GE
Grid Solutions

Multilin P30 Phasor Data Concentrator

Instruction Manual

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WORLDWIDE 10 YEAR WARRANTY

CE REGISTERED ISO 9001 GE MULTILIN

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GE Grid Solutions - Multilin P30 Phasor Data Concentrator Instruction Manual for revision 2.02.

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Warranty

For products shipped as of 1 October 2013, GE warrants most of its GE manufactured products for 10 years. For warranty details including any limitations and disclaimers, see our Terms and Conditions at https://www.gegridsolutions.com/multilin/warranty.htm

For products shipped before 1 October 2013, the standard 24-month warranty applies.

General Safety Precautions

⚠CAUTION

- Failure to observe and follow the instructions provided in the equipment manual(s) could cause irreversible damage to the equipment and could lead to property damage, personal injury and/or death.
- Before attempting to use the equipment, it is important that all danger and caution indicators are reviewed.
- If the equipment is used in a manner not specified by the manufacturer or functions abnormally, proceed with caution. Otherwise, the protection provided by the equipment may be impaired and can result in impaired operation and injury.
- Caution: Hazardous voltages can cause shock, burns or death.
- Installation/service personnel must be familiar with general device test practices, electrical awareness and safety precautions must be followed.
- Before performing visual inspections, tests, or periodic maintenance on this device or associated circuits, isolate or disconnect all hazardous live circuits and sources of electric power.
- Failure to shut equipment off prior to removing the power connections could expose you to dangerous voltages causing injury or death.
- All recommended equipment that should be grounded must have a reliable and un-compromised grounding path for safety purposes, protection against electromagnetic interference and proper device operation.
- Equipment grounds should be bonded together and connected to the facility's main ground system for primary power.
- Keep all ground leads as short as possible.
- At all times, equipment ground terminal must be grounded during device operation and service.
- In addition to the safety precautions mentioned all electrical connections made must respect the applicable local jurisdiction electrical code.
- Lexan terminal block cover on power input board: Must be replaced after electrical connects are made, to reduce the probability of electrical shock.
- **Field crimped terminal lugs used on the P30 must be of a type which are insulated. Uninsulated body terminal lugs will pose a potential risk of shock to the end user.**

Safety words and definitions

The following symbols used in this document indicate the following conditions:

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Indicates significant issues and practices that are not related to personal injury.

Indicates general information and practices, including operational information and practices, that are not related to personal injury.

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Multilin P30

Chapter 1: Multilin P30 General

Introduction

The Multilin P30 is an IEEE C37.118 and IEC 61850-90-5 based Synchrophasor Data Concentrator whose primary function is to communicate with Phasor Measurement Units (PMUs) and process synchrophasor data streams collected from a variety of PMUs. The system is intended to provide reliable and secure synchrophasor data management for Optimized Wide Area System monitoring and Post Event Analysis.

The Multilin P30 is unique in the industry in that it can be ordered with an embedded Historian complete with 256 GB of solid-state storage. Even more unique in the industry is the Multilin P30 's ability to concentrate IEC61850-90-5 R-SV sample data.

The Multilin P30 supports protocol conversion between IEEE C37.118 and IEC 61850-90-5, such that it can accept data from IEC61850-90-5 clients and concentrate it to IEC61850-90-5 R-SV output data, or even convert it to IEEE C37.118 output data. Likewise IEEE C37.118 data may be converted to IEC61850-90-5 output data. IEC61850-90-5 data may be written to the embedded Historian just like IEEE C37.118 data.

Users of the Multilin P30 can choose to save two output streams to the embedded Historian should it be installed. The Multilin P30 has been designed this way so that users can save both measurement and protection classes of data simultaneously.

This manual is intended for users of the Multilin P30 and operators of electrical transmission systems, who are:

- Power Engineers or Technicians familiar with Power Engineering concepts, including electrical power measurements (voltages, currents, phase angles, frequencies, sampling rates, phasors) and communications concepts (LAN settings, TCP/IP, IEEE C37.118),
- skilled in the use of Windows platforms, and conventional “point-and-click” interfaces, as well as web interfaces,
- involved in day-to-day transmission system operation activities, including system planning, fault analysis, and system operations.

Overview

The Multilin P30 system collects, processes, and reports Synchrophasor data for Wide Area System monitoring applications.

Synchrophasor data from a variety of PMUs are time-aligned, structured, and transmitted to upstream synchrophasor devices, which can be other Multilin P30 PDCs, Super PDCs, visualization devices, external historians, or external applications.

The Multilin P30 can be installed at the Substation Level, or at a Regional Control Center.

GE's synchrophasor data concentrator, Multilin P30 , acquires synchrophasor data from various Phasor Measurement Units (PMUs), such as the D60, G60, L30, L90, and N60 relays, and from other PMU devices with different reporting rates. The Multilin P30 can accommodate reporting rates between 1 and 120 frames/s. All PMU data sent to the Multilin P30 must comply with IEEE C37.118 or IEC 61850-90-5.

Multilin P30 Order Codes

P30	-	*	*	*	*	*	*	*	Description
Base Unit	**P30**								Base Unit
Ethernet Interface Type*		**T**	**I**	**I**	**I**	**I**	**I**	**I**	P30 Synchrophasor Processor Module, 10/100/1000 Base TX Ethernet Ports
		F	**I**	**I**	**I**	**I**	**I**	**I**	P30 Synchrophasor Processor Module, 100 BaseFX Ethernet Ports
Primary Power Supply			**HI**	**|**	**I**	**I**	**I**	**I**	125/250 VDC (88 to 280 VDC); 120/240 VAC (85 to 264 VAC, 50/60 Hz) input
			LO	**|**	**I**	**I**	**I**	**I**	48 VDC (36 to 72 VDC) input
Redundant Power Supply**				**HI**	**I**	**I**	**I**	**I**	125/250 VDC (88 to 280 VDC); 120/240 VAC (85 to 264 VAC, 50/60 Hz) input
				LO	**I**	**I**	**I**	**I**	48 VDC (36 to 72 VDC) input
				XX	**I**	**I**	**I**	**I**	No secondary power supply option
Ethernet Port Expansion Module					**TX**	**I**	**I**	**I**	2 x 10/100/1000 BaseTX Ethernet ports
					FX	**I**	**I**	**I**	2 x 100 BaseFX Ethernet ports
					XX	**I**	**I**	**I**	No Ethernet port expansion module
Historian						**02**	**I**	**I**	2500 Tag Historian Option
						XX	**I**	**I**	No Historian Option
Application Module***							**AM**		Application Module/Card
							XX		No Application Module/Card
PMU Inputs								**008**	Support for up to 8 PMU inputs
								040	Support for up to 40 PMU inputs

* Ethernet expansion module type must match type of main Ethernet interface.

** If a Redundant Power Supply is required, it must match the Primary Power Supply selection.

*** Contact GE Multilin directly to order this option (not available online).

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Description of the P30 System

The Multilin P30 system is an IEEE C37.118/IEC 61850-90-5 PDC. This Multilin P30 system can communicate with IEEE C37.118/IEC 61850-90-5 standard PMU/DC devices, such as the D60, G60, L30, L90, and N60 relays, or any other PMU/DC devices. The primary functions of the Multilin P30 are to:

- communicate with PMUs and other PDCs (eg: super-PDC)
- acquire synchrophasor data from up to 40 PMUs at different reporting rates (up to 120 frames/s for 60 Hz, and 100 frames/s for 50 Hz)
- time-align synchrophasor data from various Phasor Measurement Units (PMUs)
- filter and process the received synchrophasor data as required, if configured by the user
- structure/aggregate output datasets from the available input data
- transmit structured/aggregated output datasets to up to eight (8) output streams at various reporting rates
- archive and visualize the PMU data if the system is ordered with the optional Historian device and visualization tool for various real-time synchrophasor visualization applications
- monitor, report, latch, prioritize, and archive PMU alarms if the optional EnerVista Grid Engineer software is used.

The Multilin P30 system can be classified into the following subsystems:

- Multilin P30 Synchrophasor Processor
- EnerVista P30 Setup
- Multilin P30 Historian
- EnerVista Synchrophasor Viewer (ESV) software package
- EnerVista Grid Engineer (EGE) software package.

Multilin P30 Synchrophasor Data Processor

EnerVista P30 Setup

The EnerVista P30 Setup software allows users to interface with GE's Multilin P30 system. The user can add a PMU to the Multilin P30 input streaming device list, by entering the IP address of the PMU and specifying the communication protocol. Moreover, a user can retrieve the configuration data of up to 40 PMUs and map them to corresponding output datasets.

The EnerVista P30 Setup software can be used to configure the Multilin P30 in both online and offline mode. To use online mode, there must be a network connection between the EnerVista P30 Setup software and the Multilin P30 hardware.

To simplify the configuration of the Multilin P30 system, the EnerVista P30 Setup software can communicate directly with PMU servers to obtain their configuration data, thereby eliminating costly manual data entry. Configuration is retrieved from the specified server. Please refer to the *EnerVista P30 Setup Interface* section on how to configure the Multilin P30 using the EnerVista P30 Setup software.

The Multilin P30 is supplied with a serial port that must be used to set its initial console port IP address as well as the IP Address of an embedded Historian if it has been ordered. The console port IP address must be set before the console port can be used to configure the system using the EnerVista P30 Setup software.

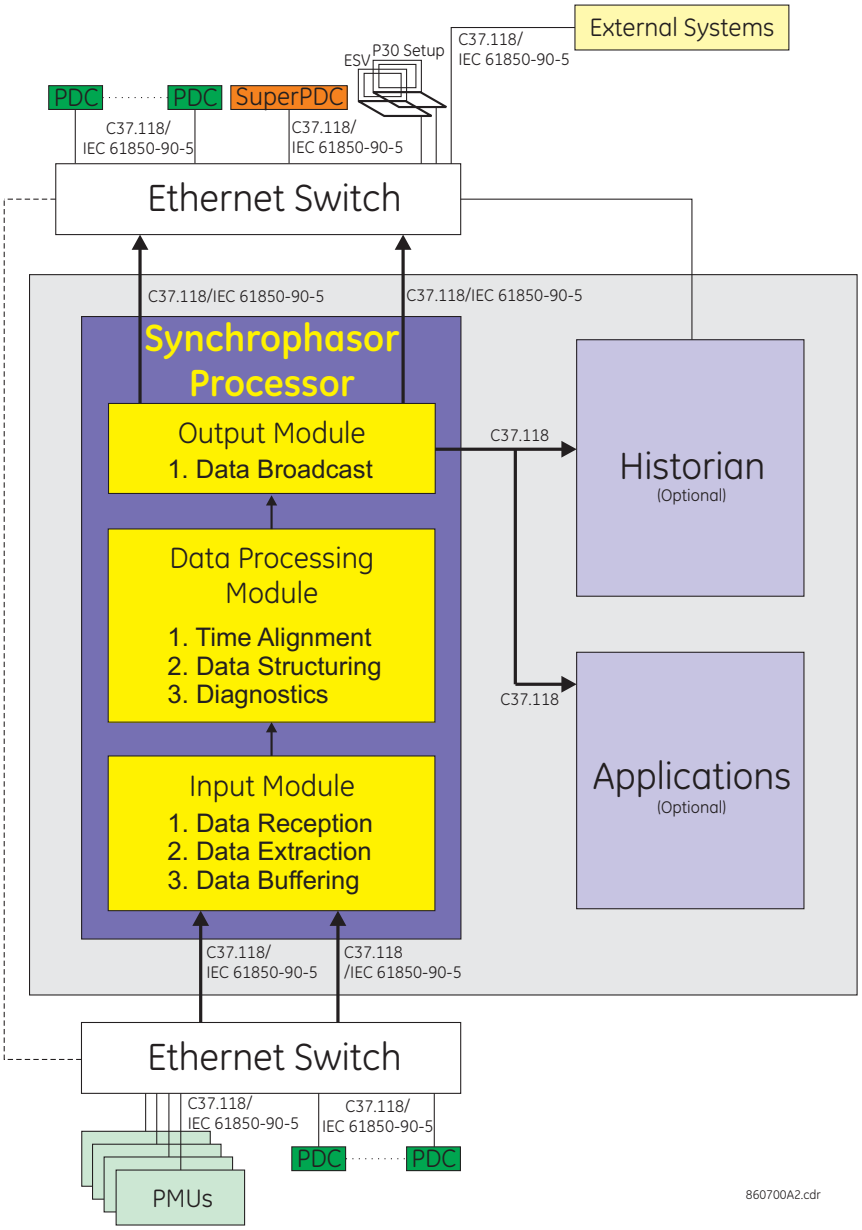
NOTE

The Multilin P30 system supports up to 4 Ethernet interfaces on the synchrophasor processor board. Although all ports support data communication, the Multilin P30 system can be configured only through the console port using the EnerVista P30 Setup tool. The console port is port 1 on the synchrophasor processor board.

P30 Architecture

The Multilin P30 Synchrophasor Processor is composed of three separate modules; the Input Module, the Data Processing Module and the Output Module. The figure below shows the Multilin P30 architecture.

Figure 1-1: Multilin P30 Architecture



Connectivity

The Multilin P30 supports up to 4 Ethernet ports: a Console (Port 1) and up to 3 additional ports if the optional PMC Ethernet expansion card is ordered. The console port supports both the EnerVista P30 Setup interface to configure the Multilin P30, as well as data communication, if required. Ports 2 through 4 support only data communication. Typically these ports will be connected to a network device (Ethernet switch/router). The Multilin P30 is also supplied with a serial port that must be used to set the initial console port IP address of it and an embedded Historian if this has been ordered.

A separate Ethernet connection between the Historian and EnerVista P30 Setup is required for configuration. Should the ESV software be used to visualize the data within the Historian archive, there must also be an Ethernet connection between the Historian and the ESV software. The Historian processor has two RJ45 Ethernet interfaces that can be connected to an external switch for this purpose.

The Multilin P30 should be connected to an IRIG-B signal in order to communicate with PC software, as well as receive, time-align and send concentrated data.

Please refer to the *Configuring Serial/Ethernet Communications* sections for information on how to set up communications with the Multilin P30.

Regardless of the operating mode selected IEEE C37.118 or IEC 61850-90-5, the Multilin P30 system uses CFG-2 frames to obtain PMU configuration data from PMU servers.

In IEEE C37.118 communication mode, for first time handshaking between the Multilin P30 and a PMU, the Multilin P30 sends a Command to turn off PMU transmission. It then sends a command frame to the PMU to request a new configuration (CFG-2) frame. When a commissioning engineer provisions the Multilin P30 device, the EnerVista P30 Setup software communicates with PMUs to obtain configuration data from CFG-2 frames.

Even when GE PMUs are set to operate in IEC61850-90-5 mode, they provide an auxiliary IEEE C37.118 communication port so that CFG-2 frames can be retrieved by the EnerVista P30 Setup software. Once the PMU receives these commands, it must send the configuration (CFG-2) frames to the Multilin P30 requesting client. In 90-5 mode, GE PMUs are designed to stream automatically without a Start command. However the contents of the data stream should match the configuration that was sent by the PMU to the EnerVista P30 Setup software. The Input Module extracts the data packets from various devices and buffers the extracted data for a limited time. The receipt of a PMU packet is time-stamped to the nearest microsecond of GPS time. This is facilitated using the IRIG-B input on the Multilin P30 chassis.

Input Module

This module acquires synchrophasor data from various Phasor Measurement Units (PMUs), such as the D60, G60, L30, L90, and N60 relays, and from other PMU devices with different reporting rates from 1 to 120 frames/s and based on IEEE C37.118/IEC 61850-90-5. Up to 40 individual PMUs are supported at the input. An aggregated frame from a device with four PMUs is also accepted, however the total number of PMUs configured with the Multilin P30 should not exceed 40. Moreover, all PMU data sent to the Multilin P30 must comply with IEEE C37.118/IEC 61850-90-5.

If configured for IEC 61850-90-5 R-SV data reception, the Multilin P30 is able to receive repeated ASDUs in an R-SV frame, to be used if previous data frames were lost from the corresponding PMU.

NOTICE

The reception of multiple ASDUs by the Multilin P30 has system performance consequences. It is highly recommended that repeated ASDUs not be sent from PMU devices to the Multilin P30.

Data Processing Module

This module provides two major functions: time alignment and data structuring. The Multilin P30 supports different reporting rates from each of the 40 possible inputs (from PMUs), and allows the user to configure a unique reporting rate from each of the Multilin P30's 8 outputs. The time alignment function provides a unified data rate. The Data Processing Module aligns the different rate data streams into a single data rate according to the Multilin P30 output configuration set by the user. For example, for system visualization, 10 points/sec may be enough but 30 points/sec is required for stability analysis. The data structuring function combines synchronized measurement data from multiple measurement devices into a single binary data stream; in other words, it is the concentrating function.

The Multilin P30 data processing module also provides a small, finite amount of data buffering to account for network characteristics that may prevent PMU data from arriving when it is expected.

The Multilin P30 also provides the capability to enable data filtering, that a user may elect to use when the provisioned data input rate is greater than the provisioned data output rate. Filtering is not required when the output-reporting rate is equal to, or higher than the input reporting rate. If the filtering option is selected and the Multilin P30 output rate is less than the Multilin P30 input rate, the concentrated data can only be established for each Multilin P30 output:

- when the PMU data for all the PMUs configured for that output is received for the corresponding time stamp and prior (N-1)/2 and later (N-1)/2 time stamps where N is the filter length and the (present time – first packet arrival time) is less than the configured wait time
- when (present time – first packet arrival time) is equal to configured wait time while all the PMU data has not been received, and the missing data is interpolated.

Please refer to the *Theory of Operation* section for more details.

Internally, the Multilin P30 normalizes all received data to 120 frames/s reporting rate. For the PMUs with reporting rate less than 120 frames/s, when the PMU data is received for two consecutive time stamps (based on reporting rate), the data is up-sampled for the time interval between two consecutive time stamps.

For instance, for the PMU with reporting rate of 30 frames/s, when data is received for time stamps corresponding to times [21:20:48 , 0 ms] and [21:20:48 , 033333 ms], data will be up-sampled for time stamps [21:20:48 , 008333 ms], [21:20:48 , 016667 ms] and [21:20:48 , 025000 ms].

Refer to the *Theory of Operation* chapter of this manual for further details about up-sampling, down-sampling, etc.

Output Module

The Multilin P30 Output Module is responsible for transmitting the concentrated PMU data to other PDCs or SuperPDCs based on the preset configuration. The Synchrophasor Processor supports up to eight (8) clients. Should it be ordered, the embedded Historian will consume up to two of these outputs. Outputs that are not configured for the Historian may be set as either IEEE C37.118 or IEC61850-90-5 type outputs. IEEE C37.118 outputs can be configured for either TCP or UDP operation. The data set and wait time must be configured separately for each output.

For first-time handshaking between any client and the Multilin P30 server, the client either sends a command frame to the Multilin P30 to request a CFG-2 frame, or sends two command frames to the Multilin P30 to request both the CFG-2 frames. In the case of IEC61850-90-5 clients, a separate user-specified application port is used to transmit CFG-2 and command transmission / reception. Once the Multilin P30 server receives these commands, it sends the CFG-2 frames to the client. The data encoded in these frames will be representative of the Multilin P30 output configuration, as provisioned by the user in EnerVista P30 Setup, based on the client configuration preset by the user.

For IEEE C37.118 outputs, after receiving both frames, the client sends a command signal to the Multilin P30 to initiate the concentrated phasor data transmission. The Multilin P30 then starts the data transmission.

The Multilin P30 wait time feature allows PMU data to be buffered for a user-defined time (between 1ms and 5 seconds), until all expected data has arrived.

The wait time buffering allows users to force the Multilin P30 to send all concentrated data in time-stamp order, on each of the Multilin P30 outputs. If the wait time for an output is provisioned, the Multilin P30 will not send output data, for a given timestamp, or any subsequent timestamp, until every input PMU to be concentrated on the output has arrived.

NOTE

Please see section SETTINGS > MULTILIN P30 SETUP > SYSTEM SETUP > OUTPUTS to determine how to configure the output wait time feature.

If all requisite data has not arrived by the time the configured wait time has elapsed, then the Multilin P30 will interpolate the missing data. For IEEE C37.118 outputs, the Multilin P30 will set Bit-9 of the STAT word in compliance with IEEE C37.118.2 Draft 3.2 (May 2011). For IEC61850-90-5 outputs, the Multilin P30 will set the appropriate bits in the STAT word of the R-SV frame, mapped into a BitString16 as an IEEE C37.118 type.

P30 Diagnosis Reporting Using the Pseudo PMU

The Multilin P30 also provides system and network diagnostic information. The Multilin P30 treats alarms and diagnostic information in a way that makes it very convenient to monitor the Multilin P30 in a wide area system. Alarms and Diagnostics can be configured to be transported in 'pseudo-PMU packets' that are created at the Multilin P30 itself. The user can select all or some of these pseudo PMUs to be concentrated into a Multilin P30 output which can be sent to other upstream devices, the Historian, or to any monitoring software.

Pseudo PMUs contain data that is generated within the Multilin P30 to provide the client with information on the status of the Multilin P30 as well as communication between the Multilin P30 and PMUs. These data are time-stamped by the Multilin P30. The Multilin P30 processes this information as it processes information coming from any other PMU. Pseudo PMUs do not contain any phasor information; just analogs and digitals. The Multilin P30 supports four Pseudo PMUs each of which contains 0 phasors, 16 analogs, and 32 digitals.

No special requirements are necessary for the visualization of pseudo PMUs in the ESV.

NOTE

Please refer to section SETTINGS > MULTILIN P30 SETUP > SYSTEM SETUP > PSEUDO PMU for more information.

Multilin P30 Historian

The Multilin P30 can be ordered with GE's own Proficy Historian, and an optimized collector for IEEE C37.118 synchrophasor data. Where Historian outputs are provisioned, all data is converted to IEEE C37.118 format before it is archived, even if the originating data format was IEC61850-90-5. All Multilin P30 s that are ordered with a Historian are also supplied with 256GB of solid state storage.

The embedded Historian is a client of the Synchrophasor Processor. When an optional Historian card is ordered, the Synchrophasor Processor card becomes the data source, from which the Historian Collector for IEEE C37.118 data will retrieve phasor data and collect them into the Historian server. The data is then made accessible to clients by the Historian server.

Both the Historian Collector and the Historian Server run on the optional Historian processor board.

The Historian Collector can accommodate a variable number of Historian tags. The number of Historian tags ordered will depend on the number of PMUs from which the Multilin P30 collects data.

NOTE

The EnerVista P30 Setup software provides the user with an interactive bandwidth calculator that displays the number of tags remaining to be used, as input data is concentrated on the Historian output. The EnerVista P30 Setup software also provides users with an interactive calculator that computes the number of days of storage available (based on the input size) before data rollover occurs.

When configured, the collector automatically gathers all phasors, analog channels, digital channels, STAT words, FREQ and DFREQ fields that appear in IEEE C37.118 data frames, that are received from the Synchrophasor Processor card. Digital channels marked as invalid in the DIGUNIT field of the configuration frame are not collected.

Nominal line frequency in the FNOM field of configuration frames is collected each time a CFG-2 frame is received. If no CFG-2 frame has been received for 24 hours, the last known value of nominal line frequency is added to Historian. Similarly, the ANUNIT and DIGUNIT fields in a CFG-2 frame are collected with the same 24-hour auto-repeating.

The CFGCNT field of the configuration frame is also collected, but no auto-repeating algorithm is applied, as the field is meant to reflect the actual time that a configuration change occurs.

No other fields in the data frame are collected, nor are any fields in any other type of IEEE C37.118 frame.

NOTE

The user is responsible for configuring the Historian output port on the Multilin P30.

The Historian-Multilin P30 relationship mimics the relationship between a DC and PMU in the IEEE C37.118 standard; in this case the Historian serves as the client, and the DC as the server.

The Synchrophasor Processor interface to the Historian is designed to accommodate a wide range of data transmission rates that vary according to the configuration of the Historian output port. The Synchrophasor Processor interface supports a range of transmission rates between 1 frames/s and 120 frames/s.

The number of Historian tag writes per second that are supported will depend on the version of Historian software installed on your Multilin P30 system. The Historian processor will support up to 200,000 tag writes per second.

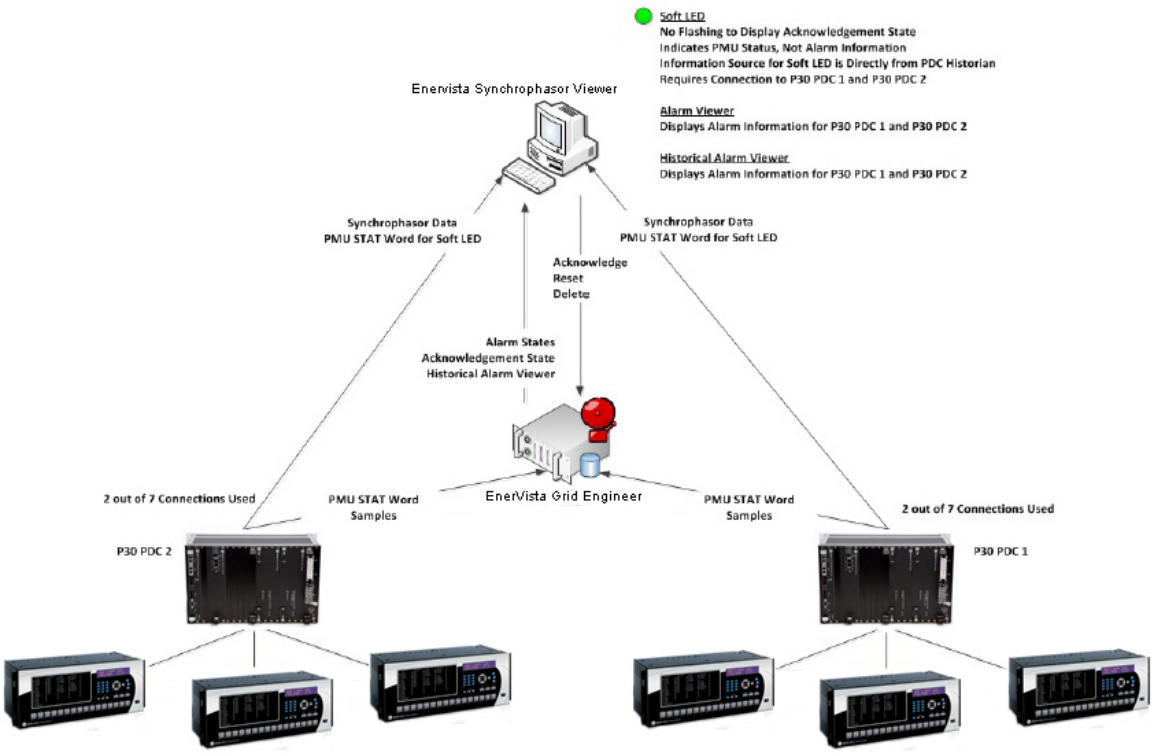
NOTICE

The Multilin P30 Historian processor is a Windows based software system. Proper care is required to ensure its reliable operation.
Before removing power on the Multilin P30 please shut down the Multilin P30 Historian processor in the correct manner, by using the “Shut Down” function available in the EnerVista P30 Setup software.

EnerVista Grid Engineer (EGE)

The EnerVista Grid Engineer software is used to serve up alarm data, housed in Historian repositories, to the EnerVista Synchrophasor Viewer (ESV).

In establishing a connection between the EnerVista Grid Engineer and one or more Historians housing PMU data, the groundwork for gathering PMU alarm data must be completed. Upon launch of the system, each time a transition state occurs in relation to a monitored STAT word bit for the PMU(s) in question, a corresponding record is stored in the Alarms database.



EnerVista Synchrophasor Viewer (ESV)

The EnerVista Synchrophasor Viewer (ESV) is a software application that provides for visualizing synchrophasor, digital, and analog data collected from substation Phasor Measurement Units (PMUs).

The ESV application facilitates visualization of data by means of the following user-configurable graphic objects:

- Phasor Display: A combination of the following:
  - A polar plot containing up to 16 rotating hands, each of which indicates a given synchrophasor's magnitude along with either its absolute angle or its angle relative to another displayed synchrophasor
  - A table listing the angle and magnitude values of each displayed synchrophasor, along with the moving average of each displayed synchrophasor's angle
- Trend Chart: A line graph displaying time-synchronized phasor, digital, and/or analog measurements over a configurable time span.

Additional graphic objects allow you to visualize PMU status as well as Phasor Data Concentrator (PDC) Historian operational statistics.

The ESV application also provides a Historical Playback feature that synchronizes all created objects and worksheets, whether currently displayed or not, to show data starting from a user-specified time in the past through any time up to and including live time.

OPERATIONAL OVERVIEW

Power transmission line data acquired by Phasor Measurement Units (PMUs) installed at substations can be visualized by means of the EnerVista Synchrophasor Viewer (ESV). This data is time-synchronized to the microsecond based on GPS clocks. The data is then collected, filtered, and time-aligned by a Phasor Data Concentrator (PDC) - the Multilin P30

Phasor Data Concentrator - which then streams the data to a Historian data collector that stores the data in a Historian repository. You can access this data for visualization in ESV using a number of graphic objects.

All data and graphic animations in ESV are based on Display Time. Display Time has different meanings depending on viewing mode. In live mode (the default), Display Time is the current system time. In historical playback mode, Display Time corresponds to a moment in the past that progresses dynamically within a user-specified period designated by way of the Dynamic Graphic Replay (DGR) control.

APPLICATION CAPACITY

Each Multilin P30 can connect to multiple PMUs; each installation of ESV can access up to 16 Multilin P30 Historians simultaneously; and each Multilin P30 Historian can be accessed by up to seven ESV users at once. For detailed information on system specifications and limitations, see the appropriate sections of this Instruction Manual.

ESV INSTALLATION

For detailed ESV installation instructions, please refer to *chapter 8* of this Instruction Manual.

APPLICATION START-UP

After the EnerVista Synchrophasor Viewer (ESV) is installed on your computer, it can be started by way of either the corresponding desktop icon or the corresponding program path from the Windows **Start** button.

To start ESV from the desktop icon

1. Insert the hardware license key in the computer's USB port.

NOTICE

Without the hardware license key, the ESV application runs in demo mode, which limits session time to two hours. Connection of the key by way of an external USB hub is not supported.

NOTICE

Do not remove the key from your node while the ESV application is running, as doing so may damage the key.

2. Double-click the EnerVista Synchrophasor Viewer icon.
   The application opens to display the main window.

To start ESV from the Start button

1. Insert the hardware license key in the computer's USB port.
2. Click the **Windows Start** button.
3. Point to **Programs** (or **All Programs**, depending on operating system), then **EnerVista Synchrophasor Viewer**, then click **EnerVista Synchrophasor Viewer**.
   The application opens to display the main window.

NOTE

If the most recently configured worksheet contains visualization objects that draw data from Historians for which you have not saved your login credentials, one or more dialog boxes will appear, in which you must enter your User Name [preceded by the appropriate Domain Name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password for the corresponding Historian, then click **OK**, after starting the application.

MAIN WINDOW OVERVIEW

The image below highlights the main components of the EnerVista Synchrophasor Viewer (ESV) main window. The table below provides a description of each component.

KEY	COMPONENT	DESCRIPTION
A	Worksheet Title	Read-only display of the active worksheet's name.
B	Last Worksheet/Next Worksheet	Toolbar buttons used to navigate between worksheets opened during the current session.
C	Historical Playback	Toolbar button for opening the control used to replay data in all created objects and worksheets—whether currently displayed or not—across a user-specified time frame.
D	Connect to P30 Historian	Toolbar button for opening the control used to establish connection to the Phasor Data Concentrator (PDC) Historian(s) containing time-synchronized phasor, digital, and analog data.*
E	Add Phasor Display	Toolbar button used to create a Phasor Display visualization object for configuration.
F	Add Trend Chart	Toolbar button used to create a Trend Chart visualization object for configuration.
G	Add PMU Status	Toolbar button used to create a Phasor Measurement Unit (PMU) Status visualization object.
H	Add P30 Historian Statistics	Toolbar button used to create a PDC Historian Statistics visualization object for configuration.
I	Save	Toolbar button used to save the active worksheet as currently populated and configured with visualization objects.
J	Question Mark Icon	Toolbar button for opening the application help file to the welcome topic.
K	Underscore Icon	Toolbar button for minimizing the application window.
L	X Icon	Toolbar button for closing the application.
M	Worksheet	Container for one or multiple visualization objects.

KEY	COMPONENT	DESCRIPTION
N	Worksheets Navigation Panel	Toggle pane displaying all saved worksheets and providing the means to refresh, open, create, duplicate, rename, or delete worksheets.
O	Message Bar	Means of conveying information on application status, with activity notifications being displayed in green, error notifications being displayed in red, and all notifications fading with age.
P	Resize Handle	Control for resizing the application window while maintaining aspect ratio.

* You must connect to the applicable Multilin P30 Historian(s) before you can perform any visualization tasks.

WORKSHEET OVERVIEW

The worksheet is the foundation of the EnerVista Synchrophasor Viewer (ESV) work environment. Similar in concept to a canvas, a ESV worksheet can contain one or multiple visualization objects. The first time you start ESV, the application opens a blank worksheet ready to be populated with visualization objects.

Whenever you navigate away from a worksheet, the application automatically saves the worksheet as currently populated and configured. Back and forward buttons in the ESV toolbar allow for navigation between worksheets accessed during a given session.

When you close the ESV, the application saves the worksheet that was active at the time of closure and earmarks that worksheet as the one to be displayed when the application is next started.

The maximum number of objects that can be created per worksheet is a function of the amount of data being visualized overall and the hardware limitations of the user's computer.

NOTICE

After changing or deleting worksheet objects, there is no way to revert to previous worksheet states. Therefore, if you think you might have some future use for a worksheet in its current state, you may want to consider duplicating it and modifying the copy, rather than modifying the original worksheet.

APPLICATION CLOSURE

When you have completed your visualization work for a given session, close the application by taking the following step:

- Click the "X" in the upper-right corner of the application window.
  The currently displayed worksheet is saved, then the application closes.

P30 System Specifications

Synchrophasor Processor Card

GENERAL

Computer Type: ..... 6U VME single board computer
Installation Type: ..... Dual slot

CPU

Floating Point Unit: ..... Embedded
Encryption/Decryption: ..... Support provided

MEMORY

SDRAM: ..... 1 GB
Boot Flash: ..... 8 MB
Firmware Flash: ..... 256 MB
Compact Flash: ..... 16 GB
NVRAM: ..... 16 MB
EEPROM: ..... Included

HEAT SINK

Type: ..... Natural convection

SERIAL COMMUNICATION

Number: ..... 1 port
Connector Type: DB9

ETHERNET COMMUNICATION

Number: ..... 2 ports
Two fiber/copper ports - 10/100/1000BASE-T or 100BASE-FX**Optional**: Fiber 100BASE-FX 2 port Ethernet PMC or copper 10/100/1000BASE-T 2 port Ethernet PMC
Connector Type: ..... Copper: RJ45
Fiber: ST

NOTE

Communication media interfaces must be homogeneous.

IRIG-B ADAPTER

Signal Type: ..... DC Shift

Historian Card

CPU

Unit Type: ..... 6U VME single board computer
Type: ..... Triple slot

MEMORY

SDRAM: ..... 4 GB
Flash Drive: ..... 32 GB

ETHERNET COMMUNICATION

Number: ..... 2 10/100/1000BASE-TX ports (on front panel)
Connector Type: RJ45

INPUT/OUTPUT

Ports: ..... 2 SATA ports (rear) through connector PO
COM1 EIA-232/485 (simplified) port on front panel (connector Type: RJ-12)
One USB port on front panel
Logical Connections: ..... Up to 7 ESV sessions

Application Card

CPU

Unit Type: ..... 6U VME single board computer
Type: ..... Triple slot

MEMORY

SDRAM: ..... 4 GB
Flash Drive: ..... 16 GB

ETHERNET COMMUNICATION

Number: ..... 2 10/100/1000BASE-TX ports (on front panel)
Connector Type: RJ45

INPUT/OUTPUT

Ports: 2 SATA ports (rear) through connector PO
COM1 EIA-232/485 (simplified) port on front panel (connector Type: RJ-12)
One USB port on front panel

NOTICE

When using an optional application card, ensure the Windows OS has shut down completely before powering down the Multilin P30. To shut down the Windows OS, connect to the card by remote desktop, and in a command window type **shutdown -f**.

Card

GENERAL

Drives: 1 solid-state drive (SSD)
MTBF: 10 years at 40°C and 55% humidity
Total SSD Capacity: 256 GB

Power Supply

HIGH RANGE POWER SUPPLY INPUTS

Nominal: 100 to 240 VAC (50/60 Hz)
125, 220, 250 VDC
Operational Range: 85 to 264 VAC (48 to 62 Hz)
88 to 280 VDC
Power Rating: 130 VA max
Hold-up time: <=2 ms
Cooling: Natural convection

LOW RANGE POWER SUPPLY INPUT

Nominal: 48 VDC
Operational Range: 36 to 72 VDC
Power Rating: 120 W max

OUTPUT CONTACTS (FORM C CRITICAL FAILURE RELAY)

Carry Current for 0.2 s: 30 A per ANSI C37.90
Carry Current - Continuous: 8 A
Operate Time: < 10 ms
Contact Material: silver alloy

Testing and Certification

APPROVALS

	Applicable Council Directive	According to:
CE Compliance	Low voltage directive	EN60255-5/EN60255-27
	EMC Directive	EN61000-6-4/EN61000-6-5
ANSI	Communication networking devices installed in Electric Power Substations	IEEE1613
ISO	Manufactured under a registered quality program	ISO9001

TYPE TESTS

TEST	REFERENCE STANDARD	TEST LEVEL
Dielectric voltage withstand		2 KVAC/2828 V DC
Impulse voltage withstand	IEEE C37.90/ EN60255-5/ EN60255-27	up to 5 KV
Insulation resistance Test		500 V DC
Damped Oscillatory	IEC60255-22-1	2.5 KV CM, 1 KV DM
Electrostatic Discharge	EN61000-4-2	Level 4
RF immunity	EN61000-4-3	Level 4
Fast Transient Disturbance	EN61000-4-4	Level 4
Surge Immunity	EN61000-4-5	Level 3
Conducted RF Immunity	EN61000-4-6	Level 3
Radiated & Conducted Emissions	CISPR11	Class A
Sinusoidal Vibration	IEC60255-21-1	Class 1
Shock Response & Withstand	IEC60068-2-27	Response Test: 5 g's Withstand Test: 15 g's 18 pulses total (3 pulses per axis)
Siesmic	IEC60255-21-3	Class 2
Power magnetic Immunity	IEC61000-4-8	Level 5
Voltage Dip & interruption	IEC61000-4-11	0, 40, 70, 80% dips, 250/300cycle interrupts
Mains Frequency Immunity	IEC61000-4-16	30 to300
Ripple on DC power port Immunity test	IEC61000-4-17	15%
Voltage dips and short interruptions on DC power port	IEC61000-4-29	Dip 10ms to 1s, Int 1ms to 1s & Voltage variations
Environmental (Cold)	IEC60068-2-1	0°C, 16 hrs
Environmental (Cold storage)	IEC60068-2-1	-40°C, 16 hrs
Environmental (Dry heat)	IEC60068-2-2	60°C, 16hrs
Environmental (Dry heat storage)	IEC60068-2-2	85°C, 16hrs
Relative Humidity Cyclic	IEC60068-2-30	6day variant 2
RF Immunity	IEEE/ANSIC37.90.2	20V/m 80 to 1Ghz
SWC Damped Oscillatory	IEEE/ANSIC37.90.1	2.5 KV CM, 2.5 KV DM
SWC EFT	IEEE/ANSIC37.90.1	4 kV, 2.5kHz
Altitude	MIL-STD-810E	2000 m to 12192 m

Physical

DIMENSIONS

Size: ..... 483 mm (19") Standard VME chassis

Weight:..... 17.33 kg [38.2 lb]

Environmental

OPERATING ENVIRONMENT

Ambient temperatures:	
Storage:	-40°C to 85°C
Operating:	0°C to 60°C
Humidity	Operating up to 95% (non condensing) @ 55°C (As per IEC60068-2-30 Variant 2, 6days)
Altitude:	2000 m (max)
Pollution Degree:	II
Overvoltage Category:	II
Insulation class:	1
Ingress Protection:	40

GE
Grid Solutions

Multilin P30

Chapter 2: Multilin P30 Installation

Hardware Description

The Multilin P30 is a multi-processor computing platform comprising multiple single board computers: a Synchrophasor Processor Single Board Computer and one other Single Board Computer - a Historian - are housed in one standard 19" (483 mm) 6U rack mounted chassis.

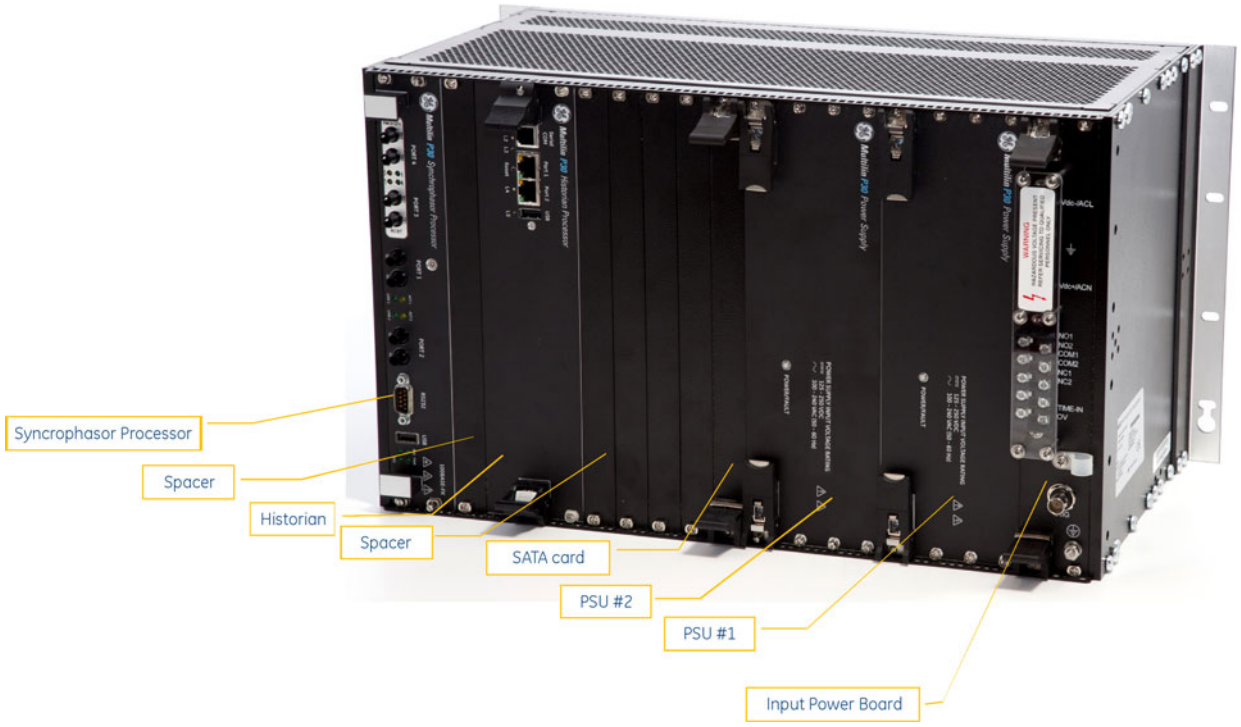
To alleviate maintenance concerns, the Multilin P30's design has eliminated the need for any moving parts, and it is cooled entirely by natural-convection (for mounting requirements for cooling, see the *Mechanical Installation* > *Mounting* section below).

In addition to its processor cards, the Multilin P30 device supports one 256GB solid-state drive connected to the Historian processor, should it be ordered, to serve as its archive location.

Finally, though the base model of the Multilin P30 has one power supply (DC or Universal), it can be equipped with a fully redundant, current sharing mate.

The components of the Multilin P30 are **not customer serviceable**. Under no circumstances should components be added or removed from the system by non-GE personnel.

The components of the Multilin P30 are **not hot-pluggable**. Under no circumstances should components be added or removed while power is supplied to the device.



Synchrophasor Processor

The Synchrophasor Processor is located in the left-most slot of the Multilin P30 chassis. A description of all ports and LEDs is provided below.

- A PMC slot, which will be populated with an Ethernet expansion module if the Multilin P30 is ordered with 4 Ethernet ports
- Two 100BASE-FX fiber ports or two 10/100/1000BASE-T copper ports
- Link/Activity LEDs:
  - For Fiber ST connectors, the LEDs are adjacent to the ports
  - For RJ-45 connectors, LEDs are built into the connectors
- DB9 connector for RS232 maintenance port
- LEDs for Power (PWR), Ready (RDY) and IRIG-B Sync (IRIG)

Though physically available, use of the USB port is not supported on the Multilin P30.

Figure 2-1: Synchrophasor Processor showing 100BASE-FX arrangement

Table 2-1: Synchrophasor Processor Status LED Indicators

LED	Color	Setting	Description
PWR	Green	On	SVDC is present.
		Off	SVDC is not present.
RDY	Green	On	When the READY light is continuously "On" it means that the device is up and running and the configuration has been successfully loaded. As a result there should be communication with PMUs, and clients should be able to connect to the Multilin P30.
		Off	If the READY light is "Off" it means that there is a problem with the configuration and there will be no communication to the PMUs. Clients will not therefore be able to connect to the Multilin P30. The configuration may be corrupted and if so, it will be necessary to use the serial console port to reconfigure.
		Blinking	If the READY light is "Blinking" it means that although the configuration has been successfully loaded, the unit has not been enabled. There will be no communication to the PMUs and clients will not be able to connect to the Multilin P30 . Please use the EnerVista P30 Setup program to enable it by means of the UNIT PROGRAMMED setting.
IRIG	Green	Flashing	Flashes at 1 HZ when a valid IRIG-B signal is detected.
		Off	IRIG-B Watchdog Timer has timed out.

Table 2-2: Synchrophasor Processor Link / Activity Status LED Indicators

ST Fiber Ethernet LEDs (100BASE-FX)			
LINK1 LINK2	Green	On	100BASE-FX link up.
		Off	100BASE-FX link down.
ACT1 ACT2	Yellow	On	Ethernet activity detected.
		Off	No Ethernet activity.
RJ-45 Copper Ethernet LEDs (10/100/1000BASE-T)			
LINK	Orange/Green	On	Orange for 1000BASE-T link-up. Green for 100BASE-TX link-up.
		Off	10BASE-T link-up or link down.
ACT	Yellow	On	Ethernet activity detected.
		Off	No Ethernet activity.

Historian Processor

The Historian Processor is located to the right of the Synchrophasor Processor in the Multilin P30 chassis. A description of all ports and LEDs is provided below:

Figure 2-2: Historian Processor

The Historian Processor provides the following front panel interfaces:

Serial Ports	COM: 1xEIA-232/EIA-485 UART interface for CPU on RJ-12 connector
Gigabit Ethernet	Two 10/100/1000BASE-T(X) ports on RJ45
USB	USB 2.0 interface
Reset	Reset pushbutton
LEDs	5 LEDs reporting the board CPU health status and activity

Front Panel LED Description

CPU LED	COLOR	DESCRIPTION
L1	RED	Permanent error on CPU subsystem (CATERR)
	GREEN	Power-up start
	AMBER	Reset state on CPU subsystem
	BLINKING	CPLD activity (I2C, SMI, or COM)
	OFF	No error, no CPLD activity
L2	RED	CPLD Watchdog reset timer expired
	GREEN	Normal operation mode
	AMBER	Factory test mode
	BLINKING	SATA activity
	OFF	No error, no SATA activity
L3	RED	CPU frequency limited to 1.2 GHz
	GREEN	1000BASE-T rear LAN link
	AMBER	10/100 BASE-T(X) rear LAN link
	BLINKING	LAN activity on rear
	OFF	No error, no rear LAN activity/link
L4	RED	PBIT failed
	GREEN	Normal operation mode
	AMBER	ALMA2f VME FPGA downloading
	BLINKING	PCI and VME buses activity
	OFF	No error, no PCI activity
L5	RED	Power failure
	GREEN	Normal operation mode
	AMBER	VITA57 FPGA downloading
	BLINKING	PCI-X activity
	OFF	No error, no PCI-X activity

Power Supplies

The Multilin P30 can be ordered with either a low voltage DC power supply or a high voltage universal AC/DC power supply. Additionally the device may be ordered with a fully redundant power supply. The Multilin P30's power supply and its mate (if installed) are located adjacent to the input power board. A LED indicator has been provided to show the status of the supply. The input power requirements are also clearly indicated on the front of each supply.

Figure 2-3: High voltage power supply

Figure 2-4: Low voltage power supply

Power Supply LED Description:

- Green: Power good
- Red: Power fault

NOTE

Critical power supply failures are communicated through contact outputs provided on the input power board.

NOTE

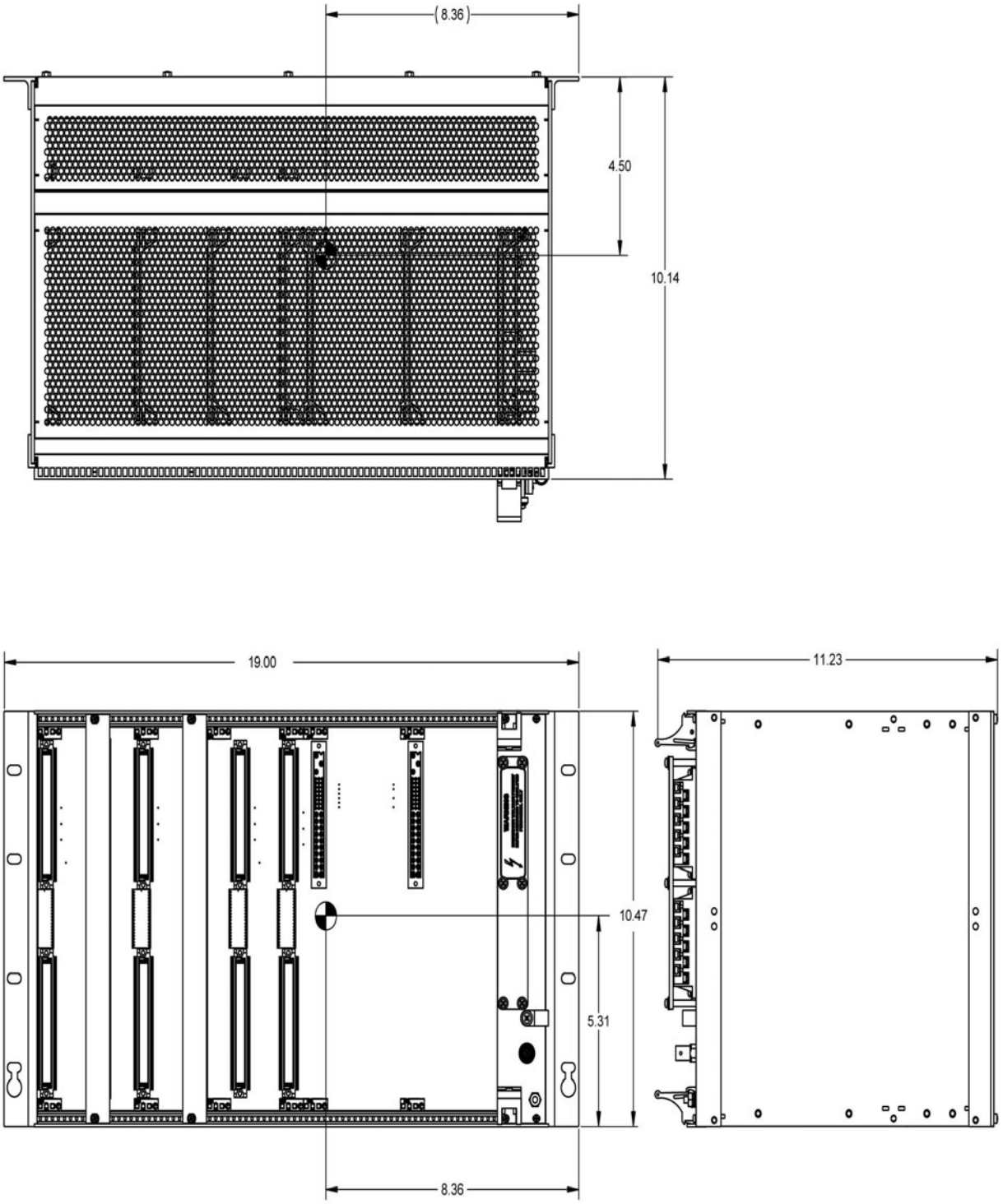
The Multilin P30 cannot be ordered with 2 different power supplies. The redundant power supply must be the same model as its mate.

Mechanical Installation

The Multilin P30 is based on an industry standard VME mechanical design and takes the form of a standard 6U 19" VME chassis. Furthermore, the hardware has been designed so all its input and output ports face to the rear, once the Multilin P30 is mounted.

Dimensions

Figure 2-5: Multilin P30 dimensions



Handling/Safety Precautions

ELECTROSTATIC DISCHARGE NOTICE

Electrostatic discharge can damage the Multilin P30 unit. To prevent ESD please read the following cautions and warning:

NOTICE

When working with the chassis of a unit not in operation, the unit must be placed on a grounded anti-static mat. If the chassis cannot be placed on a grounded anti-static mat, connect a grounding strap between the electrical input ground and the facility electrical service ground.

⚠WARNING

Depending on the chassis, open equipment enclosures and chassis can expose hazardous voltage which may cause electric shock to the installer. Be sure line power to the equipment is disconnected before servicing the chassis and components.

FIBER/LASER NOTICE

For fiber optic / laser devices, note the following warnings and notes:

⚠CAUTION

Products containing Class 1 optical/laser devices comply with:

- IEC60825-1

Invisible laser radiation may be emitted from disconnected fibers or optical/laser devices. Do not stare into beams or view directly with optical instruments as this may permanently damage your eyes.

⚠CAUTION

It is important to disconnect or remove all cables before removing or installing a board containing an optical/laser transceiver.

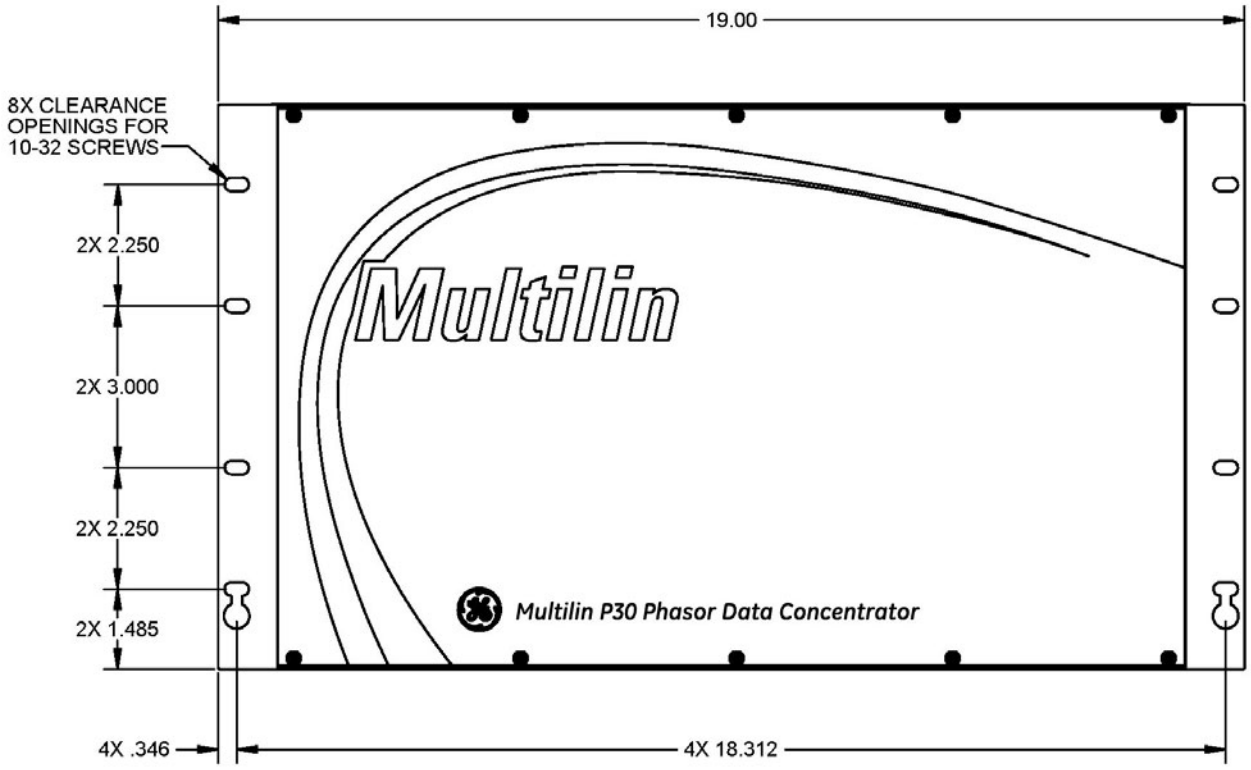
Do not leave an optical/laser transceiver uncovered except when inserting or removing a cable. The safety/dust plugs keep the port clean and prevent accidental exposure to laser light.

NOTE

Protect optical/laser devices by inserting clean dust plugs into the optical/laser device after the cables are extracted from them. Be sure to clean the optic surfaces of the fiber cables before plugging the dust plugs back into the optical bores of another device. Avoid getting dust and other contaminants into the optical bores of your device. The optics will not work correctly when obstructed with dust.

Mounting

Figure 2-6: Multilin P30 mounting



The Multilin P30's enclosure is intended for indoor use only. Do not place the Multilin P30 in environments where unusual conditions exist (windblown dust and dirt, liquids, etc.).

The Multilin P30 is mounted with 10-32 screws, to a standard VME rack mount system. Ensure that it is protected from falling debris during installation; small metal particles can drop through the ventilation holes at the top of the Multilin P30 possibly damaging, or interfering with, safe operation of the unit. If you cover the unit for maintenance, remove the cover before operation in order to provide necessary airflow for cooling.

To mount the Multilin P30 in a rack:

1. Unpack the Multilin P30.
2. Inspect the Multilin P30 for damage. Report any damage immediately to GE.
3. Align the Multilin P30 in the desired position in a 19" mounting rack.
4. Holding the Multilin P30 firmly in place in the rails of the mounting rack, install and tighten the eight rack screws.

NOTE

The Multilin P30 requires 2 U of free space between any devices/obstructions that may reside above and below it. (1 U = 1.75 inches (44.5mm))

NOTE

Use of this equipment in a manner not specified by GE may impair the intended operation of the device.

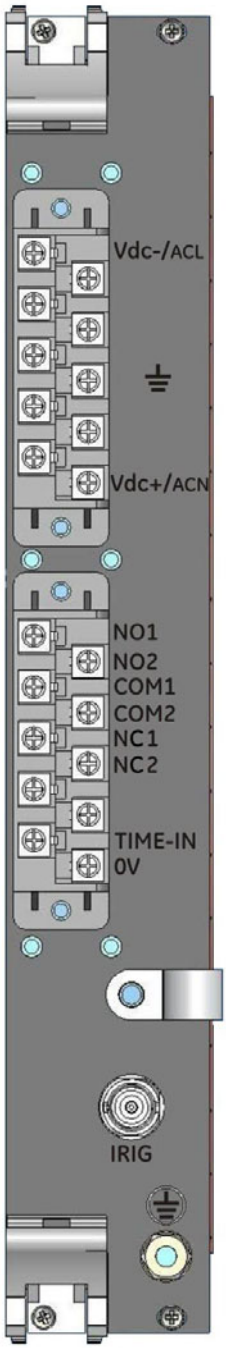
NOTE

For reasonable clearance, allow at least 14" of total cabinet depth to provide clearance for hardware and cables on the rear of the Multilin P30.

You are now ready to connect all power and communication wiring to the back of the Multilin P30 . Please refer to relevant sections of this manual.

Electrical Installation

All electrical connections to the Multilin P30 must be made on the device's input power board.



To make the terminal block connections, you will have to remove the protective plastic safety cover. Ensure that the cover is replaced once the desired connections are made. The power input board is clearly marked with the purpose of each terminal block position.

Control Power

As indicated by the input power board silkscreen, all input power connections are to be made at the upper terminal block. The Multilin P30 may accept either DC or AC input power depending on the power supply that is ordered with the device. Please refer to the product order code for further information.

Vdc-/ACL Input:

- Negative if DC input
- Line if AC input

Vdc+/ACN Input:

- Positive if DC input
- Neutral if AC input

Ensure the ground connection on the power input terminal is always assigned.

Ensure the ground stud connection on the input power board is always connected before operating the Multilin P30.

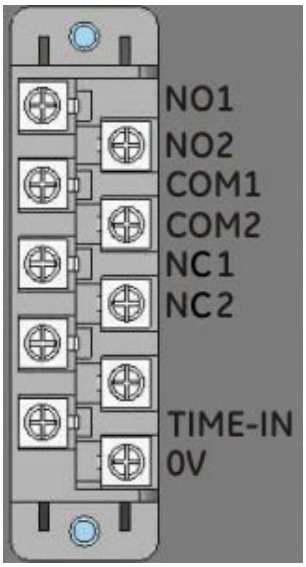
To prevent the possibility of electric shock, the Lexan terminal block cover should be replaced after all electrical connections have been made.

Field crimped terminal lugs used on the Multilin P30 must be of a type which is insulated. Uninsulated body terminal lugs will pose a potential risk of shock to the end user.

Critical Fail Relay

The Multilin P30 provides DC GOOD outputs for each power supply to indicate when either of the power supplies fitted in the device fail to provide DC power to its single board computers.

The DC GOOD outputs are provided via a FORM-C, dry contact output so that users can choose to drive external signals via either a normally-closed or normally-open contact output. All connections to the DC good signal must be made to the lower terminal block:



The NO1/NC1 signals pertain to the power supply closes to the left-hand side (facing) power supply, while the N02/NC2 signals pertain to the right-hand power supply.

Serial Communications

NOTE

When communicating with the serial port of the Multilin P30, it is important to use the optical isolator that was provided with the device.

The Multilin P30 Phasor Data Concentrator is equipped with a serial port for initial commissioning and rudimentary diagnostics. A standard DB9 interface is supplied for serial connection. A null modem cable must be used to connect a PC to the Multilin P30 Phasor Data Concentrator.

A terminal program must be used on an external PC to communicate with the Synchrophasor Processor board via serial communications. The following serial port parameters must be provisioned in the terminal program for it to operate with the Multilin P30:

- 19200bps
- 8 data bits
- 1 stop bits
- No parity bit

NOTE

The serial port cannot be used to communicate with the Multilin P30 from the EnerVista P30 Setup software.

Command Line Interface

The Multilin P30 Phasor Data Concentrator has been equipped with a Command Line Interface (CLI) to simplify initial commissioning of the device. The CLI is not intended as a means for complete device configuration, but only as a means to setup Ethernet communications with the device, and as a means to reset the device back to factory defaults should a user want to default the system.

Because the CLI is intended as a means of initial configuration, default passwords will be required when logging into the CLI for the first time. Please see the *Security* section of this manual to obtain the default local passwords required.

The CLI is exclusively available on the serial port interface of the Multilin P30 Synchrophasor Processor board. The following operations are specifically supported:

- Authentication of local users
- Setting IP / DHCP parameters of the Synchrophasor Processor card console port
- Setting IP / DHCP parameters of the Historian card network port
- Listing the MAC addresses of the Synchrophasor Processor card
- Setting the system to factory default.
- Setting Static Route networks of the Synchrophasor Processor card.

In order to access any given command, users must be logged into the system with the appropriate privileges. Please see the *Security* section for further details.

The CLI also provides a Command Completion feature for user convenience. When you type the first few characters of a command and press the **tab** key, it will print all matching commands which start with the same characters as entered by the user. This is case sensitive.

Some commands require options or additional parameters. For these commands, the parameters should be enclosed in **" "**

Commands

Login

This operation is required to gain access to the CLI. The user must login with a locally defined user ID and password. The user will be unable to proceed with any further CLI commands without logging in.

The user may have to press the ENTER key in order to make the login command visible, if he is connecting to the P30 serial port after the machine has already bootstrapped.

Example:

```
Login: Administrator
Password: p123@PDCGE
```

After hitting **Enter** you should see the GECLI prompt as shown below:

```
GECLI #>
```

GetIP

This command is used to retrieve the IP Address, subnet mask and gateway for the concentrator console port.

Example:

To retrieve the IP address information for the console port use the following command (no parameters are required):

```
GetIP
```

The following output will be displayed on the serial console after this command is executed if DHCP is disabled:

```
systemIP: 3.94.248.138 netmask: 255.255.255.0 gateway:
3.94.248.1
DHCP: Disabled
```

The following output will be displayed on serial console after this command is executed if DHCP is enabled:

```
systemIP: 3.94.248.138 netmask: 255.255.255.0
```

DHCP: Enabled

Please note that when DHCP is enabled, the P30 will not display the gateway address assigned to the P30 console port.

SetIP

This command is used to set the IP Address, subnet mask, and gateway for the Synchrophasor Processor console port.

Example:

To set a static IP address use the following command:

```
GECLI #> SetIP "3.94.248.138 netmask 255.255.255.0 gateway
3.94.248.1"
```

The following output will be displayed on the serial console after this command is executed:

```
GECLI #> Console port network parameters were changed
successfully
Please execute command SetActiveConfiguration to activate
your changes
 systemIP:3.94.248.138 netmask: 255.255.255.0 gateway:
3.94.248.1
```

To enable dhcp use the following command:

```
GECLI #> SetIP "dhcp"
```

The following output will be displayed on serial console after this command is executed:

```
GECLI #> Console port network parameters were changed
successfully
Please execute command SetActiveConfiguration to activate
your change
systemIP:dhcp
```

GetHistorianIP

This command is used to retrieve the network parameters for the front ethernet port of the Historian.

Example:

```
GECLI #> GetHistorianIP
```

SetHistorianIP

This command is used to set the IP parameters for the console port of the Historian.

Example:

```
GECLI #> SetHistorianIP "3.94.248.136 netmask 255.255.0.0
gateway 3.94.244.1"
```

To enable dhcp

```
GECLI #> SetHistorianIP "dhcp"
```

SetActiveConfiguration

This command is used to activate new configuration changes which were performed using the Multilin P30 CLI interface.

The command will reboot the system so that new parameters can be activated.

Example:

```
GECLI #> SetActiveConfiguration
```

SetFactoryDefaults

This command restores the Multilin P30 Synchrophasor Processor to factory defaults. This includes all settings, local passwords, certificates, and events. As the console port network parameters are defaulted, a "Concentrator IP Changed" event will be written to the event record. This command does not require any parameters.

The Synchrophasor Processor automatically reboots to activate the default settings. Once activated, the console port is assigned the following default network parameters.

IP Address 192.168.1.10
Net mask 255.255.255.0
Gateway 192.168.1.1

***Example*:**

```
SetFactoryDefaults
```

The following output is displayed on a serial console after this command is executed:

```
Local users passwords set to default values
 copying file /romfs/Pdc.xml -> /tffs0/Pdc.xml
Configuration parameters were set to default values
successfully
 Rebooting in 10 seconds
```

ShowMacAddress

This command is used to display the MAC addresses of all the Ethernet ports present on the Synchrophasor Processor. Here is an example output for this command:

Example:

Mac Address for port 1: `00:D0:1C:0B:0B:BD`
Mac Address for port 2: `00:D0:1C:0B:0B:BE`
Mac Address for port 3: `00:30:F7:97:1D:8A`
Mac Address for port 4: `00:30:F7:97:1D:8B`
Mac Address for port 5: `00:D0:1C:0B:0B:BF`
Mac Address for port 6: `00:D0:1C:0B:0B:C0`

UpdateOrderCode

This command is used to update the Order Code in the field. The command allows adding/removing PMC hardware. After executing this command, the "SetActiveConfiguration" command must be executed to reboot the Multilin P30 . On reboot, the firmware will read the new Order Code and the PMC card becomes enabled/disabled. It is important to ensure that the PMC card is inserted/removed from the chassis before executing this latter command. In the case of an inconsistency between the Order Code and the actual hardware, the firmware will generate a corresponding Event.

The command verifies that the entered option is either "TX," "FX," or "XX".

General format:

`GECLI #> UpdateOrderCode` [option]

Possible Options:

```
GECLI #> PMC TX
GECLI #> PMC FX
GECLI #> PMC XX
```

***Example*:**

To add a copper PMC card option to the Order Code:

```
GECLI #>UpdateOrderCode "PMC TX"
```

To add a fiber PMC card option to the Order Code:

```
GECLI #>UpdateOrderCode "PMC FX"
```

To remove the option from the PMC card:

```
GECLI #>UpdateOrderCode "PMC XX"
```

ShowOrderCode

This command is used to read the current value of the Order Code string of the Multilin P30 .

General format:

```
GECLI #> ShowOrderCode
```

***Example*:**

```
GECLI #> ShowOrderCode
```

logout

Enter the logout command to exit the Multilin P30 CLI prompt. As the Multilin P30 does not allow simultaneous logins, the CLI user must logout to allow EnerVista P30 Setup to connect to the device.

***Example*:**

Enter logout command to log out of the CLI session:

```
GECLI #>logout
```

After this command is executed, the user should see the login prompt as follows:

```
GECLI #>Login:
```

SetSNR

This command is used to set the static route number, IP Address, subnet mask, and gateway for a static route. Use this command to change network settings to accommodate the additional static network routing for Multilin P30 ports that are not set to the default gateway.

This command also removes configured static routes, if they are configured to the default settings. The default static route setting, indicating a route is not configured, is destination 127.0.0.1, netmask 255.255.252.0, and gateway 127.0.0.1.

Use the ShowRoutes command to display configured network routes.

After setting static routes and completing any other CLI configuration changes, run the SetActiveConfiguration command to activate your changes.

For more information see Static Routing in the Theory of Operation Chapter.

A static route can only be set when the associated Ethernet port is connected to the network.

***Example*:**

```
GECLI #> SetSNR "SR1 10.2.2.0 netmask 255.255.255.0 gateway
10.3.1.100"
```

ShowRoutes

This command is used to display all configured static routes.

The IP address and netmask mask are shown in the Destination column, and the gateway in the Gateway column. Static route numbers are not indicated.

Only configured routes are displayed. The default static route setting, indicating a route is not configured, is not shown.

***Example*:**

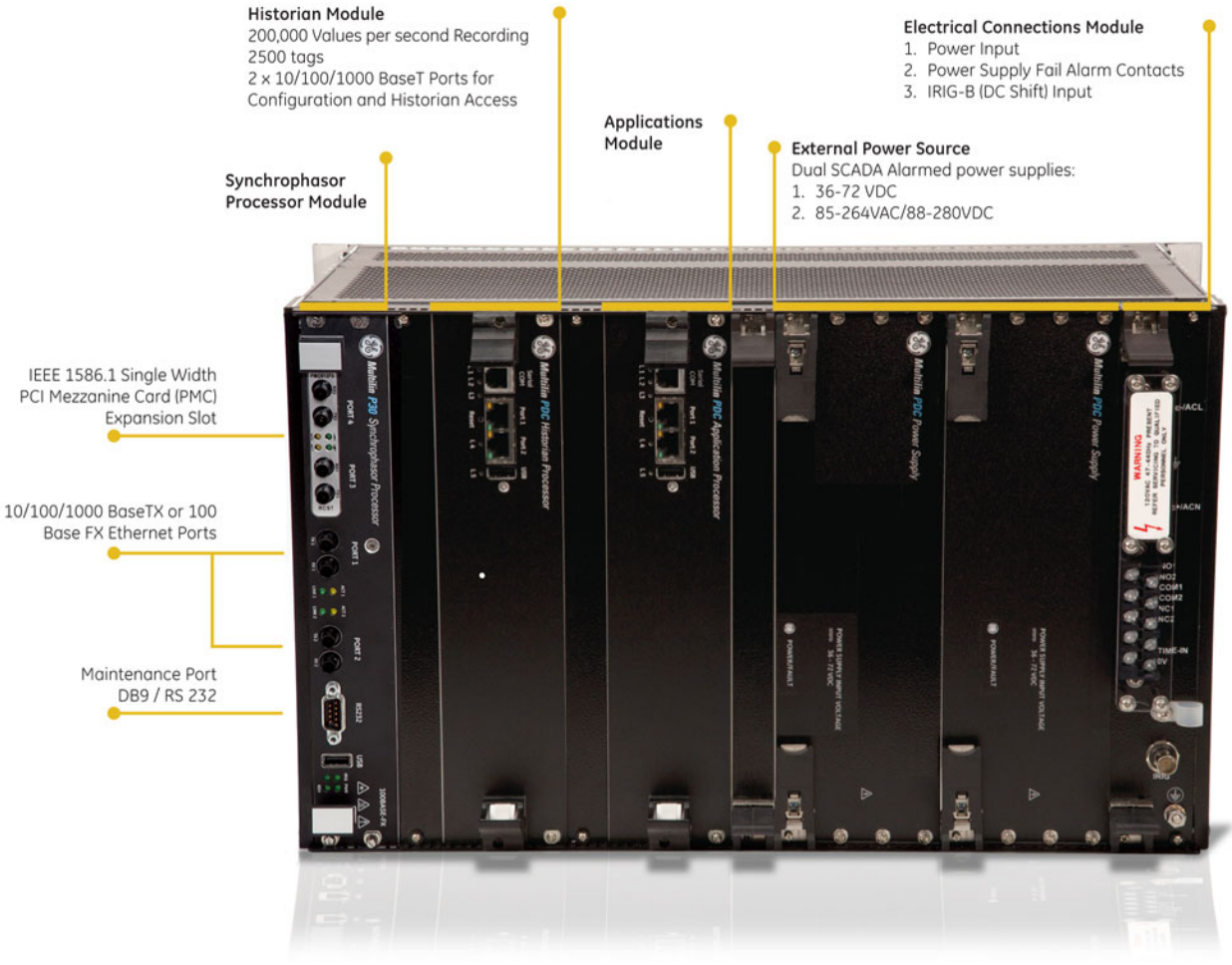
```
GECLI #>ShowRoutes
```

After this command is executed, the user sees configured routes displayed as follows:

```
GECLI #>
Destination     Gateway      Flags    Use    If       Metric
0.0.0.0/0       192.168.1.1 UGS      11     qefcc0   0
```

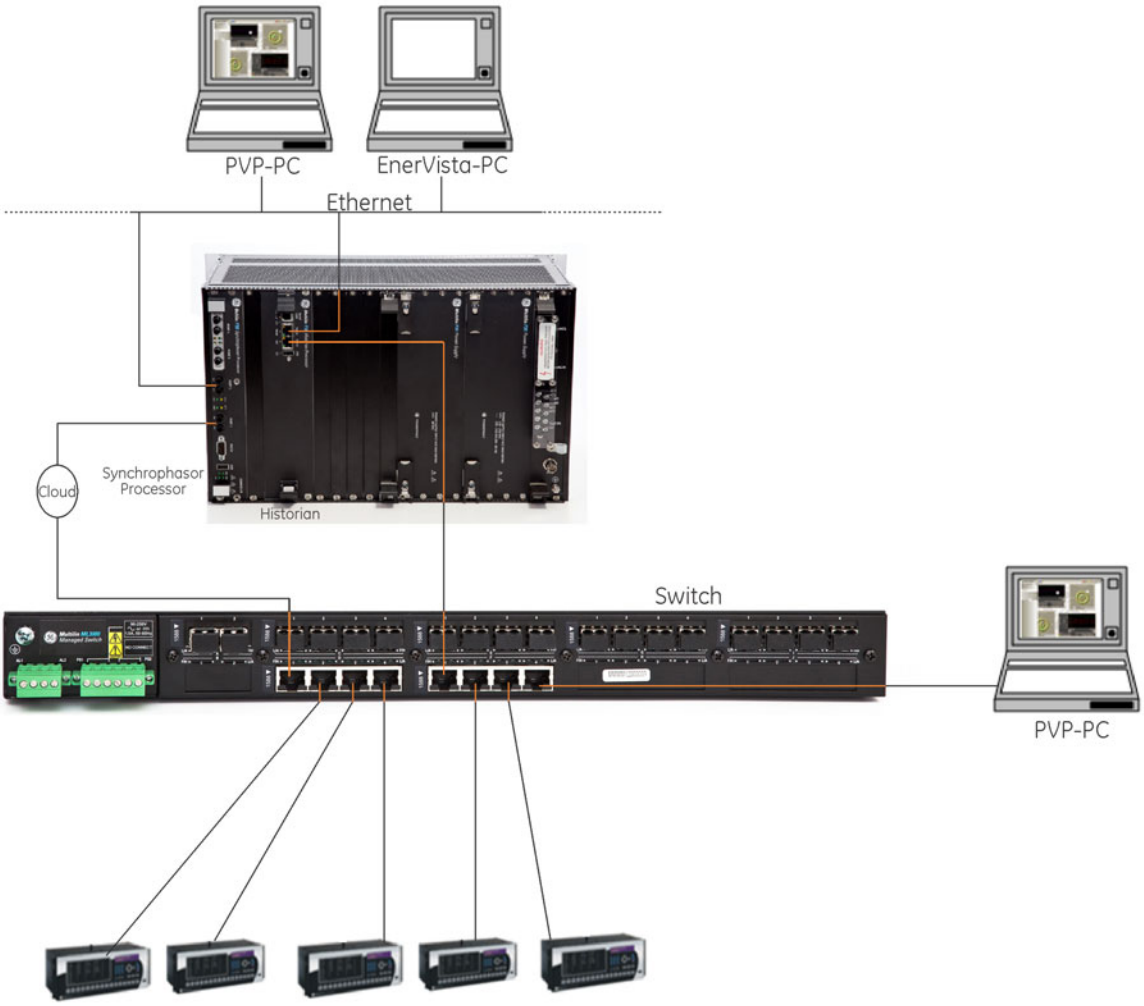
```
127.0.0.0/8     localhost    UR       0      lo0      0
3.94.247.0/24   3.94.248.1   UG       8      eth03    0
```

Wiring and Connection Details



Ethernet Communications

The diagram below shows the **external** communications surrounding a typical/expected network.



