved	0	Returns 0
18	30619	Digital board revision	0…7	0 = 02A, 1 = 03A…
19	30620	Analog board revision	0…7	0 = 02A, 1 = 03A…
20	30621	Reserved	0	Returns 0
21	30622	Reserved	0	Returns 0
22	30623	MM Device ID	0…255	Sequentially assigned at time of manufacture. May not be changed.
23	30624	Master module type, current	4,5,6,or 8	4 = M4, 5 = M5, 6 = M6, 8 = M8; reflects any upgrades
24	30625	Display module type	0…1	0 = No display module connected 1 = 1404-DM connected to master module
25	30626	Option communication type	-	00 = No optional communication (native RS-485 only) 81 = DeviceNet version 1 82 = ControlNet 84 = Remote I/O 86 = RS-232 88 = DeviceNet version 2 89 = IEC870 comm card
26	30627	Accuracy Class	0…2	Indicates revenue metering accuracy class as manufactured (refer to page 29). 0 = Class 1 1 = Class 0.5 2 = Class 0.2

TIP This is not truly a data table, but a reply to a PCCC diagnostic status request (used by RSWho to display text and an icon for the Powermonitor 3000 unit). This data is not accessible using Modbus.

DF1 PCCC Diagnostic Status Reply Parameters

Byte	Bits	Contents	Description
1	0…1	Mode/status	Unused
	2…3		
	4…7		
2	0…7	Type extender	EE
3	0…7	Extended interface type	36h = DF1 half-duplex slave (via native RS485 port or RS-232 port) 65h = Ethernet
4	0…7	Extended processor type	8Ah; 1404 Powermonitor 3000 products

DF1 PCCC Diagnostic Status Reply Parameters

Byte	Bits	Contents	Description
5	0…4	Series/revision	Unused
	5…7		
6…16	All	Catalog number (in ASCII)	Catalog number written into the device at time of production or calibration. For example, 1404-M4-05-A-RIO
17…24	All	Product Specific	Unused

Setpoint Setup/Read-back Select and Status Parameters

CSP File No.	N23
Remote I/O BT	22
CIP Assy. Inst.	24 (Write), 25 (Read)
No. of Elements	16
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Setpoint Setup/Read-back Select and Status

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
0	40701	Password	0…9999	-	0	Required for configuration, -1 for readback select, returns -1.
1	40702	Setpoint number	1…10 (M4, M5) 1…20 (M6, M8)	-	-	Refer to Writing Setpoint Configuration by Using Communication on page 134.
2	40703	Read-back mode	0…1	-	0	
3	40704	Setpoint type	0…52	-	0(1)	
4	40705	Evaluation condition	0…5	-	0	
5	40706	High limit Integer	0…9999	Depends on setpoint type	0(1)	
6	40707	High limit Exponent	-4…21		0(1)	
7	40708	Low limit Integer	0…9999		0(1)	
8	40709	Low Limit Exponent	-4…21		0(1)	
9	40710	Action delay	0…3600 (M4, M5) 0…30,000 (M6, M8)	Seconds (M4, M5) 0.1 s (M6, M8)	0	
10	40711	Release delay	0…3600 (M4, M5) 0…30,000 (M6, M8)	Seconds (M4, M5) 0.1 s (M6, M8)	0	
11	40712	Output action	0…32 (M4, M5) 0…43 (M6, M8)	-	0(1)	
12	40713	Status	0…1	-	0	

Setpoint Setup/Read-back Select and Status

Element No.	Modbus Address	Element name	Range	Units	Default Value	Comment
13	40714	Accumulated time Integer	0…9999	Seconds	-	
14	40415	Accumulated time Exponent	-1…21	-	-	
15	40716	Clear time accumulator command	0…1	-	0	

(1) On the M6 and M8, setpoint #19 and #20 default to detect voltage sag and voltage swell. See Sag and Swell, page 174.

List of Setpoint Types Parameters

Applies to	Setpoint Setup/Read-back Select and Status Parameters on page 215.
PM3000 Type	See table

List of Setpoint Types

Param. No.	Parameter Name	M4 M5	M 6	M 8	Comment
0	Not used	•	•	•	Disables the setpoint
1	Voltage[1]	•	•	•	Refer to Metering Voltage, Current, and Frequency Result Parameters
2	Current[1]	•	•	•	
3	Voltage unbalance	•	•	•	Refer to Metering Sequence Voltage, and Current Results Parameters
4	Current unbalance	•	•	•	
5	Neutral current	•	•	•	
6	W	•	•	•	Refer to Metering Power Results Parameters
7	VAR	•	•	•	
8	VA	•	•	•	
9	Total true PF	•	•	•	Refer to Metering Power Factor Results Parameters
10	Total disp PF	•	•	•	
11	Total dist PF	•	•	•	
12	W demand	•	•	•	Refer to Metering Demand Results Parameters
13	VAR demand	•	•	•	
14	VA demand	•	•	•	
15	Amp demand	•	•	•	
16	Projected amp demand	•	•	•	
17	Projected W Demand	•	•	•	
18	Projected VAR Demand	•	•	•	
19	Projected VA Demand	•	•	•	
20	Frequency	•	•	•	Refer to Metering Voltage, Current, and Frequency Result Parameters
21	Phase rotation	•	•	•	Refer to Metering Sequence Voltage, and Current Results Parameters

List of Setpoint Types

Param. No.	Parameter Name	M4 M5	M 6	M 8	Comment
22	Crest factor voltage	•	•	•	Refer to Harmonic Results; THD, Crest Factor, and More Parameters
23	Crest factor current	•	•	•	
24	Crest factor I4	•	•	•	
25	IEEE THD voltage[(1)]	•	•	•	
26	IEEE THD current[(1)]	•	•	•	
27	IEEE THD I4	•	•	•	
28	IEC THD voltage[(1)]	•	•	•	
29	IEC THD current[(1)]	•	•	•	
30	IEC THD I4	•	•	•	
31	Status input 1	•	•	•	Refer to Discrete Data Parameters
32	Status input 2	•	•	•	
33	Any status input[(1)]	•	•	•	
34	Setpoint #1 time accumulator	•	•	•	Refer to Setpoint Output Actions Parameters
35	Setpoint #2 time accumulator	•	•	•	
36	Setpoint #3 time accumulator	•	•	•	
37	Setpoint #4 time accumulator	•	•	•	
38	Setpoint #5 time accumulator	•	•	•	
39	Setpoint #6 time accumulator	•	•	•	
40	Setpoint #7 time accumulator	•	•	•	
41	Setpoint #8 time accumulator	•	•	•	
42	Setpoint #9 time accumulator	•	•	•	
43	Setpoint #10 time accumulator	•	•	•	
44	Voltage Sag[(2)]		•	•	Refer to Sag and Swell on page 174
45	Voltage Swell[(2)]		•	•	
46	Transient detected[(2)]			•	Triggers a setpoint when a transient has been detected
47	Avg IEEE THD V	•	•	•	Refer to Harmonic Results; THD, Crest Factor, and More Parameters
48	Avg IEEE THD I	•	•	•	
49	Avg IEC thd V	•	•	•	
50	Avg IEC thd I	•	•	•	
51	Avg Crest Factor V	•	•	•	
52	Avg Crest Factor I	•	•	•	

(1) A setpoint activates when the magnitude of any phase passes the activation limit and releases when all phases pass the release limit in the appropriate direction for the setpoint evaluation condition.

(2) These setpoint types apply only to the applicable Powermonitor 3000 models and will appear as inactive on other models.

Setpoint Output Actions Parameters

Applies to	Refer to Setpoint Setup/Read-back Select and Status Parameters on page 215
PM3000 Type	See table

Setpoint Output Actions

Param. #	Parameter Name	M4 M5	M 6	M 8	Comment
0	None	•	•	•	No output action, but recorded in the event log and Setpoint status recorded
1	Energize relay and set alarm flag 1	•	•	•	Refer to Discrete Data Parameters
2	Energize KYZ and set alarm flag 2	•	•	•	
3	Set alarm flag 3	•	•	•	
4	Set alarm flag 4	•	•	•	
5	Set alarm flag 5	•	•	•	
6	Set alarm flag 6	•	•	•	
7	Set alarm flag 7	•	•	•	
8	Set alarm flag 8	•	•	•	
9	Set alarm flag 9	•	•	•	
10	Set alarm flag 10	•	•	•	
11	Set alarm flag 11	•	•	•	
12	Set alarm flag 12	•	•	•	
13	Set alarm flag 13	•	•	•	
14	Set alarm flag 14	•	•	•	
15	Set alarm flag 15	•	•	•	
16	Set alarm flag 16	•	•	•	
17	Save a trend log record	•	•	•	Saves record even if periodic trending is disabled
18	Clear kWh result	•	•	•	
19	Clear kVARh result	•	•	•	
20	Clear kVAh result	•	•	•	
21	Clear Ah result	•	•	•	
22	Clear all energy results	•	•	•	

Setpoint Output Actions

Param. #	Parameter Name	M4 M5	M 6	M 8	Comment
23	Clear setpoint #1 time	•	•	•	Clears the corresponding setpoint time accumulator
24	Clear setpoint #2 time	•	•	•	
25	Clear setpoint #3 time	•	•	•	
26	Clear setpoint #4 time	•	•	•	
27	Clear setpoint #5 time	•	•	•	
28	Clear setpoint #6 time	•	•	•	
29	Clear setpoint #7 time	•	•	•	
30	Clear setpoint #8 time	•	•	•	
31	Clear setpoint #9 time	•	•	•	
32	Clear setpoint #10 time	•	•	•	
33	Clear setpoint #11 time		•	•	
34	Clear setpoint #12 time		•	•	
35	Clear setpoint #13 time		•	•	
36	Clear setpoint #14 time		•	•	
37	Clear setpoint #15 time		•	•	
38	Clear setpoint #16 time		•	•	
39	Clear setpoint #17 time		•	•	
40	Clear setpoint #18 time		•	•	
41	Clear setpoint #19 time		•	•	
42	Clear setpoint #20 time		•	•	
43	Capture oscillograph		•	•	Triggers a capture per the current oscillography configuration

Trend Log Configuration/Read-back Record Select Parameters

CSP File No.	N24
Remote I/O BT	34
CIP Assy. Inst.	26 (Write), 27 (Read)
No. of Elements	26
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Trend Log Configuration/Read-back Record Select

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	40801	Password	0…9999	0	Required for configuration, -1 for readback select, returns -1
1	40802	DeviceNet unique write identifier	-32,768… 32,767	0	Refer to DeviceNet Unique Write Identifier on page 103
2	40803	Reserved	0	0	Must be 0 on a write; returns 0
3	40804	Read-back mode	0…6	2	Refer to Setting up the Trend Log on page 151, and Reading Data from the Trend Log on page 152
4	40805	Logging interval	-1…3600	900 (15 min)	Expressed in seconds -1 = synchronize logging with demand interval 0 = disable periodic logging
5	40806	Logging mode	0…1	0	0 = Overwrite 1 = Fill and hold
6	40807	Clear trend log command	0…1	0	0 = no action 1 = clear trend log; returns 0
7	40808	Total records logged x 1000	0…999	-	Number of records = element 7 x 1000 + element 8
8	40809	Total records logged x 1	0…999	-	
9	40810	Reserved	0	-	Must be 0 on a write; returns 0
10	40811	Parameter #1 selection	1…301	122	Refer to Setting up the Trend Log on page 151 Defaults: Parameter 1: 122, Net Kilowatt-hours Parameter 2: 126, Net kVAR-hours Parameter 3: 100, Demand watts
11	40812	Parameter #2 selection	0…301	126	
12	40813	Parameter #3 selection		100	
13	40814	Parameter #4 selection		0	
14	40815	Parameter #5 selection			
15	40816	Parameter #6 selection			
16	40817	Parameter #7 selection			
17	40818	Parameter #8 selection			

Trend Log Configuration/Read-back Record Select

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
18	40819	Parameter #9 selection[1]	0…301	0	
19	40820	Parameter #10 selection			
20	40821	Parameter #11 selection			
21	40822	Parameter #12 selection			
22	40823	Parameter #13 selection			
23	40824	Parameter #14 selection			
24	40825	Parameter #15 selection			
25	40826	Parameter #16 selection			

(1) For DeviceNet Powermonitor units you may configure parameters 9…16 but the Trend Log Results Parameters tabke returns only the first eight parameters.

Trend Log Results Parameters

CSP File No.	F25
Remote I/O BT	48
CIP Assy. Inst.	28
No. of Elements	14 (DeviceNet network only), 22 (All other communication types)
User Configurable	Yes
Data Type	Floating Point
Data Access	Read only
PM3000 Type	All

Trend Log Results

Element No.	Modbus Address	Element Name	Range	Comment
0	30701-02	Reserved	0	Returns 0
1	30703-04	Internal Identifier	0…15	Increment from 1…15 for each record, rolls to 0
2	30705-06	Timestamp; Year	1998…2097	Date and time record was recorded. Refer to Expressing Data in Data Tables on page 82
3	30707-08	Month/Date	0101…1231	
4	30709-10	Hour/minute	0000…2359	
5	30711-12	Seconds/hsec	0000…5999	

Trend Log Results

Element No.	Modbus Address	Element Name	Range	Comment
6	30713-14	User selected parameter #1	-	The values of parameters that were configured.
7	30715-16	User selected parameter #2	-	
8	30717-18	User selected parameter #3	-	
9	30719-20	User selected parameter #4	-	
10	30721-22	User selected parameter #5	-	
11	30723-24	User selected parameter #6	-	
12	30725-26	User selected parameter #7	-	
13	30727-28	User selected parameter #8	-	
14	30729-30	User selected parameter #9	-	
15	30731-32	User selected parameter #10	-	
16	30733-34	User selected parameter #11	-	
17	30735-36	User selected parameter #12	-	
18	30737-38	User selected parameter #13	-	
19	30739-40	User selected parameter #14	-	
20	30741-42	User selected parameter #15	-	
21	30743-44	User selected parameter #16	-	

Min/Max Log Configuration/Read-back Select Parameters

CSP File No.	N26
Remote I/O BT	13
CIP Assy. Inst.	29 (Write), 30 (Read)
No. of Elements	9
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Min/Max Log Configuration/Read-back Select

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	40901	Password	0…9999	0	Required for configuration, -1 for readback select, returns -1.
1	40902	Min/max parameter to read	0…73	1	Refer to Interfacing with the Min/Max Log by Using Communication on page 154.
2	40903	Read-back mode	0…1	0	
3	40904	Enable/disable Min/max log	0…1	1	
4	40905	Clear min/max log	0…1	0	
5	40906	Timestamp of last min/max clear; year	1998…2097	-	
6	40907	month/day	0101…1231	-	
7	40908	hour/minute	0000…2359	-	
8	40909	second/hsec	0000…5999	-	

Min/Max Log Parameter List Parameters

Applies to	Min/Max Log Configuration/Read-back Select Parameters on page 223 Min/Max Log Results Parameters on page 227
PM3000 Type	All

Min/Max Log Parameter List

Param No.	Parameter Name	Comment
0	L1 Current	Refer to Metering Voltage, Current, and Frequency Result Parameters
1	L2 Current	
2	L3 Current	
3	Avg Current	
4	L1-N Voltage	
5	L2-N Voltage	
6	L3-N Voltage	
7	Avg L-N Voltage	
8	L1-L2 Voltage	
9	L2-L3 Voltage	
10	L3-L1 Voltage	
11	Avg L-L Voltage	
12	Frequency, last cycle	
13	L4 Current	Refer to Metering Sequence Voltage, and Current Results Parameters
14	Positive Sequence Current	
15	Negative Sequence Current	
16	% Current unbalance	
17	Positive Sequence Voltage	
18	Negative Sequence Voltage	
19	% Voltage unbalance	
20	Average frequency	

Min/Max Log Parameter List

Param No.	Parameter Name	Comment
21	L1 Real Power	Refer to Metering Power Results Parameters
22	L2 Real Power	
23	L3 Real Power	
24	Total Real Power	
25	L1 Reactive Power	
26	L2 Reactive Power	
27	L3 Reactive Power	
28	Total Reactive Power	
29	L1 Apparent Power	
30	L2 Apparent Power	
31	L3 Apparent Power	
32	Total Apparent Power	
33	Demand Current	Refer to Metering Demand Results Parameters
34	Demand Power	
35	Demand Reactive Power	
36	Demand Apparent Power	
37	Projected Demand I	
38	Projected Demand W	
39	Projected Demand VAR	
40	Projected Demand VA	
41	L1 True Power Factor	Refer to Metering Power Factor Results Parameters
42	L2 True Power Factor	
43	L3 True Power Factor	
44	Three-phase True PF	
45	L1 Displacement Power Factor	
46	L2 Displacement Power Factor	
47	L3 Displacement Power Factor	
48	Three-phase Displacement PF	Refer to Metering Power Factor Results Parameters
49	L1 Distortion Power Factor	
50	L2 Distortion Power Factor	
51	L3 Distortion Power Factor	
52	Three-phase Distortion PF	

Min/Max Log Parameter List

Param No.	Parameter Name	Comment
53	V1 % IEEE THD	Refer to Harmonic Results; THD, Crest Factor, and More Parameters
54	I1 % IEEE THD	
55	V2 % IEEE THD	
56	I2 % IEEE THD	
57	V3 % IEEE THD	
58	I3 % IEEE THD	
59	I4 % IEEE THD	
60	V1 % IEC thd (DIN)	
61	I1 % IEC thd (DIN)	
62	V2 % IEC thd (DIN)	
63	I2 % IEC thd (DIN)	
64	V3 % IEC thd (DIN)	
65	I3 % IEC thd (DIN)	
66	I4 % IEC thd (DIN)	
67	V1 Crest Factor	
68	I1 Crest Factor	
69	V2 Crest Factor	
70	I2 Crest Factor	
71	V3 Crest Factor	
72	I3 Crest Factor	
73	I4 Crest Factor	

Min/Max Log Results Parameters

CSP File No.	F27
Remote I/O BT	28
CIP Assy. Inst.	31
No. of Elements	11
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	All

Min/Max Log Results

Element No.	Modbus Address	Element Name	Range	Comment
0	30801-02	Parameter # being returned	1…73	Refer to Reading Data from the Trend Log on page 152
1	30803-04	MIN value for parameter	$-999.9x10^{21}…999.9x10^{21}$	
2	30805-06	MAX value for parameter	$-999.9x10^{21}…999.9x10^{21}$	
3	30807-08	MIN timestamp; year	1998…2097	
4	30809-10	month/day	0101…1231	
5	30811-12	hour/minute	0000…2359	
6	30813-14	sec/hsec	0000 …5999	
7	30815-16	MAX timestamp; year	1998…2097	
8	30817-18	month/day	0101…1231	
9	30819-20	hour/minute	0000…2359	
10	30821-22	sec/hsec	0000…5999	

Event Log Configuration/Read-back Record Select Parameters

CSP File No.	N28
Remote I/O BT	9
CIP Assy. Inst.	32 (Write), 33 (Read)
No. of Elements	6
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All
Applies to:	Event Log Results Parameters on page 229

Event Log Configuration/Read-back Record Select

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	41001	Password	0…9999	0	Required for configuration, -1 for readback select, returns -1
1	41002	DeviceNet unique write identifier	-32,768…32,767	0	Refer to DeviceNet Unique Write Identifier on page 103
2	41003	Read-back mode	0…6	2	Refer to Configuring the Event Log by Using Communication on page 146
3	41004	Enable/disable logging status input changes	0…1	0	
4	41005	# events in the event log	1…50 (M4,M5) 1…100 (M6, M8)	-	
5	41006	Enable/disable logging of time/date set	0…1	1	

Event Log Results Parameters

CSP File No.	N29
Remote I/O BT	21
CIP Assy. Inst.	34
No. of Elements	14, 17, or 18 (see table)
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	See table

Event Log Results

Element No.	Modbus Address	M4 M5	M 6	M 8	Element Name	Range	Comment
0	30901	•	•	•	Reserved	0	Returns 0
1	30902	•	•	•	Internal identifier	0 …32768	Refer to Reading Data from the Event Log by Using Communication on page 147
2	30903	•	•	•	Timestamp of event; Year	1998…2097	Refer to Expressing Data in Data Tables on page 82
3	30904	•	•	•	Month/day	0101…1231	
4	30905	•	•	•	Hour/minute	0000…2359	
5	30906	•	•	•	Second/hsec	0000…5999	
6	30907	•	•	•	Event type	0…19	Refer to List of Event Types Parameters
7	30908	•	•	•	Event code	-	Refer to Reading Data from the Event Log by Using Communication on page 147
8	30909	•	•	•	Setpoint type	0…52	
9	30910	•	•	•	Setpoint evaluation condition	0…5	
10	30911	•	•	•	Setpoint level integer	0…9999	
11	30912	•	•	•	exponent	-21…21	
12	30913	•	•	•	Setpoint action/release delay	0…3600 (M4, M5) 0…30,000 (M6, M8)	
13	30914	•	•	•	Setpoint action	0…32 (M4, M5) 0…43 (M6, M8)	
14	30915		•	•	Sustain limit timer integer	0…9999	
15	30916		•	•	exponent	-4…21	
16	30917		•	•	Capture identifier	0…999	
17	30918			•	Reserved	0	Returns 0

Status Error Codes

Bits	Hex	Description
bit 0	0001h	Master module code flash status
bit 1	0002h	Master module data flash status
bit 2	0004h	Master module RAM Status
bit 3	0008h	Reserved for factory use
bit 4	0010h	Master module NVRAM status
bit 5	0020h	Master module data acquisition status
bit 6	0040h	Master module real time clock status
bit 7	0080h	Reserved for factory use
bit 8	0100h	Reserved for factory use
bit 9	0200h	Display module status
bit 10	0400h	Master module watchdog timer status
bit 11	0800h	Master module optional communication status
bit 12…15	1000h…8000h	Reserved for factory use

List of Event Types Parameters

Applies to	Event Log Results Parameters on page 229
PM3000 Type	See table

List of Event Types

Event Code.	M4 M5	M 6	M 8	Event Type	Event Command Code	Comment
0	•	•	•	No event	0	The log starts with no events recorded
1	•	•	•	Setpoint triggered	Setpoint Number	A setpoint activated
2	•	•	•	Setpoint released		A previously active setpoint released
3	•	•	•	Relay force energized	Relay Number	1 = Form C relay, 2 = KYZ
4	•	•	•	Relay force de-energized		
5	•	•	•	Relay force released		
6	•	•	•	Status input set	Status Input Number	
7	•	•	•	Status input cleared		
8	•	•	•	kWh counter set or cleared	1	Records command action
8	•	•	•	kVARh counter set or cleared	2	
8	•	•	•	kVAh counter set or cleared	3	
8	•	•	•	Ah counter set or cleared	4	
8	•	•	•	All energy counters cleared	5	
8	•	•	•	Trend log cleared	6	
8	•	•	•	Min/max log cleared	7	
8	•	•	•	Factory defaults restored	8	
8	•	•	•	Status input #1 counter cleared	9	
8	•	•	•	Status input #2 counter cleared	10	
8	•	•	•	Reserved	11	
8	•	•	•	Single setpoint timer cleared	12	
8	•	•	•	All setpoint timers cleared	13	
9	•	•	•	Power-up	0	Control power was applied
10	•	•	•	Power-down	0	Control power was lost or internal reset occurred
11	•	•	•	Selftest failure	Status Error Code	Refer to Status Error Codes (bitfield)
12	•	•	•	Date/time set	0	The date and/or time was set or altered
13	•	•	•	Change of non-setpoint config data	0	
14	•	•	•	Change of setpoint config data	0	
15	•	•	•	NVRAM Clr	0	NVRAM has been cleared due to an extended loss of control power or internal error
16			•	Transient detected		

List of Event Types

Event Code.	M4 M5	M 6	M 8	Event Type	Event Command Code	Comment
17			•	Reserved		Reserved
18	•	•	•	External Demand Sync Timeout		The demand delay expired before the next expected external demand sync
19	•	•	•	Comm Card Reset		An unexpected comm card condition has been detected and the master module has reset the comm card in an attempt to resume normal operation

User-configured Table Setup Parameters

CSP File No.	N30
Remote I/O BT	35
CIP Assy. Inst.	35 (Write), 36 (Read)
No. of Elements	26
User Configurable	No
Data Type	Integer
Data Access	Read /Write
PM3000 Type	All
Applies to	User-configured Table Results Parameters on page 235

User-configured Table Setup

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	41101	Password	0…9999	0	Required for configuration, returns -1
1	41102	DF1 or Ethernet (CSP) File No.	31	31	Refer to User-configured Data Table on page 121
		RIO BT No.	62	62	
		DeviceNet, EtherNet/IP, or ControlNet Ass'y Inst.	1, 37	37	
		Modbus	1000	31	
2	41103	DeviceNet, EtherNet/IP, or ControlNet instance 1 data type	0…1	0	
3	41104	Selection for parameter #1	0…301	71 (L1-L2 V)	
4	41105	Selection for parameter #2		72 (L2-L3 V)	
5	41106	Selection for parameter #3		73 (L3-L1 V)	
6	41107	Selection for parameter #4		63 (I1)	
7	41108	Selection for parameter #5		64 (I2)	
8	41109	Selection for parameter #6		65 (I3)	
9	41110	Selection for parameter #7		90 (W)	
10	41111	Selection for parameter #8		98 (VA)	
11	41112	Selection for parameter #9		94 (VAR)	
12	41113	Selection for parameter #10		111 (PF)	
13	41114	Selection for parameter #11		100 (Dmd W)	
14	41115	Selection for parameter #12		122 (kWh)	
15	41116	Selection for parameter #13		130 (Status)	
16	41117	Selection for parameter #14		14 (Year)	

User-configured Table Setup

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
17	41118	Selection for parameter #15	0…301	21 (Mo/Dy)	Parameters 15…23 not supported by the DeviceNet network
18	41119	Selection for parameter #16		22 (Hr/min)	
19	41120	Selection for parameter #17		23 (Sec/hsc)	
20	41121	Selection for parameter #18		0	
21	41122	Selection for parameter #19			
22	41123	Selection for parameter #20			
23	41124	Selection for parameter #21			
24	41125	Selection for parameter #22			
25	41126	Selection for parameter #23			

User-configured Table Results Parameters

CSP File No.	F31
Remote I/O BT	62
CIP Assy. Inst.	37
No. of Elements	14 (DeviceNet network) or 23 (All other communication options)
User Configurable	Yes
Data Type	Floating Point
Data Access	Read only
PM3000 Type	All

User-configured Table Results

Element No.	Modbus Address	Element Name	Range	Comment
0	31001-02	User selected parameter #1	-	Parameters previously setup during a write to the User-configured Table Setup Parameters table
1	31003-04	User selected parameter #2	-	
2	31005-06	User selected parameter #3	-	
3	31007-08	User selected parameter #4	-	
4	31009-10	User selected parameter #5	-	
5	31011-12	User selected parameter #6	-	
6	31013-14	User selected parameter #7	-	
7	31015-16	User selected parameter #8	-	
8	31017-18	User selected parameter #9	-	
9	31019-20	User selected parameter #10	-	
10	31021-22	User selected parameter #11	-	
11	31023-24	User selected parameter #12	-	
12	31025-26	User selected parameter #13	-	
13	31027-28	User selected parameter #14	-	
14	31029-30	User selected parameter #15	-	The DeviceNet network supports a maximum of 14 user-configured parameters
15	31031-32	User selected parameter #16	-	
16	31033-34	User selected parameter #17	-	
17	31035-36	User selected parameter #18	-	
18	31037-38	User selected parameter #19	-	
19	31039-40	User selected parameter #20	-	
20	31041-42	User selected parameter #21	-	
21	31043-44	User selected parameter #22	-	
22	31045-46	User selected parameter #23	-	

Write Error Status Parameters

CSP File No.	N32
Remote I/O BT	4
CIP Assy. Inst.	38
No. of Elements	2
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	All

Write Error Status

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	31101	File, instance or BT number		- -	Identifies data table written to last, value depends on comms type. For Modbus, starting address of table written to last.
1	31102	Offending Element			-1 = Last write was successful 0…26 = first unacceptable element of unsuccessful write For Remote I/O Only: 0 = Last write was successful 1…27 = First unacceptable word of unsuccessful write For Modbus Only: -1 = Last write was successful 40,001…42,001 - first unacceptable address of unsuccessful write.

