Reference Manual

PlantPAx
Process Automation System

PlantPAx Process Automation System

System Release 3.0 (2014 update)





Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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

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

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

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

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

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

This manual revision concentrates on the implementation recommendations that apply to all PlantPAx™ systems.

Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

New and Updated Information

This table contains some of the changes made to this revision.

Topic	Page
Updates the PlantPAx system rules for current software versions	18, 109
Guidelines for server elements were divided into virtual and traditional categories	19, 21, 22, 23, 23, 25, 26
Focuses on virtual infrastructure and recommendations	65
Lists virtual image templates	68
Adds resource pools for virtual machines with an example of CPU and memory allocation	72
Adds HART isolated analog modules	90
Provides guidelines for adding Motor Control Center devices	95
Adds new chapter for FactoryTalk Historian and FactoryTalk VantagePoint software components	101

Notes:

Chapter 4

Alarm System Recommendations

Chapter 5

Infrastructure Recommendations

Chapter 6

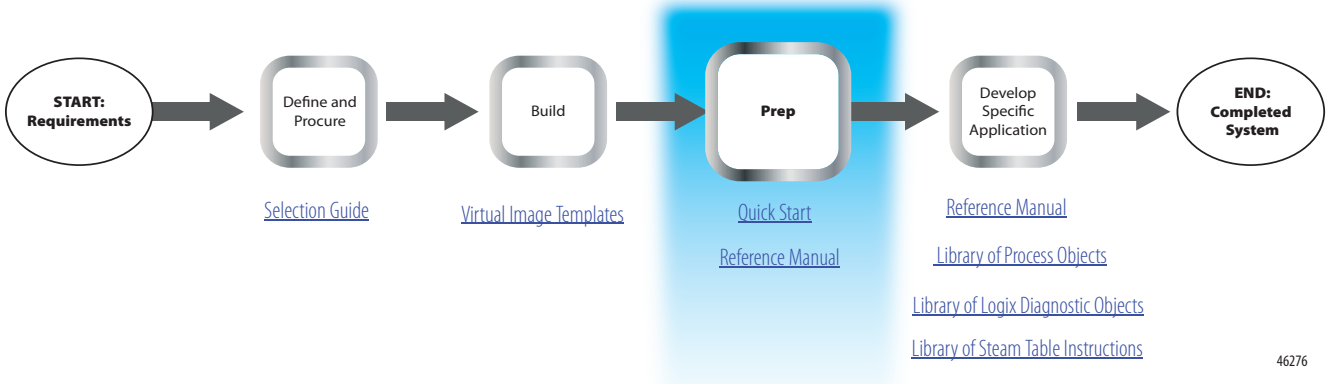
Field Device Integration Recommendations

Notes:

The PlantPAx® Process Automation System is a modern distributed control system (DCS). The system is built on a standards-based architecture by using Integrated Architecture™ components that enable multi-disciplined control and premier integration with the Rockwell Automation® intelligent motor control portfolio.

Our scalable platform provides you with the flexibility to implement a system that is tailored for your application. With the PlantPAx system, we prescribe a very specific system architecture with defined system elements, each with a specific responsibility, and detailed specifications.

Figure 1 - PlantPAx System Implementation and Documentation Strategy



- **Define and Procure** - Helps you understand the elements of PlantPAx to make sure that you buy the proper components.
- **Build** - Provides direction on how to implement the PlantPAx server architecture to help develop your application.
- **Prep** - Provides guidance on how to get started and learn the best practices for developing your application.
- **Develop Specific Application** - Contains the application-specific libraries and objects that are used to construct your application that resides on the PlantPAx architecture.

Purpose of Reference Manual

Whereas the PlantPAx Selection Guide is used to assist with system sizing and procurement, this reference manual elaborates on the **application rules** you need to follow to set up a PlantPAx system. The performance of the PlantPAx system is dependent upon following the sizing guidelines and application rules that are defined by these documents and the PlantPAx System Estimator (PSE).

The PlantPAx system does not require the use of the Rockwell Automation Library of Process Objects or the PlantPAx Virtual Image Templates. Conversely, if you use the library or the virtual image templates, you cannot achieve PlantPAx system performance without following the guidelines of the selection guide and reference manual.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Table 1 - Additional Resources

Resource	Description
System Core	
PlantPAx System Application Templates Quick Start, publication PROCES-QS001	Describes how to apply application templates to start development of your PlantPAx Process Automation System.
PlantPAx Hardware Specifications and Certifications, publication PROCES-SR027	Provides information on PlantPAx system hardware specifications and certifications.
PlantPAx Sequencer Object Reference Manual, publication PROCES-RM006	Provides a flexible controller-based step sequencing solution that reduces engineering time by automating common operator procedures.
FactoryTalk View SE Edition User Manual, publication VIEWSE-UM006	Provides details on how to use this software package for developing and running human-machine interface (HMI) applications that can involve multiple users and servers, distributed over a network.
FactoryTalk Alarms and Events System Configuration Guide, publication FTAE-RM001	Provides details on how to install, configure, and use FactoryTalk Alarms and Events services as part of a FactoryTalk-enabled automation system.
ControlLogix System User Manual, publication 1756-UM001	Explains how to use traditional and extreme environment ControlLogix® controllers.
ControlLogix Enhanced Redundancy System User Manual, publication 1756-UM535	Provides information on the installation and configuration for an enhanced redundancy controller system for greater availability.
Logix5000 Controllers Design Considerations Reference Manual, publication 1756-RM094	Details how to design and optimize Logix5000™ controller applications.
Logix5000 Controllers Common Procedures Programming Manual, Publication 1756-PM001	Provides links to a collection of programming manuals that describe how you can use procedures that are common to all Logix5000 controller projects.
Logix5000 Controllers General Instructions Reference Manual, publication 1756-RM003	Provides programming controller applications by using relay ladder instructions.
Logix5000 Controllers Advanced Process Control and Drives Instructions Reference Manual, publication 1756-RM006	Provides details on process control and drives instructions.
Logix 5000 Controllers Execution Time and Memory Use Reference Manual, publication 1756-RM087	Provides a complete listing of all instruction execution time and memory usage information for Logix5000 controllers in your RSLogix 5000™ programming software, version 20.00, program.
PlantPAx Logix Batch & Sequence Manager Product Profile, publication PROCES-PP004	Explains a controller-based batch and sequencing solution that leverages the Logix Control Platform and FactoryTalk View software for integrated control and visualization.
Rockwell Automation Library of Process Objects, publication PROCES-RM002	Provides an overview of the code objects, display elements, and faceplates that comprise the Rockwell Automation Library of Process Objects.
Rockwell Automation Library of Logix Diagnostic Objects, publication PROCES-RM003	Provides Add-On Instructions for monitoring and diagnostic information of Logix controllers.
Rockwell Automation Library of Steam Table Instructions, publication PROCES-RM004	Provides Add-On Instructions for calculating temperature and pressure steam tables.
FactoryTalk View SE Installation Guide, publication VIEWSE-IN003	Contains procedures for installing FactoryTalk View SE software.
Infrastructure	
PlantPAx Process Automation System Selection Guide, publication PROCES-SG001	Provides basic definitions of system elements and sizing guidelines for procuring a PlantPAx system.
Virtual Image Templates User Manual, publication 9528-UM001	Describes how to use the PlantPAx virtual image templates for setting up virtual machines.
Ethernet Design Considerations Reference Manual, publication ENET-RM002	Explains the infrastructure components that allow this open network to communicate seamlessly throughout a plant, from shop floor to top floor.
Converged Plantwide Ethernet (CPwE) Design and Implementation Guide, publication ENET-TD001	Provides collaborative design guidelines that are based on the Cisco Ethernet-to-the-Factory solution and the Rockwell Automation Integration Architecture solution.
Troubleshoot EtherNet/IP Networks, publication ENET-AT003	Provides guidelines for troubleshooting an EtherNet/IP network, such as setting speed and duplex.