Synchrophasor Processor

The Multilin P30 Synchrophasor Processor standard configuration provides 2 Ethernet interfaces, either 10/100/1000BT or 100BASE-FX.

In each case, port 1 and port 2 are both intended to support IEEE C37.118 and IEC 61850-90-5 client and server traffic. Users may wish to connect these ports to a standard Ethernet switch to provide a large fan in which to accommodate up to 40 unique inputs. Refer to *Chapter 5 - System Setup* in this manual to determine how to map IEEE C37.118 traffic to an individual Ethernet port on the Multilin P30 device's Synchrophasor Processor.

Management traffic from EnerVista P30 Setup software is only supported on Ethernet Port 1 of the Synchrophasor Processor. As such, to communicate with the Synchrophasor Processor, the Synchrophasor Processor console port must be reachable from the PC on which the EnerVista P30 Setup software is installed.

In the case where the EnerVista P30 Setup software PC is directly connected to the console port, its IP address must be on the same subnet as the console port.

For security reasons, all management traffic between the EnerVista P30 Setup software and the Console port is encrypted.

NOTE

To balance traffic among ports on the Synchrophasor Processor, users may consider assigning each physical interface to a separate IP subnet. In this way traffic originating from separate subnetworks may be balanced across both ports.

NOTE

Certain Synchrophasor equipment may be configured to operate in Half-Duplex mode. To reduce transmission delay in the overall system, GE recommends setting all Ethernet ports to operate in full-duplex mode.

Historian Processor

The Multilin P30 Historian processor is equipped with two 10/100/1000BASE-TX Ethernet interfaces. These ports may be connected to a LAN to provide access to the data stored within the Historian.

The ports are also required to provide the EnerVista P30 Setup software with access to the Historian for configuration and firmware upgrades. By default both Historian Ethernet ports are preconfigured for DHCP. The Historian console port must be on the same network as the Synchrophasor Processor console port and the PC for EnerVista to properly communicate with the device.

The Multilin P30 Historian is also preconfigured with a default computer name, to simplify initial configuration of the device on a Windows Network. Please see the *Historian* section of this manual for further information. Users may wish to add the Historian Processor to an existing Windows Domain.

NOTE

Because the Historian processor is a "headless" Windows system, RDP (Windows Remote Desktop Protocol) access is required for any Windows-related configuration.

NOTE

GE recommends that the Historian be left in its factory default state, but that the default passwords associated with user accounts be changed. For security purposes, all critical Windows operating system parameters are defaulted to the factory default state when the Multilin P30 is restarted, with three exceptions. The following changes persist through a restart:

- Network and Collector-related configuration changes made with EnerVista P30 Setup.
- Network configuration changes made via the CLI.
- Changes made during a computer management session (refer to the Historian Commands section).

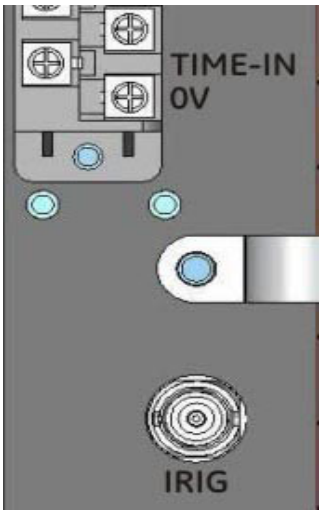
NOTE

In order to allow configuration of certain Historian features such as compression and dead-banding, the EnerVista P30 Setup software requires a TCP/IP connection to the Historian, through the Historian's Ethernet Port 1 only. Likewise, the GE EnerVista Synchrophasor Viewer (ESV) software also requires front panel Ethernet access to visualize data stored within the Historian. The EnerVista Synchrophasor Viewer software can be provisioned with the IP address of one of the Historian Ethernet ports. Please refer to the *EnerVista Synchrophasor Viewer* section of this manual for further details on the ESV software operation and its use.

IRIG-B

The Multilin P30 is intended to operate with a DC-Shift IRIG-B input; AM IRIG-B signals are not supported. Users must ensure that a valid IRIG-B signal is provided to the Multilin P30 for correct operation.

IRIG-B inputs can be provided via either a BNC connection or a two wire connection on the Multilin P30 device's power input board (PIB).



NOTE

The Multilin P30 cannot use IRIG-B output of the UR relay, as this is not a TTL signal. The Multilin P30 requires a 0 to 5 Volt, not a 10 Volt, peak to peak signal.

NOTE

Only DC-Shift IRIG-B input is supported; AM IRIG-B signals cannot be used.

NOTE

Initial Power-up: Because all versions of the IRIG-B standard do not account for the current year, users must set the Multilin P30 device's current year via the EnerVista P30 Setup program. The Multilin P30 will record an event in its event recorder if the year has not been set since power-up.

If the year has not been set in the Multilin P30 system, the EnerVista P30 Setup software will block the device from being set to the programmed state. Users are required to set the year when prompted to do so, before activating new settings.

Ordinarily setting the year is required only on initial power up. However, if the Multilin P30 system is powered down for more than 1 week, users will be required to set the year once again.

During ordinary operation, the Multilin P30 will inform users through its event recorder feature, of problems it detects with the IRIG-B signal. Should the quality of the signal become degraded, while the physical input is still connected to the Multilin P30 , an event will be generated. This event is also generated when the Multilin P30 detects a complete loss of signal.

The Multilin P30 maintains an internal timing mechanism to keep time, that can be leveraged when the external IRIG-B signal is degraded or lost, mid-operation. As such the Multilin P30 will continue to operate even when the IRIG-B signal is lost, but will mark all output time quality bits as required.

Should the external IRIG-B signal be restored, the Multilin P30 raises the appropriate event to indicate to the user that the external timing is once again available.

The Multilin P30 device's software algorithms can accommodate up to 2ms of drift between its internal timing mechanism and an external timing reference.

NOTE

The Multilin P30 flushes all its internal PMU buffers if, upon regaining an external timing reference, it detects greater than a 2ms difference between its own internal mechanism and the external reference. Should the internal PMU buffers be flushed, the Multilin P30 will write an appropriate event to its event recorder to inform the user.

NOTE

The Multilin P30 must be connected to a valid IRIG-B signal in order to carry out any installation / commissioning of the device.

Historian Local Clock

NOTE

The clock on the Historian Processor must be within five minutes of the clock on the PC running EnerVista P30 Setup software for it to communicate properly with the Historian Processor. See *Section 6 - IRIG-B Commands* for details on setting the clock.

The Historian card's local clock is synchronized to the Synchrophasor Processor's clock so that it is stable and accurate, which is necessary for the Historian card to function properly. The Historian Server will not start on boot-up until the difference between its clock and the Synchrophasor Processor's clock is less than a minimum threshold indicating that the clocks are synchronized. Collection of data from the Synchrophasor Processor card by the Historian card will not start on boot-up until their clocks are synchronized and the Synchrophasor Processor has received at least one valid update from an IRIG-B signal.

NOTE

The start-up of the Historian Server without the Synchrophasor Processor receiving an IRIG-B input on boot-up is to allow viewing of previously archived data.

If the Historian card is added to a Windows Domain, the clock(s) in the domain time server(s) must be synchronized with an IRIG-B clock, with an error margin of 10 seconds. If this requirement cannot be met, the system registry of the Historian card must be modified using regedit.exe tool in a computer management session after the card joins the domain, as follows:

Edit:

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\W32Time\Parameters\Type, so that its value is NTP (of type REG_SZ).

NOTICE

It is important to note that for Multilin P30 devices equipped with an active Historian processor, special considerations must be made when transitioning the Multilin P30 system between local and UTC IRIG-B inputs. Shifting the system between UTC and local time settings without following the appropriate procedure may result in the Historian becoming unresponsive. Should this happen, only GE personnel will be able to recover the system.

To switch the system from UTC to local time or vice versa please use the following procedure:

1. Disable streaming from the Multilin P30 using the EnerVista P30 Setup software. Refer to Chapter 5: *P30 Synchrophasor Processor Settings* > *Multilin P30 Setup* > *Installation* (**EnerVista Path**: **Device > Settings > Product Setup > Installation**)
2. Set the Multilin P30 to use either UTC or local time.
3. Set the IRIG-B clock to transmit the same time format just set on the Multilin P30.
4. Restart streaming from the Multilin P30 device.

GE
Grid Solutions

Multilin P30

Chapter 3: Multilin P30 Security

The Multilin P30 has been designed with advanced security features that provide:

- Centralized user profiles (Customer Furnished RADIUS server required with EAP-TTLS encryption between the Multilin P30 and the RADIUS server)
- Secure local passwords
- Encrypted data transmission between the EnerVista P30 Setup software and the Data Concentrator
- Secure firmware upgrades.

The Multilin P30 can be accessed using remote or local user IDs. Remote user IDs must reside on an external RADIUS server, and must be provided with the requisite user role (described below). Roles can be specified in the RADIUS server's configuration file for users.

The Multilin P30 is also supplied with 5 default local accounts. While it is not possible to provide additional local accounts or rename the accounts, it is possible to change the password for Administrator, Observer, and Engineer user accounts (see *Section 5: Settings > EnerVista P30 Setup > Security*).

The duration of a user session is controlled by an inactivity timer. If the Multilin P30 determines that no user activity has occurred for the user-configurable duration, the session will be closed and the user will be automatically logged out. The Inactivity Timeout setting has a minimum of 2 minutes, a maximum of 30 minutes, and a default value of 5 minutes.

EnerVista P30 Setup software functions that poll the Multilin P30 device, are considered to be activities that will prevent the inactivity timer from elapsing. For example, if the Trending screen is left active, the inactivity timer will be reset each time the Multilin P30 is polled by the software.

User Roles

The Multilin P30 provides user roles to limit levels of access to various device functions. The table below lists the roles that are supported and their corresponding capabilities. The Multilin P30 differentiates between the user roles and allows read/write/execute access to settings, commands, and values only according to the permissions defined for each role.

The local Restore account has been supplied to reset the Multilin P30 to factory default settings. Its password can never be reset, and it requires physical access as it can only be used via the serial port and CLI interface.

Table 3-1: Ethernet Interface Permissions

	Observer	Engineer	Administrator	Restore
Security Settings	R	R	RW	-
Local Administrator Password	-	-	W*	-
Local Engineer Password	-	-	W*	-
Local Observer Password	-	-	W*	-
Restore Password	-	-	-	-
Event Recorder Settings	R	RW	RW	-
Network Settings	R	RW	RW	-
Installation Settings	R	RW	RW	-
Historian Settings	R	RW	RW	-
Power System Settings	R	RW	RW	-
Input Configuration Settings	R	RW	RW	-
Pseudo PMU Settings	R	RW	RW	-
PMU Manager Settings	R	RW	RW	-
Output Configuration Settings	R	RW	RW	-
PMU Selection Settings	R	RW	RW	-
Basic Commands (Clear Event Recorder)	-	X	X	-
Basic Commands (Apply Configuration)	-	-	X	-
Date and Time Commands	-	X	X	-
Actual Values	R	R	R	-
Firmware Update	-	-	W	-
Clear Event Recorder	-	X	X	-
Activate New Configuration	-	-	X	-
Reset ConfRev	-	-	X	-
Analyze CPU Load	-	-	X	-
Stop Streaming	-	-	X	-

* This action applies only to Local Administrators.

Table 3-2: Command Line Interface permissions

	Restore	Observer	Engineer	Administrator
SetHistorianIP				X
SetIP				X
SetFactoryDefaults	X	X	X	X
SetActiveConfig				X
SetSNR				X

R = Read

W = Write

X = eXecute

Remote user accounts cannot change their own remote passwords from the Multilin P30 , as these passwords must be changed at the RADIUS server itself.

EnerVista P30 Setup will allow only Administrators to write an offline settings file.

Password Complexity Policy

The Multilin P30 includes a static password complexity policy to which all local user passwords must adhere. The password complexity policy requires an alpha-numeric password (for all accesses - front panel and network ports) that meets the following requirements:

- Passwords cannot contain the user's account name that exceed two consecutive characters.
- Passwords must be at least six (to 245) characters in length.
- Passwords must contain characters from three of the following four categories:
  - English uppercase characters (A through Z)
  - English lowercase characters (a through z).
  - Base 10 digits (0 through 9).
  - Non-alphabetic characters (for example, ~, !, @, #, $,%, &).

If a user selects a password that does not comply with the complexity rules, he will be informed that the selected password won't be used, and he will be prompted to select a password that meets complexity guidelines.

Lockout

The Multilin P30 provides a security feature to protect against login attacks from a remote IP address (over Ethernet). If the Multilin P30 detects 3 failed authentication attempts from a single IP address within 3 minutes, it will block all subsequent authentication attempts from that IP address for the following 3 minutes. Lockout information is volatile, and does not survive a device restart.

The Multilin P30 firmware contains the following configuration parameter for notification of failed authentication attempts:

- **Failed Authentications**: A threshold number of failed authentication attempts that indicates when a Pseudo PMU signal will be asserted. On restart of the Multilin P30, the pseudo PMU is cleared. See the *Pseudo PMU* and *Multilin P30 Synchrophasor Processor Settings* sections for more information.

The Multilin P30 does **not** protect against invalid login attempts from the serial interface, as interaction with the serial interface requires physical access to the device anyway.

Remote Authentication

NOTICE

Remote Authentication connection requires a valid IRIG-B connection to the Multilin P30 in order to function. Without a valid IRIG-B signal, a user account will NOT be able to connect to the Multilin P30 .

To use a RADIUS server, users must provide the system with the IP address of the RADIUS server that contains the user accounts to be used with the Multilin P30.

NOTE

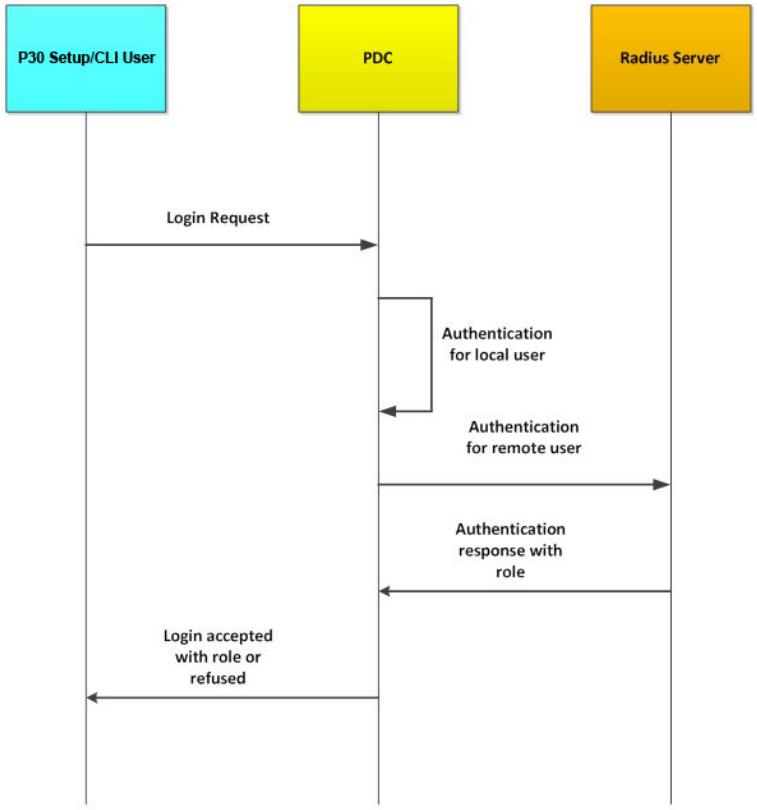
Configuration of RADIUS authentication requires an administrative understanding of RADIUS.

NOTE

A user with Administrator permissions may provide the IP address information of the RADIUS server that is to be used with the Multilin P30.

The Multilin P30 has been designed to automatically direct authentication requests to either the local user account database or a configured RADIUS server, based on user names. In this respect, local account names on the Multilin P30 should be considered as reserved, and not provided on a RADIUS server.

The Multilin P30 automatically detects whether an authentication request should be handled remotely or locally. When an external RADIUS server is used for central account management and remote authentication, the Multilin P30 will forward all authentication requests for non-local user accounts to a remote RADIUS server, and no authentication will be managed at the Multilin P30 itself.



As there are only 5 local accounts instantiated on the Multilin P30, if the user ID credential does not match one of the 5 local accounts, the Multilin P30 will automatically forward the request to a RADIUS server should one be provided. If the User ID matches a local account, the PDC will authenticate login requests locally. The Multilin P30 uses EAP-TTLS to secure the authentication process between itself and the RADIUS server.

Furthermore, the Multilin P30 requires users to provide a public key signed by a CA, to guarantee authenticity of the RADIUS server it has been commissioned to use.

If a RADIUS server is configured in the Multilin P30, but is unreachable over the network, remote authentication requests will be denied. In this situation, it is suggested that users leverage local Multilin P30 accounts to gain access to the Multilin P30 system.

NOTE

The local Administrator will remain active even after Local Authentication is disabled.

NOTE

See the specific RADIUS server instructions for information on how to provide user accounts and user roles on the RADIUS server itself. User roles provided in the server must conform to those specified above.

Remote user IDs must reside on an external RADIUS server, and must be provided with the requisite user role (described below). Users can be specified in the RADIUS server's configuration file for users. Roles can be specified in the RADIUS server dictionary. Roles that can be specified on the RADIUS server are: **Administrator**, **Engineer**, **Observer**.

NOTICE

Multilin P30 user ID length is limited to a maximum of 50 characters.

Example (FreeRADIUS):

In the file 'users':

```
exampleusername User-Password == "examplepassword"
 GE-PDC-USER-Role = Administrator,
```

In the file 'dictionary.ge':

```
# GE-PDC-USER-Role
 VALUE GE-PDC-USER-Role Administrator 2
 VALUE GE-PDC-USER-Role Engineer 1
 VALUE GE-PDC-USER-Role Observer 0
```

NOTE

Restore account role cannot be created remotely, and is confined to the local system.

Local Authentication

Administrator, Engineer and Observer, and Restore are the only local users available on the system. Local accounts cannot be added to the system.

All passwords for local accounts are set to default values when the system is restored. All local passwords are encrypted.

Default Passwords:

ADMINISTRATOR ID: "Administrator"

ADMINISTRATOR PASSWORD: "p123@PDCGE"

ENGINEER ID: "Engineer"

ENGINEER PASSWORD "p123@PDCGE"

OBSERVER ID: "Observer"

OBSERVER PASSWORD "p123@PDCGE"

RESTORE ID "Restore"

RESTORE USER PASSWORD "$ra772ser"

Historian Security

Should the Multilin P30 be equipped with a Historian processor card, user access to the Historian can be directly managed by an existing Windows Domain if the card is added to that Windows Domain.

By default the Multilin P30 Historian has been preconfigured with the local groups shown below. These local groups have specific permissions and capabilities assigned to them. Please see the table below for the permission assigned to each group:

	PDCPowerUsers	PDCAdmins
Settings	RW	RW
File Retrieval	R	R
Product Info	R	R
Stop Historian Application	X	X
Start Historian Application	X	X
Restart Historian Application	X	X
Revert Pending Configuration	X	X
Enable/Disable Remote Desktop	-	X
Recreate Archive Files	-	X
Restart Historian Card	-	X
Shutdown Historian Card	-	X
Start Computer Management Session	-	X
Firmware Update	-	X

R = Read

W = Write

X = eXecute

Default local account on passwords:

UID: “PdcAdmin” PASSWORD: “p123@PDCGE”

For ESV users who need only read access to the Historian processor, use this account:

UID: "PdcReader", Password: "rp30@PDCGE"

For accessing Historian Processor from an EnerVista(TM) Grid Engineer node, use this account:

UID: "PdcWriter", Password: "wp30@PDCGE"

It is again strongly recommended that these default passwords be changed in a computer management session prior to production use. To enter a computer management session, use the EnerVista Historian > Commands screen.

Firmware Upgrade Security

To ensure that it cannot be hijacked by illegitimate firmware, the Multilin P30 will prevent the installation of unauthorized firmware during field firmware upgrades. The Multilin P30 recognizes only firmware that is signed by GE, which can be obtained from the GE website. Operation of this feature is transparent to the user.

The firmware upgrade process has also been designed to be recoverable, by using 2 firmware storage banks. If either a power or communication interruption occurs during the firmware upgrade process, the system may be recovered by rebooting the Multilin P30 system so that firmware from the unaffected bank replaces that of the affected bank.

GE
Grid Solutions

Multilin P30

Chapter 4: The EnerVista P30 Setup Interface

Handling the EnerVista P30 Setup Software

As a hardened, embedded systems device, the Multilin P30 does not incorporate an external keypad for user input. As such a PC must be used to download settings through the Multilin P30's communications port. The EnerVista P30 Setup software is available from GE Grid Solutions to make this as convenient as possible. With EnerVista P30 Setup running, it is possible to:

- Program and modify settings
- Load and save setting files to and from a disk
- Read actual values
- Monitor status
- Get help on any topic
- Upgrade the PDC firmware.

The EnerVista P30 Setup software allows immediate access to all Multilin P30 features with easy to use pull down menus in the familiar Windows environment.

This section provides the necessary information to install EnerVista P30 Setup, upgrade the Multilin P30 firmware, and write and edit Setting files.

The EnerVista P30 Setup software can operate without a Multilin P30 connected to the computer. In such a case, settings may be saved to a file for future use. If a Multilin P30 is connected to a PC and communication is enabled, the Multilin P30 can be programmed from the setting screens. In addition, measured values, and status can be displayed with the actual value screens.

Hardware and Software Requirements

The following requirements must be met for the EnerVista P30 Setup software.

- One of the following Operating Systems:

Operating System	EnerVista P30 Setup software version
Microsoft Windows 7 – 32-bit or 64-bit	2.00 or higher
Microsoft Windows 8.1 – 32-bit or 64-bit	2.02 or higher
Microsoft Windows Server 2008 R2	2.02 or higher

- At least 2 GB of hard disk space
- At least 1 GB of RAM
- Microsoft .NET 2.0
- An Administrator account - required to install the application
- A Standard /Administrator account - required to execute the application once installed.

NOTE

Itanium systems are not supported.

Installing the EnerVista P30 Setup Software

NOTE

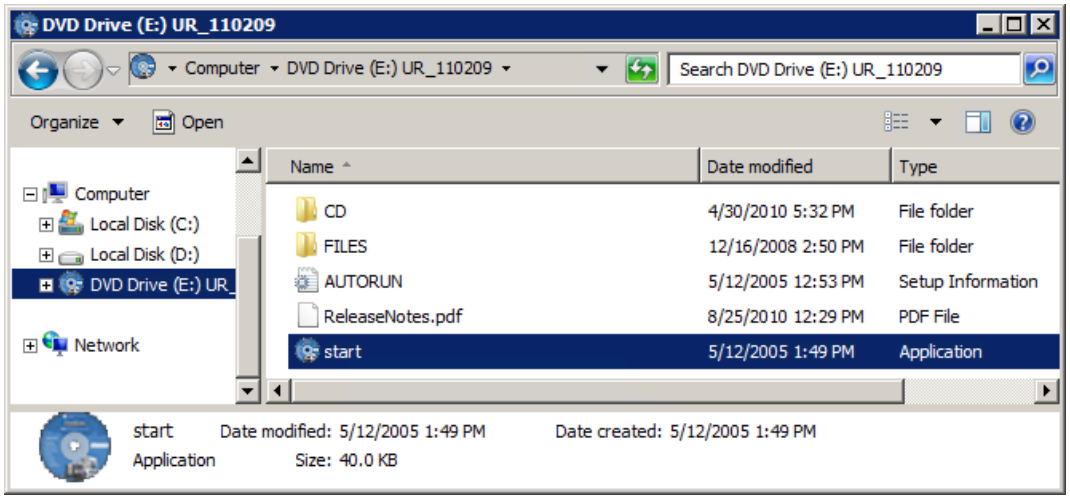
The EnerVista P30 Setup software can be installed from either the GE EnerVista CD or the GE Grid Solutions website at http://www.gegridsolutions.com.

After ensuring the minimum requirements indicated above, use the following procedure to install the EnerVista P30 Setup software from the enclosed GE EnerVista CD.

1. Insert the GE EnerVista CD into your CD-ROM drive.

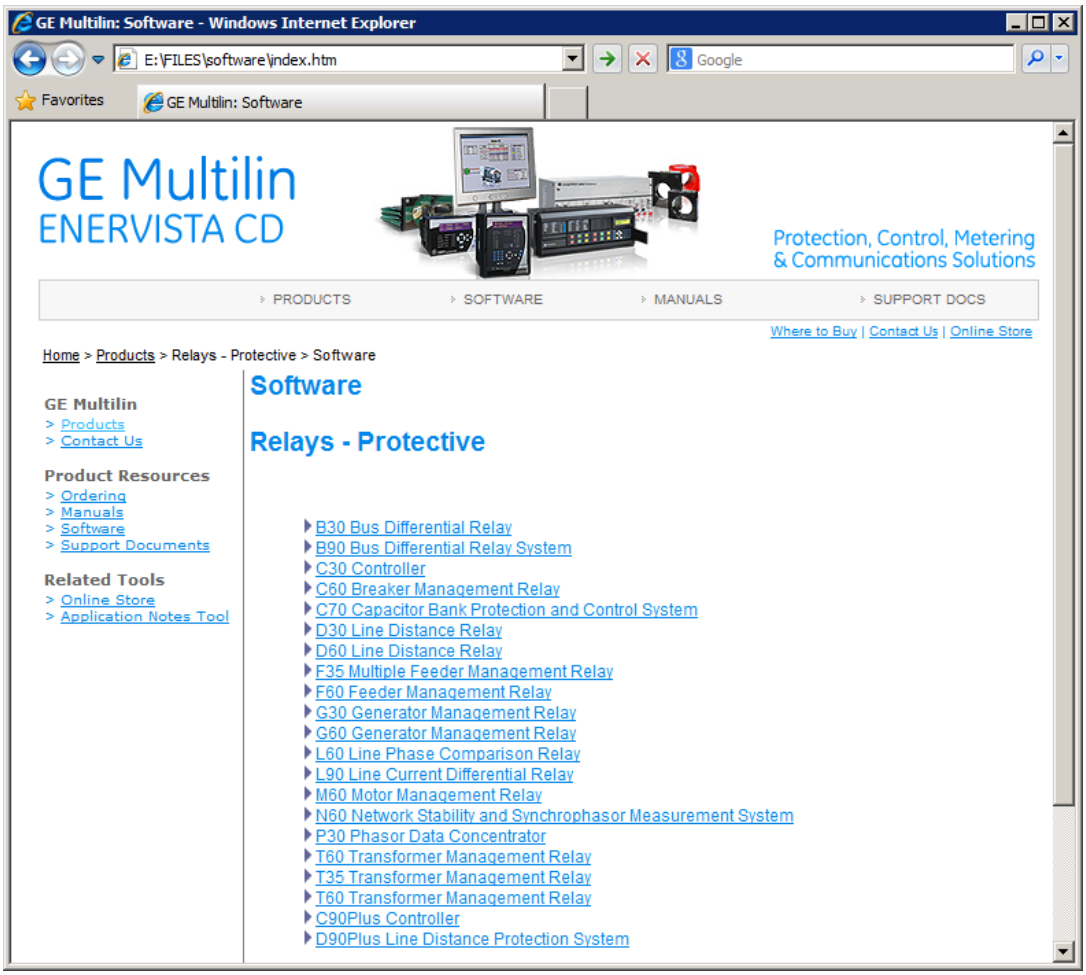
NOTE

If the "EnerVista CD" application does not automatically launch, navigate to the CD and double click on **start**.

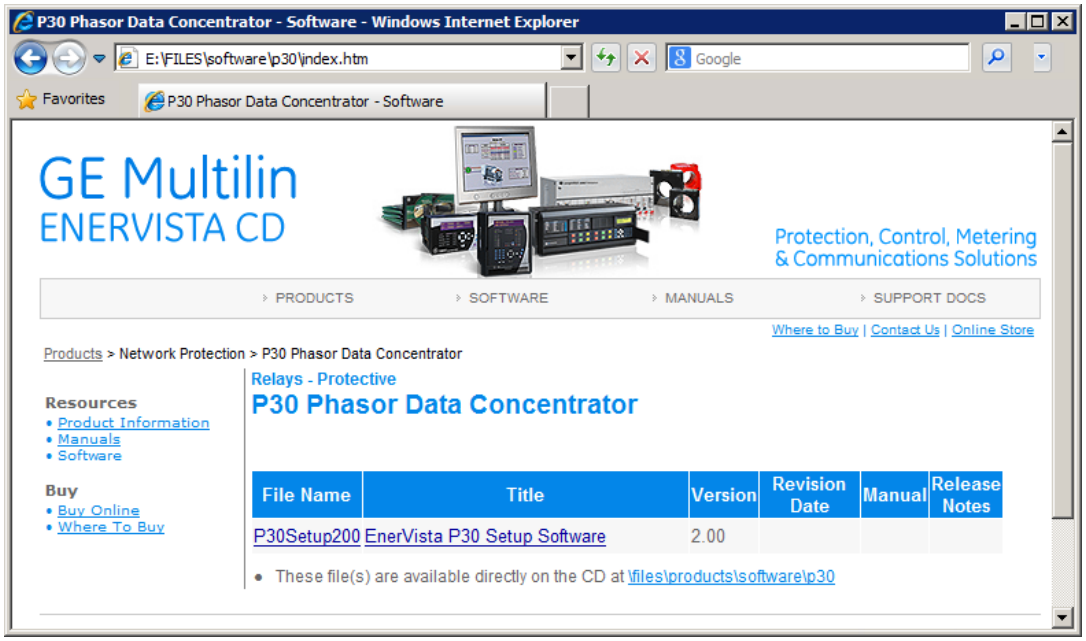


2. Click on the **Setup Software** button.

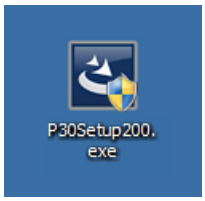
3. Click on the **P30 Phasor Data Concentrator** link.



4. Click either link (**P30Setup200** or **EnerVista P30 Setup Software**) to save the EnerVista P30 Setup installer.
   The browser will either save the Installer to the Downloads folder or prompt the user to select a location.



5. Once saved, double click the **Installer** application (shown below) and follow the on-screen instructions.



NOTE

Installation requires an Administrator account.

Connecting EnerVista P30 Setup Software to the Multilin P30

Ensure there is a TCP/IP link between the EnerVista P30 Setup computer and the Multilin P30 Synchrophasor Processor. If the Historian option has been purchased, ensure there is also a TCP/IP link between the EnerVista P30 Setup computer and the Multilin P30 Historian.

Configuring Serial Communications

The EnerVista P30 Setup program cannot be used to connect to the Multilin P30 via serial communications. However, serial communications must be used with a terminal emulator program to prepare the Multilin P30 for Ethernet communications.

Please refer to the CLI section of this manual to learn how to prepare the Multilin P30 for Ethernet TCP/IP communications using EnerVista.

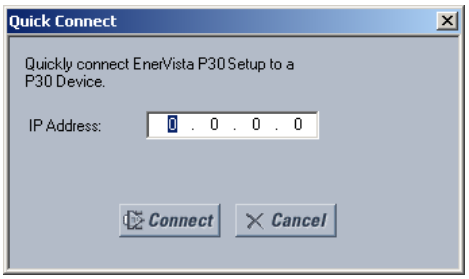
Using the Quick Connect Feature

The Quick Connect button can be used to establish a fast connection through the Multilin P30's console Ethernet port (port 1).

NOTE

The "Quick Connect" connection is normally used as a temporary connection. When the user quits EnerVista P30 Setup the device will be removed from the environment.

The following window will appear when the QuickConnect button is pressed:



When connected, a new Site called "Quick Connect" will appear in the Site List window. The Multilin P30 Device has now been configured via the Quick Connect feature for Ethernet communications. Proceed to *Configuring Ethernet Communications* below, to begin communications.

Configuring Ethernet Communications

Before starting, verify that there is a working Ethernet link between the Multilin P30 and the EnerVista P30 Setup computer.

NOTE

EnerVista P30 Setup supports a maximum of four concurrent connections to Multilin P30 devices.

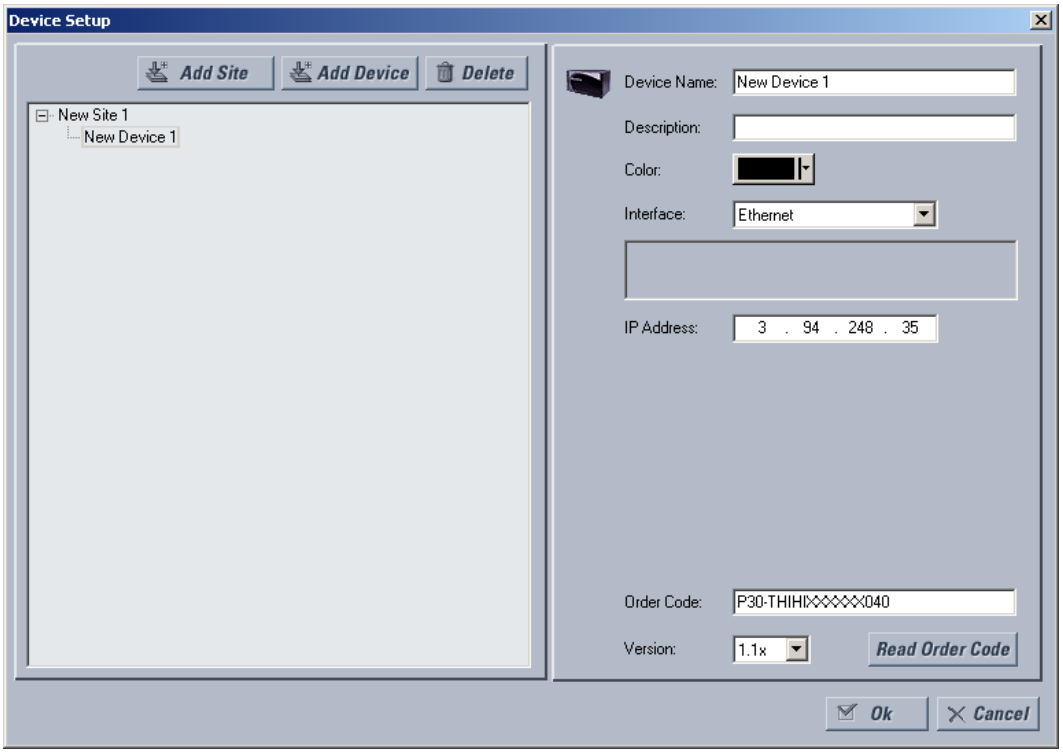
If the Multilin P30 Historian option has been purchased, ensure that there is also a TCP/IP link between the Multilin P30 Historian and the EnerVista P30 Setup computer.

NOTE

The Multilin P30 supports a maximum of one concurrent TCP/IP session.

1. Complete the procedure outlined in the "*Configuring Serial Communications*" section.
2. Click on the **Device Setup** button to open the Device Setup window and click the **Add Site** button to define a new site.
3. Enter the desired site name in the "Site Name" field. If desired, a short description of the site can also be entered.
4. The new site will appear in the upper-left list.
5. Click the **Add Device** button to define the new device.
6. Enter the desired name in the "Device Name" field, and a description (optional).

7. Select "Ethernet" from the Interface drop-down list. This will display the interface parameters that must be entered for proper Ethernet functionality.



8. Enter the IP address of the Multilin P30.
9. Click the **Read Order Code** button to connect to the Multilin P30 and to retrieve the device's Order Code. When prompted, enter your user name and password. Choose the 'local' option to authenticate using a built-in account, or choose 'remote' to be authenticated by the remote RADIUS server. If a communications error occurs, ensure that the Ethernet communication values correspond to the Multilin P30 setting values, and that nobody else is logged into the device.
10. Click **OK** when the Multilin P30 Order Code has been received. The new device will be added to the Site List window (or Online window) located in the top left corner of the main EnerVista P30 Setup window.

The Multilin P30 Device has now been configured for Ethernet communications. Proceed to the following section to begin communications.

Viewing Multilin P30 Device Definition Information

The following items are available for each device, in the EnerVista P30 Setup Online Window:

Path: Device > Device Definition > "Item"

- **Order Code**
- **Version**
- **Serial Number**
- **Description**
- **Interface**

Working with Settings and Settings Files

When configuration changes are performed in EnerVista P30 Setup, it must be activated for the changes to be applied. This can be done by sending a command called “Activate New Configuration,” as explained in the *Command* section of this manual. The lower-right portion of the EnerVista P30 Setup window indicates the revision number of the settings file that is being edited as well as the revision number of the settings file that was most recently activated. "Editing Rev" will automatically be incremented every time a settings window is saved and when a settings file is written to the device. If the revision numbers do not match, send the "Activate New Configuration" command to apply pending changes.

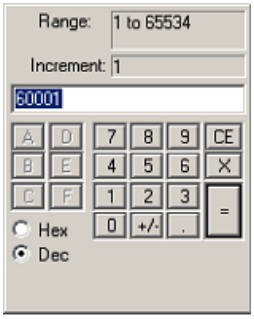
Please refer to the *Configuring Serial/Ethernet Communications* sections for information on how to set up communications with the Multilin P30.

Entering Settings into EnerVista P30 Setup

The Power System Setup page will be used as an example to illustrate the entering of settings. In this example, we will be changing the power system frequency settings.

1. Establish communications with the relay. When prompted, enter your user name and password. Choose the 'local' option to authenticate using a built-in account, or choose 'remote' to be authenticated by the remote RADIUS server.
2. Select the **System Setup > Power System** menu item.
3. Select the power system frequency by clicking the down arrow in the parameter box. For settings requiring non-numerical pre-set values, clicking anywhere within the settings value box displays a drop-down selection menu arrow. Select the desired value from this list.

4. In some cases, clicking the arrow at the end of the box displays a numerical keypad interface that allows the user to enter a value within the settings range displayed near the top of the keypad: Click **=** to exit from the keypad and keep the new value. Click on **X** to exit from the keypad and retain the old value.

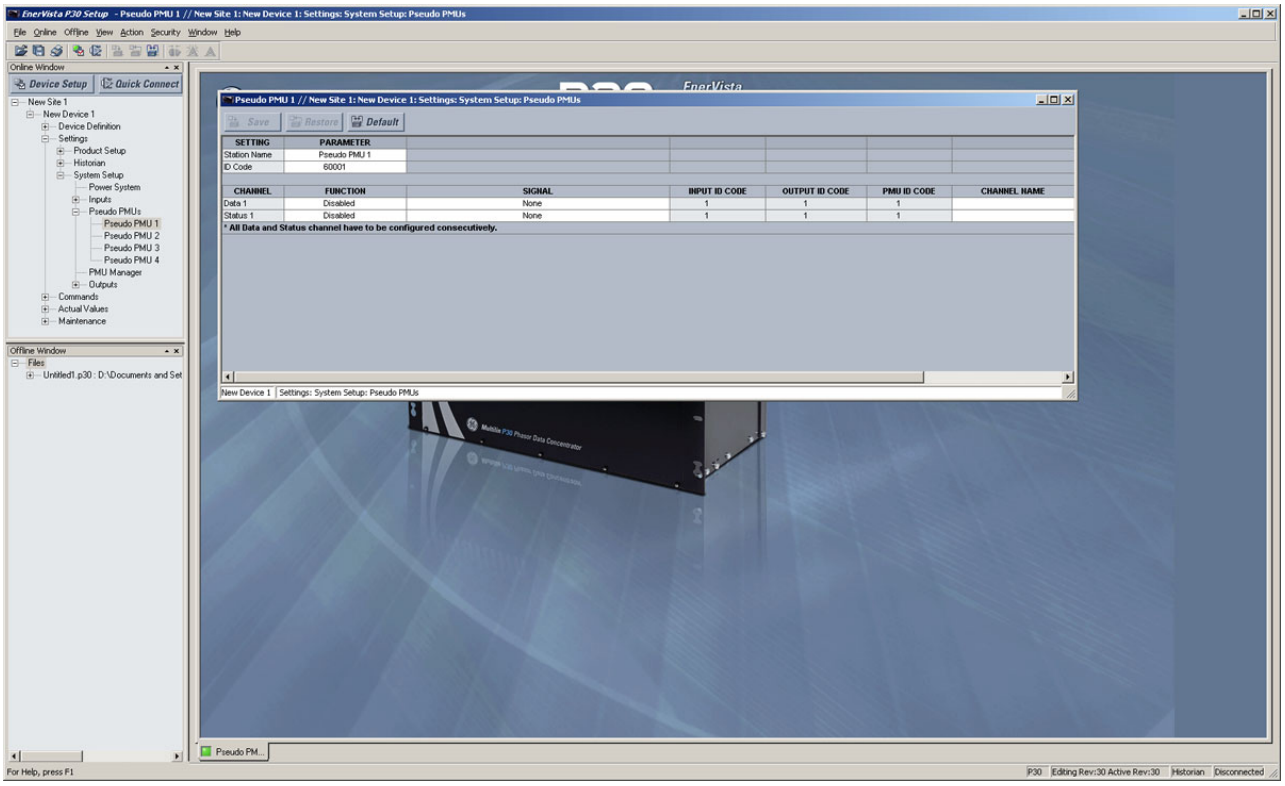


5. For settings requiring an alphanumeric text string (e.g. "P30 name"), the value may be entered directly within the settings value box.

NOTE

Multilin P30 supports 7-bit ASCII characters

6. Click on **Save** to save the values into the Multilin P30 . Click **YES** to accept any changes and exit the window. Click **Restore** to retain previous values. Click **Default** to restore default values.



7. For online devices, settings must be "activated" for the saved changes to take effect. This is explained in the “Activating Settings” section below.

File Support

Opening any EnerVista P30 Setup file will automatically launch the application or provide focus to the already opened application. If the file is a settings file which had been removed from the Settings List tree menu, it will be added back to the Settings List tree. New files will be automatically added to the tree.

Activating Settings

When working with online devices, saved settings remain in a "Pending" state until they are activated; changes do not take effect until they are activated. When connected to an online device, this information is shown in the Status bar in the lower-right portion of the application window. As this status information applies only to online devices, it is left blank when working with settings files. To activate all settings (both Synchrophasor Processor and Historian Processor settings), send the "Activate New Configuration" command, which is available via the following path: Device > Commands > Basic Commands.

Synchrophasor Processor: The Synchrophasor Processor maintains two revision numbers: one for the revision of the pending settings file, and one for the revision of the active settings file. The former increments every time settings are changed, and is displayed to the right of the text "Editing Rev". This can be compared with the most recently activated settings file revision, which is shown to the right of the text "Active Rev". If these two revision numbers do not match, there is a pending configuration change on the device.

NOTE

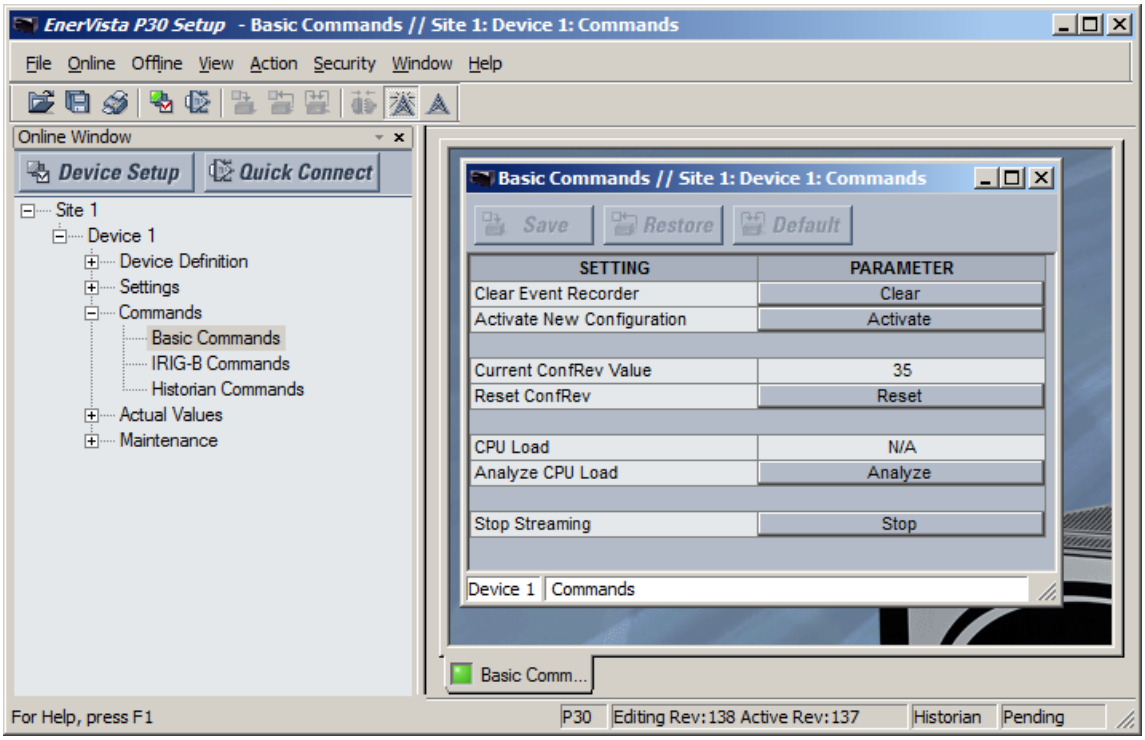
Pending Synchrophasor Processor changes will automatically be activated if power is lost.

Historian: If the Multilin P30 contains a Historian card, the software indicates "Pending" if there are setting changes that require the Historian application to be restarted, "Activated" if there are no pending changes, or "Disconnected" if EnerVista P30 Setup is not currently communicating with the Historian.

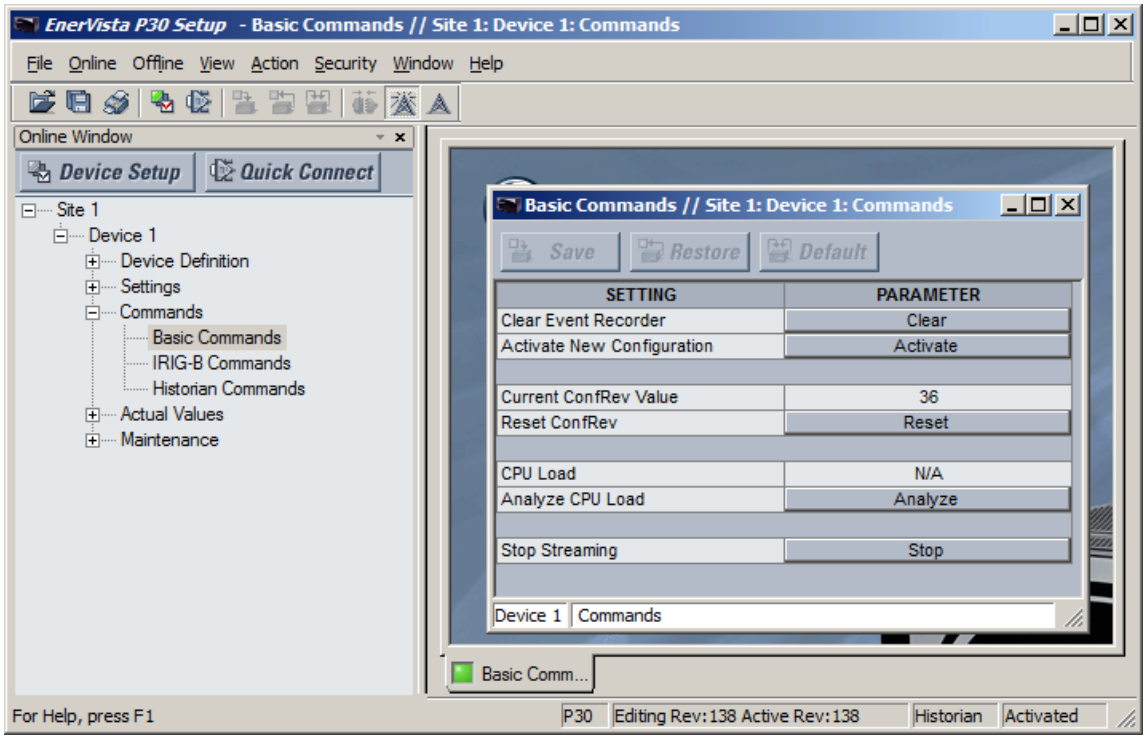
NOTE

Pending Historian Processor changes will automatically be activated when sending the "Restart Historian" command, which is available via the following path: Device > Commands > Historian.

Example: The screen below shows pending changes for both the Syncrophasor Processor and Historian Processor (note the boxes at the bottom right of the screen).



The screen below shows the changes activated after the "Activate New Configuration" button has been pressed (again, note the boxes at the bottom right of the screen).



Using Settings Files

The EnerVista P30 Setup software interface supports three ways of handling changes to Multilin P30 settings:

- In offline mode (Multilin P30 disconnected) to create or edit Multilin P30 Settings files for later download to communicating Multilin P30.
- Directly modifying Multilin P30 settings while connected to a communicating Multilin P30 , then saving the settings when complete.
- Creating/Editing Settings files while connected to a communicating Multilin P30 , then saving them to the Multilin P30 when complete.

Settings files are organized on the basis of file names assigned by the user. A Settings file contains data pertaining to the following types of relay settings:

- Device Definition
- Product Setup
- Historian (if ordered)
- System Setup.

Downloading and Saving Settings Files

NOTICE

It is highly recommended to save a settings file before performing a firmware update, changing settings, or restoring factory defaults.

The settings files in the EnerVista P30 Setup window are accessed in the Files Window. Use the following procedure to download and save settings files to a local PC:

1. Ensure that the site and corresponding device(s) have been properly defined and configured as shown in Connecting EnerVista P30 Setup to the Multilin P30 above.
2. Select the desired device from the site list.

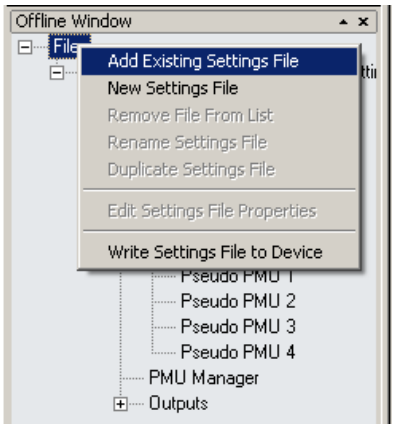
3. Select **Online > Read Device Setting**s from the Device menu item, or right-click on the device and select **Read Device Settings** to obtain settings information from the device.

4. After a few seconds of data retrieval, the software will request the name and destination path of the settings file. The corresponding file extension will be automatically assigned. Press **Receive** to complete the process. A new entry will be added to the tree in the File pane, showing path and file name for the settings file.

Adding Settings Files to the Environment

The EnerVista P30 Setup software provides the capability to review and manage a large group of settings files. Use the following procedure to add an existing file to the list:

1. In the files pane, right-click on **Files** and select the **Add Existing Setting File** item as shown:

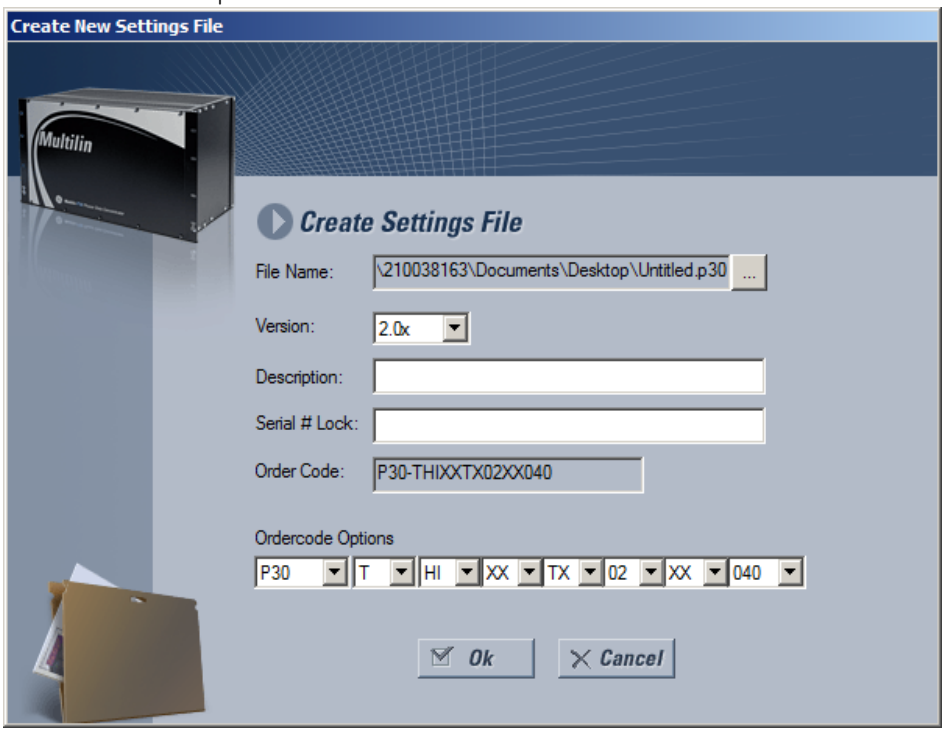


2. The "Open" dialog box will appear, prompting the user to select a previously saved settings file. As with any other MS Windows® application, browse for the file to be added then click **Open**. The new file and complete path will be added to the file list.

Creating a New Settings File

The EnerVista P30 Setup software allows the user to create new settings files independent of a connected device. These can be uploaded to a relay at a later date. The following procedure illustrates how to create new settings files:

1. In the File pane, right click on **File** and select the **New Settings File** item. The following box will appear, allowing the configuration of the settings file for the correct firmware version. It is important to define the correct firmware version to ensure that settings not available in a particular version are not downloaded into the Multilin P30.



2. Select the Firmware Version, and Order Code options for the new settings file.
3. For future reference, enter some useful information in the Description box to facilitate the identification of the device and the purpose of the file.
4. If this file is to be used with a specific Multilin P30 , enter the Serial Number of the device. The Serial Number Lock will prevent the file from being uploaded to a device with a different Serial Number.
5. To select a file name and path for the new file, click the button beside the "File Name" box.
6. Select the file name and path to store the file, or select any displayed file name to replace an existing file. All Multilin P30 settings files should have the extension 'P30' (for example, 'filename.p30').
7. Click **OK** to complete the process. Once this step is completed, the new file, with a complete path, will be added to the EnerVista P30 Setup software environment.

Upgrading Settings Files to a New Revision

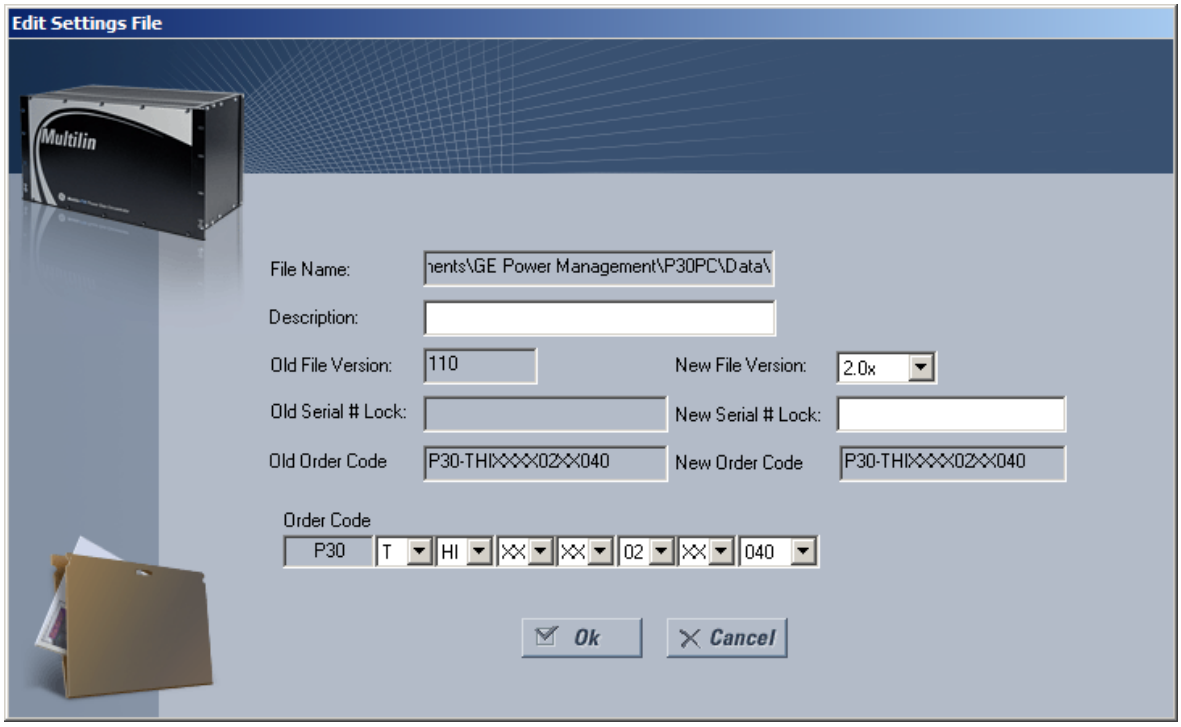
NOTE

This window allows the user to upgrade the firmware version, change the Serial Number lock and modify the Order Code. **Note that some previously configured settings can be lost when making a change to the Order Code**.

It is often necessary to upgrade the revision of a previously saved settings file after the Multilin P30 firmware has been upgraded. This is illustrated in the following procedure:

1. Establish communications with the Multilin P30.
2. Select the **Device Definition > Version** menu item and record the Firmware Revision.

3. Load the settings file to be upgraded, into the EnerVista P30 Setup environment as described in the section, *Adding Settings Files to the Environment*.
4. From the main window menu bar, select the **Offline > Edit Settings File Properties** menu item and note the File Version of the settings file. If this version is different from the Firmware Revision noted in step 2, select a New File Version that matches the Firmware Revision from the pull-down menu.
5. For example, if the firmware revision shows Firmware Revision 1.00) and the desired settings file revision is 2.00, change the settings file revision to "2.0x".



6. Enter any special comments about the settings file in the "Description" field.
7. Select the desired firmware version from the "New File Version" field.
8. Update the Device Serial Number to which the file will be locked.
9. When complete, click **OK** to convert the settings file to the desired revision. See *Loading Settings from a File* below, for instructions on loading this settings file into the Multilin P30.

Loading Settings from a File

An error message will occur when attempting to download a settings file with a revision number that does not match the Multilin P30 firmware. If the firmware has been upgraded since saving the settings file, see *Upgrading Settings Files to a New Revision* for instructions on changing the revision number of a settings file.

The following procedure illustrates how to load settings from a file. Before loading a settings file, it must first be added to the EnerVista P30 Setup environment as described in the section, *Adding Settings Files to the Environment*.

1. Select the previously saved settings file from the "File" pane of the EnerVista P30 Setup software main window.
2. Select the **Offline > Edit Settings File Properties** menu item and verify that the corresponding file is fully compatible with the hardware and firmware version of the target device. If the versions are not identical, see *Upgrading Settings Files to a New Revision* for details on changing the settings file version.
3. Right-click on the selected file and select the **Write Settings File to Device** item.

4. Select the target device from the list of devices shown and click **Send**.

If there are no incompatibilities between the target device and the settings file, the data will be transferred to the device. An indication of the percentage completed will be shown at the bottom of the main window.

Upgrading

For firmware upgrading details, please refer to *Chapter 8 - P30 Synchrophasor Processor Maintenance*.

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Multilin P30

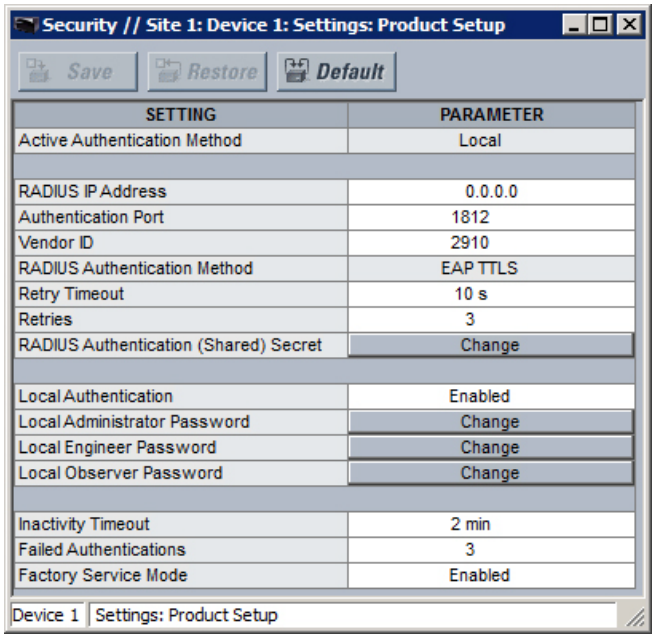
Chapter 5: Multilin P30 Synchrophasor Processor Settings

Product Setup

Security

EnerVista PDC Path: Device > Settings > Product Setup > Security

Figure 5-1: Enervista Security menu



Active Authentication Method**: Indicates whether the current session is using local or remote (RADIUS) authentication.

RADIUS IP Address: RADIUS will not be used if left at the default value: 0.0.0.0.

Authentication Port*: RADIUS IP Address Authentication Port

Vendor ID*: IANA RADIUS Vendor ID or locally assigned (local) ID

RADIUS Authentication Method**: The authentication protocol the Multilin P30 will use to authenticate with the RADIUS server. Only EAP TTLS is supported..

Retry Timeout*: Timeout in seconds in between re-transmission requests.

Retries*: Number of retries before the Multilin P30 considers the RADIUS server to be unreachable.

RADIUS Authentication (Shared) Secret: The shared secret as configured on the RADIUS server.

Local Authentication*: If enabled, users can log in using three different built-in accounts: Administrator, Engineer and Observer. A RADIUS server is not required. If disabled, the local Engineer and Observer accounts will be denied access. The local Administrator will continue to have access to the device.

Before setting Local Authentication to "Disabled," first enable, configure, and test RADIUS. Test your RADIUS connection by logging in with a remote account.

NOTICE

If Local Authentication is Disabled and the RADIUS server is not reachable, you will be temporarily locked out of the Multilin P30. To recover, log in with the local Administrator account, and update the RADIUS configuration.

Local Administrator Password**: Changes the password of the local Administrator account.

Local Engineer Password**: Changes the password of the local Engineer account.

Local Observer Password**: Changes the password of the local Observer account.

Inactivity Timeout: The length of inactivity required to return to an unauthorized state.

Failed Authentications: A threshold number of failed authentication attempts that indicates when a Pseudo PMU signal will be asserted. See the *Pseudo PMU* section for more information.

Factory Service Mode: When enabled (yes/checked selection) the device can go into Factory Service Mode. For this setting to become enabled a Administrator authentication is necessary.

*** This RADIUS/Local authentication setting will NOT be transferred to the device when writing an offline settings file to the device.**

**** These settings are not available for settings files. They are available only when connected to a Multilin P30.**

PASSWORDS

EnerVista P30 Setup will indicate any password requirement deficiencies. See *Section 3 - Security* for further Password details.

USER ROLES

See *Section 3 - Security* for further details on User Roles.

LOCKOUT

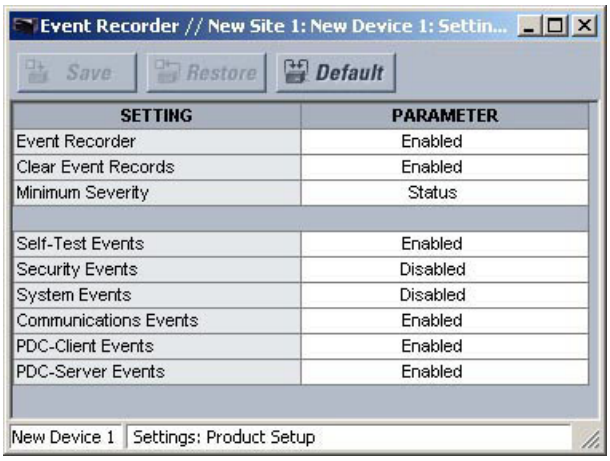
See *Section 3 - Security* for further details on Lockout.

Event Recorder

The event recorder Settings menu can be opened from the EnerVista path shown below:

EnerVista P30 Path: Device > Settings > Product Setup > Event Recorder

Figure 5-2: EnerVista Event Recorder menu



The setting options details of each item on the Event Recorder menu are as follows:

- **Event Recorder**: This setting enables or disables the event recording feature. By default, event recording is enabled. The user can see the recorded events in **Device > Actual Values > Records > Event Recorder**. Refer to the section, *Diagnosis and Event Recording* in this manual for further details on different types of events.
- **Clear Event Records:** This setting enables or disables the command to clear the Event Recorder. By default this is disabled, so the button for clearing the Event Recorder with the path, **Device > Commands > Basic Commands > Clear Event Recorder**, is disabled.

NOTE

In order to clear Event Records, the aforementioned must be set to "Enabled," which will enable the command, "Clear Event Recorder".

- **Minimum Severity**: Each event has been given a severity level in a particular event category, which can be: Critical, Major, Minor, Status. The parameter set in this field implies the minimum severity required for an event to be captured. For example, if Minimum Severity is set to Minor, the events having a severity of Minor, Major and Critical will be recorded by the Event Recorder in all categories. Refer to the section *Diagnosis and Event Recording* in this manual, for further details on the severity level of each event.

NOTE

Set the Minimum Severity parameter to **Status** in order to record all events from all categories.

Use the following settings to enable or disable logging of individual categories of events: Self-Test Events, Security Events, System Events, Communication Events, PDC-Client Events, PDC-Server Events. The default value of all of these event categories is **Enabled**, which implies that all events will be logged if Minimum Severity is set to "Status".

Refer to the section, *Diagnosis and Event Recording* in this manual for further details on categories of events.

Communication

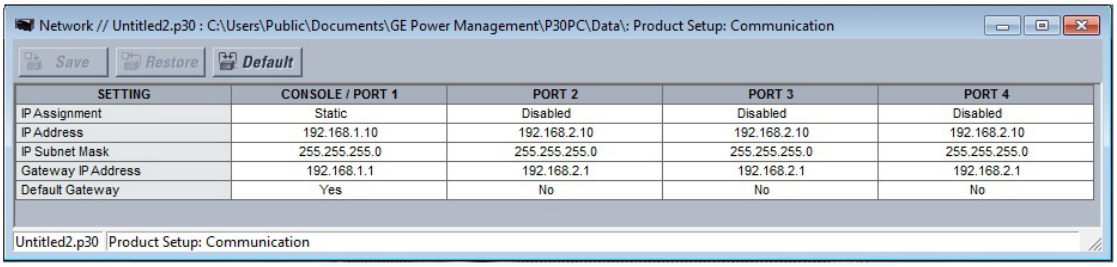
The settings menus in the Path **Device > Settings > Product Setup > Communication** are discussed in this sub-section.

Network

The Communication Network menu allows the user to set the Ethernet ports of the device.The Network settings menu can be opened from the EnerVista path shown below:

Path: **Device > Settings > Product Setup > Communication > Network**

Figure 5-3: EnerVista Communication Network Setting menu



- **IP Assignment***: There are 3 options for IP assignment:

  1. Disabled
  2. Static
  3. DHCP

  Port 1 is the console port, so it can never be disabled, because it is the only port that can communicate with EnerVista P30 Setup software.

  Port 1 is the only port that can work with DHCP, as the remaining 3 ports are data ports, and their IP addresses must be provisioned according to the way PMUs are networked.

  Ports 2 to 4 may be disabled independently of all other ports; they are data ports and customers may not wish to use all of them.

  Ports 3 and 4 are only included on devices that are equipped with the PMC Ethernet expansion option.

NOTE

IP address, Subnet Mask, and Gateway are ignored if IP Assignment is set to DHCP.

NOTE

The Multilin P30 can be configured only through Ethernet Port 1, using the EnerVista P30 Setup tool.

- **IP Address***: If IP Assignment is set to Static, a static IP (IPv4) can be assigned in this field.
- **IP Subnet Mask***: If IP Assignment is set to Static, an IP subnet mask can be set according to the standard IPv4 format.
- **Gateway IP Address***: If IP Assignment is set to Static, a Gateway IP address can be set according to standard IPv4 format. The address represents the gateway IP address for the network associated with a given port.

NOTE

When using more than one Ethernet port, configure each to a different network or subnet using the IP addresses and mask. If the same network is configured on two separate Ethernet ports, the Multilin P30 may transmit frames on either of the ports. If one network must be configured on two different ports, it must use the same gateway address for that subnetwork or internal routing errors will occur.

- **Default Gateway**: This setting designates which of the port gateways should be used as the default gateway for the device. A packet with a destination that does not resolve to any of the configured networks, will be sent out of the port with which the default gateway is associated.

*** These Console Port settings will NOT be transferred to the device when writing an offline settings file to the device.**

NOTE

In addition to the subnetwork settings shown on the EnerVista Communication Network Setting menu, users can configure static routes using CLI commands. For more information see section Command Line Interface in the Multilin P30 chapter.

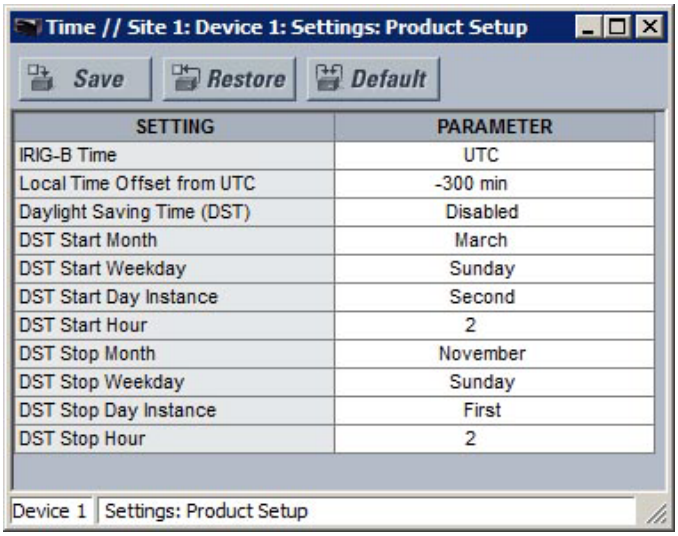
Local Time Offset

The Multilin P30 accommodates both Local and UTC time sources as external timing references.

Nevertheless, the Multilin P30 exclusively uses UTC timing internally and as such all event recording and time stamping is maintained in UTC. When the system is set to operate with a local time, external timing reference, the Multilin P30 converts the external time to UTC format using the local time offset setting.

If the localized, external time source includes Time Zone and Daylight Saving Time offset data, it is stripped out (i.e. all Multilin P30 processes will ignore this information).

Rather, the Multilin P30 system provides settings to enable and disable local time conversion, and which allow the user to configure the system to accommodate daylight savings time (DST) and Time Zone offset (TZ) specifically for local time inputs.



IRIG-B Time: Allows the user to designate whether the external timing reference is in local or UTC time.

Local Time Offset from UTC: Allows the user to specify the offset from UTC, that is inherent an a local time external time reference.

Daylight Savings Time (DST): Specifies whether the DST feature is enabled or disabled.

DST Start Month: If DST is enabled, this setting specifies the start month for DST.

DST Start Weekday: If DST is enabled, this setting specifies the starting weekday for DST.

DST Start Day Instance: If DST is enabled, this setting specifies on which instance of the specified weekday, in the specified month to start DST.

DST Start Hour: If DST is enabled, this setting specifies the start hour for DST.

DST Stop Month: If DST is enabled, this setting specifies the end month for DST.

DST Stop Weekday: If DST is enabled, this setting specifies the end weekday for DST.

DST Stop Day Instance: If DST is enabled, this setting specifies on which instance of the specified weekday, in the specified month to end DS.

DST Stop Hour: If DST is enabled, this setting specifies the end hour for DST.

Installation

To safeguard against installation of the device without any entered settings, the device allows only output streaming of data if it is set to “Programmed”. This setting is defaulted to “Not Programmed” at the factory.

Path: Device > Settings > Product Setup > Installation

Figure 5-4: EnerVista Installation Setting menu

NOTE

The Multilin P30 will not stream data to its output until Installation > Multilin P30 Settings is set to “Programmed”.

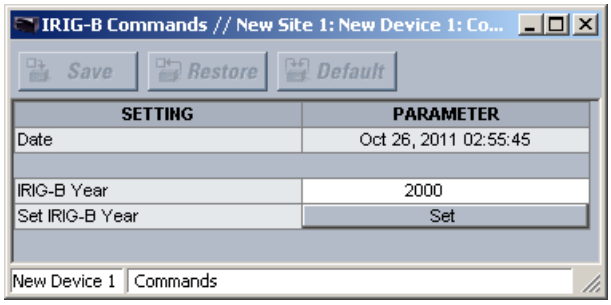
System setup

This section describes the settings for Multilin P30 system setup, which includes the Power System, Input to the Multilin P30 , Pseudo PMU, PMU manager, and Multilin P30 Output Streams.

NOTE

There are three important steps required for the Multilin P30 to operate:

1. Set the date (refer to the *IRIG-B Commands* section)
2. Configure the device (refer to the *Product Setup* and *System Setup* sections).
   - Make sure to set "P30 Settings" to "Programmed" (refer to the *Installation* section).
3. Activate the configuration (refer to the *Basic Commands* section).

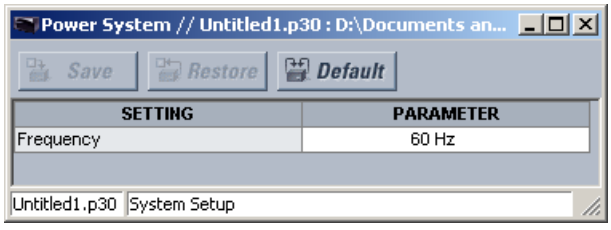


Power System

The Power System Setting menu is available from the path shown below. It is essential that the user set the power system frequency under which the Multilin P30 will be used. This setting has a direct effect on the data collection rates and filtering functionality of the Multilin P30:

Path: Device > Settings > System Setup > Power System

Figure 5-5: Typical Power System screen



Frequency: The nominal frequency of the Power System in which the Multilin P30 device is installed. The Multilin P30 has been designed to operate in either 50Hz or 60Hz power system frequencies.

NOTE

When the Frequency setting is changed, the Data Rate setting of each output will be defaulted.

Inputs

The Multilin P30 supports a maximum of either 8 or 40 PMUs depending on the Order Code. This screen provides settings for each of the 8 or 40 inputs. Each input can support up to 4 PMUs.

NOTE

The EnerVista P30 Setup tool prevents the user from saving the settings if it would result in more than the allowed (8 or 40 depending upon the Order Code) configured PMUs. Up to 4 PMUs can be supported from an input device.

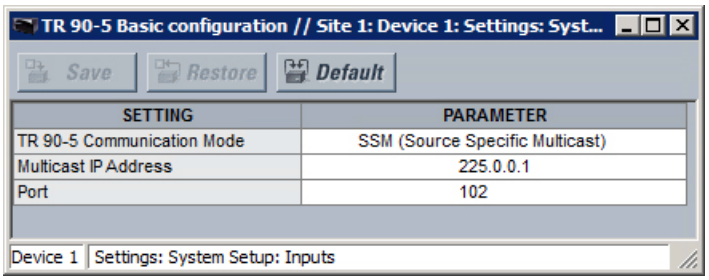
The Device Input Settings menu can be found on the path below:

Path: Device > Settings > System Setup > Inputs > Input X-X > Input X

There are total 8 or 40 identical Input screens. The user has to set the items below in order to read the configuration of an input device.