Harmonic Analysis Configuration/Read-back Select Parameters

CSP File No.	N33
Remote I/O BT	14
CIP Assy. Inst.	39 (Write), 40 (Read)
No. of Elements	9
User Configurable	No
Data Type	Integer
Data Access	Read /Write
PM3000 Type	See table
Applies to:	Harmonic Results; THD, Crest Factor, and More Parameters on page 238 (All models) Harmonic Results; Odd Harmonics 1…21 Parameters on page 239,Harmonic Results; Odd Harmonics 23…41 Parameters on page 240, Harmonic Results; Even Harmonics 2…20 Parameters on page 241, Harmonic Results; Even Harmonics 22…40 Parameters on page 242 (M6 & M8) Harmonic Results; Odd Harmonics 43…63 Parameters on page 256, Harmonic Results; Even Harmonics 42…62 Parameters on page 257 (M8 only)

Harmonic Analysis Configuration/Read-back Select

Element No.	Modbus Address	M4 M5	M6	M8	Element Name	Range	Default Value	Comment
0	41201	•	•	•	Password	0…9999	0	Required for configuration, -1 for readback select, returns -1.
1	41202	•	•	•	Channel	1…9	1	Refer to Configuring Harmonic Analysis on page 171.
2	41203	•	•	•	Read-back mode	0…1	0	
3	41204	•			Reserved	0	0	
			•	•	Individual harmonic data type	0…1	0	
4	41205	•			Reserved	0	0	
			•	•	Enable/disable Harmonics	0…1	1	
5	41206	•			Reserved	0	0	
			•	•	IEEE-519 Max I_{sc}Integer	0…9999	0	
6	41207	•			Reserved	0	0	
			•	•	IEEE-519 Max I_{sc}Exponent	-4…21	0	
7	41208	•			Reserved	0	0	
			•	•	IEEE 519 Max I_{dmnd}Integer	0…9999	0	
8	41209	•			Reserved	0	0	
			•	•	IEEE 519 Max I_{dmnd} Exponent	-4…21	0	

Harmonic Results; THD, Crest Factor, and More Parameters

CSP File No.	F34
Remote I/O BT	23
CIP Assy. Inst.	41
No. of Elements	9 (M4, M5); 10 (M6, M8)
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	See table

Harmonic Results; THD, Crest Factor, and More

Element No.	Modbus Address	M4 M5	M 6	M 8	Element Name	Range	Comment
0	31201-02	•	•	•	Channel number	1…9	Refer to Reading Harmonic Analysis Data on page 172
1	31203-04	•	•	•	% IEEE THD	0.0…1000.0	
2	31205-06	•	•	•	% IEC thd (DIN)	0.0…1000.0	
3	31207-08	•	•	•	Crest Factor	0.0…10.0	
4	31209-10	•	•	•	THD & Crest iteration	0…32,767	
5	31211-12	•			Reserved	0	
			•	•	TIF	$0.0\ldots999.9\text{x}10^{22}$	
6	31213-14	•			Reserved	0	
			•	•	K-Factor	$0.0\ldots999.9\text{x}10^{22}$	
7	31215-16	•			Reserved	0	
			•	•	IEEE-519 TDD	$0.0\ldots999.9\text{x}10^{22}$	
8	31217-18	•			Reserved	0	
			•	•	IEEE-519 Pass/Fail	-1…1	
9	31219-20	•			Reserved	0	
			•	•	FFT iteration	0…32,767	

Harmonic Results; Odd Harmonics 1…21 Parameters

CSP File No.	F35
Remote I/O BT	39
CIP Assy. Inst.	42
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Harmonic Results; Odd Harmonics 1…21

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Channel # returned	1…7	Refer to Reading Harmonic Analysis Data on page 172
1	-	Type of harmonic data returned	0…1	
2	-	1st Harmonic (Fundamental)	0.0	
3	-	3rd Harmonic	0.0…$999.9 x 10^{22}$	
4	-	5th Harmonic	0.0…$999.9 x 10^{22}$	
5	-	7th Harmonic	0.0…$999.9 x 10^{22}$	
6	-	9th Harmonic	0.0…$999.9 x 10^{22}$	
7	-	11th Harmonic	0.0…$999.9 x 10^{22}$	
8	-	13th Harmonic	0.0…$999.9 x 10^{22}$	
9	-	15th Harmonic	0.0…$999.9 x 10^{22}$	
10	-	17th Harmonic	0.0…$999.9 x 10^{22}$	
11	-	19th Harmonic	0.0…$999.9 x 10^{22}$	
12	-	21st Harmonic	0.0…$999.9 x 10^{22}$	
13	-	FFT iteration	0…32,767	

Harmonic Results; Odd Harmonics 23…41 Parameters

CSP File No.	F36
Remote I/O BT	40
CIP Assy. Inst.	43
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Harmonic Results; Odd Harmonics 23…41

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Channel # returned	1…7	Refer to Reading Harmonic Analysis Data on page 172
1	-	Type of harmonic data returned	0…1	
2	-	Reserved	0	
3	-	23rd Harmonic	$0.0…999.9x10^{22}$	
4	-	25th Harmonic	$0.0…999.9x10^{22}$	
5	-	27th Harmonic	$0.0…999.9x10^{22}$	
6	-	29th Harmonic	$0.0…999.9x10^{22}$	
7	-	31st Harmonic	$0.0…999.9x10^{22}$	
8	-	33rd Harmonic	$0.0…999.9x10^{22}$	
9	-	35th Harmonic	$0.0…999.9x10^{22}$	
10	-	37th Harmonic	$0.0…999.9x10^{22}$	
11	-	39th Harmonic	$0.0…999.9x10^{22}$	
12	-	41st Harmonic	$0.0…999.9x10^{22}$	
13	-	FFT iteration	0…32,767	

Harmonic Results; Even Harmonics 2…20 Parameters

CSP File No.	F37
Remote I/O BT	41
CIP Assy. Inst.	44
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Harmonic Results; Even Harmonics 2…20

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Channel # returned	1…7	Refer to Reading Harmonic Analysis Data on page 172
1	-	Type of harmonic data returned	0…1	
2	-	Reserved	0	
3	-	2nd Harmonic	0.0…$999.9x10^{22}$	
4	-	4th Harmonic	0.0…$999.9x10^{22}$	
5	-	6th Harmonic	0.0 …$999.9x10^{22}$	
6	-	8th Harmonic	0.0…$999.9x10^{22}$	
7	-	10th Harmonic	0.0…$999.9x10^{22}$	
8	-	12th Harmonic	0.0 …$999.9x10^{22}$	
9	-	14th Harmonic	0.0…$999.9x10^{22}$	
10	-	16th Harmonic	0.0…$999.9x10^{22}$	
11	-	18th Harmonic	0.0…$999.9x10^{22}$	
12	-	20th Harmonic	0.0…$999.9x10^{22}$	
13	-	FFT iteration	0…32,767	

Harmonic Results; Even Harmonics 22…40 Parameters

CSP File No.	F38
Remote I/O BT	42
CIP Assy. Inst.	45
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Harmonic Results; Even Harmonics 22…40

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Channel # returned	1…7	Refer to Reading Harmonic Analysis Data on page 172
1	-	Type of harmonic data returned	0…1	
2	-	Reserved	0	
3	-	22nd Harmonic	$0.0…999.9x10^{22}$	
4	-	24th Harmonic	$0.0…999.9x10^{22}$	
5	-	26th Harmonic	$0.0…999.9x10^{22}$	
6	-	28th Harmonic	$0.0…999.9x10^{22}$	
7	-	30th Harmonic	$0.0…999.9x10^{22}$	
8	-	32nd Harmonic	$0.0…999.9x10^{22}$	
9	-	34th Harmonic	$0.0…999.9x10^{22}$	
10	-	36th Harmonic	$0.0…999.9x10^{22}$	
11	-	38th Harmonic	$0.0…999.9x10^{22}$	
12	-	40th Harmonic	$0.0…999.9x10^{22}$	
13	-	FFT iteration	0…32,767	

Oscillograph Configuration/Read-back Data Select Parameters

CSP File No.	N39
Remote I/O BT	15
CIP Assy. Inst.	46 (Write), 47 (Read)
No. of Elements	11
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	M6, M8 only
Applies to:	Oscillograph Results Parameters

Oscillograph Configuration/Read-back Data Select

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	-	Password	0…9999	0	Required for configuration, -1 for readback select, returns -1
1	-	Capture No.	0…8 (M6) 0…2 (M8)	1	Refer to Configuring Oscillography on page 160
2	-	Channel No.	1…7	1	
3	-	Block No.	See page 161	1	
4	-	Read-back mode	0…2	0	
5	-	Clear/trigger command	0…10	0	
6	-	Capture type	-1…5	0	
7	-	% Pre-trigger	0…100	90	
8	-	Reserved	0	0	
9	-	Capture clear status	0…255	-	
10	-	Capture ready status	0…255	-	

Oscillograph Results Parameters

CSP File No.	N40
Remote I/O BT	61
CIP Assy. Inst.	48
No. of Elements	29 (DeviceNet network only) 59 (all other communication types)
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	M6, M8 only

Oscillograph Results

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Timestamp; Month/day	0000…1231	Trigger timestamp, see page 82.
1	-	Hour/minute	0000…2359	
2	-	Second/hsec	0000…5999	

Oscillograph Results

Element No.	Modbus Address	Element Name	Range	Comment
3	-	Capture #	1…8 (M6) 1…2 (M8)	Refer to Reading Oscillograph Data on page 162
4	-	Channel number	1…7	
5	-	Block number	See page 80	
6	-	Capture type	0…5	
7	-	Trigger source and capture identifier	0…22999	
8	-	Trigger position	1…4600 1…9200	
9	-	Oscillograph Data Point 1	-8192…8191	
10	-	Oscillograph Data Point 2		
11	-	Oscillograph Data Point 3		
12	-	Oscillograph Data Point 4		
13	-	Oscillograph Data Point 5		
14	-	Oscillograph Data Point 6		
15	-	Oscillograph Data Point 7		
16	-	Oscillograph Data Point 8		
17	-	Oscillograph Data Point 9		
18	-	Oscillograph Data Point 10		
19	-	Oscillograph Data Point 11		
20	-	Oscillograph Data Point 12		
21	-	Oscillograph Data Point 13		
22	-	Oscillograph Data Point 14		
23	-	Oscillograph Data Point 15		
24	-	Oscillograph Data Point 16		
25	-	Oscillograph Data Point 17		
26	-	Oscillograph Data Point 18		
27	-	Oscillograph Data Point 19		
28	-	Oscillograph Data Point 20		

Oscillograph Results

Element No.	Modbus Address	Element Name	Range	Comment
29	-	Oscillograph Data Point 21		DeviceNet supports only 20 data points per read.
30	-	Oscillograph Data Point 22		
31	-	Oscillograph Data Point 23		
32	-	Oscillograph Data Point 24		
33	-	Oscillograph Data Point 25		
34	-	Oscillograph Data Point 26		
35	-	Oscillograph Data Point 27		
36	-	Oscillograph Data Point 28		
37	-	Oscillograph Data Point 29		
38	-	Oscillograph Data Point 30		
39	-	Oscillograph Data Point 31		
40	-	Oscillograph Data Point 32		
41	-	Oscillograph Data Point 33		
42	-	Oscillograph Data Point 34		
43	-	Oscillograph Data Point 35		
44	-	Oscillograph Data Point 36		
45	-	Oscillograph Data Point 37		
46	-	Oscillograph Data Point 38		
47	-	Oscillograph Data Point 39		
48	-	Oscillograph Data Point 40		
49	-	Oscillograph Data Point 41		
50	-	Oscillograph Data Point 42		
51	-	Oscillograph Data Point 43		
52	-	Oscillograph Data Point 44		
53	-	Oscillograph Data Point 45		
54	-	Oscillograph Data Point 46		
55	-	Oscillograph Data Point 47		
56	-	Oscillograph Data Point 48		
57	-	Oscillograph Data Point 49		
58	-	Oscillograph Data Point 50		

Load Factor Log Configuration/Read-back Select Parameters

CSP File No.	N41
Remote I/O BT	16
CIP Assy. Inst.	49 (Write), 50 (Read)
No. of Elements	6
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	M6, M8 only
Applies to:	Load Factor Log Results Parameters on page 248

Load Factor Log Configuration/Read-back Select

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	-	Password	0…9999	0	Required for configuration or command, -1 for readback select, returns -1
1	-	Record to read-back	0…12	0	Refer to Reading the Load Factor Log on page 178
2	-	Read-back mode	0…1	1	
3	-	Clear peak / reset average command	0…1	0	
4	-	Auto clear/reset day	0…31	31	
5	-	Reserved	0	0	

Load Factor Log Results Parameters

CSP File No.	F42
Remote I/O BT	43
CIP Assy. Inst.	51
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M6, M8 only

Load Factor Log Results

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Peak Demand W	$0.0\ldots999.9x10^{21}$	Refer to Reading the Load Factor Log on page 178
1	-	Average Demand W	$0.0\ldots999.9x10^{21}$	
2	-	Load Factor W	0…100.0	
3	-	Peak Demand VAR	$0.0\ldots999.9x10^{21}$	
4	-	Average Demand VAR	$0.0\ldots999.9x10^{21}$	
5	-	Load Factor VAR	0…100.0	
6	-	Peak Demand VA	$0.0\ldots999.9x10^{21}$	
7	-	Average Demand VA	$0.0\ldots999.9x10^{21}$	
8	-	Load Factor VA	0…100.0	
9	-	Peak Demand I	$0.0\ldots999.9x10^{21}$	
10	-	Average Demand I	$0.0\ldots999.9x10^{21}$	
11	-	Load Factor I	0…100.0	
12	-	Elapsed time	$0.0\ldots999.9x10^{21}$	
13	-	Ending month/day/year	0…123199	

Transient Analysis Configuration/Read-back Select Parameters

CSP File No.	F43
Remote I/O BT	44
CIP Assy. Inst.	52 (Write), 53 (Read)
No. of Elements	10
User Configurable	No
Data Type	Floating Point
Data Access	Read / Write
PM3000 Type	M8 only
Applies to	Transient analysis metering results

Transient Analysis Configuration/Read-back Select

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	-	Password	0…9999	0	Required for configuration, -1 for readback select, returns -1.
1	-	DeviceNet unique write identifier	-32,768…32,767	0	Refer to DeviceNet Unique Write Identifier on page 103.
2	-	Capture #	0…6	1	Refer to Transient Analysis Configuration on page 180.
3	-	Cycle #	1…12	1	
4	-	Read-back mode	0…1	0	
5	-	Detection mode	0…3	1	
6	-	Reserved	0	0	
7	-	Auto-threshold set command	0…1	0	
8	-	Auto-threshold set duration	1…3600	10	
9	-	Auto-threshold set margin	1.0…100.0	20.0	
10	-	Voltage trigger threshold	0.1…100.0	10.0	
11	-	Current trigger threshold	0.1…100.0	10.0	
12	-	Auto-threshold duration time left	0	0	

Transient Analysis Metering Results Parameters

CSP File No.	F44
Remote I/O BT	32
CIP Assy. Inst.	54
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read only
PM3000 Type	M8 only

Transient Analysis Metering Results

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Capture number	1…6	Refer to Reading Transient Analysis Metering Data on page 181.
1	-	Cycle number	1…12	
2	-	L1-L2 or L1-N Voltage	$0.0 \ldots 999.9x10^{21}$	
3	-	L2-L3 or L2-N Voltage	$0.0 \ldots 999.9x10^{21}$	
4	-	L3-L1 or L3-N Voltage	$0.0 \ldots 999.9x10^{21}$	
5	-	L1 Current	$0.0 \ldots 999.9x10^{21}$	
6	-	L2 Current	$0.0 \ldots 999.9x10^{21}$	
7	-	L3 Current	$0.0 \ldots 999.9x10^{21}$	
8	-	L4 Current	$0.0 \ldots 999.9x10^{21}$	
9	-	Voltage Index at trigger	$-999.0x10^{3} \ldots 999.0x10^{3}$	
10	-	Current Index at trigger	$-999.0x10^{3} \ldots 999.0x10^{3}$	
11	-	Voltage Trigger Threshold	$0.0 \ldots 999.0x10^{3}$	
12	-	Current Trigger Threshold	$0.0 \ldots 999.0x10^{3}$	
13	-	Unique Transient Capture ID	0…30,000	

Transient Capture Clear/Read-back Data Select Parameters

CSP File No.	N45
Remote I/O BT	17
CIP Assy. Inst.	55 (Write), 56 (Read)
No. of Elements	13
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	M8 only
Applies to	Transient Capture Results Parameters on page 252

Transient Capture Clear/Read-back Data Select

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	-	Password	0…9999	0	Required for configuration, -1 for readback select, returns -1.
1	-	Dnet unique write identifier	-32,768…32,767	0	Refer to DeviceNet Unique Write Identifier on page 103.
2	-	Capture number	0…6	1	Refer to Reading Transient Capture Data on page 182.
3	-	Channel number	1…7	1	
4	-	Block number	See page 90	1	
5	-	Read-back mode	0…2	0	
6	-	Clear command	0…3	0	
7	-	Reserved	0	0	
8	-	Reserved	0	0	
9	-	Reserved	0	0	
10	-	Capture clear status	0…63	-	
11	-	Capture ready status	0…63	-	
12	-	Reserved	0	0	

Transient Capture Results Parameters

CSP File No.	N46
Remote I/O BT	60
CIP Assy. Inst.	57
No. of Elements	29 (DeviceNet network only); 59 (All other communication types)
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	M8 only

Transient Capture Results

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Timestamp; Month/day	0000…1231	Capture trigger timestamp, see page 82.
1	-	Hour/minute	0000…2359	
2	-	Second/hsec	0000…5999	

Transient Capture Results

Element No.	Modbus Address	Element Name	Range	Comment
3	-	Capture #	1…6	Refer to Reading Transient Capture Data on page 182.
4	-	Channel number	1…7	
5	-	Block number	1…70 for DeviceNet 1…28 for all other comms options	
6	-	Reserved	0	
7	-	Unique Transient Capture ID	0…30,000	
8	-	Reserved	0	
9	-	Data Point 1	-8192…8191	
10	-	Data Point 2		
11	-	Data Point 3		
12	-	Data Point 4		
13	-	Data Point 5		
14	-	Data Point 6		
15	-	Data Point 7		
16	-	Data Point 8		
17	-	Data Point 9		
18	-	Data Point 10		
19	-	Data Point 11		
20	-	Data Point 12		
21	-	Data Point 13		
22	-	Data Point 14		
23	-	Data Point 15		
24	-	Data Point 16		
25	-	Data Point 17		
26	-	Data Point 18		
27	-	Data Point 19		
28	-	Data Point 20		

Transient Capture Results

Element No.	Modbus Address	Element Name	Range	Comment
29	-	Data Point 21	-8192…8191	The DeviceNet network returns only 20 data points per read.
30	-	Data Point 22		
31	-	Data Point 23		
32	-	Data Point 24		
33	-	Data Point 25		
34	-	Data Point 26		
35	-	Data Point 27		
36	-	Data Point 28		
37	-	Data Point 29		
38	-	Data Point 30		
39	-	Data Point 31		
40	-	Data Point 32		
41	-	Data Point 33		
42	-	Data Point 34		
43	-	Data Point 35		
44	-	Data Point 36		
45	-	Data Point 37		
46	-	Data Point 38		
47	-	Data Point 39		
48	-	Data Point 40		
49	-	Data Point 41		
50	-	Data Point 42		
51	-	Data Point 43		
52	-	Data Point 44		
53	-	Data Point 45		
54	-	Data Point 46		
55	-	Data Point 47		
56	-	Data Point 48		
57	-	Data Point 49		
58	-	Data Point 50		

Advanced Metering Configuration Parameters

CSP File No.	N47
Remote I/O BT	19
CIP Assy. Inst.	58 (Write), 59 (Read)
No. of Elements	10
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	M8 only

Advanced Metering Configuration

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	-	Password	0…9999	0	Required for configuration, returns -1.
1	-	Meter result set	0…2	0	Refer to Advanced Metering Options on page 54.
2	-	Reserved	0	0	Must be 0 on a write, returns 0.
3	-				
4	-				
5	-				
6	-				
7	-				
8	-				
9	-				

Harmonic Results; Odd Harmonics 43…63 Parameters

CSP File No.	F48
Remote I/O BT	45
CIP Assy. Inst.	60
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read Only
PM3000 Type	M8 only

Harmonic Results; Odd Harmonics 43…63

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Channel # returned	1…7	Refer to Reading Individual Harmonic Values on page 173.
1	-	Type of harmonic data returned	0…1	
2	-	43rd Harmonic	$0.0…999.9x10^{22}$	
3	-	45th Harmonic		
4	-	47th Harmonic		
5	-	49th Harmonic		
6	-	51st Harmonic		
7	-	53rd Harmonic		
8	-	55th Harmonic		
9	-	57th Harmonic		
10	-	59th Harmonic		
11	-	61st Harmonic		
12	-	63rd Harmonic		
13	-	FFT iteration	0…32,767	

Harmonic Results; Even Harmonics 42…62 Parameters

CSP File No.	F49
Remote I/O BT	46
CIP Assy. Inst.	61
No. of Elements	14
User Configurable	No
Data Type	Floating Point
Data Access	Read Only
PM3000 Type	M8 only

Harmonic Results; Even Harmonics 42…62

Element No.	Modbus Address	Element Name	Range	Comment
0	-	Channel # returned	1…7	Refer to Reading Individual Harmonic Values on page 173.
1	-	Type of harmonic data returned	0…1	
2	-	42^{nd} Harmonic	$0.0…999.9x10^{22}$	
3	-	44^{th} Harmonic		
4	-	46^{th} Harmonic		
5	-	48^{th} Harmonic		
6	-	50^{th} Harmonic		
7	-	52^{nd} Harmonic		
8	-	54^{th} Harmonic		
9	-	56^{th} Harmonic		
10	-	58^{th} Harmonic		
11	-	60^{th} Harmonic		
12	-	62^{nd} Harmonic		
13	-	FFT iteration	0…32,767	

Catalog Number and WIN Parameters

CSP File No.	N51
Remote I/O BT	50
CIP Assy. Inst.	64
No. of Elements	29
User Configurable	No
Data Type	Integer
Data Access	Read only
PM3000 Type	All

Catalog Number and WIN

Element No.	Modbus Address	Element Name	Range	Comment
0	32301	Catalog # text char pair #1	-32,768 …32,767	Catalog number without dashes. Each element contains a character pair For each character pair, character 1 = element / 256 and character 2 = remainder The 6th character of the catalog string reflects the Current model of the product
1	32302	Catalog # text char pair #2		
2	32303	Catalog # text char pair #3		
3	32304	Catalog # text char pair #4		
4	32305	Catalog # text char pair #5		
5	32306	Catalog # text char pair #6		
6	32307	Catalog # text char pair #7		
7	32308	Reserved	0	Returns 0
8	32309			
9	32310	Hardware series	0…25	Indicates the series of the product; 0 = A, 1 = B
10	32311	WIN text character pair #1	-32,768 …32,767	WIN (warranty identification number). This is the same 10-character alpha-numeric string printed on the master module label. Each element contains a character pair
11	32312	WIN text character pair #2		
12	32313	WIN text character pair #3		
13	32314	WIN text character pair #4		
14	32315	WIN text character pair #5		
15	32316	Reserved	0	Returns 0
16	32317			
17	32318	Original model	0…9	The model as it was originally built. 4 = M4, 5 = M5
18	32319	Current model		Differs from Original model if field-upgraded

Catalog Number and WIN

Element No.	Modbus Address	Element Name	Range	Comment
19	32320	Reserved	0	Returns 0
20	32321			
21	32322			
22	32323			
23	32324			
24	32325			
25	32326			
26	32327			
27	32328			
28	32329			

Network Demand Sync and Time Configuration Parameters

CSP File No.	N52
Remote I/O BT	-
CIP Assy. Inst.	65, 66
No. of Elements	20
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	Ethernet

Network Demand Sync and Time Configuration

Element No.	Modbus Address	Parameter Name	Range	Default Value	Description
0	41901	Password	0…9999	0	On a write, the correct password is required to change configuration data. On a read, -1 is returned.
1	41902	Input mode	0…3	3	Refer to Network Demand / Time Configuration on page 55.
2	41903	Broadcast port number	300…400	300	
3	41904	SNTP IP address 1, octet 1	0…255	0	
4	41905	SNTP IP address 1, octet 2			
5	41906	SNTP IP address 1, octet 3			
6	41907	SNTP IP address 1, octet 4			
7	41908	Time zone	-12…12	0	
8	41909	Time set update interval	0…32,766	60 s	
9	41910	SNTP IP address 2, octet 1	0…255	0	SNTP IP address 2 is a back-up server address when the first address fails.
10	41911	SNTP IP address 2, octet 2		0	
11	41912	SNTP IP address 2, octet 3		0	
12	41913	SNTP IP address 2, octet 4		0	
13	41914	SNTP IP address 3, octet 1		0	SNTP IP address 3 is a back-up server address when the secnond address fails.
14	41915	SNTP IP address 3, octet 2		0	
15	41916	SNTP IP address 3, octet 3		0	
16	41917	SNTP IP address 3, octet 4		0	
17	41918	Reserved	0	0	Reserved for future use. On a write, only a 0 is accepted. On a read, always returns 0.
18	41919	Reserved	0	0	
19	41920	Reserved	0	0	

Controller Command Parameters

CSP File No.	N53
Remote I/O BT	-
CIP Assy. Inst.	67
No. of Elements	1
User Configurable	No
Data Type	Integer
Data Access	Write only
PM3000 Type	Ethernet

Controller Command

Element No.	Element Name	Range	Default Value	Comment
0	Controller Command Bits 0	0…32,767	0	Refer to Network Demand / Time Configuration on page 55

Daylight Saving Time Configuration Parameters

CSP File No.	N54
Remote I/O BT	47
CIP Assy. Inst.	68 (Write), 69 (Read)
No. of Elements	10
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Daylight Saving Time Configuration

Element No.	Modbus Address	Element name	Range	Default	Comment
0	42101	Password	-1…9999	0	Required for configuration. Returns -1
1	42102	DST Enable	0…1	0	0 = Disabled, 1 = Enabled
2	42103	DST Start Month	1…12	3	1 = January, 2 = February…
3	42104	DST Start Day	0…6	0	0 = Sunday, 1 = Monday…
4	42105	DST Start Day Instance	1…5	2	1 = 1st, 2 = 2nd, ... 5 = Last
5	42106	DST Start Hour	0…23	2	0 = 12:00 midnight, 1 = 1:00 AM…
6	42107	DST End Month	1…12	11	1 = January, 2 = February…
7	42108	DST End Day	0…6	0	0 = Sunday, 1 = Monday…
8	42109	DST End Day Instance	1…5	1	1 = 1st, 2 = 2nd, ... 5 = Last
9	43110	DST End Hour	0…23	2	0 = 12:00 midnight, 1 = 1:00 AM…

Time of Use Register Configuration Parameters

CSP File No.	N55
Remote I/O BT	49
CIP Assy. Inst.	70 (Write), 71 (Read)
No. of Elements	10
User Configurable	No
Data Type	Integer
Data Access	Read / Write
PM3000 Type	All

Time of Use Register Configuration

Element No.	Modbus Address	Element Name	Range	Default	Comment
0	42201	Password	-1…9999	0	Required for configuration, -1 for readback select, Returns -1
1	42202	Record to read back	0…12	0	Refer to Configuring the Time-of-use Log on page 157
2	42203	Reserved	0	0	
3	42204	Write command	0…1	0	
4	42205	Log day	1…31	31	
5	42206	Off peak day	0…127	65	
6	42207	Mid peak a.m.	0…4095	1792	
7	42208	Mid peak p.m.		120	
8	42209	Peak a.m.		2048	
9	42210	Peak p.m.		7	

Time of Use Records – Real Energy and Demand Parameters

CSP File No.	F56
Remote I/O BT	51
CIP Assy. Inst.	72
No. of Elements	12
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Time of Use Records – Real Energy and Demand

Element No.	Modbus Address	Element Name	Range	Units	Comment
0	32401-02	Off-peak real energy	-999,999.0… 999,999.0	MWh	Refer to Reading Time-of-use Log Data on page 158
1	32403-04	Off-peak real energy	-999.999.999… 999.999.999	kWh	
2	32405-06	Off-peak demand	0.0…999.9 x 10^{21}	Watts	
3	32407-08	Mid-peak real energy	-999,999.0… 999,999.0	MWh	
4	32409-10	Mid-peak real energy	-999.999.999… 999.999.999	kWh	
5	32411-12	Mid-peak demand	0.0…999.9 x 10^{21}	Watts	
6	32413-14	Peak real energy	-999,999.0… 999,999.0	MWh	
7	32415-16	Peak real energy	-999.999.999… 999.999.999	kWh	
8	32417-18	Peak demand	0.0…999.9 x 10^{21}	Watts	
9	33419-20	Record number	0…12		
10	32421-22	Start date	000101…991231	YYMMDD	Start month / day for data stored in this record, inclusive
11	32423-24	End date	000101…991231	YYMMDD	End month / day for data stored in this record, inclusive

Time of Use Records – Reactive Energy and Demand Parameters

CSP File No.	F57
Remote I/O BT	52
CIP Assy. Inst.	73
No. of Elements	12
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Time of Use Records – Reactive Energy and Demand

Element No.	Modbus Address	Element Name	Range	Units	Comment
0	32501-02	Off-peak reactive energy	-999,999.0… 999,999.0	MVARh	Refer to Reading Time-of-use Log Data on page 158
1	32503-04	Off-peak reactive energy	-999.999.999… 999.999.999	kVARh	
2	32505-06	Off-peak demand VARs	0.0…999.9 x 10^{21}	VAR	
3	32507-08	Mid-peak reactive energy	-999,999.0… 999,999.0	MVARh	
4	32509-10	Mid-peak reactive energy	-999.999.999… 999.999.999	kVARh	
5	32511-12	Mid-peak demand VARs	0.0…999.9 x 10^{21}	VAR	
6	32513-14	Peak reactive energy	-999,999.0… 999,999.0	MVARh	
7	32515-16	Peak reactive energy	-999.999.999… 999.999.999	kVARh	
8	32517-18	Peak demand VARs	0.0…999.9 x 10^{21}	VAR	
9	32519-20	Record number	0…12		
10	32521-22	Start date	000101…991231	YYMMDD	Start month / day for data stored in this record, inclusive
11	33523-24	End date	000101…991231	YYMMDD	End month / day for data stored in this record, inclusive

Time of Use Records – Apparent Energy and Demand Parameters

CSP File No.	F58
Remote I/O BT	53
CIP Assy. Inst.	74
No. of Elements	12
User Configurable	No
Data Type	Floating point
Data Access	Read only
PM3000 Type	All

Time of Use Records – Apparent Energy and Demand

Element No.	Modbus Address	Element Name	Range	Units	Comment
0	32601-02	Off-peak apparent energy	-999,999.0… 999,999.0	MVAh	Refer to Reading Time-of-use Log Data on page 158
1	32603-04	Off-peak apparent energy	-999.999.999… 999.999.999	kVAh	
2	32605-06	Off-peak demand VA	0.0…999.9 x 10^{21}	VA	
3	32607-08	Mid-peak apparent energy	-999,999.0… 999,999.0	MVAh	
4	32609-10	Mid-peak apparent energy	-999.999.999… 999.999.999	kVAh	
5	32611-12	Mid-peak demand VA	0.0…999.9 x 10^{21}	VA	
6	32613-14	Peak apparent energy	-999,999.0… 999,999.0	MVAh	
7	32615-16	Peak apparent energy	-999.999.999… 999.999.999	kVAh	
8	32617-18	Peak demand VA	0.0…999.9 x 10^{21}	VA	
9	32619-20	Record number	0…12		
10	32621-22	Start date	000101…991231	YYMMDD	Start month / day for data stored in this record, inclusive
11	33623-24	End date	000101…991231	YYMMDD	End month / day for data stored in this record, inclusive

Single Password Write Parameters

CSP File No.	N60
Remote I/O BT	-
CIP Assy. Inst.	75, 76
No. of Elements	1
User Configurable	No
Data Type	Integer
Data Access	Read/Write
PM3000 Type	All except Remote I/O units

Single Password Write

Element No.	Modbus Address	Element Name	Range	Default Value	Comment
0	42701	Password	-1…9999	0	On a write, the correct password is required to change configuration data. On a read, -1 is returned.