Table 1 - Additional Resources

Resource	Description
Application Note: Segmentation Methods within the Cell/Area Zone, publication ENET-AT004	Provides design considerations of network segmentation methodologies for the ControlLogix and CompactLogix™ 5370 controllers.
Stratix/Infrastructure Product Family Quick Reference Drawing, publication IASIMP-QR029	Illustration that shows options for connecting your plant network by using standard Ethernet technology.
Stratix 8000 and 8300 Ethernet Managed Switches Software User Manual, publication 1783-UM003	Describes the embedded software features and tools for configuring and managing the Stratix 8000™ and Stratix 8300™ Ethernet managed switches.
Stratix 6000 Ethernet Managed Switch User Manual, publication 1783-UM001	The respective user manuals describe the embedded software features and tools for configuring and managing the Stratix 6000™ and Stratix 5700™ Ethernet managed switches.
Stratix 5700 Ethernet Managed Switches User Manual, publication 1783-UM004	
ControlNet Coax Media Planning and Installation Guide, publication CNET-IN002	Provides procedures for planning, installing, and implementing a ControlNet network.
ControlNet Fiber Media Planning and Installation Guide, publication CNET-IN001	
ControlNet Modules in Logix5000 Control Systems User Manual, publication CNET-UM001	
Product Compatibility and Download Center at http://www.rockwellautomation.com/rockwellautomation/support/pcdc.page	Website helps you find product-related downloads including firmware, release notes, associated software, drivers, tools and utilities.
Field Device Integration	
FactoryTalk AssetCentre Installation Guide, publication FTAC-IN004	Provides installation instructions for monitoring your factory automation system.
FactoryTalk AssetCentre Product Profile, publication FTALK-PP001	Explains this tool for securing, managing, versioning, tracking, and reporting automation-related asset information across your entire enterprise.
1756 ControlLogix Communication Modules Specifications Technical Data, publication 1756-TD003	Contains specifications for the ControlLogix network communication modules.
Ethernet Design Considerations Reference Manual, publication ENET-RM002	Explains the infrastructure and components for the EtherNet/IP protocol, a control and information platform for industrial environments and time-critical applications.
EtherNet/IP Modules in Logix5000 Control Systems User Manual, publication ENET-UM001	Explains Logix5000 tools that are used in EtherNet/IP topologies and network operation.
EtherNet/IP and ControlNet to FOUNDATION Fieldbus Linking Device, publication 1788-UM057	Describes the installation and operation of the 1788-EN2FFR and 1788-CN2FFR linking devices.
Converged Plantwide Ethernet (CPwE) Design and Implementation Guide, publication ENET-TD001	Provides collaborative design guidelines that are based on the Cisco Ethernet-to-the-Factory solution and the Rockwell Automation Integration Architecture solution.
1788-EN2PAR User Manual, publication 1788-UM056	Describes the installation and operation of the 1788-EN2PAR linking device.
1788-CN2PAR User Manual, publication 1788-UM055	Describes the installation and operation of the 1788-CN2PAR linking device.
ControlLogix HART Analog I/O Modules User Manual, publication 1756-UM533	Contains information on how to install, configure, and troubleshoot ControlLogix HART analog I/O modules.
Promass 83 Flowmeter via PROFIBUS PA to the PlantPAx Process Automation System, publication PROCES-AP022	Provides procedures for the design and implementation of PROFIBUS PA equipment.
DeviceNet System Quick Reference, publication DNET-QR001	Provides procedures for configuring applications on the DeviceNet network.
CENTERLINE Motor Control Centers with EtherNet/IP, publication 2100-TD031	Describes cable system construction and components associated with an EtherNet/IP network that is factory installed in CENTERLINE® 2100 and CENTERLINE 2500 and IntelliCENTER® motor control centers (MCCs).
CENTERLINE 2500 Motor Control Centers with EtherNet/IP Network, publication 2500-TD003	
E+H Instruments via HART to PlantPAx User Manual, publication PROCES-UM002	Provides a step-by-step approach to integrating HART devices from Endress+Hauser into the PlantPAx system.

Table 1 - Additional Resources

Resource	Description
Batch	
PhaseManager User Manual, publication LOGIX-UM001	Explains how to define a state model for your equipment and develop equipment phases.
FactoryTalk Batch Installation Guide, publication BATCH-IN011	Provides information and procedures for installing FactoryTalk Batch software.
FactoryTalk Batch User's Guide, publication BATCH-UM011	Provides a complement of FactoryTalk recipe management, component guidelines, and software installation procedures.
Process Safety	
http://www.rockwellautomation.com/products/certification	Complete list of ControlLogix products that are certified for SIL 1 and SIL 2 applications
Using ControlLogix in SIL2 Applications Safety Reference Manual, publication 1756-RM001	ControlLogix components supported in SIL 2 configurations
AADvance Solutions Handbook, publication ICSTT-RM447	Explains the features, performance, and functionality of the AADvance controller and systems. It sets out some guidelines on how to specify a system to meet your application requirements.
AADvance System Build Manual, publication ICSTT-RM448	Provides experienced panel builders with information on how to assemble a system, switch on and validate the operation of a controller.
AADvance Configuration Guide, publication ICSTT-RM405	Defines how to configure an AADvance controller by using the AADvance Workbench to meet your Safety Instrument Function (SIF) application requirements.
AADvance Safety Manual, publication ICSTT-RM446	Defines mandatory standards and makes recommendations to safely apply AADvance controllers for a SIF application. Explains how to use tradition al and extreme environment ControlLogix controllers.
AADvance Troubleshooting and Repair Manual, publication ICSTT-RM406	Provides plant maintenance personnel with information on how to trace and repair a fault in an AADvance system and perform routine maintenance tasks.

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

System Architecture Overview

The PlantPAx system uses a combination of standard Rockwell Automation Integrated Architecture (IA) products that are configured in a prescribed way for optimal performance as a process automation system. This section describes the system elements and architectures that you can use to configure a PlantPAx system.

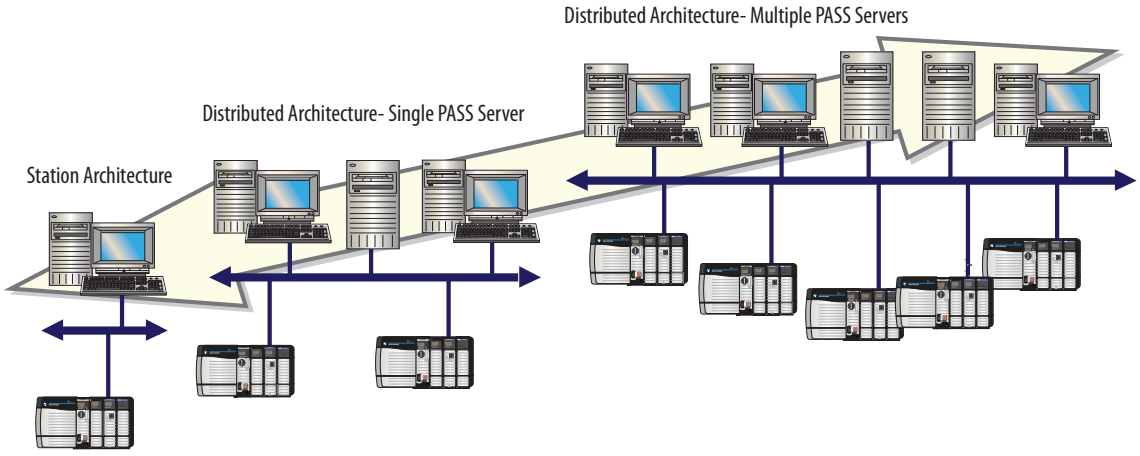
The following table describes where to find specific information.

Rockwell Automation characterizes a process automation system based on its size or architecture class. A 'characterized' (system tested) classification yields system performance data and recommended hardware and software configurations.

This section describes how the classes of PlantPAx architecture offer system scalability while organizing IA products to provide the performance and functionality expected from a Distributed Control System (DCS).

The architecture classes that are shown in the illustration are described as the following:

- System architecture with single station acting as a process automation system server (PASS), operator workstation (OWS), and engineering workstation (EWS)
- Distributed system architecture for single server with multiple OWS and EWS
- Distributed system architecture for multiple servers and multiple OWS and EWS

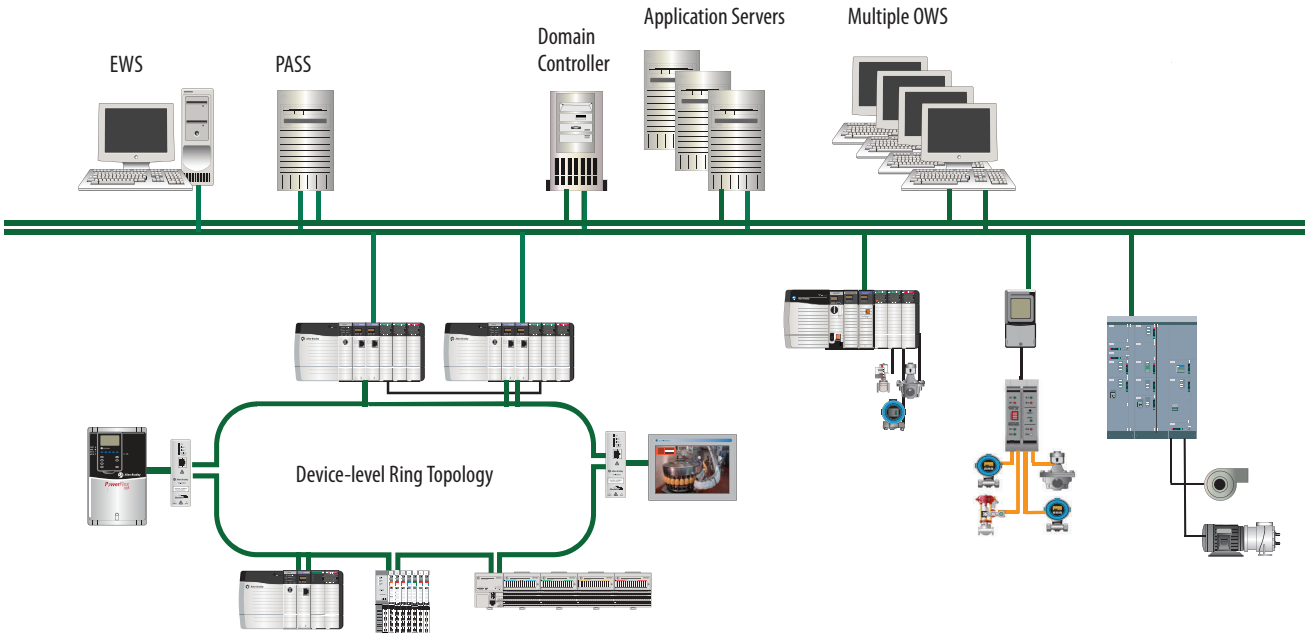


Architecture Classes

Architecture classes define referenced architecture based on the size of the required system.