TR 90-5 Communication Mode

Path: Device > Settings > System Setup > Inputs > TR 90-5 Basic Configuration



The IEC 61850-90-5 input dialog allows the user to provision settings that are universally applied for all inputs configured as 90-5 type inputs. For IEEE C37.118 based input devices, this setting window does not apply.

TR 90-5 Communication Mode: The communication mode selected for use with all 90-5 inputs. Users can select either IGMPv3 multicast modes (ASM or SSM), or Unicast (in case network devices (e.g. Routers) do not support IGMPv3). Users can select any one of the following 3 options:

- "ASM (Any-Source Multicast)"
- "SSM (Source-Specific Multicast)"
- "Unicast"

NOTE

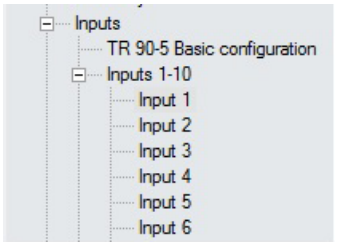
Users must ensure that the multicast group set at the input of the Multilin P30 is not the same as any multicast group specified at the output side of the device, or output traffic may unintentionally be processed at inputs, needlessly consuming CPU cycles.

Multicast IP address: The multicast group IP address that will be used for communication with IEC 61850-90-5 clients when operating in a multicast mode.

Port: The application port that will be used for communication with IEC 61850-90-5 PMUs (servers) when operating in a multicast mode.

Upon selection of the Unicast option for the communication mode setting, the Multicast IP Address is unavailable to the user.

Inputs X to X



Input X...

Figure 5-6: IEEE C37.118 Protocol

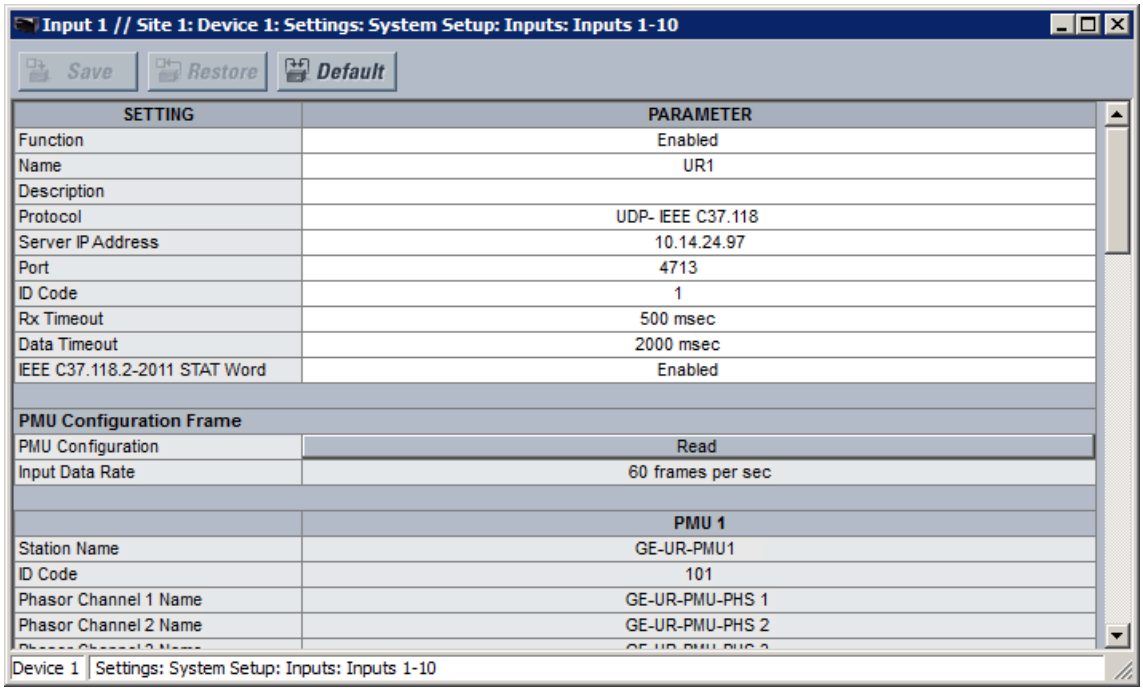
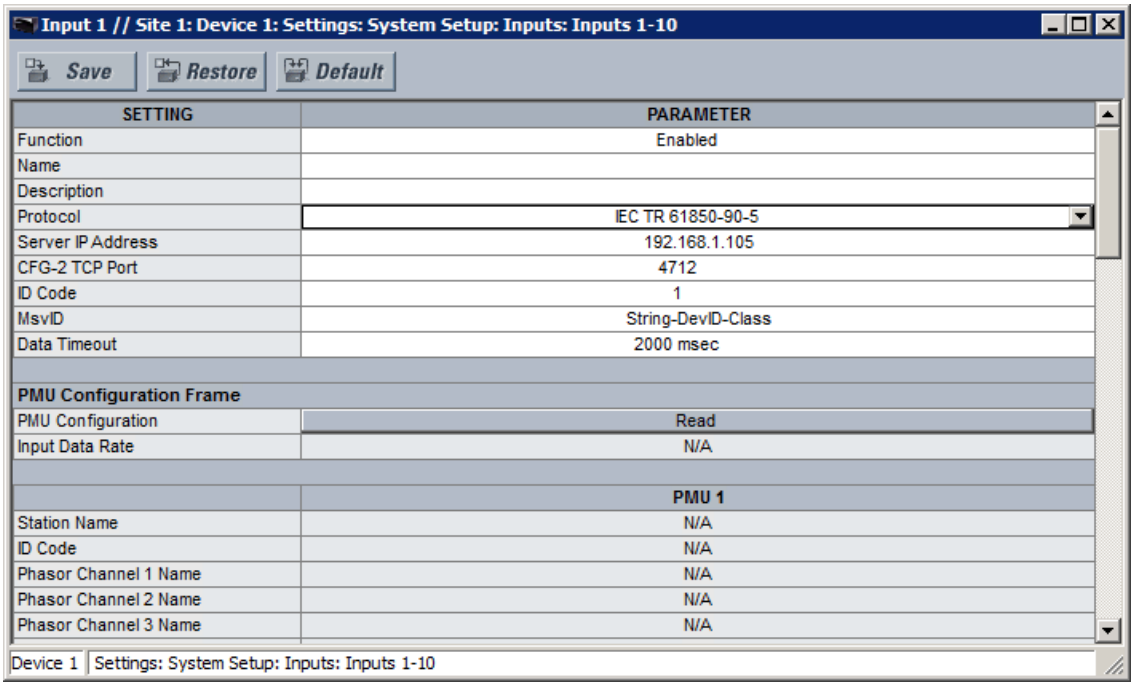


Figure 5-7: IEC 61850-90-5 Protocol



- **Function**: Each Input can be enabled or disabled. The default value is **Disabled**, which must be changed to **Enabled** before configuring the input device to the Multilin P30 .
- **Name**: The user can enter any name for a particular input device, using up to 32 characters. This field is for the user's reference only.
- **Description**: The user can enter the description of a particular input device using up to 32 characters. This field is for the user's reference only.
- **Protocol**: Specifies which protocol the input will use: either, IEC 61850-90-5, IEEE C37.118 UDP or IEEE C37.118 TCP.
- **Server IP Address**: The PMU server, or input device, IP address must be specified in order to communicate with an input device. The default IP address is set to 0.0.0.0
- **Port**: The setting is used for IEEE C37.118 type communication. By default set to 4712 when TCP-IEEE C37.118 is selected and 4713 when UDP-IEEE C37.118 is selected.
- **CFG-2 TCP Port**: for IEC 61850-90-5 operation, this port will be used to receive CFG-2 frames.
- **MsvID:** The Multicast Sampled Value ID of the IEC 61850-90-5 input.
- **ID Code**: The ID Code of the input stream must be specified in this field. If the device is a PMU aggregator like the Multilin N60, the user must provide the ID code of the aggregator, which will be distinct from the IDCODES of the individual PMUs within the aggregator. If the device is not an aggregator, the user must still provide this IDCODE, but it will match the IDCODE returned by the device when the user reads its configuration.

NOTICE

All ID Codes (including both those of all input PMUs and input streams) must be unique.

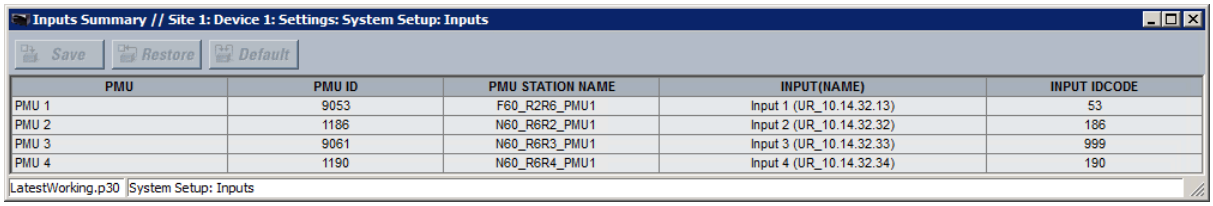
- **PMU Configuration**: The PMU configuration field has a "Read" button. When this button is pressed, EnerVista P30 Setup sends a command to the input device requesting a configuration file based on above mentioned input device settings. Upon

receiving this configuration file (ie: CFG-2), EnerVista P30 Setup automatically shows the configuration of the input device.

NOTICE

The **PMU Configuration** button must be pressed for all PMUs after a firmware upgrade.

- **Rx Timeout**: The maximum time the Multilin P30 waits for a response to a CFG-2 frame request. This setting is only applicable to IEEE C37.118 communication.
- **Data Timeout**: Once communication to the PMU server is established and sample transmission is started (for IEEE C37.118 mode this happens after the server's CFG-2 frame is received), this value represents the maximum time between data frames. If a data frame is not received during this interval, communication is reset.



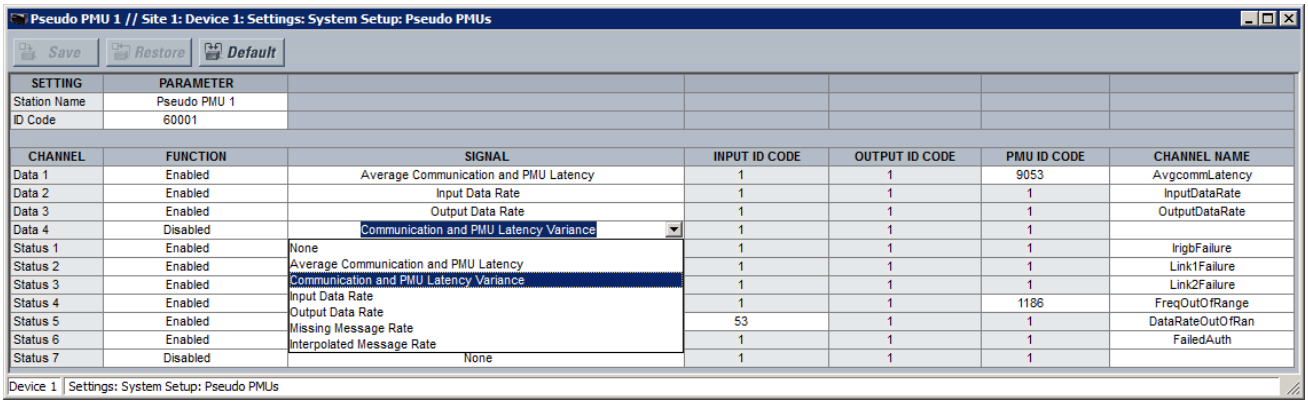
PMU	PMU ID	PMU STATION NAME	INPUT(NAME)	INPUT IDCODE
PMU 1	9053	F60_R2R6_PMU1	Input 1 (UR_10.14.32.13)	53
PMU 2	1186	N60_R6R2_PMU1	Input 2 (UR_10.14.32.32)	186
PMU 3	9061	N60_R6R3_PMU1	Input 3 (UR_10.14.32.33)	999
PMU 4	1190	N60_R6R4_PMU1	Input 4 (UR_10.14.32.34)	190

Pseudo PMUs

The Pseudo PMU contains advanced features for remote diagnostic and status information on the Multilin P30 device itself. Pseudo PMUs do not contain any phasor information; just analogs and digitals. The Multilin P30 supports four Pseudo PMUs, each Pseudo PMU containing 0 phasors, 16 analogs, and 32 digitals. These values are time-stamped by the Multilin P30 which processes this information as it processes information coming from any other PMU. Appropriate diagnostic analog values and device status information can be configured in the Pseudo PMUs, and further, can be mapped to the output stream for the upstream device to remotely monitor the Multilin P30 . The EnerVista path of the Pseudo PMU is as follows:

Path: Device > Settings > System Setup > Pseudo PMU

Pseudo PMU X...



SETTING	PARAMETER
Station Name	Pseudo PMU 1
ID Code	60001

CHANNEL	FUNCTION	SIGNAL	INPUT ID CODE	OUTPUT ID CODE	PMU ID CODE	CHANNEL NAME
Data 1	Enabled	Average Communication and PMU Latency	1	1	9053	AvgcommLatency
Data 2	Enabled	Input Data Rate	1	1	1	InputDataRate
Data 3	Enabled	Output Data Rate	1	1	1	OutputDataRate
Data 4	Disabled	Communication and PMU Latency Variance	1	1	1	
Status 1	Enabled	None	1	1	1	IrigbFailure
Status 2	Enabled	Average Communication and PMU Latency	1	1	1	Link1Failure
Status 3	Enabled	Communication and PMU Latency Variance	1	1	1	Link2Failure
Status 4	Enabled	Input Data Rate	1	1	1186	FreqOutOfRange
Status 5	Enabled	Output Data Rate	53	1	1	DataRateOutOfRan
Status 6	Enabled	Missing Message Rate	1	1	1	FailedAuth
Status 7	Disabled	Interpolated Message Rate	1	1	1	
		None				

- **Station Name**: The station name (STN field according to IEEE C37.118) of the Pseudo PMU should be assigned in this field.
- **ID Code**: The PMU ID Code (according to IEEE C37.118) can be assigned in this field. As explained earlier, each Pseudo PMU contains 16 analog (Data), and 32 digital (Status) channels.

NOTE

Upon enabling/disabling Data or Status channels, EnerVista P30 Setup dynamically increases/decreases the number of channels, to ensure that all channels are consecutive.

The corresponding ID Codes (of PMU/Input device/Output device) must be specified wherever stated in the list below. If the data or status is related to the Multilin P30, it does not require any ID code.

When saving an Input/Pseudo PMU/Output screen, the EnerVista P30 Setup software checks to ensure that the Save action will not result in a system with a duplicate ID Code. The following ID Codes are considered:

- All Input Device/Stream ID Codes
- All Input PMU ID Codes
- All Pseudo PMU ID Codes
- All Output Device ID Codes.

There is one exception: If an Input has a single PMU, this Input's ID Code may match with its PMU ID Code.

- **Data X**: Analog data channels can be added, up to 16 per Pseudo PMU. Diagnostic signals can be added as input to these channels. The available **diagnostic signals** are:
  - **Average Communication and PMU Latency**: PMU ID Code must be specified. The averaging process is performed over the last second.
  - **Communication and PMU Latency Variance**: Input ID Code of a device must be specified. The process is performed over the last second.
  - **Input Data Rate**: Total Input data received from PMUs over the last second (bytes per second); no need for any ID Code.
  - **Output Data Rate**: Total Output data sent to PDC clients over the last second (bytes per second); no need for any ID Code.
  - **Missing Message Rate**: Number of missing messages within the last second. Output ID Code (this can be configured in Device > Settings > System Setup > Outputs > Output X > Basic Configuration) and a specific PMU ID Code of interest must be specified.
  - **Interpolated Message Rate**: Messages interpolated within the last second. Output ID Code (this can be configured in Device > Settings > System Setup > Outputs> Output X > Basic Configuration) and a specific PMU ID Code of interest must be specified.
  - **CPU Temperature:** The measured value of CPU temperature in degrees Celsius. This value is updated every hour.
  - **Number of Restarts:** Increased every time the Multilin P30 is started.
- **Status X**: The total number of Multilin P30 status or digitals supported by a Pseudo PMU is 32. The value will be high, (i.e. 1) if TRUE, and low, (i.e. 0) if FALSE. Available **device statuses** are:
  - **P30 IRIG-B Failure** {1: failure, 0: detected}
  - **Ethernet 1 Link Failure** {1: failure, 0: detected}
  - **Ethernet 2 Link Failure** {1: failure, 0: detected}
  - **Nominal Frequency Out of Range**: PMU ID Code must be specified {1: true, 0: false}
  - **Data Rate Out of Range**: Input ID Code of a device must be specified {1: true, 0: false}
  - **Missing Message Exceeded**: Output ID Code (this can be configured in Device > Settings > System Setup > Outputs> Output X > Basic Configuration) and a specific PMU ID Code of interest must be specified {1: true, 0: false}

  - **Missing Message Detected**: Output ID Codes and a specific PMU ID Code of interest must be specified {1: true, 0: false}
  - **Average Communication and PMU Latency Exceeded**: Input ID Code of a device must be specified {1: true, 0: false}
  - **Data Interpolation Detected**: Output ID Code must be specified {1: true, 0: false}
  - **Failed Authentication:** {1: Exceeded failed authentication limit, 0: Normal}
  - **Historian Status:** Communications status with the Historian card {1: Historian is online, 0: Historian is offline}.
- **Channel Name**: Custom name must be specified for each channel in this field.

NOTE

When saving, EnerVista P30 Setup ensures that within one Pseudo PMU, all channel names are unique.

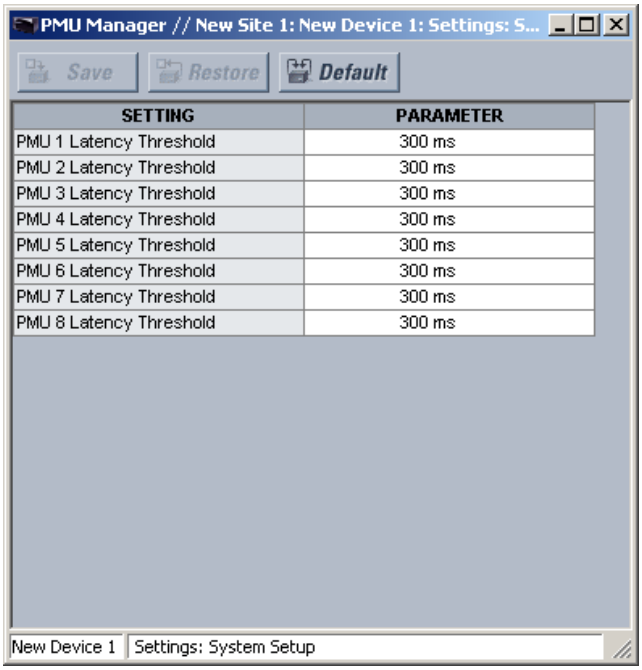
NOTE

A Pseudo PMU cannot be selected for output to both Historian outputs concurrently. However, pseudo PMUs may be duplicated across any outputs that are not Historian outputs.

PMU Manager

The PMU manager feature of the Multilin P30 allows users to set values that affect a PMU device. The EnerVista P30 Setup program shows only PMUs that have been configured in the Input Configuration screen. The EnerVista path for the PMU manager is as shown below:

Path: Device > Settings > System Setup > PMU Manager



- **Latency Threshold**: The allowable latency of each input device can be specified in milliseconds. The default parameter for this setting is 300 ms. The value can be set between 0 to 10000 ms. The Multilin P30 waits for the data message from the input device until this setting value is reached. Upon elapse, the latency threshold is reached for a particular input device, and the status of Pseudo PMU "Average Communication & PMU Latency Exceeded" will be asserted.

Outputs

The Multilin P30 supports up to 8 outputs, and can be connected as a server to up to 8 clients.

Output X

Outputs menu list Output 1 – 8: Each output has two types of configuration screen:

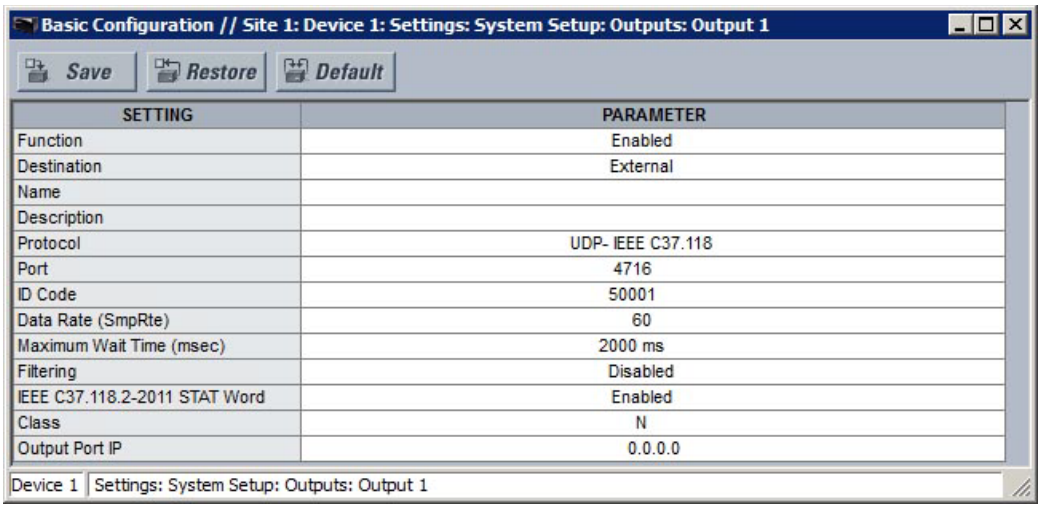
1. Basic configuration
2. PMU selection.

Both of these Settings menus are explained below:

Basic Configuration

Path: Device > Settings > System Setup > Outputs > Output X > Basic Configuration

The screen below shows settings for one of eight Multilin P30 outputs when streaming data to an external client.



- **Function**: The output port can be enabled or disabled.
- **Destination**: The destination can be set to External, one of two possible Historian data collection modules, or an embedded Application module. If Output X of the Multilin P30 must be sent to the first Historian data collection module, set it to "Historian 1," and for an Application card, set it to "Application".
- **Name and Description**: The user can set the output stream name and description in these fields. These parameters are for the user's reference only.
- **Protocol**: The protocol that will be used to stream data on the particular output being configured. This can be either IEEE C37.118-TCP, IEEE C37.118-UDP or IEC 61850-90-5. If the user selects IEC 61850-90-5 additional options will be displayed for configuration.
- **Port**: The application port to use for data transmission. The setup software supplies the following values by default: 102 for IEC 61850-90-5; 4712 for TCP-IEEE C37.118 & 4713 for UDP- IEEE C37.118.

NOTE

The port used for CFG-2 retrieval must be unique across all outputs. EnerVista P30 Setup verifies uniqueness when saving, considering both the Port setting (for IEEE C37.118 outputs) and the CFG-2 TCP Port setting (for IEC 61850-90-5 outputs).

- **ID Code**: The ID Code value of the Multilin P30 device acting as a server for Output X, must be entered in this field.

NOTICE

All ID Codes (including both all input PMU's and input stream's ID codes) must be unique.

- **Data Rate**: The output reporting rate of Output X, in terms of frames or samples per second.
- **Maximum Wait Time (msec)**: This is the maximum time the output stream should wait for configured PMUs to enter into the stream. Any PMU data frames received after the maximum wait time will not be included into the output stream.

Max. Wait Time (ms) must be greater than 2 x 1000/Data Rate.

- **Filtering**: Filtering is an option that can be enabled or disabled by the user. Normally, filtering is not required when output-reporting rate is equal to, or higher than, the input report rate. Filters are not applied to the digital signals. More information about filtering can be found from the *Theory of Operation* section.

Filtering is recommended when either the Multilin P30 output rate is less than the Multilin P30 input rate, or it is not an integer factor of the Multilin P30 input rate e.g. input 20 and output 30, for each Multilin P30 output.

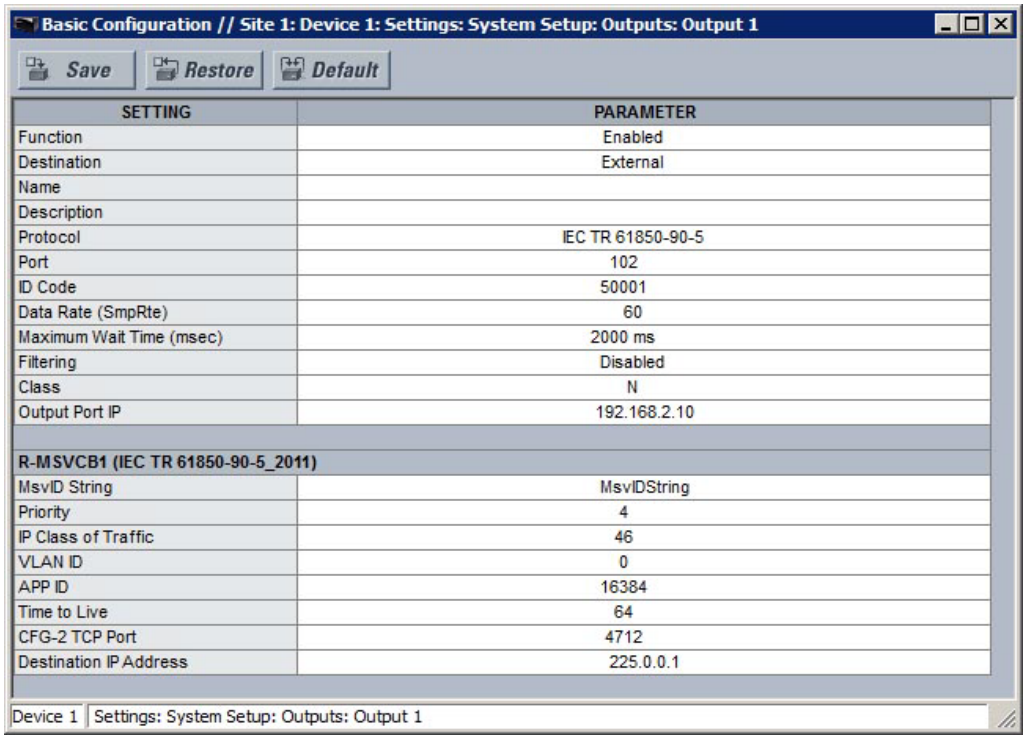
- **Nagle (TCP stacking)**: The Nagle algorithm can be enabled or disabled by the user for TCP/IP network connection. If the Nagle is enabled, it improves the efficiency of TCP/IP networks by combining small frames, and sending them all at once. This setting is not visible when IEC 61850-90-5 mode is selected, or if the output is configured as a Historian rather than external output.
- **IEEE C37.118-2011 STAT Word**: Processing of the STAT bit information, from the IEEE C37.118-2011 version of the IEEE C37.118 standard, can be enabled or disabled by using this setting. If enabled, the enhanced STAT bit information proposed in this version is used, e.g. Bit-9 is set if the missing data is interpreted, and Bit 6-8 are recognized as PMU TQ (Time Quality). Refer to *IEEE C37.118.2-2011* for more details. This setting is not visible when IEC 61850-90-5 mode is selected.

  For details of the handling of STAT bits by the Multilin P30, please refer to the section entitled *Handling of STAT Bits,* in the *Theory of Operation* section of this manual.
- **Class**: Can be used to identify the class of data that is being delivered by the output. N - designates no particular class. P - designates protection class data. M - designates measurement class data. This setting is used to form MSVID and is for the user's reference only. It does not apply any additional filtering. It is recommended that all data in the output stream should be of same Class as received from the mapped PMUs.
- **Output Port IP**: This setting allows the user to select which physical port to use for the current output. The IP address selected must correspond to the IP address of one of the physical ports configured in the network settings.

Users will not be able to specify the console port as the physical port to use, if it has been configured to use DHCP.

The setting to handle STAT bits according to the 2011 version of the IEEE C37.118 standard applies only to the STAT bits. Other optional functionalities proposed in this standard (e.g. CFG-3), are not yet supported.

R-MSVCB1-specific (IEC 61850-90-5_2011) Settings



MsvID String - A user defined string of up to 56 characters that can be used to identify the output stream. The string will be included in the MsvID sent on the particular output in the following format: MsvID String-DeviceIDCode-CLASS.

Priority: IEEE 802.1Q based Priority code point to be used at the output. This setting allows the user to specify a priority value of between 0 and 7 inclusive, that can be used by QoS disciplines to differentiate traffic from the Multilin P30. This information is sent in the VLAN tag the output applies to frames it transmits.

IP Class of Traffic: This setting provides a mechanism for classifying and managing network traffic and providing "Quality of service" (QoS) on modern "Internet Protocol" IP networks. The settings uses the 6-bit Differentiated Services Field (DS field) in the IP header for packet classification purposes. Users can specify a value between 0-63, with 46 being the default value supplied by the setup software.

VLAN ID: The setting allows the user to specify the VLAN tag that the output will use for transmission to the client that is being configured. Users may specify a value between '0 to 4095'. The default value supplied by the setup software is '0'.

APP ID: This is user defined range for identifying messages from different applications. As per IEC 61850-8-1, Annex. C, this range can be set for R-SV from 16384 to 32767. Any value outside this range is not acceptable.

Destination IP Address: This setting allows the user to specify the DESTINATION IP address in standard IPV4 address format for IEC 61850-90-5 operation. The user may specify either a unicast or multicast IP destination, as the Multilin P30 also supports unicast transmission of IEC 61850-90-5 output data.

NOTE

Users must ensure that any multicast IP address set at the output of the Multilin P30 is not the same as any multicast group specified at the input side of the device, or output traffic may unintentionally be processed at inputs, needlessly consuming CPU cycles.

Time to Live: Allows the user to specify the number of hops packets from output, will be allowed to survive on the network for.

CFG-2 TCP port: When it is configured for IEC 61850-90-5 operation, the output uses the value of this setting as the application port to send CFG-2 frames to the specified client.

NOTE

The port used for CFG-2 retrieval must be unique across all outputs, with the Historian as an exception. EnerVista P30 Setup verifies uniqueness when saving, considering both the Port setting (for IEEE C37.118 outputs) and the CFG-2 TCP Port setting (for IEC 61850-90-5 outputs).

Historian-specific Features

NOTE

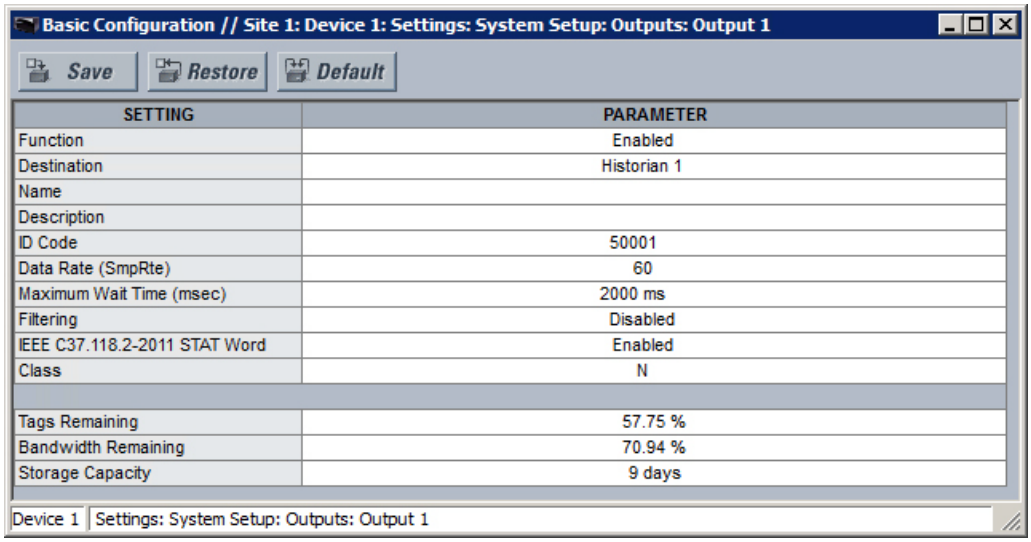
If the Order Code contains the Historian option the Destination can be set to Historian.

NOTE

The port used for CFG-2 retrieval must be unique across all outputs, with the Historian as an exception. EnerVista P30 Setup verifies uniqueness when saving, considering both the Port setting (for IEEE C37.118 outputs) and the CFG-2 TCP Port setting (for IEC 61850-90-5 outputs).

NOTE

When setting the destination of an Output to the Historian, IEEE C37.118.2-2011 STAT Word must be set to "Enabled".



- **Tags Remaining**: This value represents the percentage of tags that are still available for use on the Historian. This number is automatically decremented as additional outputs are directed to the Historian module. The updated value is reflected in any basic output configuration screen where Historian data collection has been selected. The screen cannot be saved if more tags are configured than are available.
- **Bandwidth Remaining**: This value is an approximation of the bandwidth remaining as a percentage. As this approaches zero, there is risk that the Historian will not be able to archive data as fast as the data arrives. This approximation is only available when phasor, analog, frequency, and frequency ROC compression are disabled. Compression can be turned on/off in the Historian Compression screen.
- **Storage Capacity**: This dynamic value is used to display the approximate number of days of storage available before data rollover in the Historian archive, given the current configuration. This approximation is available only when phasor, analog, frequency, and frequency ROC compression are disabled. Compression can be turned on/off in the Historian Compression screen.

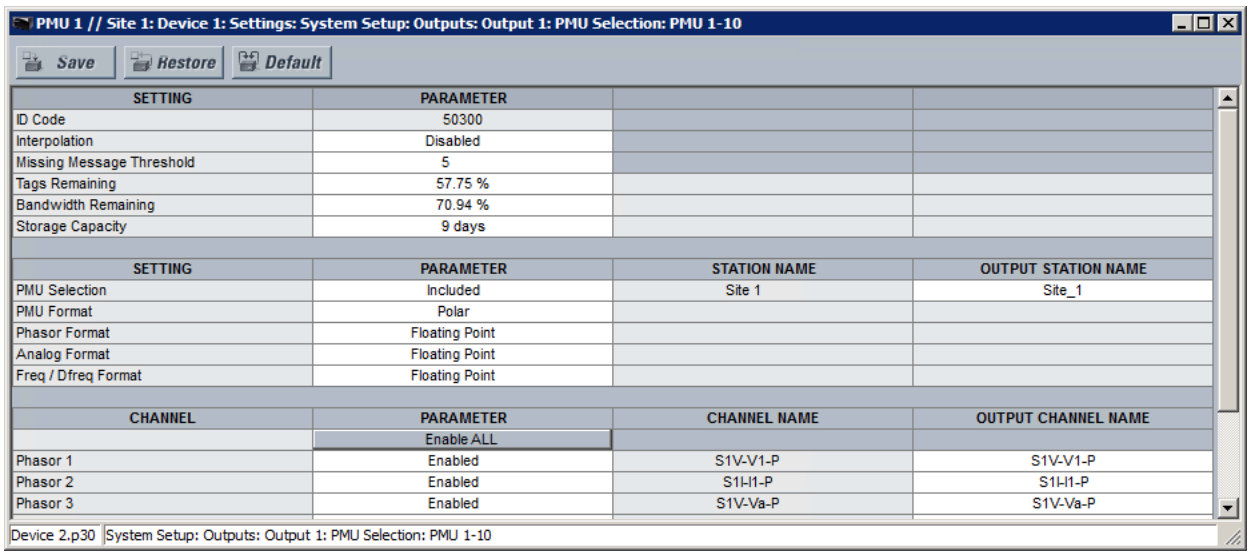
NOTE

If the Order Code contains the Historian option, the Destination can be set to a Historian endpoint, and the Tags, Bandwidth Remaining, and Storage Capacity will be shown to the user.

PMU Selection

Path (1): Device > Settings > System Setup > Outputs > Output X > PMU Selection > PMU X-X > PMU X

Path (2): Device > Settings > System Setup > Outputs > Output X > PMU Selection > Pseudo PMU 1-4 > Pseudo PMU X



This window allows the user to specify which PMUs and which channels will be in the output.

- **ID Code**: This field shows the ID Code of the PMU X. This is not a user-programmable field.
- **Interpolation**: If enabled, the Multilin P30 will interpolate the missing messages. If filtering is enabled (*Basic Configuration* screen), this setting will be ignored and data will automatically be interpolated.
- **Missing Message Threshold**: Maximum number of missing messages allowed before events to be logged. Once this threshold is reached, Pseudo PMU can report this condition, if configured to do so. Refer to section *Diagnosis and Event Recording*, as well as the Pseudo PMU settings.
- **Tags Remaining**: This value is for Historian outputs only, and represents the percentage of tags that are still available for use on the Historian. The screen cannot be saved if more tags are configured than available.

NOTE

Historian may only be selected as a destination when the Multilin P30 Order Code indicates that a Historian archiver is installed.

- **Bandwidth Remaining**: This value is for Historian outputs only and is an approximation of the bandwidth remaining as a percentage. As this approaches zero, there is risk that the Historian will not be able to archive data as fast as the data arrives. This approximation is available only when phasor, analog, frequency, and frequency ROC compression are disabled. Compression can be turned on/off in the Historian Compression screen.
- **Storage Capacity**: This value is for the Historian only, and is used to display the number of days of storage available before data rollover in the Historian archive,

given the current configuration. This is a static value that pertains only to the configuration data; the value is not updated as Historian storage is consumed during run time. This approximation is available only when phasor, analog, frequency, and frequency ROC compression are disabled. Compression can be turned on/off in the Historian Compression screen.

- **PMU Selection**: PMU X can be included or excluded from Output X using this field.
- **Station Name**: The original Station Name (STN), according to CFG-2. This is not a user-programmable field.
- **Output Station Name**: The Multilin P30 provides flexibility to the user for renaming the station name (STN) of the PMU (if required), by inserting a value in this field.
- **PMU Format**: The Output PMU data format can be configured to either rectangular or polar. This setting is unavailable when an output has been configured for IEC 61850-90-5 operation.
- **Phasor Format**: The Output phasor data format can be configured to either 16-bit integer or 32-bit floating point. This setting is unavailable when an output has been configured for IEC 61850-90-5 operation.

The Multilin P30 supports the display of NaN for floating point values that are invalid.

- **Analog Format**: The Output analog data format can be configured to either 16-bit integer or 32-bit floating point. This setting is unavailable when an output has been configured for IEC 61850-90-5 operation.
- **Freq/Dfreq Format**: The Output Frequency and rate-of-change of frequency data formats can be configured to either 16-bit integer or 32-bit floating point. This setting is unavailable when an output has been configured for IEC 61850-90-5 operation.

  The PMU X window at Output X also tabulates a list of channels configured in PMU X. The user can enable or disable a channel, as well as rename a channel, in this table.
- **Channel**: If enabled, the channel of the PMU X will be added into Output X as a part of the PMU X frame.
- **Channel Name**: The original name of the channel, according to CFG-2. This is not a user-programmable field.
- **Output Channel Name**: The user can rename the Output channel name before sending it through Output X. By default, the output channel name matches the channel name.

EnerVista P30 Setup will automatically reformat the string to meet naming requirements if the destination is set to Historian. For all output types, EnerVista P30 Setup will remove leading and trailing spaces from the name.

The EnerVista P30 Setup software blocks configurations that attempt to map the same PMU data to more than 1 Historian data collection agent.

For example, if PMU1 data is mapped to Historian 1 on output 1, users will be blocked from mapping PMU1 data to Historian 2, on any of the remaining outputs (2 to 8).

Allowing such a configuration to proceed would result in data collisions in the Historian database and the loss of the associated data

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Chapter 6: Multilin P30 Synchrophasor Processor Commands

The Multilin P30 Phasor Data Concentrator facilitates commands that the user can send to the Multilin P30 using the EnerVista P30 Setup tool. The commands are classified in two main categories:

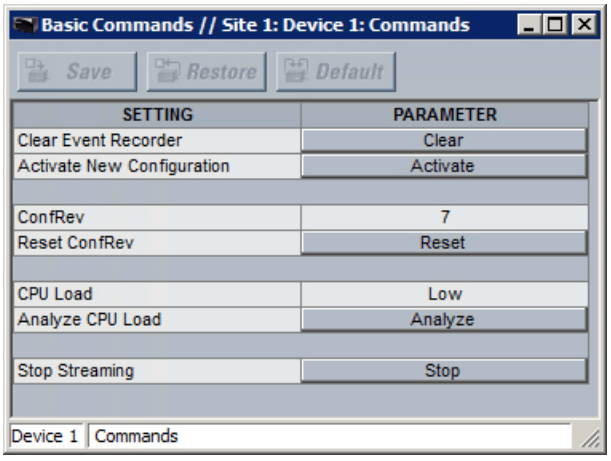
1. Basic commands
2. IRIG-B commands

These commands are explained below:

Basic Commands

The EnerVista setup path and menu figure for basic commands are shown below: Each item below is a button:

Path: Device > Commands > Basic Commands



- **Clear Event Recorder**: By pressing the **Clear** button, the Multilin P30 clears all events provided the "Clear Event Recorder" setting in the Device > Settings > Product Setup > Event Recorder is enabled.
- **Activate New Configuration**: In the case of any change in configuration of the Multilin P30 (e.g. output datasets), the user has to activate a new configuration using this

command. The command will also activate any changes made to the Historian configuration. The **Activate New Configuration** button requires Administrative access.

- **ConfRev**: This field displays the current Configuration Revision Value that is maintained in the Multilin P30.
- **Reset ConfRev**: This command allows the user to override the configuration revision, maintained in the Multilin P30 . Ordinarily, the configuration revision value maintained by the Multilin P30 is incremented each time new settings are committed to the device. Use of this feature will reset the value maintained in firmware to 0.
- **CPU Load**: This field provides a qualitative estimate of the current CPU loading when the ANALYZE CPU LOAD command is issued. As the number of inputs and outputs increase, the user can expect this value to increase from low to medium to high.

NOTE

Multilin P30 outputs are considerably more process intensive than inputs. Finally, processing requirements are increased as the frequency of reception and reporting are incremented. Accordingly, an output configured for 60 frames/s transmission is less expensive than an output configured for 120 frames/s transmission. Users are advised to avoid configurations that result in high CPU loading. Under high CPU utilization GE recommends against placing additional strain on the device as in the case of trending, retrieving actual values frequently, and requesting event recorder data.

TIP

IEC 61850-90-5 operation can be used to output data to multiple clients simultaneously (via IP Multicasting) in order to avoid the CPU utilization expense associated with traditional IEEE C37.118 outputs

- **Analyze CPU Load**: This command can be issued by users to obtain a qualitative assessment of the current CPU load.

NOTICE

Users are strongly advised to reactivate the Multilin P30 settings / configuration once the ANALYZE CPU LOAD command is issued.

- **Stop Streaming**: This command can be used to disable all streaming to and from the Multilin P30 device. To resume streaming, issue the ACTIVATE NEW CONFIGURATION command.

TIP

For configurations where users choose to accept high CPU utilization, the stop streaming command should be issued to the Multilin P30 device before proceeding with intensive interactions with the device, as in the case of retrieving settings files or retrieving the event recorder data.

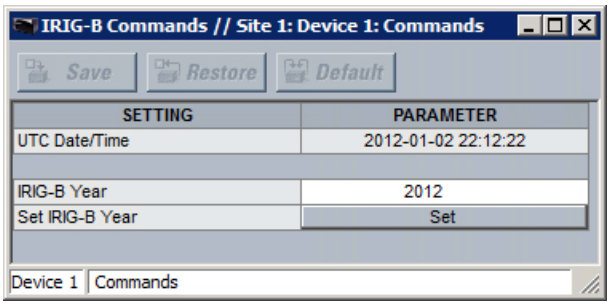
NOTE

During the process of activating the new configuration in the Multilin P30, the Multilin P30 device doesn't communicate with any input or output device.

IRIG-B Commands

The IRIG-B year can be set initially using the IRIG-B command. The EnerVista path for this command window is shown below:

Path: Device > Commands > IRIG-B Commands



- **Date**: The current date and time on the Multilin P30 .
- **IRIG-B Year**: Enter the value of current year (for IRIG-B).
- **Set IRIG-B Year**: Pressing the **Set** button sends the above IRIG-B Year to the Multilin P30 . The time is updated immediately.

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Chapter 7: Multilin P30 Synchrophasor Processor Actual Values

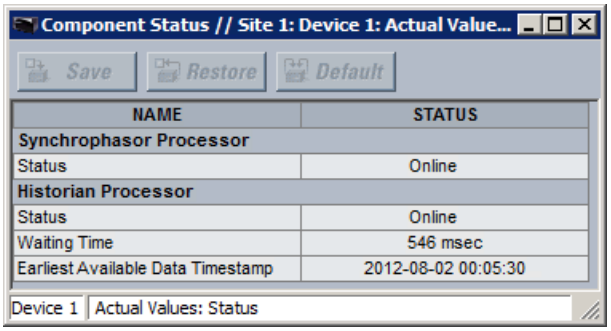
NOTE

EnerVista P30 Setup will not display certain screens when there are pending configuration changes.

Status

The status menu of the EnerVista P30 Setup tool allows the user to check the status of the Multilin P30 components, remote input and output devices connected to the Multilin P30 , the Ethernet ports, and synchronization (IRIG-B) input. The details for each item are explained below:

Component Status



Synchrophasor Processor

- **Status**: This field shows if the synchrophasor is in service and is able to stream data to outputs. The "Offline" value of this field signifies that an invalid order code or unit is not programmed or IRIG-B year value has not been set in the device. This can be confirmed by looking at the Event Recorder in the EnerVista P30 Setup tool.

Historian Processor

- **Status**: Shows the online/offline status of an installed Historian module.

- **Waiting Time**: This value shows the number of milliseconds the most recent data sample spent waiting in the queue at the Historian input.
- **Earliest Available Data Timestamp**: Shows the archival timestamp of the oldest data currently in the Historian archive.

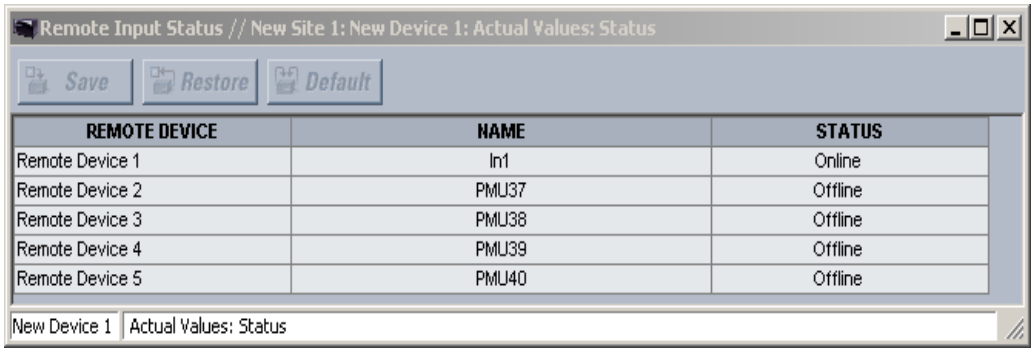
Remote Input Status

The Input Devices status configured in the Multilin P30 can be obtained using the following EnerVista path:

Path: Device > Actual Values > Status > Remote Input Devices

The current state of up to 40 Remote Input Devices is shown here:

Figure 7-1: Remote Input Status screen



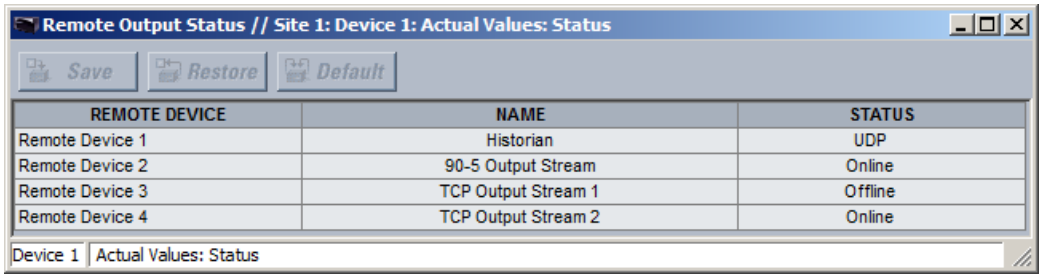
The list of remote devices will be populated based on the input devices configured in the Multilin P30. The device "Name" column shows the corresponding device name based on the configuration file (STN value).

Remote Output Status

The status of all the TCP or 90-5 -configured output streams (up to 8) can be obtained using the following EnerVista path:

Path: Device > Actual Values > Status > Remote Output Status

Figure 7-2: Remote Output Status screen



This window shows all the TCP or 90-5 -configured outputs. If set to "UDP," the program shows "UDP" in the status field. Names are based on the outputs configuration.

NOTE

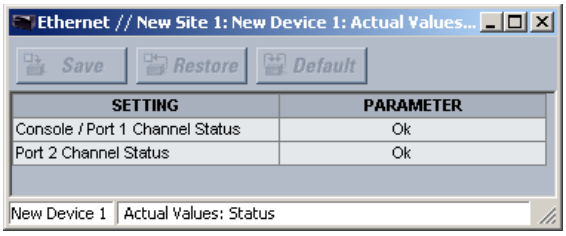
The status is available if the output protocol is set to TCP or 90-5, and not UDP. This is specified in the Output Configuration screen (setting: "Transport Protocol").

Ethernet

The status of all Ethernet communication ports can be monitored from the following EnerVista path:

Path: Device > Actual Values > Status > Ethernet

These values indicate the status of the primary and secondary Ethernet links.

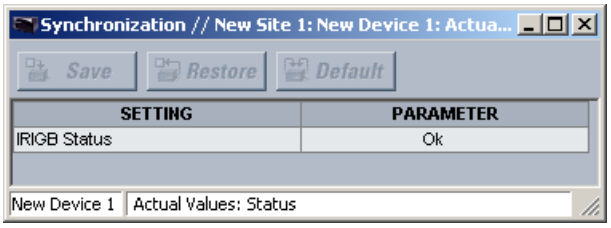


This window shows the list of all Ethernet ports available on the Multilin P30.

Synchronization

The status of all synchronization sources is available in EnerVista using the following path:

Path: Device > Actual Values > Status > Synchronization



The status of the IRIG-B time synchronization signal is available in this window. This status can be either "Fail" (if IRIG-B is not connected or the IRIG-B signal quality is degraded) or "OK" (IRIG-B is available).

Metering

The EnerVista P30 Setup tool allows metering of Inputs from PMUs, Pseudo PMUs, Outputs, and Trending. All these metering options are explained below:

Inputs

The Multilin P30 supports a maximum of either 8 or 40 Input PMUs depending on the Order Code. This screen provides the status for each of the 8[40] Multilin P30 inputs.

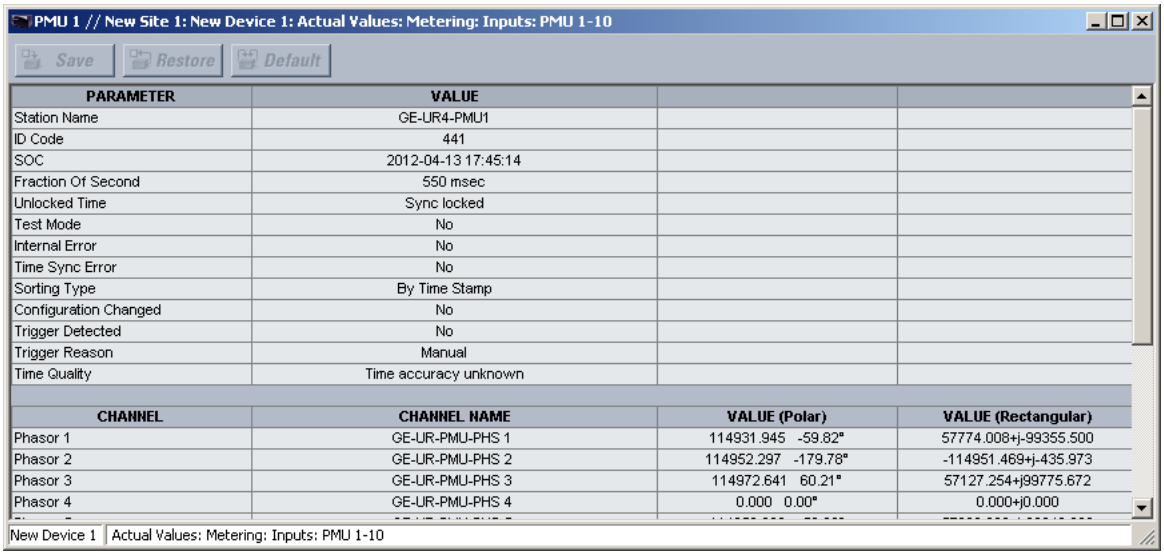
Input X

PMU X to X

PMU X

The input device status window can be found from the following path:

Path: Device > Actual Values > Metering > Inputs > PMU x-x > PMU x

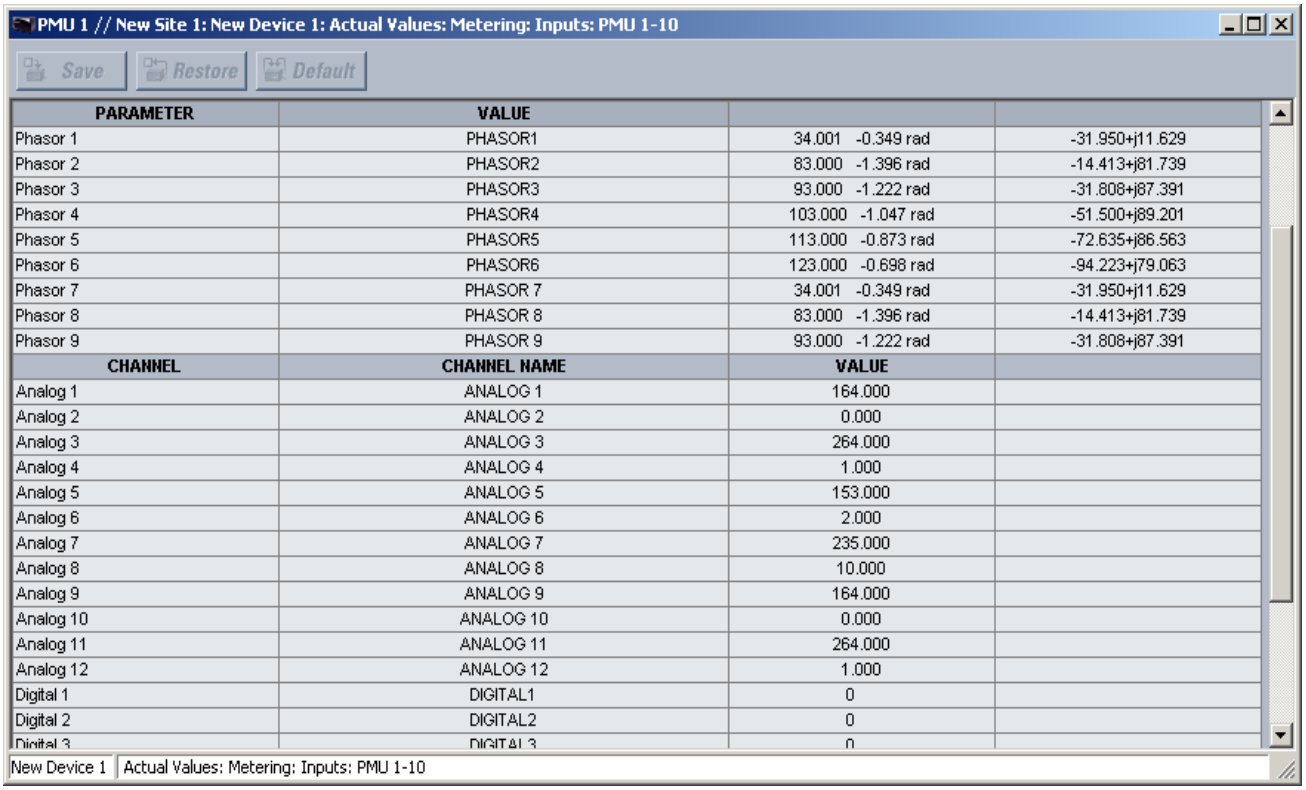


NOTE

Only a single input can be metered at any one time.

- The Station Name (STN), is determined based on the configuration file, and is not an actual value.
- The ID Code and Timestamp are based on the data frame.
- Other items are based on STAT bits of data frame -
  - Unlocked Time based on STAT bit 5-4 from the data frame (00 = sync locked, best quality 01 = Unlocked for 10 s, 10 = Unlocked for 100 s, 11 = Unlocked over 1000 s)
  - Test Mode based on STAT bit-15
  - Internal Error based on STAT bit-14
  - Time Sync Error based on STAT bit-13
  - Sorting Type based on STAT bit-12
  - Configuration Changed from STAT bit-10
  - Trigger Detected from STAT bit-11
  - Time Quality from STAT bits 8-6 according to IEEE C37.118.2 Draft 3.2 May 2011.
- Channel names are determined based on the configuration file.
  Values of all these channels (up to 20 phasor, 16 analogs, 32 digitals, 1 Freq, 1 Dfreq) are based on the received data frame.

The EnerVista P30 Setup program ensures that all data shown on the screen are from the same timestamp.



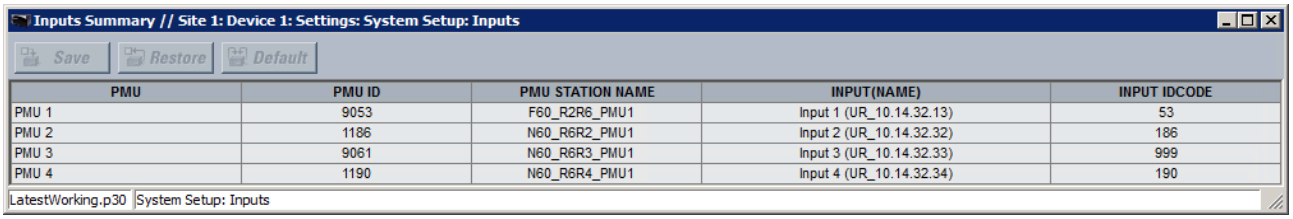
PMU 1 // New Site 1: New Device 1: Actual Values: Metering: Inputs: PMU 1-10

Save | Restore | Default

PARAMETER	VALUE		
Phasor 1	PHASOR1	34.001 -0.349 rad	-31.950+j11.629
Phasor 2	PHASOR2	83.000 -1.396 rad	-14.413+j81.739
Phasor 3	PHASOR3	93.000 -1.222 rad	-31.808+j87.391
Phasor 4	PHASOR4	103.000 -1.047 rad	-51.500+j89.201
Phasor 5	PHASOR5	113.000 -0.873 rad	-72.635+j86.563
Phasor 6	PHASOR6	123.000 -0.698 rad	-94.223+j79.063
Phasor 7	PHASOR 7	34.001 -0.349 rad	-31.950+j11.629
Phasor 8	PHASOR 8	83.000 -1.396 rad	-14.413+j81.739
Phasor 9	PHASOR 9	93.000 -1.222 rad	-31.808+j87.391
CHANNEL	**CHANNEL NAME**	**VALUE**	
Analog 1	ANALOG 1	164.000	
Analog 2	ANALOG 2	0.000	
Analog 3	ANALOG 3	264.000	
Analog 4	ANALOG 4	1.000	
Analog 5	ANALOG 5	153.000	
Analog 6	ANALOG 6	2.000	
Analog 7	ANALOG 7	235.000	
Analog 8	ANALOG 8	10.000	
Analog 9	ANALOG 9	164.000	
Analog 10	ANALOG 10	0.000	
Analog 11	ANALOG 11	264.000	
Analog 12	ANALOG 12	1.000	
Digital 1	DIGITAL1	0	
Digital 2	DIGITAL2	0	
Digital 3	DIGITAL 3	0	

New Device 1 | Actual Values: Metering: Inputs: PMU 1-10

Inputs Summary



Inputs Summary // Site 1: Device 1: Settings: System Setup: Inputs

Save | Restore | Default

PMU	PMU ID	PMU STATION NAME	INPUT(NAME)	INPUT IDCODE
PMU 1	9053	F60_R2R6_PMU1	Input 1 (UR_10.14.32.13)	53
PMU 2	1186	N60_R6R2_PMU1	Input 2 (UR_10.14.32.32)	186
PMU 3	9061	N60_R6R3_PMU1	Input 3 (UR_10.14.32.33)	999
PMU 4	1190	N60_R6R4_PMU1	Input 4 (UR_10.14.32.34)	190

LatestWorking.p30 | System Setup: Inputs

Inputs Summary consolidates key information from up to 40 PMUs in a single location. For each PMU, the following information is displayed:

- **PMU**: The index of the individual PMU (up to 8 or 40 depending on the ordercode).
- **PMU ID**: The ID Code of the individual PMU.
- **PMU STATION NAME**: The Station Name (STN) of the individual PMU.
- **INPUT(NAME)**: The index of the input that the PMU belongs to. This index corresponds with the input number in the Online and Offline Windows. The user-entered name is shown in parentheses.
- **INPUT IDCODE**: The ID Code of the Input. If an input is an aggregator, this would be the ID Code of the aggregator.

Pseudo PMUs

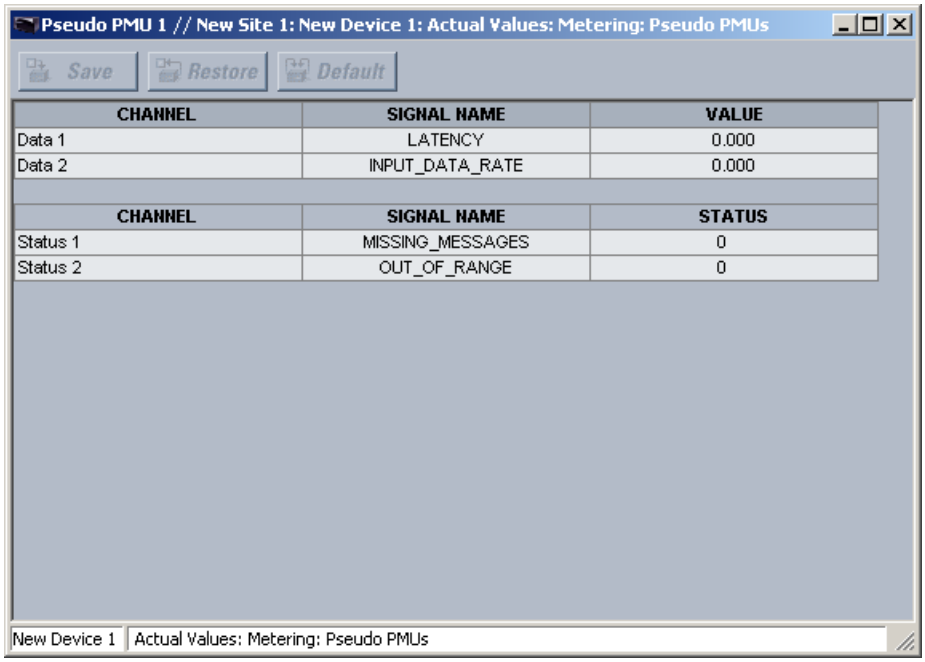
As explained before, there are 4 Pseudo PMUs, each containing 0 phasors, 16 analogs, and 32 digitals.

Pseudo PMU X

Pseudo PMU data and status can be monitored using the following EnerVista path:

Path: Device > Actual Values > Metering > Pseudo PMU > Pseudo PMU X

Figure 7-3: Pseudo PMU screen



All the configured channels, i.e. data and status channels, can be viewed in this window. The signal names are based on configuration of the Pseudo PMU. The EnerVista P30 Setup program ensures that all data shown on the screen are from the same time stamp.

Outputs

The Multilin P30 supports a total of 8 outputs, and can be connected as a server for up to 8 client connections.

Output X

PMU X to X

PMU X

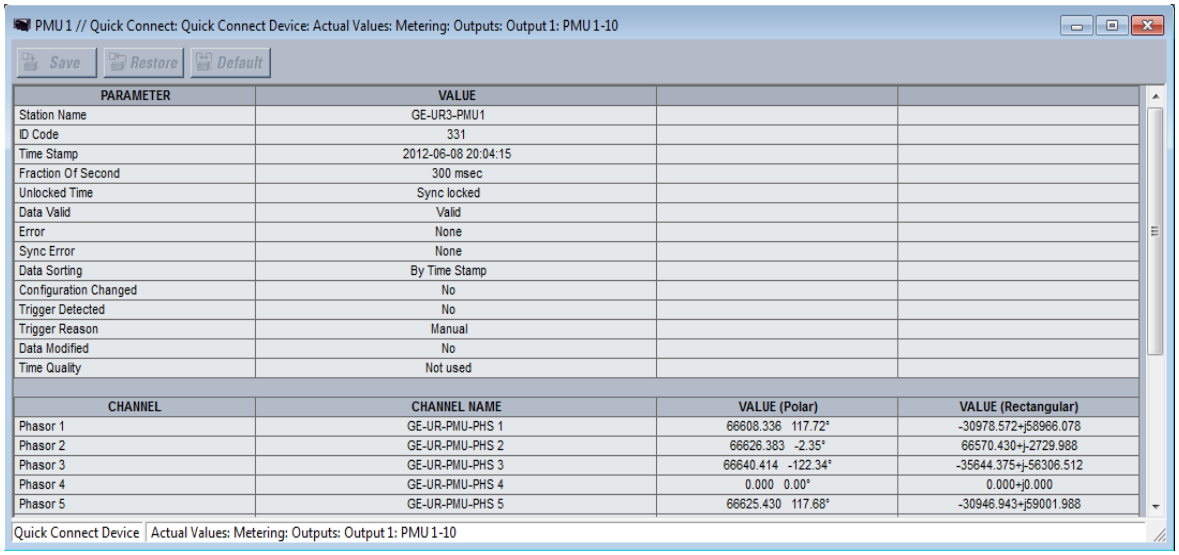
The Outputs menu lists Output 1 to 8, and each output can have multiple PMUs configured on that output stream. These can be observed from the EnerVista path shown below:

Path: Device > Actual Values > Metering > Outputs > Output x > PMU x-x > PMU x

NOTE

The PMU number in the Metering > Outputs tree corresponds with the position of the PMU in the input configuration, and NOT the concentrated frame. This means that when PMUs are skipped at configuration time, they will be skipped in the output status. The same is true for metering and trending views. This applies to Input PMUs, Pseudo PMUs, and Output PMUs.

Example: If only PMU 1 and PMU 3 are configured, then PMU 1 metering will show data from the configured PMU 1, PMU 2 metering will not show any data, and PMU 3 metering will show data for configured PMU 3. The numbering used for metering/trending will match the configuration rather than what is actually sent across the wire.



PMU 1 // Quick Connect: Quick Connect Device: Actual Values: Metering: Outputs: Output 1: PMU 1-10

Save | Restore | Default

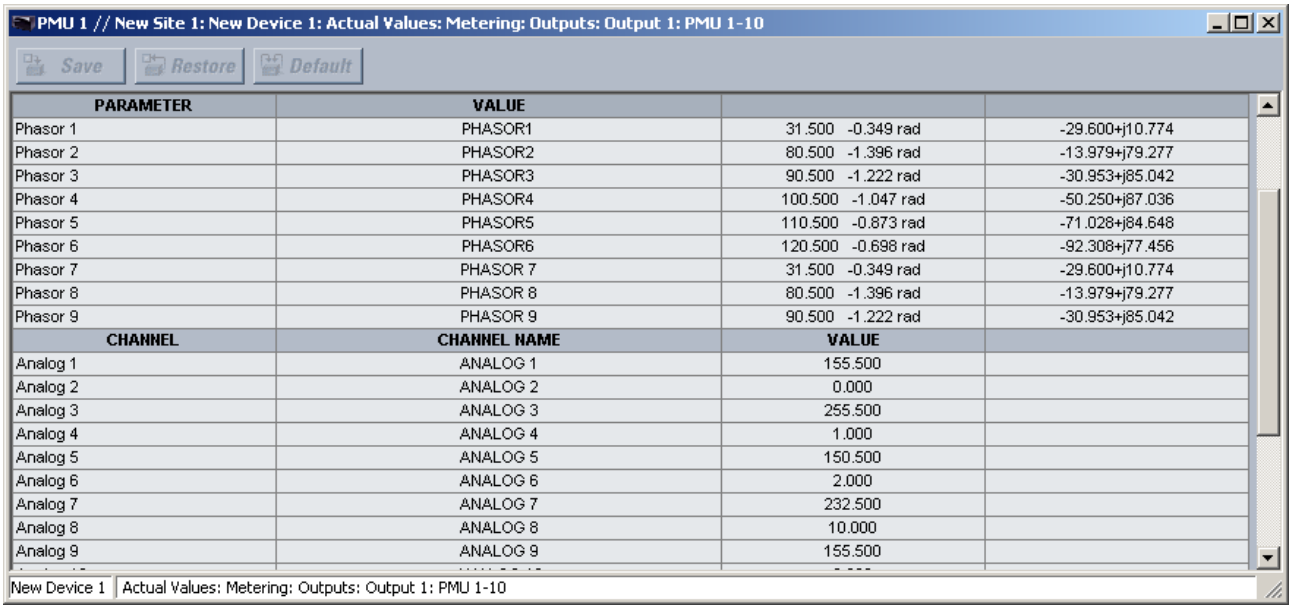
PARAMETER	VALUE		
Station Name	GE-UR3-PMU1		
ID Code	331		
Time Stamp	2012-06-08 20:04:15		
Fraction Of Second	300 msec		
Unlocked Time	Sync locked		
Data Valid	Valid		
Error	None		
Sync Error	None		
Data Sorting	By Time Stamp		
Configuration Changed	No		
Trigger Detected	No		
Trigger Reason	Manual		
Data Modified	No		
Time Quality	Not used		

CHANNEL	CHANNEL NAME	VALUE (Polar)	VALUE (Rectangular)
Phasor 1	GE-UR-PMU-PHS 1	66608.336 117.72°	-30978.572+j58966.078
Phasor 2	GE-UR-PMU-PHS 2	66626.383 -2.35°	66570.430+j-2729.988
Phasor 3	GE-UR-PMU-PHS 3	66640.414 -122.34°	-35644.375+j-56306.512
Phasor 4	GE-UR-PMU-PHS 4	0.000 0.00°	0.000+j0.000
Phasor 5	GE-UR-PMU-PHS 5	66625.430 117.68°	-30946.943+j59001.988

Quick Connect Device | Actual Values: Metering: Outputs: Output 1: PMU 1-10

NOTE

Only a single output can be displayed at any one time.



PMU 1 // New Site 1: New Device 1: Actual Values: Metering: Outputs: Output 1: PMU 1-10

Save | Restore | Default

PARAMETER	VALUE		
Phasor 1	PHASOR1	31.500 -0.349 rad	-29.600+j10.774
Phasor 2	PHASOR2	80.500 -1.396 rad	-13.979+j79.277
Phasor 3	PHASOR3	90.500 -1.222 rad	-30.953+j85.042
Phasor 4	PHASOR4	100.500 -1.047 rad	-50.250+j87.036
Phasor 5	PHASOR5	110.500 -0.873 rad	-71.028+j84.648
Phasor 6	PHASOR6	120.500 -0.698 rad	-92.308+j77.456
Phasor 7	PHASOR 7	31.500 -0.349 rad	-29.600+j10.774
Phasor 8	PHASOR 8	80.500 -1.396 rad	-13.979+j79.277
Phasor 9	PHASOR 9	90.500 -1.222 rad	-30.953+j85.042
CHANNEL	**CHANNEL NAME**	**VALUE**	
Analog 1	ANALOG 1	155.500	
Analog 2	ANALOG 2	0.000	
Analog 3	ANALOG 3	255.500	
Analog 4	ANALOG 4	1.000	
Analog 5	ANALOG 5	150.500	
Analog 6	ANALOG 6	2.000	
Analog 7	ANALOG 7	232.500	
Analog 8	ANALOG 8	10.000	
Analog 9	ANALOG 9	155.500	

New Device 1 | Actual Values: Metering: Outputs: Output 1: PMU 1-10

NOTE

The EnerVista P30 Setup program ensures that all data shown on the screen are from the same time stamp.

Trending

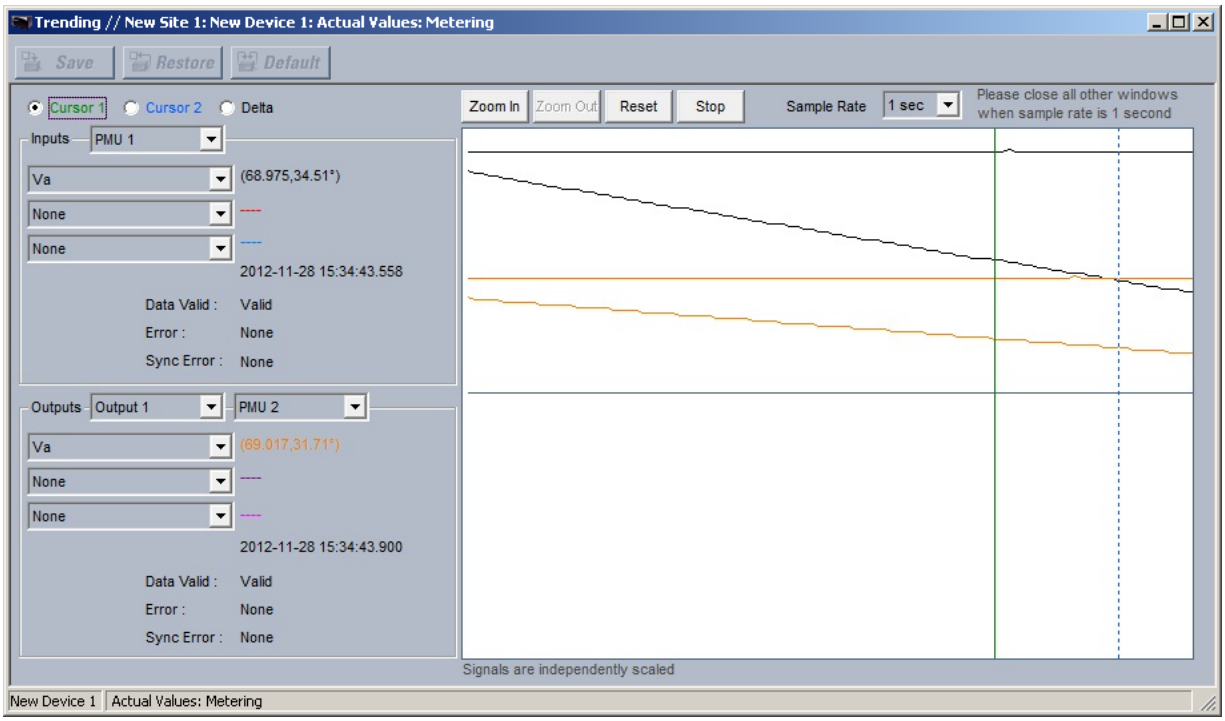
The Trending window is a system commissioning tool that allows phasors, analogs, and digitals, including STAT word bits 15 (Data Valid), 14 (PMU Error), and 13 (PMU Sync), to be plotted over time. A single input PMU and a single output PMU can be monitored at the same time. For each, up to three channels can be displayed.

NOTE

The Trending window cannot be opened unless the other metering screens are first closed.

Trending can be viewed in EnerVista using the path shown below:

Path: Device > Actual Values > Metering > Trending



Inputs: Up to three channels of a specific PMU may be monitored.

Outputs: Up to three channels of a specific Output PMU may be monitored. For each output, the PMU number corresponds with the Input PMU number, not the position of the PMU (in a concentrated frame) as seen by an output device.

Cursor 1: Show the values of the channels at cursor 1 on the plot.

Cursor 2: Show the values of the channels at cursor 2 on the plot.

Delta: Show the difference of the values at the two cursors (cursor 2 - cursor 1). Note that when Delta is selected, the timestamp field will not show the time difference. To see timestamps for each cursor, select either Cursor 1 or Cursor 2.

Zoom In: Zooms in to show fewer samples on the x-axis. If 60 seconds are displayed, clicking the Zoom In button will update the screen to show only the most recent 30 seconds.

Zoom Out: Zooms out to show more samples on the x-axis. If 30 seconds are displayed, clicking the Zoom Out button once will update the screen to show the most recent 60 seconds.

Reset: Clears the trending plot.

Run/Stop: Enables/disables retrieval of data.

Sample Rate: The polling frequency. Note that the interval is only approximate; network conditions and loading can reduce the actual rate. Use the cursors to see the exact timestamp.