Single Parameter Read Parameters

CSP File No.	-
Remote I/O BT	-
CIP Assy. Inst.	80…102
No. of Elements	1 each
User Configurable	No
Data Type	Floating point, little-endian, fixed configuration, or integer (see listing)
Data Access	Read only
PM3000 Type	DeviceNet units only

Single Parameter Read

CIP Assy. Instance	Parameter Name	Data Type	Range	Comment
80	Ave L-L Volts	Float	$0.0…999.9x10^{21}$	
81	L1-L2 Volts	Float	$0.0…999.9x10^{21}$	
82	L2-L3 Volts	Float	$0.0…999.9x10^{21}$	
83	L3-L1 Volts	Float	$0.0…999.9x10^{21}$	
84	L1 Amps	Float	$0.0…999.9x10^{21}$	
85	L2 Amps	Float	$0.0…999.9x10^{21}$	
86	L3 Amps	Float	$0.0…999.9x10^{21}$	
87	L4 Amps	Float	$0.0…999.9x10^{21}$	
88	Demand Power	Float	$0.0…999.9x10^{21}$	
89	Demand VARs	Float	$0.0…999.9x10^{21}$	
90	3 Ph PF	Float	$0.0…999.9x10^{21}$	
91	Ave Amps	Float	$0.0…999.9x10^{21}$	
92	Ave L-N Volts	Float	$0.0…999.9x10^{21}$	
93	Frequency	Float	0, 40 … 75, 999	
94	Total Watts	Float	$0.0…999.9x10^{21}$	
95	Total VARs	Float	$0.0…999.9x10^{21}$	
96	Total VA	Float	$0.0…999.9x10^{21}$	
97	Energy kWh x 1	Integer	0…999	
98	Energy kWh x 1,000	Integer	0…999	
99	Energy kWh x 1,000,000	Integer	0…999	
100	Energy kVARh x 1	Integer	0…999	
101	Energy kVARh x 1,000	Integer	0…999	
102	Energy kVARh x 1,000,000	Integer	0…999	

Parameters for Trend Log and Configurable Table Parameters

Applies to	Trend Log Configuration/Read-back Record Select Parameters on page 220 Trend Log Results Parameters on page 221 User-configured Table Setup Parameters on page 233 User-configured Table Results Parameters on page 235
PM3000 Type	Ethernet

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
0	None	No parameter
1	Relay output status	Refer to Discrete Data Parameters
2	Solid-state KYZ output status	
3	Alarm output word	
4	Status inputs state	
5	Status input #1 counter	
6	Status input #2 counter	
7	Voltage Mode (Wiring Configuration)	Refer to Basic Device Configuration Parameters
8	PT Primary	
9	PT Secondary	
10	I1/I2/I3 CT Primary	
11	I1/I2/I3 CT Secondary	
12	I4 CT Primary	
13	I4 CT Secondary	
14	Date: Year	Refer to Date and Time Parameters
15	Date: Month	
16	Date: Day	
17	Time: Hour	
18	Time: Minute	
19	Time: Seconds	
20	Time: Hundredths of seconds	
21	Date: Month/day	Refer to Date and Time Parameters (compacted to take less space)
22	Time: Hour/minute	
23	Time Second/hsec	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
24	Demand Period Length	Refer to Advanced Device Configuration Parameters
25	Number of Demand Periods	
26	Predicted Demand Type	
27	KYZ Pulse Output Parameter	
28	KYZ Pulse Output Scale	
29	KYZ Pulse Output Width	
30	Relay Pulse Output Parameter	
31	Relay Pulse Output Scale	
32	Relay Pulse Output Width	
33	RMS Resolution	
34	RMS result averaging	
35	Frequency averaging	
36	Default relay state in event of communication loss	
37	Default KYZ state in event of communication loss	
38	DM text scroll rate	
39	Protocol	Refer to Native Communication Configuration Parameters
40	Delay	
41	Baud rate	
42	Device address	
43	Data format	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
44	Comm parameter #1	Refer to Optional Communication Configuration Parameters
45	Comm parameter #2	
46	Comm parameter #3	
47	Comm parameter #4	
48	Comm parameter #5	
49	Comm parameter #6	
50	Comm parameter #7	
51	Comm parameter #8	
52	Comm parameter #9	
53	Comm parameter #10	
54	Comm parameter #11	
55	Comm parameter #12	
56	Comm parameter #13	
57	Comm parameter #14	
58	Comm parameter #15	
59	Comm parameter #16	
60	Comm parameter #17	
61	Comm parameter #18	
62	Comm parameter #19	
63	L1 Current	Refer to Metering Voltage, Current, and Frequency Result Parameters
64	L2 Current	
65	L3 Current	
66	Avg Current	
67	L1-N Voltage	
68	L2-N Voltage	
69	L3-N Voltage	
70	Avg L-N Voltage	
71	L1-L2 Voltage	
72	L2-L3 Voltage	
73	L3-L1 Voltage	
74	Avg L-L Voltage	
75	Frequency, last cycle	
76	Metering iteration	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
77	L4 Current	Refer to Metering Sequence Voltage, and Current Results Parameters
78	Positive Sequence Current	
79	Negative Sequence Current	
80	% Current unbalance	
81	Positive Sequence Voltage	
82	Negative Sequence Voltage	
83	% Voltage unbalance	
84	Phase rotation	
85	Average frequency	
86	Frequency source	
87	L1 Real Power	Refer to Metering Power Results Parameters
88	L2 Real Power	
89	L3 Real Power	
90	Total Real Power	
91	L1 Reactive Power	
92	L2 Reactive Power	
93	L3 Reactive Power	
94	Total Reactive Power	
95	L1 Apparent Power	
96	L2 Apparent Power	
97	L3 Apparent Power	
98	Total Apparent Power	
99	Demand Current	Refer to Metering Demand Results Parameters
100	Demand Power	
101	Demand Reactive Power	
102	Demand Apparent Power	
103	Projected Demand I	
104	Projected Demand W	
105	Projected Demand VAR	
106	Projected Demand VA	
107	Elapsed demand period time	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
108	L1 True Power Factor	Refer to Metering Power Factor Results Parameters
109	L2 True Power Factor	
110	L3 True Power Factor	
111	Three-phase True PF	
112	L1 Displacement Power Factor	
113	L2 Displacement Power Factor	
114	L3 Displacement Power Factor	
115	Three-phase Displacement PF	
116	L1 Distortion Power Factor	
117	L2 Distortion Power Factor	
118	L3 Distortion Power Factor	
119	Three-phase Distortion PF	
120	kWh forward	Refer to Metering Real and Apparent Energy Results Parameters
121	kWh reverse	
122	kWh net	
123	kVAh	
124	kVARh forward	Refer to Metering Reactive Energy and Amp-hour Results Parameters
125	kVARh reverse	
126	kVARh net	
127	kAh	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
128	Bulletin number	Refer to Selftest/Diagnostic Results Parameters
129	Series	
130	Overall status	
131	ASIC status	
132	Data FLASH status	
133	Real-time clock status	
134	RTC NVRAM status	
135	Option comm status	
136	Display module status	
137	Watchdog status	
138	VCO lock status	
139	Reserved	
140	Application FRN	
141	Boot code FRN	
142	ASIC 'FRN'	
143	Option comm FRN	
144	Display module FRN	
145	Reserved	
146	Digital board revision	
147	Analog board revision	
148	Option comm board revision	
149	Reserved	
150	MM Device ID	
151	MM RAM type	
152	Display module type	
153	Option comm type	
154	Reserved	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
155	Setpoint #1 type	Refer to Setpoint Setup/Read-back Select and Status Parameters
156	Setpoint #2 type	
157	Setpoint #3 type	
158	Setpoint #4 type	
159	Setpoint #5 type	
160	Setpoint #6 type	
161	Setpoint #7 type	
162	Setpoint #8 type	
163	Setpoint #9 type	
164	Setpoint #10 type	
165	Setpoint #1 evaluation condition	
166	Setpoint #2 evaluation condition	
167	Setpoint #3 evaluation condition	
168	Setpoint #4 evaluation condition	
169	Setpoint #5 evaluation condition	
170	Setpoint #6 evaluation condition	
171	Setpoint #7 evaluation condition	
172	Setpoint #8 evaluation condition	
173	Setpoint #9 evaluation condition	
174	Setpoint #10 evaluation condition	
175	Setpoint #1 high limit	
176	Setpoint #2 high limit	
177	Setpoint #3 high limit	
178	Setpoint #4 high limit	
179	Setpoint #5 high limit	
180	Setpoint #6 high limit	
181	Setpoint #7 high limit	
182	Setpoint #8 high limit	
183	Setpoint #9 high limit	
184	Setpoint #10 high limit	
185	Setpoint #1 low limit	
186	Setpoint #2 low limit	
187	Setpoint #3 low limit	
188	Setpoint #4 low limit	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
189	Setpoint #5 low limit	Refer to Setpoint Setup/Read-back Select and Status Parameters
190	Setpoint #6 low limit	
191	Setpoint #7 low limit	
192	Setpoint #8 low limit	
193	Setpoint #9 low limit	
194	Setpoint #10 low limit	
195	Setpoint #1 action delay	
196	Setpoint #2 action delay	
197	Setpoint #3 action delay	
198	Setpoint #4 action delay	
199	Setpoint #5 action delay	
200	Setpoint #6 action delay	
201	Setpoint #7 action delay	
202	Setpoint #8 action delay	
203	Setpoint #9 action delay	
204	Setpoint #10 action delay	
205	Setpoint #1 release delay	
206	Setpoint #2 release delay	
207	Setpoint #3 release delay	
208	Setpoint #4 release delay	
209	Setpoint #5 release delay	
210	Setpoint #6 release delay	
211	Setpoint #7 release delay	
212	Setpoint #8 release delay	
213	Setpoint #9 release delay	
214	Setpoint #10 release delay	
215	Setpoint #1 action type	
216	Setpoint #2 action type	
217	Setpoint #3 action type	
218	Setpoint #4 action type	
219	Setpoint #5 action type	
220	Setpoint #6 action type	
221	Setpoint #7 action type	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
222	Setpoint #8 action type	Refer to Setpoint Setup/Read-back Select and Status Parameters
223	Setpoint #9 action type	
224	Setpoint #10 action type	
225	Setpoint #1 status	
226	Setpoint #2 status	
227	Setpoint #3 status	
228	Setpoint #4 status	
229	Setpoint #5 status	
230	Setpoint #6 status	
231	Setpoint #7 status	
232	Setpoint #8 status	
233	Setpoint #9 status	
234	Setpoint #10 status	
235	Setpoint #1 accumulated active time	
236	Setpoint #2 accumulated active time	
237	Setpoint #3 accumulated active time	
238	Setpoint #4 accumulated active time	
239	Setpoint #5 accumulated active time	
240	Setpoint #6 accumulated active time	
241	Setpoint #7 accumulated active time	
242	Setpoint #8 accumulated active time	
243	Setpoint #9 accumulated active time	
244	Setpoint #10 accumulated active time	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
245	Logging interval	Refer to Trend Log Configuration/Read-back Record Select Parameters
246	Logging mode	
247	Total records logged	
248	Trend log param #1	
249	Trend log param #2	
250	Trend log param #3	
251	Trend log param #4	
252	Trend log param #5	
253	Trend log param #6	
254	Trend log param #7	
255	Trend log param #8	
256	Trend log param #9	
257	Trend log param #10	
258	Trend log param #11	
259	Trend log param #12	
260	Trend log param #13	
261	Trend log param #14	
262	Trend log param #15	
263	Trend log param #16	
264	Enable/disable Min/max log	Refer to Min/Max Log Configuration/Read-back Select Parameters
265	Timestamp of last min/max clear; year	
266	Timestamp of last min/max clear; Month/day	
267	Timestamp of last min/max clear; Hour/min	
268	Timestamp of last min/max clear; Second/hsec	
269	Enable/disable save status input changes to Event log	Refer to Event Log Configuration/Read-back Record Select Parameters
270	Number of events in the event log	
271	Write error status File/BT/Inst.No.	Refer to Write Error Status Parameters
272	Write error status Parameter number	

Parameters for Trend Log and Configurable Table

Param No.	Parameter Name	Comment
273	V1 % IEEE THD	Refer to Harmonic Results; THD, Crest Factor, and More Parameters
274	I1 % IEEE THD	
275	V2 % IEEE THD	
276	I2 % IEEE THD	
277	V3 % IEEE THD	
278	I3 % IEEE THD	
279	I4 % IEEE THD	
280	V1 % IEC THD (DIN)	
281	I1 % IEC THD (DIN)	
282	V2 % IEC THD (DIN)	
283	I2 % IEC THD (DIN)	
284	V3 % IEC THD (DIN)	
285	I3 % IEC THD (DIN)	
286	I4 % IEC THD (DIN)	
287	V1 Crest Factor	
288	I1 Crest Factor	
289	V2 Crest Factor	
290	I2 Crest Factor	
291	V3 Crest Factor	
292	I3 Crest Factor	
293	I4 Crest Factor	
294	THD & Crest iteration	
295	DeviceNet instance 1 data type	Refer to User-configured Table Setup Parameters
296	Avg IEEE THD V	Refer to Harmonic Results; THD, Crest Factor, and More Parameters
297	Avg IEEE THD I	
298	Avg IEC THD V	
299	Avg IEC THD I	
300	Avg Crest Factor V	
301	Avg Crest Factor I	

Catalog Number Explanation

Master Module

1404 - M4 05 A - ENT - 02

Bulletin Number
1404 = Power Monitoring and Management Products

Type of Device
M4 = Master module with three-phase metering, pulse input conversion, setpoints, I/O, and data logging.

M5 = M4 functionality, firmware upgradeable to an M6 or M8

M6 = M4 functionality plus oscillography, sag/swell detection, harmonics 1…41 measurement, additional setpoints and logging, firmware upgradeable to M8.

M8 = M6 functionality plus transient capture and analysis, harmonics measurement up to 63rd, transducer and energy meter modes

Current Inputs
05 = 5 A

Power Supply
A = 120…240V ac 50…60 Hz or

125…250V dc

B = 24V dc

Communication Options(1)
000 = None

232 = RS-232 Serial

DNT = DeviceNet

RIO = Remote I/O

ENT = Ethernet

CNT = ControlNet

Revenue Accuracy Class
none = Class 1 (M4),

Class 0.5 (M5, M6, M8)

02 = Class 0.2 (M5, M6, M8)

(1) In addition to Native RS-485 port.

Display Module

1404 - DM

Bulletin Number

1404 = Power Monitoring, and Management Products

Type of Device

DM = Display module with 3 Meter Cable

Sample Applications

Introduction

This appendix contains sample applications including ladder diagrams to help you get started in setting up communication between your application and a power monitor.

The application samples depict basic methods for reading and writing data between a power monitor and your programmable controller or other application. Expand on these basic steps to customize your application to meet your business needs. The sample applications include the following:

- Read and write the power monitor system clock by using a variety of controllers, applications and communication networks.
- Read multiple power monitor data tables into an SLC 500 controller by using a DeviceNet communication network.
- Set up the user-configured data table by using a ControlLogix controller and an EtherNet/IP communication network.
- Read and write power monitor tables by using an SLC 500 controller and a 1747-SCNR ControlNet scanner.
- Read and write power monitor tables by using a MicroLogix controller over EtherNet/IP and Modbus RTU communication networks.
- Read and write power monitor tables by using a Component HMI over an EtherNet/IP communication network.

ATTENTION

Proper operation of the application is your responsibility. Rockwell Automation makes no warranty, express or implied, for these sample applications. The sample applications are subject to change at any time without notice.

System Clock Sample Applications

The power monitor system clock (date and time) is an ideal sample application for these reasons:

- It is important to set the system clock so that data log records or oscillograms are recorded with accurate time stamps.
- It is easy to see if your application has successfully written and read the system clock.
- The methods used for reading and writing the system clock are applicable to reading and writing every other power monitor data table.

See Date and Time Parameters on page 195 for details of the Date and Time data table. We will look at four methods of reading and writing the system clock.

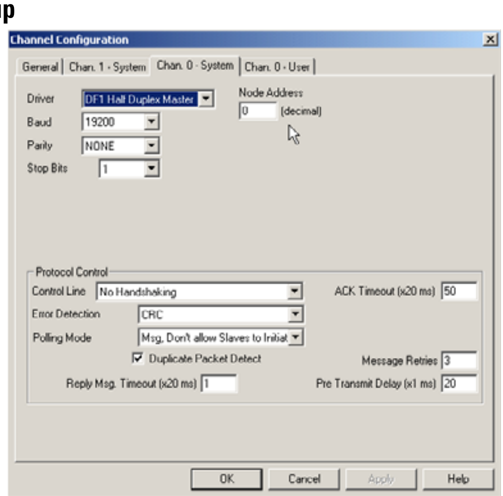
SLC 500 Controller and Native RS-485 Communication

This example reads and writes the date and time table by using the SLC 500 controller Channel 0 serial port and the native RS-485 communication port on the power monitor. You must supply an RS-232 to RS-485 converter such as a 1761-NET-AIC or B&B Electronics 485SD9TB between the SLC 500 controller and the power monitor.

Serial Port Setup

The SLC 500 serial port setup using a 1761-NET-AIC adapter is shown. The specific settings depend on your selection of RS-485 to RS-232 adapter. This example uses the DF1 half-duplex protocol.

Serial Port Setup

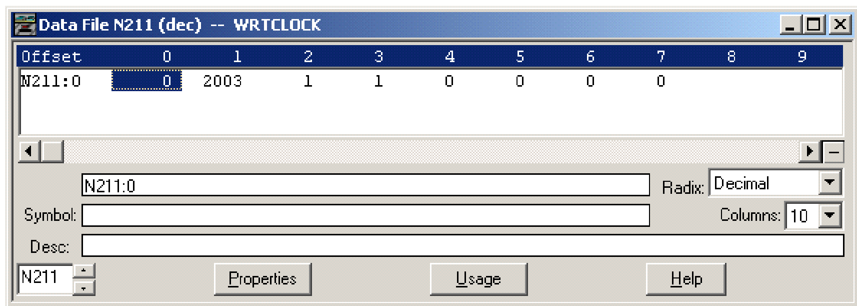


Data Tables

In the SLC 500 data tables, table N111 is the destination table for the Read message and N211 is the source for the Write message.

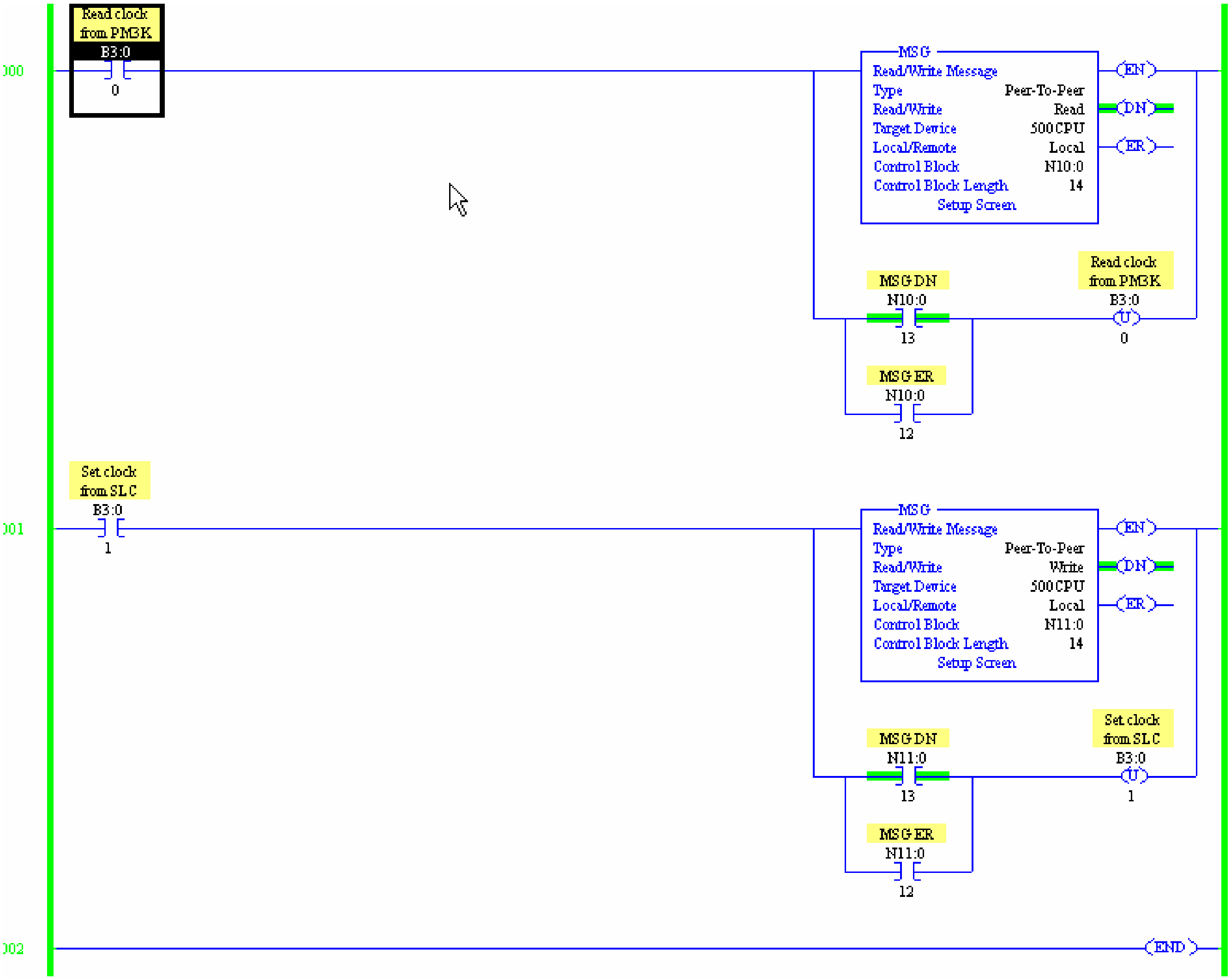
Table N211 contains the following values for setting the date and time in a power monitor with a password of 0 to January 1, 2003 at 12:00 midnight.

Table N211



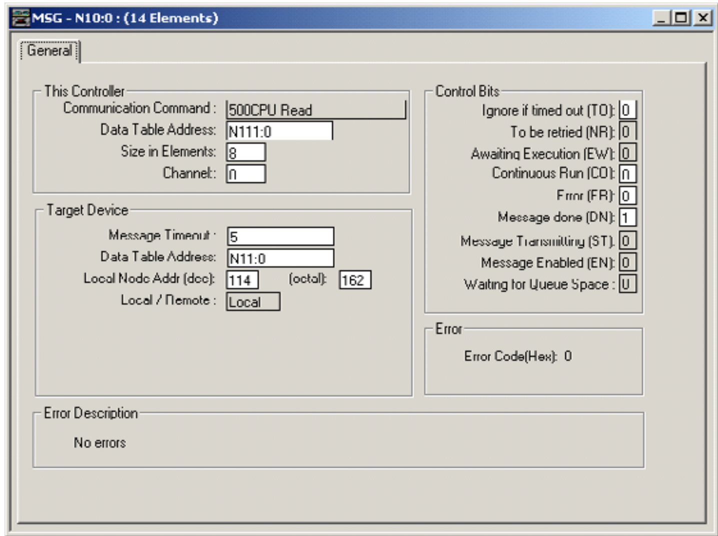
The Read Clock from PM3K and Set Clock from SLC bits are used to initiate the messages, and are reset when the message instruction either completes successfully or an error occurs. In your application code, if the message rungs are controlled programmatically, be sure that only one message is enabled at a time.

Ladder Diagram

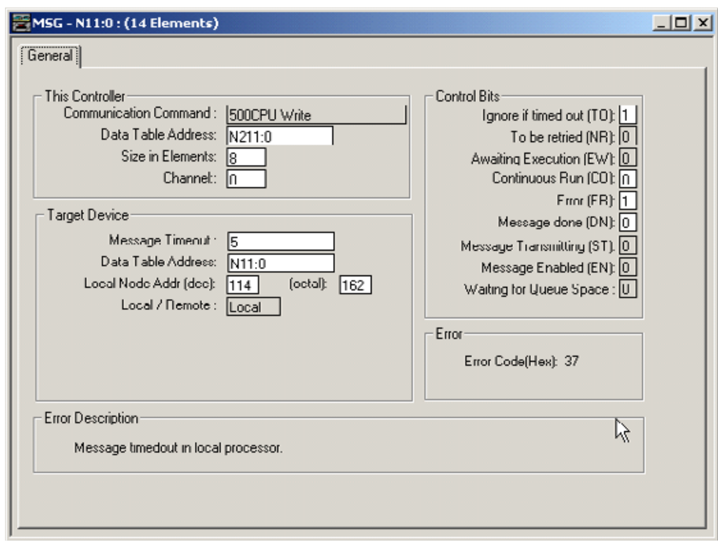


Message Setup Dialogs

Read Message Dialog



Write Message Setup



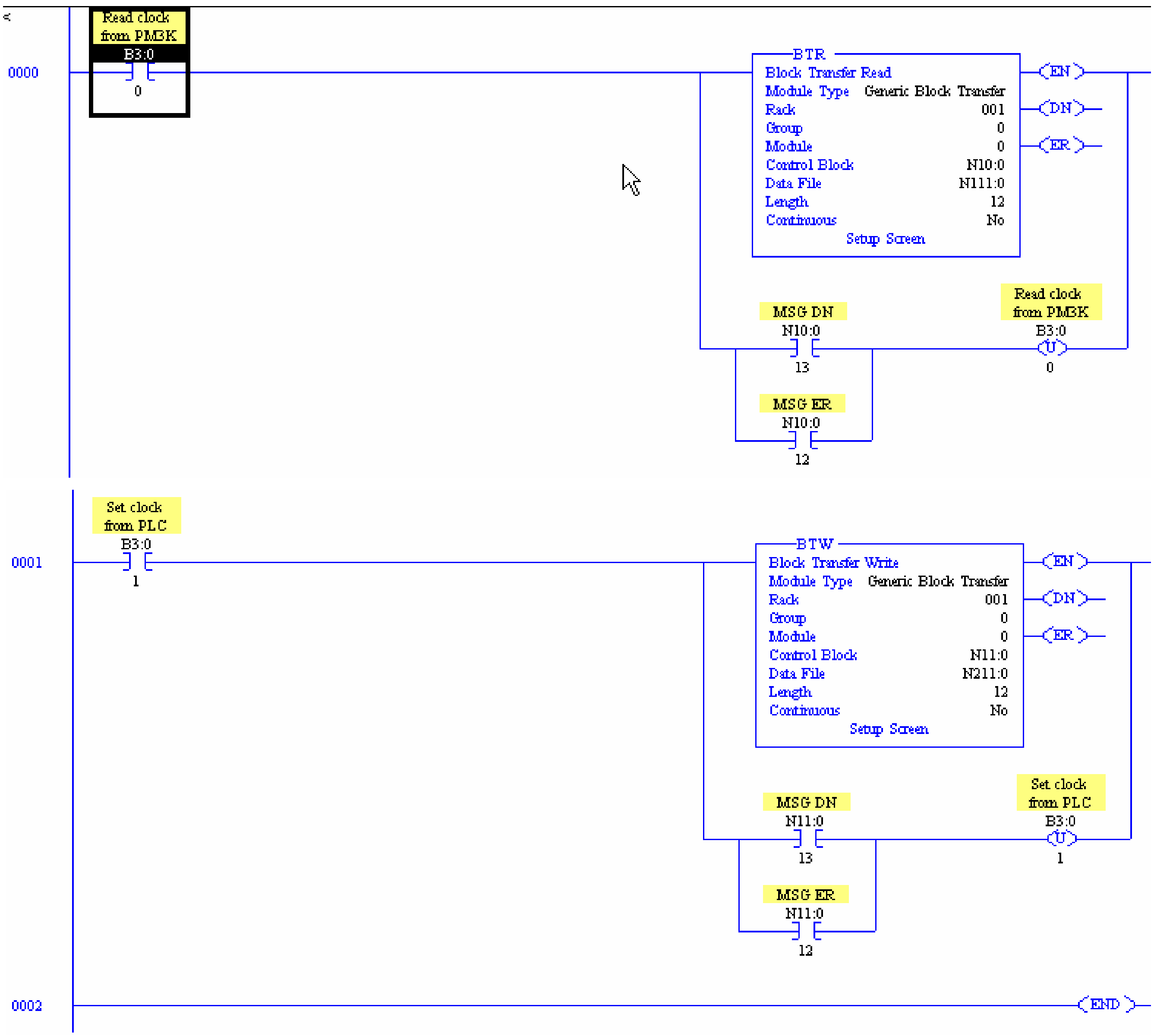
PLC-5 Controller by Using Remote I/O

The second example also reads and writes the power monitor date and time but uses a PLC-5 controller and remote I/O. In this example, a power monitor has a logical address of Rack 1, Group 0. The PLC-5 data table files used are the same as in the previous example. The main difference is that this example uses block transfer instructions rather than message instructions, and the block transfer length determines which data table is selected.

The source and destination data tables in the PLC-5 must contain at least as many words as the block transfer length.

The Read Clock from PM3K and Set Clock from PLC bits are used to initiate the messages, and are reset when the message instruction either completes successfully or an error occurs. In your application code, if the message rungs are controlled programmatically, ensure that only one message is enabled at a time, and add sufficient time delays between block transfers to avoid overloading the channel.

Ladder Diagram



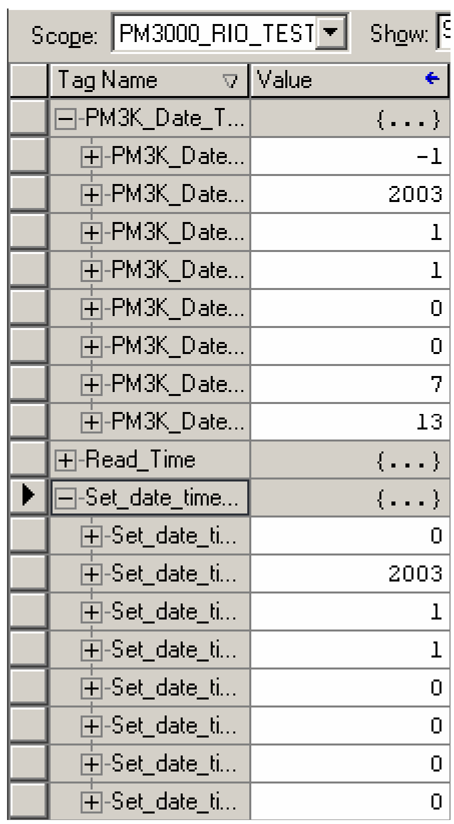
EtherNet/IP and ControlLogix Networks

The third example reads and writes the power monitor date and time data table by using a ControlLogix controller and an EtherNet/IP communication network.