Architecture	Description
Station	A single station acting as a PASS, OWS, and EWS.
Distributed - Single PASS Server	This architecture has a single PASS server and supports multiple OWS s and EWSs.
Distributed - Multiple PASS Servers	This architecture has multiple PASS servers and supports multiple OWSs and EWSs. You can add PASS servers for more capacity or to segregate servers by operating areas.

The diagram shows an example of PlantPAx system architecture by using the EtherNet/IP network. This example is a distributed architecture with one or more PASS servers.



System Elements

System elements are specific IA products grouped to provide process system functionality.

Table 2 - Architecture System Elements

System Element	Station	Distributed Class (single or multiple PASS)
PASS	Single computer serves as PASS, EWS, and OWS in an independent workstation	One PASS required and includes the following: • FactoryTalk Directory server • HMI server • Data server • Alarms and Events Server Additional PASS as needed (up to 10 servers or redundant server pairs)
EWS	Included in independent workstation	• 1 EWS required • Can have as many as 5 EWS
OWS(1)	Included in independent workstation	Up to 10 remote clients per PASS; up to 50 for system
Process controller(1)	1...5 ControlLogix controllers	1...8 ControlLogix controllers per PASS (data server)
Application servers	AppServ-Asset Management as needed AppServ-Batch as needed AppServ-Information Management (Historian or Reporting) as needed	AppServ-Asset Management as needed AppServ-Batch as needed AppServ-Information Management (Historian or Reporting) as needed AppServ-OWS as needed

(1) The actual number of OWS/controllers supported can vary based on controller selection, OWS configuration, and overall system loading. Use the PlantPAx System Estimator (PSE) to verify your system design. The PSE lets you verify your application beyond these basic guidelines.

Critical System Attributes

A critical system attribute (CSA) is a visible performance indicator of a system-wide characteristic. CSAs are used to define or identify specified levels of system operation. CSAs are evaluated on a pass/fail basis.

Critical system attributes do the following:

- Determine system limits
- Establish system rules
- Establish system recommendations
- Measure system element and system infrastructure performance

The following critical system attributes were used to verify performance during process system characterization.

Table 3 - CSA Performance Indicators

Critical System Attribute	Performance
Display callup (paint time)	A noncached display is called up by the operator and ready for operator use within 2 seconds.
Display update	The display updates control information within 1 second.
Steady state alarm time	Steady state alarms occurring at 20 per second are timestamped within 1 second.
Alarm burst time	All alarms in a burst of 1000 alarms are timestamped within 3 seconds.
Recovery	A system element returns to full operation within 5 minutes of the restoration after a failure or loss.
Operator-initiated control	Operator-initiated actions are loaded into the controller and the feedback for the operator action is within 2 seconds.
Batch server: operator action time	An operator batch command has been acted on by the controller in 1 second.
Batch server: server action time	A server batch command has been acted on by the controller in 1 second.
Batch server: controller action time	Batch status events display on the operator workstation within 1 second.

System Procurement Tools

The following chapters of this manual contain recommendations and considerations for implementing your system. If you have not selected or procured your PlantPAx system architecture and components, see the PlantPAx Selection Guide, publication PROCES-SG001, for more information.

The PlantPAx System Estimator (PSE), which is a part of the Integrated Architecture Builder (IAB) software tool, helps you define a PlantPAx system. The PSE wizard lets you specify your system architecture based on your requirements, and verifies that your process control hardware is sized properly.

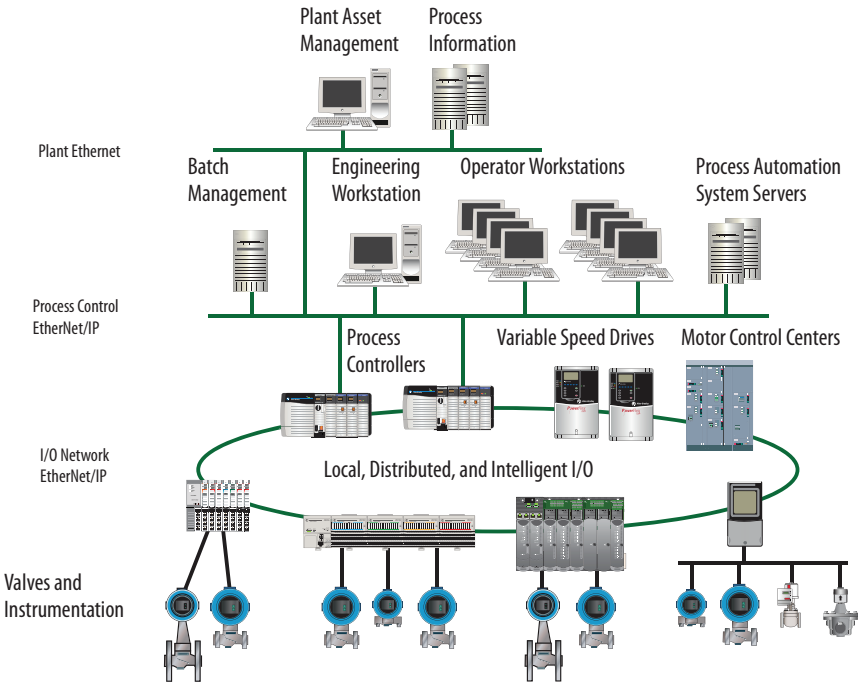
When the verification is complete, you can transfer the output of the PSE wizard into the IAB tool to develop a bill-of-material for the system based on your inputs.

See http://www.rockwellautomation.com/en/e-tools/configuration.html to access the IAB tool.

System Element Recommendations

PlantPAx system elements refer to the individual servers, clients, and controllers that comprise a PlantPAx system. These building blocks are the foundation of your system architecture.

The following table describes where to find specific information.



PlantPAx Software Components

Integrated Architecture software components and versions that comprise the PlantPAx system release 3.0, include the following:

- RSLogix™ 5000 software, version 20.*x*
- FactoryTalk View software, version 8.0
- FactoryTalk Batch software, version 12.00
- FactoryTalk AssetCentre software, version 5.0 or later
- FactoryTalk VantagePoint software, version 5.0 or later
- FactoryTalk Historian software, version 4.0 or later

Performance guidelines are based on the use of the software versions listed above. See Appendix A on page 109 for more software information.

For the latest compatible software information and to download associated library tools, see the Product Compatibility and Download Center at http://www.rockwellautomation.com/rockwellautomation/support/pcdc.page.

Process Automation System Server (PASS)

The PASS server is a required system element that hosts these essential software components to run the system.

Software Components	Description
FactoryTalk Network Directory (FTD) server(1)	Secures information from multiple Rockwell Automation software components across multiple computers and provides central administration throughout the PlantPAx system. In this way, application components, such as display and security settings, can be stored in their original environments and made available to the entire PlantPAx system without the need for duplication. See Configure the FactoryTalk Directory on page 20 for more information.
FactoryTalk Activation server(1)	The FactoryTalk Activation server is part of the FactoryTalk Services Platform. The server enables FactoryTalk-enabled software products to be activated via files generated by Rockwell Automation over the internet. This server essentially manages the files required to license Rockwell Automation products on the PlantPAx system.
FactoryTalk View HMI server	The human-machine interface (HMI) server is configured within your FactoryTalk View Site Edition (SE) application. The HMI server stores HMI project components, such as graphic displays, and serves these components to OWSs upon request. The HMI server also can manage tag databases and log historical data. Multiple HMI servers can exist on the PlantPAx system.
FactoryTalk View Data server	The Data server component provides access to information from the process controllers to servers and workstations on the PlantPAx system. FactoryTalk View software supports two types of data servers: Rockwell Automation Device servers (RSLinx® Enterprise software) and OPC Data servers. The Data server mentioned in PlantPAx documentation generally refers to the Rockwell Automation Device servers. Data servers are configured within your FactoryTalk View SE application. Multiple data servers can exist on the PlantPAx system.
FactoryTalk View Alarms and Events server	The Alarms and Events server publishes information from controllers and servers available to all subscribing OWSs. Alarms and Events servers are configured within your FactoryTalk View SE application. There are two types of Alarms and Events servers: device-based and server-based. Device-based Alarms and Events servers are configured as an option to the data server. Server-based Alarms and Events servers are configured as a separate component. The Alarms and Events server mentioned in PlantPAx documentation refers to the Alarms and Events server that is server-based. See Alarm System Recommendations on page 55 for more information.
Optional	
FactoryTalk Batch client software	If a Batch Application server is being used on the system, FactoryTalk Batch client components are required to support replication of batch-related objects on the displays to the OWS.