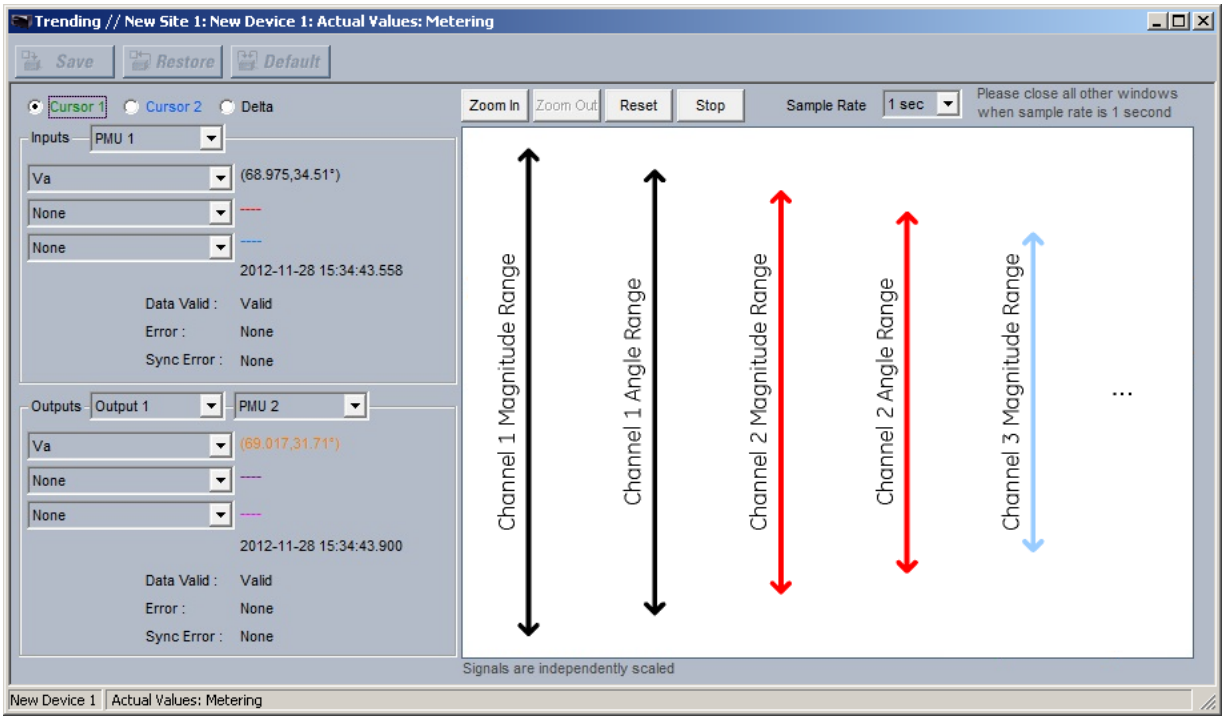
Trending Plot Cursors: Click and drag the two cursors (vertical lines on the plot) to reposition them. The corresponding values are shown alongside each channel name.

Trending Plot X-Axis: The x-axis of the trending plot represents the sample number, with the most recent sample on the right. As data points are equally spaced, cursors should be used to determine values at specific moments in time.

Trending Plot Y-Axis: The Multilin P30 trending display has been optimized to enhance the user visualization experience. Up to 12 lines (6 channels, each with magnitude and angle) are scaled independently on the y-axis such that both the maximum and minimum values are visible on the screen. The first line is scaled to 96% of the total viewable range. Each additional line is automatically scaled to use 8% less of the total range (y-axis) on the display. Therefore, the second line will be scaled to 88% (96% - 8%) of the total viewable range. If the third line is plotted, it will be scaled to 80% (96% - 8% - 8%).

The viewable range that a line is scaled to can be expressed as the following function: f(x) = 0.96 - (0.08*(line number - 1))(x), where x = total range of an empty trending chart.

As shown in the following diagram, two lines of the same magnitude will be displayed with different heights on the trending chart. This feature makes it possible to visualize the trend of all data that is plotted, regardless of magnitude:



Records

The Event Records menu shows the contextual data associated with up to the last 8192 events, listed in chronological order from most recent to oldest. If all 8192 Event Records have been filled, the oldest record is removed as a new record is added. Each event record shows the event identifier/sequence number, cause, and date/time stamp associated with the event trigger. Refer to the COMMANDS > CLEAR RECORDS menu for clearing Event Records.

NOTE

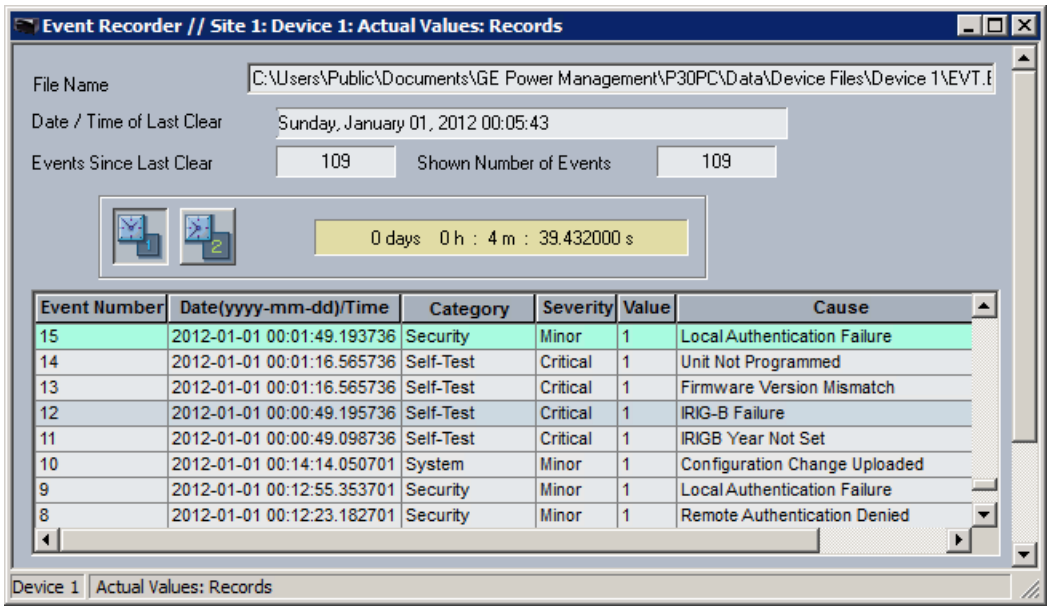
The EnerVista P30 Setup program displays time in UTC.

Event Recorder

NOTE

The event recorder must be enabled in the event recorder settings function, to enable the Multilin P30 to capture the sequence of events.

Path: Device > Actual Values > Records > Event Recorder



The Multilin P30 supports 4 severities of events: Critical, Major, Minor, and Status. Multilin P30 events are date- and time-stamped to the nearest microsecond. Recording of minor, major, and critical severity levels is enabled by default.

Event Recording

The events recorded by the Multilin P30 are classified in following categories:

- System events
- Self-test (diagnostics) events
- Communications events
- P30 client events
- P30 server events
- Security events.

NOTE

Each event has a value of 1 or 0. Value 1 indicates that the condition shown by the event is active and value 0 indicates that the condition for that event has been cleared.

The categories of Multilin P30 events are explained below:

System Events

1. **Concentrator Powered ON**: This event is generated each time the Synchrophasor Processor is restarted or shut down either by soft or hard reset/shut down.
   Event severity: status

2. **Configuration Change Uploaded**: This event is generated when a new configuration has been uploaded to the Multilin P30 from the set-up software. Changes to the concentrator configuration will not take effect until the Activate New Configuration command is issued or the Multilin P30 is restarted.
   Event severity: status
3. **Invalid Configuration**: This event is generated when the Multilin P30 is unable to read the currently loaded Synchrophasor Processor configuration. The event can be addressed by resending the configuration file from the set-up software.
   Event severity: major
4. **Firmware Uploaded**: Generated when a new firmware image has been installed on the Multilin P30 Synchrophasor processor card, and the firmware upgrade has been committed. This event will be posted to the event recorder only after the firmware download has completed.
   Event severity: minor

NOTE

If firmware uploaded to the Multilin P30 is the same version that was previously running on the device, this event will not be generated.

5. **Firmware Upgrade Pending Restart**: Generated when a new firmware binary has been uploaded to the Multilin P30 Synchrophasor Processor card, but has not been committed. Though the upgrade can be reverted at this time, by uploading and committing the previous version of firmware, this event can only be addressed by restarting the Synchrophasor Processor card.
   Event name: Firmware upgrade pending restart
   Event severity: minor

NOTE

If firmware uploaded to the Multilin P30 is the same version that was previously running on the device, this event will not be cleared.

6. **Events Cleared**: This event is generated when a user clear all events in the event recorder.
   Event severity: minor
7. **Clock Synchronized Event**: This event is generated each time the date/time is changed, either by EnerVista P30 Setup software or IRIG-B.
   Event severity: status
8. **Firmware upgrade checksum failure**: This event is generated when a firmware binary has been uploaded to the Multilin P30 but after the secure firmware signature has been validated, the checksum for the firmware binary is invalid. This event can be raised even though an invalid firmware event is not raised.
   Event severity: major
9. **Data Streaming Stopped**: This event is generated each time an authorized Multilin P30 user sends the Stop Streaming command to the device from the EnerVista P30 Setup software. After receiving this command the Multilin P30 stops receiving data from the PMU servers and also stops the streaming of data to clients.
   Event severity: major

Self-test (Diagnostics) Events

1. **Invalid Order Code**: This event is generated when the Synchrophasor Processor card has been programmed with an invalid order code. Call GE Grid Solutions Support to resolve this event.
   Event severity: critical
2. **Inter Card Communication Failure**: This event is generated when the Synchrophasor Processor card has unexpectedly lost communications with the Historian card.
   Event severity: major

3. **Equipment Mismatch**: This event is generated when the Synchrophasor Processor card detects that the installed equipment does not match the system Order Code. For example the event is generated when (a) the firmware detects the wrong PMC type compared to the one specified in the Order Code, or (b) the PMC is missing.
   Event severity: major
4. **Unit Not Programmed**: This event is generated when critical Multilin P30 settings have not been commissioned (i.e. the device is in not-programmed mode).
   Event severity: critical
5. **IRIG-B Failure**: This event is generated when the Multilin P30 detects that there is a loss of IRIG-B input. The event value will show the current state. A value of 1 shows that the signal has been lost or is no longer fit for its purpose. The value will be 0 when an IRIG-B signal has been detected. The Multilin P30 's functionality is severely compromised when a suitable IRIG-B signal is unavailable. (For example, Remote Authentication will not function without an IRIG-B signal.)
   Event severity: critical
6. **Watchdog** Failure: This event is generated when the Synchrophasor processor card's watchdog mechanism has detected that a critical task has become unresponsive.
   Event severity: critical
7. **Firmware Version Mismatch**: The Multilin P30 will normally have one system firmware version, which will comprise different sub-versions that correspond to the components installed in the system as indicated by the Order Code. Sub-versions may correspond to each system image including: Historian, and Synchrophasor processor. Firmware version management ensures that per the system version, the correct sub-versions are installed on each system component. Any firmware version mismatch will generate an event that will be posted to the Event Recorder as soon as the mismatch is detected. A firmware version mismatch may severely impede the operation of the Multilin P30.
   Event severity: critical
8. **Factory Password Generation Failed**: This event is generated if the factory password was not correctly provisioned at the Multilin P30's creation. If this error is visible in the event recorder, users should call customer support.
   Event severity: critical
9. **IRIGB Year Not Set**: If the unit is in the programmed state, the firmware will check the value of current year at system start-up. If the year has not been set, the Multilin P30 will log an event with a value of 1 to indicate that the IRIG-B year has not been set. The operation of the Multilin P30 will be severely diminished if the year is not set. Where IRIG-B signals do not provide the year, users must set the Multilin P30 year using the EnerVista P30 Setup software.
   Event severity: critical

Communications Events

1. **Console Ethernet Failure**: This event is generated whenever the console Ethernet port on the Synchrophasor processor card cannot detect an Ethernet link. Restoring the Ethernet link clears the event.
   Event severity: major
2. **Ethernet_2 Failure**: This event is generated whenever Ethernet port 2 on the Synchrophasor processor card cannot detect an Ethernet link. Restoring the Ethernet link clears the event.
   Event severity: major
3. **Ethernet_3 Failure**: This event is generated whenever Ethernet port 3 on the Synchrophasor processor card cannot detect the Ethernet link and the port is enabled. Restoring the Ethernet link clears the event. This event cannot be enabled if the Multilin P30 Order Code does not include a PMC Ethernet expansion module.
   Event severity: major

4. **Ethernet_4 Failure**: This event is generated whenever Ethernet port 4 on the Synchrophasor processor card cannot detect the Ethernet link and the port is enabled. Restoring the Ethernet link clears the event. This event cannot be enabled if the Multilin P30 Order Code does not include a PMC Ethernet expansion module.
   Event severity: major
5. **Historian Communication Failure**: This event is generated whenever internal communications between the Synchrophasor processor and Historian cards is interrupted. Users may only enable this event if the Multilin P30 Order Code specifies that a Historian card has been installed. Restoration of the communication between these processors clears the event.
   Event severity: major
6. **Input Buffer Overflow**: This event is generated when the concentrator is not able to process all input 90-5 samples. This condition can happen when the 90-5 server is sending more data than P30 is expected to process at that instant.
   Note that the input data rate cannot be only influenced by the PMU server configured data rate but also by network configuration and other conditions. For example transient conditions such as network congestion, duplicate packets on the network, or a sudden burst of packets due to disconnection/connection of the servers can cause instantaneous date rate to be much higher when compared to normal conditions.
   Event severity: major

P30 Client Events

1. **Client State**: This event is generated when the Multilin P30 is connected to the configured PMU. Events can be generated for up to 40 PMU clients. Reporting cannot be enabled / disabled for individual Multilin P30 clients. States that are reported correspond to the individual states specified in the IEEE C37.118-2005 standard.
   Event severity: status
2. **Nominal Frequency Out of Range**: This event is generated when the configured nominal frequency setting is out of range. Possible options are 50Hz or 60Hz.
   Event severity: major
3. **Data Rate Out of Range**: This event is generated when the configured data transmission rate is out of range. Allowable range for 60 Hz is 120, 60, 30, 20, 15, 12, 10, 5, 4, 2, 1 and for 50 Hz is 100, 50, 25, 10, 5, 2, 1.
   Event severity: major
4. **Client Configuration Change**: Is generated when configuration change (bit-10) of a PMU is received. The event remains active until the Multilin P30 starts receiving/ understanding the data frames of the new configuration.
   Event severity: major

P30 Server Events

1. **Server State**: This event is generated when a client is connected to the configured Multilin P30 server. Events can be generated for up to 8 PMU servers. Reporting cannot be enabled / disabled for individual Multilin P30 clients. States that are reported will correspond to the individual states specified in the IEEE C37.118 standard.
   Event severity: status
2. **TCP Client Window Full**: This event may be generated when a client stops accepting data on a TCP socket. The Multilin P30 can diagnose this situation. In some cases a client connected to the Multilin P30 may not keep pace with the data that the Multilin P30 is streaming to it. If this occurs the client may stop responding because the client's TCP window is full. Users should examine the affected client when this event is raised.
   Event severity: major

Security Events

1. **Remote Authentication Denied**: This event is generated when an authentication request has been denied access by the remote RADIUS server. The event is posted to the Event Recorder only after the RADIUS server has sent an unsuccessful authentication response back to the Multilin P30 Synchrophasor processor card.
   Event severity: minor
2. **Local User Database Update**: This event is generated when any change has been made to the local user database, including password changes.
   Event severity: status
3. **Local Authentication Unsuccessful**: This event is generated when a user has been denied authentication against the local user database, or has not been authenticated. The event is posted to the Event Recorder only after the local authentication mechanism has indicated that an unsuccessful /successful authentication has taken place.
   Event severity: minor
4. **Invalid Firmware Upload**: This event is generated when firmware has been uploaded to the Multilin P30 but the secure firmware upgrade feature determines that the upload is invalid.
   Event severity: major
5. **Concentrator IP Changed**: This event is generated when the Synchrophasor processor console port IP Address is changed by the Serial port CLI application.
   Event severity: minor
6. **Unauthorized Command**: This event is generated when a user attempts to execute a command for which they do not have sufficient privileges.
   Event severity: major
7. **Exceeded Failed Authentication Limit**: This event is generated when the number of failed authentications for a particular user, at a remote computer, reaches the limit as specified by the “invalid attempt” setting. This feature does not apply to CLI authentication requests.
   Event severity: major

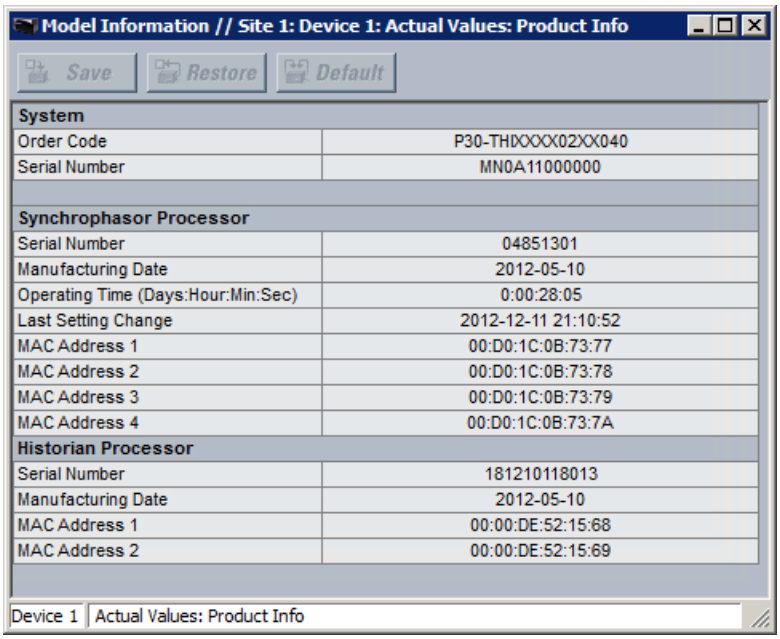
Product Information

Product Information includes information about Multilin P30 Historian firmware revisions, and Multilin P30 model information. This information menu depends completely upon the Order Code, i.e. Whether the Historian is included or not. If the Historian in not included, information about the Historian will not be displayed.

Model Information

Multilin P30 Model Information details of can be viewed using the following EnerVista path:

Path: Device > Actual Values > Product Info > Model Information



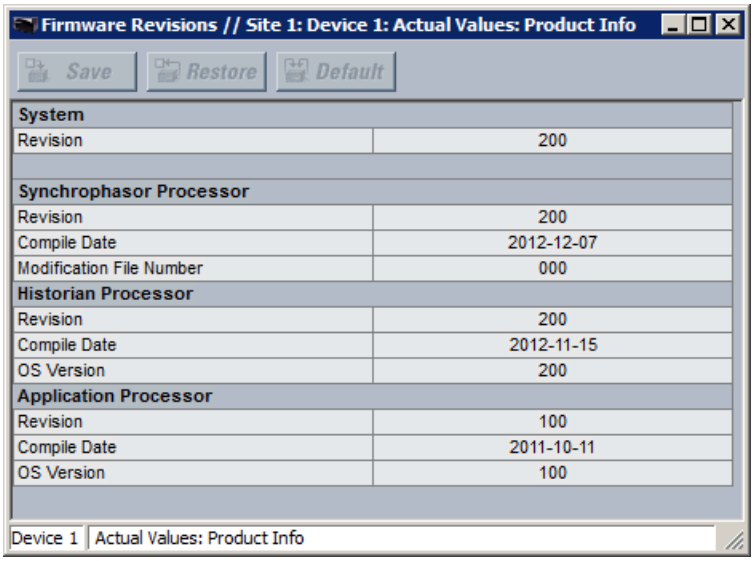
The Order Code and Serial Number of the entire Multilin P30 system are shown at the top. Following this, is the individual Multilin P30 Synchrophasor Processor information such as, Serial number, Manufacturing data, Operating time, Date of Last Setting change, and MAC addresses of the ordered Ethernet interfaces.

Information about the Historian Processor is available if it has been ordered as a part of the Multilin P30 system. If such is the case, the Serial number, Manufacturing date, and MAC addresses are available to the user.

Firmware Revisions

Firmware Revision details can be obtained using the following EnerVista path:

Path: Device > Actual Values > Product Info > Firmware Revisions



At the top of the screen, the System Revision value shows the revision level of the entire Multilin P30 system.

Following this, firmware-related information about each of the subsystems is displayed:

The S**ynchrophasor Processor section** provides the revision, compile date, and modification file number.

The **Historian Processor section** provides the revision, compile date, and OS version if the Historian option is selected.

The **Application Processor section** provides the revision, compile date, and OS version if the Application option is selected.

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Multilin P30

Chapter 8: Multilin P30 Synchrophasor Processor Maintenance

Upgrading P30 Synchrophasor Processor Firmware

To upgrade the Multilin P30 Synchrophasor Processor firmware, follow the procedures listed in this section. Upon successful completion of this procedure, the Multilin P30 will have new Synchrophasor Processor firmware installed. The latest firmware files are available from the GE Grid Solutions website at http://www.gegridsolutions.com.

NOTE

The user should save the Synchrophasor Processor settings to an offline settings file so that they may be restored after the upgrade has completed.

NOTE

Settings file conversion during system firmware upgrades is supported only when upgrading between two consecutive major versions. For example, data conversion upon upgrading 1.0 to 1.1x is supported; it is not when upgrading from 1.0x to 1.2x. Settings will reset to factory defaults where conversion is not supported.

Users can expect settings to be reset for any downgrade between major versions, or if they skip a major version during an upgrade. For example, downgrading 2.0x to 1.1x and upgrading 1.0x to 2.0x (skipping version 1.1x) would both result in the device being set to factory defaults.

NOTE

System downgrades to firmware version 1.0 are not supported, and are blocked.

Process for Upgrading P30 Synchrophasor Processor Firmware

To upgrade the Multilin P30 Synchrophasor Processor firmware, follow the procedures listed in this section.

EnerVista P30 Setup software prevents incompatible firmware from being loaded into a Multilin P30 device, while the Multilin P30 secure firmware upload feature will ensure that only official GE firmware can be loaded into the device.

NOTE

An event will be posted to the event recorded if an attempt is made to load invalid firmware to the Multilin P30. Please see the *Event Recorder* section of this document for details.

NOTICE

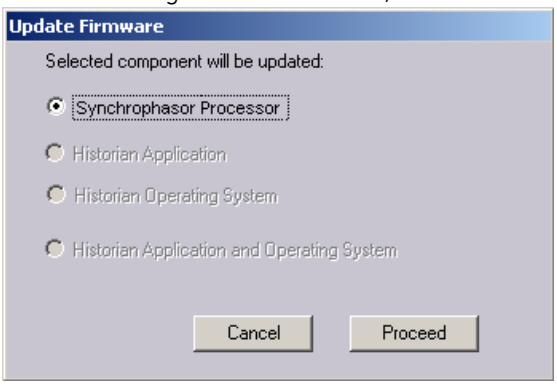
Before upgrading firmware, it is very important to save the current Multilin P30 settings to a file on your PC, as a backup procedure. After the firmware has been upgraded, it may be necessary to load this file back into the Multilin P30. Refer to *Downloading and Saving Settings Files* for details on saving device settings to a file.

NOTE

It is required to stop the operation of the Multilin P30 before starting a firmware upgrade. The Multilin P30 may be halted by setting the programmed state to "not programmed," then activating the configuration.

Loading new firmware into the Multilin P30 flash memory is accomplished as follows:

1. From the maintenance branch in the online setting tree select "Update Firmware".
2. Select the latest firmware image obtained from GE, and click the **OPEN** button.



3. In the "Update Firmware" dialog that appears, select the **Synchrophasor Processor** radio button. Click **Proceed** to begin the firmware upgrade process.

   One of the following messages will appear on the screen:

   - "The configuration files on the device are not supported by this firmware version. The device will be restored to Factory Defaults*. Are you sure you want to update the firmware?" [**Please be aware that this option will reset the console port IP address, and will cause you to lose connectivity from the EnerVista P30 Setup software.**]
     Scenarios:
     Upgrading between non-consecutive major releases. e.g. 1.00 to 1.20 or 1.00 to 2.00
     When downgrading the firmware. e.g. 2.10 to 2.00
   - "The configuration files on the device are not supported by this firmware version. They will be converted to work with this firmware version. Are you sure you want to update the firmware?"
     Scenario: *Upgrading between consecutive major releases. e.g. 1.0x to 1.1x*
   - "The configuration files on the device are supported by this firmware version. No configuration changes are necessary during the update. Are you sure you want to update the firmware?"
     Scenario: *Upgrading between minor releases.*
   - "Firmware version 1.00 is not supported. No changes will be made to the device.
     Scenario: *When attempting to install a version that is not supported by the device or software. e.g. 1.10 to 1.00*

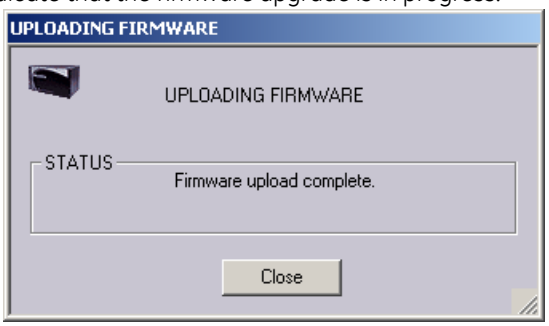
   * Factory Defaults will be applied to the entire device, including:

All settings (As noted above, before upgrading firmware, it is very important to save the current Multilin P30 settings as a backup, to a file on your PC for possible loading back into the PC once the upgrade has taken place.)
Events
Local Passwords
RADIUS Shared secret
RADIUS CA Certificate
Files not supported by the current firmware version (example: If you downgrade from V5.00 to V1.10, files specific to V5.00 will be deleted.)

NOTE

The IP Address will be reset. After the firmware update, the user must use the CLI to reset the IP Address (for details, see *Chapter 2: Serial Communications > Command Line Interface*).

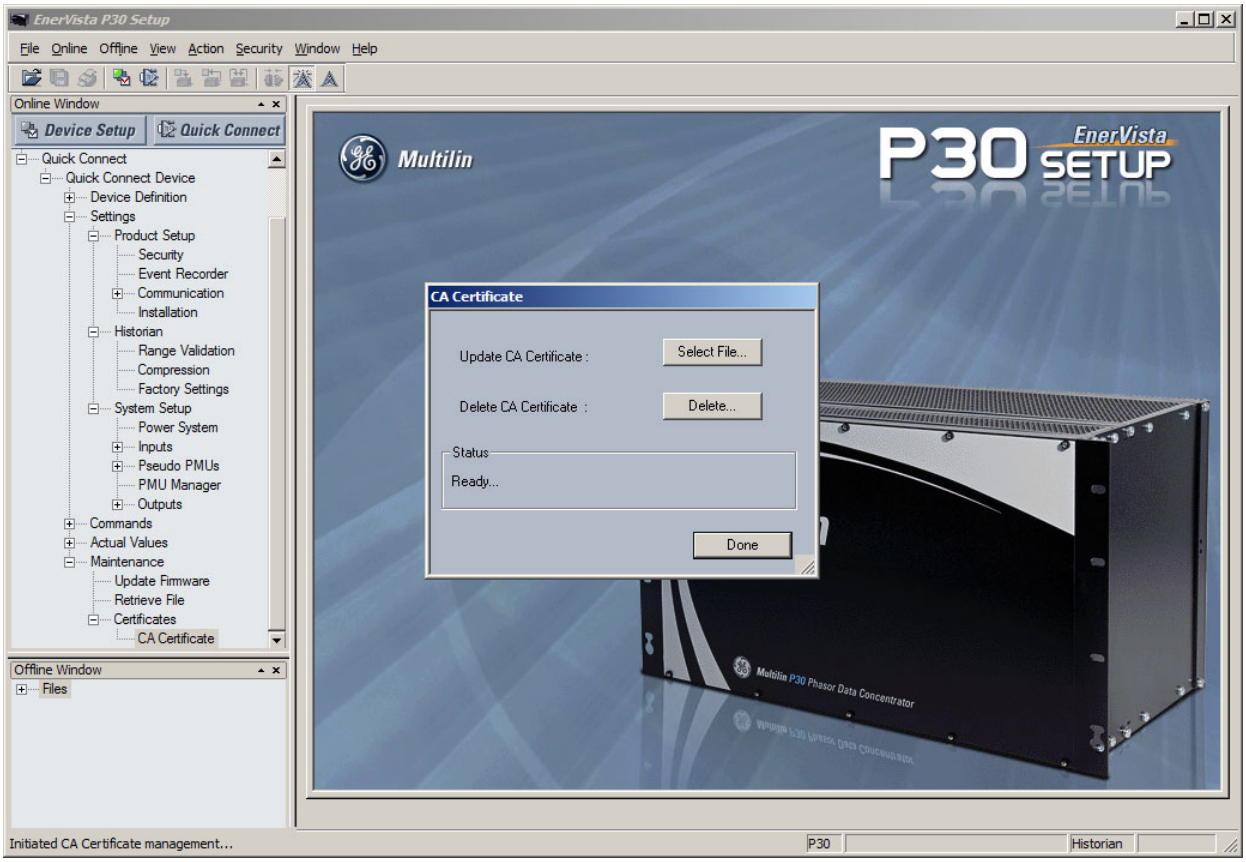
4. A dialog will indicate that the firmware upgrade is in progress.



5. Upon a successful update, the user will be prompted to restart the Multilin P30 to apply the changes immediately, or to restart the device at a later time. A restart is required to activate the new firmware.
6. To activate the new firmware at a later time, click the **Activate New Configuration** button.

Certificates

- The "Certificate Management" window allows the user to upload or delete the CA Certificate used by the Multilin P30 during RADIUS authentication.



- The RADIUS certificate is a X.509 v3 certificate type, that has a file extension **.der**, and is signed by the Certificate Authority (CA). The Multilin P30 Client automatically renames this file in accordance with GE naming requirements.
- The RADIUS Server must be configured according to standard procedures in order to use this certificate. This is part of the RADIUS Server configuration and is not provided by GE.

NOTE

For a RADIUS server application example, please refer to *Appendix A* of this reference manual.

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Chapter 9: Multilin P30 Historian Configuration

Configuring Historian - The Main Steps

NOTICE

Powering up the Multilin P30 Historian processor board while a USB storage device is inserted in the Historian's USB port will adversely affect the Windows operating system's enumeration of storage devices, and will cause mis-operation of the Historian firmware.

Before using the ESV application, you must configure the Multilin P30 Historian. This process involves the following seven main steps:

1. Set up and start hardware
2. Configure Multilin P30 Historian network settings using the Multilin P30 Command Line Interface

NOTE

Interfacing with the Multilin P30 Historian must be done over the network by way of Remote Desktop Protocol (RDP).

3. Log in to the Multilin P30 Historian.
4. Change Multilin P30 Historian login credentials and, optionally, computer name
5. Set up Multilin P30 Historian users
6. Adjust Multilin P30 Historian configuration settings
7. Verify Multilin P30 Historian operation.

Set Up and Start Hardware

1. Connect both a Historian Processor Ethernet port and Synchrophasor Processor console port to the appropriate network switch.
2. The Multilin P30 Historian card starts automatically.
3. Complete the steps outlined under *Configure Multilin P30 Historian Network Settings*.
4. Complete the steps outlined under *Log in to the Multilin P30 Historian*.

Configure P30 Historian Network Settings

The Historian Network settings can be configured via the serial port and through EnerVista P30 Setup. Refer to the *Serial Communications* > *Command Line Interface* section for instructions on how to set up the Historian IP Address using **SetHistorianIP CLI Command**.

To configure via EnerVista P30 Setup:

1. Connect to the Multilin P30 using the console Ethernet port.
2. The Historian network settings can be sent to the Multilin P30 Historian using the Historian Commands window (Device > Commands > Historian). If this is the first time the network settings are being configured, click **Cancel** when prompted for the Historian User Name/Password (there is no need to authenticate with the Historian as the new Historian network parameters will be sent via the Synchrophasor Processor).
3. Enter the new network parameters and press the **Set** button to apply them immediately. Record the IP Address, as it will be needed when logging in to the Multilin P30 Historian.
4. Close the Historian Commands window.

Log Into the P30 Historian

1. From EnerVista P30 Setup, open the Historian Commands window (**Device > Commands > Historian**).
2. Press the **Enable Remote Desktop** button to allow RDP connections directly to the Historian.


NOTE

To prevent unauthorized users from attempting to access the Multilin P30 Historian, RDP connections will be accepted only for a limited amount of time. See the *Historian Commands* section for more information.

3. Start Windows Remote Desktop Connection.
   The Remote Desktop Connection dialog box appears.
4. In the Computer field, enter the IP address of the Multilin P30 Historian.
5. Click **Connect**.
   The "Logon to Windows" dialog box appears.
6. Enter "PDCAdmin" as the Username and "p123@PDCGE" as the Password, then click **OK**.
   The Multilin P30 Historian desktop appears.


NOTE

"p123@PDCGE" is the initial default password.

NOTICE

Installation of additional software to the Historian card may lead to unexpected behavior including system error. Such installation is therefore neither recommended nor supported.

7. Complete the steps outlined under *Change Multilin P30 Historian Login Credentials*.

Change P30 Historian Login Credentials


NOTE

The Multilin P30 Historian password should be changed upon initial login. **This process should be performed in computer management mode for changes to persist after a restart.**

1. In the remote desktop connection, press **CTRL** + **ALT** + **END**.
2. Select "Change Password".
3. Enter the applicable values in the Old Password, New Password, and Confirm New Password fields, and then click **OK**. See the *Security* section of this manual for default passwords.
4. Optionally, change the Multilin P30 Historian name, as follows:
   - Click **Start**, select **Control Panel** then **System and Security**.
   - Click **System** and **Change Settings** under group **Computer name, domain and workgroup settings**. The "System Properties" dialog box appears
   - On the "Computer Name" tab, click **Change**. The "Computer Name" dialog box appears.
   - Enter the desired Computer Name in the corresponding field.


NOTE

The name can contain no more than 15 characters, and may not contain any of the following characters: /\[]":;|<>+=,?*_

5. Proceed as applicable based on whether user authentication and security for the Multilin P30 Historian are to be controlled locally or by the domain server:
   - If authentication and security are to be controlled locally, click **OK** to close the Computer Name dialog box, and then proceed to step 9.

   OR
   - If authentication and security are to be controlled by the domain server, click the **Domain** option, and then proceed to step 6.
6. In the Domain text field, type the domain name, then click **OK**.
   A dialog box appears, prompting you to provide a domain administrator username and password.
7. In the corresponding fields, enter the domain administrator Username and Password, then click **OK**.
8. Click **OK**. The "Computer Name" dialog box closes.
9. In the "System Properties" dialog box, click **OK**. A dialog box appears, prompting you to indicate whether you want to restart the computer.
10. Click **Yes**, unless you wish to continue with step 11 below.
11. Complete the steps under *Set up Multilin P30 Historian Users*.

Set Up Multilin P30 Historian Users

Multilin P30 Historian users can fall into one or more of the following groups based on differing levels of privilege:

- **Administrators**: provides privileges to access the Multilin P30 Historian card by way of RDP for the purpose of performing Windows administrative tasks including setting up users
- **iH Readers**: provides privileges for reading data from the Multilin P30 Historian card
- **PDCPowerUsers**: provides limited administrative privileges, including the ability to change configuration settings of the Multilin P30 Historian card
- **PDCAdmins**: provides full administrative privileges, including the ability to re-image the Multilin P30 Historian card
- **iH Security Admins**: provides full administrative privileges to the Multilin P30 Historian server


NOTE

The iH Security Admins group should be reserved for troubleshooting purposes by the way of the Historian Administrator tool.

The process for setting up Multilin P30 Historian users differs based on whether user authentication and security are to be controlled locally or by domain server. This section provides a separate set of instructions for each context.

User Setup in a Local Context

1. Start a computer management session. (To enter a computer management session, use the EnerVista Historian > Commands screen.)
2. Complete steps 1 through 6 under *Log in to the Multilin P30 Historian*, using the login credentials newly established under *Change Multilin P30 Historian Login Credentials*.
3. On the Multilin P30 Historian desktop, double-click the "Administrative Console" icon. The "Administrative Console" window appears.
4. In the left (navigation) pane, expand the Local Users and Groups (Local) folder, then click the "Users" subfolder.
5. In the right pane, right-click, then select "New User". The "New User" dialog appears.
6. Specify credentials for the Multilin P30 Historian user by entering the following information in the corresponding fields:
   - User name

This designation will subsequently be used by the user when establishing connection between the ESV application and the Multilin P30 Historian, which must be done from within the application post install and before any application features can be used.

   - Full name
   - Description
   - Password

This password will subsequently be used by the user when establishing connection between the ESV application and the Multilin P30 Historian, which must be done from within the application post install and before any application features can be used.

   - Confirm password
7. Click **Create**.
8. Repeat steps 3 through 6 for each Multilin P30 Historian user you want to add.
9. Designate Windows administrator users, as follows:
   - In the left (navigation) pane and within the Local Users and Groups (Local) folder, click the **Groups** folder.
     The right pane refreshes to display the list of groups.
   - In the right pane, right-click the "Administrators" listing, then select "Add to Group". The "Administrators" dialog box appears.
   - Click **Add**. The "Select Users" dialog box appears.
   - In the text field, enter the name of the user you want to assign Windows administrator privileges to, being sure to preface the name with that of the Multilin P30 Historian followed by a backslash (for example, PDCHistorian1\PDCHistorian User1).

You may enter a portion of the user's name, then click **Check Names** to access a dialog box from which you can select the desired user.

   - Click **OK**. The "Select Users" dialog box closes, and the selected user's name is added to the "Members" pane in the "Administrators" dialog box.
   - Repeat steps 8c through 8e for each user to whom you want to assign Windows administrator privileges.

- When you are finished designating Windows administrator users, click **OK** to close the "Administrators" dialog box.

10. Designate Multilin P30 Historian read-only users, as follows:
    - In the left (navigation) pane and within the "Local Users and Groups (Local)" folder, click the "Groups" folder. The right pane refreshes to display the list of groups.
    - In the right pane, right-click the **iH Readers** listing, then select "Add to Group". The iH Readers dialog box appears.
    - Click **Add**. The "Select Users" dialog box appears.
    - In the text field, enter the name of the user to whom you want to assign read-only privileges, being sure to preface the name with that of the Multilin P30 Historian followed by a backslash (for example, PDCHistorian1\PDCHistorian User1).
    - Click **OK**. The "Select Users" dialog box closes, and the selected user's name is added to the "Members" pane in the "iH Readers" dialog box.
    - Repeat steps 9.3 through 9.5 for each user to whom you want to assign read-only privileges.
    - When you are finished designating Multilin P30 Historian read-only users, click **OK** to close the "iH Readers" dialog box.
11. Designate Multilin P30 Historian limited-administrator users, as follows:
    - In the left (navigation) pane and within the "Local Users and Groups (Local)" folder, click the **Groups** folder. The right pane refreshes to display the list of groups.
    - In the right pane, right-click the **PDCPowerUsers** listing, then select "Add to Group". The "PDCPowerUsers' dialog box appears.
    - Click **Add**. The "Select Users" dialog box appears.
    - In the text field, enter the name of the user to whom you want to assign limited-administrator privileges, being sure to preface the name with that of the Multilin P30 Historian followed by a backslash (for example, PDCHistorian1\PDCHistorianUser1).
    - Click **OK**. The "Select Users" dialog box closes, and the selected user's name is added to the "Member" pane in the "PDCPowerUsers" dialog box.
    - Repeat steps 10.3 through 10.5 for each user to whom you want to assign limited-administrator privileges.
    - When you are finished designating Multilin P30 Historian limited-administrator users, click **OK** to close the "PDCPowerUsers" dialog box.
12. Designate Multilin P30 Historian full-administrator users, as follows:
    - In the left (navigation) pane and within the "Local Users and Groups (Local)" folder, click the **Groups** folder. The right pane refreshes to display the list of groups.
    - In the right pane, right-click the **PDCAdmins** listing, then select "Add to Group". The "PDCAdmins" dialog box appears.
    - Click **Add**. The "Select Users" dialog box appears.
    - In the text field, enter the name of the user to whom you want to assign full-administrator privileges, being sure to preface the name with that of the Multilin P30 Historian followed by a backslash (for example, PDCHistorian1\PDCHistorianUser1).
    - Click **OK**. The "Select Users" dialog box closes, and the selected user's name is added to the Members pane in the "PDCAdmins" dialog box.
    - Repeat steps 11.3 through 11.5 for each user to whom you want to assign full-administrator privileges.
    - When you are finished designating Multilin P30 Historian full-administrator users, click **OK** to close the "PDCAdmins" dialog box.
13. Designate Multilin P30 Historian server troubleshooting users, as follows:

- In the left (navigation) pane and within the "Local Users and Groups (Local)" folder, click the **Groups** folder. The right pane refreshes to display the list of groups.
- In the right pane, right-click the "iH Security Admins" listing, then select "Add to Group". The "iH Security Admins" dialog box appears.
- Click **Add**. The "Select Users" dialog box appears.
- In the text field, enter the name of the user to whom you want to assign PDC Historian server troubleshooting privileges, being sure to preface the name with that of the Multilin P30 Historian followed by a backslash (for example, PDCHistorian1\PDCHistorian User1).
- Click **OK**. The "Select Users" dialog box closes, and the selected user's name is added to the "Members" pane in the "iH Security Admins" dialog box.
- Repeat steps 12.3 through 12.5 for each user to whom you want to assign Multilin P30 Historian server troubleshooting privileges.
- When you are finished designating Multilin P30 Historian server troubleshooting users, click **OK** to close the "iH Security Admins" dialog box.

14. Close the "Administrative Console" window.
15. End the computer management session by restarting the computer.
16. Complete the steps outlined under *Adjust Multilin P30 Historian Archive and Configuration Settings*.

NOTE

To modify user and group settings after this point, you must first start another management session.

User setup in a Domain Context

In preparation for Multilin P30 Historian user setup in a domain context, it is recommended that you establish five domain user groups based on the following Multilin P30 Historian–related privilege levels:

- **Administrators**: provides privileges to access the Multilin P30 Historian card by way of RDP for the purpose of performing Windows administrative tasks including setting up users
- **iH Readers**: provides privileges for reading data from the Multilin P30 Historian card but no administrative privileges
- **PDCPowerUsers**: provides limited administrative privileges, including the ability to change configuration settings of Multilin P30 Historian card, but no privileges to read data from the card
- **PDCAdmins**: provides full administrative privileges, including the ability to re-image the Multilin P30 Historian card, but no privileges to read data from the card
- **iH Security Admins**: provides full administrative privileges to the Multilin P30 Historian server

NOTE

The iH Security Admins group should be reserved for troubleshooting purposes by way of the Historian Administrator.

After you have established the requisite domain groups, take the following steps to set up Multilin P30 Historian users.

1. Complete steps 1 through 6 under *Log in to the Multilin P30 Historian*, using the login credentials newly established under *Change Multilin P30 Historian Login Credentials*.
2. On the Multilin P30 Historian desktop, double-click the **Administrative Console** icon. The "Administrative Console" window appears.
3. In the left (navigation) pane and within the "Local Users and Groups (Local)" folder, click the **Groups** folder. The right pane refreshes to display the list of groups.

4. Designate the Windows administrator domain group, as follows:
   - In the right pane, right-click the "Administrators" listing, then select "Add to Group". The "Administrators" dialog box appears.
   - Click **Add**. The "Select Users" dialog box appears.
   - In the text field, enter the name of previously created Windows administrator domain group, being sure to preface the name with that of the domain followed by a backslash (for example, DomainName\DomainGroupName).

You may enter a portion of the group's name, then click **Check Names** to access a dialog box from which you can select the desired user.

   - Click **OK**. The "Select Users" dialog box closes, and the selected domain group's name is added to the "Members" pane in the "Administrators" dialog box.
   - When you are finished designating the Windows administrator domain group, click **OK** to close the "Administrators" dialog box.

5. Designate the Multilin P30 Historian read-only domain group as follows:
   - In the right pane, right-click the "iH Reader"s listing, then select "Add to Group". The "iH Readers" dialog box appears.
   - Click **Add**. The "Select Users" dialog box appears.
   - In the text field, enter the name of the previously created Multilin P30 Historian read-only domain group, being sure to preface the name with that of the domain followed by a backslash (for example, DomainName\DomainGroupName).

You may enter a portion of the group's name, then click **Check Names** to access a dialog box from which you can select the desired group.

   - Click **OK**. The "Select Users" dialog box closes, and the selected domain group's name is added to the "Members" pane in the "iH Readers" dialog box.
   - When you are finished designating the Multilin P30 Historian read-only domain group, click **OK** to close the "iH Readers" dialog box.

6. Designate the Multilin P30 Historian limited-administrator domain group as follows:
   - In the right pane, right-click the **PDCPowerUsers** listing, then select "Add to Group". The "PDCPowerUsers" dialog box appears.
   - Click **Add**. The "Select Users" dialog box appears.
   - In the text field, enter the name of the previously created Multilin P30 Historian limited-administrator domain group, being sure to preface the name with that of the domain followed by a backslash (for example, DomainName\DomainGroupName).

You may enter a portion of the group's name, then click **Check Names** to access a dialog box from which you can select the desired group.

   - Click **OK**. The "Select Users" dialog box closes, and the selected domain group's name is added to the "Members" pane in the "PDCPowerUsers" dialog box.
   - When you are finished designating the Multilin P30 Historian limited-administrator domain group, click **OK** to close the "PDCPowerUsers" dialog box.

7. Designate the Multilin P30 Historian full-administrator domain group as follows:
   - In the right pane, right-click the **PDCAdmins** listing, then select "Add to Group". The "PDCAdmins" dialog box appears. Click **Add**. The "Select Users" dialog box appears.
   - In the text field, enter the name of the previously created Multilin P30 Historian full-administrator domain group, being sure to preface the name with that of the

domain followed by a backslash (for example, DomainName\DomainGroupName).

NOTE

You may enter a portion of the group's name, then click **Check Names** to access a dialog box from which you can select the desired group.

- Click **OK**. The "Select Users" dialog box closes, and the selected domain group's name is added to the "Members" pane in the "PDCAdmins" dialog box.
- When you are finished designating the Multilin P30 Historian full-administrator domain group, click **OK** to close the "PDCAdmins" dialog box.

8. Designate the Multilin P30 Historian server troubleshooting domain group, as follows:
   - In the right pane, right-click the **iH Security Admins** listing, then select "Add to Group". The "iH Security" dialog box appears.
   - Click **Add**. The "Select Users" dialog box appears.
   - In the text field, enter the name of the previously created Multilin P30 Historian server troubleshooting domain group, being sure to preface the name with that of the domain followed by a backslash (for example, DomainName\DomainGroupName).

NOTE

You may enter a portion of the group's name, then click **Check Names** to access a dialog box from which you can select the desired group.

   - Click **OK**. The "Select Users" dialog box closes, and the selected domain group's name is added to the "Members" pane in the "iH Security" dialog box.
   - When you are finished designating the Multilin P30 Historian server troubleshooting domain group, click **OK** to close the "iH Security" dialog box.
9. Close the "Administrative Console" window.
10. End the management session by restarting the computer.
11. Complete the steps outlined under *Adjust Multilin P30 Historian Configuration Settings*.

P30 Historian Tag Names

Multilin P30 Historian tags are named based on fields in the IEEE C37.118 CFG-2 file. For details, see *Historian Tag Naming Conventions* below.

P30 Historian Tag Naming Conventions

Phasors and other measurements that can be visualized in the EnerVista Synchrophasor Viewer (ESV) are each assigned an identifying string called a **Historian tag**.

There are three main types of Historian tag:

- PMU configuration tags
- Data tags
- PDC Historian statistic tags.

In the case of PMU configuration and data tags, the first component in the name is always the PMUBaseName, which is the IEEE C37.118 station name (STN) followed by the PMU ID code (IDCODE), separated by a period, for example, ***STATION_A.10***. In the case of Multilin P30 Historian statistic tags, the first component in the name is always PDCBaseName, which is the IEEE C37.118 PDC ID code (IDCODE) prefaced by the literal string PDC, for example, ***PDC56***.

Following are the Historian tag naming conventions and corresponding examples.

PMU Configuration Tags

Parameter	Naming Convention	Example
Nominal Frequency	PMUBaseName "." FNOM	STATION_A.10.FNOM
Configuration Count	PMUBaseName "." CFGCNT	STATION_A.10.CFGCNT
Digital Configuration	PMUBaseName "." CHNAM "." D	STATION_A.10.CHA.D
Analog Configuration	PMUBaseName "." CHNAM "." A	STATION_A.10.CHB.A
Phasor Configuration	PMUBaseName "." CHNAM "." P	STATION_A.10.CHC.P

Data Tags

Measurement	Naming Convention	Example
Current Phasor Magnitude	PMUBaseName "." CHNAM "." IM	STATION_A.10.PHAI.IM
Current Phasor Angle	PMUBaseName "." CHNAM "." IA	STATION_A.10.PHAI.IA
Voltage Phasor Magnitude	PMUBaseName "." CHNAM "." VM	STATION_A.10.PHAV.VM
Voltage Phasor Angle	PMUBaseName "." CHNAM "." VA	STATION_A.10.PHAV.VA
Analog RMS	PMUBaseName "." CHNAM "." AR	STATION_A.10.PHM1.AR
Analog Instantaneous Value	PMUBaseName "." CHNAM "." AI	STATION_A.10.PHM2.AI
Digital Open	PMUBaseName "." CHNAM "." DO	STATION_A.10.BK1.DO
Digital Closed	PMUBaseName "." CHNAM "." DC	STATION_A.10.BK2.DC
Frequency	PMUBaseName "." FREQ	STATION_A.10.FREQ
Rate of Change of Frequency	PMUBaseName "." DFREQ	STATION_A.10.DFREQ
PMU Status	PMUBaseName "." STAT	STATION_A.10.STAT
Trigger Bit	PMUBaseName "." TB	STATION_A.10.DB

Multilin P30 Historian Statistic Tags

Measurement	Naming Convention	Example
Number of tag updates written to the Historian since the data collector service last started.	PDCBaseName.TotalSamples Written	PDC56.TotalSamplesWritten
Number of tag updates written to the Historian in the last ten seconds.	PDCBaseName.SamplesWritten LastTenSeconds	PDC56.SamplesWrittenLastTen Seconds
Size of the queue between the Synchrophasor Processor and Historian.	PDCBaseName.CurrentQueueSize	PDC56.CurrentQueueSize
Number of IEEE C37.118 data frames sent out of chronological order since the data collector service last started.	PDCBaseName.OutofOrderFrame Count	PDC56.OutofOrderFrameCount
Total number of IEEE C37.118 data frames processed by the Historian since the data collector service last started.	PDCBaseName.TotalDataFrames Processed	PDC56.TotalDataFrames Processed
Total number of bad IEEE C37.118 data frames since the data collector service last started.	PDCBaseName.BadFrameCount	PDC56.BadFrameCount
Total number of IEEE C37.118 data frames discarded due to queue overrun since the data collector service last started.	PDCBaseName.DiscardedFrame Count	PDC56.DiscardedFrameCount

Measurement	Naming Convention	Example
The number of milliseconds the current IEEE C37.118 data frame waited in the queue between the data collector service and the Historian.	PDCBaseName.WaitingTime	PDC56.WaitingTime
Timestamp of the IEEE C37.118 data frame just processed.	PDCBaseName.CurrentData FrameTimestamp	PDC56.CurrentDataFrame Timestamp
Collector heartbeat since the data collector service last started.	PDCBaseName.Heartbeat	PDC56.Heartbeat

P30 Historian Storage Requirements

Each sampled value for a Multilin P30 Historian tag requires a number of bytes for storage on a drive, which includes bytes for the value, timestamp, and quality field for each logged sample.

Overall drive sizing requirements are a function of the following:

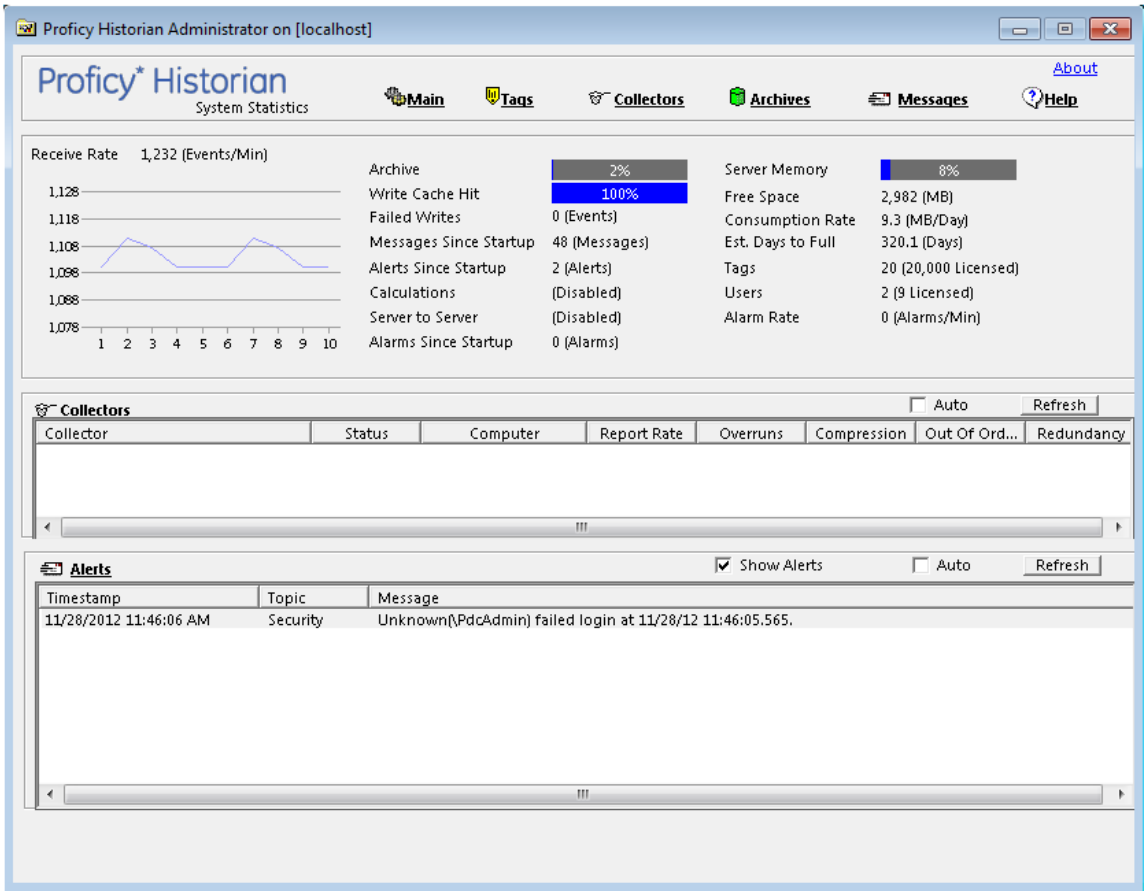
- Number of PMUs
- Number of phasor channels
- Number of analog channels
- Number of digital channels
- Data rate.

For a reference on calculating drive-sizing requirements, see *Chapter 11 - Theory of Operation - P30 Historian Storage Requirements*. Note that the equations provided are based on default compression settings. These compression settings are configurable.

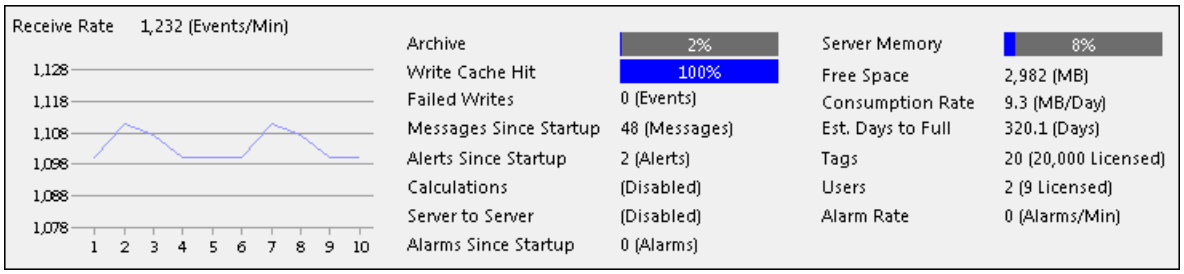
Verify Multilin P30 Historian Operation

1. Ensure that the Synchrophasor Processor card is in service. This can be verified either by checking the component status menu in the EnerVista P30 Setup software, or by checking the status of the RDY LED on the face plate of the Synchropasor Processor card.
   When the READY light is continuously “On” it means that the device is up and running and the configuration has been successfully loaded. As a result there should be communication with PMUs, and clients should be able to connect to the Multilin P30 .
2. On the Multilin P30 Historian desktop, double-click the Administrative Console icon. Select the “Services” (Local) item, then restart the IEEE C37.118 Collector service.

3. From the Multilin P30 Historian desktop, click **Start**, point to All Programs followed by Proficy Historian 4.5, then select **Historian Administrator**. For the first time, a login dialog box appears. Login using the Historian user credentials and the Proficy Historian Administrator window appears:



4. Near the top of the window, verify that the Receive Rate is reflecting positive activity.



5. Close the Proficy Historian Administrator window.
6. Log off from the communications connection.

Configure P30 Historian Settings

NOTE

The clock on the Multilin P30 must be within five minutes of the clock on the PC for EnerVista P30 Setup to communicate properly. See *Section 6 - IRIG-B Commands* for details on setting the clock.

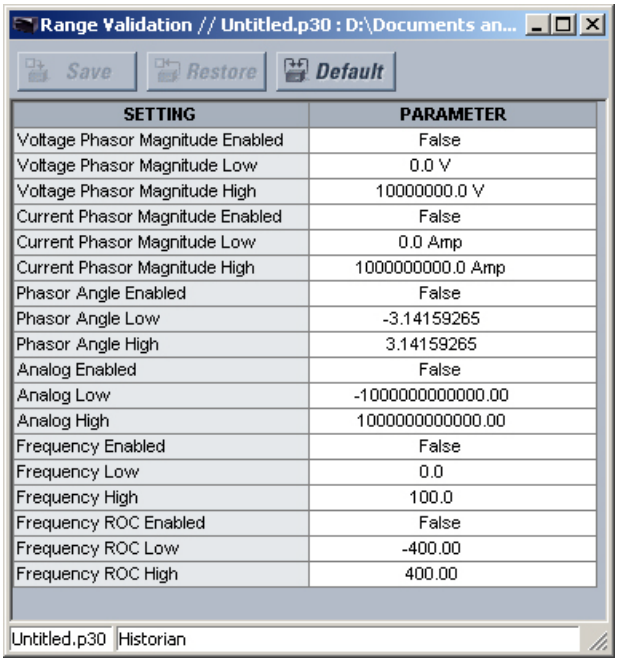
1. From EnerVista P30 Setup, configure the Multilin P30 Historian Settings.
2. Complete the steps outlined under *Verify Multilin P30 Historian Operation*.

Range Validation

Path: Device > Settings > Historian > Range Validation

This screen allows configuration of Range Validation within the Multilin P30 Historian.

Figure 9-1: Typical Range Validation screen



Voltage Phasor Magnitude Enabled: Whether range-validation of phasor magnitude is enabled for voltage phasors.

Voltage Phasor Magnitude Low: The lowest possible value of phasor magnitude (in Volts).

Voltage Phasor Magnitude High: The highest possible value of phasor magnitude (in Volts).

Current Phasor Magnitude Enabled: Whether range-validation of phasor magnitude is enabled for current phasors.

Current Phasor Magnitude Low: The lowest possible value of phasor magnitude (in Amperes).

Curent Phasor Magnitude High: The highest possible value of phasor magnitude (in Amperes).

Phasor Angle Enabled: Whether range-validation of phasor angle is enabled.

Phasor Angle Low: The lowest possible value of phasor angle (in Radians).

Phasor Angle High: The highest possible value of phasor angle (in Radians).

Analog Enabled: Whether range-validation of phasor analog channels is enabled.

Analog Low: The lowest possible value of analog channel.

Analog High: The highest possible value of analog channel.

Frequency Enabled: Whether range-validation of frequency field of PMU data blocks is enabled.

Frequency Low: The lowest possible value of frequency field of PMU data blocks.

Frequency High: The highest possible value of frequency field of PMU data blocks.

Frequency ROC Enabled: Whether range-validation of DFREQ field of PMU data blocks is enabled.

Frequency ROC Low: The lowest possible value of DFREQ field of PMU data blocks.

Frequency ROC High: The highest possible value of DFREQ field of PMU data blocks.

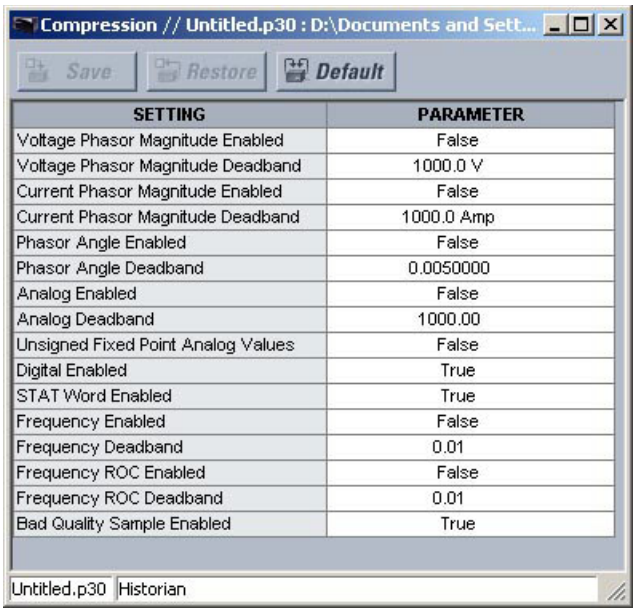
Compression

Path: Device > Settings > Historian > Compression

This screen allows configuration of Compression within the Multilin P30 Historian.

Historian compression allows the user to store the synchrophasor data only if there is change in value. This results in a longer overall period for data storage in the Historian, as compared with the shorter period offered using continuous storage. Compression can be set to True/False (i.e. Enabled/Disabled respectively) for each data type coming from the synchrophasor data frame. If compression is enabled, the deadband for the compression should be provided. A sample is compressed away if its value does not deviate from the previous value by this deadband. Zero is a valid value for the deadband.

Figure 9-2: Typical Compression screen



Voltage Phasor Magnitude Enabled: Whether the Historian compresses phasor magnitudes.

Voltage Phasor Magnitude Deadband: If compression is enabled, the deadband for the compression.

Current Phasor Magnitude Enabled: Whether the Historian compresses phasor magnitudes.

Current Phasor Magnitude Deadband: If compression is enabled, the deadband for the compression.

Phasor Angle Enabled: Whether the Historian compresses phasor angles.

Phasor Angle Deadband: If compression is enabled, the deadband for the compression.

Analog Enabled: Whether the Historian compresses analog channels.

Analog Deadband: If compression is enabled, the deadband for the compression.

Unsigned Fixed Point Analog Values: If analog channels are in fixed point format, whether to interpret the two bytes as a signed or unsigned integer before applying the scaling factor.

Digital Enabled: Whether the Historian compresses digital channels.

STATWord Enabled: Whether the Historian compresses stat words.

Frequency Enabled: Whether the Historian compresses frequencies.

Frequency Deadband: If compression is enabled, the deadband for the compression.

Frequency ROC Enabled: Whether the Historian compresses DFREQ values.

Frequency ROC Deadband: If compression is enabled, the deadband for the compression.

Bad Quality Sample Enabled: Whether the Historian compresses bad quality samples.

Factory Settings

Path: Device > Settings > Historian > Factory Settings

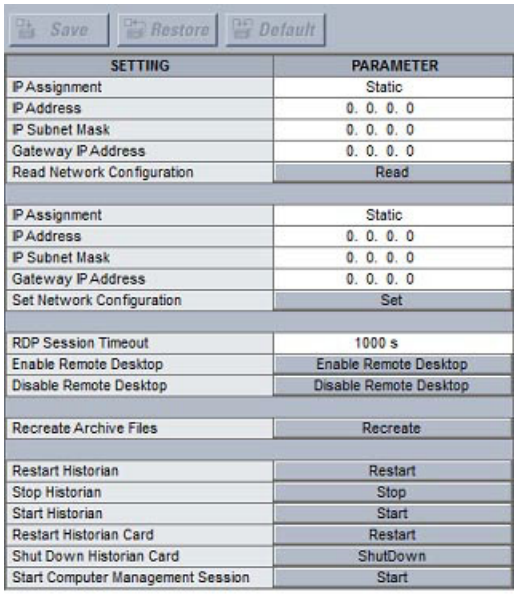
The Factory Settings screen contains settings that should be changed only by the GE Grid Solutions support team. The settings are provided for special scenarios where the standard configuration is not appropriate.

P30 Historian Commands

The following section describes the aspects of an installed Historian Processor Card that can be affected by the EnerVista P30 Setup software.

These features will be required to perform routine maintenance on the Historian card, and to gain access to the Embedded Windows desktop, should users wish to access the Historian software directly.

Path: Device > Commands > Historian



To view the network configuration of the Historian console port, the user must first issue the Read Network Configuration command. This will populate the IP Assignment, IP Subnet Mask, and Gateway IP Address fields.

IP Assignment: Indicates whether the Historian console port is using Static or DHCP IP assignment.

IP Address: The IP of the Historian console port.

IP Subnet Mask: The subnet mask of the Historian console port.

Gateway IP Address: The IP of the gateway used by the Historian console port.

Read Network Configuration: Press the **Read** button to send a command to retrieve the network configuration.

To change the network configuration of the Historian console port, the user must first enter the IP Assignment, IP Address, IP Subnet Mask and Gateway IP Address fields. Once complete, use the "Set Network Configuration" command to immediately update the Historian console port network configuration.

IP Assignment: Indicates whether the Historian console port is using Static or DHCP IP assignment.

IP Address: The IP of the Historian console port.

IP Subnet Mask: The subnet mask of the Historian console port.

Gateway IP Address: The IP of the gateway used by the Historian console port.

Set Network Configuration: Press the **Set** button to send a command to immediately apply the above network configuration.

Changing the IP will temporarily prevent EnerVista P30 Setup from communicating with the Historian Processor. After issuing this command, log out then log in to continue configuring the device.

RDP Session Timeout: The number of seconds to allow new "Remote Desktop" connections.

Enable Remote Desktop: Allow "Windows Remote Desktop Connection" to access the Historian.

Disable Remote Desktop: Stop "Windows Remote Desktop Connection" from accessing the Historian.

Recreate Archive Files: Deletes all archive files. This should be used if the archive files have been damaged (from a power failure, etc.) and are beyond repair. Use caution with this command, as it will delete archived data.

Restart Historian: Restart the Historian application. Note that this will also activate any Historian settings changes made with EnerVista P30 Setup.

Stop Historian: Stop the Historian application.

Start Historian: Start the Historian application.

Restart Historian Card: Gracefully restart the Historian.

Shut Down Historian Card: Gracefully power down the Historian. This should be done before disconnecting power from the Multilin P30.

NOTICE

To prevent loss of data, ensure the Windows OS on the Historian has shut down completely before powering down the Multilin P30. To shut down the Windows OS, use the Shut Down Historian Card command from the Historian Commands Window.
To ensure the Windows OS is completely shutdown, wait until the P30 Actual Values > Status > Component Status > Historian Processor > Status becomes Offline.

Start Computer Management Session: Reboots the Historian and automatically enables RDP for 15 minutes. Any changes made during this session will be retained after reboot. This would typically be used for computer management tasks, such as renaming the computer or joining a domain.

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Chapter 10: Multilin P30 Historian Operating Considerations

P30 Historian Storage Requirements

Each sampled value for a Multilin P30 Historian tag requires a number of bytes for storage on a drive, which includes bytes for the value, timestamp, and quality field for each logged sample.

Overall drive sizing requirements are a function of the following:

- Number of PMUs
- Number of phasor channels
- Number of analog channels
- Number of digital channels
- Data rate.

The table below summarizes the average byte count required to store one sample of the different PDC tag types.

Tag Type	Data Type for Tag's Sample Value	Bytes
Phasor	Magnitudes (Float/Scaled); Angles (Scaled)	14/12
Analog	Float/Scaled	8/6
Digital	Integer	6
Frequency	Float/Scaled	8/6
Frequency Rate of Change	Float/Scaled	8/6
PMU Status Word	Integer	6
Trigger Bit	Integer	6

Notice that depending on whether the incoming formats (as defined in the FORMAT field of a CFG-2 file) of phasor magnitudes, analogs, and frequencies are floating point or fixed point, sample values will be stored as float or scaled in Historian archives. Also notice that numbers of bytes per sample value listed above are average, since multiple sample values may share the storage of timestamps and/or quality and this sharing could be uneven.

The storage consumption rate Z (in bytes per second) is determined by the following equation, assuming archive compression is disabled and all continuous quantities are sent in floating point numbers:

$$Z = \sum_{i=1}^{NMR\_PMU} \left[\left(\frac{14 \times PHNMR_i}{CmpRatio_P} + \frac{8 \times ANNMR_i}{CmpRatio_A} + \frac{6 \times DIGINMR_i}{CmpRatio_D} + \frac{16}{CmpRatio_F} + \frac{12}{CmpRatio_D} \right) \times DATA\_RATE \right] + 72.6$$

or if compression for phasor channels, analog channels, and frequencies are disabled, and CmpRatioD is the same as DATA_RATE:

$$Z = \sum_{i=1}^{NMR\_PMU} \left[(14 \times PHNMR_i + 8 \times ANNMR_i + 16) \times DATA\_RATE + 6 \times DIGINMR_i + 12 \right] + 72.6$$

The formula to determine storage space in units of bytes is,

X = Z x DATA_RETENTION x 86400

Where DATA_RETENTION is the number of days retained in the PDC. The reader should note that in addition to X bytes, there needs to be some more space required on the Data Storage Card to account for other overhead, such as log files, buffer files, configuration files, etc., up to about 10 GB.

Multilin P30 Historian Card Power Cycling

Non-programmatic shut-down of the Multilin P30 Historian card, including by way of power loss, should be avoided as it may result in corruption of the two most recently created data archive files. In such an instance, these two archive files are “parked” to prevent undesirable outcomes related to data corruption, and two new empty archive files are created in place of the parked files, to be populated in sequence after the Multilin P30 Historian card is restarted.

NOTE

Only two archive files can be parked at any given time. For example, after two successive non-programmatic shut-down events, only the two latest archive files will be parked, and the prior two parked archive files will be deleted. Frequent successive parking operations will result in additional data loss.

One symptom of non-programmatic shut-down is a gap in data in Trend Chart objects.

To determine whether a non-programmatic shut-down of the Multilin P30 Historian card has occurred, take the following steps:

1. By way of EnerVista P30 Setup, enable RDP for the given Multilin P30 Historian.
2. Remote Desktop into the Multilin P30 .
3. Navigate to **F:\Proficy Historian Data\Archives\Parked**, then proceed as applicable:
   - If the Parked folder does not contain files, non-programmatic shut-down has not occurred, and no further action is required on your part.

   OR

   - If the Parked folder does contain files, non-programmatic shut-down has occurred at some point. Proceed to step 4.
4. Compare the Date Modified value for the archive files against the gap in Trend Chart data and, if the time frames coincide and you need to recover the data, contact GE Technical Support.

Operational Log Files

Several log files provide information on operation of the Historian application, as follows:

When contacting GE technical support you may be asked to retrieve the contents of some or all of these files.

- **DataArchiver-##.txt**: This file logs statistics and errors related to operation of the Multilin P30 Historian.
- **Collector.watchdog.#.log**: This file logs activity of the Multilin P30 Collector's watchdog, which monitors the Collector and Historian Archiver to ensure that both are running, attempts to restart them if this is not the case, and restarts the system if the restart attempt fails.
- **Collector.#.#.log**: This file logs activity of the Multilin P30 Historian Collector, specifically failure of the Collector to connect to Historian; location that the Collector's configuration file is loaded from; and shut-down of the Collector.
- **Stats.PDC#.log**: This file logs statistics, including explanations, related to operation of the Multilin P30 Collector.

Data Validity Indication within ESV

Each Multilin P30 Historian tag sample includes a quality field. This field is used by the ESV application to determine the validity of a tag's sampled value for the time requested and, if necessary, adjust visualization to indicate when values are invalid or unknown. For details, see *Multilin P30 Historian Tag Quality* in Chapter 12.

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Chapter 11: Multilin P30 Historian Maintenance

Upgrading Firmware

To upgrade the Multilin P30 Historian Processor firmware, follow the procedures listed in this section. Upon successful completion of this procedure, the Multilin P30 Historian Processor will have new firmware installed. The latest firmware files are available from the GE Grid Solutions website at http://www.gegridsolutions.com.


NOTE

Please contact technical support to upgrade from 1.x to 2.x firmware.


NOTE

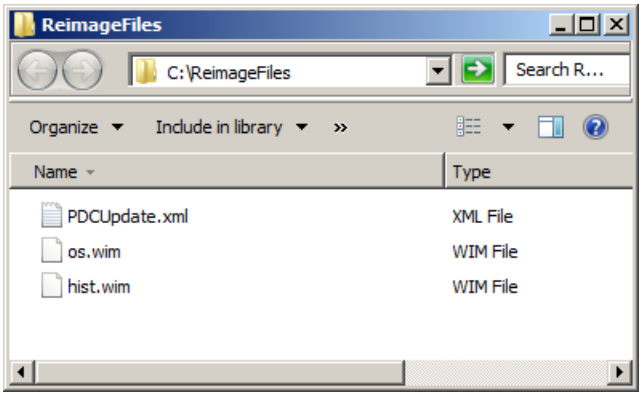
Upgrading or restoring firmware may result in loss of settings and archive data.Before applying the firmware image, it is very important to save the current Multilin P30 settings to a file on your PC. After the firmware has been upgraded, the settings file can be upgraded and loaded back into the Multilin P30. Refer to *Downloading and Saving Settings Files* for details on saving device settings to a file.To prevent loss of historical data, export the data from archives as explained in the P30 Historian Data Export to Excel section.


NOTE

It is recommended to stop the operation of the Multilin P30 before starting a firmware upgrade. The Multilin P30 may be halted by setting the programmed state to “not programmed,” then activating the configuration.