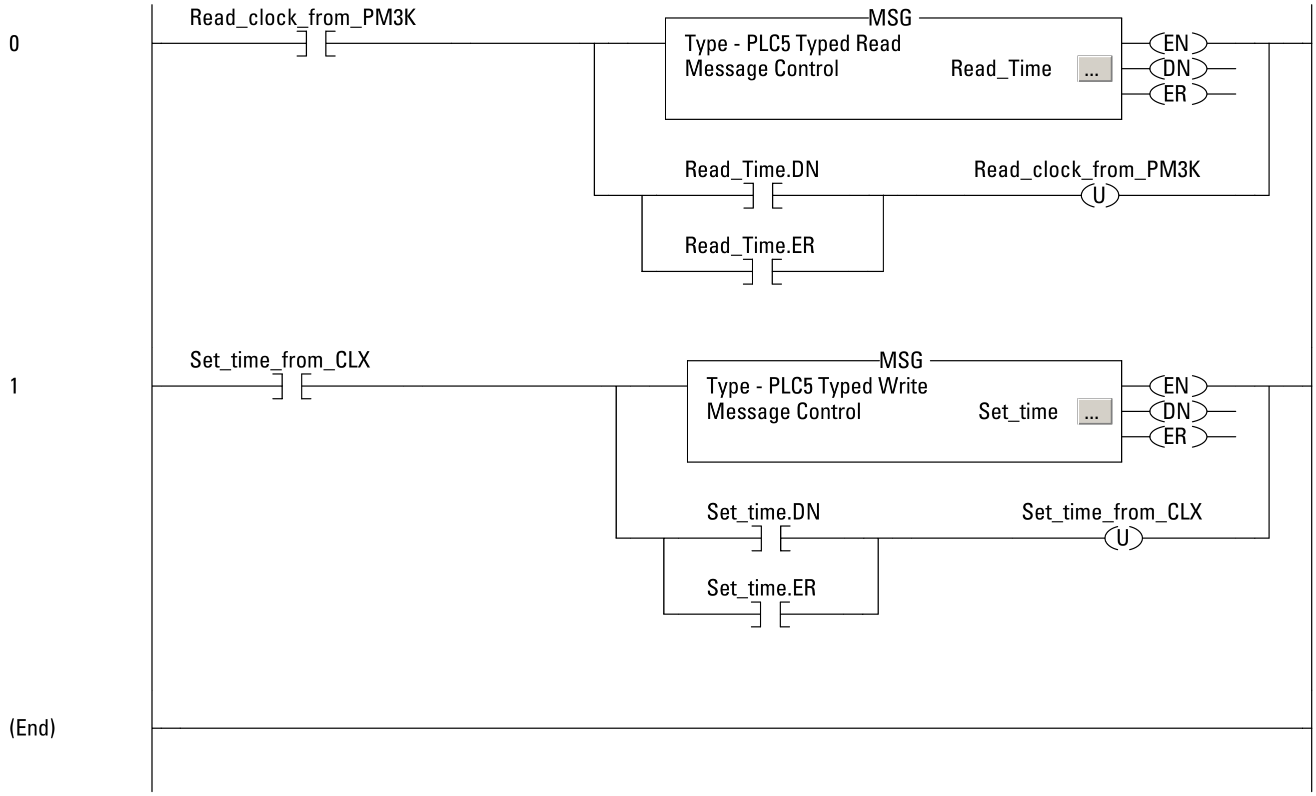
Tags

The example uses two ControlLogix tags, PM3K_Date_Time and Set_date_time. Both are arrays of 8 INT elements. The program also uses two standard MESSAGE tags, Read_time and Set_time. The following figure shows the Set_date_time to set the power monitor clock to January 1, 2003 at midnight. The tag PM3K_Date_Time shows the results of a read 7.13 seconds after the write.

Set Date Time



Ladder Diagram



Message Setup Dialogs

The example uses PLC-5 Typed read and write message types. The setup dialogs are similar to those found on page 107 and page 108.

ControlNet and ControlLogix

The fourth example reads and writes the power monitor date and time by using a ControlLogix controller and ControlNet communication.

Tags

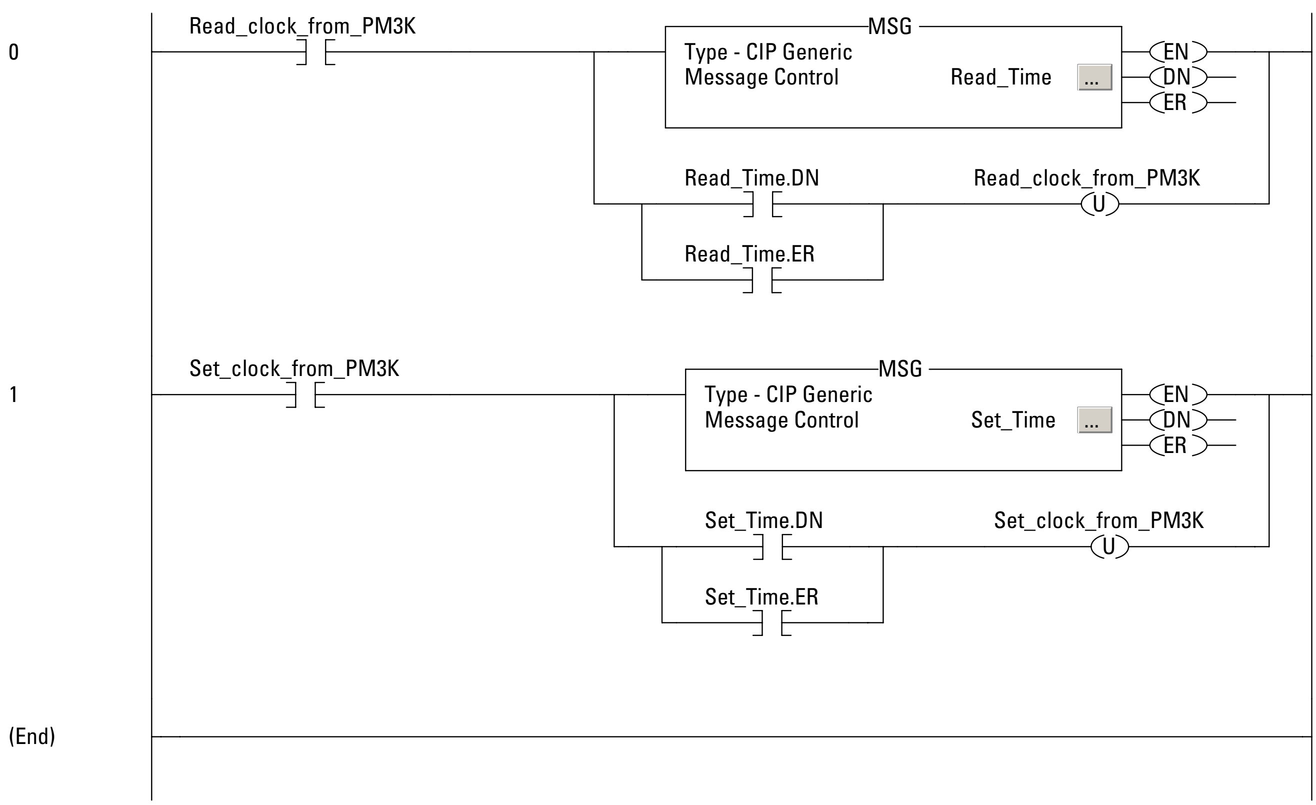
The example uses two ControlLogix tags as shown below. The tags are INT(8) arrays.

ContrlLogix Tags

Date_time_from_PM3K	{...}
Date_time_from_PM3K[0]	-1
Date_time_from_PM3K[1]	2003
Date_time_from_PM3K[2]	4
Date_time_from_PM3K[3]	14
Date_time_from_PM3K[4]	12
Date_time_from_PM3K[5]	29
Date_time_from_PM3K[6]	3
Date_time_from_PM3K[7]	47

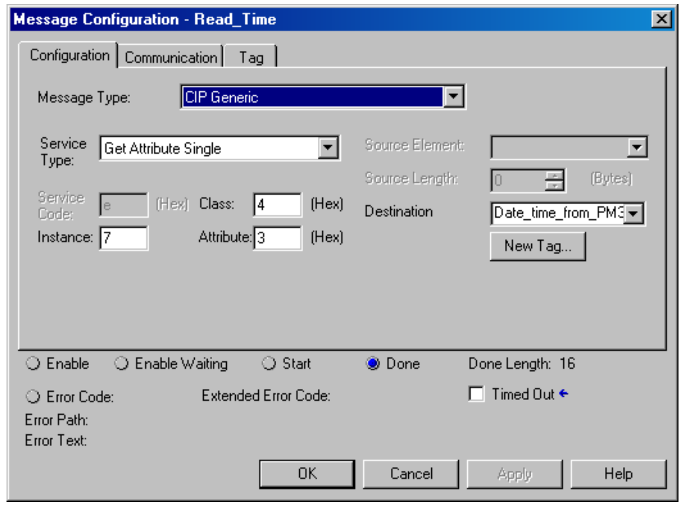
Set_PM3K_Date_Time	{...}
Set_PM3K_Date_Time[0]	0
Set_PM3K_Date_Time[1]	2003
Set_PM3K_Date_Time[2]	4
Set_PM3K_Date_Time[3]	14
Set_PM3K_Date_Time[4]	12
Set_PM3K_Date_Time[5]	29
Set_PM3K_Date_Time[6]	0
Set_PM3K_Date_Time[7]	0

Ladder Diagram



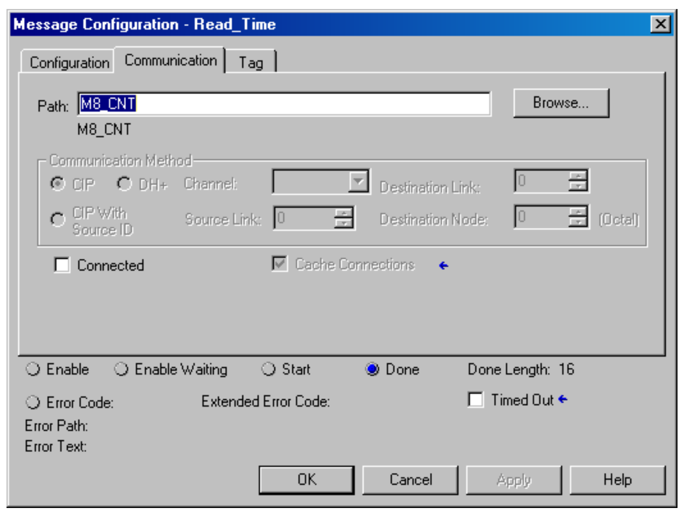
Message Setup Dialogs

Read Message Dialog



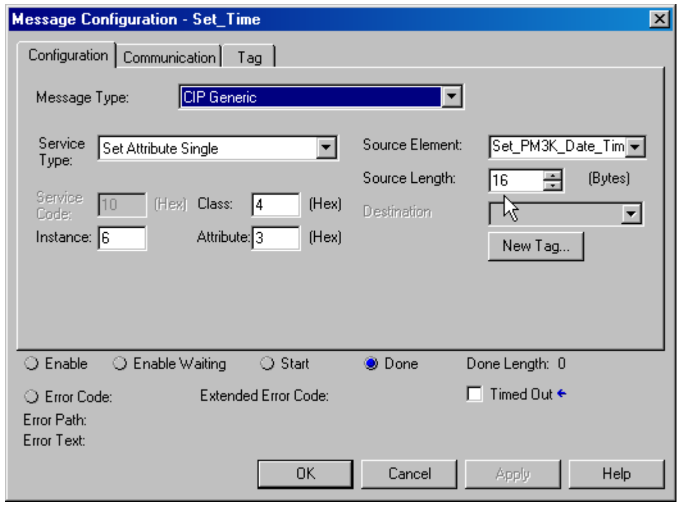
The communication tab of the message setup simply shows the module name in the I/O configuration for this example.

Communication Tab



The write message dialog is similar to the Read.

Write Message Dialog



Note that the source length is in Bytes, not elements. Since this message write 8 INT elements, the message length is 16 bytes.

RSLinx DDE/OPC and Microsoft Excel Software

You may create a simple data transfer application by using RSLinx direct data exchange (DDE) capabilities and a DDE client such as Microsoft Excel software. This example uses DDE to read and write the value of the real-time clock in a power monitor. You may utilize similar techniques to transfer data to and from any power monitor data tables.

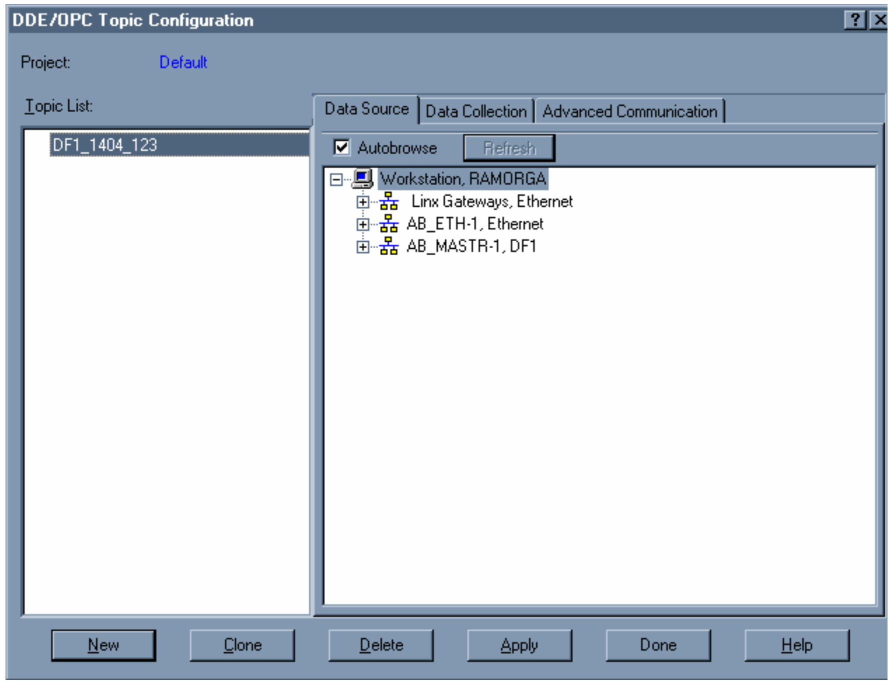
Setting up a DDE Topic in RSLinx Software

Follow these steps to create a DDE topic in RSLinx software. You need RSLinx OEM, Professional, Gateway or SDK software to support DDE communication.

1. Establish communication between RSLinx software and your power monitor by using the communication method of your choice.

   The example uses the native communication port in DF1 half-duplex configuration.

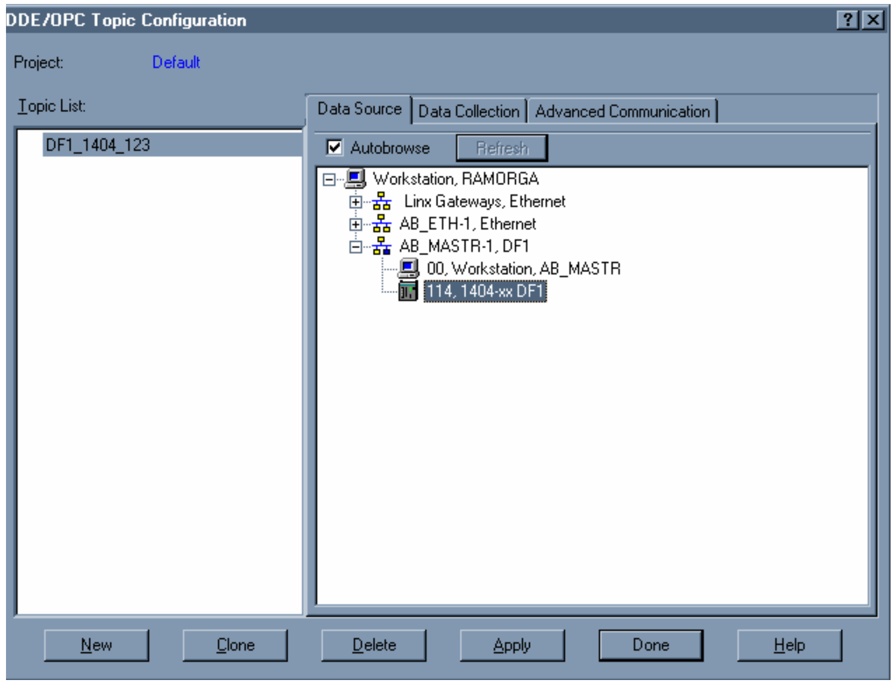
2. In RSLinx software, select DDE/OPC from the main menu.



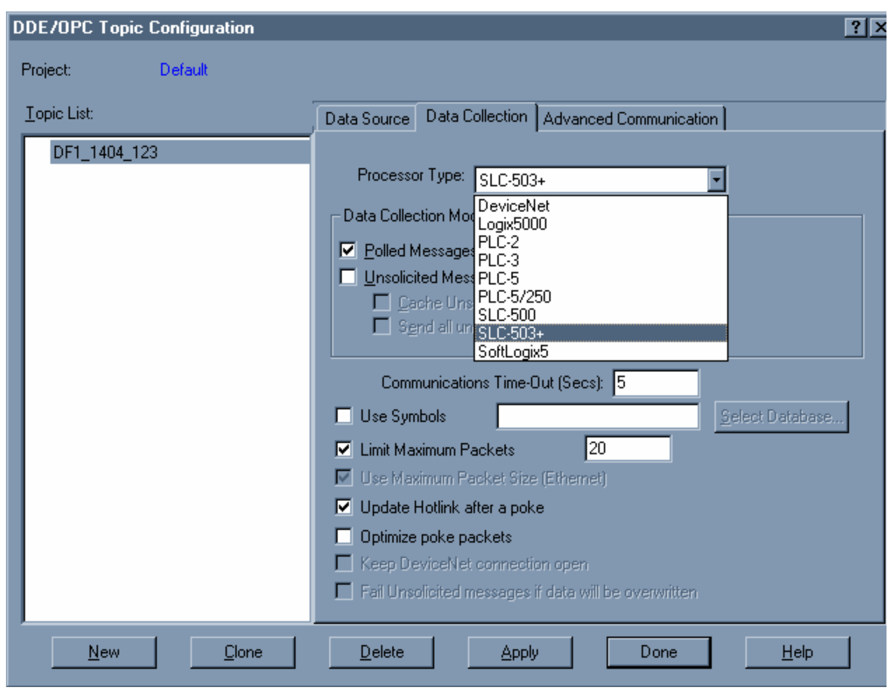
3. Click New and enter a name for the DDE/OPC topic.

   The example uses DF1_1404_123.

4. Browse through the tree in the Data Source dialog to locate your power monitor and click its icon to select it.

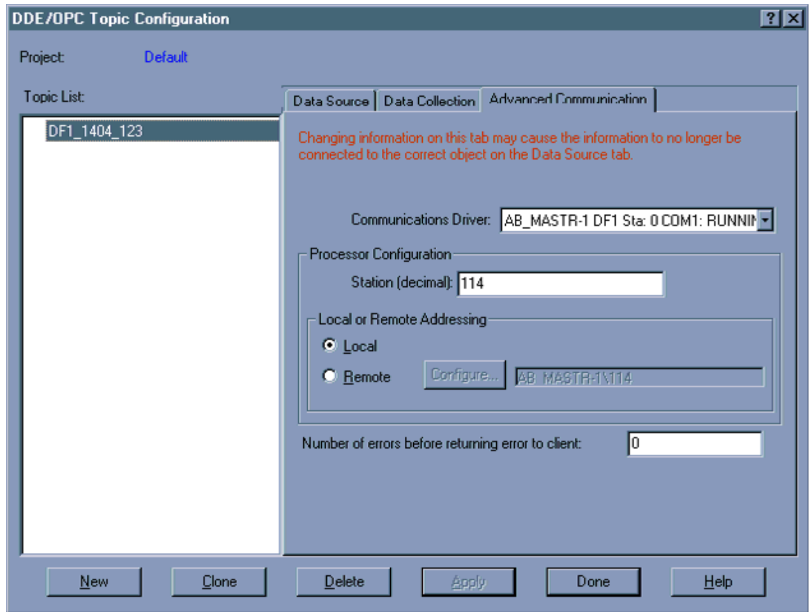


5. Click the Data Collection tab, select SLC 5/03+ as the Processor Type, leaving the rest of the settings as default.



6. Click Apply and confirm when prompted.

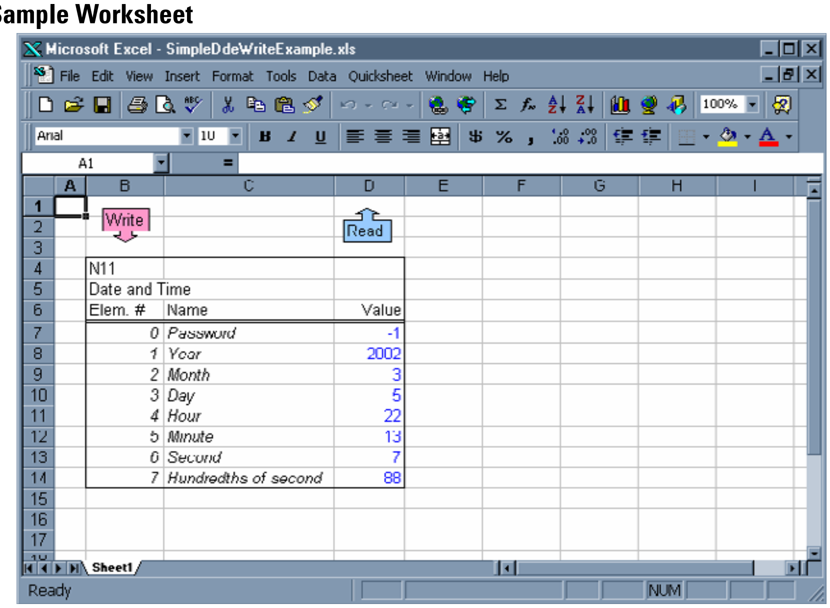
7. Click the Advanced Communication tab to verify the driver and path settings in the topic and click Done.



The Microsoft Excel Sample Worksheet

The sample worksheet uses Visual Basic for Applications (VBA) macros to read and set the date and time in the power monitor.

Sample Worksheet



The range Sheet1!D7:D14 is the write source range and the read target range. The Read graphic element is associated with the following VBA script or macro.

Sub ReadDateAndTime()

```
'Open DDE link; the first argument is the application we
'want to DDE with. Second argument is the DDE topic name
'configured in RSLinx
RSIchan = DDEInitiate("RSLINX", "DF1_1404_123")
'Read the date/time table from the PM3000 and put it in
'the excel sheet
Range("Sheet1!D7:D14") = DDERequest(RSIchan, "N11:0,L8")
'Close DDE link
DDETerminate (RSIchan)
```

End Sub

The Write graphic element is associated with the following VBA script.

Sub WriteDateAndTime()

```
'Open DDE link
RSIchan = DDEInitiate("RSLINX", "DF1_1404_123")
'Write data from the excel sheet into the PM3000
DDEPoke RSIchan, "N11:0,L8", Range("Sheet1!D7:D14")
'Close DDE link
DDETerminate (RSIchan)
```

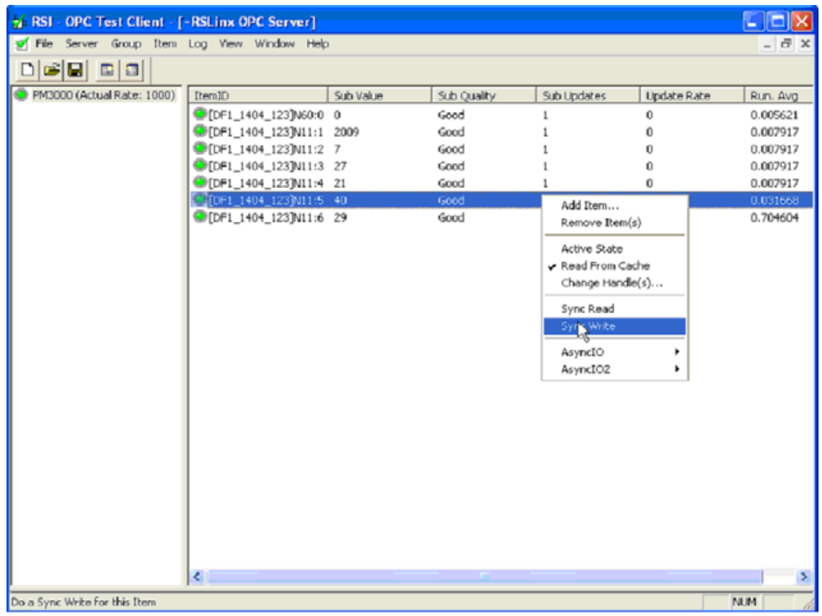
End Sub

To read the date and time from the power monitor, click the Read graphic element. To write the data and time to the power monitor, enter the desired data and time into the worksheet along with the power monitor password (default = 0) and click the Write graphic element.

Use OPC for Single Element Password Write

First, create an OPC topic that points to your power monitor. In the OPC client, add the single password write parameter item with address N60:0, along with any other parameters that you want to write. Right click the single password write ItemID, and then select 'Sync Write.' Enter your power monitor password (Default password = 0). You now have 30 minutes to write values to your other writeable parameters. Your write session will expire when idle for durations longer than 30 minutes.

IMPORTANT	If you are using RSLinx Classic software as your OPC software, a licensed RSLinx OEM or higher version is required.



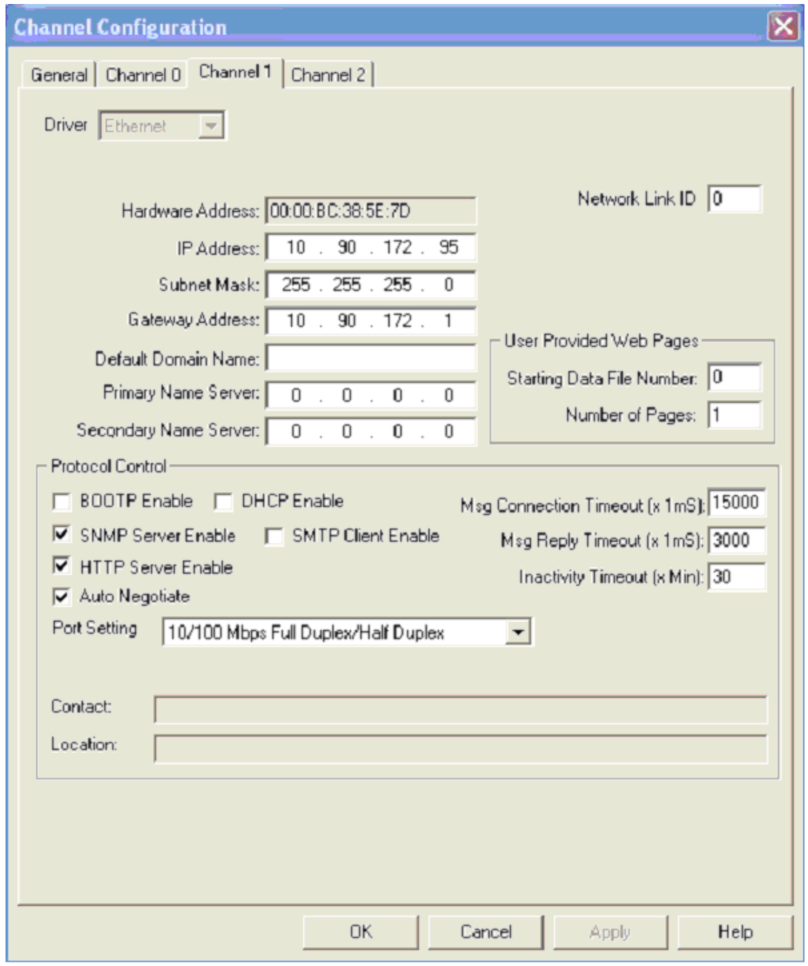
MicroLogix Controller and EtherNet/IP Communication Networks

This example reads and writes the power monitor date and time table by using a MicroLogix 1400 controller and EtherNet/IP communication.

IMPORTANT	The power monitor master module firmware must be 4.*x* or later and the Ethernet protocol must be set to CIP or CSP/CIP to support communication with a MicroLogix controller.

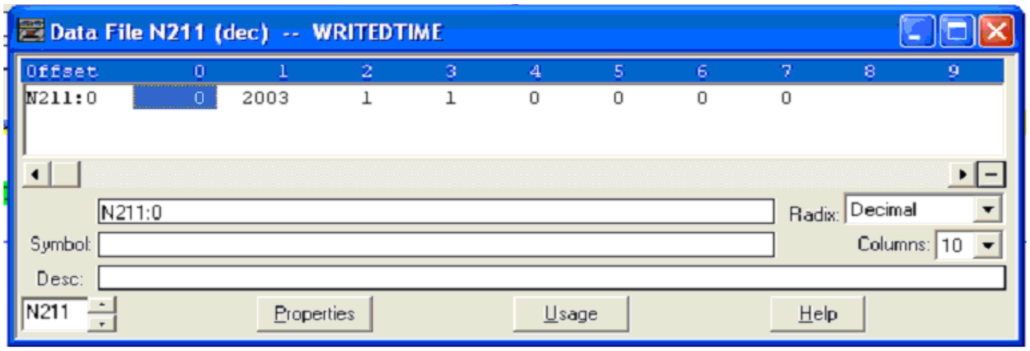
MicroLogix Controller Ethernet Port Setup

Assign the MicroLogix controller and the power monitor compatible network addresses. In this example the power monitor IP address is 10.90.172.91 and the ML1400 IP address is 10.90.172.95.