(1) In redundant PASS configurations, this component is included on the primary PASS only. See PASS Server Redundancy on page 19 for more information.

The PASS can be utilized as a data, HMI, and/or alarm server. You need to determine how many PASS servers are needed for your architecture. See the PlantPAx Process Automation System Selection Guide, publication PROCES-SG001.

PASS Server Redundancy

PASS servers can be configured as redundant for the following software components:

- HMI server
- Data server
- Alarm server

IMPORTANT When enabling redundancy in FactoryTalk View Studio software, select the option to 'Continue using the secondary server even when the primary server becomes available again' to avoid excessive switchovers and to be able to manage replication of application changes made before or after the switchover occurs. We recommend that you configure your HMI displays to indicate when the system is running without backup.

The FactoryTalk Directory server does not require redundancy to maintain availability of the system if the FTD server fails. The FTD information is cached on each computer that is participating in a distributed application. If the FTD server computer is disconnected from the network or fails, the OWS, EWS, and other application servers can continue to access everything within the application as long as the computer had previously accessed the FTD server.

Table 4.1 - PASS Virtual Requirements

Attribute	Product(1)
Virtual infrastructure	Required: • 2 vCPU • 4 GB vRAM min Recommended CPU and memory allocation: • High priority Resource pool(2) Recommended hard drive sizing averages:(3) • 40 input/output operations per second (IOPS) • 35 reads/sec • 5 writes/sec
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

(1) All numbers and figures are referenced for initial sizing only. Actual performance can vary in final implementation.

(2) See Resource Pool Allocation on page 72.

(3) Check with your drive manufacturer for specifics. Manufacturers provide drives with varying amount of capacity at each speed.

Table 4.2 - PASS Traditional Requirements

Attribute	Product
Traditional infrastructure	The PASS must be installed on server-class hardware. The following are sample specifications based on PlantPAx system characterization: • Intel Xeon Multicore processor (4 cores or greater) • 2.40 GHz CPU • 4 GB RAM min • Dual hard drives (one for application code; one for logging if data logging is used or for historian data collection buffering if historian is used) • Ethernet card that supports redundant media if NIC-teaming is used (If you plan to use a motherboard-NIC make sure it supports redundant media)
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

Configure the FactoryTalk Directory

Before starting a project, you must install FactoryTalk Directory (FTD) services on the workstation hosting the FTD or the PASS. The FTD server manages applications that can exist on multiple clients and servers on separate computers on the PlantPAx system.

IMPORTANT	It is required to have a username and password with administrator privileges to install FactoryTalk software and to specify a FTD location. Use the same username and password for all FactoryTalk installations on the PlantPAx system.

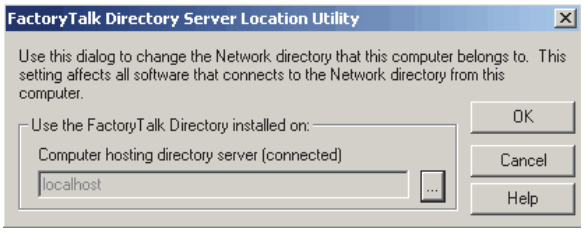
After Rockwell Automation software components are installed, you need to specify the FTD location on all servers and workstations. Specify the location as follows:

- Workstation hosting the FTD or localhost on the PASS
  - We recommend the FTD be on its own independent station
- Name of the FTD workstation or server on each remaining PASS, OWS, EWS, and so forth

Do these configuration steps.

1. On each server and workstation hosting a PASS, Application Server, EWS, or OWS, choose Start>Programs>Rockwell Software> FactoryTalk Tools>Specify FactoryTalk Directory Location.

   The FactoryTalk Directory Server Location Utility appears.

2. In the Computer hosting directory server (connected) box, do the following:
   a. Type localhost if you are configuring the PASS server.
   b. Click Browse ... and select the workstation or server name if configuring an EWS, OWS, additional PASS server, and so forth.
   c. Click OK.
   d. Restart the server or workstation after making a change.

   See the PlantPAx System Application Template Quick Start, publication PROCES-QS001, for more information on setting up servers and workstations on the FactoryTalk Directory.

Engineering Workstation (EWS)

The EWS supports system configuration, application development, and maintenance functions. This is the central location for monitoring and maintaining the system operation.

If a batch application server is used, the FactoryTalk Batch client and editor components are required to configure the FactoryTalk Batch system and set up the FactoryTalk objects on the displays.

Table 5.1 - EWS Virtual Requirements

Attribute	Product(1)
Virtual infrastructure	Required: • 2 vCPU • 4 GB vRAM min Recommended CPU and memory allocation: • Normal priority Resource pool(2) Recommended hard drive sizing averages:(3) • 30 input/output operations per second (IOPS) • 24 reads/sec • 6 writes/sec
Operating system	Windows 7 Professional SP1 operating system, 64 bit

(1) All numbers and figures are referenced for initial sizing only. Actual performance can vary in final implementation.

(2) See Resource Pool Allocation on page 72

(3) Check with your drive manufacturer for specifics. Manufacturers provide drives with varying amount of capacity at each speed.

Table 5.2 - EWS Traditional Requirements

Attribute	Product
Traditional infrastructure	The EWS must be installed on workstation-class hardware. The following are sample specifications based on PlantPAx system characterization. • Intel Core 2 Duo • 2.40 GHz CPU • 4 GB RAM min • Ethernet card that supports redundant media if NIC-teaming is used (If you plan to use a motherboard-NIC make sure it supports redundant media)
Operating system	Windows 7 Professional SP1 operating system, 64 bit

Operator Workstation (OWS)

The OWS provides a graphical interface for the operator; it's not meant to support development or maintenance activities.

FactoryTalk View Site Edition (SE) client software must be installed on the OWS. The OWS also can contain clients for non-core application servers, such as FactoryTalk Batch, FactoryTalk Historian, or FactoryTalk AssetCentre.

Table 6.1 - OWS Virtual Requirements

Attribute	Product(1)
Virtual infrastructure	Required: • 1 vCPU • 2 GB vRAM min Recommended CPU and memory allocation: • Normal priority Resource pool(2) Recommended hard drive sizing averages:(3) • 15 input/output operations per second (IOPS) • 10 reads/sec • 5 writes/sec
Operating system	Windows 7 Professional SP1 operating system, 64-bit

(1) All numbers and figures are referenced for initial sizing only. Actual performance can vary in final implementation.

(2) See Resource Pool Allocation on page 72

(3) Check with your drive manufacturer for specifics. Manufacturers provide drives with varying amount of capacity at each speed.

Table 6.2 - OWS Traditional Requirements

Attribute	Product
Traditional infrastructure	The OWS must be installed on workstation-class hardware. The following are sample specifications based on PlantPAx system characterization: • Intel Core 2 Duo • 2.40 GHz CPU • 2 GB RAM min • Ethernet card that supports redundant media if NIC-teaming is used (If you plan to use a motherboard-NIC make sure it supports redundant media)
Operating system	Windows 7 Professional SP1 operating system, 64-bit

Operator Workstation Application Server (AppServ-OWS)

The AppServ-OWS uses Microsoft Remote Desktop Services (RDS) technology to serve multiple instances of the OWS as thin clients from a single-server. Thin clients can run applications and process data on a remote computer. The AppServ-OWS is only configured to run FactoryTalk View SE clients and the recommended limit is 10 clients per application server

Table 7 - AppServ-OWS Virtual Requirements

Attribute	Product(1)
Virtual infrastructure	Required: • 4 vCPU • 8 GB vRAM min Recommended CPU and memory allocation: • Normal priority Resource pool(2) Recommended hard drive sizing averages:(3) • 40 input/output operations per second (IOPS) • 25 reads/sec • 5 writes/sec
Operating system	Windows 2008 R2 SP1 operating system, 64-bit

(1) All numbers and figures are referenced for initial sizing only. Actual performance can vary in final implementation.

(2) See Resource Pool Allocation on page 72

(3) Check with your drive manufacturer for specifics. Manufacturers provide drives with varying amount of capacity at each speed.

Independent Workstation (IndWS)

The IndWS combines the roles of the PASS, EWS, and OWS in one computer.

Table 8 - IndWS Traditional Requirements

Attribute	Product
Traditional infrastructure	The IndWS must be installed on workstation-class hardware.The following are sample specifications based on PlantPAx system characterization: • Intel Core 2 Duo • 2.40 GHz CPU • 8 GB RAM • Ethernet card that supports redundant media if NIC-teaming is used (If you plan to use a motherboard-NIC make sure it supports redundant media)
Operating system	Windows 7 Professional SP1 operating system, 64-bit

Information Application Server (Historian)

The Information Management server can include a historian application to collect, manage, and analyze data. A base installation of a FactoryTalk Historian server is available via a virtual image template. For more information, see the Virtual Image Templates User Manual, publication 9528-UM001.

Table 9.1 - AppServ-Info (Historian) Virtual Requirements

Attribute	Product(1)
Virtual infrastructure	Required: • 2 vCPU • 4 GB vRAM min Recommended CPU and memory allocation: • High priority Resource pool(2) Recommended hard drive sizing averages:(3) • 100 input/output operations per second (IOPS) • 20 reads/sec • 80 writes/sec
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

(1) All numbers and figures are referenced for initial sizing only. Actual performance can vary in final implementation.