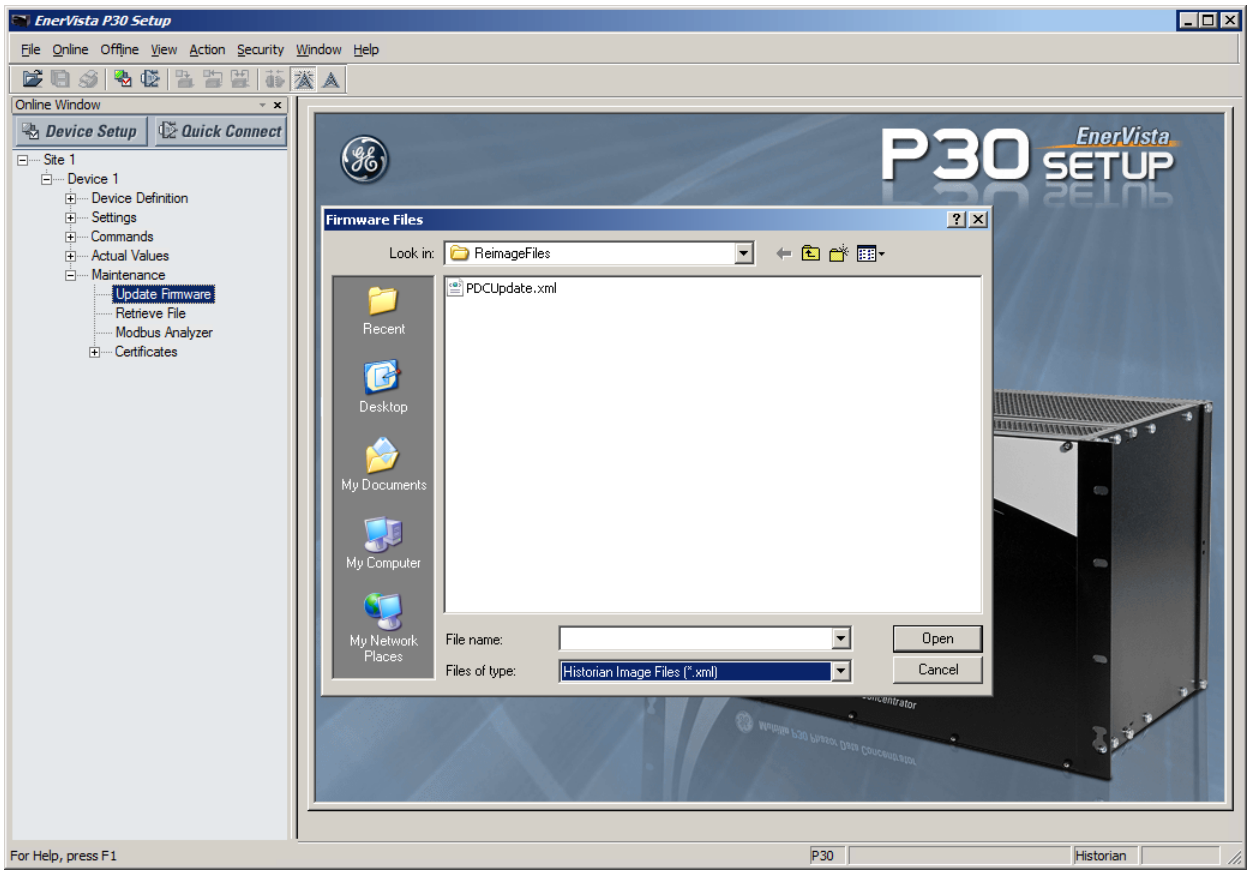
Process for Upgrading Multilin P30 Historian Firmware

1. Ensure that all firmware files (PDCUpdate.xml and any *.wim files) are in a single folder.



2. In EnerVista P30 Setup, go to Maintenance > Update firmware.

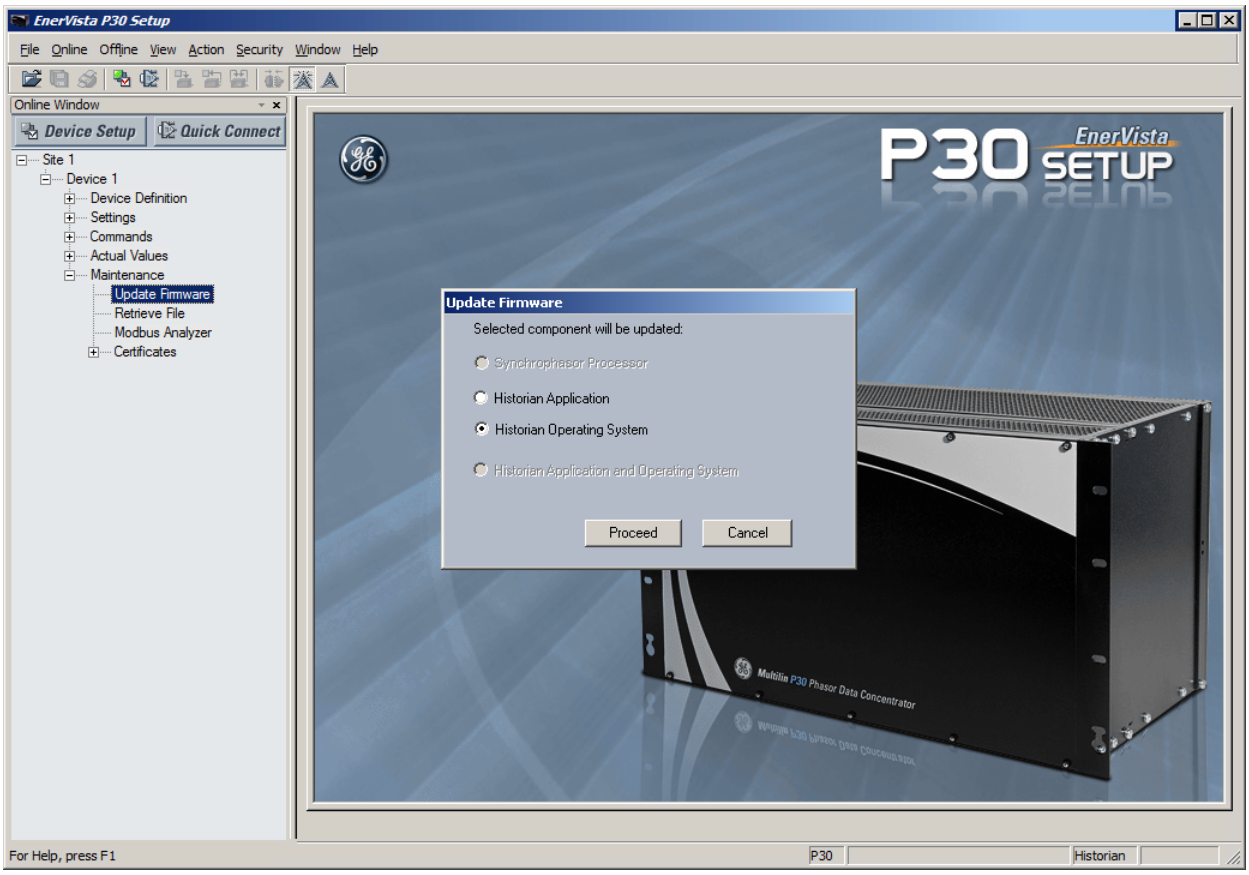
3. Select “Historian Image files (*.xml)” from “Files of type:” then select **PDCUpdate.xml**.



4. Historian firmware files can include the Historian Application, the Historian Operating System, or both.
   Select what you would like to upgrade. EnerVista P30 Setup will restrict allowable updates based on the current version of the Historian and the new firmware files.

NOTE

If the update package provided by GE includes an operating system (OS) upgrade in addition to an Historian application upgrade, then the OS must be upgraded before the application.



5. The image is now being uploaded to the Historian.

6. The image is now successfully restored or updated. Please wait for 30 minutes.
   If the Historian Operating System was NOT updated, you may go ahead and use the device.

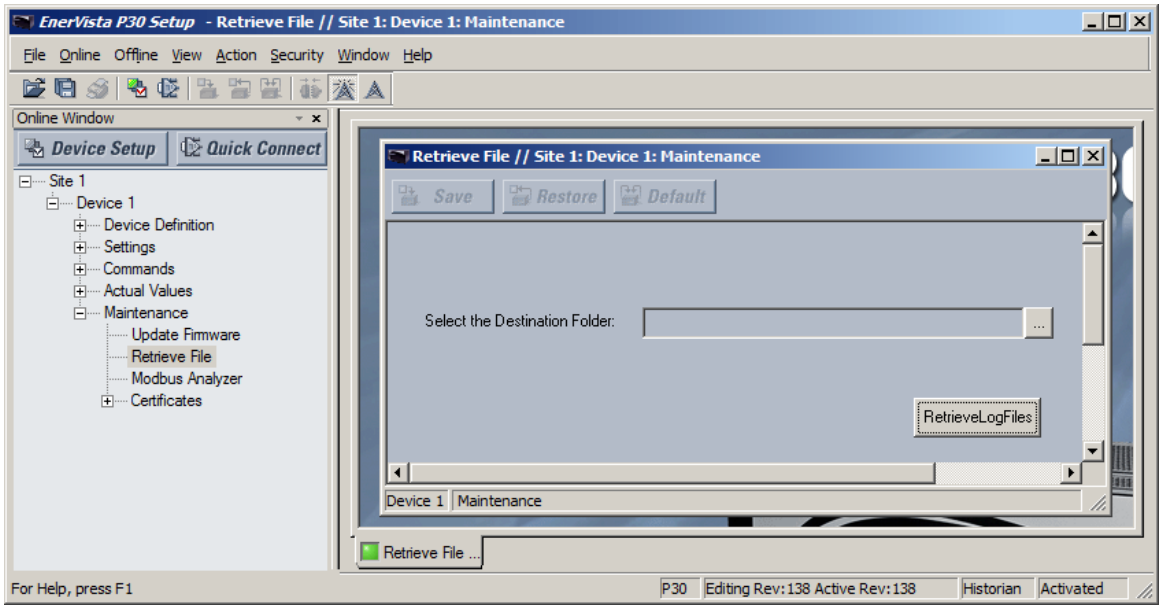
7. If the Historian Operating System WAS updated, after 30 minutes login to the console and issue the SetHistorianIP command with the appropriate parameters.
   For example: **SetHistorianIP "3.94.248.121 netmask 255.255.255.0 gateway 3.94.248.1"**

Retrieve Historian Log Files

The log files collected by EnerVista P30 Setup provide vital information on the Historian's current state. They are text files where following information (with timestamps) is recorded:

- Synchrophasor communication status
- Statistics
- Errors (if any) from the perspective of archiving data and the current Historian session
- Any connection failures or unsuccessful attempts to load Historian configuration
- Other errors reported by the historian

Analysis of these log files can help troubleshoot any issues and can help determine how the current configuration is affecting the Historian.



1. In EnerVista P30 Setup, go to Maintenance > Retrieve File
2. Select the desired location to save the files
3. Click the **Retrieve Log Files** button to save all Historian log files to the selected location.

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Chapter 12: EnerVista Grid Engineer (EGE)

System Initialization

Specify Access Credentials for the Alarm Database

As part of installing the EnerVista Grid Engineer, you were required to provide access credentials for the SQL database to which the application will log alarm data. The first step in initializing EnerVista Grid Engineer post-installation is to enter those credentials by way of the application. To do so, perform the following steps:

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Project Branch**, then double-click the **Database Logger Branch**.
   The CIMPLICITY Database Logger Configuration dialog box appears.
3. Right-click **Alarm_Log**, then select **Logging Properties**.
   The Logging Properties dialog box appears.
4. Click the **Default Alarm Connection** tab.
5. Set the ODBC data source to **CIMPLICITY Logging - Alarms**.
6. In the Database user and Password fields, enter the access credentials you provided during the EnerVista Grid Engineer installation process.
7. Click **Apply**.
8. Click the **Default Point Connection** tab.
9. Repeat steps 5 through 7.
10. Click **OK**.
    The Logging Properties dialog box closes.

Connect to PMU Data Repositories

Data collected from PMUs installed at substations and used by the EnerVista Grid Engineer to serve up alarms to the EnerVista Synchrophasor Viewer (ESV) is housed in Historian repositories. Part of initializing the EnerVista Grid Engineer, then, is to establish connection with the applicable Historian(s). To do so, perform the following steps.

NOTICE

By default, all users are provided access to all Historians (and, thus, alarm data for all PMUs) that the EnerVista Grid Engineer is configured to monitor, unless the user configurations (or, alternatively, the resource configurations) are manually edited to deny such access. For this reason, it is recommended that you establish connection with all necessary Historians before developing custom user configurations.

NOTE

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Computer Branch**, then double-click the **Options Branch**.
   The CIMPLICITY Options dialog box appears.
3. Click the **Historian Connections** tab.
4. Click **Add**.
   The Add Historian Connection dialog box appears.
5. Perform the following steps:
   - In the Connection Name field, enter an identifying name of your choice for the Historian.

NOTE

Connection names must be no more than 16 characters in length. Certain characters are prohibited. For details, consult Illegal Characters for Historian Connection Name

   - In the Server Name field, enter the node name or IP address for the Historian.

NOTE

The node name is preferred.

   - Select the Specify Username/Password check box, then type your Username (preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment) and Password in the corresponding fields.
   - Click **Test**.
     Assuming all information you entered is correct, a dialog box appears, confirming that the connection is ready.
   - Click **OK**.
     The confirmation dialog box closes.
   - Click **OK**.
     The Add Historian Connection dialog box closes.
6. For each Historian that you want to connect to, repeat steps 4 and 5.
7. When you have connected to all desired Historians, click **OK** to close the CIMPLICITY Options dialog box.

Set Up Users

Develop Custom User Configurations

The EnerVista Grid Engineer employs a combination of users, roles, and resources to manage access and privileges related to monitoring and managing PMU alarms in the EnerVista Synchrophasor Viewer (ESV) application.

The EnerVista Grid Engineer comes pre-configured with three users: Administrator, PDC Alarm Analyzer, and System. The PDC Alarm Analyzer user represents the EnerVista Grid Engineer component that assesses transitions in PMU stat word bits for the purpose of determining whether an alarm state exists and, thus, should not be used for any other purpose. Likewise, the System user should be left as is and not be used in relation to

EnerVista Synchrophasor Viewer (ESV) users. While the Administrator user could theoretically be used in relation to ESV users, this approach has two main drawbacks, including that:

- it provides all such users full privileges in relation to monitoring and responding to alarms for all PMUs that the EnerVista Grid Engineer is configured to track
- it provides no traceability of user action in response to alarms.

For these reasons, it is advisable that as part of initializing the EnerVista Grid Engineer, you develop custom user configurations.

NOTE

As part of this process, you should also designate a password for the Administrator user, as this configuration lacks a password by default.

To develop custom user configurations, take the following steps.

NOTE

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Project Branch**, followed by the **Security Branch**, then double-click the **Users**.
   The New User dialog box appears.
3. In the User ID field, enter a description identifying the type of user being created.
4. Click OK.
   The User Properties dialog box appears.
5. Click one of the controls beside the Role field, then select the option that provides the required privileges for the user configuration.

NOTE

All pre-configured roles provide the same level of privilege in the context of the EnerVista Grid Engineer, namely the ability to modify the setup of the interface for viewing current alarms in the ESV application, including by way of filtering. If you want to deny a user configuration this privilege, you can create a custom role for this purpose. Limiting privileges in other ways, including preventing users from acknowledging alarms, can be accomplished by way of alarm routing. For more information, see the CIMPLICITY help file, specifically, the section on 'Process Systems with CIMPLICITY' section.

6. Set the Authentication Type to CIMPLICITY.
7. In the Password and Confirm Password fields, enter and re-enter a password.
8. In the User Name field, enter an identifying name for the user configuration being created.
9. Select the **Enable** check box.
10. If required in your work environment, specify the number of days after which the password will expire, by selecting the desired value from the Password Expires list.
11. Click the **Resources** tab.
12. In the Configured pane, select the listing for each Historian that should NOT be accessible to the user configuration being developed.

NOTICE

By default, new users are provided access to all Historians (and, thus, alarm data for all PMUs) that the EnerVista Grid Engineer is configured to monitor. Likewise, if the EnerVista Grid Engineer is later configured to monitor additional Historians, any previously created user configurations are provided access to those Historians unless you manually edit the user configurations (or, alternatively, the resource configurations) to deny such access. For this reason, it is recommended that you establish connection with all necessary Historians before developing custom user configurations.

13. Click **Remove**.
    The listing(s) move from the Configured to the Available pane.
14. Click **OK**.

Prevent User Access to Repository-specific Alarm Data

Whenever you establish connection between the EnerVista Grid Engineer and a Historian repository housing data collected from PMUs, all EnerVista Grid Engineer user configurations, including pre-existing configurations, are provided access to the Historian. and hence the alarm data for all PMUs served by the HIstorian. However, you can prevent user access to Historian-specific alarm data by modifying the resource setup. To do so, take the following steps.

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Project Branch**, followed by the **Security Branch**, then click **Resources**.
3. In the table displayed beside the navigation tree, double-click the row corresponding to the Historian to which you want to limit access
   A Historian-specific Resource Definition dialog box appears.
4. In the 'Users for This Resource' pane, select each user configuration that should NOT be provided access to the Historian, then click the **Remove** button.
   The listings move to the Available Users pane.
5. Click **OK**.

Prevent Reconfiguration of the Alarm Viewing Interface

All pre-configured roles provide the same level of privilege in the context of the EnerVista Grid Engineer, namely the ability to modify the setup of the interface for viewing current alarms in the EnerVista Synchrophasor Viewer (ESV) application, including by way of filtering. If you want to deny ESV users this privilege, you can create a custom role for this purpose, then assign the role to a custom user configuration.

Limiting privileges in other ways, including preventing users from acknowledging alarms, can be accomplished by way of alarm routing. For more information, see the CIMPLICITY help file, specifically, the section on Process Systems with CIMPLICITY.

To configure a role for preventing re-configuration of the ESV interface for viewing current alarms then assign that role to a custom user configuration, perform the following steps.

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Project Branch**, followed by the **Security Branch**, then double-click **Roles**.
   The New Role dialog box appears.
3. In the Role ID field, enter a description identifying the type of role being created.
4. Click OK.
   The Role Properties dialog box appears.
5. In the Alarms section, clear the **Modify Alarm Setups** check box.
6. Click **OK**.
   The Role Properties dialog box closes.

7. In the navigation tree, expand the **Project Branch**, followed by the **Security Branch**, then click **Users**.
8. In the table displayed beside the navigation tree, double-click the row corresponding to the custom user configuration that you want to be denied the privilege of re-configuring of the ESV interface for viewing current alarms.
   The User Properties dialog box appears.
9. Beside the Role field, click one of the provided controls, then select the newly created role.
10. Click **OK**.

Set Data Retention Preferences

Data Retention Overview

In establishing connection between the EnerVista Grid Engineer and one or more Historians housing PMU data, you lay the groundwork for gathering PMU alarm data. Upon launch of the system, each time a transition state occurs in relation to a monitored STAT word bit for the PMU(s) in question, a corresponding record is stored in the alarms database. In order to prevent database overrun while minimizing degradation in system performance, the EnerVista Grid Engineer is by default set to maintain an alarm record threshold of 600,000, trimming the database at 12 midnight each day, as necessary. However, through a combination of maintenance actions and events, you can hone data retention and storage.


NOTE

The alarms database is capped at 10 GB.

In terms of maintenance actions, which should be established as the first step in setting data retention preferences, you can do any of the following, alone or in combination:

- Increase or decrease the number of records retained, or tie retention to a specified number days rather than records.
- Save deleted records to file.
- Export records.
- Execute an SQL command designed to meet your specific data retention needs.
- Run a program designed to meet your specific data retention needs.

After specifying the desired maintenance actions, the second step of setting data retention preferences is to delineate the time-based or condition-based events and values that will trigger the actions.

Define Data Retention Actions

In order to prevent database overrun while minimizing degradation in system performance, the EnerVista Grid Engineer is by default set to maintain an alarm record threshold of 600,000, trimming the database at 12 midnight each day, as necessary. However, the EnerVista Grid Engineer provides for honing data retention and storage. The first step in this process is to define the desired maintenance actions. To do so, perform the following steps.


NOTE

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Project** branch, then double-click the **Database Logger** branch.
   The CIMPLICITY Database Logger Configuration dialog box appears.

3. Right-click **Alarm_Log**, then select **Properties**.
   The ALARM_LOG Table Properties dialog box appears.
4. Click the **Maintenance Actions** tab.
5. Adjust one or more of the action settings as required to meet your needs:
   - To specify criteria for deleting data:
     - Ensure that the **Delete Records** check box is selected.
     - Select either **By Count** or **By Time** as the deletion parameter.
     - Set the deletion threshold value (and, if the chosen deletion parameter is time, the unit as minutes, hours, or days).
   - To specify that deleted data be saved to file:
     - Select **Save Deleted** in file check box.
     - Enter the name of the destination file.
   - To specify criteria for exporting data:
     - Select the **Export Records** check box.
     - Select either **All**, **By Count**, or **By Time** as the export parameter.
     - Set the export threshold value (and, if the chosen export parameter is time, the unit as minutes, hours, or days).
     - Enter the name of the destination file.
   - To specify an SQL command designed for managing data retention.
     - Select the **Execute SQL Command** check box.
     - Enter the name of the command.
   - To specify your own program to manage data retention.
     - Select the **Run Program** check box.
     - Enter the path to the program executable.
6. Click **Apply**.
7. Complete the steps shown below: To define events for triggering data retention actions.

Define Data Retention Events

In order to prevent database overrun while minimizing degradation in system performance, the EnerVista Grid Engineer is by default set to maintain an alarm record threshold of 600,000, trimming the database at 12 midnight each day, as necessary. However, the EnerVista Grid Engineer provides for honing data retention and storage. After defining the desired maintenance actions, the next step in establishing data retention preferences is to delineate the events that will trigger the actions. You can set the system to initiate data retention actions:

- on a periodic interval and/or
- when a threshold that you specify for a system-defined condition is exceeded.

To define events for triggering data retention actions, perform the following steps.

NOTE

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2; if the ALARM_LOG Table Properties dialog box is already open, start the procedure from step 4.?

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Project** branch, then double-click the **Database Logger** branch.
   The CIMPLICITY Database Logger Configuration dialog box appears.
3. Right-click **Alarm_Log**, then select **Properties**.
   The ALARM_LOG Table Properties dialog box appears.
4. Click the **Maintenance Events** tab.
5. Adjust the event settings as required to best meet your needs.

– To specify values for timed maintenance:
 - Select **Periodic**, enter the numeric interval value, then select the desired unit as minutes, hours, or days).
 - Select **Synchronized**, then specify the time that the system should use to determine the start of each event interval.

– To specify conditioned maintenance based on low-disk space:
 - Select **Disk Space Low**.
 - Select the **Drive**: letter
 - Enter the applicable space remaining (MB) value.


NOTE

The alarms database is capped at 10 GB.

– To specify conditioned maintenance based on number of records logged since the system was last started:
 - Select **Logging Count**.
 - Enter the desired number of logged records.

6. Click **Apply**.
7. Click **OK**.
 The ALARM_LOG Table Properties dialog box closes.

Save Custom System Configuration Settings

Any time after adjusting system configuration settings, including as part of initiating the system, save your settings by performing the following steps.


NOTE

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
 The CIMPLICITY Workbench dialog box appears.
2. In the CIMPLICITY Workbench toolbar, click **Configuration Update**.

Start the System

System Startup Overview

Before you can use the EnerVista Synchrophasor Viewer (ESV) to monitor and manage PMU-related alarms, you must start Alarm Logging by way of the EnerVista Grid Engineer. You can elect to do so either automatically at startup of the system, which is the recommended setting, or manually.

Enable Alarm Monitoring at System Startup

Before you can use the EnerVista Synchrophasor Viewer (ESV) to monitor and manage PMU-related alarms, you must start alarm logging by way of the EnerVista Grid Engineer. You can elect to do so automatically at startup of the system. To do so, perform the following steps.


NOTE

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.?

1. Double-click the **EnerVista Grid Engineer** desktop icon.
 The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Computer Branch**, and then double-click the **Options Branch**.
 The CIMPLICITY Options dialog box appears.
3. Click the **Startup Options** tab.
4. In the System boot options area, select **Start Projects**.

5. Click **Add**.
   The CIMPLICITY Default Options dialog box appears.
6. Click **Browse**, navigate to and select **C:\[Program Files]\Proficy\EnerVista Grid Engineer\EGE_Server\EGE_SERVER.gef**, then click **Open**.
   The Project field in the CIMPLICITY Default Options dialog box refreshes to reflect the selected project file.
7. Click **OK** to close the CIMPLICITY Default Options dialog box.
8. In the CIMPLICITY Options dialog box, click **Apply** followed by **OK**.

Manually Start the System

Before you can use the EnerVista Synchrophasor Viewer (ESV) to monitor and manage PMU-related alarms, you must start alarm logging by way of the EnerVista Grid Engineer. You can elect to do so either automatically at startup of the system, which is the recommended setting, or manually. To manually initiate alarm logging, perform the following steps.

NOTE

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the CIMPLICITY Workbench toolbar, click **Run**.
   The Configuration Update dialog box appears.
3. Click **Yes**.
   A dialog box appears, prompting you to indicate whether you want to start the project.
4. Click **OK**.
   A dialog box reflecting the startup of the various system components appears, then closes when startup is complete.

Maintenance

Maintenance Overview

As your work environment evolves, your needs related to gathering alarm data may change. The EnerVista Grid Engineer provides various options for maintaining alarm data. Specifically, you can:

- Change alarm data retrieval interval
- Manage alarm data logging triggers
- Refine alarm analysis.

Change Alarm Data Retrieval Interval

By default, the EnerVista Grid Engineer is set to retrieve PMU status samples from all configured Historian(s), analyze those samples for any alarm transitions, and generate or reset alarms, as applicable, every 23 seconds. If a different setting would better suit the needs of your work environment, you can change the interval value accordingly. To do so, perform the following steps.

NOTE

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Project Branch**, followed by the **Script Engine Branch**, then double-click the **Event Editor**.
   The CIMPLICITY Event Editor dialog box appears.
3. In the Event ID table, double-click **ANALYSIS_TIMER**.
   The Modify Event dialog box appears.
4. In the Event int fields, change the values for hours (HH), minutes (MM), and/or seconds (SS) to reflect the interval between queries to Historians for PMU status samples.
5. Click **Apply**.
6. Click **OK**.
   The Modify Event dialog box closes.

Manage Logging Triggers

By default, the EnerVista Grid Engineer logs an alarm record each time an alarm is generated, acknowledged, reset, or deleted. However, you can eliminate any of these conditions as logging triggers to better suit your data gathering and storage needs. To do so, perform the following steps.

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Project Branch**, and then double-click the **Database Logger Branch**.
   The CIMPLICITY Database Logger Configuration dialog box appears.
3. Right-click **Alarm_Log**, then select **Properties**.
   The ALARM_LOG Table Properties dialog box appears.
4. Click the **Default Logging Conditions** tab.
5. Eliminate one or more of the following alarm conditions as logging triggers by selecting the corresponding check box to clear the check mark:
   - Generate
   - Acknowledge
   - Reset
   - Delete
6. Click **Apply**.
7. Click **OK**.
   The ALARM_LOG Table Properties dialog box closes.

Refine Alarm Data Analysis

As your work environment evolves, your needs related to gathering alarm data may change. The EnerVista Grid Engineer provides for fine-tuning alarm data analysis by adjusting any of the following parameters:

- Maximum number of seconds' worth of samples processed during any given pass. This variable is initially set to a value larger than the analysis event period, so it will affect the system only after an error or shutdown has prevented the normal processing for a comparatively long period.

- Maximum time an analysis pass can run before an alarm warning the user that it has taken too long is generated. Initially, and ideally, this interval is set slightly longer than the analysis event period, such that the alarm will generate only if a problem results in the processing taking too long.
- Maximum time honored between ownership claims by more than one EnerVista Grid Engineer instance against a single Historian.

NOTE

Only one EnerVista Grid Engineer instance can "claim" a given Historian at a time, and thereby become the system automatically discovered by EnerVista Synchrophasor Viewer (ESV) users for purposes of monitoring and managing corresponding PMU alarms. The ownership setting is designed to manage potential conflicts resulting from running multiple instances of the EnerVista Grid Engineer, which is NOT recommended. The value specified is the time interval during which one of the EnerVista Grid Engineer instances can claim the Historian before the next EnerVista Grid Engineer instance automatically claims the Historian. In the unlikely event that multiple EnerVista Grid Engineer instances attempt to claim the Historian at the same time, the last of the instances to do so will claim the Historian. Regardless of which EnerVista Grid Engineer instance has claim of a Historian at any given time, however, all instances configured to monitor the Historian will log the same alarm data.

- Granularity of information sent to the core status log for operational traceability purposes. Options are only errors; errors plus basic process status; errors plus detailed process status; and all available information.

NOTICE

You should NOT refine alarm data analysis unless advised to do so by GE staff.

To refine alarm data analysis, perform the following steps.

NOTE

If the CIMPLICITY Workbench dialog box is already open, start the procedure from step 2.

1. Double-click the **EnerVista Grid Engineer** desktop icon.
   The CIMPLICITY Workbench dialog box appears.
2. In the navigation tree, expand the **Project Branch**, then click the **Points Branch**.
3. Proceed as applicable based on the refinement being made:

If changing the...	...then
Maximum number of seconds' worth of samples processed during any given analysis pass	Right-click **ALARM_ANALYZER_MAXCYCLETIME**, then select **Point Control Panel**.
Maximum time an analysis pass can run before an alarm warning the user that it has taken too long is generated	Right-click **ALARM_ANALYZER_MAXPROCESSTIME**, then select **Point Control Panel**.
Maximum time honored between ownership claims	Right-click **ALARM_ANALYZER_OWNERSHIPEXP**, then select **Point Control Panel**.
Granularity of information sent to the core status log	Right-click **ALARM_ANALYZER_TRACELEVEL**, then select **Point Control Panel**.

   The Point Control Panel dialog box appears.
4. Double-click the displayed listing.
   The corresponding Point Properties dialog box appears.
5. Enter the desired value in the Set Value field based on the refinement being made:

If changing the...	...then
Maximum number of seconds' worth of samples processed during any given analysis pass	Enter a value between 0 and 32768.
Maximum number of seconds' worth of samples processed during any given analysis pass	Enter a value between 0 and 32768.
Maximum time honored between ownership claims	Enter a value between 0 and 32768.
Granularity of information sent to the core status log	Enter one of the following: 0 to send only errors; 1 to send errors plus basic process status; 2 to send errors plus detailed process status; and 3 to send all available information. **NOTE**: A setting of 2 or 3 will adversely affect system performance, and, in general, the latter should be elected only if recommended by GE staff for troubleshooting purposes.

6. Click **OK**.
   The Point Properties dialog box closes.
7. Close the Point Control Panel dialog box by clicking the "**X**" in the upper-right corner.

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Chapter 13: EnerVista Synchrophasor Viewer (ESV)

REQUIRED HISTORIAN VERSION

The EnerVista Synchrophasor Viewer (ESV) application requires Historian version 4.5. This is the version of Historian client tools that is included as part of the ESV setup package.

HARDWARE LICENSE KEY NOTES

A hardware license key is required in order to run the ESV application. Typically, you install the key as the first step in running the ESV installation. If you are using Windows Server 2008 R2, note that you first must download and install a **HASP driver from Aladdin Knowledge Systems, Inc.** (*http://www3.safenetinc.com/support/hasp/enduser.aspx*) in order for the key to be recognized. For further information on using the hardware license key, see the corresponding topic in the ESV electronic help.

EnerVista Synchrophasor Viewer System Requirements

HARDWARE REQUIREMENTS

The minimum EnerVista Synchrophasor Viewer hardware requirements are:

- Pentium 4–based 3-GHz CPU
- 2 GB RAM
- 4 GB free hard disk space
- CD-ROM Drive
- NETBIOS-compatible or TCP/IP-compatible network interface adapter
- Ethernet adapter
- Additional ports for I/O hardware
- SVGA or better color graphics monitor, 24-bit graphics card capable of 800x600 resolution and at least 65,535 colors
- Two-button mouse or compatible pointing device (such as a touch screen)

SOFTWARE REQUIREMENTS

This section describes the minimum software requirements for the ESV application, including the operating system.

Supported Operating Systems:

Any of the following operating systems, with specified service packs or revisions, fulfill the operating system minimum requirements:

- Microsoft Windows 7, Professional (x86 and x64)
- Microsoft Windows 7, Enterprise (x86 and x64)
- Microsoft Windows 7, Ultimate (x86 and x64)
- Windows XP, Professional, SP3 (x86)

Additional Required Software:

- Microsoft .NET Framework 4.0 SP1

This version is included as part of the ESV setup package and will be installed automatically, if necessary.

- Proficy CIMPLICITY 8.2

A supported version of Proficy CIMPLICITY is included as part of the ESV setup package and will be installed automatically if Proficy CIMPLICITY is not already installed. For information on how the ESV installation manages pre-existence of Proficy CIMPLICITY, refer to the Release Notes tab and, specifically, *Installing the Application*, below.

- Proficy Historian 4.5

This version of Historian client tools is included as part of the ESV setup package.

- Microsoft Excel 2003, 2007, or 2010

Excel is required for exporting Multilin P30 Historian data to spreadsheet format, but is not required for core functionality of the ESV application.

Installing the ESV Application

Take the following steps to install the ESV application.

1. Insert the hardware license key in the computer's USB port.

Connection of the key by way of an external USB hub is not supported.
A message box appears, informing you that the device driver software is being installed, followed a short time later by a second message box, informing you that the device is ready to use.

If you are using Windows Server 2008 R2, you first must download and install a **HASP driver from Aladin Knowledge Systems, Ltd.** in order for the key to be recognized.

The license takes effect after the restart at the end of the installation process.

2. Insert the EnerVista Synchrophasor Viewer installation DVD into the computer's CD-ROM/DVD drive.
3. In the root of the ESV installation DVD, double-click **InstallFrontEnd.exe**. The EnerVista Synchrophasor Viewer Installation page appears.
4. Click EnerVista Synchrophasor Viewer Install. A page prompting you to designate the desired installation location appears.

The default of **C:\Program Files\Proficy** is the recommended location.

NOTE

If a non-supported version of Proficy CIMPLICITY pre-exists on the computer, a dialog box prompting you to uninstall the program appears in place of the installation location dialog box. In this case, the installation terminates upon closure of the dialog box, after which you must remove the pre-existing version before recommencing the ESV installation. If a supported version of Proficy CIMPLICITY pre-exists on the computer, a dialog box appears prompting you to indicate whether you want to continue using that version. In this case, either select No to quit the installation and uninstall the pre-existing version of CIMPLICITY manually before recommencing the ESV installation, or select Yes to continue using the pre-existing version.

5. After confirming the installation location, click **OK**.
   A progress bar indicating installation procession of Proficy CIMPLICITY and any other supporting components, as required, appears, after which the Proficy Historian Setup page appears.

NOTE

It can take up to 10 minutes for the Proficy Historian Setup page to appear. Proficy Historian setup on the ESV node is required to install client tools that allow ESV to connect and communicate with Multilin P30 Historians residing in your application.

6. Click **Next** to begin the Proficy Historian setup.
7. Leave the default feature selections unchanged, then click **Next**.
8. Leave the default directory unchanged, then click **Next**.
   A dialog box appears, prompting you to enter the name of the Historian Server to be used as the default for Excel Add-in.
9. Enter default, then click **Next**.
10. Click **Next**.
    A progress bar appears, indicating procession of the Proficy Historian installation, then the "Finish" page appears.
11. Click **Finish**.
    A progress bar appears, indicating installation procession of other Proficy support components, after which the Proficy Historian SIM 1 Setup page appears.
12. Click **Next**.
13. Click **Yes**, to accept the terms of the License Agreement.
14. Click **Next**.
    A progress bar appears, indicating procession of the Proficy Historian SIM 1 installation, then the "EnerVista Synchrophasor Viewer Setup" page appears.
15. Select, "I accept the terms of the License Agreement," then click **Install**.
    A progress bar appears, indicating procession of the ESV installation, then the "Finish" page appears.
16. Click **Finish**.
    A dialog box prompting you to indicate whether you want to restart the computer appears.
17. Click **Yes**.
    After restarting the computer, you can start using the ESV software, assuming you have already configured the Multilin P30 Historian as outlined in *Chapter 9: Multilin P30 Historian Configuration* of this Instruction Manual.

Using the ESV Application

PREREQUISITES FOR APPLICATION USE

Before you can use the EnerVista Synchrophasor Viewer (ESV) application to visualize power transmission line data, you must establish connection between the application and the Multilin P30 Historian(s) containing the data in question. For instructions on establishing connection between the ESV application and Multilin P30 Historians, see *Visualization Preparation* in the ESV electronic help.

SYSTEM SPECIFICATIONS AND LIMITATIONS

Each Multilin P30 Historian can connect to multiple PMUs; each installation of ESV can access up to 16 Historians simultaneously; and each Historian can be accessed by up to seven ESV users at once.

By default, ESV retrieves data from the Multilin P30 Historian for display in visualization objects once per second. You can adjust this setting to be as short as 0.25 seconds or as long as 10 seconds. (For instructions, see the topic on changing worksheet refresh rate in the ESV electronic help.) If the data in the PDC Historian has not been updated within the specified time frame, ESV will display the most current data available, with a maximum latency of 10 seconds.

The optimal screen resolution for visualization objects is 1440 x 900 pixels.

All Multilin P30 Historian timestamps are based on Coordinated Universal Time (UTC). The ESV application displays timestamps based on the time zone setting of the local node being used to visualize data, adjusting for daylight savings time as necessary.

WORK ENVIRONMENT

The worksheet is the foundation of the ESV work environment. Similar in concept to a canvas, a ESV worksheet can contain one or multiple visualization objects. The first time you start ESV, the application opens a blank worksheet ready to be populated with visualization objects. Whenever you navigate away from a worksheet, the application automatically saves the worksheet as currently populated and configured. Back and forward buttons in the ESV toolbar allow for navigation between worksheets accessed during a given session.

When you close ESV, the application saves the worksheet that was active at the time of closure and earmarks that worksheet as the one to be displayed when the application is next started.

The maximum number of objects that can be created per worksheet is a function of the amount of data being visualized overall and the hardware limitations of the user's computer.

REMOVING THE APPLICATION

Take the following steps to uninstall the ESV application:

1. From the Start menu, open the Control Panel, then select “Add or Remove Programs” (or Programs followed by Programs and Features, depending on the operating system).
2. Remove the following programs in the order indicated:
   - EnerVista Synchrophasor Viewer install
   - Proficy Change Management Client API
   - Proficy Driver Server
   - Proficy HMI/SCADA - CIMPLICITY
   - Proficy Historian

Do NOT uninstall Proficy Keyless License unless instructed to do so. Also, in the event that an uninstall process fails, restart the computer and retry WITHOUT opening the ESV application.

3. After all programs have been removed, restart the computer to complete the removal of all ESV-related components.

NOTE

Existing worksheets are not removed as part of uninstalling the ESV application. If you subsequently re-install the application to a different location, however, the ESV will not be able to locate pre-existing worksheets unless you move them from the original to the new installation directory. If you install a newer version of the application, note that worksheets created in earlier versions may not be compatible.

ESV ELECTRONIC HELP

There are two ways to access the ESV electronic help:

- **Interface Icon**: Click the "**?**" icon within the program interface components.
- **Program Group**: From the Start menu, point to (All) Programs, then EnerVista Synchrophasor Viewer Install, then click EnerVista Synchrophasor Viewer Help.

There are several ways to use the help:

- **Table of Contents**: The table of contents is organized into books and pages. Double-click **a book** to expand it and display the books and pages nested below it. Click **a page** to display the corresponding topic.
- **Index**: To access the online help index, click the **Index** tab in the left-hand pane. In the ESV help index, you can search for topics by keyword. Type a keyword in the box, or select one from the list. When you find the topic that you want, double-click it to display that topic. If more than one topic applies to the keyword, the Topics Found dialog box appears listing all topics that apply to that keyword.
- **Full-text Search**: To access the online help full-text search, click the **Search** tab in the left-hand pane. Use the Search tab to perform full-text searches in the help. If your search results include too many results, you can enter additional terms to narrow down the list. Click the "**right arrow**" button to add boolean terms to your search expression, such as AND, OR, NEAR, and NOT. If you want to search for a specific phrase, enclose the phrase in quotation marks.

Visualization Preparation

Visualization Preparation Overview

Power transmission line data acquired by Phasor Measurement Units (PMUs) installed at substations can be visualized using the EnerVista Synchrophasor Viewer (ESV). This data is time-synchronized to the microsecond based on GPS clocks. The data is then collected, filtered, and time-aligned by a Multilin P30 Synchrophasor Processor card, which then streams the data to a Historian data collector that stores the data in a Historian repository.

Before you can use ESV to visualize power transmission line data, you must first establish a connection to the Historian(s) containing the data in question.

P30 Historian Tag Quality

Each Multilin P30 Historian tag sample has a timestamp, value, and quality field. Client applications that use Historian data, such as the EnerVista Synchrophasor Viewer (ESV), use the quality field to determine the validity of a tag's sampled value for the time requested.

If a Historian tag sample being visualized in a ESV object is of either bad or unknown quality, the text value displayed for the sample is either ####, ****, or ????, and the graphical indicator either disappears (in the case of a Trend Chart object) or turns black. This is also the case if the connection between the ESV application and a Multilin P30 Historian is lost, under which circumstance an additional indicator in the form of a red banner reading No Connection is displayed diagonally across any affected PDC Historian Statistics objects.

The quality of a Historian tag sample is considered bad or unknown under the following conditions:

- The sample's value falls outside a user-configurable range.

- The time quality value in bits 8 through 6 of the STAT word for the PMU that originated the data frame encompassing the sample equals 011, 100, 101, 110, or 111 (binary).
- Bit 14 or 15 in the PMU STAT word for the PMU that originated the sample equals *True*.
- The Historian card loses communication with the Multilin P30 Synchrophasor Processor that would have streamed the sample.
- A transmission error such as a failed CRC check is detected in the data frame containing the sample.

Connect to Historians

Before you can use the EnerVista Synchrophasor Viewer (ESV) to visualize synchrophasor and other measurements, you must establish connection between the ESV and the Historian(s) containing the data. To do so, take the following steps:

1. On the main ESV toolbar, click **Configure PDC Historians**.
   The "Cimplicity Options" dialog box appears.
2. Click the **Historian Connections** tab.
3. Click **Add**.
   The "Add Historian Connection" dialog box appears.
4. Complete the following:
   - In the "Connection Name" field, enter an identifying name of your choice for the Historian.

Certain characters are prohibited. For details, consult *Illegal Characters for Historian Connection Name*, below.

   - In the "Server Name" field, enter the node name or IP address for the Historian.

The node name is preferred.

   - Set the "Specify Username/Password" option based on your organization's security policy:

If your organization's security policy allows for local password storage:	If your organization's security policy does not allow for local password storage:
1. Enable the option by selecting the corresponding check box. 2. Type your Username [preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password in the corresponding fields.	Proceed to step ** below.

If this option is disabled, you will be prompted to enter your Username and Password the first time you access a worksheet containing data from a given Historian within a given session. If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close then reopen the application.

   - **Click **Test**.
     Assuming all information you entered is correct, a dialog box appears, confirming that the connection is ready.
   - Click **OK**.
     The confirmation dialog box closes.
   - Click **OK**.
     The "Add Historian Connection" dialog box closes.
5. For each Historian to which you want to connect, repeat steps 3 and 4.

6. When you have connected to all desired Historians, click **OK** to close the "Cimplicity Options" dialog box.

ILLEGAL CHARACTERS FOR HISTORIAN CONNECTION NAME

When specifying a connection name as part of connecting to Historian(s) for use with the EnerVista Synchrophasor Viewer (ESV), the following characters are prohibited:

Character	Description
NULL	ASCII: 0; NULL
SOH	ASCII: 1; Start of Heading
STX	ASCII: 2; Start of Text
ETX	ASCII: 3; End of Text
EOT	ASCII: 4; End of Transmit
ENQ	ASCII: 5; Enquiry
ACK	ASCII: 6; Acknowledge
BEL	ASCII: 7; Bell
BS	ASCII: 8; Back Space
HT	ASCII: 9; Horizontal Tab
LF	ASCII: 10; Line Feed
VT	ASCII: 11; Vertical Tab
FF	ASCII: 12; FORM FEED
CR	ASCII: 13; CARRIAGE RETURN
SO	ASCII: 14; SHIFT OUT
SI	ASCII: 15; SHIFT IN
DLE	ASCII: 16; DATA LINE ESCAPE
DC1	ASCII: 17; DEVICE CONTROL 1
DC2	ASCII: 18; DEVICE CONTROL 2
DC3	ASCII: 19; DEVICE CONTROL 3
DC4	ASCII: 20; DEVICE CONTROL 4
NAK	ASCII: 21; NEGATIVE ACKNOWLEDGE
SYN	ASCII: 22; SYNCHRONOUS IDLE
ETB	ASCII: 23; END OF TRANSMIT BLOCK
CAN	ASCII: 24; CANCEL
EM	ASCII: 25; END OF MEDIUM
SUB	ASCII: 26; SUBSTITUTE
ESC	ASCII: 27; ESCAPE
FS	ASCII: 28; FILE SEPARATOR
GS	ASCII: 29; GROUP SEPARATOR
RS	ASCII: 30; RECORD SEPARATOR
US	ASCII: 31; UNIT SEPARATOR
SP	ASCII: 32; SPACE
"	ASCII: 34; DOUBLE QUOTATION MARK
$	ASCII: 36; DOLLAR SIGN
&	ASCII: 38; AMPERSAND
'	ASCII: 39; APOSTROPHE OR SINGLE QUOTE
(	ASCII: 40; LEFT PARENTHESIS
)	ASCII: 41; RIGHT PARENTHESIS
*	ASCII: 42; ASTERISK OR MULTIPLY
+	ASCII: 43; PLUS SIGN
,	ASCII: 46; PERIOD
/	ASCII: 47; FORWARD SLASH
:	ASCII: 58; COLON
<	ASCII: 60; LESS THAN SIGN
=	ASCII: 61; EQUAL SIGN
>	ASCII: 62; GREATER THAN SIGN
?	ASCII: 63; QUESTION MARK
@	ASCII: 64; AT SIGN
[	ASCII: 91; LEFT BRACKET
\	ASCII: 92; BACKWARD SLASH
]	ASCII: 93; RIGHT BRACKET
^	ASCII: 94; CARET
{	ASCII: 123; LEFT BRACE
|	ASCII: 124; PIPE
}	ASCII: 125; RIGHT BRACE
DEL	ASCII:127; DELETE

ESV Worksheet Management

The worksheet is the foundation of the EnerVista Synchrophasor Viewer (ESV) work environment. Similar in concept to a canvas, an ESV worksheet can contain one or multiple visualization objects.

Tasks related to worksheet management are performed primarily from the Worksheets panel, which provides controls for doing any of the following:

- Open a worksheet
- Create a worksheet
- Duplicate the currently displayed worksheet
- Rename the currently displayed worksheet
- Delete a worksheet
- Refresh list of available worksheets

The main application toolbar provides for performing the following additional worksheet-related tasks:

- Navigate between worksheets
- Save worksheets

NOTICE

After changing or deleting worksheet objects, there is no way to revert to previous worksheet states. Therefore, if you think you might have future use for worksheet objects in their current states, you may want to consider duplicating the worksheet and changing object configuration on the worksheet copy, rather than doing so on the original worksheet.

TO CREATE A WORKSHEET

To create a new worksheet ready to be populated with visualization objects, perform the following steps:

1. In a blank area of the displayed worksheet, right-click, point to **Worksheets**, then select **Create New**.
   The Create New dialog box appears.

NOTE

You can also access this dialog box by clicking the double-headed arrow on the Worksheets panel, then clicking **Create New**.

2. Enter the desired name for the worksheet.

TIP

If you want to put the worksheet in a group other than the initial default group of Multilin P30s, preface the worksheet's name with the desired group name followed by a backslash (for example, My Group Name\My Worksheet Name). Subgroups are not supported.

3. Click **OK**.
   A new, blank worksheet appears.

NOTE

The worksheet group and name are displayed in the main toolbar (see *Main Window Overview*).

TO OPEN A WORKSHEET

In the EnerVista Synchrophasor Viewer (ESV), one worksheet is always displayed, and only one worksheet can be displayed at a time. Whenever you open a worksheet, the previously displayed worksheet is automatically saved before the other worksheet appears.

To open a worksheet, perform the following steps:

1. Click the double-headed arrow on the Worksheets panel.
   The panel expands, displaying a list of all worksheets.
2. Click the worksheet that you want to open, then click **Open**.

TIP

If you do not see the worksheet in the list, click the plus-sign (+) beside the parent group to expand it and show all child worksheets.

NOTE

You can also open a worksheet by double-clicking it in the list. The Worksheets panel collapses, the selected worksheet opens, and the objects on the worksheet refresh to reflect data for the Display Time.

NOTE

If the worksheet contains visualization objects that draw data from Historians for which you have not saved your login credentials, one or more dialog boxes will appear, in which you must enter your User name [preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password for the corresponding Historian, and then click **OK**, before proceeding with your work. **If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close and then reopen the application.**

TO DUPLICATE A WORKSHEET

If the currently displayed worksheet as configured with visualization objects would serve as a good basis for a new worksheet, you can duplicate the displayed worksheet by taking the following steps:

1. Open the worksheet that you want to use as the source for a new, duplicate worksheet.

NOTE

For instructions, refer to the previous section, "*To Open a Worksheet*"

2. In a blank area of the displayed worksheet, right-click, point to Worksheets, and then select Duplicate. The Duplicate dialog box appears.

NOTE

You can also access this dialog box by clicking the double-headed arrow on the Worksheets panel, then clicking **Duplicate Current**.

3. Enter the desired name for the new worksheet.

TIP

If you want to put the worksheet in a group other than the initial default group of Multilin P30 s, preface the worksheet's name with the desired group name followed by a backslash (for example, My Group Name\My Worksheet Name). Subgroups are not supported.

4. Click **OK**.
   The source worksheet is automatically saved, the Worksheets panel collapses, then a new worksheet appears, reflecting the same visualization objects that were configured for the source worksheet.

NOTE

The worksheet group and name are displayed in the main toolbar (see *Main Window Overview*).

TO NAVIGATE BETWEEN WORKSHEETS

After you have viewed more than one worksheet during a given session, toolbar buttons provide for accessing worksheets previously viewed during the same session. To navigate between worksheets viewed during a given session, take the following steps.

At any time after accessing more that one worksheet during a given session, proceed as applicable, depending on the desired direction of navigation:

- **To navigate to the worksheet that was open immediately prior to the currently displayed worksheet**:

  Click **Last Worksheet** in the main toolbar.

NOTE

The "Last Worksheet" button becomes active only after you have opened more than one worksheet in a given session.

The worksheet accessed immediately prior appears.

- **To navigate to the worksheet that you most recently navigated away from by way of the Last Worksheet button:**

  Click **Next Worksheet** in the main toolbar.

NOTE

The "Next Worksheet" button becomes active only after you have used the Last Worksheet button.

The worksheet accessed immediately prior appears.

NOTE

If you delete or rename a worksheet accessed during the session and then use the Last Worksheet and/or Next Worksheet button to navigate between worksheets, a warning message will be displayed if the navigation reaches the point of the deleted or renamed worksheet.

NOTE

If the worksheet contains visualization objects that draw data from Historians for which you have not saved your login credentials, one or more dialog boxes will appear, in which you must enter your User name [preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password for the corresponding Historian, and then click **OK**, before proceeding with your work. **If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close and then reopen the application.**

TO RENAME A WORKSHEET

You can rename the currently displayed worksheet by taking the following steps:

1. In a blank area of the displayed worksheet, right-click, point to **Worksheets**, then select **Rename**. The "Rename" dialog box appears.

NOTE

You can also access this dialog box by clicking the double-headed arrow on the Worksheets panel, then clicking **Rename Current**.

2. Enter the desired new name for the worksheet.

TIP

If you also want to put the renamed worksheet in a different group, preface the worksheet's name with the desired group name followed by a backslash (for example, My Group Name\My Worksheet Name). Subgroups are not supported.

3. Click **OK**. The worksheet is renamed, as reflected in the mail toolbar.

NOTE

If the renamed worksheet was the only worksheet in a given group and you designated a new group for the worksheet, the worksheet's prior group is deleted.

NOTE

If you rename a worksheet and then use the "Last Worksheet" and/or "Next Worksheet" toolbar buttons to navigate between worksheets opened in the same session, a warning message will be displayed if the navigation reaches the point of the renamed worksheet.

TO REFRESH THE WORKSHEET LIST

Any time you create, rename, duplicate, or delete a worksheet within the EnerVista Synchrophasor Viewer (ESV), the list of available worksheets in the Worksheets panel automatically refreshes accordingly. You can also manually refresh the list at any time by taking the following steps.

1. Click the double-headed arrow on the Worksheets panel. The panel expands, displaying a list of all available worksheets organized by group.
2. Click **Refresh**. The worksheet list refreshes to display all available worksheets.

TO DELETE A WORKSHEET

If you no longer need a worksheet, you can delete it by taking the following steps:

1. Click the double-headed arrow on the Worksheets panel. The panel expands, displaying a list of all available worksheets.
2. Click the **\worksheet** that you want to delete.

TIP

If you do not see the worksheet in the list, click the plus-sign (**+**) beside the parent group to expand it and show all child worksheets.

3. Click **Delete Selected**. A dialog box appears, prompting you to confirm whether you want to complete the deletion process.
4. Click **Yes**. The dialog box closes, and the Worksheets panel collapses.

NOTE

If you delete the currently displayed worksheet, the worksheet that was open immediately prior appears in place of the deleted worksheet.

NOTE

If the deleted worksheet was the only worksheet in a given group, the group is also deleted.

NOTE

If you delete a worksheet then use the "Last Worksheet" and/or "Next Worksheet" toolbar buttons to navigate between worksheets opened in the same session, a warning message will be displayed if the navigation reaches the point of the deleted worksheet.

Visualization Object Creation in ESV

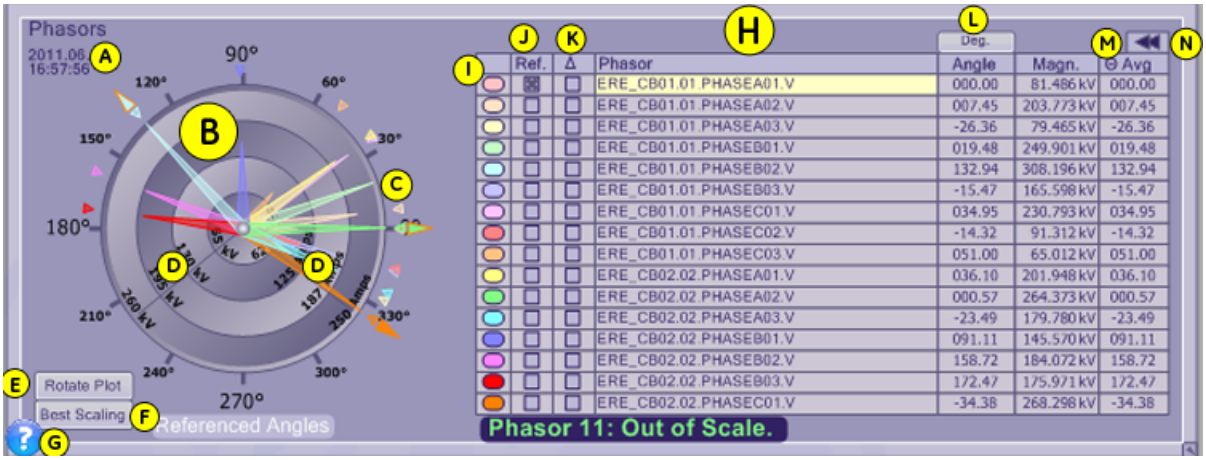
In the EnerVista Synchrophasor Viewer (ESV), you can create the following visualization objects, alone or in combination, for display on a given worksheet:

- Phasor Display object
- Trend Chart object
- PDC Historian Statistics object
- PMU Status object

Regardless of the object being created, the basic process is the same, namely, generate the object itself then choose the data to be visualized in the object.

Phasor Display Object Description

The image below highlights the main components of a Phasor Display object.



KEY	COMPONENT	DESCRIPTION
A	Display Time	In live mode (the default), the current system time; in historical playback mode, a moment in the past that progresses dynamically within a user-specified time period designated by way of the Dynamic Graphic Replay (DGR) control (see Historical Visualization Overview).
B	Polar plot	Circular dial containing up to 16 rotating hands, each of which indicates a given synchrophasor's magnitude (as reflected by length) along with either its absolute angle or its angle relative to another displayed synchrophasor.
C	Angular scale	Ring around the perimeter of the polar plot that indicates angle in either degrees or radians, based on user preference, and contains a triangular icon for each displayed synchrophasor to highlight the corresponding angle.
D	Radial scales	Two lines reaching outward from the center of the polar plot and indicating magnitude for either voltage synchrophasors [measured in kilovolts (kV)] or current synchrophasors [measured in amperes (Amps)]. NOTE: If the magnitude of a phasor exceeds the radial scale limits, a slowly blinking triangular icon is displayed at the terminal end of the corresponding hand in the polar plot, just beyond the smaller triangular icon highlighting the phasor's angle. For instructions on adjusting scaling, see To change polar plot radial scale.
E	Rotate Plot	Button for toggling the zero point of the polar plot to either the default position of 3 o'clock, for which the positive angular direction (and positive indicator rotation) is counter-clockwise, or 12 o'clock, for which the positive angular direction (and positive indicator rotation) is clockwise.
F	Best Scaling	Button for adjusting the polar plot radial scale limits to best encapsulate the synchrophasors currently displayed.
G	Question mark icon	Button for opening the application help file to the topic describing the Phasor Display object.
H	Phasor table	A grid listing the phasor name along with the angle, magnitude, and moving average of each displayed synchrophasor.
I	Color designator	In the phasor table, an oval indicator of the color currently assigned to the corresponding phasor as reflected in the polar plot.
J	Ref.	In the phasor table, a check box that when enabled, sets the phasor in the corresponding row as the reference point that all other displayed phasor angles are measured against.
K	Δ	In the phasor table, a check box that when enabled for two synchrophasors, results in the display below the polar plot of a text value for the current angular difference between the two phasors as well as a corresponding arc and triangular indicators of the chosen synchrophasors around the outside of the plot.
L	Deg./Rad.	Button used to toggle the object's angular measurement unit between degrees and radians.
M	Double-headed arrow	In the upper-right corner of the phasor table, a button used to toggle between hiding and showing the value columns in the table.
N	Θ Avg	In the phasor table, a column displaying the moving average of a synchrophasor's angle over a user-configurable time span reaching backward from the Display Time and defaulting to 2 seconds.

To Create a Phasor Display Object:

Assuming you have already established connection with the Historian(s) containing data for the synchrophasors you want to visualize, take the following steps to create a Phasor Display reflecting data for those synchrophasors.

1. On the main tool bar, click **Add Phasor Display**. The application populates the worksheet with a blank Phasor Display object.
2. Right click within the **Phasor Display** object, then select Select Phasors. The Select Phasors dialog box appears.

3. From the PDC drop-down list, select the PDC Historian containing the data for the synchrophasor you want to visualize.

NOTE

If you have not saved your login credentials for the selected Historian or have not previously logged in to the Historian during the current session, a dialog box will appear, in which you must enter your User name [preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password, and then click **OK**, before continuing. **If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close and then reopen the application.**

4. Use the additional provided search filters alone or in combination to locate a synchrophasor you want to visualize, as follows:
   - **PMU**: After selecting the applicable PDC from the corresponding filter, choose the PMU through which data for the synchrophasor you want to visualize is collected.
   - **Data Type**: Type V or I or click the drop-down arrow to choose either V: Voltage or I: Current, depending on the type of synchrophasor you want to visualize.
   - **Name Filter**: Enter the Historian tag name for the synchrophasor you want to visualize.

TIP

You can enter either a partial or full name.

5. Click **Browse**. The Available Tags pane is populated with all Historian tags matching the criteria you specified.

NOTE

For further Information, refer to *Historian Tag Naming Conventions*.

6. In the Available Tags pane, click the listing for each synchrophasor you want to visualize in the current object. The selected synchrophasor is displayed in the "Selected Tags" pane.

NOTE

To clear a synchrophasor from the "Selected Tags" pane, click the corresponding tag listing in the pane.

7. Progress as applicable depending on whether you want to visualize additional phasors not located based on your most recently specified search criteria:

- **If you want to visualize additional synchrophasors**

  A. Repeat steps 3 through 6 until you have designated all synchrophasors that you want to visualize in the current object.

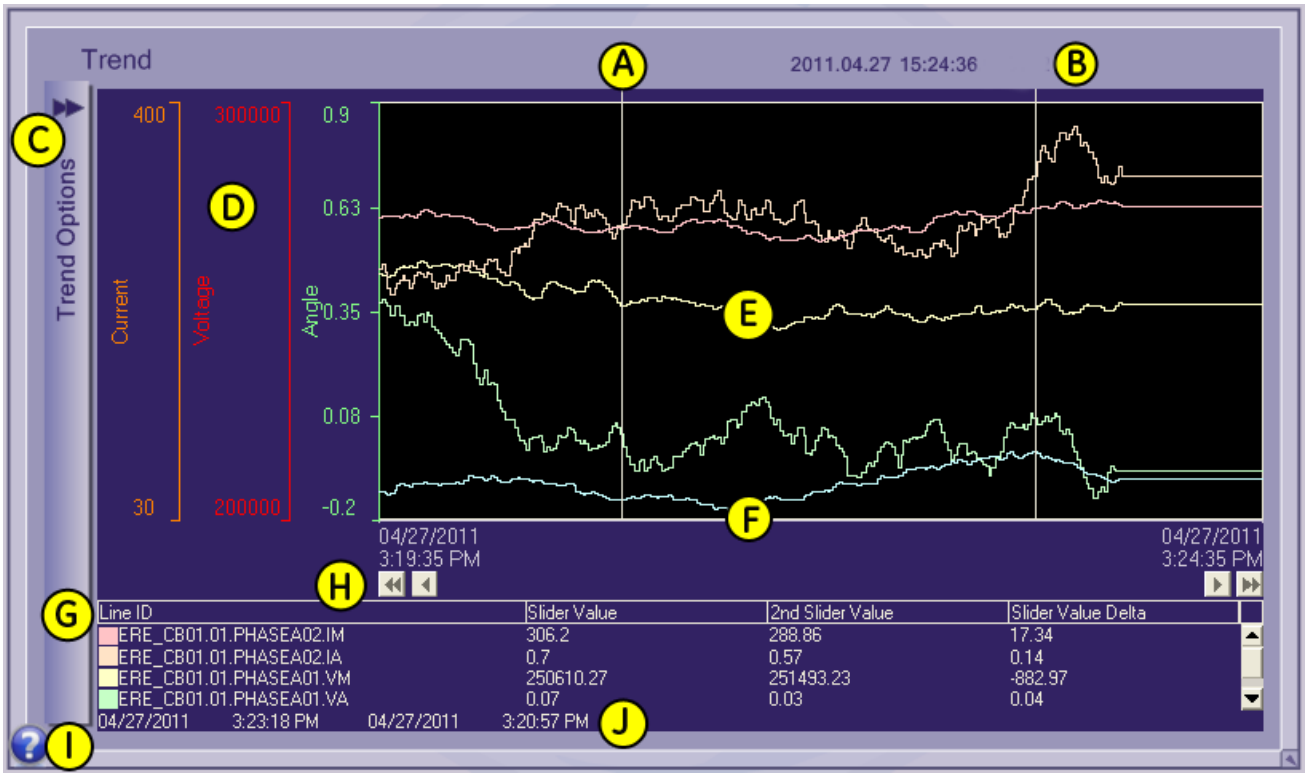
  B. Click **OK**. The "Select Phasors" dialog box closes and the "Phasor Display" object reflects data for all selected synchrophasors as of the Display Time.

- **If you do *not* want to visualize additional synchrophasors**

  A. Click **OK**. The "Select Phasors" dialog box closes and the "Phasor Display" object reflects data for all selected synchrophasors as of the Display Time.

Trend Chart Description

The image below highlights the main components of a Trend Chart object.



KEY	COMPONENT	DESCRIPTION
A	Slider bars	On the X axis of the chart, movable vertical lines that can be used to ascertain data values at specific points in time, as well as the difference in data values between two points in time.
B	Display Time	In live mode (the default), the current system time; in historical playback mode, a moment in the past that progresses dynamically within a user-specified time period designated by way of the Dynamic Graphic Replay (DGR) control (see Historical Visualization Overview).
C	Trend Options	Expandable panel that provides for quick access at runtime to common settings such as duration, legend and grid display, and resumption of play after pausing or zooming.
D	Y axis(es)	User-configurable vertical scale of data value.
E	Data display region	Area where color-coded trend lines represent the values of user-specified data elements within a user-configured time span (that is, duration).
F	X axis(es)	User-configurable scale of duration.
G	Legend	User-configurable color-coded listing of displayed data element names as well as corresponding data values at the point(s) in time marked by the slider bar(s). Assuming both slider bars are in use, the difference in data values between the two points in time marked by the slider bars is also displayed.
H	Scroll arrows	Buttons that allow you to shift the time span for the data being viewed in the chart either by a configured percentage backward or forward (single left or right arrow, respectively) or fully backward or forward (double left or right arrow, respectively) relative to the current duration setting.
I	Question mark icon	Button for opening the application help file to the topic describing the Trend Chart object.
J	Slider bar value indicators	Text reflecting the positioning of each slider bar as a date and time value.

To Create a Trend Chart Object

To create and populate a Trend Chart object, take the following steps:

1. On the main EnerVista Synchrophasor Viewer tool bar, click **Add Trend Chart**. The worksheet area refreshes to display a blank Trend Chart object.
2. Right-click within the data display area of the object, then select **Trend Control Properties**. The "CIMPLICITY Trend Chart Control Properties" dialog box appears, displaying the "Lines" tab.
3. In the toolbar below the table on the "Lines" tab, click **Create a new line**. The table refreshes to display an entry for the newly created trend line.
4. From the "Line Type" drop-down list, select the applicable option based on whether you want the trend line to reflect straight data or data as the function of an expression:

If you want the trend line to reflect straight data:	If you want the trend line to reflect data as the function of an expression:
A. Select "Historian". **B**. If the "Use Connections" option is not already enabled, as indicated by a check mark in the corresponding check box, select the check box.	**A**. Select "Historian Expression". The dialog box refreshes to display the "Expression" field.

Line types other than Historian and Historian Expression are not applicable to the EnerVista Synchrophasor Viewer.

5. Proceed as applicable based on whether the trend line you are creating will be based on straight data or data as the function of an expression:

If the trend line will be based on straight data:	**If the trend line will be based on data as the function an expression**:
A. From the Connection drop-down list, select the Historian containing the desired phasor, digital, or analog data element (that is, tag). **NOTE**: If you have not saved your login credentials for the selected Historian or have not previously logged in to the Historian during the current session, a dialog box will appear, in which you must enter your User name [preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password, and then click OK, before continuing. If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close and then reopen the application. **B**. Click the **ellipsis** button beside the Tag ID field. The "Select a Tag" dialog box appears. **C**. Click Browse. The pane in the lower area of the "Select a Tag" dialog box refreshes to display a table listing the tags contained in the Historian. **NOTE**: For information, see Historian tag naming conventions. **D**. In the table of tags, click the listing for the desired tag. **E**. Click **OK**. The "Select a Tag" dialog box closes, and the table on the Lines tab refreshes to display the selected tag in the entry created at step 3.	**A**. Click the button directly to the right of the Expression field. The "Edit Expression" dialog box appears. **B**. In the Edit Expression dialog box, click **Historian**. The "Select a Tag" dialog box appears. **C**. From the Connection drop-down list, select the Historian containing the phasor, digital, or analog data point (that is, tag) that you want to use in the expression. **NOTE**: If you have not saved your login credentials for the selected Historian or have not previously logged in to the Historian during the current session, a dialog box will appear, in which you must enter your User name [preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password, and then click OK, before continuing. If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close and then reopen the application. **D**. Click Browse. The pane in the lower area of the "Select a Tag" dialog box refreshes to display a table listing the tags contained in the Historian. **NOTE**: For information, see Historian tag naming conventions. **E**. In the table of tags, click the listing for the tag that you want to use in the expression. **F**. Click **OK**. The "Select a Tag" dialog box closes, and the input field of the "Edit Expression" dialog box refreshes to display the selected tag. **NOTE**: All Historian tags must be fully qualified by the Historian connection name and must be enclosed in single quotes. **G**. Repeat steps **B** through **F** for each tag that you want to include as part of the expression. **H**. In the input field of the "Expression Editor" dialog box, position your cursor at the location where you want to insert the desired expression operator. **I**. Below the input field in the "Expression Editor" dialog box, double-click the box containing the operator you want to include in the expression. **NOTE**: For information on expression operators, see Expression Operators Overview.The selected operator is inserted in the input field at the location of your cursor. **J**. Repeat steps **H** and **I** for each operation you want to perform as part of the expression. **K**. Insert other required terms into the expression, by positioning your cursor at the location where you want to insert the term, and then entering it. **L**. When you are finished building the expression, click **OK**. The Expression Editor dialog box closes, and the table on the Lines tab refreshes to display the designated expression in the entry created at step 3.

6. Review the **Auto Update** option setting to ensure that it is enabled, as indicated by a check mark in the corresponding check box.

NOTE

This option controls whether the Trend Chart continually refreshes to reflect updated data acquired by the Historian.

7. Click **Apply**.
   The Trend Chart refreshes to display a trend line for the specified data.
8. Proceed as applicable based on whether you want to add additional trend lines to the object:

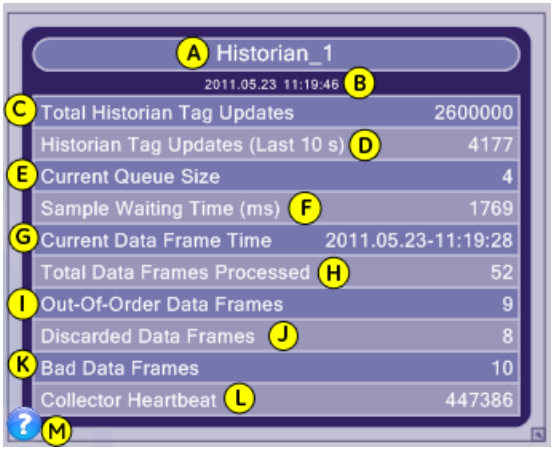
If you want to add additional trend lines to the object:	If you do not want to add additional trend lines to the object:
A. Repeat steps 3 through 7.	**A**. Proceed to step 9.

9. Proceed as applicable based on whether you want to configure design of the Trend Chart object:

If you want to configure design of the Trend Chart object:	If you do not want to configure design of the Trend Chart object:
A. Leave the CIMPLICITY Trend Chart Control Properties dialog box open. **B**. Refer to Trend Chart Configuration Overview for links to configuration instructions.	**A**. Click **OK**. The CIMPLICITY Trend Chart Control Properties dialog box closes.

PDC Historian Statistics Object Description

The image below highlights the main components of a PDC Historian Statistics object.



Key	Component	Description
A	Object Title	User-specified connection name for the Multilin P30 Historian being visualized.
B	Display Time	In live mode (the default), the current system time; in historical playback mode, a moment in the past that progresses dynamically within a user-specified time period designated by way of the Dynamic Graphic Replay (DGR) control (see Historical Visualization Overview).
C	Total Historian Tag Updates	Number of measurement updates written to the Historian since the data collector service last started.
D	Historian Tag Updates (last 10 s)	Number of measurement updates written to the Historian in the last ten seconds.
E	Current Queue Size	Number of measurement updates pending between the Synchrophasor Processor and Historian.

Key	Component	Description
F	Sample Waiting Time (ms)	Number of milliseconds the current IEEE C37.118 data frame spent waiting in the queue between the data collector service and the Historian.
G	Current Data Frame Time	Date and time stamp of the most recently archived IEEE C37.118 data frame.
H	Total Data Frames Processed	Number of IEEE C37.118 data frames processed by the Historian since the data collector service last started.
I	Out-of-Order Data Frames	Number of IEEE C37.118 data frames sent out of chronological order since the data collector service last started.
J	Discarded Data Frames	Number of IEEE C37.118 data frames disposed of due to queue overrun since the data collector service last started.
K	Bad Data Frames	Number of defective IEEE C37.118 data frames since the data collector service last started.
L	Collector Heartbeat	Counter to confirm ongoing communication between the data collector and the Historian since the data collector service last started.
M	Question Mark Icon	Button for opening the application help file to the topic describing the PDC Historian Statistics object.

To create a PDC Historian Statistics object

To create and populate a PDC Historian Statistics object, take the following steps:

1. On the main toolbar, click **Add PDC Historian Statistics**.
   The worksheet area refreshes to display a blank PDC Historian Statistics object.
2. Right-click within the object itself, then choose **Select PDC**. The "Select P30" dialog box appears.
3. From the PDC Connection drop-down list, select the PDC Historian in which data for the desired Multilin P30 is stored.

NOTE

If you have not saved your login credentials for the selected Historian or have not previously logged in to the Historian during the current session, a dialog box will appear, in which you must enter your User Name [preceded by the appropriate domain Name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password, and then click **OK**, before continuing. If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close, then reopen, the application.

4. From the PDC drop-down list, select the Historian tag for the desired Multilin P30 .

NOTE

For further Information, refer to Historian Tag Naming Conventions.

5. Click **OK**.
   The PDC Historian Statistics object refreshes to display data for the selected Multilin P30.

PMU Status Object Description

The IEEE C37.118 Standard mandates that each Phasor Measurement Unit (PMU) data block include a STAT word containing complete status information for that data block. The EnerVista Synchrophasor Viewer (ESV) PMU Status object uses this STAT word to indicate the status of the PMU, with the bits that compose the STAT word denoting the state of discrete PMU attributes. The PMU Status object displays state information starting with the most significant bits to the least significant bits in the STAT word, excluding bits 12 and 9. The four least significant bits (03-00) are used to indicate the state of the Trigger attribute. In each case, attribute state is indicated by a combination of a colored animated icon and descriptive text that change dynamically with changes in state.

NOTE

If the Multilin P30 Synchrophasor Processor loses communication with the Multilin P30 Historian, the animated icons turn black, and the descriptive text changes.

NOTE

If the animated icons of both the Data and Error attributes are red, it may indicate a disconnect between the PMU and the Multilin P30. For descriptions of other states that this scenario may indicate, see items E and F in the following table.

The image below highlights the main components of a PMU Status object.

Key	Feature	Purpose
A	Object Title	Historian tag for the PMU.
B	Display Time	In live mode (the default), the current system time; in historical playback mode, a moment in the past that progresses dynamically within a user-specified time period designated by way of the Dynamic Graphic Replay (DGR) control (see *Historical Visualization Overview*).
C	Frequency	Text indicator of Frequency.
D	ΔF/Δt	Text indicator of change in Frequency per second.
E	Data Status	Combination of an animated icon and text reflecting the validity of PMU data as indicated by bit 15 of the STAT word, with green indicating Valid and red indicating Invalid or Test data.
F	Error Status	Combination of an animated icon and text reflecting whether any internal and/or configuration errors have been detected in the PMU as indicated by bit 14 of the STAT word, with green and None denoting the absence, and red and PMU Error denoting the presence of such errors.
G	Sync Error Status	Combination of an animated icon and text reflecting whether the PMU clock has drifted as indicated by bit 13 of the STAT word, with green and None denoting the absence of time drift, and red and Lost Sync denoting the presence of time drift.

Key	Feature	Purpose
H	Trigger Status	Combination of an animated icon and text reflecting whether a triggering event has been detected in the PMU as indicated by bit 11 of the STAT word, with green and None denoting the absence of such an event, and yellow denoting the presence of such an event, the nature of which is denoted by one of the following descriptions: • Manual • Magnitude Low • Magnitude High • Phase Angle Δ • Freq. High/Low • Δf/Δt High • Reserved • Digital • User Defined
I	Configuration Status	Combination of an animated icon and text reflecting whether PMU configuration has Not Changed (green) or Changed (yellow) as indicated by bit 10 of the STAT word.
J	Time Quality Status	Combination of an animated icon and text reflecting the extent of time error in the PMU as indicated by bits 8–6 of the STAT word, as follows: **Icon Color - Green**: Not Applicable (that is, the PMU is not compliant with the IEEE C37.118.2 Standard) OR Error < 100 ns OR Error < 1 µs **Icon Color - Yellow**: Error < 10 µs OR Error < 100 µs OR Error < 1 ms **Icon Color - Orange**: Error < 10 ms **Icon Color - Red**: Error > 10 ms
K	Unlocked Time Status	Combination of an animated icon and text reflecting the time span that the PMU clock was unlocked for as indicated by bit 11 of the STAT word, with green denoting 0 s, yellow denoting 10 s, orange denoting 100 s, and red denoting greater than 1,000 s.
L	Question Mark Icon	Button for opening the application help file to the topic describing the PMU Status object

To Create a PMU Status Object

To create and populate a PMU Status object, take the following steps:

1. On the main toolbar, click **Add PMU Status**. The worksheet area refreshes to display a blank "PDC Status" object.
2. Right-click within the object itself, then choose **Select PMU**. The "Select PMU" dialog box appears.
3. From the PDC drop-down list, select the Multilin P30 Historian in which data for the desired PMU is stored.

If you have not saved your login credentials for the selected Historian or have not previously logged in to the Historian during the current session, a dialog box will appear, in which you must enter your User name [preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password, then click **OK**, before continuing. **If you choose to cancel this**

prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close and then reopen the application. The display pane below refreshes to list Historian tags for all applicable PMUs.

NOTE

For further Information, refer to *Historian Tag Naming Conventions*.

4. In the list of PMU tags, click the entry for the desired PMU. The Selected PMU field near the top of the dialog box refreshes to display the chosen PMU tag.
5. Click **OK**. The PMU Status object refreshes to display data for the selected PMU.

PMU Status Indicator Object Description

The IEEE C37.118 Standard mandates that each Phasor Measurement Unit (PMU) data block include a STAT word containing complete status information for that data block. The EnerVista Synchrophasor Viewer (ESV) uses this STAT word to ascertain the status of PMUs, with the bits that compose the STAT word denoting the state of discrete PMU attributes. Among these attributes are data validity (bit 15), internal and/or configuration errors (bit 14), time drift (bit 13), trigger events (bit 11), and configuration change (bit 10). The ESV application monitors these attributes and determines whether any has undergone a transition in state. Such transitions result in alarms, which can be visualized by way of the PMU Status Indicator object.