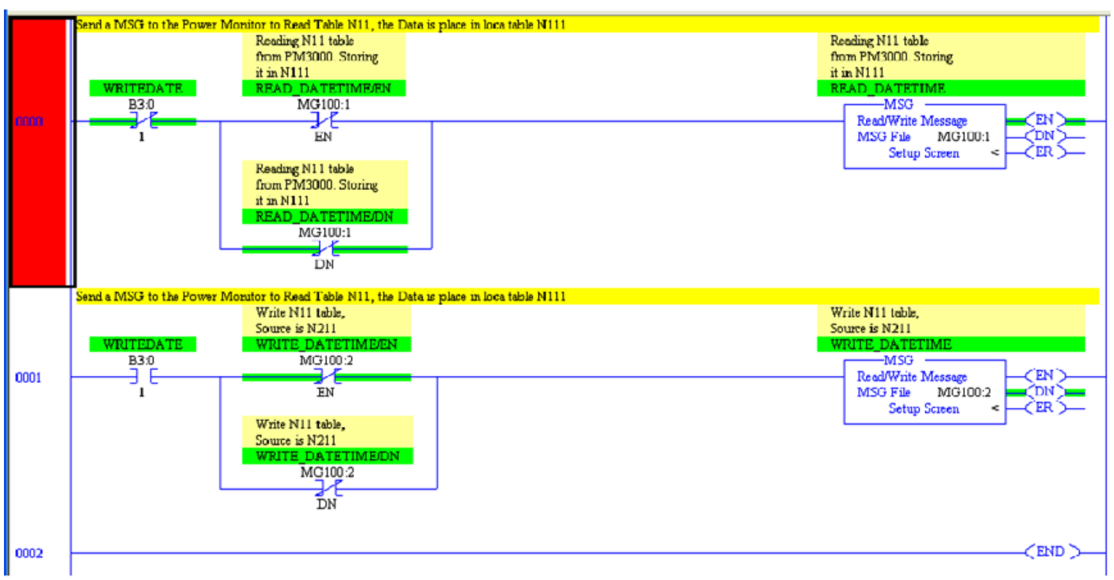
Data Tables

The MicroLogix 1400 data table N111 is the destination table for the Read message and N211 is the source for the Write message. Table N211 contains the following values for setting the date and time in a power monitor with a password of 0 to January 1, 2003 at 12:00 midnight.

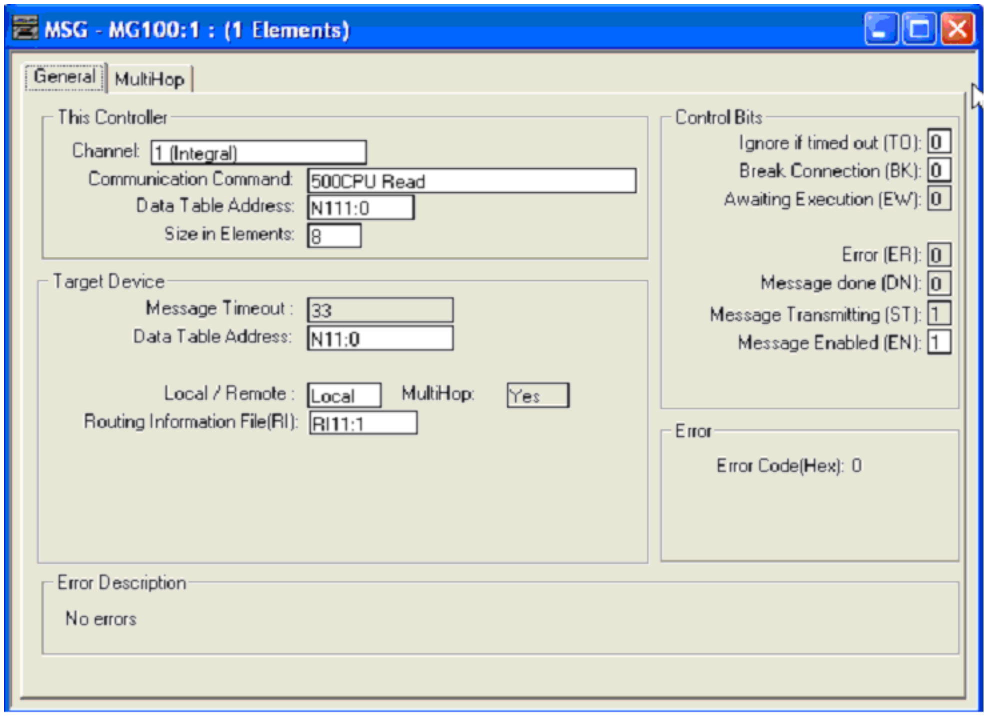


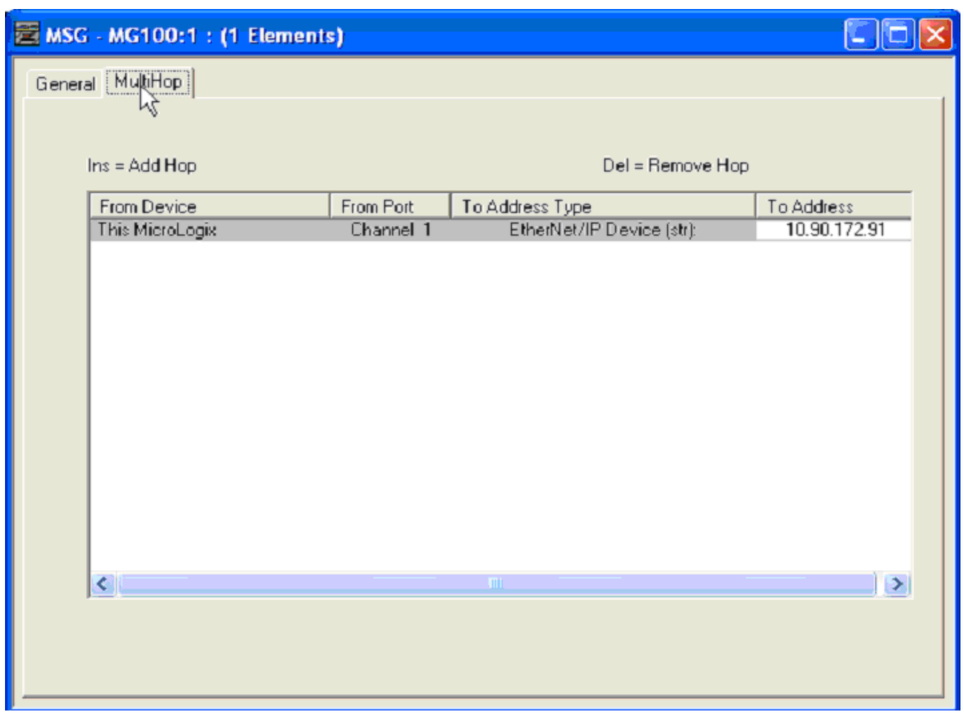
The Read Clock from the Powermonitor 3000 unit and Set Clock from the MicroLogix 1400 controller bits are used to initiate the messages, and are reset when the message instruction either completes successfully or an error occurs. In your application code, if the message rungs are controlled programmatically, be sure that only one message is enabled at a time.

Ladder Program

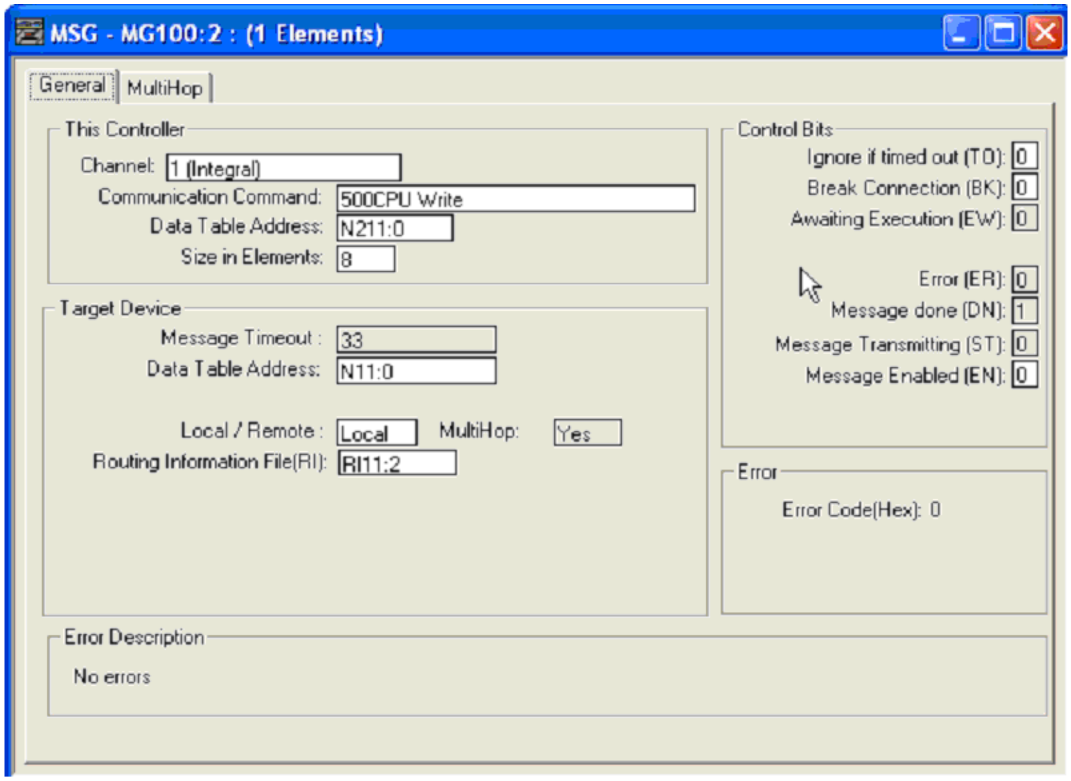


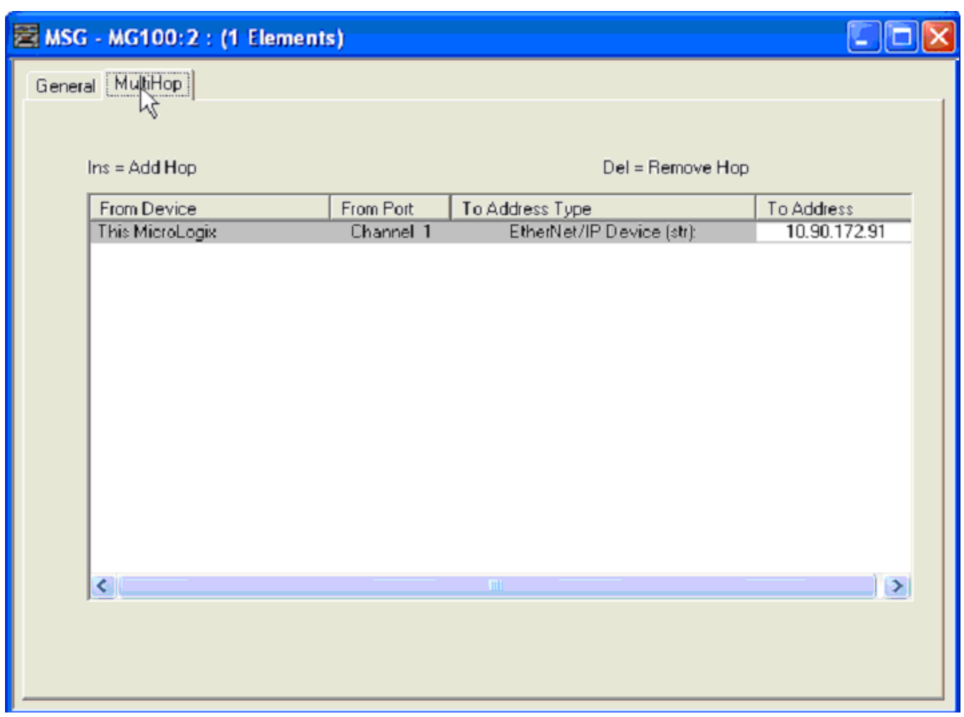
Message Configuration: Read





Message Configuration: Write





MicroLogix Controller and Modbus Communication Network

This example reads and writes the power monitor date and time table by using the MicroLogix 1400 controller using serial RS485 communications and the Modbus RTU protocol.

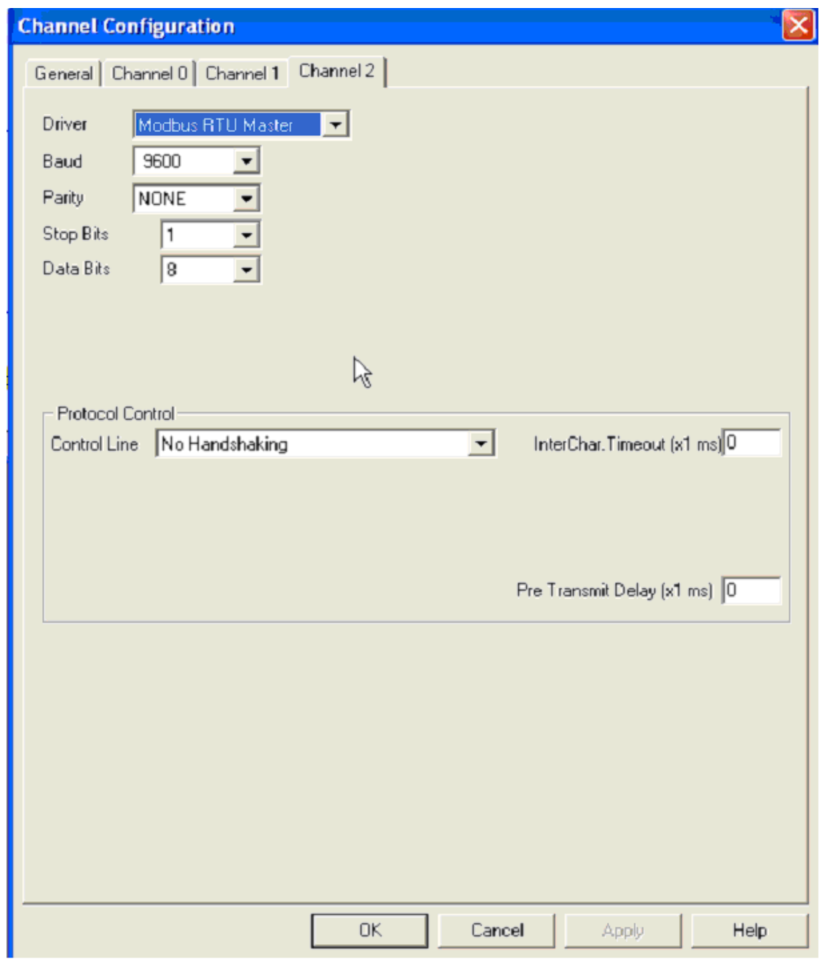
Refer to the Powermonitor 3000 Installation Instructions, publication 1404-IN007 for serial communications wiring.

Serial Port Setup:

Either MicroLogix 1400 controller serial port may be configured as Modbus master. This example uses Channel 2, which is a 9 pin D-Shell RS-232 connector.

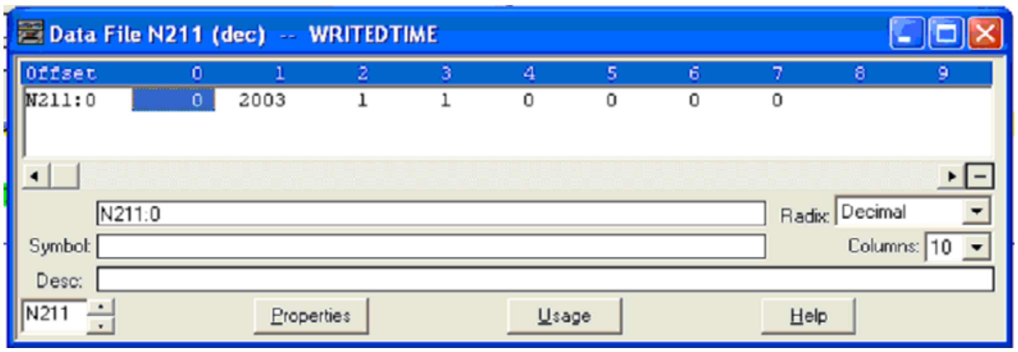
Powermonitor 3000 native port configuration: Modbus RTU, 9600 baud, node address 1, CRC

MicroLogix 1400 Port Configuration



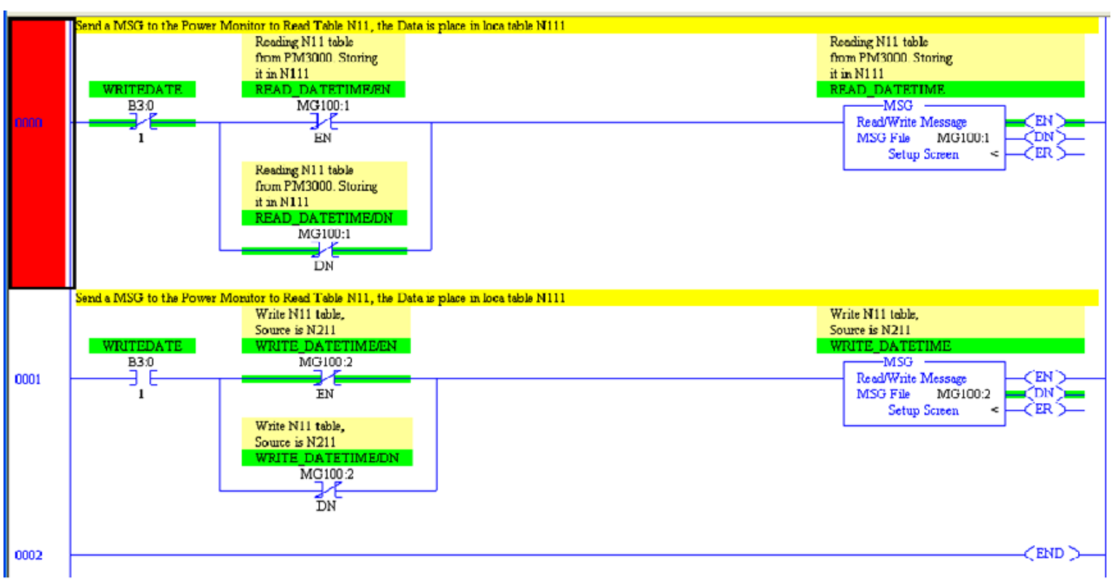
Data Tables

ML1400 data table N111 is the destination table for the Read message and N211 is the source for the Write message. Table N211 contains the following values for setting the date and time in a power monitor with a password of 0 to January 1, 2003 at 12:00 midnight.

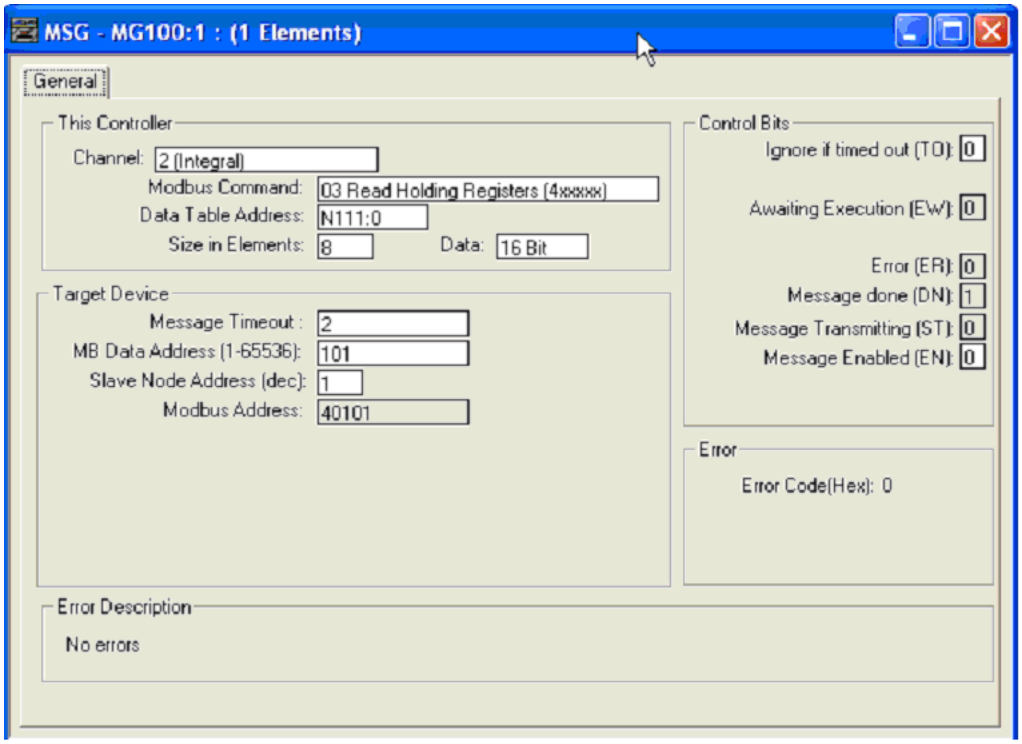


The Read Clock from PM3K and Set Clock from ML1400 bits are used to initiate the messages, and are reset when the message instruction either completes successfully or an error occurs. In your application code, if the message rungs are controlled programmatically, be sure that only one message is enabled at a time.

Ladder Program

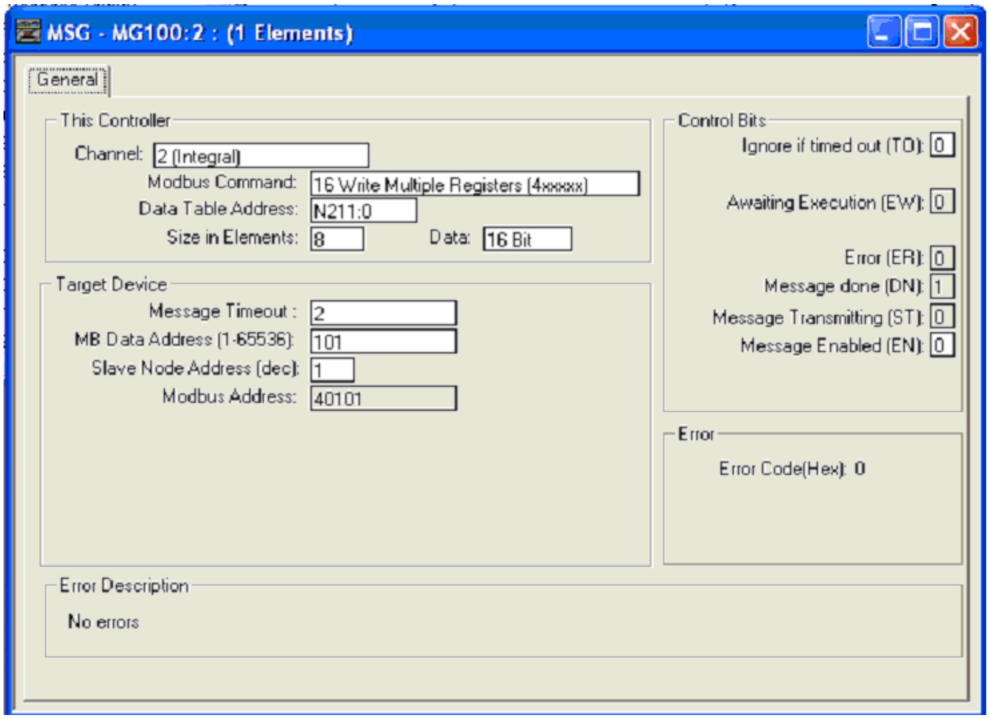


Message Configuration: Read



Modbus Date and Time table registers: 40101-40108, length 8 elements.

Message Configuration: Write



Date and Time Summary

You may use the examples above as building blocks to create applications to meet your business needs.

Refer to Appendix A for detailed information on the power monitor data tables as well as the sections of this manual that describe the functionality you wish to include in your application.

Rockwell Automation also offers software products, such as RSPower, RSPowerPlus, and RSEnergyMetrix, that perform much of the data integration work for you. Please contact your Rockwell Automation representative for more information.

Multiple Data Table Reads by Using DeviceNet

The following is a ladder program designed to return a number of real-time data tables from a power monitor to an SLC 500 processor via DeviceNet by using a DeviceNet scanner module. The following example and ladder diagram uses these settings:

- Node (MAC ID) = 5
- Port = 0
- Class = 4
- Instance = 14, 16, 18, 20, 22, 17, 25
- Attribute = 3
- Command = 1, 4
- Size 3
- Size = 3
- Service = 14

Explicit Message Transfer Setup

The Explicit Message Transfer Block header for this example is assembled in integer file N10:0. The header contains the information for all aspects of the transmission request. Each different node or instance requires assembling another file. Each file has to be moved in turn to the output M0 file starting at word 224.

Refer to Devicenet Scanner Module Installation Instructions, publication 1747-IN058, for a detailed description of all coding.

Explicit Message Transfer Block

TXID	cmd/status
Port	Size
Service	MAC ID
Class	
Instance	
Attributes	

Word M0:1.224

A unique TXID (Transmit Identifier) and Command byte is needed for this word. These are the valid command codes.

- 1 = Execute transaction block
- 4 = Delete transaction from response queue

A command byte of 1 is used first to start the explicit message. After a response has been received from the scanner, a command byte of 4 is used to remove this transaction from the scanner. If the command byte of 4 is not written to the SLC 500 DeviceNet Scanner, then it does not process further transactions.

Word M0:1.224

TXID	**Cmd**
TXID x 256 +	Cmd
20 x 256 +	1
5121	

Word M0:1.225

A port number and transaction body size is needed for this word. The port number is the DeviceNet scanner port that handles this transaction; an SLC 500 controller uses port 0 and the PLC-5 controller uses port 0 or 1. The size is the number of bytes (2 bytes = 1 word) in the transaction body which is 6 (6 bytes = 3 words).

Word M0:1.225

Port	**Size**
Port x 256 +	Size
0 x 256 +	6
6	

Word M0:1.226

A service code and MAC ID is needed for this word. The service code is the DeviceNet network service that can be used on the Class 4 assembly instances; these are the valid service codes.

- 14 = Get_Attributes_Single
- 16 = Set_Attributes_Single

The MAC ID is the node number of the device that the DeviceNet scanner is communicating to; this example uses node 5.

Word M0:1.226

Service		MAC ID
Service x 256	+	MAC ID
14 x 256	+	5
3589		

Word M0:1.227

The class number is the first word of the transaction body; class 4 is used to retrieve the real-time data assemblies.

Word M0:1.227

Class
4

Word M0:1.2278

The instance number is the second word of the transaction body; instance 14 is used to retrieve the real-time voltage, current, and frequency metering information.

Word M0:1.2278

Instance
14

Word M0:1.229

The attribute number is the third word of the transaction body; attribute 3 is used to get the metering information.

Word M0:1.229

Attribute
3

SLC 500 Sequencer Operation

This example uses a sequencer instruction and indirect addressing to optimize program operation.

During initialization of Run mode, the sequencer input file is loaded with the numbers corresponding to the two explicit message transfers to be performed. Once Run mode has begun, the ladder program remains in this mode.

TIP The speed at which the processor performs the messages may be altered by resetting the On-Delay timer that is located within the sequencer output rung. However, the availability of new data values is controlled by the power monitor table update rate.

Data Files Used

Data Files

Data File Address	Number of Elements	Description
N9	1	N9:0 Sequencer Output
N10	Variable	N10:0 Sequencer Input
R6:0		Sequencer Control
Message Read Data Table Locations		
(Control/Data)		
N20 / F30	14	Voltage/Current Data
N21 / F31	13	Real-Time Power
N22 / F32	13	Power Factor
N23 / N33	23	kWh and kVAh
N24 / N34	23	kVarh
N25 / F35	10	Demand
N26 / N36	27	Diagnostic

The reset word for the sequencer is N10:0. The first word in the rotation of the sequencer is N10:1. The value in N10:0 must be the same as that in N10:1. The size of file N10 is equal to the size of the largest sequencer input file. This size depends on the number of explicit message transfers to be performed. The sequencer length may be expanded or reduced for Run mode. It is imperative that the corresponding file that serves as the source of the sequencer's input file, N10, must be modified accordingly.

IMPORTANT	Failure to modify the length of file N10 for a modification of either the Configuration or Run sequence results in improper operation of the ladder program, and possible fault of the processor due to invalid indirect offsets.

File Data Values

Prior to running the sample ladder, the sequencer initialization file needs to be loaded with the numbers that correspond to the explicit message transfer sequence. The following is a list of each mode's initialization file and the required/possible numbers to be stored in each. The first value of a block transfer sequence must be duplicated in both position 0 and 1 of an initialization file.

N10 - Run Mode
Required numbers are 20, 20, 21, 22, 23, 24, 25, and 26.