(2) See Resource Pool Allocation on page 72

(3) Check with your drive manufacturer for specifics. Manufacturers provide drives with varying amount of capacity at each speed.

Table 9.2 - AppServ-Info (Historian) Traditional Requirements

Attribute	Product
Traditional infrastructure	The Information Management server must be installed on server-class hardware: • Intel Xeon Multicore processor (4 cores or greater) • 2.40 GHz CPU • 4 GB RAM min • Dual hard drives (one for application code; one for logging) • Ethernet card that supports redundant media if NIC-teaming is used (If you plan to use a motherboard-NIC make sure it supports redundant media)
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

Information Application Server (VantagePoint)

The Information Management server can be used as a decision support tool by installing VantagePoint software.

Table 10.1 - AppServ-Info (VantagePoint) Virtual Requirements

Attribute	Product[1]
Virtual infrastructure	Required: • 2 vCPU • 4 GB vRAM min Recommended CPU and memory allocation: • Normal priority Resource pool[2] Recommended hard drive sizing averages:[3] • 100 input/output operations per second (IOPS) • 20 reads/sec • 80 writes/sec
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

(1) All numbers and figures are referenced for initial sizing only. Actual performance can vary in final implementation.

(2) See Resource Pool Allocation on page 72.

(3) Check with your drive manufacturer for specifics. Manufacturers provide drives with varying amount of capacity at each speed.

Table 10.2 - AppServ-Info (VantagePoint) Traditional Requirements

Attribute	Product
Traditional infrastructure[1]	The Information Management server must be installed on server-class hardware: • Intel Xeon Multicore processor (4 cores or greater) • 2.40 GHz CPU • 4 GB RAM min • Ethernet card that supports redundant media if NIC-teaming is used (If you plan to use a motherboard-NIC make sure it supports redundant media)
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

(1) A Microsoft Excel software license is required.

Asset Management Application Server (AppServ-Asset)

An asset management server (AppServ-Asset) is an extension to the PlantPAx system that adds maintenance and plant operations to the system. This server provides disaster recovery controller data, diagnostics, calibration, real-time monitoring, as well as auditing equipment and network health to improve overall resource availability.

Table 11.1 - AppServ-Asset Virtual Requirements

Attribute	Product(1)
Virtual infrastructure	Required: • 2 vCPU • 4 GB vRAM min Recommended CPU and memory allocation: • Normal priority Resource pool(2) Recommended hard drive sizing averages:(3) • 100 input/output operations per second (IOPS) • 20 reads/sec • 80 writes/sec
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

(1) All numbers and figures are referenced for initial sizing only. Actual performance can vary in final implementation.

(2) See Resource Pool Allocation on page 72

(3) Check with your drive manufacturer for specifics. Manufacturers provide drives with varying amount of capacity at each speed.

Table 11.2 - AppServ-Asset Traditional Requirements

Attribute	Product
Traditional infrastructure	The Information Management server must be installed on server-class hardware: • Intel Xeon Multicore processor (4 cores or greater) • 2.40 GHz CPU • 4 GB RAM min • Dual hard drives (one for application code; one for logging) • Ethernet card that supports redundant media if NIC-teaming is used (If you plan to use a motherboard-NIC make sure it supports redundant media)
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

Batch Management Application Server (AppServ-Batch)

The batch management server (AppServ-Batch) offers comprehensive batch management, including recipe management, procedural control of automated and manual processes, and material management. System size varies from small to large and system requirements vary from simple to complex.

Table 12.1 - AppServ-Batch Virtual Requirements

Attribute	Product(1)
Virtual infrastructure	Required: • 2 vCPU • 4 GB vRAM min Recommended CPU and memory allocation: • Normal priority Resource pool(2) Recommended hard drive sizing averages:(3) • 100 input/output operations per second (IOPS) • 20 reads/sec • 80 writes/sec
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

(1) All numbers and figures are referenced for initial sizing only. Actual performance can vary in final implementation.

(2) See Resource Pool Allocation on page 72

(3) Check with your drive manufacturer for specifics. Manufacturers provide drives with varying amount of capacity at each speed.

Table 12.2 - AppServ-Batch Traditional Requirements

Attribute	Product
Traditional infrastructure	The Information Management server must be installed on server-class hardware: • Intel Xeon Multicore processor (4 cores or greater) • 2.40 GHz CPU • 4 GB RAM min • Dual hard drives (one for application code; one for logging) • Ethernet card that supports redundant media if NIC-teaming is used (If you plan to use a motherboard-NIC make sure it supports redundant media)
Operating system	Windows 2008 R2 SP1 operating system, 64-bit (includes Microsoft Internet IIS with WWW service)

Process Controller

This section describes the components and sizing attributes for simplex, skid-based, and redundant controllers.

Simplex Controller

Non-redundant controllers are referred to as simplex controllers.

Table 13 - Simplex Controller Hardware Requirements

Category	Cat. No.
Process controller(1) (2)	ControlLogix 1756-L71, 1756-L72, 1756-L73, or 1756-L74, or 1756-L75 controller
EtherNet/IP interface	• 1756-EN2TR, 1783-ETAP, 1783-ETAP1F, 1783-ETAP2F (supports device-level ring topology) • 1756-EN2T, 1756-ENBT, 1756-EWEB, 1756-EN2F • 1756-EN2TSC for supported secure connections
ControlNet interface (if applicable)	• 1756-CN2, 1756-CN2R • 1756-CNB, 1756-CNBR

(1) If environmental conditions warrant, you can use an extreme temperature controller, for example, the 1756-L74XT.

(2) For a PlantPAx system, we recommend that you use the 1756-L7x controller family. The 1756-L6x controller family is supported for existing applications. Use the PSE if sizing information is required.

Table 14 - Simplex ControlLogix Controller Sizing

Category(1)	1756-L71	1756-L72	1756-L73	1756-L74	1756-L75(2)
User memory	2 MB	4 MB	8 MB	16 MB	32 MB
Total I/O recommended, max	375	750	1500	2250	2250
Total tags, max	15,625	31,250	62,500	112,500	112,500
Recommended control strategies, max(3)	60	125	250	450	450
Total control strategies @ 250 ms, max	60	125	250	250	250
Total control strategies @ 500 ms, max	60	125	250	450	450
Tags/sec delivered to data server, max	10,000	20,000	20,000	20,000	20,000

(1) These values are recommended maximum limits. It's possible that achieving all of these values in a single controller is not doable. For more detailed sizing, you can use the PSE (see page 16).

(2) The advantages to using the 1756-L75 controller is to maintain common spare parts with redundant systems or if you are doing some memory intensive storage not accounted for in the sizing model.

(3) Recommended maximum control strategies are based on all controller strategies being simple regulatory control. See Process Controller I/O Considerations on page 47.

Redundant Controllers

ControlLogix controllers support redundancy on ControlNet and EtherNet/IP networks. In a redundant controller system on PlantPAx, you need these components:

- Two 1756 chassis each set up the same with the following:
  - Number of slots
  - Modules in the same slots
  - Redundancy firmware revisions in each module
  - Two additional ControlNet or Ethernet nodes outside the redundant chassis pair
- One 1756-RM2 module per chassis

Table 15 - Redundant Controller Hardware Requirements

Category	Cat. No.
Process controller(1)	ControlLogix 1756-L73, 1756-L74, or 1756-L75 controller
Redundancy module	1756-RM2(2)
Ethernet interface	• 1756-EN2TR, 1783-ETAP, 1783-ETAP1F, 1783-ETAP2F (DLR support) • 1756-EN2T, 1756-ENBT, 1756-EWEB, 1756-EN2F (no DLR support)
ControlNet interface (if applicable)	• 1756-CN2, 1756-CN2R • 1756-CNB, 1756-CNBR

(1) If environmental conditions warrant, you can use an extreme temperature controller, for example, the 1756-L74XT.

(2) The PlantPAx system recommendation is to use only one redundant controller in a chassis with a 1756-RM2 redundancy module. While a 1756-RM2 module can support two controllers, the resulting performance of each controller is not easily predicted.

Make sure each controller in the redundancy chassis has enough memory to store twice the amount of controller data and I/O memory to support program modifications. The increased memory usage in a redundant controller provides for a bumpless transfer during a switchover to make sure the secondary Logix controller has the same values in its output image as the primary Logix controller. This prevents a switchover to a secondary controller with a mixture of old and new data memory.

When using the PlantPAx System Estimator, the PSE accounts for additional memory requirements required for redundancy as memory used.

Table 16 - Redundant ControlLogix Controller Sizing

Category(1)	1756-L73	1756-L74	1756-L75
User memory	8 MB	16 MB	32 MB
Total I/O recommended, max	750	1500	2250
Total tags, max	31,250	62,500	112, 500
Recommended control strategies, max(2)	125	250	450
Total control strategies @ 250 ms, max	120	120	120
Total control strategies @ 500 ms, max	125	220	220
Tags/sec delivered to data server, max	20,000	20,000	20,000

(1) These values are recommended maximum limits. It's possible that achieving all of these values in a single controller is not doable. For more detailed sizing, you can use the PSE (see page 16).