Similar to the LED light on the faceplate of an actual PMU, the PMU Status Indicator object allows you to quickly determine whether a given PMU is experiencing an alarm state, as reflected by a change in color. The object also serves as the portal for viewing details related to current and past alarms for all PMUs that the EnerVista Grid Engineer is configured to monitor.

NOTICE

Because it reflects live data, the PMU Status Indicator object does not "latch" alarm states. For details on current and latched alarms, use the Alarm Viewer interface.

NOTE

If the Multilin P30 Synchrophasor Processor card loses communication with the Historian, the PMU Status Indicator object turns gray, and the descriptive text changes.

The image below highlights the main components of a PMU Status Indicator object.

Key	Feature	Purpose
A	"At" icon	Placeholder for Historian tag name representing the PMU being monitored. **NOTE**: For instructions on displaying the Historian tag name, see To display PMU name or To pop up PMU name.
B	Alarm state indicator	Animated icon reflecting whether an alarm state exists in relation to bits 10, 11, 13, 14, and/ or 15 of the STAT word for the PMU being monitored, or whether the Multilin P30 gathering data from the PMU in question has lost communication with the Historian, as shown in the table below. **NOTE**: In relation to alarm states, the color displayed indicates the highest priority represented among the current alarm set. You can readily ascertain the categories of the current alarms by right-clicking the **PMU Status Indicator** object, then selecting Quick View. **TIP**: The table above reflects the default color settings for PMU Status Indicator objects, which can be changed on a per-object basis. For instructions on doing so, see *To Change the Colors Denoting Pmu State*.
C	Question Mark icon	Button for opening the application help file to the topic describing the PMU Status Indicator object.

Table 13-1: Lost Communication icon colors

Default Icon Color	Meaning	Priority
Green	*No alarm state in relation to any bit*	N/A
Red	*Alarm state in relation to bit 13 (time drift), 14 (internal and/or configuration errors), and/or 15 (data validity)*	1 (top)
Orange	*Alarm state in relation to bit 11 (trigger event)*	2 (middle)
Yellow	*Alarm state in relation to bit 10 (PMU configuration change)*	3 (low)
Gray	*Loss of communication between the Multilin P30 Synchrophasor Processor and the Historian*	N/A

Visualization Object Configuration in ESV

General Configuration

Configuration tasks that relate either to the application in general or to all visualization objects are as follows:

- Managing display and size of the application window
- Sizing visualization objects
- Positioning visualization objects on worksheets
- Deleting visualization objects from worksheets
- Displaying the worksheet clock.

TO CONFIGURE THE APPLICATION WINDOW

In terms of configuring the application window, you can do any of the following:

- Minimize the window

- Maximize the window
- Customize the size of the window.

To Minimize the Window:

1. Click the "Bar" at the upper-right corner of the window.

NOTE

You can also right-click in a blank area of the worksheet, then select **Minimize**.

The window collapses to its icon on the Taskbar.

NOTE

To restore the window to its previous state, click the icon on the Taskbar

To maximize the Window:

1. Right-click in a blank area of the worksheet, then select **Maximize**.
   The window refreshes to its full size.

NOTE

To restore the window to its previous state, right-click in a blank area of the worksheet, then select **Restore**.

To Customize the Size of the Window:

1. Click and hold the "Control Tab" at the lower-right corner of the window, then drag the Control Tab until the window is sized as desired.

NOTE

This control maintains the aspect ratio of the window.

TO REPOSITION VISUALIZATION OBJECTS ON A WORKSHEET

If the positioning of visualization objects on a worksheet does not meet your needs, you can move the objects by taking the following step:

1. Click the object, hold down your mouse button, then drag the object to the desired position on the worksheet.

NOTE

In a Trend Chart object, click just inside any of the edges.

TO RESIZE VISUALIZATION OBJECTS

To size a visualization object to best suit your needs, take the following step:

1. Click and hold the "Corner Arrow Control" on the lower-right corner of the object, then drag your mouse until the object is the desired size.

NOTE

This control maintains the aspect ratio of the object.

TO DELETE VISUALIZATION OBJECTS FROM A WORKSHEET

If you no longer need a visualization object, you can delete it from its worksheet by taking the following steps:

⚠CAUTION

After you have deleted an object, there is no way to recover it. Therefore, if you think you might have future use for the object, you may want to consider duplicating the worksheet and deleting the object from the copy, rather than deleting the object from the original worksheet.

1. Right-click within the object.

NOTE

In a Trend Chart object, right-click above the data display area.

2. Select **Delete This Object**. A dialog box appears, prompting you to confirm whether you want to complete the deletion process.
3. Click **Yes**. The object is deleted from the worksheet.

TO CHANGE THE WORKSHEET REFRESH INTERVAL

By default, the EnerVista Synchrophasor Viewer (ESV) retrieves data from the Multilin P30 Historian for display in visualization objects once per second. You can adjust this setting to be as short as 0.25 seconds or as long as 10 seconds, allowing you find an optimal balance between data updates and system performance based on the number and complexity of the objects configured.

To change the worksheet refresh interval, take the following steps:

1. Right-click in a blank area of the worksheet, point to **Settings**, then select **Worksheet Refresh Interval**. The "Worksheet Refresh Interval" dialog box appears.
2. Enter the desired refresh interval value in seconds.

You can designate a value from 0.25 to 10 seconds.

3. Click **OK**. The "Worksheet Refresh Interval" dialog box closes, and the worksheet refresh interval reflects the newly designated value.

If the data in the Multilin P30 Historian has not been updated within the specified time frame, PVP will display the most current data available, with a maximum latency of 10 seconds.

Phasor Display Object Configuration

At a minimum, Phasor Display configuration involves generating the object itself, then choosing the synchrophasors that you want to visualize in the object.

After completing these initial steps, you have a number of options for configuring the corresponding data. Specifically, you can do any of the following:

- Change polar plot radial scale
- Change polar plot rotation
- Change angular scale measurement unit
- Change the reference synchrophasor
- View angular difference between two synchrophasors
- Change time span for determining synchrophasor moving average
- Hide values in the Phasor Display table
- View an obscured synchrophasor indicator in a polar plot
- Change the color indicator for a displayed synchrophasor
- Change Phasor Display object title
- Replay the visualization for a historical period of your choosing

TO CHANGE POLAR PLOT RADIAL SCALE

If, after creating and populating a Phasor Display object with data of your choosing, you find that the polar plot radial scale does not exactly meet your visualization needs, you have several options for changing the scale. Specifically, you can do any of the following:

- Have the application calculate and adjust the scale to best encapsulate the displayed synchrophasor(s), thereby optimizing the scale
- Change the voltage scale based on a new maximum limit of your choosing
- Change the current scale based on a new maximum limit of your choosing

If, after completing any of these rescaling procedures, the magnitude of a phasor changes such that it exceeds the radial scale limits, a slowly blinking triangular icon is displayed at the terminal end of the corresponding hand in the polar plot, just beyond the smaller triangular icon highlighting the phasor's angle. If the polar plot configuration makes it difficult to discern the affected phasor, you can position your mouse pointer over the blinking icon to display identifying text below the phasor table. In this way, you can ascertain the phasor's magnitude by consulting the corresponding listing in the table and, if desired, further adjust the radial scale to encompass the phasor's magnitude.

To Programmatically Optimize the Polar Plot Radial Scale

1. Below the polar plot, click Best Scaling.
   The polar plot refreshes to reflect the optimal radial scale for visualizing magnitude of the currently displayed synchrophasor(s).

To Change Voltage Scale Based on a New Maximum Limit of your Choosing

1. Right click within the Phasor Display, then point to **Display Configuration**, then select **Voltage Scale**.
   The "Manual Scale" dialog box appears.
2. In the text entry field, type the desired maximum voltage value in kilovolts.
3. Click **OK**.
   The polar plot refreshes to reflect an application-calculated voltage scale based on the newly specified maximum value.

To Change Current Scale Based on a New Maximum Limit of your Choosing

1. Right click within the Phasor Display, then point to **Display Configuration**, then select **Current Scale**.
   The "Manual Scale" dialog box appears.
2. In the text entry field, type the desired maximum current value in amperes.
3. Click **OK**.
   The polar plot refreshes to reflect an application-calculated current scale based on the newly specified maximum value.

TO CHANGE POLAR PLOT ROTATION

By default, the zero point of the polar plot in a Phasor Display object is set to 3 o'clock, for which the positive angular direction (and positive indicator rotation) is counter-clockwise. You can, however, change the zero point to 12 o'clock, thereby changing the positive angular direction (and positive indicator rotation) of the plot to clockwise. To do so, take the following step:

1. Below the polar plot, click **Rotate Plot**.
   The polar plot refreshes to change the zero point from 3 o'clock to 12 o'clock and therefore the positive angular direction (and positive indicator rotation) from counter-clockwise to clockwise.

To change the zero point of the polar plot back to 3 o'clock (and, therefore, the positive angular direction and positive indicator rotation from clockwise to counter-clockwise), click the **Rotate Plot** button again.

TO CHANGE ANGULAR SCALE MEASUREMENT UNIT

If, after creating and populating a Phasor Display object, you want to change the default angular scale measurement unit from degrees to radians, take the following step:

1. In the phasor table, above the Angle column, click **Deg**.
   The polar plot scale and the values in the phasor table are refreshed to reflect radians as the angular measurement unit.

To change the angular scale measurement unit back to degrees, click **Rad**. above the "Angle" column in the phasor table.

TO CHANGE THE REFERENCE SYNCHROPHASOR

If after creating a Phasor Display object, you want to select or change the reference synchrophasor, take the following step:

1. In "Ref." column of the "Phasor Display" table, click the check box corresponding to the synchrophasor that you want to set as the reference.
   The table and polar plot are updated to reflect a value of 0 for the newly designated

reference synchrophasor, and the values for all other displayed synchrophasors are refreshed based on their angles compared to that of the newly designated reference synchrophasor.

NOTE

The values shown are for the Display Time.

TIP

To change to a different reference phasor, select the check box in the "Ref." column for that phasor to insert an X; to set the reference phasor back to absolute, clear the previously selected "Ref." column check box.

TO VIEW THE ANGULAR DIFFERENCE BETWEEN TWO SYNCHROPHASORS

If after creating and populating a Phasor Display object, you want the application to calculate and display the angular difference between synchrophasors, take the following step:

1. In the Δ column of the Phasor Display table, select the check box corresponding to the synchrophasor(s) for which you want the application to calculate and display the angular delta.

NOTE

You can select one or two synchrophasors. In the former case, the angular delta is calculated based on the value of the chosen synchrophasor as compared to zero; in the latter case the angular delta is calculated based on the values of the chosen synchrophasors.

The delta value is displayed below the polar plot, and arc and delta indicators are displayed on the perimeter of the plot.

TIP

To end the calculation and display of angular delta, clear the check box(es) selected in the Δ column of the table.

TO CHANGE MOVING AVERAGE TIME-SPAN

The default time-span against which the application calculates synchrophasor angle moving average in a Phasor Display object is 2 seconds. You can, however, change this time-span to a minimum of 1 second and a maximum of 60 seconds. To do so, take the following steps:

1. Right click within the Phasor Display, then point to **Display Configuration**, then select **Set Hist. Avg. Span**.
   The Multilin P30 Historical Average Span dialog box appears.
2. In the text entry field, enter the time span against which you want the application to calculate synchrophasor moving average.
3. Click **OK**.
   The Moving Average column of the Phasor Display table refreshes to reflect updated values based on the newly designated time span.

NOTE

If you selected a reference synchrophasor in the Phasor Display table, moving average will be relative to the reference; otherwise, moving average will be absolute.

TO HIDE VALUES IN A PHASOR DISPLAY TABLE

If after creating and populating a Phasor Display object you want to configure the table to hide the synchrophasor values, take the following step:

1. In the upper-right corner of the Phasor Display table, click the **double-arrow** button.
   The table refreshes to hide the Angle, Magn., and Θ Avg. columns.

NOTE

To display angle, magnitude, and moving average values in the table again, click the **double-arrow** button a second time.

TO VIEW AN OBSCURED SYNCHROPHASOR INDICATOR IN A POLAR PLOT

If more than one of the synchrophasors being visualized in a Phasor Display object are of the same or very similar magnitude and angle, the corresponding hand indicator for one of the synchrophasors may obscure those of the others in the polar plot. To view any such obscured synchrophasor indicator, take the following step:

1. In the first column of the "Phasor Display" table, double-click the colored oval for the obscured synchrophasor.
   The polar plot refreshes to display the hand indicator for the corresponding synchrophasor on top of all hand indicators in the plot.

TO CHANGE THE COLOR INDICATOR FOR A DISPLAYED SYNCHROPHASOR

If after creating and populating a Phasor Display object you want change the color used by the application to identify a synchrophasor in the table and polar plot, take the following steps.

1. In the first column of the "Phasor Display" table, right-click the colored oval for the synchrophasor to which you want to assign a new identifying color, then select Select Color.
   The "Select Color" dialog box appears.
2. In the "Select Color" dialog box, click the color that you want to assign to the synchrophasor in question.
   The Phasor Display object refreshes to reflect the new color for the synchrophasor in the corresponding hand and triangular indicator on the polar plot, and the colored oval in the first column of the table.

If you subsequently want to cancel a color change, right-click the colored oval then select **Default Color**.

TO CHANGE PHASOR DISPLAY TITLE

If after creating a Phasor Display you want to change the object's title, take the following steps:

1. Right click within the Phasor Display object, then point to **Display Configuration**, then select **Set Display Title**.
   The PDC UI dialog box appears.
2. In the text entry field of the Multilin P30 UI dialog box, enter the desired object title.
3. Click **OK**.
   The Phasor Display object refreshes to reflect the specified title.

Trend Chart Object Configuration

At a minimum, Trend Chart configuration involves generating the object itself then specifying the data you want to visualize as trend lines in the object.

After completing these initial steps, you have a number of options for configuring the object. Specifically, you can do any of the following:

- Add and map one or more axes
- Add trend lines to the object
- Delete trend lines from the object
- Change axis mapping
- Change axis scaling
- Change the appearance of trend lines
- Modify axis label name and appearance
- Control display of certain object components
- Change data retrieval mode
- Change data sample interval
- Change automatic update interval

- Control progression in the object
- Zoom the view in the object
- Shift the time span for which data is being viewed
- Ascertain at a glance the difference in a given measurement's value between two points in time
- Change the distance from the slider bar that you can position the mouse pointer and still grab the bar
- Enable primary axis synchronization
- Enforce a single duration setting
- Replay the visualization for a historical period of your choosing.

TO ADD LINES TO A TREND CHART OBJECT

If, after creating and populating a Trend Chart object, you want to add trend lines to the object, you can do either of the following:

- Add lines from scratch
- Duplicate existing lines as the basis for new lines

To Add Trend Lines from Scratch:

If, after creating and populating a Trend Chart object, you want to add trend lines to the object from scratch, take the following steps:

1. Right-click within the data display area of the Trend Chart object, then select **Trend Control Properties**
   The CIMPLICITY "Trend Chart Control Properties" dialog box appears, displaying the Lines tab.
2. Below the displayed table on the Lines tab, click **Create a new line**.
   The table refreshes to display an entry for the newly created trend line.
3. From the "Line Type" drop-down list, select the applicable option based on whether you want the trend line to reflect straight data or data as the function of an expression:

If you want the trend line to reflect straight data:	If you want the trend line to reflect data as the function of an expression:
A. Select **Historian**. **B**. If the "Use Connections" option is not already enabled, as indicated by a check mark in the corresponding check box, select the check box.	**A**. Select **Historian Expression**. The dialog box refreshes to display the "Expression" field.

Line types other than Historian and Historian Expression are not applicable to the EnerVista Synchrophasor Viewer.

4. Proceed as applicable based on whether the trend line you are creating will be based on straight data or data as the function of an expression:

If the trend line will be based on straight data:	If the trend line will be based on data as the function an expression:
A. From the Connection drop-down list, select the Historian containing the desired phasor, digital, or analog data element (that is, tag). **NOTE**: If you have not saved your login credentials for the selected Historian or have not previously logged in to the Historian during the current session, a dialog box will appear, in which you must enter your User Name [preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password, then click **OK**, before continuing. **If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close, then reopen, the application**. **B**. Click the ellipsis button beside the "Tag ID" field. The "Select a Tag" dialog box appears. **C**. Click **Browse**. The pane in the lower area of the Select a Tag dialog box refreshes to display a table listing the tags contained in the Historian. **NOTE**: For information, see Historian tag naming conventions. **D**. In the table of tags, click the listing for the desired tag. **E**. Click **OK**. The "Select a Tag" dialog box closes, and the table on the "Lines" tab refreshes to display the selected tag in the entry created in step 2.	**A**. Click the button directly to the right of the Expression field. The "Edit Expression" dialog box appears. **B**. In the Edit Expression dialog box, click Historian. The "Select a Tag" dialog box appears. **C**. From the "Connection" drop-down list, select the Historian containing the phasor, digital, or analog data point (that is, tag) that you want to use in the expression. **NOTE**: If you have not saved your login credentials for the selected Historian or have not previously logged in to the Historian during the current session, a dialog box will appear, in which you must enter your User Name [preceded by the appropriate domain name followed by a backslash (that is, DomainName\UserName), if applicable to your environment] and Password, and then click **OK**, before continuing. **If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close, then reopen, the application**. **D**. Click Browse. The pane in the lower area of the "Select a Tag" dialog box refreshes to display a table listing the tags contained in the Historian. **NOTE**: For information, see Historian tag naming conventions. **E**. In the table of tags, click the listing for the tag that you want to use in the expression. **F**. Click **OK**. The "Select a Tag" dialog box closes, and the input field of the "Edit Expression" dialog box refreshes to display the selected tag. **NOTE**: All Historian tags must be fully qualified by the Historian connection name and must be enclosed in single quotes. **G**. Repeat steps **B** through **F** for each tag that you want to include as part of the expression. **H**. In the input field of the "Expression Editor" dialog box, position your cursor at the location where you want to insert the desired expression operator. **I**. Below the input field in the "Expression Editor" dialog box, double-click the box containing the operator you want to include in the expression. **NOTE**: For information on expression operators, see *Expression Operators Overview*. The selected operator is inserted in the input field at the location of your cursor. **J**. Repeat steps **H** and **I** for each operation you want to perform as part of the expression. **K**. Insert other required terms into the expression, by positioning your cursor at the location where you want to insert the term, then entering it. **L**. When you are finished building the expression, click **OK**. The "Expression Editor" dialog box closes, and the table on the "Lines" tab refreshes to display the designated expression in the entry created in step 2.

5. Review the "Auto Update" option setting to ensure that it is enabled, as indicated by a check mark in the corresponding check box.


NOTE

This option controls whether the Trend Chart object continually refreshes to reflect updated data acquired by the Historian.

6. Click **Apply**.
   The Trend Chart refreshes to display a trend line for the specified data.
7. Proceed as applicable based on whether you want to add additional trend lines to the object:

If you want to add additional trend lines to the object:	If you do not want to add additional trend lines to the object:
A. Repeat steps 3 through 6	**A**. Proceed to step 8

8. Proceed as applicable based on the axes to which the newly-added trend line should be mapped:

If the trend line should be mapped to the primary (that is, Chart) X and Y axes:	If the trend line should be mapped to a secondary X and/or Y axis:
A. Click **OK**. The "CIMPLICITY Trend Chart Control Properties" dialog box closes, fully revealing the Trend Chart.	**A**. Leave the "CIMPLICITY Trend Chart Control Properties" dialog box open, then complete the steps outlined under either *To Add and Map Axes in a Trend Chart Object* or *To Change Axis Mapping in a Trend Chart Object*, as applicable.

To Duplicate Existing Trend Lines as the Basis for New Lines

If an existing line in a Trend Chart object would serve as a good basis for a new trend line in the same object, you can duplicate the line by taking the following steps:

1. Right-click within the data display area of the Trend Chart object, then select **Trend Control Properties**.
   The "CIMPLICITY Trend Chart Control Properties" dialog box appears, displaying the Lines tab.
2. In the table, click the row corresponding to the trend line that you want to duplicate.
3. Below the displayed table on the Lines tab, click **Duplicate the selected line**.
4. Configure the newly added line as desired.


NOTE

Refer to *Trend Chart Configuration Overview* for a list of configuration options.

5. When you are finished configuring the newly added trend line, click **Apply**.
   The Trend Chart refreshes to display the newly added trend line.
6. Click **OK**.

TO DELETE LINES FROM A TREND CHART OBJECT

If, after creating and populating a Trend Chart object, you want to delete one or more lines from the object, take the following steps.

1. Right-click within the data display area of the object, then select **Trend Control Properties**.
   The "CIMPLICITY Trend Chart Control Properties" dialog box appears, displaying the "Line" tab.
2. In the table, click the row corresponding to the trend line that you want to delete.
3. Below the table, click **Delete the selected line**.
   The table refreshes to reflect deletion of the selected line.


NOTE

If you decide you do not want to delete the line after all, click **Cancel**.

4. Click **Apply**.
   The Trend Chart refreshes to reflect deletion of the selected trend line.
5. Proceed as applicable based on whether you want to delete additional trend lines:

If you want to delete additional trend lines:	If you do *not* want to delete additional trend lines:
A. Repeat steps 2 through 4.	**A**. Click **OK**.

TO ADD AND MAP AXES IN A TREND CHART OBJECT

In certain circumstances, such as when visualizing different types of data within the same Trend Chart, you may want to add one or more Y or X axes. To do so, take the following steps:

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select **Trend Control Properties** to open the dialog box.

1. Click the **Axis** tab.
2. In the toolbar below the displayed table, click **Create a new axis**.
   The "New Axis" dialog box appears.
3. In the "Axis ID" field, enter the desired name for the axis.

NOTE

This is the name that will be reflected in the table on the "Axis" tab for the purpose of identifying the axis, rather than the axis label to be displayed in the Trend Chart object itself. You can assign the latter in step 6.

4. Specify the desired Axis Type by selecting either the Y Axis (for value) or X Axis (for time) option.
5. Click **OK**. The table on the Axis tab refreshes to reflect the newly created axis.
6. If desired, specify a Label for the new axis by entering the desired name in the corresponding field.
7. Proceed as applicable depending on whether you are adding a Y axis or an X axis:

If you are adding a Y-axis:	In you are adding an X-axis:
A. Review the Autoscale option setting, and, if desired, change the setting by selecting the check box to enable or by clearing the check box to disable. **NOTE**: Enabled by default, this option results in automatic calculation of optimal upper and lower scale limits based on the data being visualized in the Trend Chart. If you disable the option, you can customize scale limits by entering the desired values in the Default lower limit and Default upper limit fields.	**A**. Review the Duration setting and, if desired, specify a different setting by entering it directly in the corresponding field. **NOTE**: Duration format is ddd:hh:mm:ss, where: **ddd** - day number: 0–365 **hh** - Hours: 0–24 **mm** - minutes: 0–59 **ss** - seconds: 0–59 **TIP**: If you have configured the Trend Chart with multiple lines, setting the duration to 1 day or longer may result in a brief delay in data display, during which the Trend Chart goes blank.

8. Review the number of Ticks specified to be displayed on the scale, and, if desired, change the number.

NOTE

The default number of ticks is 0. When you specify a number greater than 0, ticks are displayed at even intervals on the scale.

9. Review the "Numbered Option" setting, and, if desired, change the setting by selecting the check box to enable, or by clearing the check box, to disable.

NOTE

Enabled by default, this option results in a number being displayed beside each tick mark to reflect the value of the mark within the scale.

10. Proceed as applicable, based on whether you want to add another axis to the Trend Chart object:

If you want to add another axis to the object:	If you do not want to add another axis to the object:
A. Repeat steps 2 through 9.	**A**. Proceed to step 11.

11. In the toolbar below the table of axes, click **Line-Axis Mapping**.
    The "Line-Axis Mapping" dialog box appears.
12. Map each trend line to the desired axis, as follows:
    - In the Lines pane, click the trend line to be mapped.
    - From either the Configured X-axis or Configured Y-axis drop-down list, as applicable, select the axis to which the trend line should be mapped.
13. When you are finished mapping trend lines to axes, click **OK**.
    The Line-Axis Mapping dialog box closes.
14. Click **Apply**.
    The Trend Chart refreshes to reflect the newly created axis and trend line mappings.

NOTE

If you do not see the new axis, verify that the applicable Single axis setting(s) are disabled, and that the Y-axis display option is set to Multiple.

15. Proceed as applicable based on whether you want to further configure design of the Trend Chart object:

If you want to further configure design of the Trend Chart object:	If you do *not* want to further configure design of the Trend Chart object:
A. Leave the "CIMPLICITY Trend Chart Control Properties" dialog box open. **B**. Refer to *Trend Chart Configuration Overview* for a list of configuration options.	**A**. Click **OK** to close the "CIMPLICITY Trend Chart Control Properties" dialog box.

TO CHANGE AXIS MAPPING IN A TREND CHART OBJECT

When you add data to a Trend Chart object, the corresponding trend line is by default mapped to the primary X- and Y-axes (that is, the Chart X-Axis and the Chart Y-Axis). If you have specified more than one X- or Y-axis, however, you can map trend lines to the appropriate axes by taking the following steps:

1. Begin as applicable, based on the mode in which you are working:

If the CIMPLICITY Trend Chart Control Properties dialog box is *not* open:	If the CIMPLICITY Trend Chart Control Properties dialog box is open:
A. Right-click within the data display or axis areas of the Trend Chart object, then select **Line/Axis Mapping**. The "Line-Axis Mapping" dialog box appears.	**A**. Click the **Axis** tab. **B**. In the toolbar below the axes table, click **Line-Axis Mapping**. The "Line-Axis Mapping" dialog box appears.

2. In the Line-Axis Mapping dialog box, map each trend line to the desired axis, as follows:
    - In the Lines pane, click the trend line to be mapped.
    - From either the Configured X-axis or Configured Y-axis drop-down list, as applicable, select the axis to which the trend line should be mapped.

3. When you are finished mapping trend lines to axes, click **OK**.
   The "Line-Axis Mapping" dialog box closes.
4. Proceed as applicable based on the mode you were working in when you began the axis mapping process:

If the CIMPLICITY Trend Chart Control Properties dialog box was not open:	If the CIMPLICITY Trend Chart Control Properties dialog box was open:
The Trend Chart object refreshes to reflect the newly designated mapping(s) after you complete step 3, and no further action is required.	**A**. Click **OK**. The dialog box closes and the Trend Chart object refreshes to reflect the newly designated mapping(s).

TO CHANGE AXIS SCALING IN A TREND CHART OBJECT

If after creating and populating a Trend Chart object you find that the scaling of one or more axes does not meet your visualization needs, you can do any of the following:

- Customize duration as represented on the X-axis
- Set a pre-configured duration as represented on the X-axis
- Set custom minimum and maximum limits on the Y-axis
- Optimize the Y-axis scale
- Set the Y-axis scale to reflect percentage

To Customize Duration as Represented on the X-Axis

By default, the duration across which a Trend Chart object displays data, as reflected on the X-axis, is 5 minutes. If a different duration better meets your visualization needs, you can change the time span of any X-axis in the object. To do so, take the following steps:

1. Begin as applicable, based on the mode in which you are working.

If the CIMPLICITY Trend Chart Control Properties dialog box is not open:	If the CIMPLICITY Trend Chart Control Properties dialog box is open:
A. Right-click within the data display area of the object, then choose **Timing**. The "X-Axis" dialog box appears.	**A**. Click the "Axis" tab.

2. In the table listing the axes in the object, click the row corresponding to the X-axis whose duration you want to change.
3. In the "Duration" field below the axis table, enter the desired time span for the X-axis.

Duration format is ddd:hh:mm:ss, where:

- ddd - day number: 0–365
- hh - Hours: 0–24
- mm - minutes: 0–59

ss - seconds: 0–59

4. Click **Apply**.
   The Trend Chart refreshes to update the display of all trend lines associated with the axis to reflect the newly specified duration.

If you have configured the Trend Chart with multiple lines, and have set the duration to 1 day or longer, a brief delay in data display may result, during which the Trend Chart goes blank.

If the axis is a secondary X-axis and does not reflect the newly specified duration, check the Single Time Duration option to ensure that it is disabled.

5. Proceed as applicable based on whether you want to change the duration for another X-axis in the Trend Chart object:

If you want to change the duration for another X axis in the object:	If you do not want to change the duration for another X axis in the object:
A. Repeat steps 2 through 4.	**A**. Click **OK**. The dialog box closes, fully revealing the Trend Chart object.

To Set a Pre-configured Duration as Represented on the X-Axis

By default, the duration across which a Trend Chart object displays data, as reflected on the X-axis, is 5 minutes. If a different duration better meets your visualization needs, you can change the time span assigned to the primary X-axis (that is, the Chart X-Axis) and, in turn, any data mapped to that axis, to one of several pre-configured values, specifically, 1 second, 1 minute, 1 hour, or 1 day. To do so, take the following steps.

1. Click the **double-headed arrow** on the "Trend Options" panel. The panel expands.
2. In the "Duration" area of the expanded "Trend Options" panel, click the corresponding button to assign the primary X-axis a duration of 1 Sec., 1 Min., 1 Hr., or 1 Day.
   The Trend Chart refreshes to update the display of all trend lines associated with the primary X-axis to reflect the newly specified duration.

If you have configured the Trend Chart with multiple lines, setting the duration to 1 day or longer may result in a brief delay in data display, during which the Trend Chart goes blank.

3. When you are satisfied with the duration setting, click the **double-headed arrow** on the "Trend Options" panel.
   The "Trend Options" panel collapses to fully reveal the chart area.

To Set Custom Minimum and Maximum Limits on the Y-axis

If after creating and populating a Trend Chart object you find that the scaling of one or more Y-axes does not meet your visualization needs, you can specify custom lower and upper scale limits. To do so, take the following steps:

1. Begin as applicable based on the mode in which you are working:

If the CIMPLICITY Trend Chart Control Properties dialog box is not open:	If the CIMPLICITY Trend Chart Control Properties dialog box is open:
A. Right-click within the Y-axis area of the object and then select **Limits**. The "Y-Axis" dialog box appears.	**A**. Click the **Axis** tab

2. In the displayed table, click the entry for the Y-axis whose scale you want to change.
3. If the **Autoscale** option is enabled, disable it by clearing the corresponding check box.
4. Specify the desired Default upper limit and Default lower limit for the scale by entering the values in the corresponding fields.
5. Click **Apply**.
   The Trend Chart refreshes to reflect the new axis scale and adjust the positioning of all associated trend lines accordingly.
6. Proceed as applicable based on whether you want to customize scaling of another Y-axis in the Trend Chart object:

If you want to customize scaling of another Y-axis in the object:	If you do not want to customize scaling of another Y-axis in the object:
A. Repeat steps 2 through 5.	**A**. Click **OK** to close the dialog box.

To set optimal upper and lower scale limits on the Y-axis

In a Trend Chart object, Y-axis scaling is by default set to reflect automatic calculation of optimal upper and lower scale limits based on the data mapped to the axis(es). If you disable this Autoscale option and subsequently want to enable it, take the following steps:

1. Complete the applicable steps based on the mode in which you are working:

If the CIMPLICITY Trend Chart Control Properties dialog box is not open:	If the CIMPLICITY Trend Chart Control Properties dialog box is open:
A. Right-click within the Y-axis area of the object, point to **Autoscale**, then select the listing for the Y-axis for which you want to set optimal upper and lower axis limits. The object refreshes to display optimal upper and lower limits for the selected Y-axis. **B**. Repeat step **1A** for each Y-axis for which you want to set optimal upper and lower axis limits.	**A**. Click the **Axis** tab. **B**. In the table of axes, click the row containing the Y-axis for which you want to set optimal upper and lower limits. The dialog box refreshes to display the "Limits" area. **C**. Select the **Autoscale** check box. **D**. Click **Apply**. The object refreshes to display optimal upper and lower limits for the selected Y-axis. **E**. Repeat steps **1B** through **1D** for each Y-axis for which you want to set optimal upper and lower axis limits. **F**. Click **OK**.

To Set the Y-axis to Reflect Percentage

By default, the primary Y-axis (that is, the Chart Y-Axis) in a Trend Chart object is configured to reflect values for the lines that you map to the axis. If preferred, you can set the axis scale to reflect percentage instead. To do so, take the following steps:

1. Right-click within the data display area of the object, then select **Trend Control Properties**.
   The "CIMPLICITY Trend Chart Control Properties" dialog box appears.
2. Click the **Chart** tab, then click the **Advanced** button.
3. Set the Y-axis display option to **Percent configured**.
4. Click **OK** to close the "Advanced" dialog box.
5. Click **OK**.
   The primary Y-axis refreshes to reflect percentage, and all other Y-axes in the chart are hidden.

TO ASCERTAIN VALUE DELTAS ACROSS TIME IN A TREND CHART OBJECT

If you want to ascertain at a glance the difference in a given measurement's value between two points in time, you can do so by taking the following steps:

1. In the data display area of the Trend Chart object, point to the vertical slider bar until a double-headed arrow appears.
2. Click and drag the slider bar to the desired point in time, as indicated by the left slider bar value indicator near the bottom of the object, then repeat with the other slider bar until it is positioned at the desired point in time, as indicated by the right slider bar value indicator near the bottom of the object.
   The legend below the data display area dynamically updates to show each measurement's value at the two points in time marked by the slider bars as well as the Slider Value Delta in the corresponding columns.

If you previously adjusted your display settings to hide the legend and/or the Slider Value Delta column within the legend, refer to *To Control Display of Components in a Trend Chart Object* for instructions on showing the necessary component(s).

TO CHANGE LINE APPEARANCE IN A TREND CHART OBJECT

If, after specifying data to be displayed in a Trend Chart object, you find that the presentation attributes of the corresponding trend line(s) do not meet your visualization needs, you have several options for changing line appearance. Specifically, you can do any of the following:

- Change line color
- Change line style (that is, solid versus broken)
- Change line width (that is, thickness)
- Change line curve type

To Change Line Color in a Trend Chart Object

If, after specifying data to be displayed in a Trend Chart object, you want to change the color of the corresponding trend line, take the following steps:

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select **Trend Control Properties** to open the dialog box.

1. Click the **Lines** tab.
2. In the "Color" column of the table, click the colored box for the trend line whose color you want to change. A drop-down arrow appears beside the box.
3. Click the **drop-down arrow** beside the colored box. A color selection dialog box appears.
4. On the "Palette" tab In the color selection dialog box, click the color that you want to assign to the trend line.
   The color selection dialog box closes and the corresponding box in the table changes to reflect the selected color.
5. Click **Apply**.
   The Trend Chart refreshes to reflect the selected color for the line.
6. Proceed as applicable, based on whether you want to change the color of additional trend lines in the object:

If you want to change the color of additional trend lines in the object:	If you do not want to change the color of additional trend lines in the object:
A. Repeat steps 2 through 5.	**A**. Proceed to step 7.

7. Proceed as applicable, based on whether you want to further configure design of the Trend Chart object:

If you want to further configure design of the Trend Chart object:	If you do not want to further configure design of the Trend Chart object:
A. Leave the "CIMPLICITY Trend Chart Control Properties" dialog box open. **B**. Refer to *Trend Chart Configuration Overview* for a list of configuration options.	**A**. Click **OK** to close the "CIMPLICITY Trend Chart Control Properties" dialog box.

To Change Trend Line Style, Width, and/or Curve Type

If, after specifying data to be displayed in a Trend Chart object, you want to change the style (that is, solid versus broken), width (that is, thickness), and/or curve type of a displayed trend line, take the following steps:

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select **Trend Control Properties** to open the dialog box.

1. Click the **Lines** tab.

2. In the table, click the row corresponding to the trend line whose style, width, and/or curve type you want to change.
3. Below the table, click **Display**. The "Line Display" dialog box appears.
4. Proceed as applicable, based on whether you want to change the style, width, and/or curve type for the trend line:

To Change the Trend Line's...	Do This...
Style	Click the drop-down arrow beside the "Style" field, then select the desired option.
Width	Click the **drop-down arrow** beside the "Width" field, then select the desired option.
Curve Type	Click the drop-down arrow beside the "Expansion" field, then select the desired option: - **Step**: Connects data points in a stepped curve. OR - **Smooth**: Connects data points in a smooth curve. The legend will always display the last actual value to the left of the cursor, such that the value in the legend does not reflect the line interpolation.

5. Click **OK**. The "Line Display" dialog box closes.
6. Click **Apply**.
   The Trend Chart refreshes to reflect the selected style, width, and/or curve type for the trend line.
7. Proceed as applicable, based on whether you want to change the style, width, and/or curve type of additional trend lines in the object:

If you want to change the style, width, and/or curve type of additional trend lines in the object:	If you do not want to change the style, width, and/or curve type of additional trend lines in the object:
A. Repeat steps 2 through 6.	**A**. Proceed to step 8.

8. Proceed as applicable, based on whether you want to further configure design of the Trend Chart object:

If you want to further configure design of the Trend Chart object:	If you do not want to further configure design of the Trend Chart object:
A. Leave the "CIMPLICITY Trend Chart Control Properties" dialog box open. **B**. Refer to *Trend Chart Configuration Overview* for a list of configuration options.	**A**. Click **OK** to close the "CIMPLICITY Trend Chart Control Properties" dialog box.

TO CONTROL DISPLAY OF COMPONENTS IN A TREND CHART OBJECT

You can control display of the following Trend Chart components:

- Trend lines in the data display area
- Chart axes
- Chart grid
- Chart scroll buttons
- Second chart slider bar
- Object legend
- Trend lines in the object legend

- Columns in the object legend
- Column headings in the object legend
- Slider bar value indicators

To Control Display of Trend Lines in the Data Display Area of a Trend Chart Object

You can control which, if any, trend lines are displayed in the data display area of a Trend Chart object. To do so, take the following steps:

1. Take the steps applicable to the mode you are working in:

If the "CIMPLICITY Trend Chart Control Properties" dialog box is not open:	If the "CIMPLICITY Trend Chart Control Properties" dialog box is open:
A. Right-click within the data display area of the object, point to **Show** followed by **Line**, then select the listing for the line that you want to either display (as indicated by a check mark) or hide (as indicated by a cleared check mark). **NOTE**: If you have not yet added data to the object, no lines will be available for selection. The data display area of the object refreshes to either display or hide the trend line. **B**. Repeat step **1A** for each trend line for which you want to change display settings.	**A**. Click the **Lines** tab. **B**. In the table of lines, select or clear the Visible check box to display or hide, respectively, the corresponding line in the data display area of the object. **C**. Click Apply. The data display area of the object refreshes to either display or hide the trend line. **D**. Repeat steps **1B** and **1C** for each trend line for which you want to change display settings. **E**. When you are satisfied with the trend line display settings, click **OK** to close the dialog box.

To Control Display of Trend Chart Axes

You can control which axes are displayed in a Trend Chart object. To do so, take the following steps:

1. Right-click within the X-axis or Y-axis area of the object, as applicable, point to **Show**, then select the listing for the axis that you want to either display (as indicated by a check mark) or hide (as indicated by a cleared check mark).
2. Repeat step 1 until the display of axes meets your requirements.


NOTE

You can also hide all Y-axes except the primary axis (that is, the Chart Y-Axis) at once, by taking the following steps:

- Right-click within the data display area of the object, then select **Trend Control Properties**.
  The CIMPLICITY "Trend Chart Control Properties" dialog box appears.
- Click the **Chart** tab, then click **Advanced**.
  The "Advanced" dialog appears.
- Set the Y-axis display option to **Single**.
- Click **OK** to close the "Advanced" dialog box.

Click **OK**.

To Control Display of the Trend Chart Grid

You can control whether the grid is displayed in the data display area of a Trend Chart object. To do so, take the following step:

1. Right-click within the data display area of the object, point to Show, then select **Grid** to either display the grid (as indicated by a check mark) or hide the grid (as indicated by a cleared check mark).


NOTE

You can also control display of the grid by clicking the double-headed arrow on the "Trend Options" panel, clicking **Toggle Grid**, then clicking the double-headed arrow on the "Trend Options" panel to close the panel.

To Control Display of Trend Chart Scroll Buttons

You can control whether a Trend Chart displays the buttons used to shift the time span for the data being viewed in a Trend Chart object either fractionally or fully backward or forward relative to the current duration setting. To do so, take the following step:

1. Right-click within the data display area of the object, point to Show, and then select Scroll Buttons to either display the scroll buttons (as indicated by a check mark) or hide the scroll buttons (as indicated by a cleared check mark).

To Control Display of the Second Slider Bar in a Trend Chart Object

You can control whether to display the second slider bar, which allows for ascertaining at a glance the difference in a given measurement's value between two points in time. To do so, take the following step:

1. Right-click within the data display area of the object, point to **Show**, then select **2nd Slider** to either display the second slider bar (as indicated by a check mark) or hide the second slider bar (as indicated by a cleared check mark).

To Control Display of Trend Chart Legend

You can control whether the legend is displayed in a Trend Chart object. To do so, take the following step:

1. Right-click within the legend area or the data display area of the object, then select **Legend** to either display the legend (as indicated by a check mark) or hide the legend (as indicated by a cleared check mark).

NOTE

You can also control display of the legend by clicking the **double-headed arrow** on the "Trend Options" panel, clicking **Toggle Legend**, then clicking the **double-headed arrow** on the "Trend Options" panel to close the panel.

To Control Display of Trend Lines in a Trend Chart Legend

You can control which, if any, trend lines are displayed in the legend of a Trend Chart object. To do so, take the following steps:

1. Take the steps applicable to the mode in which you are working:

If the "CIMPLICITY Trend Chart Control Properties" dialog box is not open:	If the "CIMPLICITY Trend Chart Control Properties" dialog box is open:
A. Right-click within the legend area of the object, point to **Add Lines**, then select the listing for the line that you want to either display (as indicated by a check mark) or hide (as indicated by a cleared check mark). The object legend refreshes to either display or hide the trend line. **B**. Repeat step **1A** for each trend line for which you want to change display settings.	**A**. Click the **Lines** tab. **B**. In the table of lines, select or clear the **In legend** check box to display or hide, respectively, the corresponding line in the object legend. **C**. Click **Apply**. The object legend refreshes to either display or hide the trend line. **D**. Repeat steps **1B** and **1C** for each trend line for which you want to change display settings. **E**. When you are satisfied with the trend line display settings, click **OK** to close the dialog box.

To Control Display of Columns in a Trend Chart Legend

You can customize the legend in a Trend Chart object to display or hide columns. To do so, take the following steps:

1. Right-click within the legend area of the object, point to **Show Fields**, then select the listing for the legend column that you want to either display (as indicated by a check mark) or hide (as indicated by a cleared check mark).
2. Repeat step 1 until the legend is configured as desired.

To Control Display of Column Headings in a Trend Chart Legend

You can control whether column headings are displayed in the legend of a Trend Chart object. To do so, take the following step:

1. Right-click within the legend area of the object, then select **Title** to either display the legend column headings (as indicated by a check mark) or hide the legend column headings (as indicated by a cleared check mark).

To Control Display of Slider Bar Value Indicators in a Trend Chart Object

You can control whether a Trend Chart object displays the text reflecting positioning of each slider bar as a date and time value. To do so, take the following step:

1. Right-click within the legend area of the object, then select **Status** to either display the slider bar value indicators (as indicated by a check mark) or hide the slider bar value indicators (as indicated by a cleared check mark).

You can also control display of slider bar value indicators by right-clicking within the data display area of the object, pointing to **Show**, then selecting **Legend Status**.

TO CHANGE AXIS LABEL AND APPEARANCE IN A TREND CHART OBJECT

If, after specifying data to be displayed in a Trend Chart object, you find that the names and/or presentation attributes of the object axes do not meet your visualization needs, you can do any of the following:

- Change axis label text
- Change axis label font settings
- Change axis color

To Change Axis Label Text

If, after specifying data to be displayed in a Trend Chart object, you find that the names of the object axes do not meet your visualization needs, you can change axis labels by taking the following steps.

1. Begin as applicable, based on the mode in which you are working:

If the "CIMPLICITY Trend Chart Control Properties" dialog box is not open:	If the "CIMPLICITY Trend Chart Control Properties" dialog box is open:
A. Right-click within the X- or Y-axis area, as applicable, then select **Label**. The applicable "Axis Labels" dialog box appears.	**A**. Click the **Axis** tab.

2. In the table of axes, click the row containing the axis whose label text you want to change.
3. In the **Label** field, enter the desired name for the axis.
4. Click **Apply**. The Trend Chart object refreshes to reflect the newly specified label text for the selected axis.
5. Proceed as applicable, based on whether you want to change the label text for additional axes in the object:

If you want to change the label text for additional axes in the object:	If you do not want to change the label text for additional axes in the object:
A. Repeat steps 2 through 4.	**A**. Click **OK**.

To Change Axis Label Font

If, after specifying data to be displayed in a Trend Chart object, you find that the font settings of the axis labels do not meet your visualization needs, you can change the settings by taking the following steps:

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select "Trend Control Properties" to open the dialog box.

1. Click the **Axis** tab.
2. In the table of axes, click the row containing the axis whose label font you want to change.
3. In the toolbar below the table of axes, click the square "A^{a}" button. The "Font" dialog box appears.
4. Select the desired **Font** family, **Font Style**, and **Size** from the corresponding drop-down lists, then click **OK** to close the "Font" dialog box.
5. Click **Apply**. The Trend Chart object refreshes to reflect the newly specified label font settings for the selected axis.
6. Proceed as applicable, based on whether you want to change the label font settings for additional axes in the object:

If you want to change the label font for additional axes in the object:	If you do not want to change the label font for additional axes in the object:
A. Repeat steps 2 through 5.	**A**. Click **OK**.

To Change Axis Color

If, after specifying data to be displayed in a Trend Chart object, you find that the colors of the object axes do not meet your visualization needs, you can change the axis color by taking the following steps:

1. Begin as applicable, based on the mode in which you are working:

If the "CIMPLICITY Trend Chart Control Properties" dialog box is not open:	If the CIMPLICITY Trend Chart Control Properties dialog box is open:
A. Right-click within the X- or Y-axis area, as applicable, then select **Label**. The applicable "Axis Labels" dialog box appears.	**A**. Click the **Axis** tab.

2. In the **Color** column of the table, click the colored box for the axis whose color you want to change.
   A drop-down arrow appears beside the box.
3. Click the **drop-down arrow** beside the colored box.
   A color selection dialog box appears.
4. On the Palette tab In the color selection dialog box, double-click the color that you want to assign to the axis.
   The color selection dialog box closes and the corresponding box in the axis table changes to reflect the selected color.
5. Click **Apply**.
   The Trend Chart refreshes to reflect the selected color for the axis.
6. Proceed as applicable, based on whether you want to change the color of additional axes in the object:

If you want to change the color of additional axes in the object:	If you do not want to change the color of additional axes in the object:
A. Repeat steps 2 through 5.	**A**. Click **OK**.

TO CONTROL PROGRESSION IN A TREND CHART OBJECT

In controlling progression in a Trend Chart object, you can do the following:

- Temporarily pause progression

- Resume progression

To Temporarily Pause Progression in a Trend Chart Object

If you need time to examine Trend Chart data, you can pause progression in the object by taking the following step:

1. Right-click within the data display area of the object, then select **Pause**.

To Resume Progression in a Trend Chart Object

After temporarily pausing progression in a Trend Chart object, you can reestablish progression by taking the following step:

1. Do either of the following:
   - Right-click within the data display area of the object, then select **Pause**.

   OR

   - Click the **double-headed arrow** on the "Trend Options" panel, click **Clear Pause/ Zoom**, then click the **double-headed arrow** on the "Trend Options" panel to close the panel.
     Progression resumes and is synchronized to the Display Time.

TO SHIFT THE TIME SPAN IN A TREND CHART OBJECT

If you want to shift the time span for the data being viewed in a Trend Chart object either fractionally or fully backward or forward relative to the duration setting of the primary X-axis (that is, the Chart X-Axis), take the following step:

1. While the Trend Chart object is either running or paused, click the applicable scroll button below the data display area:
   - [**<**] Shifts the time span backward by a configured percentage relative to the duration associated with the primary X-axis


TIP

The default scroll percentage is 50, which you can modify as outlined under *To change scrolling percentage in a Trend Chart object*.

   - [**<<**] Shifts the time span backward fully relative to the duration associated with the primary X-axis
   - [**>**]Shifts the time span forward by a configured percentage relative to the duration associated with the primary X-axis


NOTE

If you are viewing a time span predating the current system time by more than the duration associated with the primary X-axis, clicking this button or the button described below will result in trend lines disappearing at the right-most side of the chart, because the time span will have shifted to the future.

   - [**>>**]Shifts the time span forward fully relative to the duration associated with the primary X axis

TO CHANGE SCROLLING PERCENTAGE IN A TREND CHART OBJECT

By default, the percentage that the time span in a Trend Chart object shifts when you click either the [**<**] or [**>**] scroll button is 50. If a different percentage better meets your visualization needs, you can change this setting by taking the following steps.


NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, select **Trend Control Properties**, then take the following steps.

1. Click the **Chart** tab.
2. Click **Advanced**. The "Advanced" dialog box appears.
3. Specify the desired "Scroll Percentage" setting by entering the value in the corresponding field.
4. Click **OK** to close the "Advanced" dialog box.

5. Click **OK** to close the "CIMPLICITY Trend Chart Control Properties" dialog box.

TO ZOOM THE VIEW IN A TREND CHART OBJECT

If you need to more closely examine data for a time span within the overall duration that a Trend Chart object is currently set to visualize, you can temporarily freeze progression in the object and adjust the display area to show only the desired time span and trend lines magnified accordingly. To do so, take the following step:

1. In the data display area of the Trend Chart object, click and drag to highlight the time span and trend line(s) that you want to examine.
   Progression pauses and the duration is adjusted based on your selection, while the affected trend line(s) are magnified, and all other object components are changed accordingly.

TIP

To cause trend lines to display data based on zoom level—such that if the view is zoomed out, an interpolated retrieval mode is used to optimize performance, whereas if the view is zoomed in to examine data over a very short duration, raw mode is used to show the actual measured samples at high resolution—set the data retrieval mode to one of the hybrid options, being sure to enable the Auto Sample Interval option as part of the process.

NOTE

To cancel zooming and resume progression in the object, either right-click within the display area of the object, then select **Unzoom**, or click the **double-headed arrow** on the "Trend Options" panel, click **Clear Pause/Zoom**, and then click the **double-headed arrow** on the "Trend Options" panel to close the panel.

TO CHANGE AUTOMATIC UPDATE INTERVAL IN A TREND CHART OBJECT

In relation to trend lines whose Auto update setting is enabled, the automatic update interval is the time period between data updates. The default setting is 5 seconds. If a different interval better suits your visualization needs, you can change this setting on a per-line basis by taking the following steps:

NOTICE

A setting lower than 5 seconds may cause a degradation in stability.

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select **Trend Control Properties** to open the dialog box.

1. Click the **Chart** tab.
2. Adjust the **Auto update interval** setting by entering the desired value in the corresponding field.

TIP

Auto update interval format is hh:mm:ss, where:

- hh - Hours: 0–24
- mm - minutes: 0–59

ss - seconds: 0–59

NOTE

This setting determines the time between data updates in trend lines whose Auto update option is enabled, but does not change the shape of the trend lines or the number of data points represented.

3. Click **OK**.
   The dialog box closes, and the Trend Chart updates all affected lines according to the newly designated interval.

TO CHANGE DATA RETRIEVAL MODE IN A TREND CHART OBJECT

The default mode of retrieving data for display in a Trend Chart object is Hybrid Lab. If this setting does not meet your visualization needs, you can change it on a per-line basis.

NOTE

One of several hybrid modes can be used to return data in the Trend Object based on zoom level, such that if the view is zoomed out, an interpolated retrieval mode is used to optimize performance, whereas if the view is zoomed in to examine data over a very short duration, raw mode is used to show the actual measured samples at high resolution. This may prove particularly helpful when visualizing synchrophasor data, which is sampled at very high rates. Note that this functionality requires the Auto sample interval option to be enabled.

To change data retrieval mode in a Trend Chart object, take the following steps.

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select **Trend Control Properties** to open the dialog box.

1. Click the **Lines** tab.
2. In the table of lines, click the row containing the line whose data retrieval mode you want to change.
3. Below the table of lines, click **Display**. The "Line Display" dialog box appears.
4. From the "Retrieval Mode" drop-down list, select the desired option:

NOTE

Raw mode is NOT supported in the EnerVista Synchrophasor Viewer. To view raw data, instead choose one of the Hybrid modes, then while viewing the chart, zoom in to examine data over a very short duration. When you do so, the actual measured samples are shown at high resolution. The default and recommended retrieval mode is Hybrid Lab.

RETRIEVAL MODE	PLOTTED VALUE	
Raw Average		
	Definition	Arithmetic average of raw tags in the sample interval.
	Comment	This is useful only when a sufficient number of raw samples are collected.
Minimum		
	Definition	Minimum value in the sample interval.
	Comment	The value may be a raw value or an interpolated value.
Maximum		
	Definition	Maximum value in the sample interval.
	Comment	The value may be a raw value or an interpolated value.
Lab		
	Definition	Actual collected raw values.
	Comment	Interval timestamps are the same as in interpolated sampling; it is the values that can be different. Since lab sampling will return real collected values, it is more accurate when a sufficient number of raw samples are stored. Use Interpolated sampling for highly compressed data.
Average		
	Definition	Average of the raw samples.
	Comment	There is special logic for time weighting and for computing the value at the start of the sample interval. **NOTE**: This is useful for computing an average on compressed data.
Trend		
	Definition	Raw minimum and raw maximum value for each specified interval.

RETRIEVAL MODE	PLOTTED VALUE	
	Comment	Use to maximize performance when retrieving data points for plotting. **IMPORTANT**: A start time, end time, and an interval or number of samples must be specified. Trend sampling always returns an even number of samples, rounded up when necessary. If for instance, you request one sample in a specified time interval, trending returns two samples. The graphical output from a request for seen samples is the same as the output for eight samples.
Interpolated		
	Definition	Evenly spaced interpolated values based on the sampling interval configured for the trend line.
	Comment	Compression requires interpolation. Even if you are not using compression, you can use interpolation if you want samples spaced on intervals other than the collection rate. If you only want actual collected values to be returned, use Lab sampling. Typically, you use interpolated queries when data is not collected on a set time schedule, or if you want to see the results returned in an interval that is less than the collection rate. For example, these instances show when you can use interpolated mode to make evenly spaced values: – An Historian tag is collected as unsolicited. In this case, we really do not know what the time interval is between collected values. – The Historian deadband and/or archive compression for a tag results in non-evenly spaced collection intervals. – An Historian tag is collected once per 8 hours, but you want to see it displayed in 1-hour intervals with a linear slope between points.
Raw Standard Deviation		
	Definition	Arithmetic standard deviation of raw values for each calculation interval.
	Comment	
Standard Deviation		
	Definition	Time-weighted standard deviation for each calculation interval.
	Comment	This is useful for computing a standard deviation on compressed data.
Count		
	Definition	Number of raw samples in the interval.
	Comment	This addresses only the count and not values or qualities of the samples. Count is useful for analyzing the distribution of the raw data samples.
Raw Total		
	Definition	Arithmetic sum of raw values for each interval.
	Comment	Use this mode to compute an accurate total when a sufficient number of raw samples are collected.
Total		
	Definition	Time-weighted total for each calculation interval.

RETRIEVAL MODE	PLOTTED VALUE	
	Comment	The collected value must be a rate. This calculation mode determines a count from the collected rate.
Hybrid Lab		
	Definition	Hybrid of the Raw and Lab sample modes that: – returns Lab values if the actual number of stored samples is more than the requested number of samples based on the Trend Chart duration, OR – returns Raw values if the actual number of stored samples is fewer than or equal to the requested number of samples based on the Trend Chart duration.
Hybrid Trend		
	Definition	Hybrid of the Raw and Trend sample modes that: – returns Trend values if the actual number of stored samples is more than the requested number of samples based on the Trend Chart duration, OR – returns Raw values if the actual number of stored samples is fewer than or equal to the requested number of samples based on the Trend Chart duration.
Hybrid Interpolated		
	Definition	Hybrid of the Raw and Interpolated sample modes that: – returns interpolated values if the actual number of stored samples is more than the requested number of samples based on the Trend Chart duration, OR – returns Raw values if the actual number of stored samples is fewer than or equal to the requested number of samples based on the Trend Chart duration.

5. If you have selected a calculated retrieval mode, and you want 1,000 samples to be retrieved for the corresponding trend line even when some portion of the display area is zoomed, causing the duration to change accordingly, ensure that the **Default Sample Interval Enable** option is enabled, as indicated by a check mark in the corresponding check box.
6. Click **OK**. The "Line Display" dialog box closes.
7. Click **Apply**. The Trend Chart refreshes to reflect the selected retrieval mode for the trend line.
8. Proceed as applicable, based on whether you want to change the data retrieval mode for additional trend lines in the object:

If you want to change the data retrieval mode for additional trend lines in the object:	If you do not want to change the data retrieval mode for additional trend lines in the object:
A. Repeat steps 2 through 7.	**A**. Click **OK**.

TO CHANGE DATA SAMPLE INTERVAL IN A TREND CHART OBJECT

Sample interval is the time over which data is collected for calculation or combination to obtain a single point of data in a trend line. The default sample interval is 1 second. If a different sample interval better suits your visualization needs, you can change this setting on a per-line basis by taking the following steps.

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select **Trend Control Properties** to open the dialog box.

1. Click the **Lines** tab.
2. In the table of lines, click the row containing the line whose data sample interval you want to change.
3. Below the table of lines, click **Display**.
   The "Line Display" dialog box appears.
4. If the **Auto sample interval** option is enabled, disable it by clearing the corresponding check box.

NOTE

Disabling this option prevents what may be the desired behavior of 1,000 samples being retrieved for the trend line even when some portion of the data display area is zoomed, causing the duration to change accordingly.

5. Adjust the Sample interval setting by specifying the desired numerical value and unit of time (that is, second, minute, or hour) in the corresponding fields.

NOTICE

The designated sample interval should limit the number of data points displayed on any given trend line to approximately 1,000.

Example: If the X-axis that the trend line is associated with is configured to show 2 days of data (Duration setting of 02:00:00:00) at a sample interval of 1 second (00:00:01), there will be 172,800 values to plot. However, the server limit is approximately 5,000 data points. So in this scenario, a reasonable sample interval would be 2 minutes (00:02:00) or higher, that is, 1,440 data points to plot across the chart.

6. Click **OK**. The "Line Display" dialog box closes.
7. Click **Apply**. The Trend Chart refreshes to reflect changes in the corresponding trend line based on the selected sample interval.
8. Proceed as applicable, based on whether you want to change the data sample interval for additional trend lines in the object:

If you want to change the data sample interval for additional trend lines in the object:	If you do not want to change the data sample interval for additional trend lines in the object:
A. Repeat steps 2 through 7.	**A**. Click **OK** to close the dialog box.

TO ENABLE PRIMARY AXIS SYNCHRONIZATION IN A TREND CHART OBJECT

In a Trend Chart object, you can configure multiple X- and Y-axes, and trend lines are synchronized to whichever axes you specify. If it better suits your visualization needs to synchronize all trend lines to the primary X and/or Y axis (that is, the Chart X-Axis and/or Chart Y-Axis), regardless of the axis(es) that you have mapped lines to, you can do so by taking the following steps.

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select **Trend Control Properties** to open the dialog box.

1. Click the **Chart** tab.
2. Click **Advanced**. The "Advanced" dialog box appears.
3. Select the Single X-axis defined and/or Single Y-axis defined check box.

NOTE

The Single X-axis defined option is mutually exclusive with the Single Time Duration option, such that if you enable the former, the latter becomes unavailable.

4. Click **OK** to close the Advanced dialog box.
5. Click **OK**.
   The Trend Chart object refreshes to display only the primary X- and/or Y-axis and synchronizes all trend lines accordingly.

NOTE

If you select to synchronize all trend lines to the primary Y-axis, and the **Autoscale** option is enabled, the axis rescales to encompass the values of all trend lines in the object. In this scenario, if the scale of any secondary axis to which one or more trend lines are mapped is markedly different from that of the primary Y-axis, those trend lines may be positioned at the far extreme of the scale, rendering them more difficult to discern. In this case, disabling the **Autoscale** option for the primary Y-axis and specifying scale limits well outside the values of the trend lines should make the lines easier to discern. For instructions, see *To add and map axes in a Trend Chart object*.

TO ENFORCE A SINGLE DURATION SETTING IN A TREND CHART OBJECT

If you have configured multiple X-axes for a Trend Chart object, you can, by default, establish different durations for each axis. If you prefer that all axes reflect the duration specified for the primary X-axis (that is, the Chart X-Axis), take the following steps.

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select **Trend Control Properties** to open the dialog box.

1. Click the **Chart** tab.
2. Click **Advanced**. The "Advanced" dialog box appears.
3. Select the **Single Time Duration** check box.

NOTE

This option is unavailable if the Single X-axis defined option is enabled, because a single X-axis requires a single time duration.

4. Click **OK** to close the Advanced dialog box.
5. Click **OK**.
   The Trend Chart object refreshes all axes to reflect the duration specified for the primary X-axis.

NOTE

The Single time duration option does not alter the configured duration settings of secondary X-axes, such that if you want to subsequently disable the option, the secondary X-axes will again reflect their respective duration settings.

TO CHANGE SLIDER BAR GRAB MARGIN IN A TREND CHART OBJECT

By default, the distance from the slider bar that you can position the mouse pointer and still grab the bar is 2 pixels. If a different distance better meets your needs, you can change this setting by taking the following steps.

NOTE

The following procedure assumes that the "CIMPLICITY Trend Chart Control Properties" dialog box is already open. If this is not the case, right-click within the data display area of the object, then select **Trend Control Properties** to open the dialog box.

1. Click the **Chart** tab.
2. Click **Advanced**. The "Advanced" dialog box appears.
3. Specify the desired Slider Grab Margin setting by entering a value between 0 and 10 in the corresponding field.

NOTE

Slider bar grab margin is measured in pixels.

4. Click **OK** to close the "Advanced" dialog box.
5. Click **OK**.

PMU Status Indicator Object Configuration

PMU Status Indicator Configuration Overview

At a minimum, PMU Status Indicator Configuration involves generating the object itself, then choosing the PMU you want to visualize using the object.

After completing these initial steps, you have a number of options for configuring the object. Specifically, you can do any of the following:

- Change the colors denoting PMU status
- Control whether the object pulses by state
- Display the name of the corresponding PMU
- Temporarily display the name of the corresponding PMU.

Change the Colors Denoting PMU Status

If, after creating a PMU Status Indicator object, you want change the color used by the application to denote PMU status, perform the following steps:

1. Right-click within the object itself, then select **Set Indicator Colors**.
   The Status Indicator Color Selector dialog box appears.
2. Using the applicable drop-down list, adjust the settings to have the object reflect the selected color for PMU state, as follows:
   - **Priority 1 Alarm Color**: Alarm state in relation to bit 13 (time drift), 14 (internal and/or configuration errors), and/or 15 (data validity)
   - **Priority 2 Alarm Color**: Alarm state in relation to bit 11 (trigger event)
   - **Priority 3 Alarm Color**: Alarm state in relation to bit 10 (PMU configuration change)
   - **Bad Communications Color**: Loss of communication between the Multilin P30 PDC card and the Historian
   - **Normal State Color**: No alarm state in relation to any bit.

NOTE

You can also control whether the object pulses in relation to any of these states by selecting the **Pulse** check box. This option is enabled by default for each of the alarm states.

3. Click **OK**.

Control Pulsing of Object by State

To visually cue users to the highest priority alarm states, the PMU Status Indicator object is set by default to pulse. However, you can disable this feature or enable it in relation to other PMU states on a per-object basis. To do so, perform the following step:

1. Right-click within the object itself, then select **Set Indicator Colors**.
   The Status Indicator Color Selector dialog box appears.

2. Select or clear the applicable Pulse check box(es) to have the object pulse or remain solid in relation to the corresponding PMU state(s), as follows:
   - **Priority 1 Alarm Color**: Alarm state in relation to bit 13 (time drift), 14 (internal and/or configuration errors), and/or 15 (data validity)
   - **Priority 2 Alarm Color**: Alarm state in relation to bit 11 (trigger event)
   - **Priority 3 Alarm Color**: Alarm state in relation to bit 10 (PMU configuration change)
   - **Bad Communications Color**: Loss of communication between the Multilin P30 PDC card and the Historian
   - **Normal State Color**: No alarm state in relation to any bit.

You can also control the color the object displays in relation to any of these states by selecting from the corresponding drop-down lists.

3. Click **OK**.

Display PMU Name

When initially created, a PMU Status Indicator object does not display the name of the PMU being monitored. However, you can set any PMU Status Indicator object to display the corresponding PMU name on a per-object basis. To do so, perform the following step:

1. Right-click within the object itself, then select **Show Label**.
   The object refreshes to display the Historian tag name for the corresponding PMU in place of the ampersand icon.

To subsequently mask the Historian tag name, right-click within the object, then select **Hide Label**. Whenever the Historian tag name is hidden, you can also temporarily view it in a pop-up display by positioning your cursor over the @ icon, then clicking and holding your mouse button.

Temporarily Display PMU Name

When initially created, a PMU Status Indicator object does not display the name of the PMU being monitored. However, you can temporarily view the corresponding PMU name in a pop-up display. To do so, perform the following step.

1. Position your cursor over the @ icon, then click and hold your mouse button.
   The object refreshes to temporarily display the Historian tag name for the corresponding PMU in place of the @ icon.

You can also set any PMU Status Indicator object to display the corresponding PMU name until you elect to again hide it. To do so, right-click within the object, then select **Show Label**.

Historical Visualization in ESV

The Historical Playback feature synchronizes all created visualization objects and worksheets—whether currently displayed or not—to show data starting from a specified time in the past through any time up to and including live time. When this feature is enabled, any object created or worksheet opened will reflect data for the specified historical time frame until you either disable the feature or the close the EnerVista Synchrophasor Viewer (ESV) session.

TO ENABLE HISTORICAL PLAYBACK

Take the following steps to enable Historical Playback of all created visualization objects:

1. On the main toolbar, click **Historical Playback**.
   The "CIMPLICITY DGR" dialog box appears.

2. In the "Mode" area, select **Historical Replay**.
   After initialization (which may take some time), the dialog box refreshes to make available the "Time Definition input area," and play pauses in all created visualization objects.
3. In the corresponding fields, specify the desired time frame for which you want to visualize data:
   - **Start date / End date**: Either enter the date components directly in the field, or click the drop-down arrow, then select the date from the displayed calendar.
   - **Start time / End time**: Either enter the time components directly in the field, or click the time component that you want to change, then click the **up** or **down arrow** beside the field until the desired value is displayed.
4. Click **Set Start and End Date Time**.
   All created objects refresh to reflect the specified start time as the Display Time.
5. Optionally, adjust the Playback Speed by clicking the slider control, holding down the mouse button, then dragging the control until the desired playback speed is displayed.
6. Proceed as applicable, based on the desired visualization mode:

To visualize data in continuous playback mode:	**To visualize data in jog playback mode:**
A. Click [**>**]. All created visualization objects automatically play back data based on the specified historical period and playback speed. **TIPS**: - You can pause and then resume playback from either the pause time or the beginning of the specified historical period. To do the former, click the "Pause" button followed by [**>**]; to do the latter, click the "Stop" button followed by [**>**]. - To specify a different historical period, playback must be stopped by clicking the "Stop" button.	**A**. In the Jog Interval field, enter the time span that you want the visualization playback to progress by in each start/stop cycle. **NOTES**: - You can specify a value down to the microsecond. - If the Jog Interval field is not available, pause or stop playback by clicking "Pause" or "Stop" buttons, respectively. **B**. Click the "Play/Pause" button. All created visualization objects play back data for the specified time span, then playback pauses. **NOTE**: If you needed to pause or stop playback at step 6A, playback resumes either from pause time or the beginning of the specified historical period, respectively. **C**. Repeat step **6B** as required to meet your visualization needs.

7. When you are finished visualizing historical data, disable **Historical Playback** mode in one of the following ways:
   - In the Mode area of the "CIMPLICITY DGR" dialog box, select **Live**.
   - Close the EnerVista Synchrophasor Viewer application.

NOTE

The preceding two methods leave the "CIMPLICITY DGR" dialog box open and your "Historical Playback" configuration settings in place, should you want to subsequently replay visualization using the same settings.

   - Close the "CIMPLICITY DGR" dialog box.

Multilin P30 Historian Expression Operators Overview in ESV

Expressions can be used to perform a variety of calculations on the data for one or more Historian tags in order to visualize the results in a Trend Chart line. The tables below show the operators used to build such expressions.

The section below: *Building an Historian Expression Showing the Angular Difference Between Two Synchrophasors*, is an example that illustrates how to build an Historian expression for determining the phase angle difference between two voltage synchrophasors, which facilitates visualizing interconnection-wide views of grid stress. This is a common application of synchrophasor data.

ARITHMETIC OPERATORS

-	Returns	Difference between X and Y

	Format	***<expr1>-<expr2>***
		
		Example:
		To determine angular difference between voltage phasors:
		`'\\MyHistorianConnection\StationA.10.PhaseA.VA' -`
		`'\\MyHistorianConnection\StationB.14.PhaseA.VA'`

*	Returns	Product of X and Y
	Format	***<expr1>*<expr2>***
/	Returns	Quotient of X and Y

	Format	***<expr1>/<expr2>***
		
		NOTE: The result of dividing two integers in an expression will be an integer. If you want the result to be a floating tag, multiply the numerator by **1.0** before dividing.
		
		Example:
		`'\\MyHistorianConnection\StationA.10.PhaseA.IM' is set to 6.`
		`'\\MyHistorianConnection\StationA.14.PhaseA.IM' is set to 4.`
		
		Results:
		`'\\MyHistorianConnection\StationA.10.PhaseA.IM`
		`'\\MyHistorianConnection\StationA.14.PhaseA.IM = 1`
		`('\\MyHistorianConnection\StationA.10.PhaseA.IM/'*1.0`
		`T'\\MyHistorianConnection\StationA.14.PhaseA.IM = 1.5`

^	Returns	Value of X raised to the power of Y
	Format	***<expr1>^<expr2>***
|	Will be substituted by double quotes in an expression	
+	Returns	Sum of X and Y
	Format	***<expr1>+<expr2>***
ABS	Returns	Absolute value of X
	Format	***ABS(expr)*** *Example:* `ABS(-2.6)` returns 2.6
CEIL	Returns	Nearest integer greater than, or equal to, X
	Format	***CEIL (expr)*** *Example:* `CEIL(2.3)` returns 3 `CEIL(-2.3)` returns -2
FLR	Returns	Nearest integer less than, or equal to, X
	Format	***FLR(expr)*** *Examples:* `FLR(2.6)` returns 2 `FLR(-2.6)` returns -3
MAX	Returns	Maximum comparing X and Y
	Format	***<expr1> MAX <expr2>*** *Example:* `3 MAX 4` returns 4

MIN	Returns	Minimum comparing X and Y
	Format	***<expr1> MIN <expr2>*** *Example:* `3 MIN 4` returns 3
MOD	Returns	Value of X modulo Y
	Format	***<expr1> MOD <expr2>*** *Example:* `9 MOD 8` returns 1
RND	Returns	Integer nearest to X
	Format	***RND(expr)*** *Example*: `RND(2.6)` returns 3 `RND(-2.6)` returns -3
SQR	Returns	Square root of X
	Format	***SQR(<expr>)***
TRUNC	Returns	Value of X with the fractional part removed; the result is its integer value.
	Format	***TRUNC(expr)*** *Examples:* `TRUNC(2.6)` returns 2 `TRUNC(-2.6)` returns -2

BITWISE OPERATORS

BAND	Performs	Bitwise **AND** of X and Y
	Format	***<expr1>AND<expr2>***
BOR	Performs	Bitwise **OR** of X and Y
	Format	***<expr1>OR<expr2>***
BNOT	Performs	Bitwise **NOT** of X and Y
	Format	***<expr1>NOT<expr2>***
BXOR	Performs	Bitwise **XOR** of X and Y
	Format	***<expr1>XOR<expr2>***
SHL	Performs	Value of X shifted left by Y bits
	Format	***<expr1>SHL<expr2>*** *Example:* `2 SHL 1` returns 4 NOTE: When SHL goes out of range the: • Tag becomes unavailable • Tag Control Pane is starred • Core status log notes that it is unavailable.
SHR	Performs	Value of X shifted right by Y bits
	Format	***<expr1>SHR<expr2>*** *Example:* `2 SHR 1` returns 1 NOTE: When SHR goes out of range the: • Tag becomes unavailable • Tag Control Pane is starred • Core status log notes that it is unavailable.

CONVERSION OPERATOR

VAL	Returns	Numeric value of a text string. NOTE: **VAL** converts a variable that consists of numbers in text string format to a numeric format that can be included in calculations.
	Format	***VAL(expr)***

LOGICAL OPERATORS

AND	Performs	Logical **AND** of X and Y
	Format	***<expr1>AND<expr2>***
NOT	Performs	Logical **NOT** of X
	Format	***NOT<expr>***
OR	Performs	Logical **OR** of X and Y
	Format	***<expr1>OR<expr2>***
XOR	Performs	Logical **XOR** of X and Y
	Format	***<expr1>XOR<expr2>***

QUALITY OPERATORS

GetQualityBit	Gets	Quality Bit for the specified bit index NOTE: **GetQualityBit** retrieves the quality of the specified expression for a given bit number. The bit number ranges from **0** to **31**.
	Format	***GetQualityBit(<expression>,<bit index>)***
IsAvailable	Returns	If X is available
	Format	***IsAvailable(<value>)***
QL	Retrieves	The quality (32 bit integer) returned for the wrapped expression.
	Format	***QLS[<expr>]***

RELATIONAL OPERATORS

EQ	Returns	True if X is equal to Y
	Format	***<expr1>EQ<expr2>***
GE	Returns	True if X is greater than or equal to Y
	Format	***<expr1>GE<expr2>***
GT	Returns	True if X is greater than Y
	Format	***<expr1>GT<expr2>***
LE	Returns	True if X is less than or equal to Y
	Format	***<expr1>LE<expr2>***
LT	Returns	True if X is less than Y
	Format	***<expr1>LT<expr2>***
NE	Returns	True if X is not equal to Y
	Format	***<expr1>NE<expr2>***

SCIENTIFIC OPERATORS

ACOS	Returns	Arc cosine (angle in radians) of X radians.
	Format	***ACOS(<expr>)***
ASIN	Returns	Arc sine (angle in radians) of X radians.
	Format	***ASIN(<expr>)***
ATAN	Returns	Arc tangent (angle in radians) of X radians.
	Format	***ATAN(<expr>)***
COS	Returns	Cosine (angle in radians) of X radians.
	Format	***COS(<expr>)***
EXP	Returns	Value of e raised to the power of X. NOTE: **EXP** is the exponential (ex) value of an expression where X is the expression.
	Format	***EXP(<expr>)***
LOG	Returns	Natural logarithm (**base e**) of X.
	Format	***LOG(<expr>)***
LOG10	Returns	Base 10 logarithm of X.
	Format	***LOG10(<expr>)***
SIN	Returns	Sine (angle in radians) of X radians.
	Format	***SIN(<expr>)***
TAN	Returns	Tangent (angle in radians) of X radians.
	Format	***TAN(<expr>)***

TIMESTAMP OPERATORS

CalcSpan	Returns	An unsigned 64-bit integer containing a timestamp (in decimicroseconds) that represents the span of that duration.
	Format	***CalcSpan[<days>,<hours>,<minutes>,<seconds>,<fracsec>]***
CalcStamp	Returns	An unsigned 64-bit integer containing the timestamp (in decimicroseconds) that represents them.
	Format	***CalcStamp[<year>,<month>,<day>,<hour>,<minute>,<second>,<fracsec>]***
TS	Retrieves	Timestamp returned for the wrapped expression.
	Format	***TS(<expr>)***

Multilin P30 Historian Data Export to Excel

To assist with research and analysis, the EnerVista Synchrophasor Viewer (ESV) application allows you to export Synchrophasor, digital, and analog data stored in Historian(s). To do this, perform the following steps.

1. Right-click in a blank area of any ESV worksheet, then select **Data Export Tool**. The GE Historian Export Tool dialog box appears.
2. Proceed as applicable based on whether you have previously configured your system to connect to the Historian housing the desired data:
   - If you have previously configured your system to connect to the Historian, choose Select from Configured Historian Connections, and then select the Historian from the corresponding drop-down list.
   - If you have NOT previously configured your system to connect to the Historian, choose Enter Historian Access Information, and then enter the Server Name, User Name, and Password in the corresponding fields.