N20:0
Required numbers are 5121, 6, 3589, 4, 14, 3

N21:0
Required numbers are 5377, 6, 3589, 4, 16, 3

N22:0
Required numbers are 5633, 6, 3589, 4, 18, 3

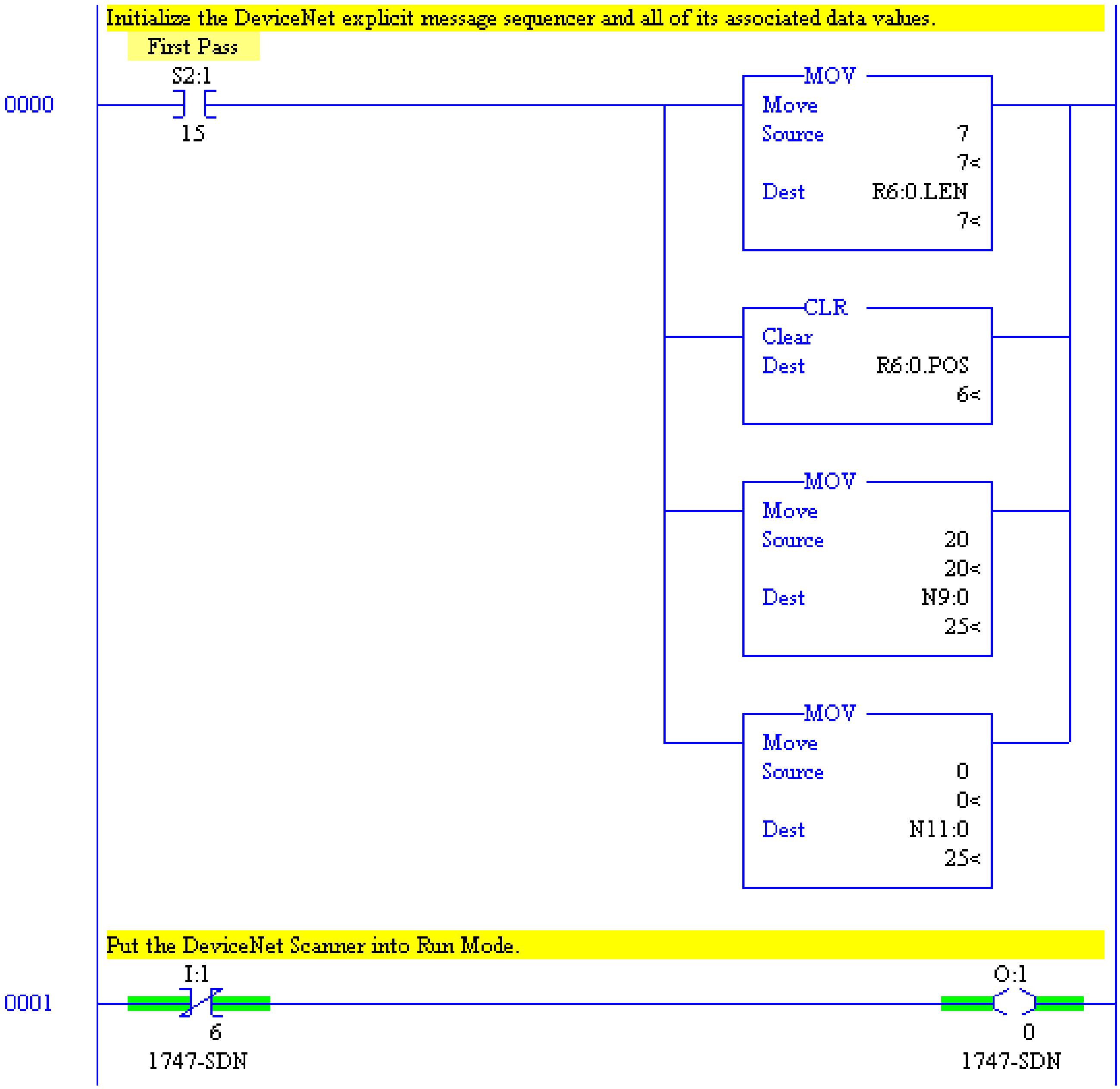
N23:0
Required numbers are 5889, 6, 3589, 4, 20, 3

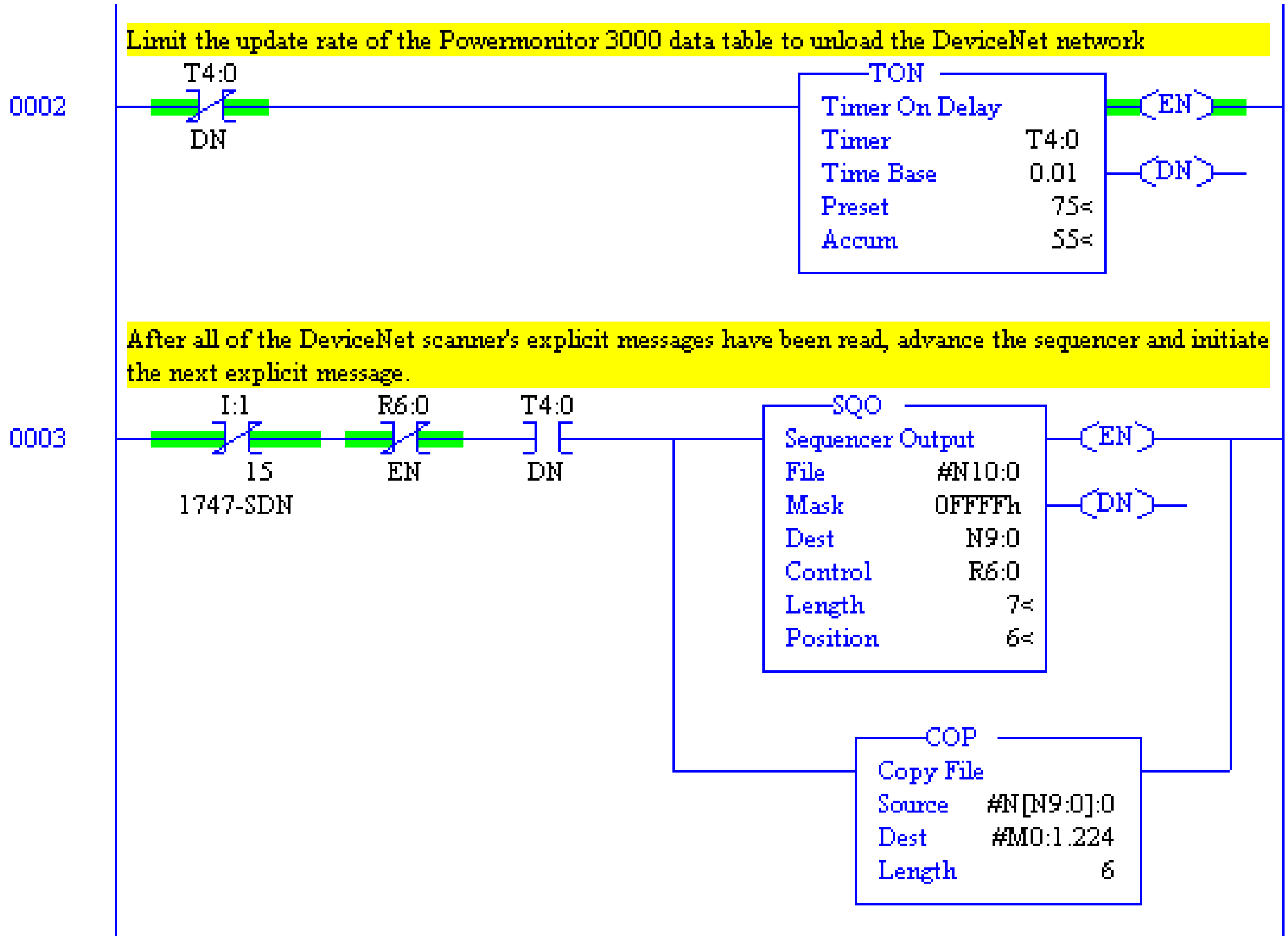
N24:0
Required numbers are 6145, 6, 3589, 4, 22, 3

N25:0
Required numbers are 6401, 6, 3589, 4, 17, 3

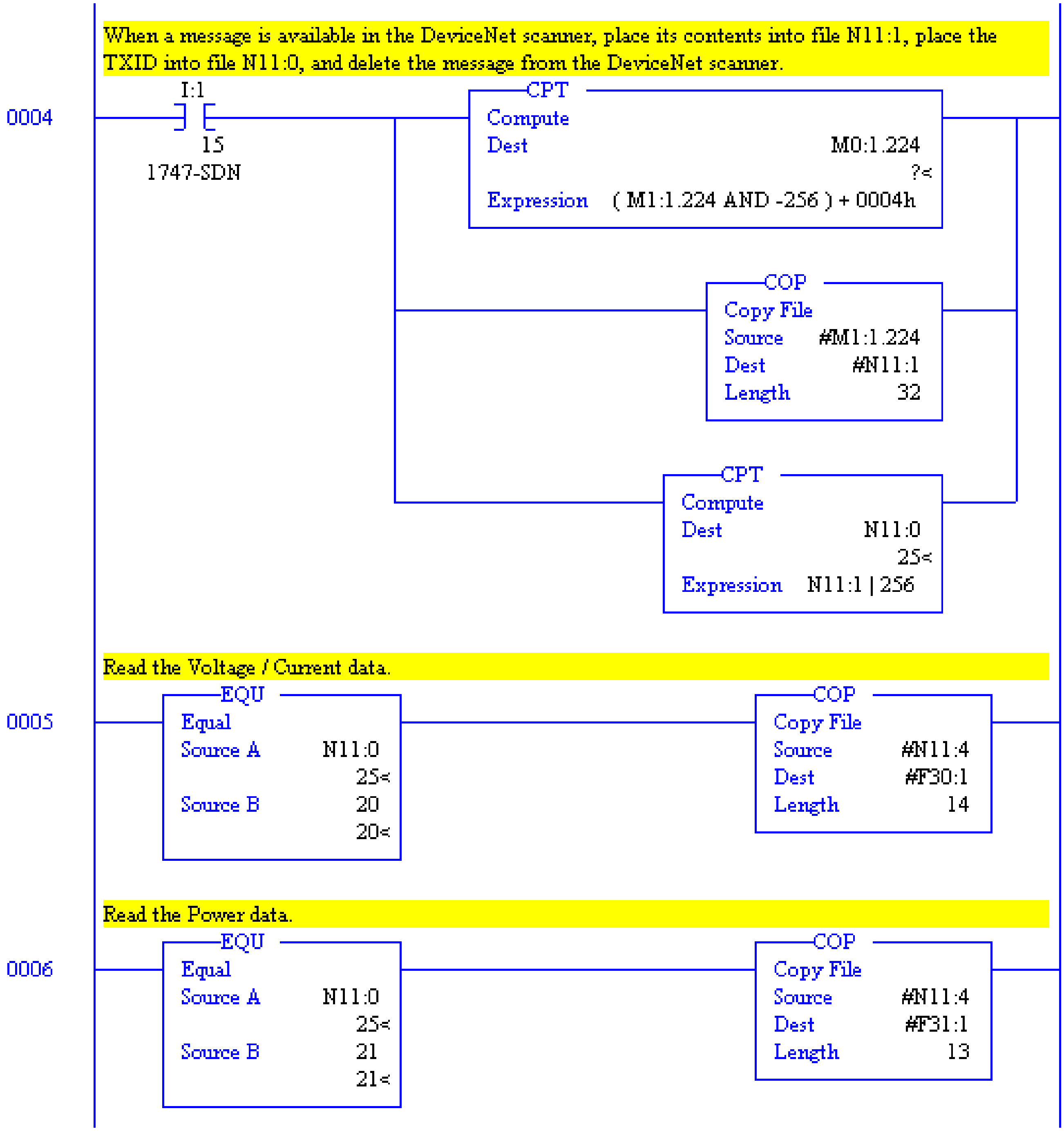
N26:0
Required numbers are 6657, 6, 3589, 4, 23, 3

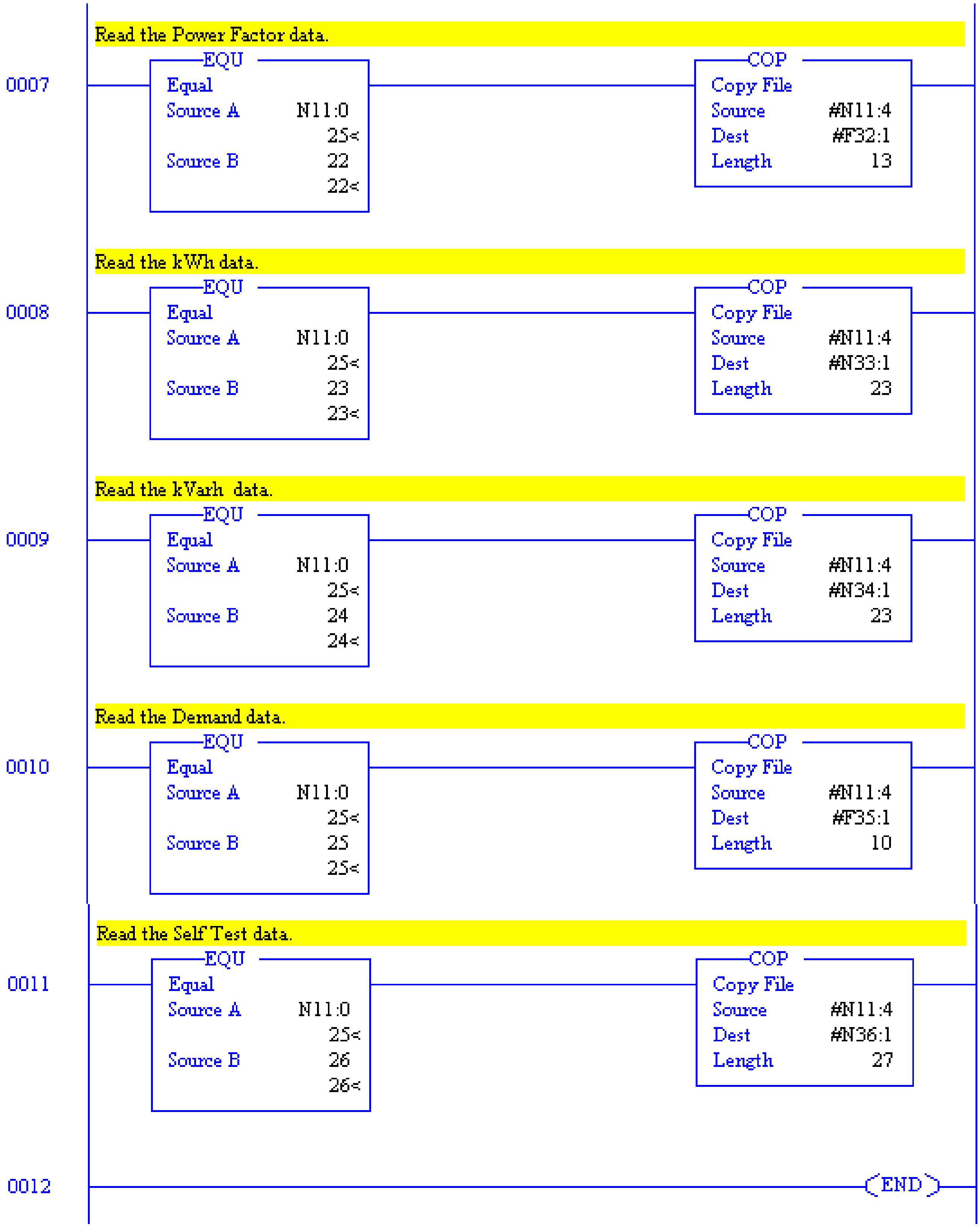
Ladder Diagram





Limit the update rate of the Powermonitor 3000 data table to unload the DeviceNet network
0002
T4:0
DN
TON
Timer On Delay
Timer T4:0
Time Base 0.01
Preset 75<
Accum 55<
EN
DN
After all of the DeviceNet scanner's explicit messages have been read, advance the sequencer and initiate the next explicit message.
0003
I:1
15
1747-SDN
R6:0
EN
T4:0
DN
SQO
Sequencer Output
File #N10:0
Mask 0FFFFh
Dest N9:0
Control R6:0
Length 7<
Position 6<
EN
DN
COP
Copy File
Source #N[N9:0]:0
Dest #M0:1.224
Length 6


When a message is available in the DeviceNet scanner, place its contents into file N11:1, place the TXID into file N11:0, and delete the message from the DeviceNet scanner.
0004
I:1
15
1747-SDN
CPT
Compute
Dest M0:1.224
?<
Expression (M1:1.224 AND -256) + 0004h
COP
Copy File
Source #M1:1.224
Dest #N11:1
Length 32
CPT
Compute
Dest N11:0
25<
Expression N11:1 | 256
Read the Voltage / Current data.
0005
EQU
Equal
Source A N11:0
25<
Source B 20
20<
COP
Copy File
Source #N11:4
Dest #F30:1
Length 14
Read the Power data.
0006
EQU
Equal
Source A N11:0
25<
Source B 21
21<
COP
Copy File
Source #N11:4
Dest #F31:1
Length 13


Read the Power Factor data.
0007
EQU
Equal
Source A N11:0
25<
Source B 22
22<
COP
Copy File
Source #N11:4
Dest #F32:1
Length 13
Read the kWh data.
0008
EQU
Equal
Source A N11:0
25<
Source B 23
23<
COP
Copy File
Source #N11:4
Dest #N33:1
Length 23
Read the kVarh data.
0009
EQU
Equal
Source A N11:0
25<
Source B 24
24<
COP
Copy File
Source #N11:4
Dest #N34:1
Length 23
Read the Demand data.
0010
EQU
Equal
Source A N11:0
25<
Source B 25
25<
COP
Copy File
Source #N11:4
Dest #F35:1
Length 10
Read the Self Test data.
0011
EQU
Equal
Source A N11:0
25<
Source B 26
26<
COP
Copy File
Source #N11:4
Dest #N36:1
Length 27
0012
END

User-configured Data Table Setup by Using ControlLogix and EtherNet/IP Networks

This example shows a ladder program designed to customize the User-configured Data Table in a power monitor by using a ControlLogix controller via its EtherNet/IP Bridge (1756-ENET/B).

Use of the user-configured data table to consolidate parameters from different power monitor data tables can increase the efficiency of communication. The following example and ladder listing use these settings:

- IP Address: 130.151.70.173
- Subnet mask: 255.255.0.0
- Message type: PLC-5 Typed Read

Sample Program Operation

The ladder program is executed within a continuous task. This sample logic reads and saves the existing User Configured Data Table setup file from the power monitor to permit an Undo operation. You must create tags listed in the ControlLogix Tags Used table on page 315 and enter data correctly to configure the power monitor User Configurable Data Table successfully.

The Start flag begins the logic execution. The Select tag's value determines which configuration is written to the power monitor.

- 0 - Default table setup
- 1 - Custom table setup
- 2 - Undo the last write

First, the logic reads the existing setup table from the power monitor and saves it in the Old tag. After a brief delay, it writes the selected setup table. If the number of parameters in the User Configured Data Table changes, the power monitor resets. After another delay, the write status table is read and if it indicates a successful write, the Success flag is set.

The message configuration for writing the new configuration table to the power monitor is shown below. Note the instance name is the lower of the two values given in the Summary of Powermonitor 3000 Data Tables for all Communication Options table on page 188. Service code 10 (hex) is for a write Set_attribute_single.

ControlLogix Tags Used

Tag Name	Type	# of Elems	Description	Table #
msgReadOld	MESSAGE	N/A	Read Existing Config	N30
msgWriteNew	MESSAGE	N/A	Write New Config.	N30
msgGetStatus	MESSAGE	N/A	Write Status	N32
Start	BOOL	1	Start Operation	
Failed	BOOL	1	Failure Flag	
Success	BOOL	1	Success Flag	
Oneshot_1	BOOL	1	One shot	
Oneshot_2	BOOL	1	One shot	
Timer1	TIMER	1	Inter-message Delay	
Timer2	TIMER	1	PM3000 Reset Time	
Counter1	COUNTER	1	Message Retry	
Default	INT	26	Default Configuration	
Custom	INT	26	Custom Configuration	
Old	INT	26	Previous Config	
Download	INT	26	New Config to Write	
Pwd	INT	1	PM3000 Password	
Status	INT	2	Write Status	
Select	INT	1	User Selection	

You must enter data into the Default and Custom tags.

Refer to User-configured Data Table on page 121 for the structure and rules for the User-configured Table Setup data table and its default settings.

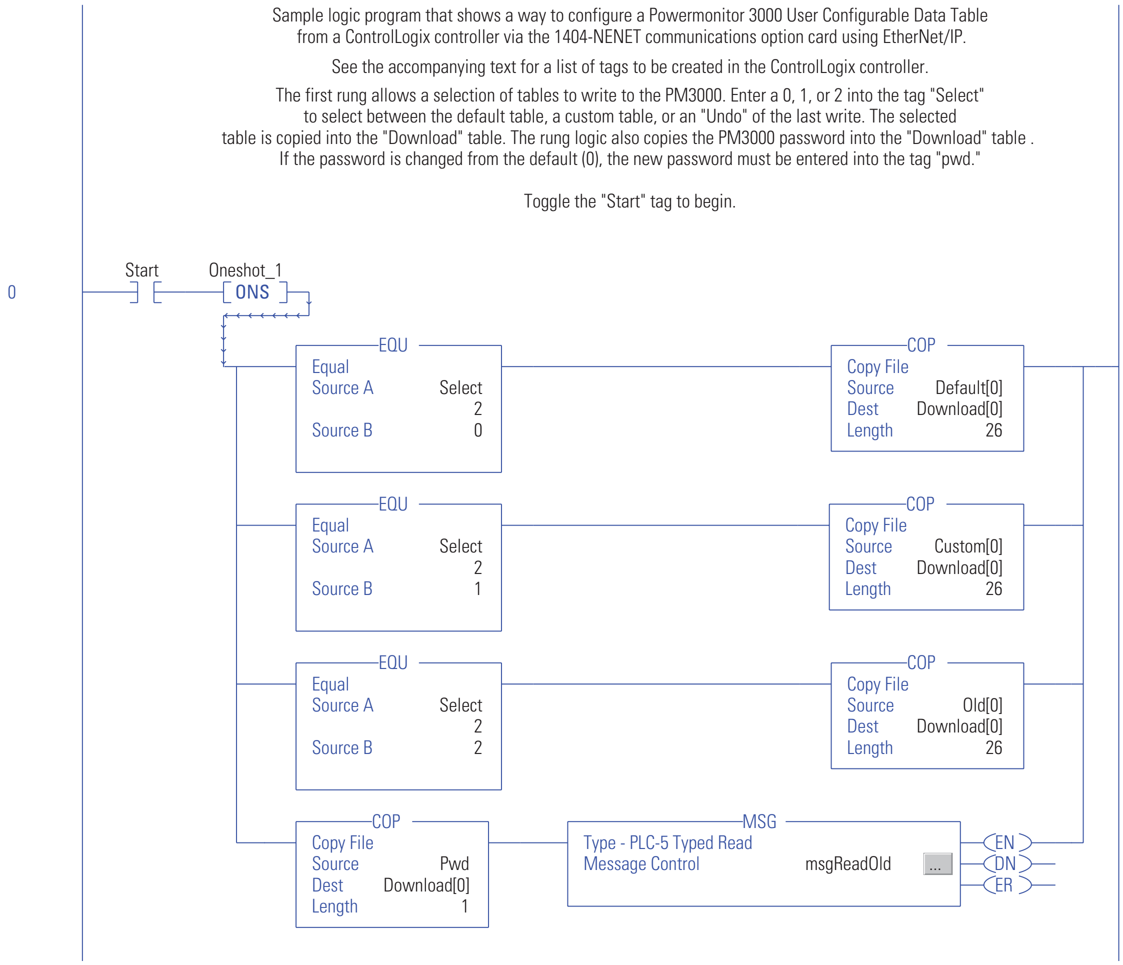
See Parameters for Trend Log and Configurable Table Parameters on page 268 for parameters that may be included in the User Configured Table Setup.

IMPORTANT

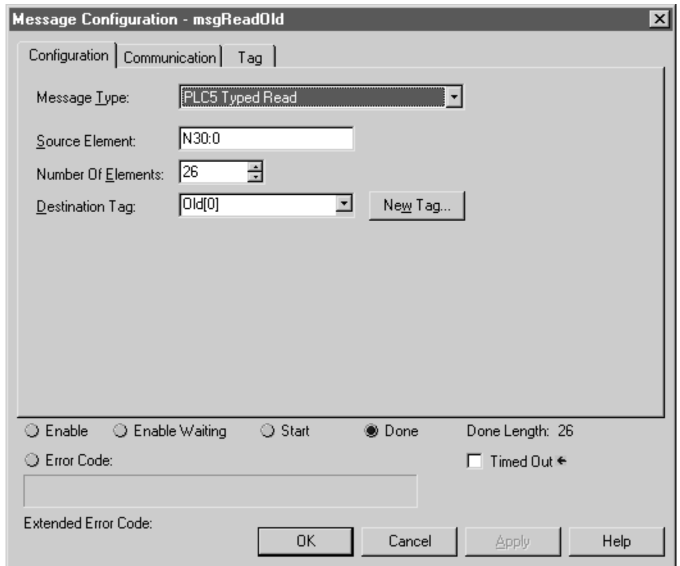
Words 0…3 of the User Configurable Table Setup array must have specific values.

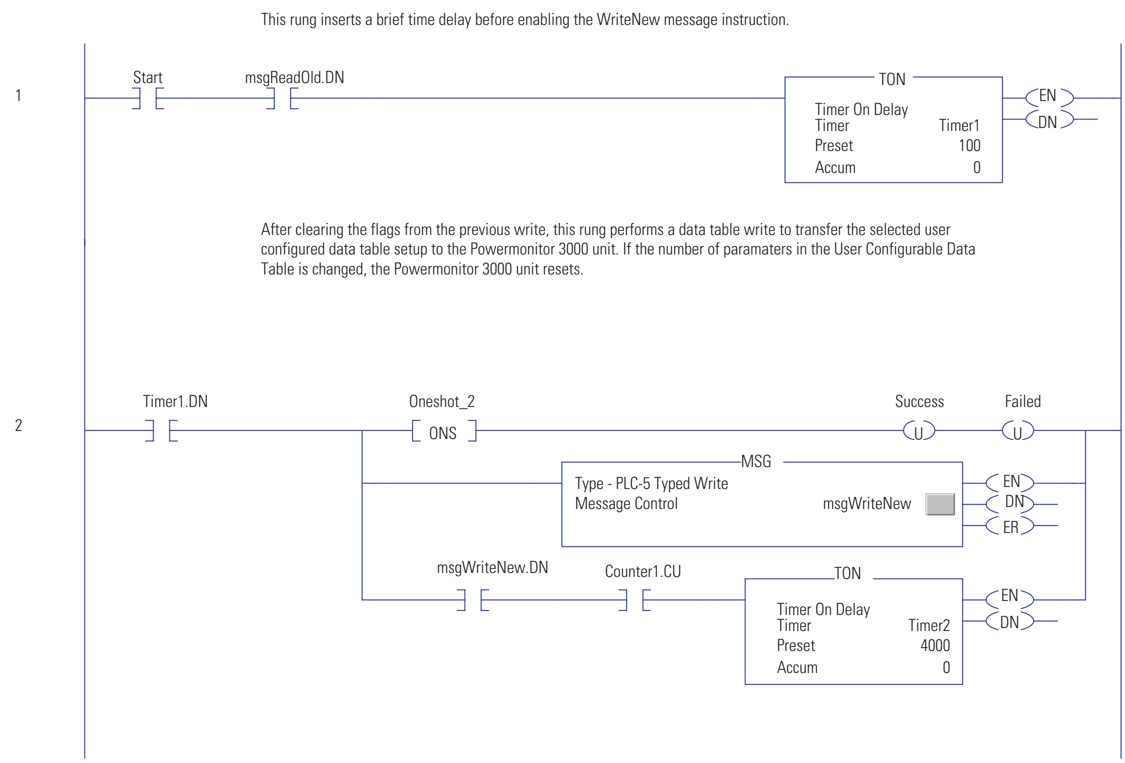
- Word 0: power monitor password (default = 0)
- Word 1 must be one of the following decimal values:
  - 31, for CSP/PCCC
  - 1 or 37 for CIP
- Word 2: zero (0) for writes to table 31. For configuring instance 1: 0 = all integer or data type, 1 = float data type.
- Word 3: between 1 and 295 incl.

Ladder Diagram

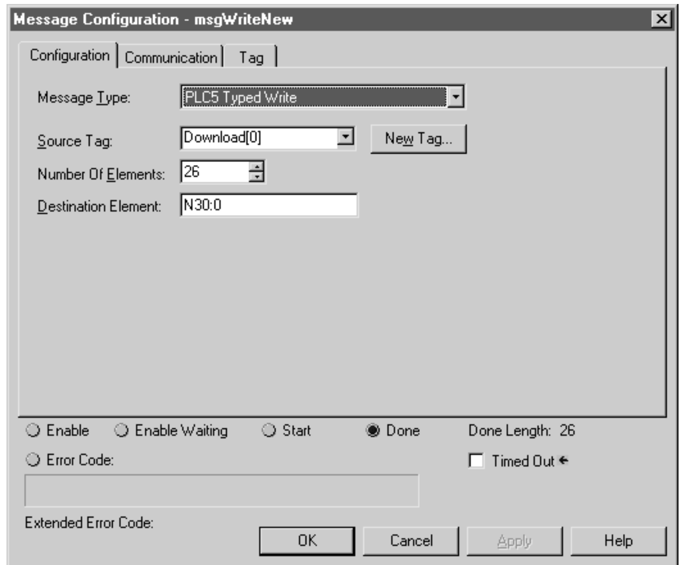


The message configuration for the ReadOld message is shown below.