(2) Recommended maximum control strategies are based on all controller strategies being simple regulatory control. See Process Controller I/O Considerations on page 47.

Skid-based Controller

The PlantPAx process automation system is a complete, scalable system, from single controller to a fully distributed set of equipment. You can easily integrate skid-based equipment into the overall system.

The CompactLogix controller platform offers a solution for skid-based equipment to be part of the overall PlantPAx system if the application requires the following:

- Control of multiple loops for temperature, pressure, flow, or level
- Operating as a sub-system with sequencing and automation
- Controlled as part of the overall process, accepting reference inputs, and delivering process variables to a supervisory controller

IMPORTANT Be aware of memory usage within the CompactLogix family when using Library objects. See the PlantPax System Application Templates Quick Start, PROCES-QS001, for guidance of how to configure CompactLogix controllers with the Library of Process Objects.

Table 17 - Skid-based Controller Sizing

Category(1)	CompactLogix 1769-L24ER - QBFC1B	CompactLogix 1769-L33ER
User memory	0.75 MB	2.0 MB
Total I/O recommended, max	80	250
Total tags, max	4000	12,800
Recommended control strategies, max(2)	10	30
Total control strategies @ 250 ms, max	10	30
Total control strategies @ 500 ms, max	10	30
Tags/sec delivered to data server, max	3000	3000

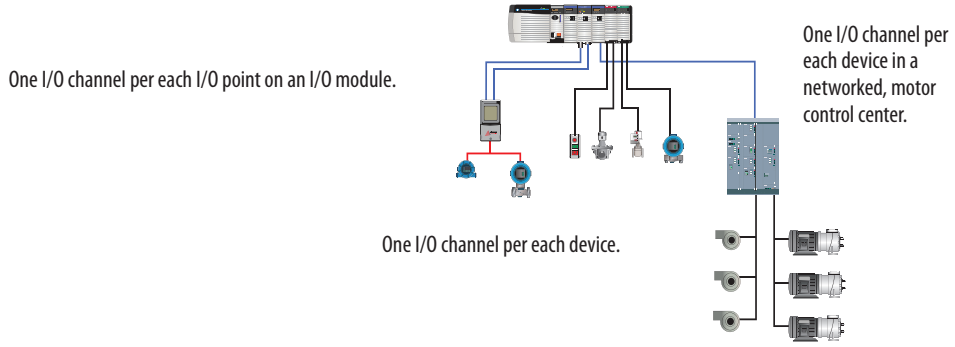
(1) These values are recommended maximum limits. It's possible that achieving all of these values in a single controller is not doable. For more detailed sizing, you can use the PSE (see page 16).
(2) Recommended maximum control strategies are based on all controller strategies being simple regulatory control. See Process Controller I/O Considerations on page 47.

Determining I/O Count

The I/O count for controller sizing is often determined directly from the application P&ID or plant design.

On existing systems where only classic I/O (for example, 4...20 mA, 24V DC dry contacts, and so forth) is used, the I/O count can be determined by the number of I/O channels available on the I/O cards.

When you have integrated smart devices, such as drives or transmitters, on an EtherNet/IP network, any signal from the device used by your control strategy is considered an I/O point when using the PSE to size based on control strategies.



For example, an I/O count for a system comprised with the following:

- Two 8-channel 4...20 mA input cards
- One 8-channel 4...20 mA output cards
- Two 16-channel 24V DC dry-contact input cards
- One MCC with six drives
  - Each drive provides six signals to the control strategy: speed reference, actual speed, start, stop, running, and fault.
- Two Coriolis meters on PROFIBUS PA, with each meter providing three signals for flow, temperature, and density.

The I/O count example has the following calculation:

4...20 mA AI	2 x 8 = 16	
4...20 mA AO	1 x 8 = 8	
24V DC DI	2 x 16 = 32	
MCC	6 x 6 = 36	(6 AI, 6 AO, 12 DI, 12 DO)(1)
Smart instruments	2 x 3 = 6	(6 AI)
Controller I/O count	98	

TIP When calculating I/O count for controller sizing, it is good practice to add spare capacity to allow for project changes or future enhancements.

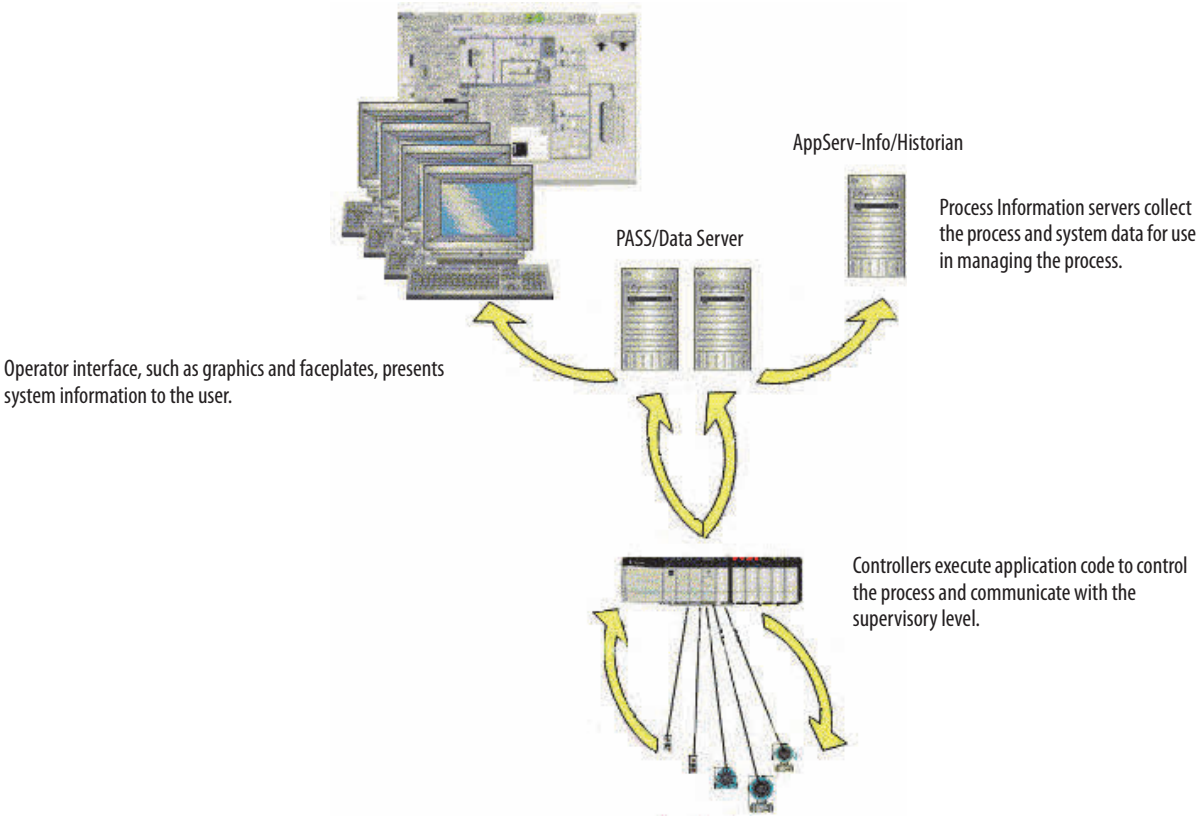
(1) By using this method, you are overusing alarm estimation. Our recommendation is to reduce the percentage of potential alarms used in the PSE.

Sizing Control Strategies

A control strategy encompasses all of the application code required to implement a specific control function. This includes the I/O, controller code, display elements, and faceplates.

By using the control strategy model, we are able to estimate the following system parameters:

- Controller memory usage
- Controller CPU utilization
- Data server memory usage
- Communication bandwidth (tags/sec delivered to data server)



By estimating the size of control strategies, you have a better prediction of system performance.

The amount of resources consumed by the system elements to support a control strategy provides a 'footprint'. To size systems, these base control strategies have been established as system footprints in the PSE:

- **Simple regulatory:** This is a simple PID loop with a single analog input and analog output.
- **Complex regulatory:** This is a more complex regulatory loop such as PID controllers in a cascade configuration with two analog inputs and one analog output.
- **Simple 2-state discrete:** A simple valve or motor with basic interlock logic and a single digital input and output.
- **Complex 2-state discrete:** A valve or motor with complex interlock, permissive, and restart inhibit logic that can have two digital inputs and two digital outputs
- **Complex regulatory non-PID:** This can be a complex control strategy, such as a loss in weight feeder, that can include an analog input, valves, and a motor.
- **Digital indicator:** A digital input used for indication and/or alarm only.
- **Analog indicator:** An analog input used for indication and/or alarm only.

While this is not a comprehensive list of the types of strategies used in an application, they do provide a reasonable set of examples that can be used to approximate the loading of the majority of typical application code.