NOTE

For the server name, the node name is preferred. If you want the connection to the Historian to persist, select the **Remember Password** check box.

3. Click **Connect**.
   A dialog box for selecting Historian tags appears.
4. Proceed as applicable based on whether you want to filter the list of available data sources in the Historian by tag name:
   - If you DO want to use filtering, type the applicable Tag Mask in the corresponding field, then click **Search**.

NOTE

For more information, see *Historian Tag Naming Conventions*.

   - If you do NOT want to use filtering, click **Search**.
     The Tags Found pane refreshes to display a list Historian tags matching the defined search criteria.
5. In the **Tags Found** pane, select the tags representing Synchrophasor, digital, and/or analog data you want to export, using the buttons beside the pane to move your selections to the Tags Selected to Export Values for pane and/or specify the order in which you want the related data to be sorted in the target .csv file.
6. Click **Next**.
7. Specify the time range for which you want to export data:
   - In the **Start/Date Time** field, enter the commencement values.
   - In the **End/Date Time** field, enter the terminal values.

NOTE

To specify the date, you can either type directly in the field, or click the drop-down arrow, then select the desired date from the displayed calendar. To specify the time, type directly in the field, replacing the currently displayed hour, minute, and/or second with the desired values.

8. Beside the Export File Name field, click the **ellipsis** button.
   A standard dialog for saving files appears.
9. Navigate to the location where you want to save the export file, specify the File Name, then click **Save**.
10. Click **Export**.
    When the export is complete, a confirmation dialog box appears.
11. Click **OK** in the confirmation dialog box.
12. Click **Close** in the export tool dialog box.

Alarm Oversight

Alarm Access

Alarm Access Overview

Assuming you have been provided rights to do so, you can monitor and manage current PMU operational problems published to EnerVista Synchrophasor Viewer (ESV) as alarms by the related EnerVista Grid Engineer application. Regardless of your user privileges, you can also view past PMU alarms for the purpose of analysis. Three interfaces are provided in ESV for accessing PMU alarm data, as follows:

- The ESV Alarm Viewer displays details on current alarms for all PMUs the EnerVista Grid Engineer is configured to monitor.
- The Quick Alarm Viewer displays summary alarm information for a given PMU.
- The Historical Alarm Viewer displays details on past alarms for all PMUs the EnerVista Grid Engineer is configured to monitor.

Quick Alarm Viewer Description

The EnerVista Synchrophasor Viewer (ESV) provides a dedicated interface for ascertaining at a glance the current alarms for a given PMU. Change in color of a PMU Status Indicator object from green (or whichever color you have set to indicate normal state) serves as the visual indicator of one or more alarms in the corresponding PMU, with the specific color indicating the highest priority represented among the current alarm set for the PMU. The Quick Alarm Viewer is opened by way of a right-click menu from any PMU Status Indicator object, and displays summary alarm information in the form of the Historian tag for the corresponding PMU, along with the bit number and description for each current alarm.

NOTICE

Because it reflects live data, the Quick Alarm Viewer does not "latch" alarm states. For details on current and latched alarms, use the Alarm Viewer interface.

View Summary Alarm Information for a Specific PMU

Change in color of a PMU Status Indicator object from green (or whichever color you have set to indicate normal state) serves as the visual indicator of one or more alarms in the corresponding PMU. In the event of such a change, you can ascertain at a glance the current alarms for a given PMU. To do so, perform the following steps.

NOTE

If you have not yet created a PMU Status Indicator object, follow the steps under *To Create a PMU Status Indicator Object* before completing the following procedure.

1. Right-click within the PMU Status Indicator object itself, then select Quick View.
   The Quick Alarm Viewer appears, displaying summary alarm information in the form of the Historian tag for the PMU in question, along with the bit number and description for each current alarm.

NOTICE

Because it reflects live data, the Quick Alarm Viewer does not "latch" alarm states. For details on current and latched alarms, use the Alarm Viewer interface.

ESV Alarm Viewer Description

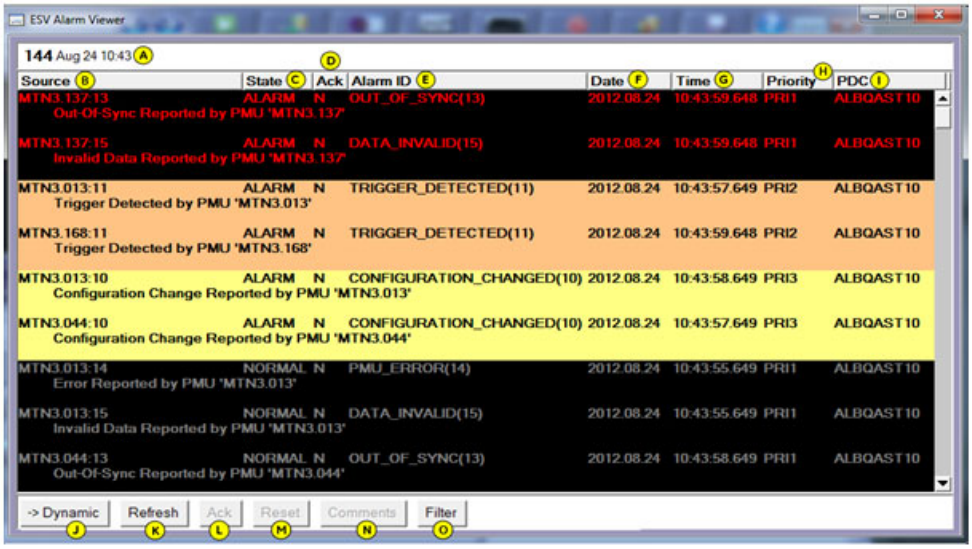
Assuming you have been provided rights to do so, the ESV Alarm Viewer allows you to monitor and respond to alarms detected in any PMU tracked by the EnerVista Grid Engineer. When a transition state first occurs in relation to a monitored STAT word bit for such a PMU, the EnerVista Grid Engineer publishes an alarm listing for display in the ESV Alarm Viewer, where the listing is subsequently updated with each transition in state until it is removed by virtue of user acknowledgment followed by reset (or vice versa). Transitions in state may be from Normal to in Alarm or in Alarm to Normal.

Change in color of a PMU Status Indicator object from green (or whichever color you have set to indicate normal state) serves as the visual indicator of one or more alarms in the corresponding PMU, with the specific color indicating the highest priority represented among the current alarm set for the PMU. The ESV Alarm Viewer is opened by way of right-click menu from any PMU Status Indicator object.

NOTE

The ESV Alarm Viewer cannot be displayed when Historical Playback is enabled.

The image below highlights the main components of the ESV Alarm Viewer.



Key	Feature	Purpose
A	Count and Time Indicators	Reflects the number of alarms that could be displayed in the viewer based on the Multilin P30s that the current user is authorized to access.
B	Source Column	Lists the Multilin P30 identifier for the PMU to which the alarm corresponds, along with the related STAT word bit (following the terminal colon in the PMU identifier) and a description of the alarm type (under the PMU identifier).
C	State Column	Designates a value of either in Alarm or Normal. **NOTE**: For state transitions indicating an inability to retrieve samples from the Historian for any given PMU during the current alarm analysis cycle, the state remains in Alarm until manually reset by a user. Other alarm types may either be automatically reset based on changes in PMU operations or be manually reset by a user. As a visual aid in identifying alarms potentially requiring attention, listings that are in Alarm blink by default.
D	Ack Column	Lists either a **Y** to indicate that the alarm has been acknowledged by a user, or an **N** to indicate no such acknowledgement.
E	Alarm ID Column	Lists the alarm identifier followed in parentheses by the related STAT word bit.
F	Date Column	Lists the year, month, and day of the transition in bit state, that resulted in the alarm.
G	Time Column	Lists the hour, minute, second, and millisecond of the transition in bit state, that resulted in the alarm. **NOTE**: For state transitions between in Alarm and Normal, and vice versa, this time is accurate to within 1 millisecond, based on the timestamp of the Historian sample that indicated the transition in question. For state transitions indicating an inability to retrieve samples for any given PMU during the current alarm analysis cycle, the time reflects that of the cycle start. By default, a cycle is 23 seconds in length.

Key	Feature	Purpose
H	Priority Column	Lists a designation reflecting the significance of the alarm as either PRI1 (priority 1), PRI2 (priority 2), or PRI3 (priority 3), in descending order of significance. **NOTE**: Priority 1 alarms relate to bit 13 (time drift), 14 (internal and/or configuration errors), and/or 15 (data validity); priority 2 alarms relate to bit 11 (trigger event); and priority 3 alarms relate to bit 10 (PMU configuration change). **TIP**: Regardless of priority, alarms having a state of Normal are represented by gray text, whereas those in Alarm are color coded as follows: • Priority 1 alarms alternate between red text on black background, and black text on red background as they blink. • Priority 2 alarms alternate between orange text on black background, and black text on orange background as they blink. • Priority 3 alarms alternate between yellow text on black background, and black text on yellow background as they blink.
I	PDC Column	Lists the Historian name as specified by the user when establishing connection between EnerVista Grid Engineer and the Multilin P30 that collected the data from the PMU with which the alarm is associated.
J	Dynamic/Static Button	Toggle control that when clicked, sets the viewer either to automatically update to reflect any change to alarms as they occur or to display only that information current as of the time that the viewer was last opened or most recently updated using the Refresh button (see below). **TIP**: Static mode (in conjunction with use of the Refresh button) may be preferred if you plan to take action in relation to alarms, as this mode prevents listings from scrolling within the viewer in response to changing conditions.
K	Refresh Button	Control that when clicked, updates the viewer to reflect any changes to alarms since the viewer was either last opened or most recently updated by way of the button. Such changes may include addition of new alarms; removal of previously published alarms that have been acknowledged and reset (or vice versa) by a user; and modification to one or more attributes of previously published alarms that have undergone some change but have yet to be dismissed by way of user acknowledgment and reset (or vice versa). **NOTE**: This control is available only when the viewer is set to static mode.
L	Ack Button	Control that when clicked, performs one of the following actions or set of actions, depending on whether the alarm was previously reset: • If the alarm was NOT previously reset, changes the value in the Ack column of the table from an N (to indicate lack of acknowledgment) to a Y (to indicate acknowledgment), and suspends blinking of the table listing. • If the alarm was previously reset, removes the alarm listing from the table (but not from the alarm log, such that the alarm details can still be accessed by way of the Historical Alarm Viewer).

Key	Feature	Purpose
M	Reset Button	Control that when clicked, performs one of the following actions or set of actions, depending on whether the alarm was previously acknowledged: • If the alarm was NOT previously acknowledged, changes its state from in Alarm to Normal, regardless of the actual state of the related device; sets the table listing text to gray and its background to black; and suspends blinking of the listing. • If the alarm was previously acknowledged, removes the alarm listing from the table (but not from the alarm log, such that the alarm details can still be accessed by way of the Historical Alarm Viewer).
N	Comments Button	Control that when clicked, opens an interface that allows the user to create, view, and delete comments related to the alarm.
O	Filter Button	Control that when clicked, opens a dialog box that provides for limiting display of alarms by priority, PMU, time, and/or state. **NOTE**: The ability to change viewer setup is privilege based.

View Current PMU Alarms

Change in color of a PMU Status Indicator object from green (or whichever color you have set to indicate normal state) serves as the visual indicator of one or more alarms in the corresponding PMU. In the event of such a change, you can view details on current alarms for all PMUs that the EnerVista Grid Engineer is configured to monitor. To do so, perform the following steps.

NOTE

If you have not yet created a PMU Status Indicator object, you must do so before completing the following procedure.

1. Right-click within the object itself, then select **Open Alarm Viewer**.
   The ESV Alarm Viewer appears, displaying details on current alarms for all PMUs that the EnerVista Grid Engineer is configured to monitor.

TIP

A number of options exist for customizing data display in the ESV Alarm Viewer. For more information, see *Alarm Display Configuration Overview*.

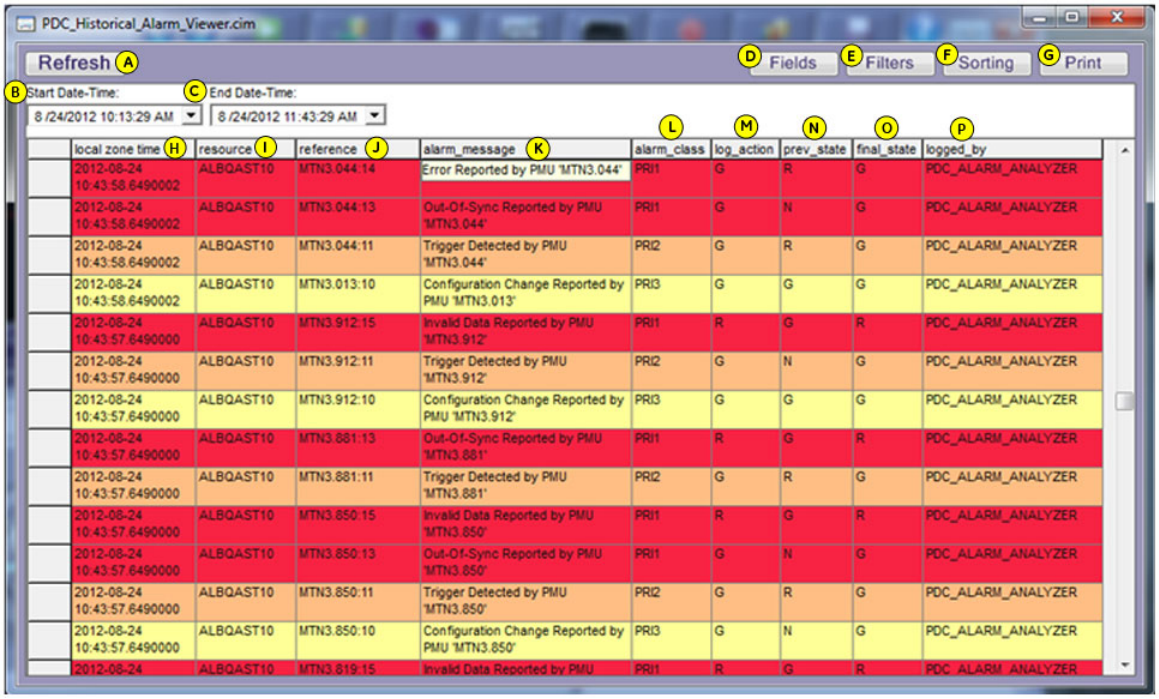
Historical Alarm Viewer Description

The Historical Alarm Viewer allows you to monitor and analyze alarms previously detected in any PMU tracked by the EnerVista Grid Engineer. Each time a transition state occurs in relation to a monitored STAT word bit for such a PMU, the EnerVista Grid Engineer creates a corresponding record for storage in a database. Such logged records can then be retrieved for display by way of the Historical Alarm Viewer in the EnerVista Synchrophasor Viewer (ESV). In this way, you can view the progression of any PMU alarm across a past time period that you specify.

NOTE

You cannot take any action against the alarms corresponding to the records displayed by way of the Historical Alarm Viewer. Rather, the Historical Alarm Viewer is designed to assist with alarm analysis.

The image below highlights the main components of the Historical Alarm Viewer.



	Feature	Purpose
A	Refresh Button	Control that when clicked, updates the viewer to reflect those alarm records that meet the most recently defined date-range criteria.
B	Start Date-Time Field	Control that allows for specifying the commencement date and time of the time range for which you want to view alarm records. **NOTE**: By default, the time range is one-half hour prior to the current system time unless Historical Playback is enabled, in which case it is one-half hour prior to the current Historical Playback time. **TIP**: To specify the date, you can either type directly in the field, or click the drop-down arrow, then select the desired date from the displayed calendar. To specify the time, type directly in the field, replacing the currently displayed hour, minute, and/or second with the desired values.
C	End Date-Time Field	Control that allows for specifying the terminal date and time of the time range for which you want to view alarm records. **NOTE**: To specify the date, you can either type directly in the field, or click the drop-down arrow, then select the desired date from the displayed calendar. To specify the time, type directly in the field, replacing the currently displayed hour, minute, and/or second with the desired values.
D	Fields Button	Control that when clicked, opens a dialog box that provides for choosing which categories of data to display in the viewer as table columns.
E	Filters Button	Control that when clicked, opens a dialog box that provides for limiting display of alarm records by user-defined values for application-defined parameters.
F	Sorting Button	Control that when clicked, opens a dialog box that provides for changing the order of the listings currently displayed in the viewer based on the categories represented by the column headings.

	Feature	Purpose
G	Print	Control that when clicked, opens a dialog box that provides for printing the contents currently displayed in the viewer.
H	Local Zone Time Column	Lists the log action time adjusted to the local time of the EnerVista Grid Engineer server. **NOTE**: For state transitions between in Alarm and Normal, and vice versa, this time is accurate to within 1 millisecond, based on the timestamp of the Historian sample that indicated the transition in question. For state transitions indicating an inability to retrieve samples for any given PMU during the current alarm analysis cycle, the time reflects that of the cycle start.
I	Resource Column	Lists the connection name, as specified in the EnerVista Grid Engineer, for the Historian that collected the data from the PMU to which the alarm record is associated.
J	Reference Column	Lists the Multilin P30 identifier for the PMU to which the alarm corresponds, along with the related STAT word bit (following the terminal colon in the PMU identifier).
K	Alarm Message Column	Lists the specific alarm message.
L	Alarm Class Column	Lists a designation reflecting the significance of the alarm as either PRI1 (priority 1), PRI2 (priority 2), or PRI3 (priority 3), in descending order of significance. **NOTE**: Priority 1 alarms relate to bit 13 (time drift), 14 (internal and/or configuration errors), and/or 15 (data validity); priority 2 alarms relate to bit 11 (trigger event); and priority 3 alarms relate to bit 10 (PMU configuration change). **TIP**: Record listings are color coded based on priority level of the corresponding alarm, as follows: • Priority 1 alarm records have a red background. • Priority 2 alarm records have an orange background. • Priority 3 alarm records have a yellow background.
M	Log Action Column	Specifies the activity that resulted in the alarm record, as follows: • **G** (Generated) represents a change in state from Normal to in Alarm. • **R** (Reset) represents a change in state from in Alarm to Normal. • **A** (Acknowledged) represents a change in acknowledgment state from N (no) to Y (yes) based on user acknowledgment. • **D** (Deleted) represents relegation of the alarm from current to historical status by virtue of user acknowledgment followed by reset (or vice versa). **NOTE**: The D designation can also represent deletion of an alarm comment, in which case the previous and final states (see below) are both set to U to indicate unchanged. • **C** (Commented) represents user posting of a comment to the alarm. **NOTE**: This log action results in both the previous and final states (see below) being set to U to indicate unchanged.

	Feature	Purpose
N	Prev State Column	Specifies the activity that immediately preceded the activity that resulted in the alarm record, as follows: • **G** (Generated) represents a change in state from Normal to in Alarm. • **R** (Reset) represents a change in state from in Alarm to Normal. • **A** (Acknowledged) represents a change in acknowledgment state from N (no) to Y (yes) based on user acknowledgment. • **N** (None) represents lack of existence. • **U** (Unchanged) represents addition or deletion of a user comment but otherwise no change in state.
O	Final State Column	Specifies the terminal state of the alarm record, as follows: • **G** (Generated) represents a change in state from Normal to in Alarm. • **R** (Reset) represents a change in state from in Alarm to Normal. • **A** (Acknowledged) represents a change in acknowledgment state from N (no) to Y (yes) based on user acknowledgment. • **D** (Deleted) represents relegation of the alarm from current to historical status by virtue of user acknowledgment followed by reset (or vice versa). • **U** (Unchanged) represents addition or deletion of a user comment but otherwise no change in state
P	Logged By Column	Lists the name of the user as configured in relation to the EnerVista Grid Engineer who took the action that resulted in the alarm record.

View Past PMU Alarms

To aid in analysis of PMU operation, EnerVista Synchrophasor Viewer (ESV) provides for viewing detailed information on alarms previously detected in any PMU that the related EnerVista Grid Engineer application is configured to track. Each time a transition state occurs in relation to a monitored STAT word bit for such a PMU, the EnerVista Grid Engineer creates a corresponding record for storage in a database. Such logged records can then be retrieved for display by way of the Historical Alarm Viewer in ESV. In this way, you can research the progression of any PMU alarm across a past time period that you specify.

To do so, perform the following steps.

The Historical Alarm Viewer is launched by way of the PMU Status Indicator object. If you have not yet created such an object, you must do so before completing the procedure below.

1. Right-click within a PMU Status Indicator, then select **Open Historical Alarm Viewer**. The Historical Alarm Viewer appears.
2. Specify the past time period for which you want to view alarm records:
   - In the Start/Date Time field, enter the commencement values.
   - In the End/Date Time field, enter the terminal values.

NOTE

By default, the time range is one-half hour prior to the current system time unless Historical Playback is enabled, in which case it is one-half hour prior to the current Historical Playback time.

TIP

To specify the date, you can either type directly in the field, or click the drop-down arrow, then select the date from the displayed calendar. To specify the time, type directly in the field, replacing the currently displayed hour, minute, and/or second with the desired values.

3. Click **Refresh**.
   The Historical Alarm Viewer refreshes to display all alarm records for the specified period.

NOTE

You cannot act on the alarms corresponding to the records displayed by way of the Historical Alarm Viewer. Rather, the Historical Alarm Viewer is designed to assist with alarm analysis.

TIP

Several options exist for customizing data display in the ESV Alarm Viewer. For more information, see *Alarm Display Configuration Overview*.

Alarm Display Configuration

Alarm Display Configuration Overview

Assuming you have been provided rights to do so, you can monitor and manage current PMU operational problems published to EnerVista Synchrophasor Viewer (ESV) as alarms by the related EnerVista Grid Engineer application. Regardless of your user privileges, you can also view past PMU alarms for the purpose of analysis.

Two interfaces are provided in ESV for accessing detailed alarm data for all PMUs that the EnerVista Grid Engineer is configured to monitor: the ESV Alarm Viewer for current alarms, and the Historical Alarm Viewer for past alarms. Each of these interfaces provides for customizing display of alarm data and, in the case of the ESV Alarm Viewer, saving custom display settings (assuming you have been provided rights to do so).

Set Display Refresh Mode for Current PMU Alarms

Assuming you have been provided rights to do so, you can monitor and respond to current alarms detected in any PMU tracked by the related EnerVista Grid Engineer application. When a transition state first occurs in relation to a monitored STAT word bit for such a PMU, the EnerVista Grid Engineer publishes an alarm listing for display in the ESV Alarm Viewer. By default, this list of current alarms in the ESV Alarm Viewer is set to refresh automatically in response to any change to alarms as they occur. However, you can instead set the ESV Alarm Viewer to display only that information current as of the time that the viewer was last opened or most recently manually refreshed.

To set Display Refresh Mode for current PMU alarms, perform the following step.

NOTE

Display settings are modified from within the ESV Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, if you have not yet created such an object then opened the ESV Alarm Viewer, you must do so before completing the following procedure.

1. In the ESV Alarm Viewer, click the **toggle** button to reflect your display update preference:
   - To set the ESV Alarm Viewer to refresh automatically in response to any change to alarms as they occur, click **Dynamic**.
   - To set the ESV Alarm Viewer to display only that information current as of the time that the viewer was last opened or most recently manually updated, click **Static**.

TIP

The latter mode may be preferred if you plan to take action in relation to alarms, as this setting prevents listings from scrolling within the viewer in response to changing conditions. However, if working in this mode, you must remember to click the **Refresh** button to update the display to reflect changing conditions.

The selected display update preference is immediately reflected in the ESV Alarm Viewer.

TIP

A number of options exist for customizing data display in the ESV Alarm Viewer. For more information, see *Alarm Display Configuration Overview*.

Change Sort Order of Current PMU Alarms

By default, current alarms as displayed in the ESV Alarm Viewer are sorted in descending order based on time. However, if viewing the alarms in a different order and/or sorted by a different data attribute would better suit your needs, you can change the sort order of current alarms. To do so, perform the following steps.

NOTE

Display settings are modified from within the ESV Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the ESV Alarm Viewer, you must do so before completing the following procedure.

1. In the ESV Alarm Viewer, click the heading of the column representing the data attribute by which you want to sort alarms.
   - If the alarms were previously sorted by another data attribute, the ESV Alarm Viewer refreshes to list alarms in ascending order based on the newly selected data attribute.
   - If the alarms were previously sorted by the same data attribute, the ESV Alarm Viewer refreshes to list alarms in descending order based on the attribute.

TIP

Clicking the same column heading multiple times toggles the sort order between ascending and descending order.

NOTE

Assuming you have been provided rights to do so, you can customize display of current alarm data in the ESV Alarm Viewer in other ways as well, then save the custom display configuration. For more information, see *Alarm Display Configuration Overview*.

Limit Display of Current PMU Alarms Based on Data Attribute Value

Assuming you have been provided rights to do so, you can limit display of current alarms in the ESV Alarm Viewer based on data attribute values, then save the custom configuration. Specifically, you can filter display of current alarms based on any of the following, alone or in combination:

- Alarm priority
- Multilin P30 Phasor Data Concentrator (PDC)
- Commencement time
- Alarm state in conjunction with acknowledgment state.

To limit display of current PMU alarms based on data attribute values, perform the following steps.

NOTE

Display settings are modified from within the ESV Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, if you have not yet created such an object then opened the ESV Alarm Viewer, you must do so before completing the following procedure.

1. In the ESV Alarm Viewer, click the **Filter** button.
   The Alarm Setups dialog box appears.
2. In the Setup field, type the desired name for the display configuration being designed and saved.
3. Click **Modify Current**.
   The Modify Setup dialog box appears.
4. Proceed as applicable based on the desired change:
   - If you want to limit display of current alarms in the ESV Alarm Viewer based on alarm priority, click **Classes**, then clear the check box for each priority for which you do not want to view alarms.
   - If you want to limit display of current alarms in the ESV Alarm Viewer based on the Multilin P30, click **Resources**, then clear the check box for each Multilin P30 for which you do not want to view alarms.
   - If you want to limit display of current alarms in the ESV Alarm Viewer based on commencement time and/or a combination of alarm and acknowledgment states, click **Time and State Filter**; select the **Use Time Filter** check box and enter the desired values in the Select Alarms Since fields, if filtering by commencement time; and select or clear the desired **Filter by state** check boxes, if filtering by states.
5. Click **OK**.
   The Modify Setup dialog box closes.
6. Click **Save**.


TIP

Optionally, you can set the newly configured display setup to be used by also clicking **Make Default**.

7. Proceed as applicable based on whether you want to immediately enable the newly configured filtered display settings:
   - If you do want to immediately enable the newly configured filtered display settings, click **Load**. The Modify Setup dialog box closes, and the ESV Alarm Viewer refreshes accordingly.
   - If you do not want to immediately enable the newly configured filtered display settings, click **Done**. The Modify Setup dialog box closes, and the ESV Alarm Viewer display remains unchanged.


TIP

To subsequently enable any such saved filtered display settings, click the **Filter** button to open the Alarm Setups dialog box, select the applicable listing, then click **Load**.

Change Sort Order of Past PMU Alarm Records

By default, past alarms as displayed in the Historical Alarm Viewer are sorted in descending order based on the timestamp. However, if viewing the alarms in a different order and/or sorted by a different data attribute would better suit your needs, you can change the sort order of current alarms. To do so, perform the following steps.


NOTE

Display settings are modified from within the ESV Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the ESV Alarm Viewer, you must do so before completing the following procedure.

1. In the Historical Alarm Viewer, click the **Sorting** button.
   The Select Sorting Criterion dialog box appears.
2. Proceed as applicable based on the desired change:

- If you want to change the sort order but not the data attribute by which alarm records are sorted, click **Ascending** or **Descending**, as appropriate.
- If you want to change the data attribute by which alarm records are sorted to a different attribute, click the check box beside the desired attribute and clear the check box beside the formerly selected attribute, then click **Ascending** or **Descending**, as appropriate.

TIP

Optionally, you can select multiple data attributes for sorting purposes, in which case be sure to also specify the order of priority among the attributes by using the **Up** or **Down** button to reposition the listings, as necessary.

3. Click **OK**.
   The Select Sorting Criterion dialog box closes, and the Historical Alarm Viewer refreshes to reflect the new sorting settings.

Change Data Attributes Displayed for Past PMU Alarm Records

By default, past alarm records as reflected in the Historical Alarm Viewer encompass the following data attributes:

- Local zone time (timestamp_UTC)
- Multilin P30 Phasor Data Concentrator (resource)
- PMU (reference)
- Alarm description (alarm_message)
- Alarm priority (alarm_class)
- Activity that triggered creation of the alarm record (log_action)
- Activity that immediately preceded the activity that triggered creation of the alarm record (prev_state)
- Terminal state of the alarm activity (final_state)
- User as configured in relation to the EnerVista Grid Engineer who took the action that resulted in the alarm record (logged_by)

If desired, you can change whether these, as well as several additional, attributes are displayed for past alarm records. To do so, perform the following steps.

NOTE

Display settings are modified from within the Historical Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the Historical Alarm Viewer, you must do so before completing the following procedure.

1. In the Historical Alarm Viewer, click the **Fields** button.
   The Select Fields to View dialog box appears.
2. Select the check box for each data attribute that you want displayed for past alarm records, and clear the check box for each data attribute that you do not want displayed for past alarm records.

NOTE

You can also specify the left-to-right order of the corresponding columns in the Historical Alarm Viewer by way of the **Up** and **Down** buttons. The higher in the list of attributes, the farther to the left in the Historical Alarm Viewer.

3. Click **OK**.
   The Select Fields to View dialog box closes, and the Historical Alarm Viewer refreshes to reflect the selected data attributes for each alarm record.

Limit Display of Past PMU Alarm Records Based on Data Attribute Value

If desired, you can limit display of past alarms in the Historical Alarm Viewer based on values you define for one or more available data attributes as terms in an expression. To do so, perform the following steps.

NOTE

Display settings are modified from within the Historical Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the Historical Alarm Viewer, you must do so before completing the following procedure.

1. In the Historical Alarm Viewer, click the **Filters** button.
   The Edit Filters dialog box appears.
2. In the Fields pane, select the data attribute for which you want to define a value by which to limit display of alarm records.
3. Click **Modify Condition**.
   The Select Values dialog box opens.
4. Select the value or operator applicable to the filtering expression you are defining, then, if applicable in the latter case, enter the desired value in the text field.
5. Repeat steps 2 through 4, as necessary, for each additional data attribute value that you want to include as a term in the expression, then click **OK**.
   The Edit Filters dialog box closes, and the Historical Alarm Viewer refreshes to reflect filtering of alarm records based on the defined expression.

Rearrange Data Columns in Past PMU Alarm Records

Within the Historical Alarm Viewer, data attributes for past alarm records are arranged in columns. The default order from left to right is as follows:

- Time zone (timestamp_UTC)
- Multilin P30 Phasor Data Concentrator (resource)
- PMU (reference)
- Alarm description (alarm_message)
- Alarm priority (alarm_class)
- Activity that triggered creation of the alarm record (log_action)
- Activity that immediately preceded the activity that triggered creation of the alarm record (prev_state)
- Terminal state of the alarm activity (final_state)
- User as configured in relation to the EnerVista Grid Engineer who took the action that resulted in the alarm record (logged_by)

If desired, you can rearrange data columns for past alarm records. To do so, perform the following steps.

NOTE

Display settings are modified from within the Historical Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the Historical Alarm Viewer, you must do so before completing the following procedure.

1. In the Historical Alarm Viewer, click the **Fields** button.
   The Select Fields to View dialog box appears.
2. Specify the desired order of data columns by using the **Up** or **Down** button to move selected attributes within the list.

NOTE

The higher in the list of attributes, the farther to the left the corresponding data column will be in the Historical Alarm Viewer.

3. Click **OK**.
   The Select Fields to View dialog box closes, and the Historical Alarm Viewer refreshes accordingly.

Alarm Management

Alarm Management Overview

Assuming you have been authorized to view and respond to current PMU alarms, you can do any of the following:

- Acknowledge alarms
- Reset alarms
- Post comments to alarms
- View alarm comments
- Delete alarm comments.

To aid in alarm tracking and analysis, you can also export historic alarm data and print such data.

Acknowledge a Current PMU Alarm

Assuming you have been provided rights to do so, you can monitor and respond to current alarms detected in any PMU tracked by the related EnerVista Grid Engineer application. When a transition state first occurs in relation to a monitored STAT word bit for such a PMU, the EnerVista Grid Engineer publishes an alarm listing for display in the ESV Alarm Viewer, from which you can acknowledge the alarm.

NOTICE

When you acknowledge an alarm, its acknowledgment status as reflected in the ESV Alarm Viewer changes from N (to indicate lack of acknowledgment) to a Y (to indicate acknowledgment), and its listing stops blinking. These changes serve as an indication to other users who may be monitoring the alarm by way of the ESV Alarm Viewer that someone either has or is in the process of attending to the corresponding situation. If for some reason you cannot do so within the time frame required, you should not acknowledge the alarm or, if you have already done so, you should not then reset it, as the latter action will result in its removal from the list of current alarms. While you can still view removed alarms by way of the Historical Alarm Viewer, you cannot act on the alarm in that context.

To acknowledge a current alarm, take the following steps.

NOTE

Alarms are acted on from within the ESV Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the ESV Alarm Viewer, you must do so before completing the following procedure.

1. In the ESV Alarm Viewer, click the listing for the alarm that you want to acknowledge.

TIP

If necessary, you can prevent listings from scrolling in response to changing conditions, by clicking the **Static** button in the ESV Alarm Viewer. When you do so, only that information current as of the time that the viewer was either last opened or most recently manually refreshed is displayed going forward, until you either click the **Refresh** button to update the display or again enable **Dynamic** updating by way of the corresponding button.

2. Click the **Ack** button.
   The alarm's acknowledgment status changes from *N* (to indicate lack of acknowledgment) to a *Y* (to indicate acknowledgment), and its listing stops blinking.

NOTE

Optionally, you can also post a comment in relation to the alarm.

Reset a Current PMU Alarm

Assuming you have been provided rights to do so, you can monitor and respond to current alarms detected in any PMU tracked by the related EnerVista Grid Engineer application. When a transition state first occurs in relation to a monitored STAT word bit for such a PMU, the EnerVista Grid Engineer publishes an alarm listing for display in the ESV Alarm Viewer, from which you can reset the alarm.

NOTICE

You should reset an alarm only as a maintenance action when the device that caused the alarm is out of communication or synchronization with the alarm display. Under normal circumstances, alarms reset automatically. In the event that you do need to reset an alarm, you should not then acknowledge it, as the latter action will result in its removal from the list of current alarms. While you can still view removed alarms by way of the Historical Alarm Viewer, you cannot act on the alarm in that context.

To reset a current alarm, perform the following steps.

NOTE

Alarms are acted on from within the ESV Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the ESV Alarm Viewer, you must do so before completing the following procedure.

1. In the ESV Alarm Viewer, click the listing for the alarm that you want to reset.

TIP

If necessary, you can prevent listings from scrolling in response to changing conditions by clicking the **Static** button in the ESV Alarm Viewer. When you do so, only that information current as of the time that the viewer was either last opened or most recently manually refreshed is displayed going forward, until you either click the **Refresh** button to update the display or again enable **Dynamic** updating by way of the corresponding button.

2. Click the **Reset** button.
   The alarm's state designation changes from *Alarm* to *Normal*, regardless of the actual state of the related device, and the listing stops blinking and changes in appearance to gray text on black background.

NOTE

Optionally, you can also post a comment in relation to the alarm.

Comment on a Current PMU Alarm

Assuming you have been provided rights to do so, you can monitor and respond to current alarms detected in any PMU tracked by the related EnerVista Grid Engineer application. When a transition state first occurs in relation to a monitored STAT word bit for such a PMU, the EnerVista Grid Engineer publishes an alarm listing for display in the ESV Alarm Viewer, from which you can post one or more comments in relation to the alarm. Such comments can be viewed by any user with access to the alarm.

NOTE

Commenting on a current alarm does not change its state, but you can comment on an alarm after its state has been changed by way of either acknowledgment or reset. Alarms that have been commented on carry a log action designation of C in past alarm records, as displayed in the Historical Alarm Viewer.

To comment on a current PMU alarm, take the following steps.

NOTE

Alarms are acted on from within the ESV Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the ESV Alarm Viewer, you must do so before completing the following procedure.

1. In the ESV Alarm Viewer, click the listing for the alarm that you want to comment on.

TIP

If necessary, you can prevent listings from scrolling in response to changing conditions, by clicking the **Static** button in the ESV Alarm Viewer. When you do so, only that information current as of the time that the viewer was either last opened or most recently manually refreshed is displayed going forward, until you either click the **Refresh** button to update the display or again enable **Dynamic** updating by way of the corresponding button.

2. Click the **Comment** button.
   The Alarm Comments dialog box appears.

3. Click **Add Comment**.
   The Add Comment dialog box appears.
4. In the text field, enter your comment.
5. Click **OK**.
   The Alarm Comments dialog box refreshes to display the text of the comment along with the date and time of entry.

TIP To subsequently delete a comment, click the comment listing in the Alarm Comments dialog box, then click **Delete Comment**.

6. Click Done.
   The Alarm Comments dialog box closes.

View Current PMU Alarms

Change in color of a PMU Status Indicator object from green (or whichever color you have set to indicate normal state) serves as the visual indicator of one or more alarms in the corresponding PMU. In the event of such a change, you can view details on current alarms for all PMUs that the EnerVista Grid Engineer is configured to monitor. To do so, perform the following steps.

NOTE If you have not yet created a PMU Status Indicator object, you must do so before completing the following procedure.

1. Right-click within the object itself, then select **Open Alarm Viewer**.
   The ESV Alarm Viewer appears, displaying details on current alarms for all PMUs that the EnerVista Grid Engineer is configured to monitor.

TIP A number of options exist for customizing data display in the ESV Alarm Viewer. For more information, see *Alarm Display Configuration Overview*.

Delete a PMU Alarm Comment

Assuming you have been provided rights to do so, you can monitor and respond to current alarms detected in any PMU tracked by the related EnerVista Grid Engineer application. When a transition state first occurs in relation to a monitored STAT word bit for such a PMU, the EnerVista Grid Engineer publishes an alarm listing for display in the ESV Alarm Viewer, from which you can post one or more comments in relation to the alarm. If you subsequently want to delete such comments, you can do so, as well.

NOTE Deleting a PMU alarm comment does not change the alarm's state. However, alarms that have been deleted carry a log action designation of *D* in past alarm records, as displayed in the Historical Alarm Viewer.

To delete a PMU alarm comment, perform the following steps.

NOTE Alarms are acted on from within the ESV Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the ESV Alarm Viewer, you must do so before completing the following procedure.

1. In the ESV Alarm Viewer, click the listing for the alarm from which you want to delete a comment.

TIP If necessary, you can prevent listings from scrolling in response to changing conditions by clicking the **Static** button in the ESV Alarm Viewer. When you do so, only that information current as of the time that the viewer was either last opened or most recently manually refreshed is displayed going forward, until you either click the **Refresh** button to update the display or again enable **Dynamic** updating by way of the corresponding button.

2. Click the **Comment** button.
   The Alarm Comments dialog box appears.
3. Click the comment that you want to delete, then click **Delete Comment**.
   The Alarm Comments dialog box refreshes to reflect removal of the comment.
4. Click **Done**.
   The Alarm Comments dialog box closes.

Export Historic PMU Alarm Data

To aid in analysis of PMU operation, the EnerVista Synchrophasor Viewer (ESV) provides for exporting whatever historic alarm data is currently displayed in the Historical Alarm Viewer to a comma-separated value (.csv) file. To do so, take the following steps.

NOTE

Exporting of historic alarm data is initiated from within the Historical Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the Historical Alarm Viewer, you must do so before completing the following procedure.

1. Right-click within the white bar near the top of the Historical Alarm Viewer, then select **Export**.
   A standard Save As dialog box appears.
2. Navigate to the location to which you want to save the export file, specify the desired File Name, then click **Save**.

Print Historic PMU Alarm Data

To aid in analysis of PMU operation, the EnerVista Synchrophasor Viewer (ESV) provides for printing whatever historic alarm data is currently displayed in the Historical Alarm Viewer. To do so, perform the following steps.

NOTE

Printing of historic alarm data is initiated from within the Historical Alarm Viewer itself, which, in turn, is accessed from a PMU Status Indicator object. Therefore, If you have not yet created such an object then opened the Historical Alarm Viewer, you must do so before completing the following procedure.

1. Right-click within the white bar near the top of the Historical Alarm Viewer, then select **Print**.
   The Page Setup dialog box appears.
2. If required, set the printing settings, then click **OK**.

GE
Grid Solutions

Multilin P30

Chapter 14: Multilin P30 Theory of Operation

Up Sampling

The data obtained from the PMUs installed at different geographical locations, may have multiple reporting rates and different time delays over the network. However, the Multilin P30 must align and structure all these received PMU data at one user-defined output rate. One solution to address the different rates is to "Up-sample" all rates to a common rate. On a 60 Hz system, 120 frames/s is the least common multiple of all standardized reporting rates (100 frames/s for a 50 Hz system). To address the variable data-arrival latency, a user-defined wait-time is also implemented to ensure that communication channel-delayed PMU data can be included in the aggregated data frames.

The Multilin P30 uses an up-sampling algorithm for this feature, which is not applied to the data if the input and output data rates are identical. In addition, if the Multilin P30 sends any up-sampled data, it also sets STAT bit-9 for that corresponding PMU. This will be set (if standard Draft support is enabled while configuration is outputting) to indicate that inserted data has been interpolated, not actually measured.

Data Interpolation for Missing Data

When the relationship (present time – stored arrival time) is greater than, or equal to, the configured wait time - while all the PMU data for a given time stamp (slot) has not been received, and sufficient buffered data exists - missing data will be interpolated. If we consider N to be the FIR filter length used in the Multilin P30 firmware, then data for both prior (N-1)/2 and post (N-1)/2 time stamps are generally required for data interpolation. However the Multilin P30 firmware carries out the operation so long as the amount of missing data is less than, or equal to, 1+2*(120/Reporting Rate -1).

In the case where missing data is obtained from interpolation, the Multilin P30 indicates this by setting the IEEE C37.118.2 STAT bit-9 (Draft 2 of the IEEE C37.118 specification must be enabled in the EnerVista P30 Setup software) for the corresponding PMU. In this way users are informed of when data has been interpolated by the Multilin P30, and is not actually received from a PMU.

In cases where data cannot be interpolated, the Multilin P30 inserts invalid data into the configured output, and sets STAT bit 15.

Down Sampling

Filtering is an option and it is applied when it is selected by user.

NOTE

It is recommended when either the Multilin P30 output rate is less than the Multilin P30 input rate or it is not an integer factor of the Multilin P30 input rate (e.g. input 20 and output 30, for each Multilin P30 output). Filtering is not required when the output-reporting rate is equal to, or higher than, the input reporting rate. Filters are not applied to the digitals.

Even though the data is up-sampled to 120 frames/s, the up-sampled data will not be used if filtering and up-sampled data are not essentially required.

The filter is calculated using the following equation:

$$Y(n) = \sum_{i=0}^{L=1} b_i \, . \, X(n - (L-1/2) + i)$$

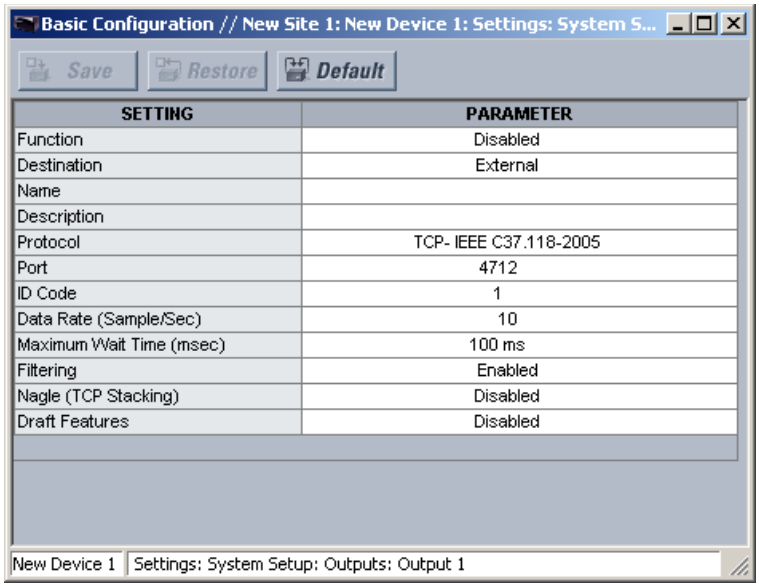
Where Y is the output of the FIR filter and X is the input phasor to the FIR filter, b=[b0, b1, b2, ... bL-1] which is the filter coefficient, L is the length of the filter (number of taps), n is the phasor index number. Note that L is purposely selected as an odd number, so that (L-1) is divisible by 2 (i.e. make the filter symmetrical so as to eliminate the phase shift of the filter).

Note that when the report rate is set to 60 frames/s, the number of taps of the FIR filter is 9, i.e. totally 9 phasors are required as the input to the filter. These 9 phasors include the present phasor X(n), 4 historical phasors: X(n-1), X(n-2), X(n-3), X(n-4) and 4 future phasors: X(n+1), X(n+2), X(n+3), X(n+4).

The output of the filter: Y(n)=b0*X(n-4) + b1*X(n-3) + b2*X(n-2) + b3*X(n-1) + b4*X(n)+ b5*X(n+1) + b6*X(n+2) + b7*X(n+3) + b8*X(n+4).

Handling of STAT Bits

The Basic Configuration screen (see the *System Setup* > *Outputs* section) contains a setting - "Draft Features" - based on the IEEE C37.118.2 Draft Version (D3.2, released in May 2011).



The STAT bit information, from the IEEE C37.118.2 Draft Version, can be enabled or disabled. If enabled, the enhanced STAT bit information proposed in this Draft Version is used. For example, Bit-9 is set if the missing data is interpreted, and Bits 6 to 8 are recognized as PMU TQ (Time Quality). Refer to IEEE C37.118.2/D3.2, May 2011 for more details.

NOTE

The Draft Version applies only to the STAT bits in the latest draft. Other functionalities proposed in this draft standard (e.g. CFG-3) are not yet supported.

1. STAT bit-15 (Data Valid) can be set to high by the Multilin P30 if the PMU connection is lost or valid data is not received. Moreover, the Multilin P30 also inserts invalid data, mag-1 and angle-360, in the data field.
2. STAT bit-14 (PMU Error) is allowed to pass through if received “high”. The ESV >> PMU status window flashes “Internal or Configuration Error” if this bit is high.
3. STAT bits-14 and 15 both are set to 1 by the Multilin P30 if the Multilin P30 has lost connection with a particular PMU. This way, the ESV knows that there is a connection loss between the PMU and the Multilin P30 ; not between the Historian and the Synchrophasor Processor.
4. STAT bit-13 (PMU Sync Error) is allowed to pass through the Multilin P30 ; the Multilin P30 does not change this bit in any case. The ESV >> PMU status window flashes the “Time Sync Error” item which is on the list.
5. STAT bit-12 (Data Sorting Type) is not used by Multilin P30. Currently the Multilin P30 simply discards the message if the time stamp received is not within the +/- 1ms tolerance required by the Multilin P30. This bit is passed through by the Multilin P30.
6. STAT bit-11 (PMU Trigger Pickup). The Multilin P30 does not use this bit; it is simply set to zero under all conditions. The ESV has the provision to display when this bit is high, but the bit is passed through by the Multilin P30.
7. STAT bit-10 (Configuration Changed) received from the PMU, is passed through the Multilin P30 . No masking/resetting is done on this bit.

8. Bit-9 (Data Modified Indicator) will be set to high by the Multilin P30 in the case where the data frame (for the corresponding time stamp of the aggregated frame) is not received from a client/ PMU, and the Multilin P30 has interpolated the data. In this case, the Draft Version setting must be enabled (otherwise it's masked). It is also set to "high" for filtered data.
9. The Multilin P30 passes through STAT bits 6 to 8, as received from the PMU (per the C37.118-2005 standard), where either the C37.118.2 Draft 3.2 version is not enabled in the Multilin P30 OR the Draft version is enabled in the Multilin P30 Client/PMU. On the other hand, if the Multilin P30 Client/PMU is not compliant with the C37.118.2 Draft 3.2, the Multilin P30 can still send Time Quality (TQ) using STAT bits 6 to 8 (if the Draft version is enabled during Output configuration), by obtaining this information from the FRACSEC TQ nibble.
10. STAT bits-4 and 5 (Unlocked Time). The Multilin P30 allows these bits to pass through. The ESV >> PMU status window shows "Unlock time" close to the display of "Time Sync Error".
11. STAT bits-0 to 3 (Trigger Reason) are not used by the Multilin P30 . The Multilin P30 simply allows these bits to pass through.
12. The Pseudo PMU also supports 8 STAT bits which represent the TQ of the Multilin P30 device, as well as STAT bit-13 (of the Pseudo PMU), representing the status of the synchronization source for the Multilin P30. The remaining STAT bits are unused for Pseudo PMUs, and are hence set to 0.

Handling of IEC61850-90-5 R-SV Data

The Multilin P30 is the first PDC in the industry to receive and send PMU data as IEC 61850-90-5 based Routable Sampled Values (R-SV). In fact the Multilin P30 is even capable of converting data between C37.118 and 61850-90-5 formats. This allows users great flexibility in routing Synchrophasor data between Layer 3 networks. The Multilin P30 has made possible the inter-utility transfer of PMU data across disparate layer 3 networks.

The Multilin P30 is able to support the receipt and transmission of Synchrophasors data objects via the IEC61850 90-5 Routable-Sampled Values (R-SV) profile, as defined in IEC 61850 90-5, and is capable of receiving R-SV data frames that do and do not have IEEE 802.1Q tags (for VLAN and priority tagging). Moreover, users of the Multilin P30 may or may not elect to use 802.1Q tag to output data, on a per-output basis, that egresses the devices.

Due to periodic nature of Synchrophasor data transmission, the Multilin P30 has been engineered to operate with UDP multicast traffic as the transport mechanism for R-SV data. Both source-specific (SSM) and any-source (ASM) variants of the IGMPv3 specification are implemented in the Multilin P30.

A Multilin P30 device may receive R-SV data with repeated multiple ASDUs (Application Specific Data Unit represents a Synchrophasor Datasets for a particular time stamp) from the server. However, the Multilin P30 supports only one ASDU per frame per time stamp on its own outputs.

NOTICE

The reception of multiple ASDUs by the Multilin P30 has system performance consequences. It is highly recommended that repeated ASDUs not be sent from PMU devices to the Multilin P30 .

As mapped to C37.118 data frame, a typical ASDU includes: STAT word, Synchrophasor data values, frequency and rate-of-change-of-frequency; analog values; digital values.

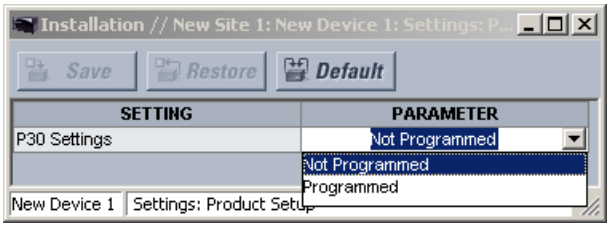
IEEE C37.118 Client/PMU Configuration Change

If the Multilin P30 receives the STAT Bit-10 high from a PMU, the Multilin P30 logs the event "Client Configuration Change," and sends a STOP data command to the particular PMU which sent the indication of a configuration change. Subsequent to the STOP command the Multilin P30 requests the PMU to send a new CFG-2 frame. Upon receipt of this frame, the Multilin P30 updates the internal buffers and sends a START command to the PMU. If a change in configuration is possible automatically, the received data frame is interpreted by the Multilin P30, otherwise user intervention is required upon recognition of the Client Configuration Change event in the system Event Recorder.

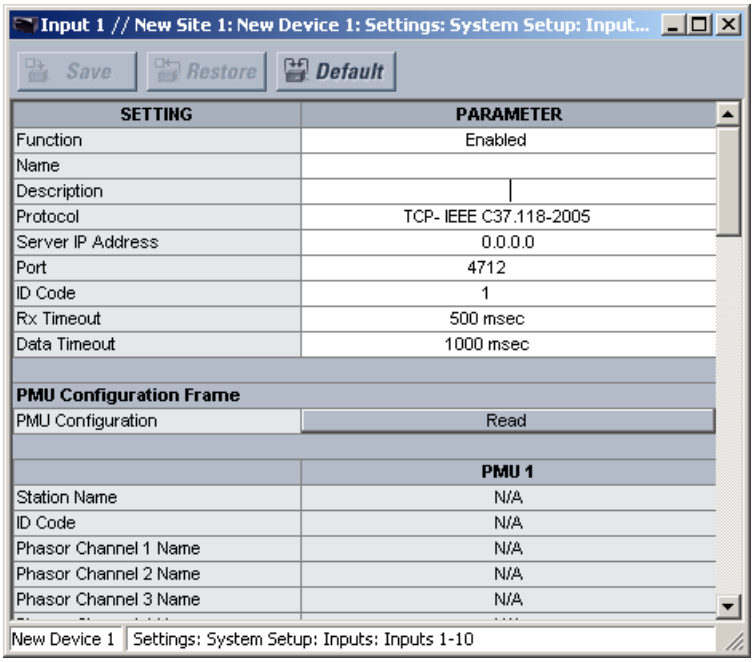
NOTE

The unit must be set to the "Programmed" mode before the configuration change is activated.

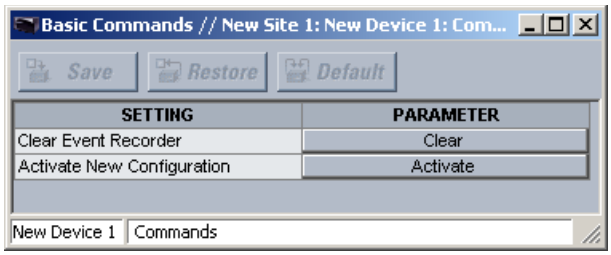
If the user sees continuous invalid data for a particular PMU at an output where it has been included, the user should go to Product Setup > Installation, and set "Unit not programmed".



Then the user should go to System Setup > Inputs and click on the **Read** button to read the new configurations and configure the outputs accordingly.



The user should then press the button in Command > Activate New Configuration.



This will reboot the Multilin P30 and establish a connection again, with a new configuration. Make sure that the unit is again set to "Programmed" in order to enable its inputs and outputs.

1. Automatic reconfiguration by the Multilin P30 : if there is change of the time base (TIME_BASE); Data rate change (DATA_RATE); Data format change (rectangular/polar OR int/float) (FORMAT). Automatic reconfiguration does not apply for IEC 61850-90-5 based input devices.
2. Other than the above, the following items require manual reconfiguration: number of PMUs included in data frame (NUM_PMU), PHNMR, ANNMR, DGNMR, CHNMR, FNOM, Data scale change (PHUNIT, ANUNIT, DIGUNIT).

NOTE

Upon receipt of a configuration change (STAT bit-10) from a client/PMU, the Multilin P30 latches an event "Client Configuration Change" in the Event Recorder for the corresponding Client/PMU. Upon this event occurring, the user should confirm if any of the output streams is affected by this Client/PMU configuration change (continuous streaming of INVALID data from the Multilin P30). If the answer is "yes," the user should reconfigure the corresponding Multilin P30 inputs and outputs.

Networking and Operation of Routable Sampled Values

To facilitate the transmission of routable sampled values, as per IEC 61850-90-5, while reducing the amount of configuration and management overhead required, the Multilin P30 system implements a hybrid approach of relying on CFG-2 frames to obtain and transmit configuration for inputs and outputs respectively and R-SV frames to send and receive sample values. This hybrid approach has the advantage of both protocols: IEEE C37.118 based configuration using CFG-2, and IEC 61850-90-5 based multicasting of synchrophasor data over R-SV. All multicast data is sent via UDP sockets, while CFG-2 data may be sent via TCP.

With this unique approach CID files need not be configured and sent to the device, or retrieved form it. Rather, a configuration frame (ie: CFG-2) is sent on the same network plane on which sample values are sent.

Specific application ports can be assigned by the commissioning engineer to send / receive CFG-2 frames, while separate ports can be provisioned to send / receive R-SV data.

For added convenience, and for extensibility across varying network architectures, the Multilin P30 can also support both the unicasting (in case network devices or firewalls do not support IGMPv3 based multicasting traffic) and multicasting, of R-SV data.

With respect to inputs, the Multilin P30 system supports one multicast group, so all input multicast RS-V data transmitted to the device must originate from PMU servers located on the same multicast group (IP and port specified by commissioning engineer).

With respect to outputs, as many multicast groups as IEC 61850-90-5 outputs may be provisioned.

Please note that multicasting of output data is recommended to:

1. Reduce overall configuration of the device
2. Extend Multilin P30 system performance.

When output data is multicasted, rather than unicasted, potentially fewer outputs need to be provisioned to communicate with the same number of clients, provided that said clients belong to the same multicast group.

Likewise when fewer outputs are provisioned on the Multilin P30 device, fewer CPU cycles are required to manage output functions, and consequently more inputs and higher reporting rates can be supported in place.

The Multilin P30 does not support unicast and multicast (ASM/SSM) input R-SV data simultaneously. All 90-5 PMU inputs to the Multilin P30 must either send unicast, or ASM / SSM data. Having said this, the Multilin P30 system does support unicasting at the input side of the device while multicasting at the output side of the device. Similarly, some outputs on the Multilin P30 may be configured to unicast data, while others are set to multicast it.

Input Operation

When configuring the input functions of the Multilin P30 device, users are presented with the opportunity of selecting what type of IEC 61850-90-5 behavior the system will operate according to, and this behavior will be applied across all inputs that are configured for IEC 61850-90-5 operation.

Input-wide behavior that can be selected includes whether to operate in:

1. Source Specific Multicast Mode (SSM)
2. Any Source Multicast Mode (ASM)
   The selection of which will depend on the deployment network configuration. If either of the above are selected, users must also supply the Multilin P30 system with the address of the multicast group and port, for which the PMU servers are configured. Alternatively, if the system designers choose not to avail of the benefits of multicast technology, the commissioning engineers can select…
3. Unicast R-SV operation
   In this case, settings for the multicast group address are not applied to inputs configured for IEC 61850-90-5 operation and the Multilin P30 does not send any IGMPv3 (ASM/SSM) requests to be added in the multicast group. Setting the application port address is still required for unicast operation.

Output Operation

The Multilin P30 system supports both unicasting and multicasting of R-SV data, on a per output basis. Unicast or multicast operation is simply based on the IP address that is provisioned as the destination address for a logical output.

In addition to specifying the destination IP address, users must also specify the IP address of the physical port from which the output traffic will egress onto the output network.

When the Multilin P30 output protocol is selected as IEC 61850-90-5, the Multilin P30 uses TCP server functionality to serve up CFG-2 frames required by a client, for 120 seconds. After 120 seconds, the TCP connection is terminated by the Multilin P30 device (this is desired to optimize the performance of the Multilin P30 as well as to support multiple TCP clients at the same output in a multicast domain).

Gateway Configuration

The Multilin P30 has been equipped with powerful layer three networking features, and may include up to four physical Ethernet interfaces.

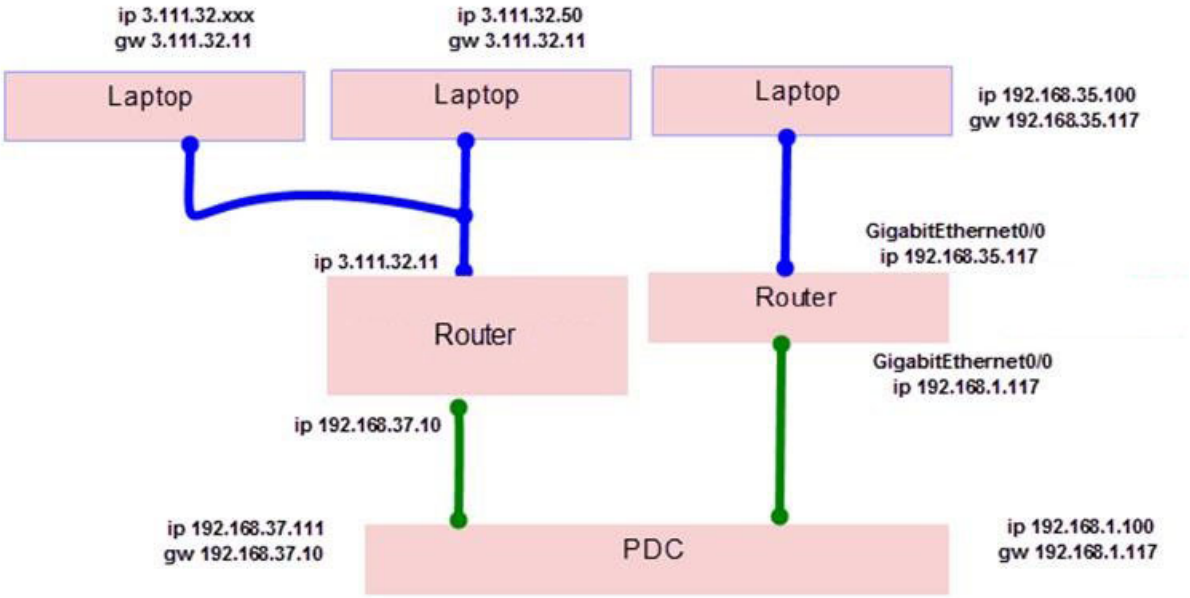
Each of the Multilin P30's Ethernet interfaces can be provisioned with separate IP addresses that belong to disparate layer three subnetworks. In addition to this, each network interface should be supplied with its own network mask and gateway IP address.

The gateway IP address associated with each Ethernet interface is used by the Multilin P30 to contact the gateway interface / router for the network that is attached to that interface.

NOTE

When using more than one Ethernet port, configure each to a different network or subnet using the IP addresses and mask. If the same network is configured on two separate Ethernet ports, the Multilin P30 may transmit frames on either of the ports. If one network must be configured on two different ports, it must use the same gateway address for that subnetwork or internal routing errors will occur.

In the event that the Multilin P30 must communicate with a layer three device that is not a member of any of the subnetworks connected to any of its Ethernet interfaces, a default gateway must be used to reach the device. To provide this functionality, a commissioning engineer must designate one of the interface gateways that has been provisioned, as the default gateway for the device. The Multilin P30 will not allow system commissioning to complete until a default gateway has been specified.



Commissioning engineers must take special care to note layer three network configurations, so that the default gateway can be provisioned appropriately.

In the networking example above, assume 24-bit network masks.

Either of 192.168.37.10 or 192.167.1.117 can be provisioned as the default gateway for the Multilin P30. There are consequences to each option, and users must be careful to note such situations. If 192.168.1.117 is provisioned as the default gateway, any device on the 192.168.35.x will be reachable by the Multilin P30.

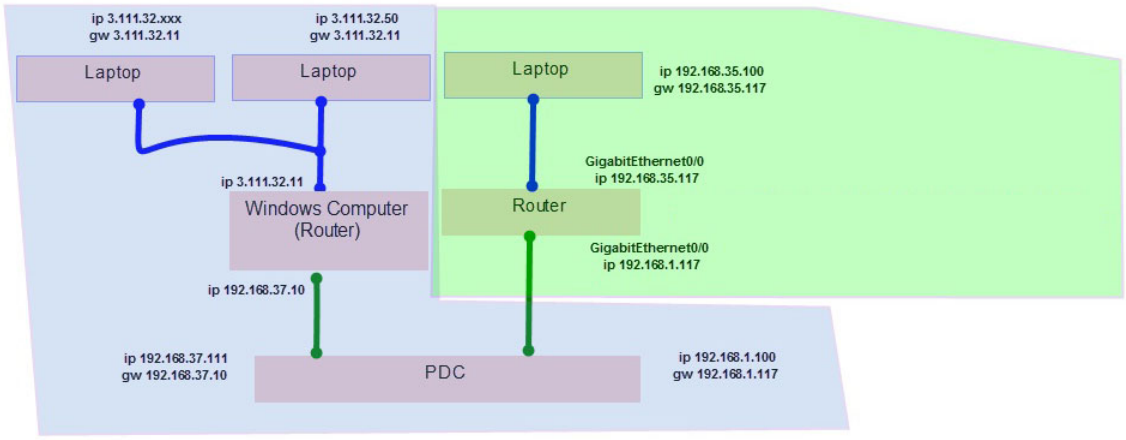
However, devices that reside outside of the networks provisioned on the Multilin P30 's Ethernet interfaces, and outside of 192.168.35.x, will not be reachable. That is simply because any device that does not reside on either the 192.168.37.10 or 192.167.1.117 will be directed to the default gateway (192.168.1.117) from where it will be routed to its ultimate destination if this is possible.

Therefore devices in the 3.11.32.x network will not be reachable when 192.168.1.117 is provisioned as the Multilin P30 default gateway. If on the other hand, 192.168.37.10 is set as the default gateway for the device, devices on the 192.168.35.x network become

unreachable. Users must resolve such an impasse by ensuring that all networks are reachable by some core router, and that the Multilin P30 's default gateway interfaces in some way or another to that core router.

In the above case, if no PMUs reside on the 192.168.35.x, and no Enervista tools (ESV, EGE) reside there either, then it is probably wiser to use 192.168.37.10 as the default gateway for the system, especially if 192.168.37.x contains PMUs and Enervista tools.

In the diagram below, devices on 192.168.35.x are not reachable when the default gateway is set to 192.168.37.10. However, by appropriately setting the Static Routing (explained in the following section), devices on 192.168.35.x can be reached successfully.

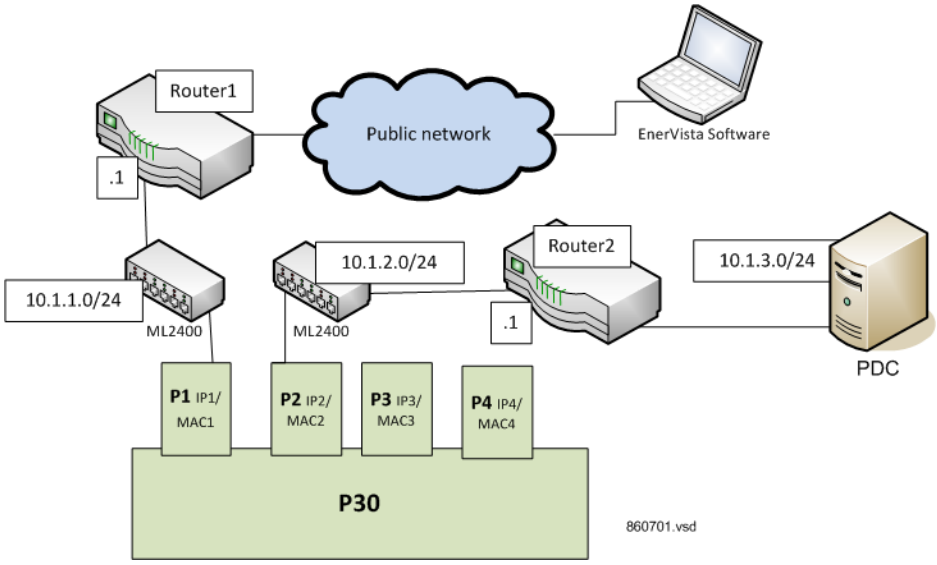


Static Routing

Prior to release 2.0x, the Multilin P30 did not have explicit configuration of network routes, with the only available route the default route configured as part of the network settings (port gateway IP address). This limited the capacity of routing to specific destinations, particularly if those destinations were reachable through a different interface than the default gateway.

Starting with release 2.0x, up to 6 static network routes may be configured in addition to a default gateway.

Figure 14-1: Example topology benefitting from a static route



In the example shown, the Multilin P30 is connected through two of its Ethernet ports:

- Port 1 (IP address 10.1.1.2) connects the Multilin P30 to LAN 10.1.1.0/24 and to the Internet through Router 1. Router 1 has an interface on 10.1.1.0/24 and the IP address of this interface is 10.1.1.1.
- Port 2 (IP address 10.1.2.2) connects the Multilin P30 to LAN 10.1.2.0/24 and to a remote Phase Data Concentrator (PDC) through Router 2. Router 2 has an interface on 10.1.2.0/24 and the IP address of this interface is 10.1.2.1.

Configuration without static routing:

Multilin P30 Network addresses:

Port 1

PRT1 IP ADDRESS = 10.1.1.2
PRT1 SUBNET IP MASK = 255.255.255.0
PRT1 GWY IP ADDRESS = 10.1.1.1
Default Gateway: Yes

Port 2

PRT2 IP ADDRESS = 10.1.2.2
PRT2 SUBNET IP MASK = 255.255.255.0
PRT2 GWY IP ADDRESS = 10.1.2.1
Default Gateway: No

When sending packets to the remote PDC, the Multilin P30 notices that the destination is not on a connected network and tries to find a route to destination. Since the default route is the only known route, this is used. Yet the remote PDC is on a private network, and is not reachable through Router 1. As a result, a destination unreachable message is received from the router.

Configuration with static routing:

Multilin P30 Network addresses:

Port 1

PRT1 IP ADDRESS = 10.1.1.2
PRT1 SUBNET IP MASK = 255.255.255.0
PRT1 GWY IP ADDRESS = 10.1.1.1
Default Gateway: Yes

Port 2

PRT2 IP ADDRESS = 10.1.2.2
PRT2 SUBNET IP MASK = 255.255.255.0
PRT2 GWY IP ADDRESS = 10.1.2.1
Default Gateway: No

Routing Settings:

STATIC NETWORK ROUTE: 1
SNR1 DESTINATION = 10.1.3.0/24
SNR1 NETMASK = 255.255.255.0
SNR1 GATEWAY = 10.1.2.1

Routing Command:

SetSNR "SR1 10.1.3.0 netmask 255.255.255.0 gateway 10.1.2.1"

One static network route to the destination 10.1.3.0/24 has been added using the SetSNR CLI command, leading to the remote PDC. This static route uses a different gateway (10.1.2.1) than the default route. This gateway is the address of Router 2, which has knowledge of 10.1.3.0 locations and is able to route packets coming from the Multilin P30 and destined for the remote PDC.

VLAN Separation for Multicast Traffic

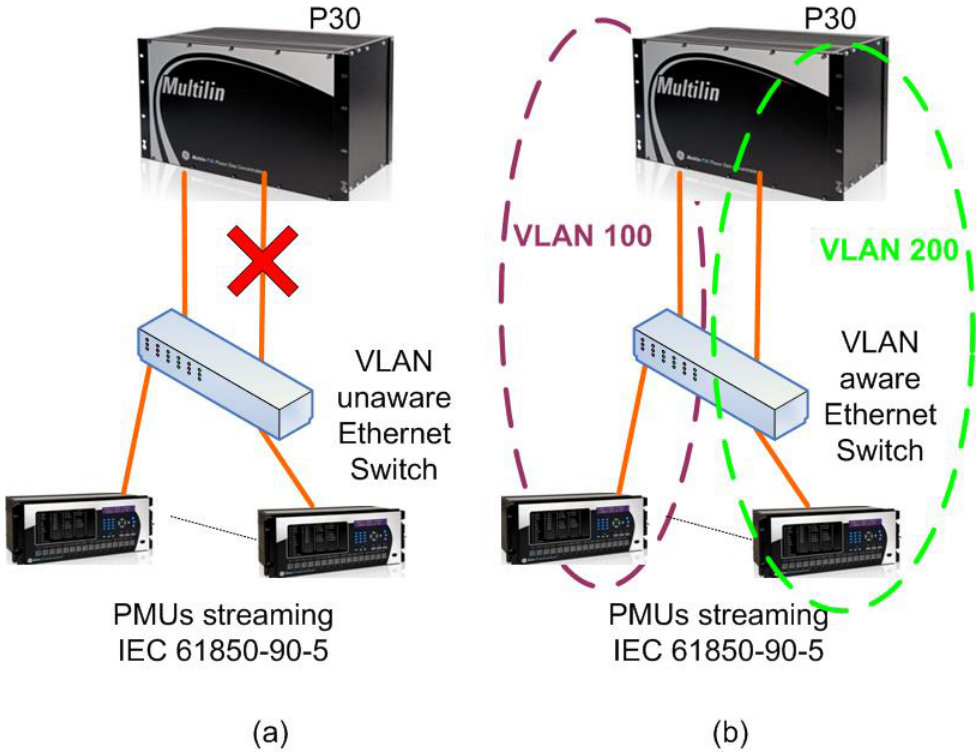
For networks that are configured to use IEC61850-90-5, multicast communication will typically be used to transmit RS-V data to and from the Multilin P30 Phasor Data Concentrator. There are important network design considerations to be made when deploying a synchrophasor network that uses multicast traffic.

In particular multicast traffic can inadvertently be repeated to multiple Multilin P30 input ports if careful layer two network separation is not implemented in the network design. This situation can overburden the Multilin P30 by wasting CPU cycles, and can lead to longer than expected latencies and even packet loss.

Consider the case where two individual PMUs are multicasting RS-V data on the same VLAN, and within that VLAN two individual switch ports are connected to two separate Multilin P30 inputs.

If the Multilin P30 is configured to process multicast traffic, each of the connected ports will receive traffic from both of the PMUs that are streaming multicast RS-V data. In other words the RS-V data from each connected PMU will be duplicated at each of the Multilin P30 inputs.

To avoid this scenario, VLANs can be used to create simple layer two separation between PMUs to prevent the duplication of multicast traffic at multiple P30 inputs. If PMUs are contained within one VLAN, and each VLAN is terminated at a single Multilin P30 input, duplication of RS-V data should not occur. Please refer to the figure below, which provides a simple example of how to separate multicast traffic using VLANs.



NOTE

Many Ethernet switches allow separation of R-SV multicast traffic from PMUs connected to a Multilin P30 (with the corresponding VLAN ID) either using VLAN by configuring "VLAN access port" or by other means. Check with the network device vendor for available techniques of multicast traffic separation for your device.

GE
Grid Solutions

Multilin P30

Chapter 15: Application Examples

Example 1: End-to-End Configuration

Configuring the P30 Device

In order to monitor Synchrophasor data using the Multilin P30 system a number of essential provisioning activities must be carried out on the Multilin P30 device. The following example is intended to illustrate the steps required to eventually monitor and visualize synchrophasor data in the GE EnerVista Synchrophasor Viewer application.

It is assumed that readers of this literature have access to a Multilin P30 device equipped with a Synchrophasor Processor and a Historian Processor, as well as the required configuration and visualization software. The EnerVista P30 Setup software and the EverVista Synchrophasor Veiwer (ESV) software must be installed in accordance with the instructions provided in Multilin P30 Reference Guide.

Enabling Communications with the EnerVista P30 Setup Software

Commissioning the Multilin P30 system requires use of the EnerVista P30 Setup software which communicates directly with the Multilin P30 Synchrophasor Processor over Ethernet. Engineers must use the serial interface of the Synchrophasor Processor to configure the console port IP address of the device so that it is on the same subnet as the PC where the Multilin P30 software is installed. Once this process is complete, Ethernet can be used for the remainder of the commissioning procedure.

A standard DB9 interface is supplied for serial connection and a null modem cable must be used to connect a PC to the Multilin P30 Phasor Data Concentrator. A terminal program like "PuTTY" should be installed on an external PC, so that it can be used to communicate with the Synchrophasor Processor board via serial communications.

The following serial port parameters must be provisioned in the terminal program for it to operate with the Multilin P30:

- 19200bps
- 8 data bits
- 1 stop bit

- No parity bit

To set the console IP address users will have to Login to the Command Line Interface and use the SetIP command:

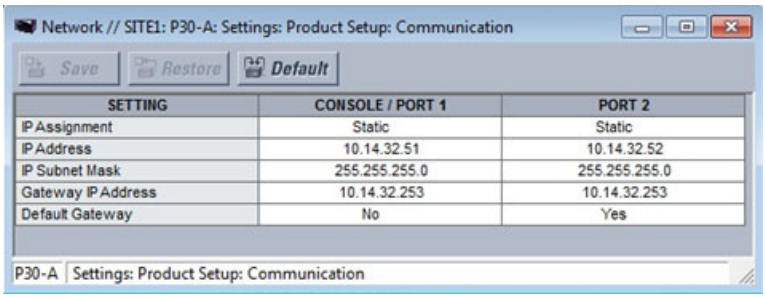
```
GECLI #> SetIP "3.94.248.138 netmask 255.255.255.0 gateway
3.94.248.1
```

The following output will be displayed on the serial console after this command is executed:

```
GECLI #> Console port network parameters were changed
successfully
```

Once the appropriate network settings have been made via the Command Line Interface, the EnerVista P30 Setup software can be used to connect to the Multilin P30 device.