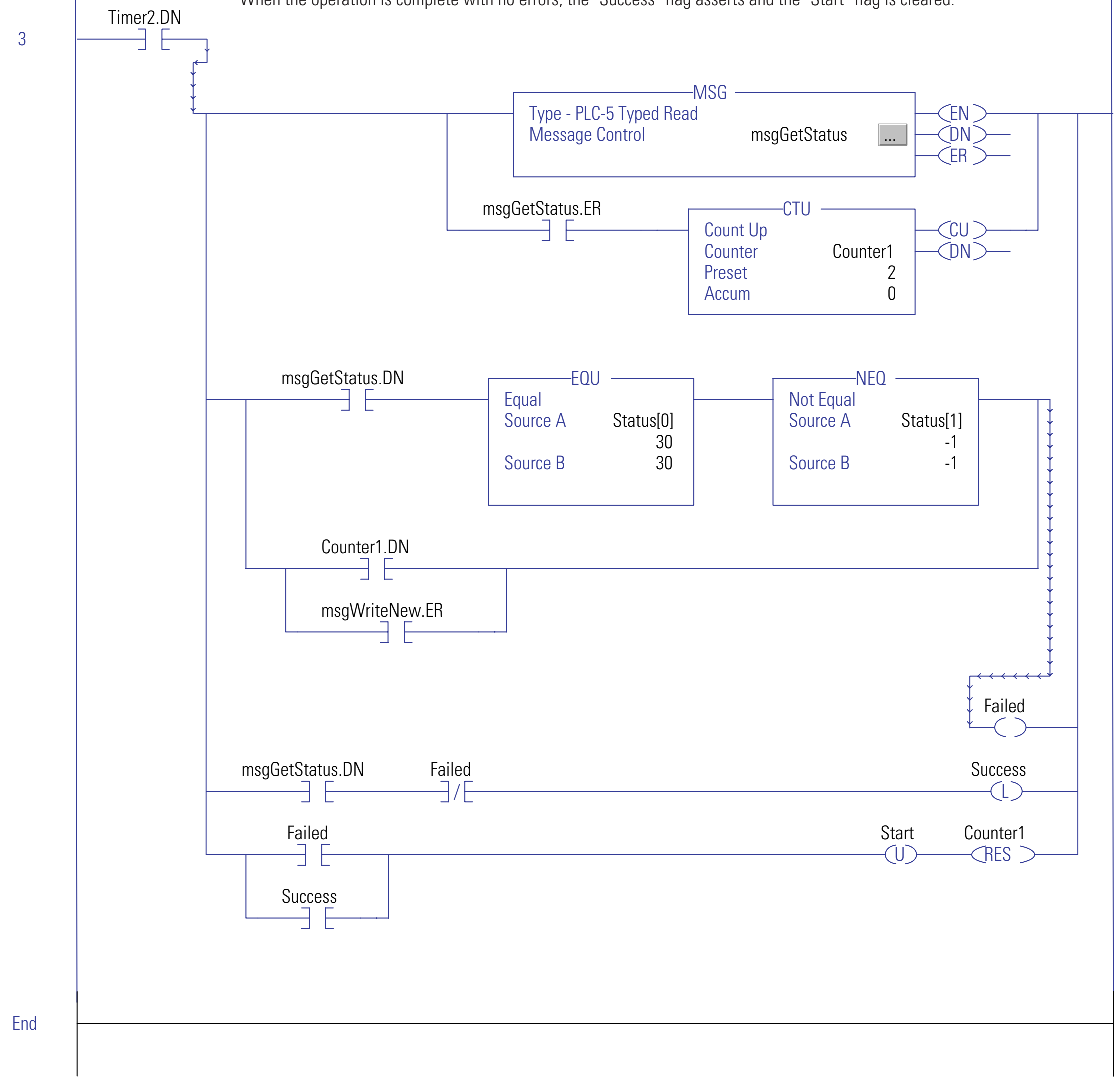




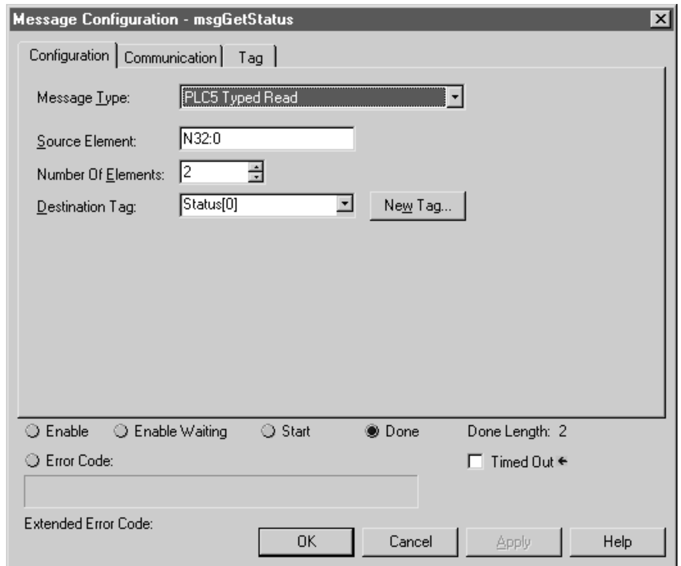
The message configuration for writing the new configuration table to the power monitor is shown below.



Timer2 delays evaluating the write status until the Powermonitor 3000 unit has reset.
This rung evaluates the results of writing the new configuration.
The "Failed" flag asserts if the WriteNew message instruction errors-out, or if the GetStatus instruction errors out twice, or if the write status indicates bad data in the download table. If there is a bad data indication, verify that word 0 of the download table is the correct Powermonitor 3000 password, that word 1 is a value of 31 (decimal) and that at least one or more words beginning with word 3 are non-zero. Then try toggling "start" again.
Counter1 increments if the GetStatus message errors out. The logic will wait until Timer2 times out and then retry the GetStatus message.
When the operation is complete with no errors, the "Success" flag asserts and the "Start" flag is cleared.



The message configuration for the GetStatus message is shown below.



Communicating with a SLC 5/05 (1747-L552) Controller and ControlNet Scanner (1747-SCNR), Unscheduled Messaging

The Power Energy and Management Systems development team tested the following example ladder. The scan times for execution of the ladder are as follows.

Operation	Scan Time
Table reads for Integer and float files	20 ms
Table writes of Integer and float files	30 ms

All the communication operations of the ladder are locked out until the read or write bits are set. This was done so that other operations performed by the ladder will have minimum overhead from communication. The following files are of importance when using the ladder example.

N7 SCNR_FILE

The following items are of importance in file N7:0.

File N7:0

Bit #	Importance N7:0	Read/Write
N7:0/15	EN - Written to by the ladder to enable communication transaction.	R/W
N7:0/14	Unused	N/A
N7:0/13	DN bit - Response received	R
N7:0/12	ER bit - Error bit returned form SCNR scanner	R
N7:0/11	CO - Continuous mode Not used	N/A
N7:0/10	EW - Message taken into account by 1747 - SCNR scanner	R
N7:0/9	SUCCESS - Used by ladder for notification of successful communication transfer.	R
N7:0/8	TO - The message transaction has timed out.	R

While other words in the N7 SCNR_FILE are important to communication these values are copied from file N9 CIP_SETUP to file N7.

N9 CIP_SETUP

This file is the CIP message setup file. The importance of the following words should be noted.

N9 CIP

Word #	Description of Function
N9:0	Not used by CIP_SETUP.
N9:1	Target MAC ID (Power monitor MAC ID)
N9:2	Communication transaction timeout setting in ms. (2048 recommended)
N9:3	Complex IOI size. Not used and set to 0.
N9:4	Service code. 0xE for Get Attribute Single or 0x10 Set Attribute single.
N9:5	Class code of Instance Object. Power monitor class 4 assembly instance.(4)

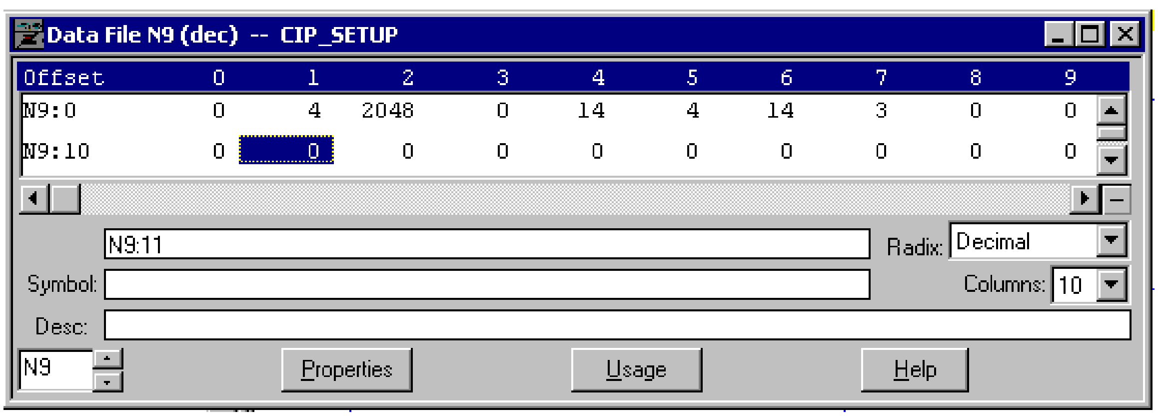
N9 CIP

Word #	Description of Function
N9:6	Targets Instance number to read or write.
N9:7	Target Attribute. Power monitor Attribute of assembly instance is 3. (3)
N9:8	Target member number. (Not used)
N9:9	Size of the data in words. Used for writes only. When performing a read operation this parameter is forced to 0. Size of Power monitor tables is type N = elements x 1, type F = elements x 2.
N9:10	Not used by CIP_SETUP.
N9:11	Enables a read/write operation. Writing a 1 starts the process for writing an assembly instance of the power monitor. Writing a 2 starts the read process of assembly instance from the power monitor.

Receiving Information from the SCNR Scanner

Observe the sample of the CIP_SETUP file for the retrieval of VIF table assembly instance 14 of the power monitor.

CIP Setup File



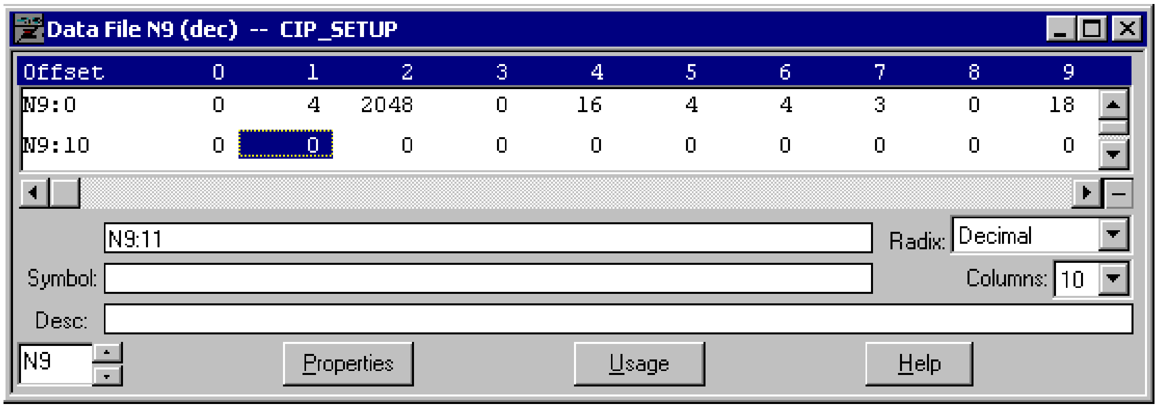
After setting up the communication parameters a 2 is written to location of N9:11. The transaction is complete when bit N7:0/9 becomes true. The information will be located in file F8, FLT_DATA starting at location 0. The length of usable information is the length of elements in table instance 14 VIF table of the power monitor.

TIP When receiving integer information from the power monitor the data will be readable from file number N10 INT_DATA. The length is the number of elements in the assembly instance being read.

Writing Information through the SCNR Scanner

Observe the sample of the CIP_SETUP file for the writing the configuration of the basic configuration table Instance 4 of the power monitor.

CIP Setup File



TIP The write procedure differs slightly from the read process. N9:4 service has been changed to 0x10 or 16 decimal (Set Single Attribute). N9:6 is the write instance assembly number of the power monitor basic configuration table. N9:9 is the size of the table in words for a 1404-M805A-CNT A. The size for float tables is two times the number of elements. Integer tables are one times the size of the table elements.

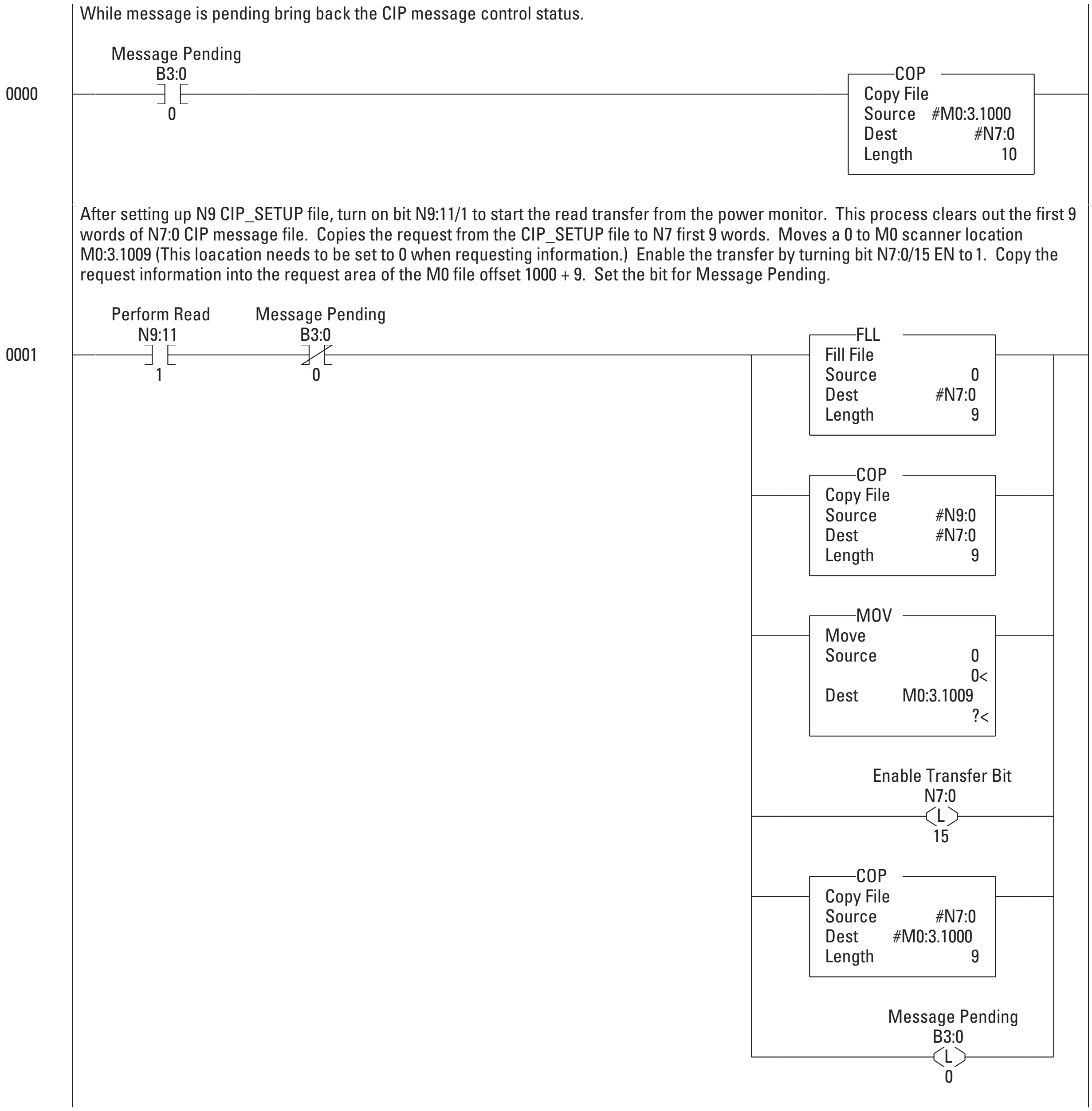
When a 1 is written to location N9:11 the contents of file F13 WR_TRANSFR are sent to the power monitor. In this case starting with float F13:0 through F13:8.

The writing of an integer file sends the contents of N14 WR_TRANSFR.

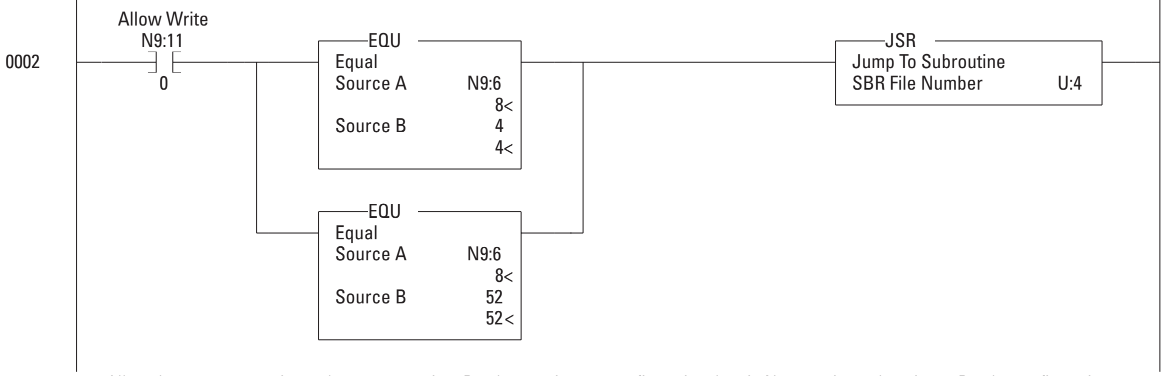
For further reading on the functionality of the 1747-SCNR scanner refer to the user manual, publication 1747-RM623.

Power Monitor Ladder Example for SLC Scanner Module through SCNR

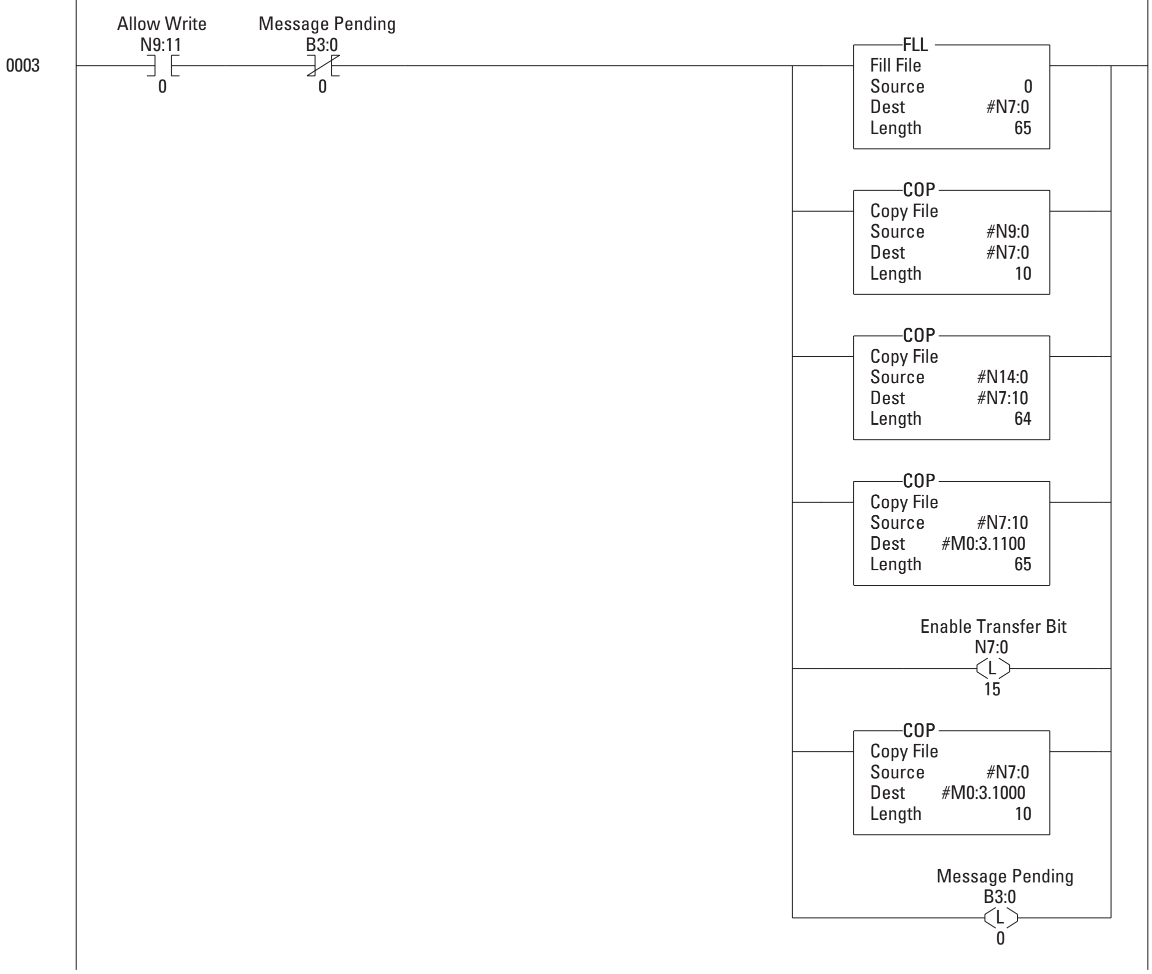
Power Monitor with SLC Scanner Module



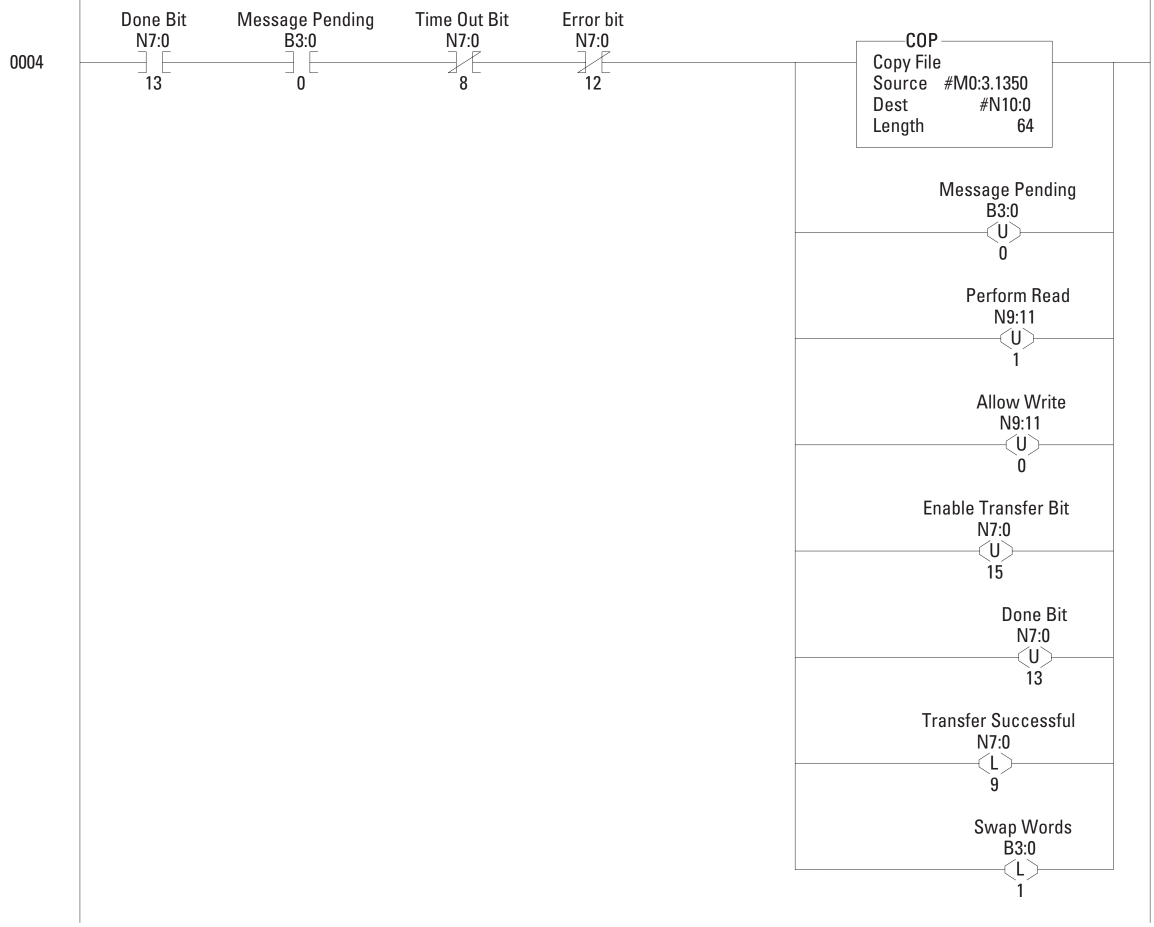
When a write of a float file is being performed it is necessary to swap the words in teh float file before sending the write request. This is only necessary for Instance 4 or Instance 52.

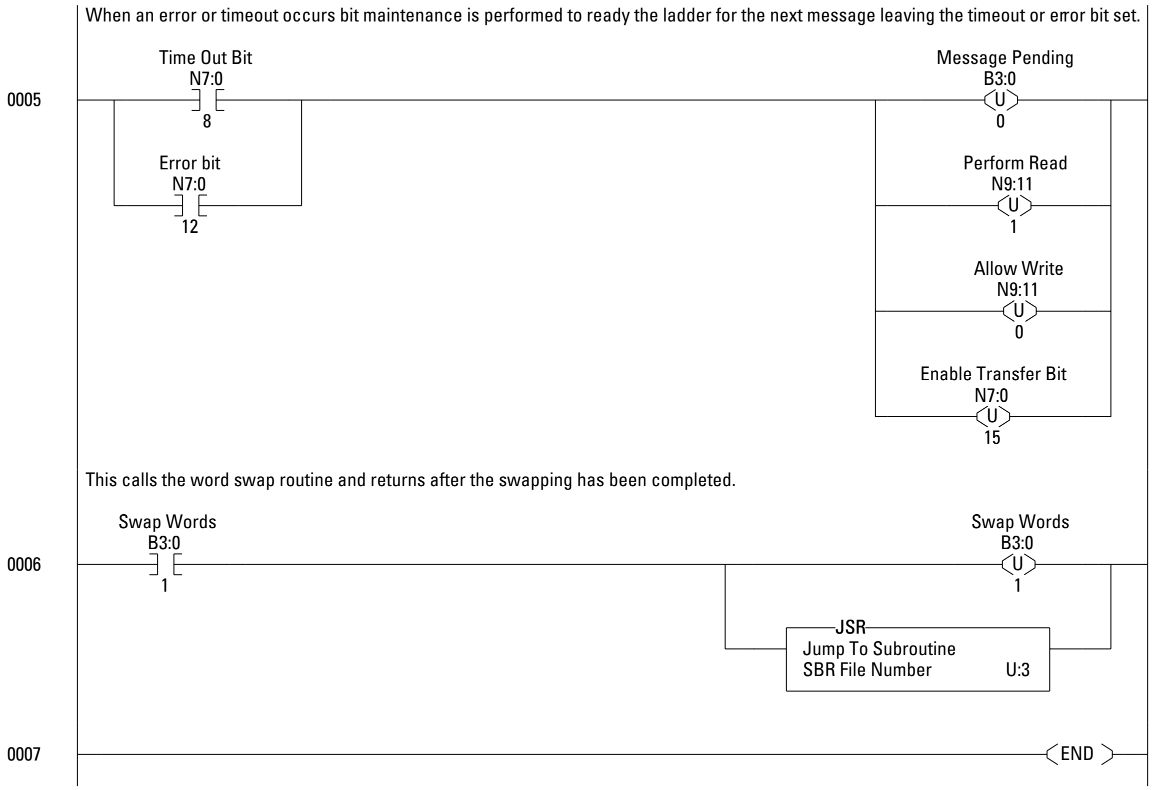


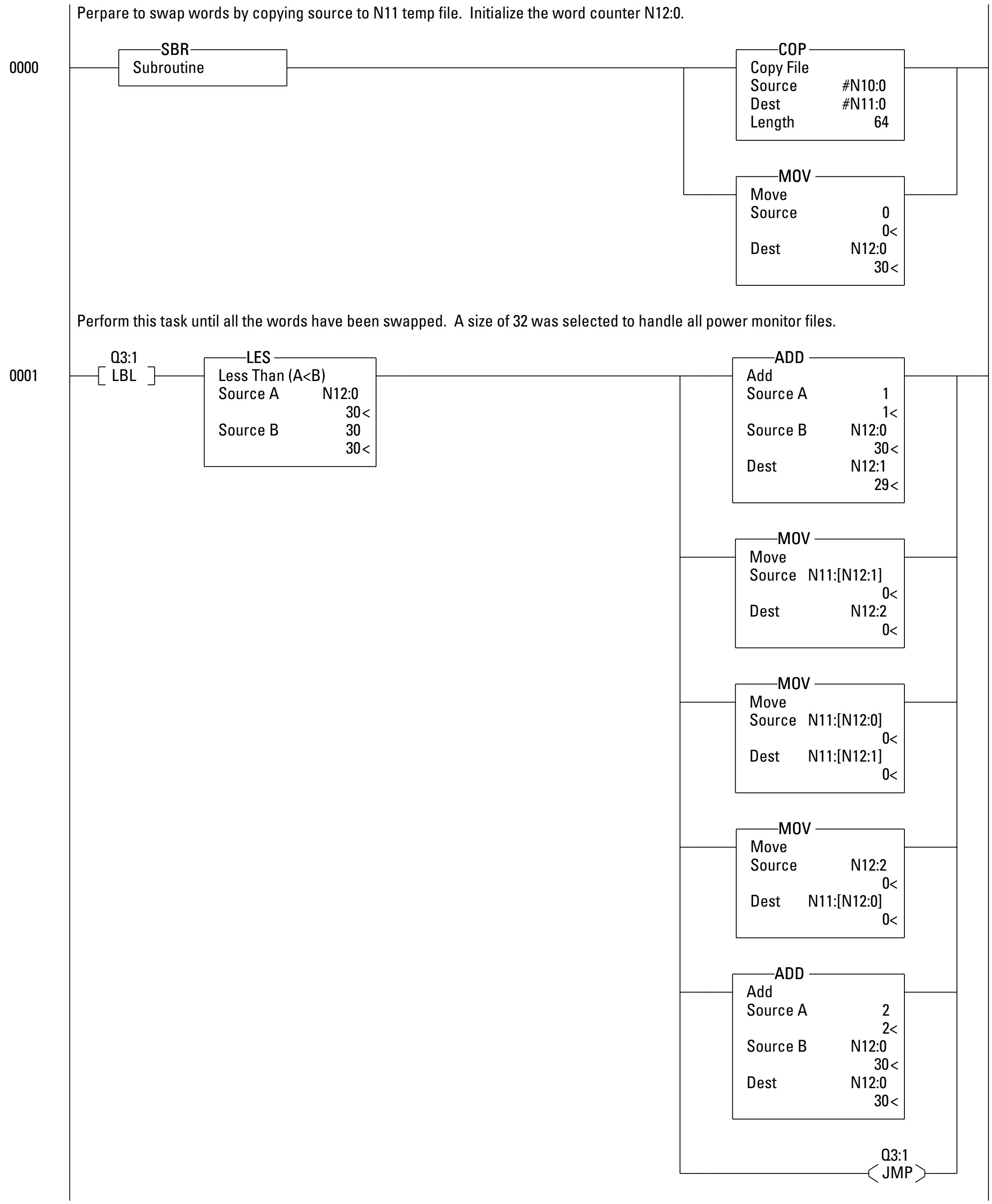
Allow the scanner to write to the power monitor. Put the new integer configuration data in N14 starting at location 0. Put the configuration if it is of float type in file F13 starting with word 0. Enter the rest of the CIP message information needed for transfer in N9 starting with word 0. The process is similar to the request of information except that the size in words of the data to write is to appear in N7:9 and the service to be performed is changed.