For each control strategy, we can estimate the footprint based on the following:

- **Visualization Tags:** The number of tags within the control strategy that can be visualized through a display or faceplate on the OWS (inclusive of operation, maintenance, and debug activities). This number affects server and controller memory utilization.
- **Historian Tags:** The number of tags within the control strategy that are typically brought into the historian. This number affects communication bandwidth for example, active tags on scan/sec).
- **# of Potential Alarms:** The maximum number of alarms that can be defined. It is assumed that not every alarm is configured for use. The alarms used are configured in the server that contains the controller.
- **Memory, KB:** The amount of memory an instance of the control strategy and its associated tags uses inside of a simplex controller.
- **Execution time (microseconds):** The amount of controller CPU time it takes to run an instance of the control strategy under simulated loading (this is inclusive of the cross loading time for redundant controllers).

When a control strategy is instantiated, its impact to the controller is dependent on task rate for the task containing a control strategy. A PID loop running every 250 milliseconds takes twice the CPU capacity as the same PID loop running every 500 milliseconds.

Redundancy Considerations

The following occurs by using redundant controllers:

- Scan rate increases 2...3 times.
- Memory use increases 1.1...1.2 times.
  - When looking at controller memory, you will not see the total memory usage for redundancy. You need to calculate the actual memory that is used.

IMPORTANT Spare memory requirement also is increased in redundancy.

See the ControlLogix Enhanced Redundancy System User Manual, publication 1756-UM535, for more information.

Notes:

System Application Recommendations

This section contains integral information for configuring controllers and other applications on your PlantPAx system. We strongly recommend that you review these topics to be sure the system is set-up and performing properly.

The following table describes where to find specific information.

Controller Recommendations

Logix controllers must be configured for optimal performance in process applications. Using RSLogix 5000 software, follow these recommendations when configuring your controllers:

- Use periodic tasks **only**, with minimum number of tasks used to define execution speed, faster tasks getting higher priority (lower number).
- Set up monitoring of your controller utilization by using the L_CPU Add-On Instruction.
- Specify a requested packet interval (RPI) that is two times faster than task execution or based on inherent properties of the signal being measured. For example, a 500 ms task requires a 250 ms RPI on each I/O card, but temperature measurements can be set slower as they are unlikely to change that quickly.
- Limit the number of synchronous copy commands (CPS) as these act as an interrupt to the controller. Tasks that attempt to interrupt a CPS instruction are delayed until the instruction is done.
- Use Compatible Keying for configuring I/O module cards. However, in a validated environment you can use an Exact Match for keying.

  For more information, see Electronic Keying in Logix5000 Control Systems Application Technique, publication Logix-AT001.

Table 18 shows memory and CPU recommendations for simplex and redundant controllers.

Table 18 - Simplex and Redundant Controller Memory Recommendations

Environment	Simplex Controllers	Redundant Controllers
Outside of production environment (before connecting FactoryTalk View and Historian clients)	50% free memory to support communication and handling of abnormal conditions	>50% free memory at all times
	50% free CPU time to handle communication, abnormal conditions, and other transient loads	
In the production environment (while FactoryTalk View and Historian are connected)	30% free memory to support handling of abnormal conditions	>50% free memory at all times
	25% free CPU time	50% free CPU time

Task Configuration and CPU Utilization

The controller operating system is a preemptive, multitasking system that is IEC 61131-3 compliant. ControlLogix and CompactLogix controllers define the schedule and priority of how programs are executed by using tasks.

Periodic Task Configuration

As we stated earlier, controllers configured for the PlantPAx system must use periodic tasks **only**. PlantPAx system sizing rules and tools are dependent on this specific execution configuration. For example, a controller is typically configured with three periodic tasks:

- Fast task (100...250 ms) for discrete control, such as motors and pumps
- Medium task (250...500 ms) for flow and pressure loops or analog inputs
- Slow task (1000...2000 ms) for temperature, phases, batch sequencing

As shown in Table 19, a naming convention is used so that tasks are listed in RSLogix 5000 software programming in the order of execution period: fastest to slowest regardless of the tasks used. A dedicated task is created to monitor status of the controller and other tasks. We recommend that you delete tasks not used or create tasks only required by the application.

Table 19 - Recommended Task Configurations

Name	Type	Period (ms)	Priority (lower number yields higher priority)	Watchdog (ms)	Disable Automatic Output Processing
Task_A_50ms	Periodic	50	5	150	Unchecked
Task_B_100ms		100	6	300	
Task_C_250ms		250	7	750	
Task_D_500ms		500	8	1500	
Task_E_1s		1000	9	3000	
Task_F_2s		2000	10	6000	
Task_G_5s		5000	11	15,000	
Task_H_10s		10,000	12	30,000	
_Controller_Status		1000	13	3000	

Each task that exists and is not inhibited has execution overhead. For sizing the PlantPAx system, we estimate this overhead as 1000 µs per task. The PSE calculates CPU utilization by calculating the required CPU time for the selected quantity of control strategies in each task.

Although a project can contain multiple tasks, the controller executes only one task at a time. If a periodic or event task is triggered while another task is currently executing, the priority of each task tells the controller what to do. Make sure your periodic task priorities are unique.

The total execution time of all the tasks should be less than half the execution time of the lowest priority task or slowest task. For example, if you have a few hundred I/O points in a controller and a fast loop in a 15 ms task that executes every.5 ms, your other code could not be greater than 6.5 ms.

Follow these guidelines for task execution:

- **Never use continuous tasks**. Use periodic tasks only, with minimum number of tasks used to define execution speed, faster tasks getting higher priority (lower number).

  A continuous task is created by default in RSLogix 5000 software. This continuous task **must** be deleted. If left as the default, the continuous task runs in the background of the controller as the lowest priority task. Any controller CPU time that is not allocated to other operations or tasks is used to execute the continuous task.

  When the continuous task completes, it restarts automatically and is stopped only by a system overhead time slice. The system overhead time slice defines the amount of time the controller has available for communication. Thus, an overhead time slice interrupts the continuous task for communicating to HMI devices, processing MSG instructions, and alarm instruction processing.

  This limits the flexibility of the controller to apply resources to handle abnormal conditions in communication. However, the overhead time slice is **ignored** when a continuous task is not configured.

- Removal of the continuous task:

  – Improves predictability of the controller CPU availability for communication to the system
  – Provides a more accurate view of the controller loading at run time. With continuous task, controller loading is always 100%
  – Reduces the amount of task switching that improves overall application and system performance

- Time-based operations, such as a PID algorithm, do not function accurately when run in a continuous task

- Do not use more than three periodic tasks to maintain optimum CPU performance. Batching can require more tasks, but we recommend that periodic tasks be event tasks if not in a redundant controller.

Estimating Controller CPU Utilization

The PSE uses a sizing model to estimate controller CPU utilization in a production environment. This calculation is as follows:

- Task Execution time is 1000 µs + sum of control strategy execution times assigned to the task
- Total controller execution time is a summation of task execution times normalized to the slowest task. For example:

  250 ms Task Execution Time * 4 + 500 ms Task Execution Time * 2 + 1000 ms Task Execution time (if using 3 tasks: 250 ms, 500 ms, and 1000 ms)

- Tasks without assigned control strategies are ignored. It is assumed that these tasks are not created or are inhibited in the controller.
- CPU utilization is a percentage of the controller execution time/slowest task rate

Higher priority tasks interrupt lower priority tasks if needed to run. When the task interrupted is in progress, we call this task switching. A task switch adds execution overhead as well. If your faster tasks have higher priority, task switching does not occur in properly sized controllers. (A properly sized controller is when the total execution time of all of the tasks is less than half of the fastest task rate.) Hence, the PSE sizing model does not account for task switching when estimating utilization.

When periodic tasks have the same priority, the controller task switches every 1 ms until tasks are completed, each switch adding 250 -> 25 µs. This is why it's important that periodic tasks are given separate priorities. In Logix, you have up-to 15 user-defined priorities.

Keep in mind we want CPU load in a production environment to be 75% or less. It's important to keep 25% CPU capacity as reserve to handle online edits, data server switchover, and so forth. The PSE provides a warning when the calculated CPU load > 70%.

A task overlap is when a task is interrupted too frequently or too long that it doesn't complete its execution before it is triggered again. Avoid task overlaps that can be monitored by using the L_TaskMon Add-On Instruction.

For more general information on ControlLogix execution capabilities, see the Logix5000 Controllers Design Considerations Reference Manual, publication 1756-RM094.

Estimating CPU Utilization Examples

The following examples show how configuration affects the sizing model and actual CPU utilization. For all scenarios, we are assuming a 1756-L7*x* controller that is running 100 PID loops (575 µs execution per loop).

Example 1: 100 PID loops in a single periodic task @ 100ms:

Task Execution Time: 1000 µs + (100 PID loops * 575 µs) = 58,500 µs

CPU = 58,500 µs /100,000 µs = 58.5% load

Example 2: 100 PID loops evenly split for two periodic tasks @ 100 ms but same priority:

Task 1 Execution: 1000 µs + (50 PID loops * 575 µs) = 29,750 µs

Task 2 Execution: 1000 µs + (50 PID loops * 575 µs) = 29,750 µs

The task switch occurs every 1 millisecond until both tasks complete. For this example, we estimate the overhead for a task switch to be 25 µs.
47 task switches * 25 µs = 1175 µs

Total Execution time: 29,750 µs + 29,750 µs + 1175 µs = 60,675 µs

CPU = 60,675 µs /10,000 µs = 61%

In this scenario, loading is okay. However, because the PSE assumes proper task configuration, it doesn't account for the impact of the additional task overhead or the task switching.