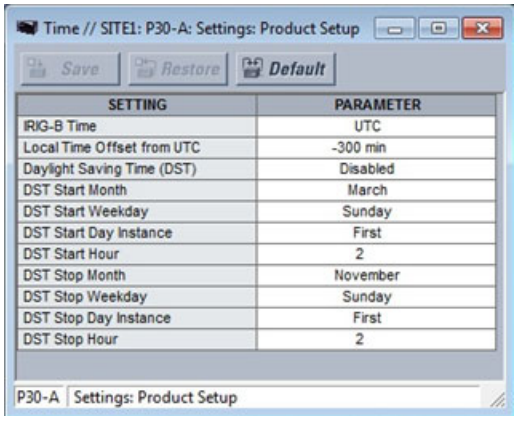
Setting Up Network Settings

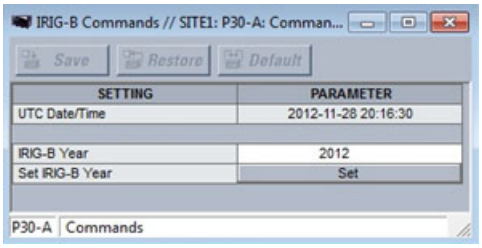


Users must configure the network settings of the other Ethernet ports installed on the P30 device – the default hardware configuration has two Ethernet ports. Typically, it is preferable to separate management and data traffic in a synchrophasor communication network. Thus the other port(s) on the P30 device can be set to operate on different subnets than the console port, as in the example above.

Though each port settings group allows users to specify a gateway IP address, only one of them must be designated to serve as the default gateway for the device. All traffic with destination addresses that do not match any of the subnetworks (including static routes) assigned to the device will be transmitted out of the interface whose gateway IP address is set as the default gateway.

Setting Up Time Input





The Multilin P30 can maintain a large internal buffer of frames, and accurate transmission of those frames, through the use of an external IRIG-B timing reference.

Users are required to specify whether the external reference is set to local or UTC time, and are also required to specify the year, as not all IRIG-B signals provide this information. When using local time as opposed to UTC time, users must also select whether or not to use DST.

For the sake of simplicity, the use of UTC is recommended as depicted above.

Configuring the Power System

In order to organize its internal buffers, the Multilin P30 must be set to operate on either a 50 Hz or 60 Hz power system frequency. The selection of power system frequency will affect which reporting rates users are able to select for both data transmission and data collection. Generally speaking, the 60 Hz reporting rate will be used in North America, whereas 50 Hz is more common in Europe and Asia.

Configuring Inputs

Before advancing to configuring the Multilin P30 outputs, users must indicate the inputs that will stream synchrophasor data to the device. The Multilin P30 can be configured to operate with both IEEE C37.118 and IEC 61850-90-5 type PMU devices. In either case, users must provide the IP address and port information for the PMUs with which they intend to operate the Multilin P30 device.

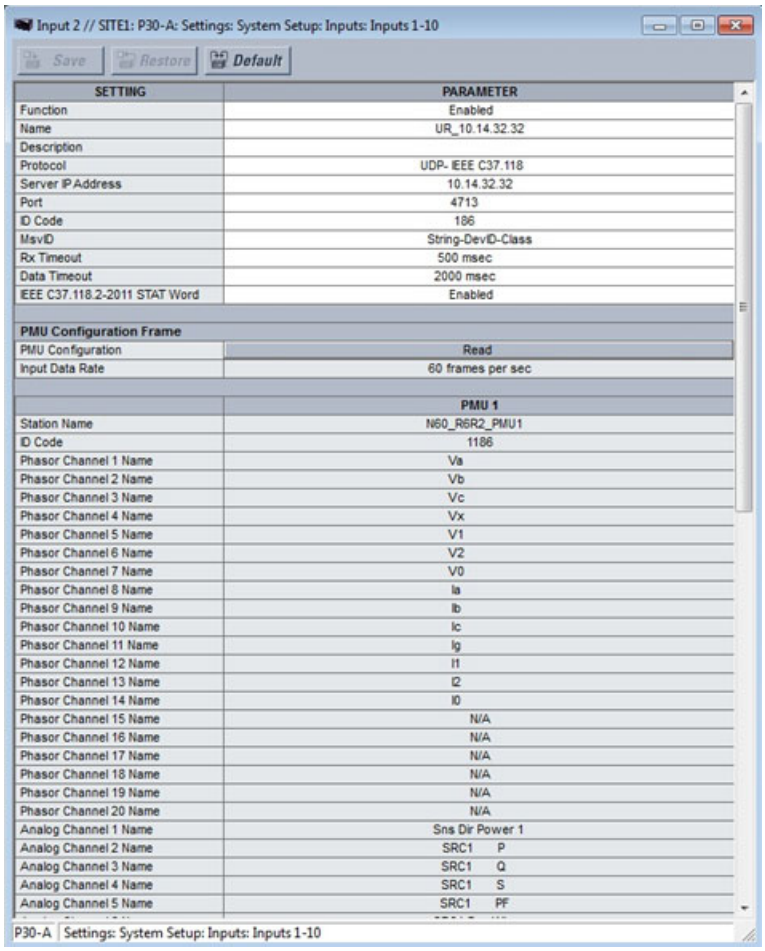
Timeout settings must be engineered to suit the network in which the device is deployed. Input response can be fine-tuned for both the arrival of CFG-2 frame requests and the expected time between the arrival of data frames.

The EnerVista P30 Setup software must be used to obtain the PMU configuration from the PMU server that resides at the indicated IP address and port. Ultimately settings for the Multilin P30 device itself are derived from this information.

IEEE C37.118-based Input Devices

For IEEE C37.118 type PMUs, users may elect to operate in either TCP or UDP mode depending on the capabilities of the PMU. In the example below, the user has configured the system to operate with a PMU server located at IP address, 10.14.32.32 and UDP port 4713. The IDCODE is also required to identify the configured PMU.

If the device is a PMU aggregator like the Multilin N60, users must provide the ID code of the aggregator; this will be distinct from the IDCODES of the individual PMUs within the aggregator. If the device is not an aggregator, users must still provide this IDCODE, but it will match the IDCODE returned by the device when users read its configuration.

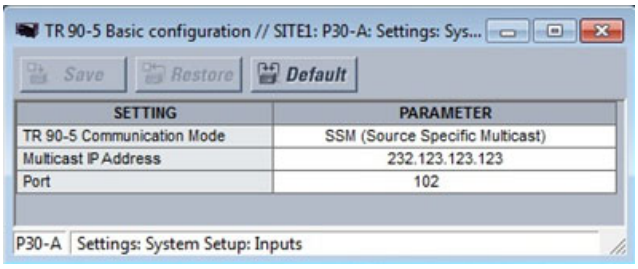


IEC 61850-90-5-based Input Devices

For PMUs that are set to operate in IEC61850-90-5 mode, the basic 90-5 operating parameters should be set before any 90-5 clients are configured. The Multilin P30 is capable of receiving data from one multicast group and can support either ASM or SSM multicast mode. Multicast traffic can be received at every port of the device, including the console port when multicast operation is configured.

NOTE

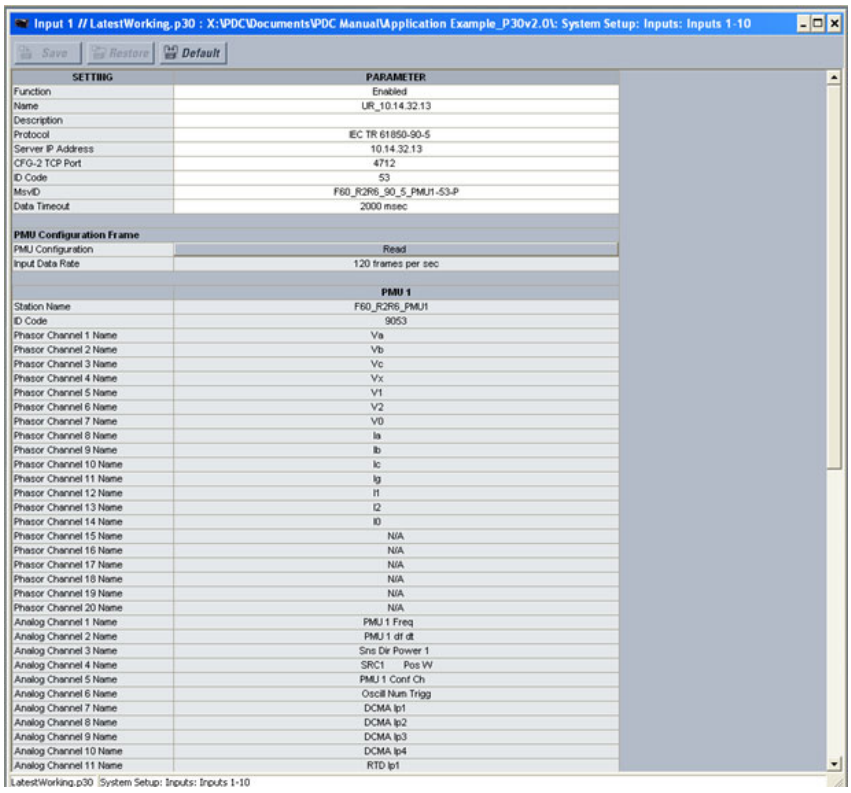
To reduce the probability of unintended multicast traffic adversely affecting the performance of the device, multicast reception will not occur unless at least one 90-5 client is configured to receive multicast data.



Even when set to operate in 90-5 mode, the Multilin P30 system depends on CFG-2 frames to obtain PMU configuration data. Within the Multilin P30 system, it is the EnerVista P30 Setup software that obtains the PMU configuration from the PMU server that resides at the

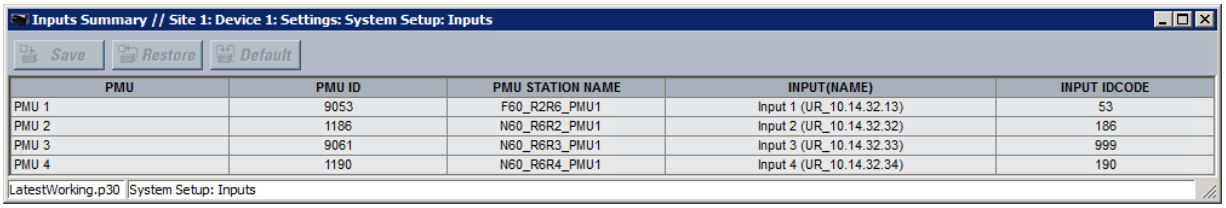
indicated IP address and port. As such, users must provide the TCP port address at which CFG-2 frames are served up on the PMU being configured for a 90-5 type input. This method has been implemented in GE PMUs like the N60 to reduce the complexity typically associated with IEC61860 SCL configuration files.

Also, as in the case of C37.118 operation, users must provide the IP address and IDCODE of the configured PMU. If the device is a PMU aggregator like the Multilin N60, users must provide the ID code of the aggregator; this will be distinct from the IDCODES of the individual PMUs within the aggregator. If the device is not an aggregator, users must still provide this IDCODE, but it will match the IDCODE returned by the device when users read its configuration. The multicast Sampled Value ID (MSVID) is automatically detected for IEC 61850-90-5 inputs when the read configuration operation is performed.



Input Summary

Users may elect to use the Input Summary screen to verify that they have correctly mapped PMUs to the Multilin P30's inputs. The summary screen reflects both the input device IDCODE as well as individual PMU IDCODES.



PMU	PMU ID	PMU STATION NAME	INPUT(NAME)	INPUT IDCODE
PMU 1	9053	F60_R2R6_PMU1	Input 1 (UR_10.14.32.13)	53
PMU 2	1186	N60_R6R2_PMU1	Input 2 (UR_10.14.32.32)	186
PMU 3	9061	N60_R6R3_PMU1	Input 3 (UR_10.14.32.33)	999
PMU 4	1190	N60_R6R4_PMU1	Input 4 (UR_10.14.32.34)	190

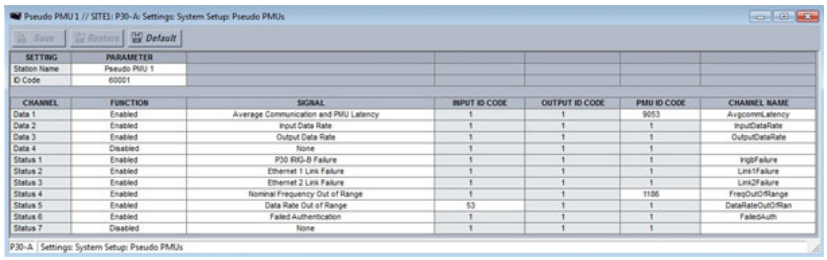
Configuring Pseudo PMUs

Selecting Data and Status

The Multilin P30 incorporates a powerful feature to enable the transport of system telemetry within an ordinary output data stream. The GE pseudo PMU within the Multilin P30 device can be used to measure and transport Multilin P30 diagnostic data in an IEC61850-90-5 or IEEE C37.118 packetized format that may be mapped to any Multilin P30 output.

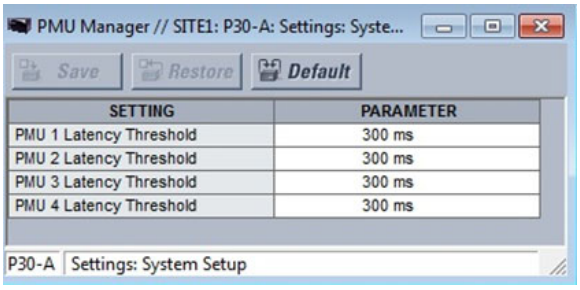
Both analog and digital points within the device can be measured. The Multilin P30 supports four Pseudo PMUs, each Pseudo PMU containing up to 0 phasors, 16 analogs, and 32 digitals. These values are time-stamped by the Multilin P30 which processes this information as it processes information coming from any other PMU. Data points that pertain to specific PMU clients must be identified via their unique ID codes.

When diagnosing wait time issues for example, it can be very useful to collect, archive and eventually plot the average communication and PMU latency on a per PMU basis. Data from pseudo PMUs can be plotted in both the EnerVista P30 Setup Software Trending windows, as well as in the EnerVista Synchrophasor Viewer software (discussed later).



PMU Manager

After configuring pseudo PMUs, it's advisable to set the average latency threshold for each PMU that is configured to operate with a Multilin P30 input. The average latency value can be set to anywhere between 0 and 1 second, in increments of 1ms. The Multilin P30 waits for the data message from the input device until this setting value is reached. Upon elapse of this time, the latency threshold is reached for a particular input device, and the status of a Pseudo PMU "Average Communication & PMU Latency Exceeded".



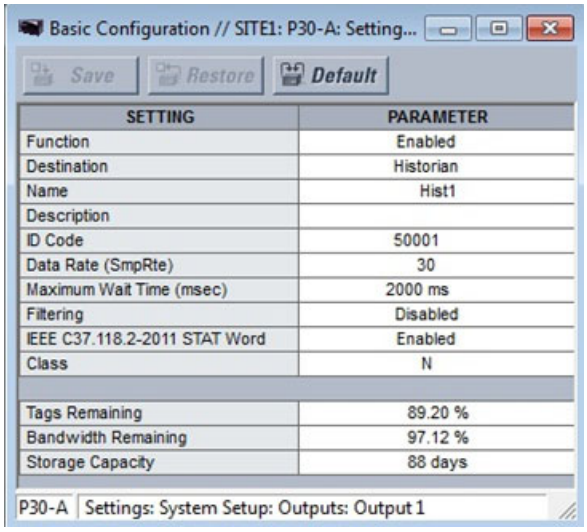
Once the input side of the Multilin P30 device has been configured, both inputs and pseudo PMUs should be mapped to at least one of the device's 8 possible outputs.

Configuring Outputs (including Historian)

For devices that are equipped with a Historian archiver, up to two outputs may be configured as Historian-type outputs. The intent of providing two Historian outputs is to provide commissioning engineers the ability to archive both P class and M class data. The Multilin P30 system will not allow separate instances of the same data points to be

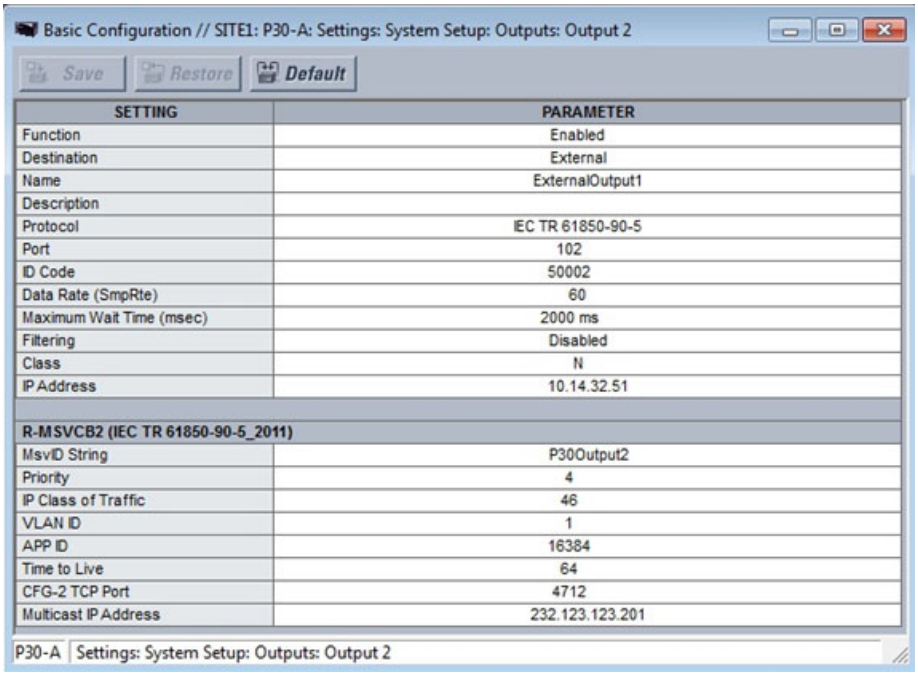
mapped concurrently to both of the two possible Historian outputs. This situation, which would result in a data collision in the archive, is blocked by the EnerVista P30 Setup software.

Historian outputs are automatically configured to operate in IEEE C37.118 UDP mode, so users need not specify the standard and protocol to use for data storage. Users must however provide an ID code, and the other information necessary to uniquely identify the outputs.



SETTING	PARAMETER
Function	Enabled
Destination	Historian
Name	Hist1
Description	
ID Code	50001
Data Rate (SmpRte)	30
Maximum Wait Time (msec)	2000 ms
Filtering	Disabled
IEEE C37.118.2-2011 STAT Word	Enabled
Class	N
Tags Remaining	89.20 %
Bandwidth Remaining	97.12 %
Storage Capacity	88 days

When configuring Historian type outputs, the EnerVista P30 Setup software also displays critical Historian statistics to help commissioning engineers determine if they are potentially over-using the Historian with their intended configuration. These statistics are calculated over all the Historian outputs that are configured on the Multilin P30 device.

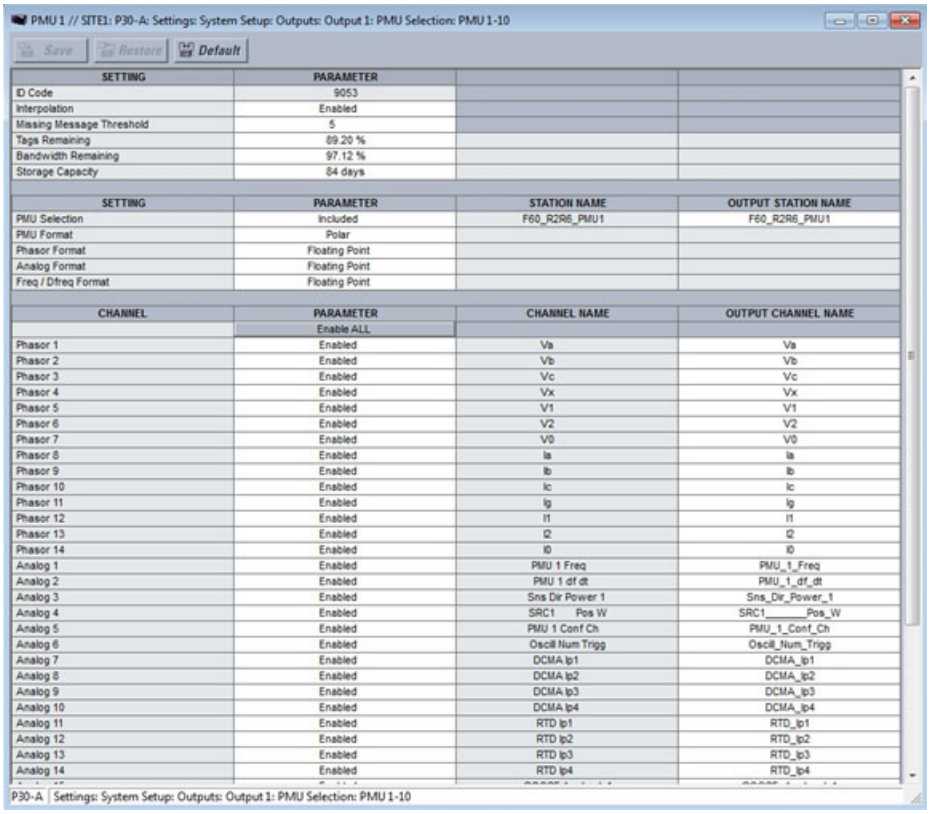


SETTING	PARAMETER
Function	Enabled
Destination	External
Name	ExternalOutput1
Description	
Protocol	IEC TR 61850-90-5
Port	102
ID Code	50002
Data Rate (SmpRte)	60
Maximum Wait Time (msec)	2000 ms
Filtering	Disabled
Class	N
IP Address	10.14.32.51
R-MSVCB2 (IEC TR 61850-90-5_2011)	
MsvID String	P30Output2
Priority	4
IP Class of Traffic	46
VLAN ID	1
APP ID	16384
Time to Live	64
CFG-2 TCP Port	4712
Multicast IP Address	232.123.123.201

The maximum wait time should also be configured for all types of outputs. The wait time setting is important because it directly influences the burstiness of the output traffic. If all the PMU data for a given timeslot on a given output has not arrived, the data for that

timeslot and any subsequent timeslots will not be sent until either the missing data arrives or the wait time elapses. Consequently a large wait time setting may result in large traffic bursts originating from theMultilin P30's outputs.

Any PMU data that arrives after the wait time elapses will be discarded. With respect to IEC61850-90-5 traffic, the Multilin P30 may receive multiple ASDUs in a single RS-V frame, which can potentially be used to reduce the effect of long wait times. However, the method of leveraging multiple ASDUs per RS-V frame comes with its own side-effect of dramatically increasing the burden on the Multilin P30's available CPU cycles.



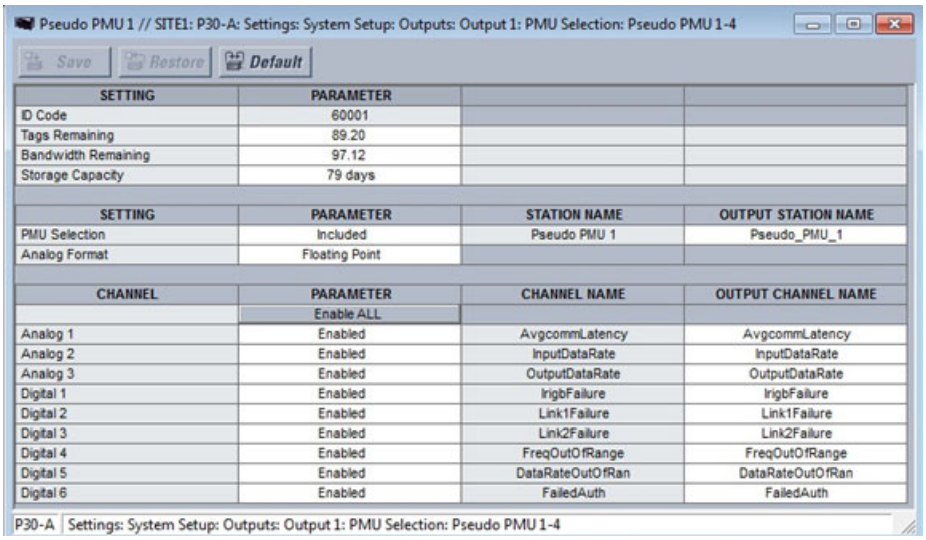
SETTING	PARAMETER		
ID Code	9053		
Interpolation	Enabled		
Missing Message Threshold	5		
Tags Remaining	89.20 %		
Bandwidth Remaining	97.12 %		
Storage Capacity	84 days		

SETTING	PARAMETER	STATION NAME	OUTPUT STATION NAME
PMU Selection	Included	F60_R2R6_PMU1	F60_R2R6_PMU1
PMU Format	Polar		
Phasor Format	Floating Point		
Analog Format	Floating Point		
Freq / Dfreq Format	Floating Point		

CHANNEL	PARAMETER	CHANNEL NAME	OUTPUT CHANNEL NAME
	Enable ALL		
Phasor 1	Enabled	Va	Va
Phasor 2	Enabled	Vb	Vb
Phasor 3	Enabled	Vc	Vc
Phasor 4	Enabled	Vx	Vx
Phasor 5	Enabled	V1	V1
Phasor 6	Enabled	V2	V2
Phasor 7	Enabled	V0	V0
Phasor 8	Enabled	Ia	Ia
Phasor 9	Enabled	Ib	Ib
Phasor 10	Enabled	Ic	Ic
Phasor 11	Enabled	Ig	Ig
Phasor 12	Enabled	I1	I1
Phasor 13	Enabled	I2	I2
Phasor 14	Enabled	I0	I0
Analog 1	Enabled	PMU 1 Freq	PMU_1_Freq
Analog 2	Enabled	PMU 1 df dt	PMU_1_df_dt
Analog 3	Enabled	Sns Dir Power 1	Sns_Dir_Power_1
Analog 4	Enabled	SRC1 Pos W	SRC1_____Pos_W
Analog 5	Enabled	PMU 1 Conf Ch	PMU_1_Conf_Ch
Analog 6	Enabled	Oscill Num Trigg	Oscill_Num_Trigg
Analog 7	Enabled	DCMA Ip1	DCMA_Ip1
Analog 8	Enabled	DCMA Ip2	DCMA_Ip2
Analog 9	Enabled	DCMA Ip3	DCMA_Ip3
Analog 10	Enabled	DCMA Ip4	DCMA_Ip4
Analog 11	Enabled	RTD Ip1	RTD_Ip1
Analog 12	Enabled	RTD Ip2	RTD_Ip2
Analog 13	Enabled	RTD Ip3	RTD_Ip3
Analog 14	Enabled	RTD Ip4	RTD_Ip4

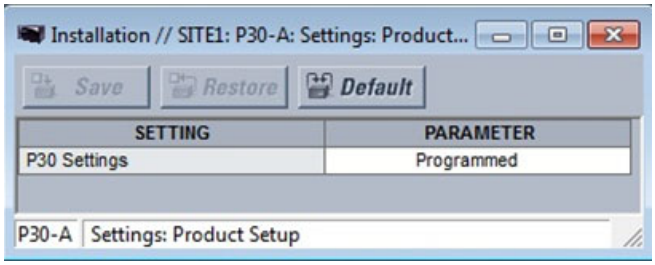
In the case of both IEEE C37.118 and IEC61850-90-5 type outputs, when selecting individual PMUs to be assigned to an output, the EnerVista P30 Setup software can be used to select which values from a given PMU will be mapped to that output. Each value can be individually enabled or disabled.

Pseudo PMUs may be assigned to outputs just like ordinary PMUs. Moreover, if a user elects to map pseudo PMUs to a Historian type output, the ESV visualization software can be used to visualize the pseudo PMU values.



Loading and Activating Configuration Data

Once all input selection and output mappings have been identified, the Multilin P30 must be set to 'programmed' mode before any newly implemented settings are activated. The Activate New Configuration should be issued to activate all settings once the device is set to 'programmed' mode.



Commissioning/First Time Startup

Checking CPU Usage

Certain Multilin P30 configurations are more resource-intensive than others. Higher frame rates and enabled outputs are key contributors to Multilin P30 CPU cycle consumption. For this reason it is highly recommended that all unused outputs be disabled.

Configurations that result in high CPU usage are not recommended as they are prone to higher than expected latency or in some cases data loss.

After activating any configuration, the Multilin P30's 'CPU Load' feature should be used to measure the CPU usage that results from that configuration. Configurations that exhibit low to medium CPU usage are recommended. Configurations that result in high CPU usage are deployed at the user's own risk.

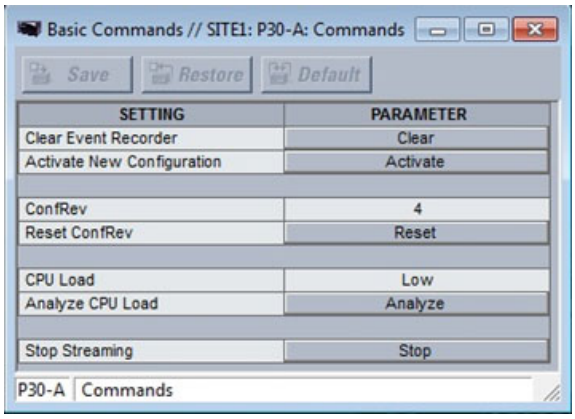
NOTE

GE recommends that the configuration be re-activated after the CPU usage is measured.

The final stages of commissioning the Multilin P30 device should:

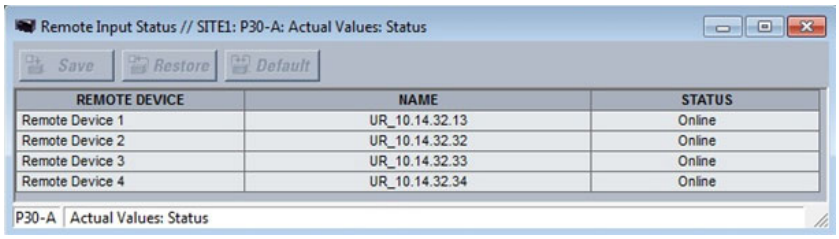
- Set the device to the programmed state
- Activate the new configuration
- Analyze the CPU load

- Activate the new configuration.

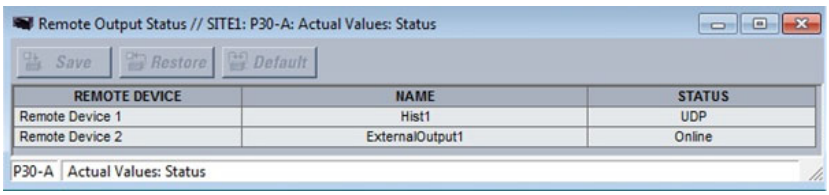


Actual Values

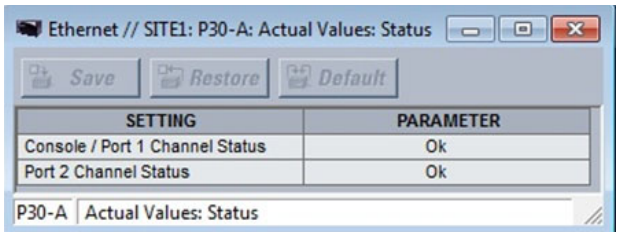
After streaming has initiated, the EnerVista P30 Setup software should be used to verify that all remote devices are online as expected. Below, all remote devices connected to the Multilin P30 are reported as being online.



It is important to note that operational status is available only for devices configured to operate in TCP mode. Servers that are set to operate in UDP mode on the other hand, will only be shown as having a status of 'UDP'. UDP is a connection-less protocol and as such the Multilin P30 device does not receive indication of availability from devices configured for UDP.



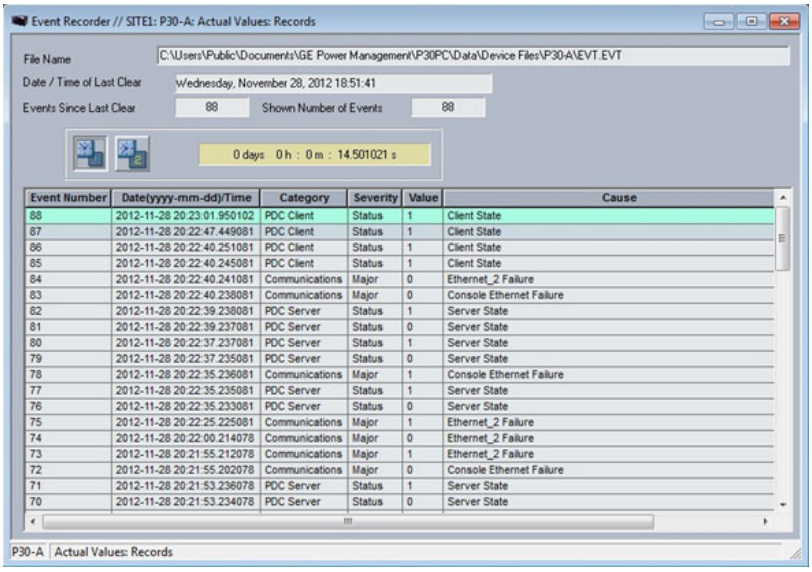
If the EnerVista P30 Setup software's remote device statuses indicate that any connected equipment is offline, troubleshooting activities should incorporate checking the Multilin P30's Ethernet ports' link status as a first step. Ethernet connection issues will ultimately result in remote devices being displayed as 'offline'. Ethernet ports will be shown as 'Ok' only when physical connectivity is established.



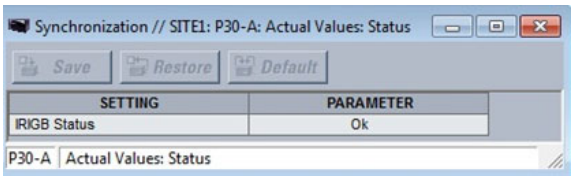
Furthermore if the IRIG-B year has not been established in the device, the Multilin P30 cannot be set to 'programmed' mode.

If the year was correctly set, but a valid IRIG-B signal is not received at the Multilin P30, the device can operate. However, when a valid IRIG-B signal is not detected, the Event Recorder will indicate that a valid signal has not been received.

In the figure below, it is clear that the Multilin P30 in use has detected a valid IRIG-B signal since there is no indication of IRIG-B failure in the Event Recorder.

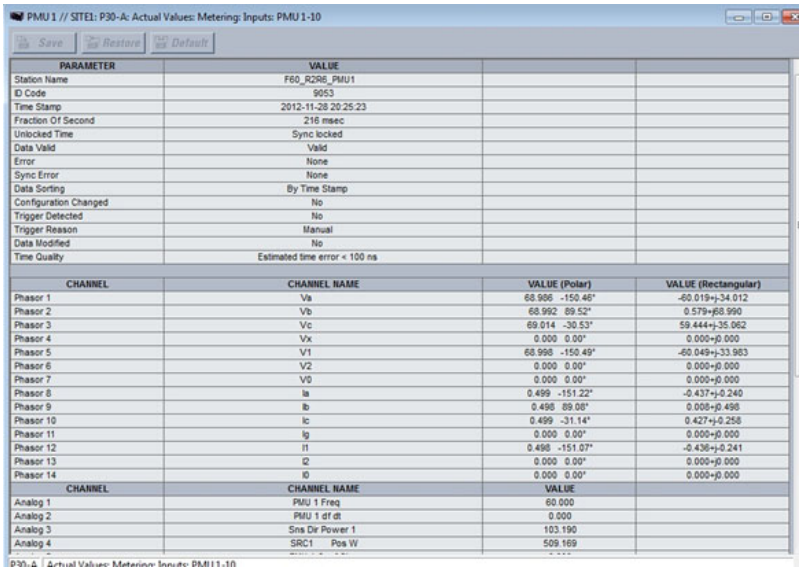


When a valid IRIG-B signal is eventually detected, and the Multilin P30 discerns a material difference between its internal free running clock, and the newly received external signal, the internal buffer will be flushed and concentration will restart from the time the valid signal was detected.



The EnerVista P30 Setup software has been designed with a Metering feature, the intent of which is to act as a commissioning tool, especially in the case where the external visualization tool (ESV) cannot be loaded, or the Historian option has not been purchased.

The EnerVista P30 Setup tool allows metering of Inputs from PMUs, Pseudo PMUs, and Outputs. Additionally, the EnerVista P30 Setup program ensures that all data shown on the screen originate with the same time stamp to make the troubleshooting process easier.



PMU 1 // SITE1: P30-A: Actual Values: Metering: Inputs: PMU 1-10

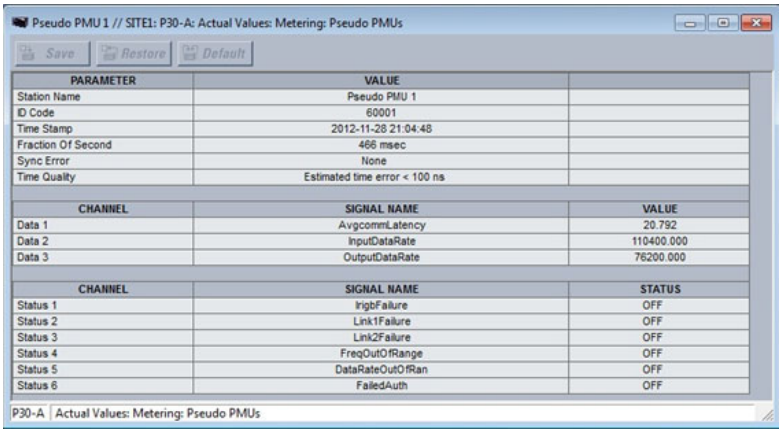
Save | Restore | Default

PARAMETER	VALUE		
Station Name	F60_R2R6_PMU1		
ID Code	9053		
Time Stamp	2012-11-28 20:25:23		
Fraction Of Second	216 msec		
Unlocked Time	Sync locked		
Data Valid	Valid		
Error	None		
Sync Error	None		
Data Sorting	By Time Stamp		
Configuration Changed	No		
Trigger Detected	No		
Trigger Reason	Manual		
Data Modified	No		
Time Quality	Estimated time error < 100 ns		
CHANNEL	CHANNEL NAME	VALUE (Polar)	VALUE (Rectangular)
Phasor 1	Va	68.906 -150.46°	-60.019+j-34.012
Phasor 2	Vb	68.992 89.52°	0.579+j68.990
Phasor 3	Vc	69.014 -30.53°	59.444+j-35.062
Phasor 4	Vx	0.000 0.00°	0.000+j0.000
Phasor 5	V1	68.998 -150.49°	-60.049+j-33.983
Phasor 6	V2	0.000 0.00°	0.000+j0.000
Phasor 7	V0	0.000 0.00°	0.000+j0.000
Phasor 8	Ia	0.499 -151.22°	-0.437+j-0.240
Phasor 9	Ib	0.498 89.08°	0.008+j0.498
Phasor 10	Ic	0.499 -31.14°	0.427+j-0.258
Phasor 11	Ig	0.000 0.00°	0.000+j0.000
Phasor 12	I1	0.498 -151.07°	-0.436+j-0.241
Phasor 13	I2	0.000 0.00°	0.000+j0.000
Phasor 14	I0	0.000 0.00°	0.000+j0.000
CHANNEL	CHANNEL NAME	VALUE	
Analog 1	PMU 1 Freq	60.000	
Analog 2	PMU 1 df dt	0.000	
Analog 3	Sns Dir Power 1	103.190	
Analog 4	SRC1 Pos W	509.169	

P30-A | Actual Values: Metering: Inputs: PMU 1-10

When debugging a system that has recently been commissioned, it is advisable to ensure that the input data matches the expected output from the connected PMU servers. Once all inputs have been verified, the next logical step in the debugging sequence is to ensure that input data has been mapped to output data as intended. In general a commissioning engineer should ensure that the values sent to the Multilin P30's inputs closely match those being mapped to its outputs by the installed configuration.

If for some reason this is not the case, a pseudo PMU can be used for further debugging in order to measure the latency of a given PMU data stream, or to monitor the states of Ethernet ports for example.

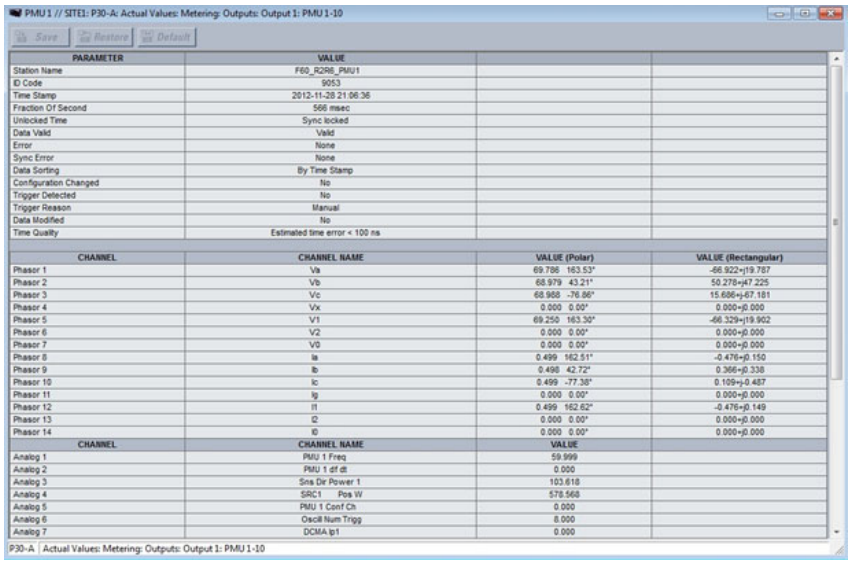


Pseudo PMU 1 // SITE1: P30-A: Actual Values: Metering: Pseudo PMUs

Save | Restore | Default

PARAMETER	VALUE	
Station Name	Pseudo PMU 1	
ID Code	60001	
Time Stamp	2012-11-28 21:04:48	
Fraction Of Second	466 msec	
Sync Error	None	
Time Quality	Estimated time error < 100 ns	
CHANNEL	SIGNAL NAME	VALUE
Data 1	AvgcommLatency	20.792
Data 2	InputDataRate	110400.000
Data 3	OutputDataRate	76200.000
CHANNEL	SIGNAL NAME	STATUS
Status 1	IrigbFailure	OFF
Status 2	Link1Failure	OFF
Status 3	Link2Failure	OFF
Status 4	FreqOutOfRange	OFF
Status 5	DataRateOutOfRan	OFF
Status 6	FailedAuth	OFF

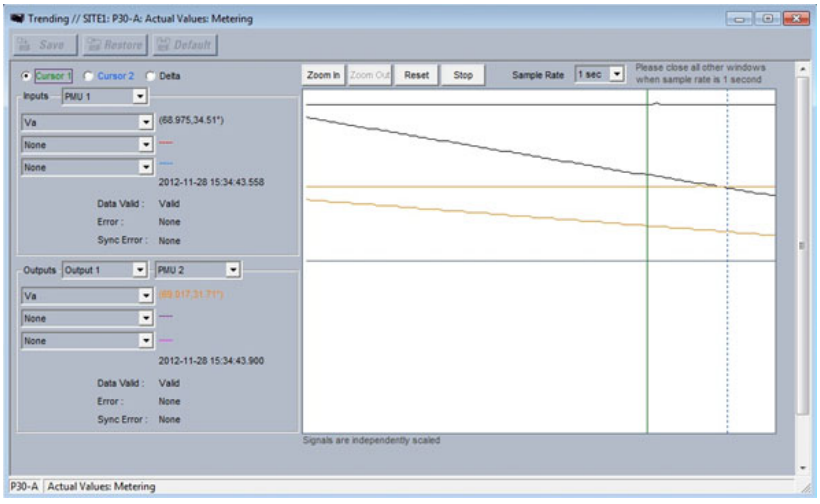
P30-A | Actual Values: Metering: Pseudo PMUs



The Trending window is another system commissioning tool, provided with the EnerVista P30 Setup software, that allows phasors, analogs, and digitals, including STAT word bits 15 (Data Valid), 14 (PMU Error), and 13 (PMU Sync), to be plotted over time. A single input PMU and a single output PMU can be monitored at the same time. For each, up to three channels can be displayed.

Commissioning engineers may consider the Trending window as a more convenient commissioning tool than the input and output Metering windows because of the aforementioned characteristics, as it eliminates the need to flip between input and output Metering windows to compare values.

Also, users who do not have access to a Historian and the EnerVista Synhcrophasor Viewer package can use the Trending feature to achieve a similar visualization effect. More often than not, this will be the primary visualization tool available to commissioning engineers who do not have a licensed copy of EnerVista Synhcrophasor Viewer, and to those engineers who are working with Multilin P30 systems that have not been purchased with the Historian option.



EnerVista Synchrophasor Viewer

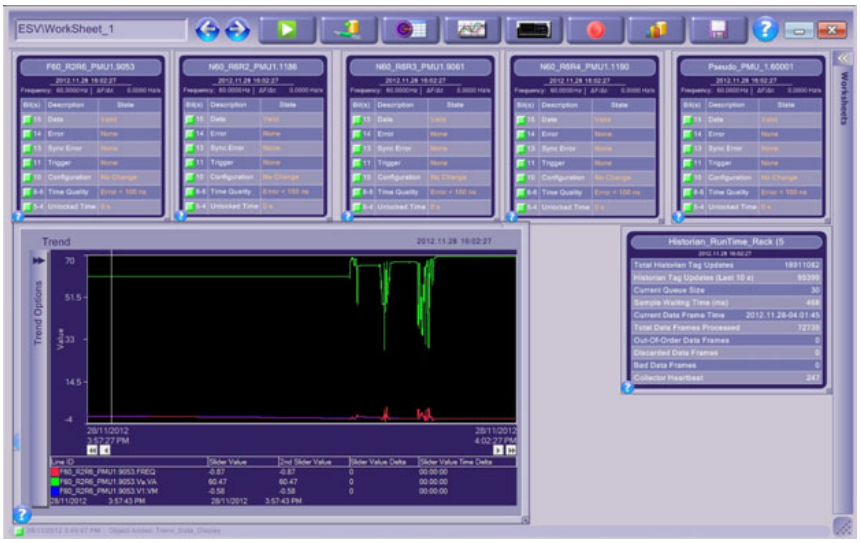
For systems equipped with the optional Historian hardware, the worksheet-based EnerVista Synchrophasor Viewer software can be used to visualize all data that is sent to the Historian output. The software can also be used to play back archived data to perform pre- and post-fault analysis.

The ESV application facilitates visualization of data by means of the following user-configurable graphic objects:

- **Phasor Display**: A combination of the following:
  - A polar plot containing up to 16 rotating hands, each of which indicates a given synchrophasor's magnitude along with either its absolute angle or its angle relative to that of another displayed synchrophasor
  - A table listing the angle and magnitude values of each displayed synchrophasor, along with the moving average of each displayed synchrophasor's angle.
- **Trend Chart**: A line graph displaying time-synchronized phasor, digital, and/or analog measurements over a configurable time span.

Additional graphic objects allow you to visualize PMU status as well as Phasor Data Concentrator (PDC) Historian operational statistics.

The ESV Historical Playback feature will synchronize all created objects and worksheets, whether currently displayed or not, to show data starting from a user-specified time in the past through any time up to and including live time.



Regardless of the worksheet object being created, the basic process to do so is the same, namely, generate the object itself then choose the data to be visualized in the object.

Commissioning engineers are advised to use the PMU Status object to display state information contained in the STAT word. The IEEE C37.118 Standard mandates that each Phasor Measurement Unit (PMU) data block include a STAT word containing complete status information for that data block. The EnerVista Synchrophasor Viewer (ESV) PMU Status object uses this STAT word to indicate the status of the PMU, with the bits that compose the STAT word denoting the state of discrete PMU attributes.

The ESV application monitors these attributes and determines whether any have undergone a transition in state. Such transitions result in alarms, which can also be visualized by way of the PMU Status Indicator object. Similar to the LED light on the faceplate of an actual PMU, the PMU Status Indicator object allows you to quickly determine whether a given PMU is experiencing an alarm state, as reflected by a change in color.

Example 2: Building a Historian Expression in ESV Showing the Angular Difference Between Two Synchrophasors

Expressions can be used to perform a variety of calculations on the data for one or more Historian tags in order to visualize the results in a Trend Chart line. The tables below show the operators used to build such expressions.

The section below: *Building an Historian Expression Showing the Angular Difference Between Two Synchrophasors*, is an example that illustrates how to build an Historian expression for determining the phase angle difference between two voltage synchrophasors, which facilitates visualizing interconnection-wide views of grid stress. This is a common application of synchrophasor data.

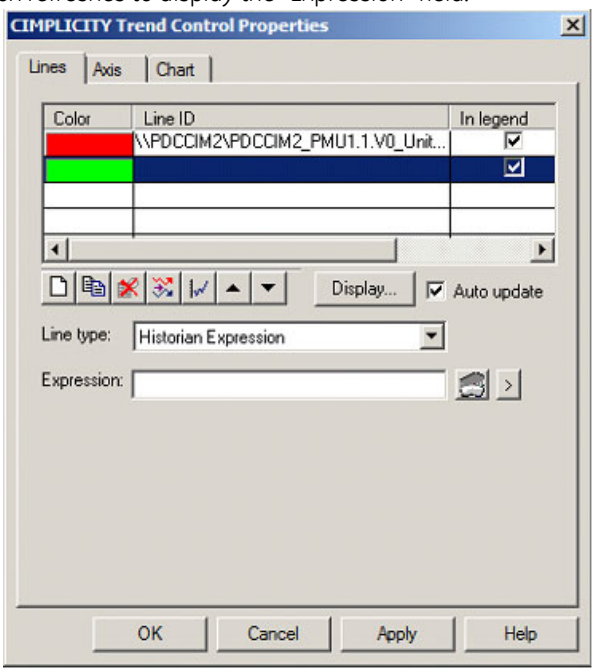
1. Right-click within the data display area of the Trend Chart object, then select **Trend Control Properties**.
   The "CIMPLICITY Trend Chart Control Properties" dialog box appears, displaying the Lines tab.

2. Below the displayed table on the Lines tab, click **Create a new line**.
   The table refreshes to display an entry for the newly created trend line.
3. From the "Line Type" drop-down list, select **Historian Expression**.

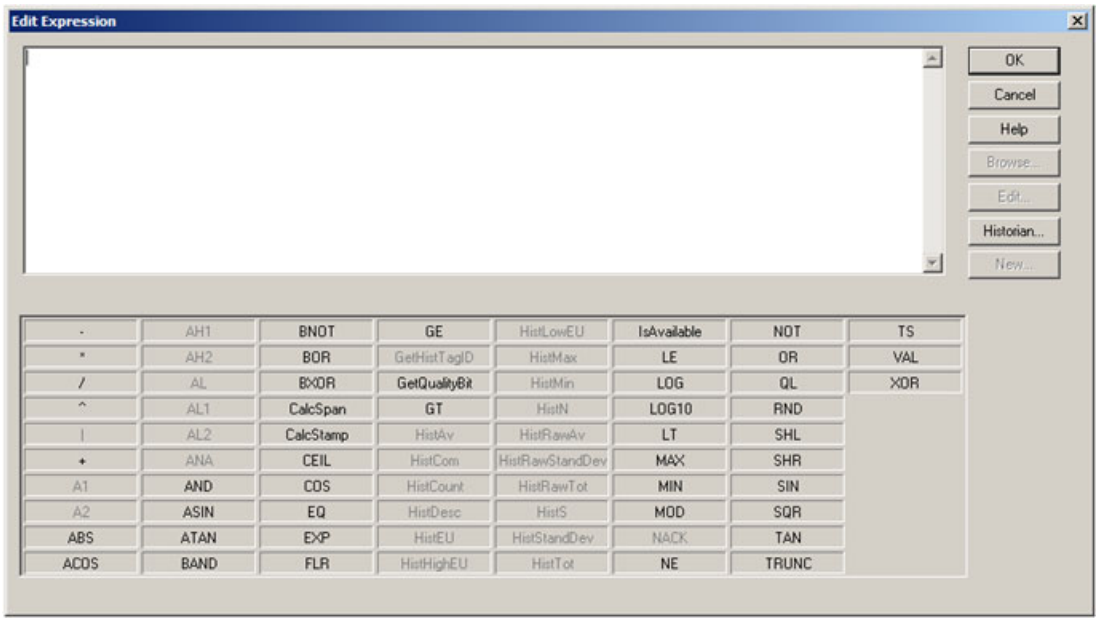
NOTE

Line types other than Historian and Historian Expression are not applicable to the ESV.

The dialog box refreshes to display the "Expression" field.



4. Click the button directly to the right of the "Expression" field.
   The "Edit Expression" dialog box appears.



5. In the Edit Expression dialog box, click **Historian**.
   The "Select a Tag" dialog box appears.
6. From the Connection drop-down list, select the Historian containing the synchrophasor (that is, tag) that you want to use in the expression.

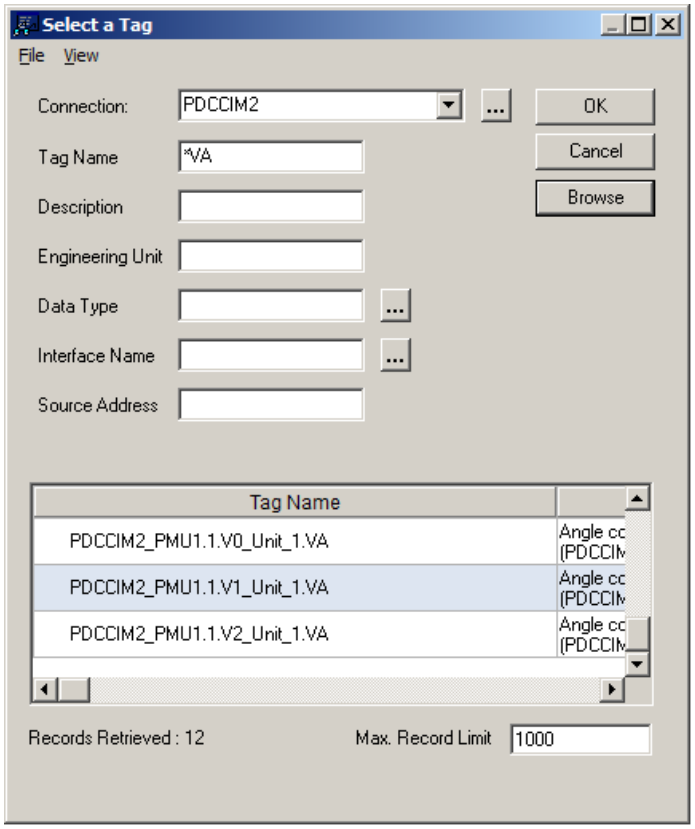
NOTE

If you have not saved your login credentials for the selected Historian and have not previously logged in to the Historian during the current session, a dialog box will appear, in which you must enter your User Name [preceded by the appropriate Domain Name followed by a backslash (that is, DomainName\UserName), if applicable to your environment) and Password, then click **OK**, before continuing. If you choose to cancel this prompt, you will not be able to access data in the corresponding Historian until you either navigate away from the worksheet or close, then reopen, the application.

7. Click **Browse**.
   The pane in the lower area of the "Select a Tag" dialog box refreshes to display a table listing the tags contained in the Historian.

NOTE

For information, see *Historian tag naming conventions*.



8. In the table of tags, click the listing for the tag that you want to use in the expression.
9. Click **OK**.
   The "Select a Tag" dialog box closes, and the Input field of the "Edit Expression" dialog box refreshes to display the selected tag.

NOTE

All Historian tags must be fully qualified by the Historian connection name and must be enclosed in single quotes.

10. Below the Input field in the "Expression Editor" dialog box, double-click the box containing the minus sign.

NOTE

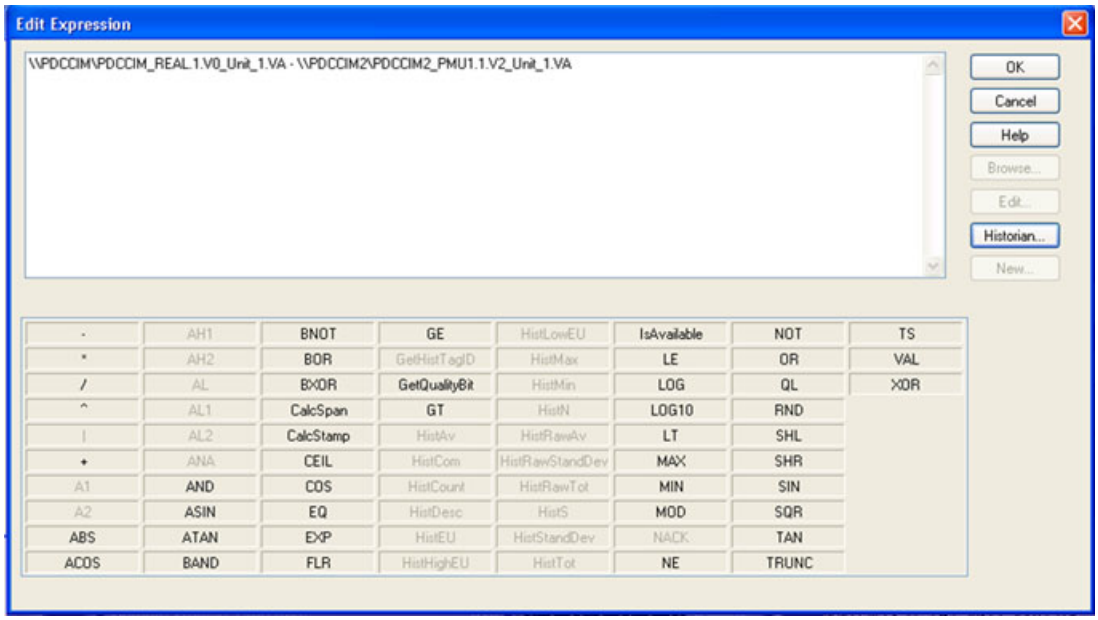
For information on expression operators, see *Expression Operators Overview*.

   The operator is inserted in the Input field at the location of your cursor.

11. Repeat steps 5 through 9 for the second tag that you want to include as part of the expression. After this, the "Edit Expression" dialog box reflects the complete expression for visualizing the angular difference between the selected synchrophasors.

NOTE

As illustrated in the image below, expressions can use synchrophasor data from more than one Multilin P30 Historian.



12. Click **OK**.
    The "Expression Editor" dialog box closes, and the table on the Lines tab refreshes to display the designated expression in the entry created at step 2.
13. Review the Auto Update option, setting to ensure that it is enabled, as indicated by a check mark in the corresponding check box.

NOTE

This option controls whether the Trend Chart object continually refreshes to reflect updated data acquired by the Historian.

14. Click **Apply**.
    The Trend Chart refreshes to display a trend line for the specified expression.
15. Click **OK**.
    The "CIMPLICITY Trend Chart Control Properties" dialog box closes, fully revealing the Trend Chart.

Example 3: Certificate Management and FreeRADIUS.net Setup

Multilin P30 can act as a RADIUS client and has the ability to authenticate users with a central/remote RADIUS server using EAP-TTLS protocol. Authentication is performed with the help of certificates.

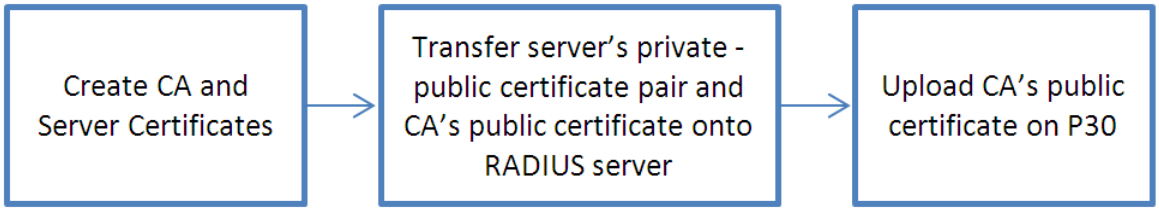
Initial Setup:

Any cryptography application like OpenSSL etc can be used to create certificates. First, a private key and certificate request are created for the server. The certificate request contains the public key, and the server's information (name, email, organization etc.).

The certificate request is then sent to a certificate authority (CA) for their digital signature. If the request is sent to a well-known CA, then upon receiving payment from the RADIUS server's administrator, the CA verifies the information and signs the certificate. The administrator can choose not to use external well known CA's services and create a local CA instead.

The signed certificate of the server along with CA's public certificate are then sent back to the RADIUS server administrator. Finally, the CA's public certificate is uploaded on to the Multilin P30.

In this example, a local CA is created and used to sign the server's certificate request.

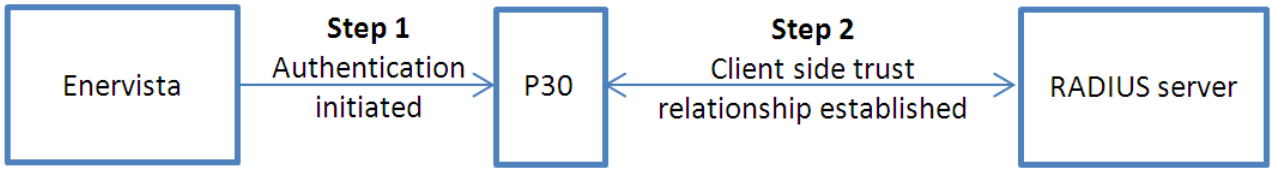


Authentication:

The Multilin P30 user initiates the authentication process by providing user credentials. P30 then tries to establish a trust relationship with the radius server. The RADIUS server identifies itself via a certificate which it sends to the Multilin P30. This certificate holds the server's information:

- version
- public key
- subject
- serial number
- valid from
- valid until
- key-usage
- signature algorithm
- "issuer" (i.e. CA) etc.

The Multilin P30 then validates server's identity by verifying the server's certificate against the CA's certificate that it has. If both the server and CA's certificates are signed by the same trusted authority (CA), a client side trust relationship is successfully established.



Setting up a Simple RADIUS Server

The following example demonstrates how one could set up a test bench RADIUS server. A proper RADIUS server should only be deployed by qualified IT professionals. The third party tools and services mentioned below are for demonstration purposes and do not imply endorsement by GE.

OpenSSL

OpenSSL is used to create certificates. Download and install the windows port of OpenSSL (Win32 OpenSSL v1.0.1) from the following location: http://www.slproweb.com/products/Win32OpenSSL.html

RADIUS Server

Download and install FreeRADIUS.net (Windows version) from the following location: http://freeradius.net/

Certificate Management

Create Private Key for Server

To create a private key:

openssl genrsa –out server.key 4096

Here:

1. RSA based private key is generated
2. It is not a password protected key.

Create Certificate Request for Server

To create a certificate request:

openssl req –new –key server.key –out server.csr

While using the above command, you will be asked to enter the following information that will be incorporated into the certificate request. What you enter here is called a Distinguished Name or a DN. All this information is sent with the certificate request. The two 'extra' attributes ("A challenge password" and "An optional company name") are left blank for this example.

Example:

```
Country Name (2 letter code) [AU]:CA
State or Province Name (full name) [Some-State]:Ontario
Locality Name (eg, city) []:Markham
Organization Name (eg, company) [Internet Widgits Pty Ltd]:Example Company
Organizational Unit Name (eg, section) []:XYZ Department
Common Name (e.g. server FQDN or YOUR name) []:PDC Radius Server
Email Address []:xyz@xyz.xyz

Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password []:
An optional company name []:
```

Create a Signed Certificate for Server

CA certificates (assuming it to be your root certificate from CA) are created and later used to sign the server's certificate request.

1. Create a private key for the root CA:
   openssl genrsa -out ca.key 4096
2. Create a public certificate and self-sign it:
   openssl req -new -x509 -days 3650 -key ca.key -out ca.crt
   While using the above command, you will be asked to enter information that will be incorporated into your certificate. Please make sure that while entering this information (as depicted in the previous step) at least the Common Name (CN) of the CA and the Server certificate does NOT match. This will avoid possible naming collision and related errors later on.
3. Use server's certificate request (server.csr) that was created in the previous section and sign it with CA:
   openssl x509 –req –days 3650 –in server.csr –CA ca.crt –CAkey ca.key –set_serial 01 –out server.crt

[Here, x509 tool is used to add a digital signature to the certificate:

- –req, with this option, a certificate request is expected instead of the certificate (by default).
- –in, specifies the input file to read the certificate from.
- –CA, specifies the CA certificate to be used for signing. When this option is present, x509 behaves like a "mini CA". The input file is signed by this CA using this option: that is its issuer name is set to be the subject name of the CA and it is digitally signed using the CA's private key. This option is normally combined with the –req option. Without the –req option, the input is a certificate which must be self-signed.
- –CAkey, when the -CA option is used to sign a certificate, it uses a serial number specified in a file. This file consists of one line containing an even number of hex digits with the serial number to use. After each use, the serial number is incremented and written out to the file again.
- –set_serial, specifies the serial number to use.
- –out, specifies the output file to write to.
- –days, specifies the number of days the certificate is valid for.]

RADIUS Server Configuration

Transfer Certificates to Server

Copy the following files onto the FreeRADIUS.net server under the directory containing the certificates. In this example, <Path_to_Radius>\etc\raddb\certs\FreeRADIUS.net\DemoCerts:

1. server.key
2. server.crt
3. ca.crt

Configuration

Modify the following files to configure RADIUS server:

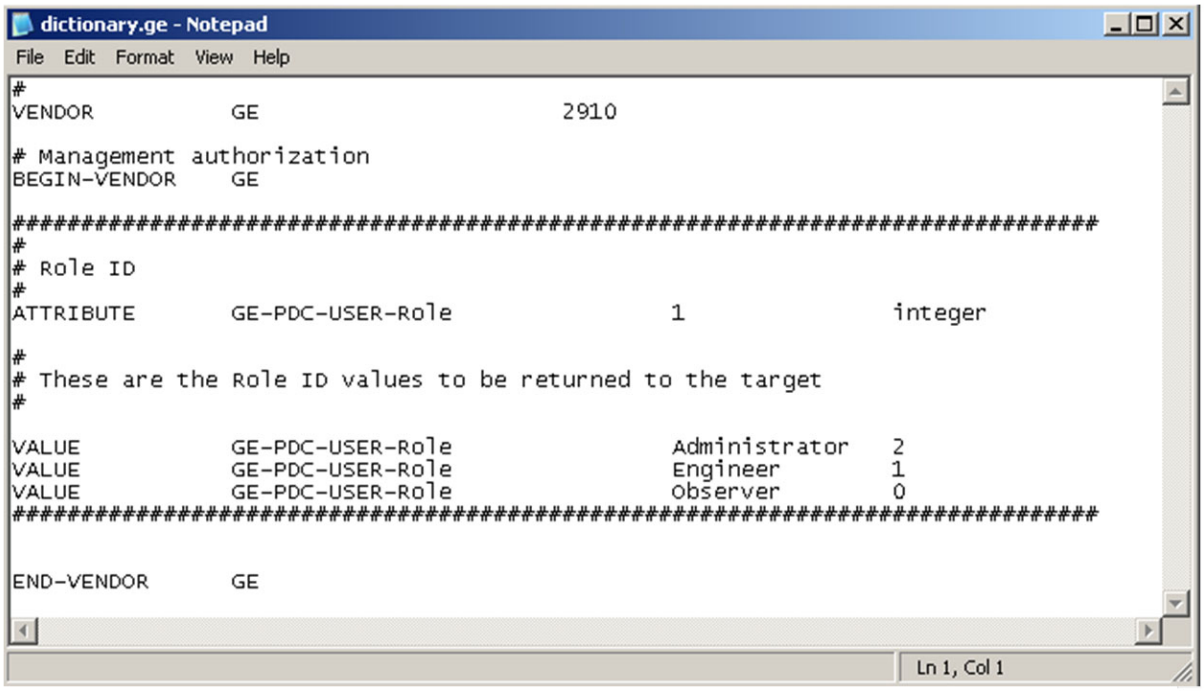
- RADIUSD.CONF
  Locate the "bind_address" field and set it to your server's IP address.
- USERS.CONF
  Add users in this file. It is available under <Path_to_Radius>\etc\raddb directory.
  Adding the following text configures a user "Tester" which has "Administrator" role:
  Tester:
  ->User-Password == "Testing"
  ->GE-PDC-USER-Role = Administrator
- CLIENTS.CONF
  Add clients in this file. It is available under <Path_to_Radius>\etc\raddb directory.

  The following text defines a RADIUS client (Multilin P30) with the assumption that its IP-address is 10.0.0.2 and subnet mask is 255.255.255.0. The "secret" that is specified here should also be configured on the Multilin P30 for successful authentication.

```
client 10.0.0.2/24 {
 secret = testing123
 shortname = private-network-1
 }
```

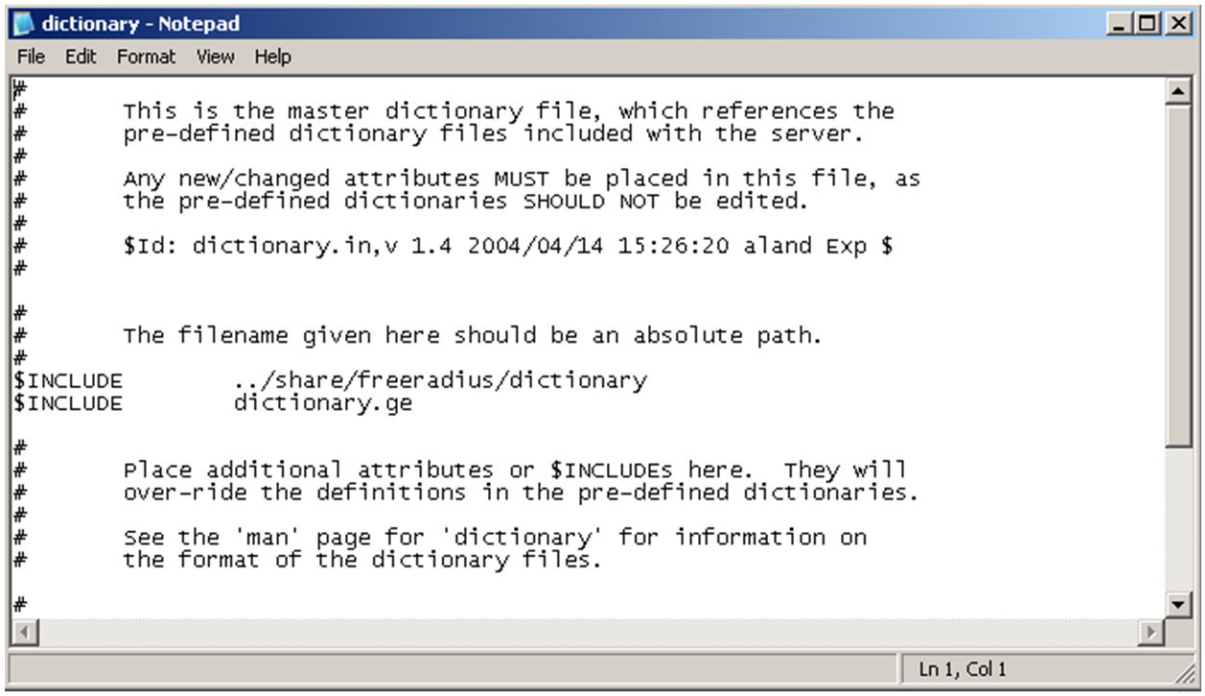
- DICTIONARY.GE
  Create a file called "dictionary.ge" under <Path_to_Radius>\etc\raddb and add the

following content to it:



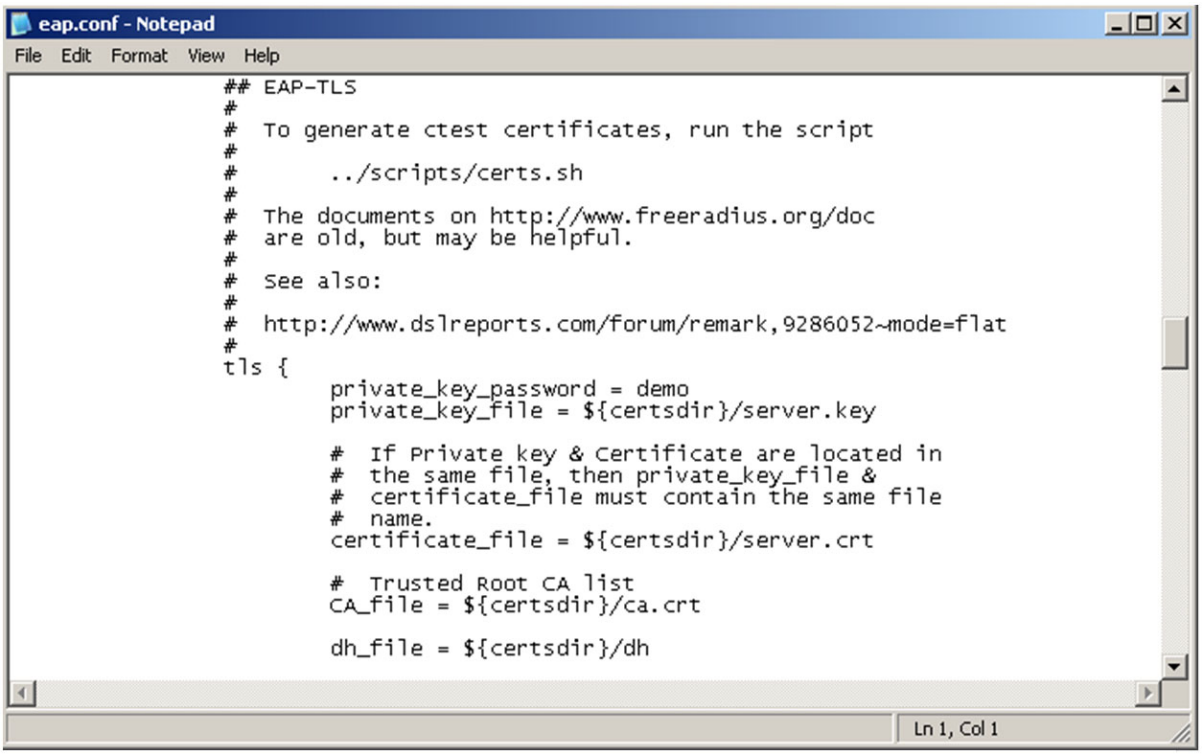
Add the following line (as shown in the figure below) to the "dictionary" file present under <Path_to_Radius>\etc\raddb:

```
$INCLUDE dictionary.ge
```



- EAP.CONF
  The file is available under <Path_to_Radius>\etc\raddb directory.

Locate the "tls" block and add respective entries to "private_key_file", " certificate_file" and "CA_file" fields as shown below:



Start Server

The following file can be used to start the RADIUS server in debug mode:<Path_to_Radius>/start_radiusd_debug.bat

It is recommended to first run the RADIUS server in debug mode, otherwise, you will not be able to see what is going on and you will not be able to correct any problems.

P30 (RADIUS Client) Configuration

The CA's public certificate needs to be transferred to Multilin P30 . Since the Multilin P30 accepts the certificates in DER format, we must first convert the signed certificate from PEM format to DER:

openssl x509 -in ca.crt -inform PEM -out ca.der -outform DER

Place the DER file (ca.der) on the Multilin P30 device via EnerVista P30 Setup (Device -> Maintenance -> Certificates).

Finally update the Remote RADIUS shared secret (as set up in clients.conf) via EnerVista P30 Setup.

GE
Grid Solutions

Multilin P30

Appendix A: Revision History

Appendix A includes the revision history.

Revision history

Table A-1: Revision History

MANUAL P/N	RELEASE DATE
1601-0267-A1	November 2011
1601-0267-A2	June 2012
1601-0267-A3	February 2013
1601-0267-A4	November 2013
1601-0267-A5	August 2014
1601-0267-A6	January 2016

Major Updates

Table A-2: Major Updates for P30 Instruction Manual A6

SECTION or PAGE NUMBER	CHANGES
	Manual revision number from A5 to A6
Ch 1	P30 system specifications updated for SATA SSD and SATA SSD Carrier Card, and for Testing and Certification > Type Tests > Shock Response & Withstand
Ch 2	Hardware Description updated > P30 supports one 256 GB solid-state drive
Ch 9	P30 Historian Commands: NOTICE added to ensure prevention of data loss.

Table A-3: Major Updates for P30 Instruction Manual A5

SECTION or PAGE NUMBER	CHANGES
	Manual revision number from A4 to A5
Ch 7	Added input buffer overflow in communications events section.

Table A-4: Major Updates for P30 Instruction Manual A4

SECTION or PAGE NUMBER	CHANGES
Cover	Manual revision number from A3 to A4
Ch 14	Added CLI commands, example, and updates for static routing feature changed in release 2.01.
n/a	Minor Corrections throughout.