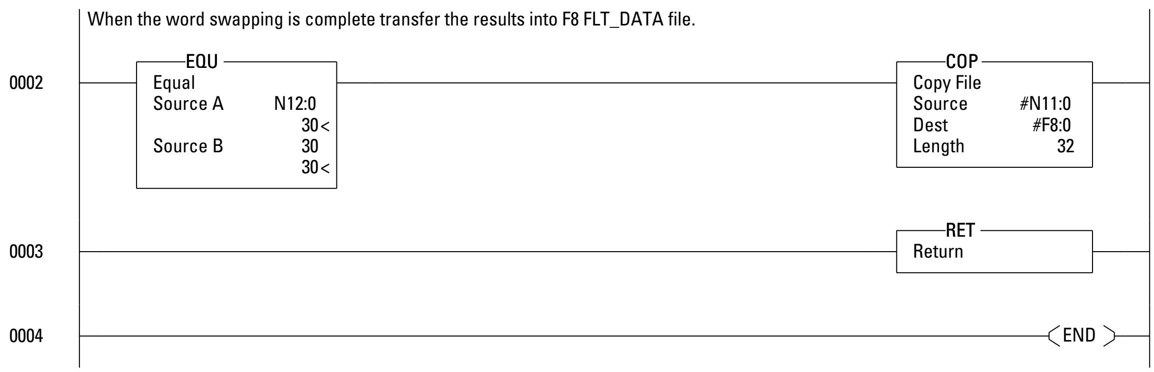


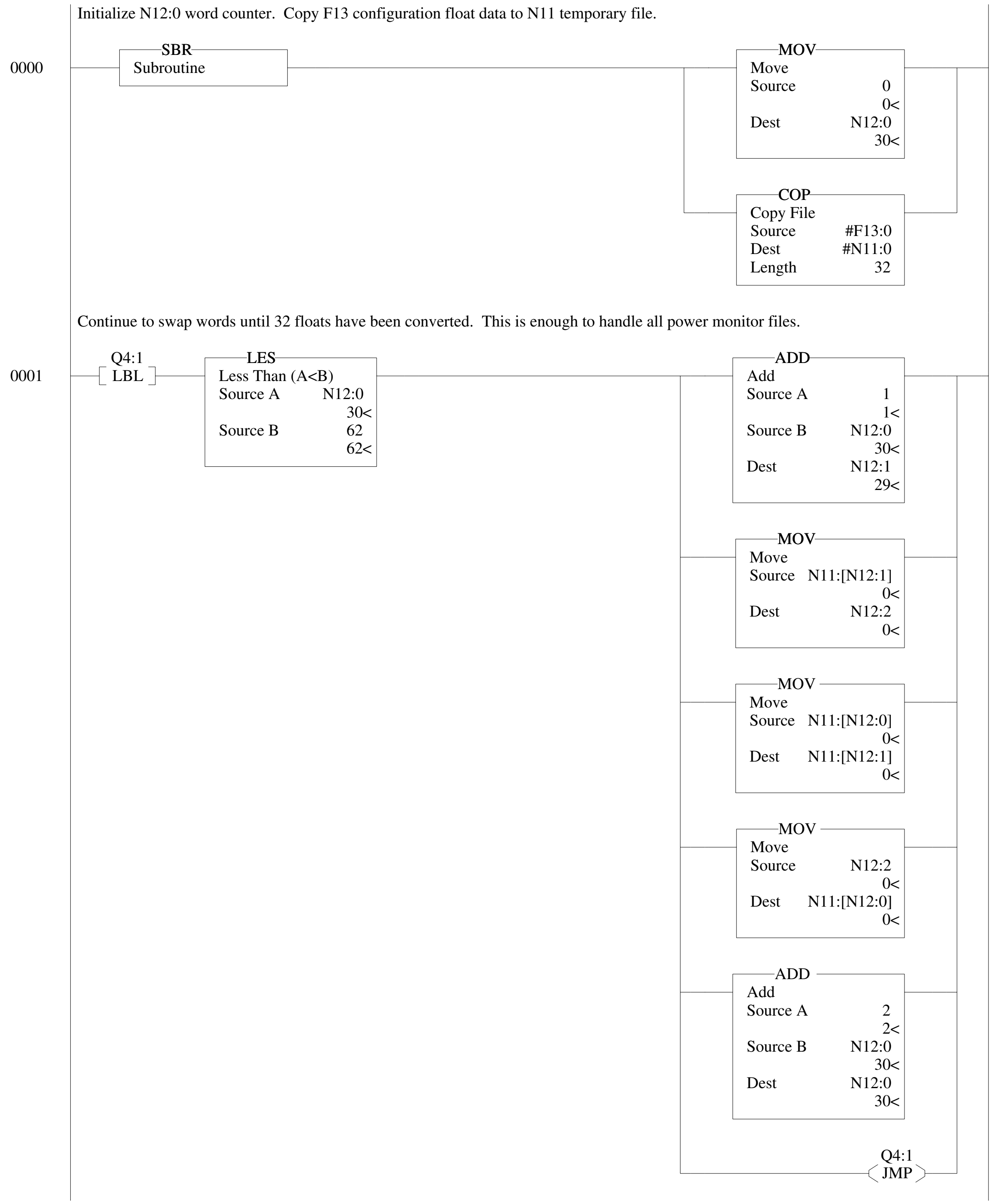
This rung looks for the done bit with no errors. When the done bit is received the return information is tranfered and mainten ance is performed. Integer information can be read from file N10:0. Float information can be read from F8:0. The enable and done bit s are turned off and the bit N7:9 is latched to notify the user that the transfer was successful. Bit B3:0/1 is set to transfer any floats to the F8:0 file after swapping words from the incomming message.

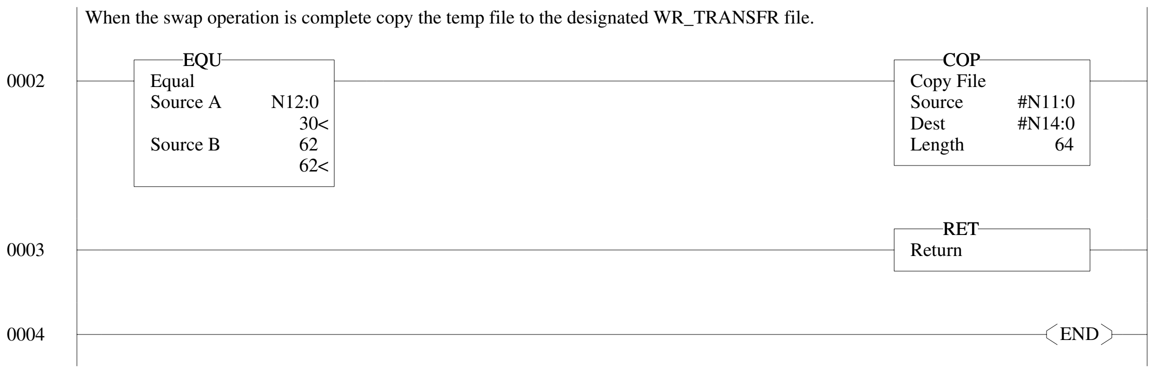



When an error or timeout occurs bit maintenance is performed to ready the ladder for the next message leaving the timeout or error bit set.
0005
Time Out Bit
N7:0
8
Error bit
N7:0
12
Message Pending
B3:0
U
0
Perform Read
N9:11
U
1
Allow Write
N9:11
U
0
Enable Transfer Bit
N7:0
U
15
This calls the word swap routine and returns after the swapping has been completed.
0006
Swap Words
B3:0
1
Swap Words
B3:0
U
1
JSR
Jump To Subroutine
SBR File Number U:3
0007
END


Perpare to swap words by copying source to N11 temp file. Initialize the word counter N12:0.
0000
SBR
Subroutine
COP
Copy File
Source #N10:0
Dest #N11:0
Length 64
MOV
Move
Source 0
0<
Dest N12:0
30<
Perform this task until all the words have been swapped. A size of 32 was selected to handle all power monitor files.
0001
Q3:1
LBL
LES
Less Than (A<B)
Source A N12:0
30<
Source B 30
30<
ADD
Add
Source A 1
1<
Source B N12:0
30<
Dest N12:1
29<
MOV
Move
Source N11:[N12:1]
0<
Dest N12:2
0<
MOV
Move
Source N11:[N12:0]
0<
Dest N11:[N12:1]
0<
MOV
Move
Source N12:2
0<
Dest N11:[N12:0]
0<
ADD
Add
Source A 2
2<
Source B N12:0
30<
Dest N12:0
30<
Q3:1
JMP


When the word swapping is complete transfer the results into F8 FLT_DATA file.
0002
EQU
Equal
Source A N12:0
30<
Source B 30
30<
COP
Copy File
Source #N11:0
Dest #F8:0
Length 32
0003
RET
Return
0004
END


Initialize N12:0 word counter. Copy F13 configuration float data to N11 temporary file.
0000
SBR
Subroutine
MOV
Move
Source 0
0<
Dest N12:0
30<
COP
Copy File
Source #F13:0
Dest #N11:0
Length 32
Continue to swap words until 32 floats have been converted. This is enough to handle all power monitor files.
0001
Q4:1
LBL
LES
Less Than (A<B)
Source A N12:0
30<
Source B 62
62<
ADD
Add
Source A 1
1<
Source B N12:0
30<
Dest N12:1
29<
MOV
Move
Source N11:[N12:1]
0<
Dest N12:2
0<
MOV
Move
Source N11:[N12:0]
0<
Dest N11:[N12:1]
0<
MOV
Move
Source N12:2
0<
Dest N11:[N12:0]
0<
ADD
Add
Source A 2
2<
Source B N12:0
30<
Dest N12:0
30<
Q4:1
JMP



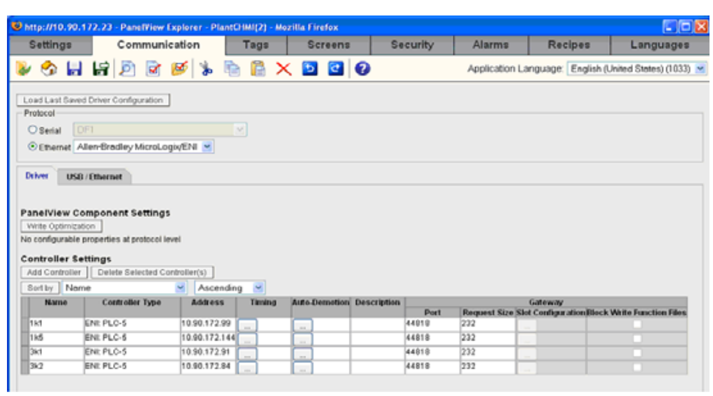
PanelView Component HMI and EtherNet/IP Communication Network

This example demonstrates reading and writing power monitor date, time, and other configuration parameters by using a PanelView Component HMI terminal, the single element password write, and the EtherNet/IP communication network.

Please refer to applicable product literature for information on configuration and use of the PanelView Component HMI terminal. Illustrations in this example were made using a Firefox 2.*x* browser. The power monitor master module firmware must be version 4.*x* or later and PanelView Component HMI firmware must be version 1.11 or later. Power monitor Ethernet protocol selection may be either CIP or CIP/CSP.

CHMI Communications Setup

In this example, controller 3k1 is a Powermonitor 3000 unit with IP address 10.90.172.91. It is configured with controller type Allen-Bradley MicroLogix/ENI:PLC-5.



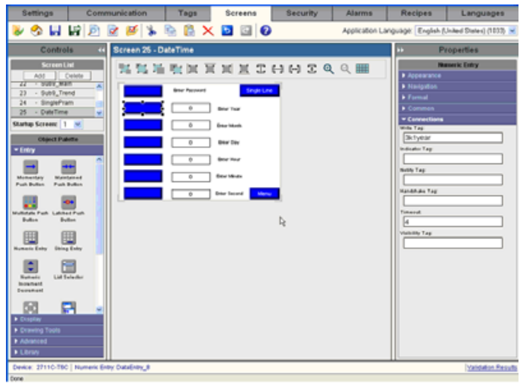
Tag Configuration

This example includes the following tags.

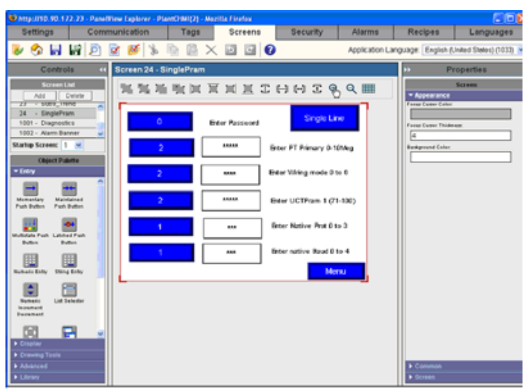
Name	Address	Data type
Year	N11:1	16 bit Integer
Month	N11:2	16 bit Integer
Day	N11:3	16 bit Integer
Hour	N11:4	16 bit Integer
Minutes	N11:5	16 bit Integer
Seconds	N11:6	16 bit Integer
Voltage Mode	F10:1	Real
Voltage Primary	F10:2	Real
User Config Table Parm 1 Setup	N30:3	16 bit Integer
Native Comms Protocol	N13:1	16 bit Integer
Native Comms Baud Rate	N13:3	16 bit Integer
Single Element Password	N60:0	16 bit Integer

Example Screens

The first example screen lets you read and write date and time to and from the power monitor. Entering the correct password (default = 0) permits single element writes until 30 minutes of inactivity has elapsed.



The second example is a screen that may be used to view and set selected configuration parameters in the power monitor.



Technical Specifications

Product Approvals

Powermonitor 3000 units have the following approvals and certifications.

EtherNet/IP Conformance Testing

All products equipped with an EtherNet/IP communication port bear the mark shown below. This mark indicates the power monitor unit has been tested at an Open Device Vendor Association (ODVA) independent test lab and has passed the EtherNet/IP conformance test. This test provides a level of assurance that the power monitor will interoperate with other conformance tested EtherNet/IP devices (including devices from other vendors). Two representative devices from the power monitor EtherNet/IP family of devices; the 1404-M405A-ENT B and the 1404-M8805A-ENT B have been tested by ODVA using EtherNet/IP Conformance Test version A2.8. The ODVA website (http://www.odva.org) maintains a list of products that have passed the conformance test at one of their test labs.

EtherNet/IP conformance tested

ControlNet Conformance Testing

All products equipped with a ControlNet communication port bear the mark shown below. This mark indicates the power monitor has been tested at a ControlNet International (CI) independent test lab and has passed the ControlNet conformance test. This test provides a level of assurance that the power monitor will interoperate with other conformance tested ControlNet devices (including devices from other vendors). Two representative device from the power monitor ControlNet family of devices; the 1404-M405A-CNT A and the 1404-M805A-CNT A have been tested by CI using ControlNet Conformance Test version 12. The CI website (http://www.ControlNet.org) maintains a list of products that have passed the conformance test at one of their test labs.

ControlNet Conformance Tested

UL/CUL

UL 508 listed, File E96956, for Industrial Control Equipment and CUL Certified.

CE Certification

If this product bears the CE marking, it is approved for installation within the European Union and EEA regions. It has been designed to meet the following directives.

EMC Directive

This product is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) and the following standards, in whole, documented in a technical construction file:

- EN 50081-2 - Generic Emission Standard, Part 2 - Industrial Environment
- EN 50082-2 - Generic Immunity Standard, Part 2 - Industrial Environment

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of IEC 1010-1.

This equipment is classified as open equipment and must be installed (mounted) in an enclosure during operation as a means of providing safety protection.

International Standard IEC 529 / NEMA / UL 508 Degree of Protection

The Bulletin 1404 master module is rated as IP10 degree of protection per International Standard IEC 529. It is considered an open device per NEMA and UL 508.

The Bulletin 1404 display module is rated as IP65 degree of protection per International Standard IEC 529. It is rated as Type 4 (Indoor) per NEMA and UL 508.

Follow the recommended installation guidelines to maintain these ratings.

ANSI/IEEE Tested

Meets or exceeds the Surge Withstand Capability (SWC) C37.90.1 - 1989 for protective relays and relay systems on all power connection circuit terminations.

Technical Specifications

The Powermonitor 3000 unit has these specifications.

Measurement Accuracy and Range

See table below for the rating of each parameter

Measurement Accuracy and Range

Parameter	Accuracy in % of Full Scale at +25 °C (77 °F 50/60 Hz Unity Power Facator				Nominal/Range
	M4	M5	M6	M8	
Voltage Sense Inputs: V1, V2, V3	±0.2%	±0.05%	±0.05%	±0.05%	347V/15…399V $_{L-N}$ RMS 600V/26…691V $_{L-L}$ RMS
Current Sense Input: I1, I2, I3, I4	±0.2%	±0.05%	±0.05%	±0.05%	5 A/50 mA – 10.6A RMS
Frequency	±0.05 Hz	±0.05 Hz	±0.05 Hz	±0.05 Hz	50 or 60 Hz/40…75 Hz
Power Functions: kW, kVA, kVAR Demand Functions: kW, kVA Energy Functions: kWH, kVAH	ANSI C12.16 and EN 61036 Class 1 Accuracy	ANSI C12.20 and EN 60687 Class 0.5 Accuracy (Class 0.2 is also available)	ANSI C12.20 and EN 60687 Class 0.5 Accuracy (Class 0.2 is also available)	ANSI C12.20 and EN 60687 Class 0.5 Accuracy (Class 0.2 is also available)	
Metering Update Rates	55…80 ms	45…70 ms	45…75 ms	40…90 ms	

General Input, Output, and Environmental Ratings

Input and Output Ratings

Control Power	1404-xxxxA-xxx	102…264V ac 47…63 Hz or 106…275V dc (0.2 A max loading)
	1404-xxxxB-xxx	18…50V dc (15V A max loading)
Voltage Sense Inputs: V1, V2, V3	Input Impedance: 1 Mohm min, 399V ac max; V1, V2 and V3 to N.	
Current Sense Inputs: I1, I2, I3, I4	Overload Withstand: 15 A Continuous, 200 A for 1 s Burden: 0.05V A Impedance: 0.002 ohms Maximum Crest Factor at 5 A is 3 Starting Current: 5 mA	
Status Inputs	Contact Closure (Internal 24V dc)	
Control Relay KYZ Output	(1) ANSI C37.90-1989 trip duty (1) Solid State KYZ - 80 mA at 240…300V dc	

Control Relay[1]

Rating	50/60 Hz ac rms	DC
Max Resistive Load Switching	10 A at 250V (2500V A)	10A at 30V and 0.25A at 250V
Min Load Switching	10 mA at 24V	10 mA at 24V
UL 508, CSA 22.2, IEC Rating Class	B300	Q300
Max Make Values (Inductive Load)	30 A at 120V 15 A at 240V (3600V A)	0.55 A at 125V 0.27 A at 250V (69V A)
Max Break Values (Inductive Load)	3 A at 120V 1.5 A at 240V (360V A)	0.55A at 125V 0.27 A at 250V (69V A)
Max Motor Load Switching	1/3 HP at 125V 1/2 HP at 250V	

(1) Meets ANSI/IEEE C37.90-1989 standards for trip duty.

Relay Life[1]

Parameter	Number of Operations
Mechanical	5×10^6
Electrical	1×10^5

(1) Meets ANSI/IEEE C37.90-1989 standards for trip duty.

General Specifications

Dielectric Withstand	Control Power	2000V
	Voltage Inputs	2000V
	Current Inputs	2000V
	Status Inputs	500V
	Control Relays	1600V
Terminal Blocks	Power Supply and Voltage input Terminals	4 mm^2 (12 AWG) max, 1.02 Nm (9 lb-in) Torque., 75 °C (167 °F) or Higher Copper Wire only
	Relay, KYZ outputs, Current input terminals[1]	2.5 mm^2 (14 AWG) max, 1.18 Nm (10.4 lb-in) Torque 75 °C (167 °F) or Higher Copper Wire only
	Status inputs, RS485	2.5 mm^2 (14 AWG) max 0.56 Nm (5 lb-in) Torque
	RIO, DNT (When present)	2.5 mm^2 (14 AWG) max 0.56 Nm (5 lb-in) Torque
Temperature, Operating	-20…60 °C (-40…140 °F) Cat. No. 1404-DM, 1404-Mxxxx-000, 1404-Mxxxx-DNT 0…55 °C (32…131 °F) 1404-Mxxxx-232, -RIO, -ENT, -CNT	
Temperature, Storage	-40…85 °C (-40…185 °F)	
Humidity	5…95%, Noncondensing	
Vibration	10…500 Hz: 2 g Operational (±0.012 in.)	
Shock	1/2 Sine Pulse, 11 ms duration: 30 g Operational and 30 g Nonoperational	

(1) Recommended Ring lug: AMP part # 320634.

Frequently Asked Questions

Q. Can I program the power monitor through the display?

A. Yes. All programmable attributes can be accessed and programmed through the display module.

Q. Do I need a display module?

A. All features of the monitor can be accessed and programmed through the communication ports. The display module is a highly recommended option.

Q. Can I power the power monitor from the source being monitored?

A. Yes, but it's not advisable. Assuming a voltage match, logging of power outages and voltage phase loss anomalies would be difficult, if not impossible.

Q. What determines what information I get by using RIO block transfers?

A. The word length of the block transfer.

Q. My Volt and Amp readings look good, but why are my power numbers way off?

A. One or more Current/Voltage transformers are wired with reverse polarity or improper phase sequence.

Q. What size fuses do I use for my voltage inputs?

A. Size the fuses to the National Electrical Code for the size of the wire being used.

Q. Why do I need shorting terminal blocks for the current transformers?

A. If for any reason, the meter's current transformer wires are removed or disturbed to cause an open circuit in the Current Transformers secondary while primary current is applied, a hazardous voltage will occur, which may cause personal injury, death, property damage, or economic loss.

Q. Can I monitor several loads from one monitor?

A. It is not advisable to switch current transformer inputs. Besides the need for special current transformer switches, confusion over logged data and setpoint activation would also have to be considered.

Q. Can I change communication networks?

A. Unlike the other Allen-Bradley power monitors, the Powermonitor 3000 unit ships with a non-interchangeable communication network card.

ampere

A unit of electrical current or rate of flow of electrons. One volt across one ohm of resistance causes a current flow of one ampere. A flow of one coulomb per second equals one amp.

apparent power

The product of voltage magnitude and current magnitude in a circuit. Units are VA or some multiple thereof.

balanced load

An alternating, current power system consisting of more than two current carrying conductors in which these current carrying conductors all carry the same current.

billing demand

The demand level that a utility uses to calculate the demand charges on the current month's bill. Various methods may be used to determine the value, such as minimum demand, peak demand or a ratchet clause. It can be based on Watt Demand, VA Demand, VAR Demand or some combination of these. A rate at which a transmission occurs, where one baud equals one bit per second.

broadcast

Broadcast address is a value used for performing commands on all Modbus slaves that are connected on the network. Slave address 0 is reserved for this value.

burden

The electrical load placed on source of VA or the load an instrument or meter places on a current or potential transformer. All current and potential transformers have a rated burden which should not be exceeded or else transformer transformation accuracy deteriorates.

capacitor

A device consisting essentially of two conducting surfaces separated by an insulating material or dielectric. A capacitor stores electrical energy, blocks the flow of direct current, and permits the flow of alternating current to a degree dependent upon the capacitance and frequency. They may also be used to adjust the power factor in a system.

coil

This is a Modbus mapped location used for reading and writing bit length data. These bits typically reflect the value of the discrete outputs. Powermonitor 3000 units do not support this data type.

connected load

The total load which a customer can impose on the electrical system if everything was connected at one time. Connected loads can be measured in horsepower, watts or volt-amperes. Some rate schedules establish a minimum demand charge by imposing a fee per unit of connected load.

current transformer (CT)

A transformer, intended for measuring or control purposes, designed to have its primary winding connected in series with a conductor carrying the current to be measured or controlled. CT's step down high currents to lower values which can be used by measuring instruments.

current transformer ratio

The ratio of primary amperes divided by secondary amperes.

data table

Power monitor data is organized in data tables similar to those found in an SLC 5/03 Programmable Controller. The detailed data table definitions are covered in Appendix A of the Bulletin 1404 Powermonitor 3000 User Manual.

demand hours

The equivalent number of hours in a month during which the peak demand is fully utilized. In other words, if energy consumption for the current month is X kwhr and the peak demand is Y kW, then the demand hours is equal to X/Y hours. The higher the number of demand hours, the better the demand leveling situation, and the more effectively demand is being used.

demand interval

Demand charges are based on peak demand over a utility specified time interval, not on the instantaneous demand (or connected load) at any given moment. Typical demand intervals are 15, 20, and 30 minutes.

discrete input

This is a Modbus mapped location used for reading bit length data. These bits typically reflect the value of the discrete inputs. Powermonitor 3000 units do not support this data type.

exception reply

This is the Reply Packet for a Modbus Command that was unsuccessful in operation.

frequency

The number of recurrences of a periodic phenomenon in a unit of time. In electrical terms, frequency is specified as so many Hertz (Hz) where one Hz equals one cycle per second.

function code

Function byte: second byte of any Modbus Command packet.

holding register

This is a Modbus mapped location used for reading the writing word length data. For a power monitor slave device, the locations are defined by the Modbus Memory Map.

horsepower (hp)

A unit of power, or the capacity of a mechanism to do work. It is equivalent to raising 33,000 pounds one foot in one minute. One horsepower equals 746 watts.

impedance

The total opposition (that is, resistance and reactance) a circuit offers to the flow of alternating current at a given frequency. It is measured in ohms.

induction motor

An alternating current motor in which the primary winding (usually the stator) is connected to the power source and induces a current into a secondary (usually the rotor).

inductor

A device consisting of one or more windings with or without a magnetic core. Motors are largely inductive.

initiator pulses

Electrical impulses generated by pulse-initiator mechanisms installed in utility revenue meters. Each pulse indicates the consumption of a specific number of watts. These pulses can be used to measure energy consumption and demand.

input register

This is a Modbus mapped location used for reading word length data. For a power monitor slave device, the locations are defined by the Modbus Memory Map.

lagging current

The current flowing in an ac circuit which is mostly inductive. If a circuit contains only inductance the current lags the applied voltage by 90°. Lagging current means lagging power.

leading current

The current flowing in a circuit which is mostly capacitive. If a circuit contains only capacitance the current leads the applied voltage by 90°. Leading current means leading power factor.

load

Any device or circuit consuming power in an electrical system.

load shedding

The removal of load from the line to limit load and control demand level.

load restoring

The energizing of loads that were previously removed from the line to limit load and control demand level.

Modbus

Industrial communication network protocol created by the Modicon Corporation.

neutral

The conductor chosen as the return path for the current from the load to the source. It is also a voltage reference point in a power system.

ohm

The unit of electrical resistance. One ohm is the value of resistance through which a potential difference of one volt will maintain a current flow of one ampere.

peak demand

The highest average load over a utility specified time interval during a billing period. If there is no ratchet clause in the rate schedule, then the peak demand is also the billing demand.

polyphase

Having or utilizing several phases. A polyphase power circuit has several (typically three) phases of alternating current with a fixed phase angle between phases.

potential transformer (PT)

An transformer with the primary winding connected in parallel with the circuit whose voltage is to be measured or controlled. PT's are normally used to step down high-voltage potentials to lower levels acceptable to measuring instruments. Also known as voltage transformer (VT).

potential transformer ratio

The ratio of primary voltage divided by secondary voltage.

power factor

The ratio of real power in watts of an alternating current circuit to the apparent power in volt-amperes. Also expressed as the cosine of the phase angle between the fundamental voltage applied to a load and the current passing through it.

power factor correction

Steps taken to raise the power factor by closely aligning the current to be in phase with the applied voltage. Most frequently this consists of added capacitance to increase the lagging power factor of inductive circuits.

power factor penalty

The charge utilities impose for operating at power factor below some rate schedule-specified level. This level ranges from a lagging power factor of 0.80 to unity. There are innumerable ways by which utilities calculate power factor penalties.

ratchet clause

A rate schedule clause which states that billing demand may be based on current month peak demand or on historical peak demand, depending on relative magnitude. Usually the historical period is the past eleven months, although it can be for the life of the contract. Billing demand is either the current month peak demand or some percentage (75% is typical) of the highest historical peak demand, depending on which is largest. It is designed to compensate the electric utility for maintaining equipment not fully utilized.

reactance

The opposition to the flow of alternating current. Capacitive reactance is the opposition offered by capacitors and inductive reactance is the opposition offered by an inductive load. Both reactances are measured in ohms.

real power

The component of apparent power that represents real work in an alternating current circuit. It is expressed in watts and is equal to the apparent power times the power factor.

resistance

The property of a substance which impedes current flow and results in the dissipation of power in the form of heat. The unit of resistance is the ohm. One ohm is the resistance through which a difference of potential of one volt will produce a current of one ampere.

revenue meter

A meter used by a utility to generate billing information. Many types of meters fall in this category depending on the rate structure.

root mean square (RMS)

The effective value of alternating current or voltage. The RMS values of voltage and current can be used for the accurate computation of power in watts. The RMS value is the same value as if continuous direct current were applied to a pure resistance.

RTU

Remote Terminal Unit, one of two possible transmission formats supported by Modbus. Powermonitor 3000 units only supports RTU slave function.

slave address

This is the numerical label for slave devices. Valid slave device addresses are in the range of 0…247 decimal. The individual slave devices are assigned addresses in the range of 1…247. The value of 0 is reserved for broadcast.

sliding demand interval

A method of calculating average demand by averaging the average demand over several successive short time intervals, advancing one short time interval each time. Updating average demand at short time intervals gives the utility a much better measure of true demand and makes it difficult for the customer to obscure high short-term loads.

sub function code

Sub function word: third and forth bytes of any Modbus Command packet.

unbalanced load

A situation existing in a three-phase alternating current system using more than two current carrying conductors where the current is not due to uneven loading of the phases.

volt-ampere (VA)

The unit of apparent power. It equals volts times amperes regardless of power factor.

volt-ampere demand

Where peak average demand is measured in volt-amperes rather than watts. The average VA during a predefined interval. The highest average, for example, Peak VA demand, is sometimes used for billing.

voltage (V)

The force which causes current to flow through a conductor. One volt equals the force required to produce a current flow of one ampere through a resistance of one ohm.

watt (W)

A measure of real power. The unit of electrical power required to do work at the rate of one joule per second. It is the power expended when one ampere of direct current flows through a resistance of one ohm. Equal to apparent power VA times the power factor.

watt demand

Power during a predetermined interval. The highest average, for example, Peak demand is commonly used for billing.

watt hour (Whr)

The number of watts used in one hour. Since the power usage varies, it is necessary to integrate this parameter over time. Power flow can be either forward or reverse.

wattmeter

An instrument for measuring the real power in an electric circuit. Its scale is usually graduated in watts, kilowatts, or megawatts.

volt ampere reactive hours (VARH)

The number of VARs used in one hour. Since the value of this parameter varies, it is necessary to integrate it over time. VARs can be either forward or reverse.

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For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience an anomoly within the first 24 hours of installation, review the information that's contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

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Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

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Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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