Example 3: 100 PID loops evenly split for two periodic tasks, first @ 50 ms, second @ 250 ms:

Task 1 Execution Time: 1000 µs + (50 PID loops * 575 µs) = 29,750 µs

Task 2 Execution Time: 1000 µs + (50 PID loops * 575 µs) = 29,750 µs

Total Execution per 250 ms = ((29,750 µs *5)+29,750 µs) = 178,500 µs

CPU Utilization: 178,500 µs / 250,000 µs = 71.4%

In this scenario, loading is not okay (> 70%). However, this matches the PSE calculation that gives you a warning.

Example 4: Loops evenly split to 10 periodic tasks @ 100 ms and different priorities:

Task Execution per task: 1000 µs + (10 PID Loops * 575 µs) = 6750 µs

Total Execution time: 10 * 6750 µs = 67,500 µs

CPU = 67,500 µs / 10,000 µs = 67.5%

In this example, loading is near the desired limit but still okay (<70%). The PSE assumes proper task configuration, but it doesn't account for the impact of the additional task overhead or the task switching (approximate 20% increase in CPU load).

The goal of the PlantPAx system recommendations and PSE is to make it simple to size the system and provide assurance that everything works as expected. This is a critical need. While the examples are simple; they illustrate how configuration can impact load.

Monitoring Controller CPU Utilization

Free process controller CPU time is required to handle communication, abnormal conditions, and other transient loads. Therefore, it's important to consider CPU utilization when implementing the application code.

When defining the application code, make sure the CPU utilization of the process controller can accommodate these values:

- In the development environment, CPU utilization is recommended to be less than 50% to allow for the additional CPU load that is experienced in the production environment.
- During the operation of the system, monitor the CPU utilization, especially after a change to the application code, and it cannot exceed 75%.
- During the design of the application code, it's important to account for software components, such as FactoryTalk View or Historian. The software is actively collecting data from the controller so be sure that CPU utilization is less than 75% to allow for communication with the supervisory system elements (EWS, OWS, Information server).

There are two options for reviewing controller loading:

- Task Monitor - Available from RSLogix 5000 software on the EWS. If more than one task monitor is viewing a controller at the same time, it's possible controller data is not reporting correctly.
- Logix Controller CPU Utilization (L_CPU) Add-On Instruction - See the Rockwell Automation Library of Logix Diagnostic Objects Reference Manual, publication PROCES-RM003.

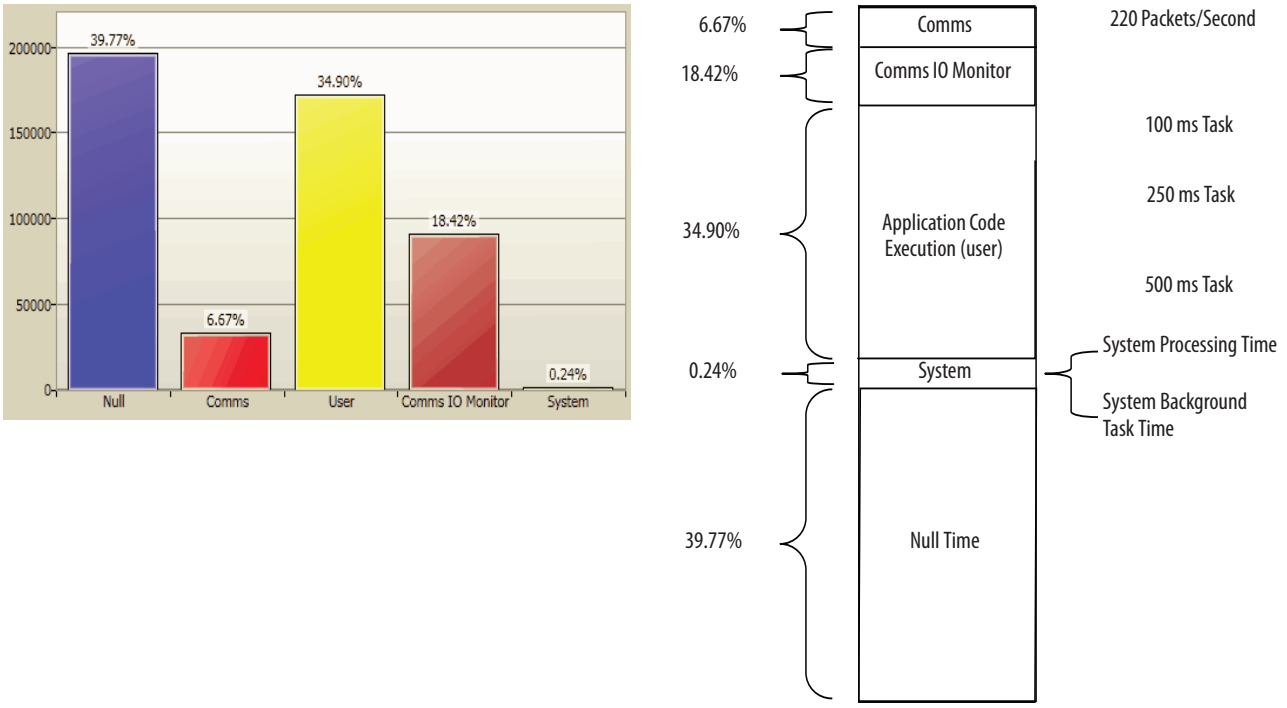
IMPORTANT	The L_CPU instruction is the preferred method to monitor controller performance because the logic monitors the Logix controller that is being executed. The controller is used in place of, or in addition to, the task monitor to provide more system-specific controller loading information.

Controller loading includes controller CPU utilization, communication usage, memory usage, and task scan times. This data provides information for diagnosing communication, controlling responsiveness issues, or in tuning the performance of control tasks for optimum controller performance.

The diagram in Figure 2 shows a properly loaded controller for the following:

- Application code execution is less than 50% CPU
- Total execution including comms is less than 75% CPU

Figure 2 - CPU Utilization



For more information, see the Rockwell Automation Library of Logix Diagnostic Objects Reference Manual, publication PROCES-RM003.

Tag and Memory Allocation

Table 20 shows the memory of a controller is divided into several areas depending on the type of controller.

Table 20 - Controller Memory Allocation

Controller Type	Storage	Memory
1756 ControlLogix 1768 CompactLogix	I/O tags	I/O memory
	Produced/consumed tags	
	Communication via message (MSG) instructions	
	Communication with workstations	
	Communication with polled (OPC/DDE) tags that use RSLinx software(1)	
	Tags other than I/O, produced, or consumed tags	Data and logic memory
	Logic routines (for example, control strategies)	
	Communication with polled (OPC/DDE) tags that use RSLinx software(1)	
	UDT and Add-On Instruction definition	
1769-L2*x* CompactLogix 1769-L3*x* CompactLogix	These controllers do not divide their memory. They store all of the elements in one common memory area	

(1) To communicate with polled tags, the controller uses both I/O data and logic memory.

When configuring displays, we recommend that you use direct tag referencing to access data from the controller directly without creating an HMI tag. This requires less configuration steps and is easier to maintain.

Use DINT and REAL data types whenever possible. Mathematical routines in the controller consume less CPU resources when DINT and REAL data types are used.

A user-defined data type (UDT) or Add-On-instruction data type lets you organize data to match your machine or process. Additional advantages of using a UDT or an Add-On Instruction include the following:

- One tag contains all the data related to a specific system activity. This keeps related data together and easier to locate, regardless of its data type.
- Each individual piece of data (member) gets a descriptive name. This automatically creates an initial level of documentation for your logic.
- You can use the data type to create multiple tags with the same data layout.

  For example, you can use a UDT to store all the parameters for a tank, including temperatures, pressures, valve positions, and preset values. Create a tag for each of your tanks based on that data type.

You can create a UDT when online or offline. However, you can modify an existing UDT definition when offline only.

General Recommendations

- Define tags in arrays and a UDT whenever possible. Tag data that is packed into an array is sent more efficiently to the HMI than if you were using scattered tag data.
- When defining a UDT, group BOOL tags together whenever possible. Inside the controller memory, BOOL tags must align on 8-bit boundaries. But, if they are placed adjacent to each other they can share the same byte and use less memory and communication bandwidth.
- BOOL data types that are not members of an array or structure use 4-bytes of controller memory. When communicating multiple BOOL tags between controllers or to displays, use a UDT or array to consolidate multiple BOOL tags into a single word.
- Define a tag naming convention that minimizes the length of the tag names. Long tag names can decrease the bandwidth available for communicating data.

For more information, see the Logix5000 Controllers I/O and Tag Data Programming Manual, publication 1756-PM004.

Estimating Controller Memory Utilization

The PSE uses a sizing model that is based on control strategies to estimate controller memory utilization in a production environment. There are three sources of memory that comprise this sizing model:

- Memory for base definitions - Base definition memory varies depending on the amount of Add-On Instruction and UDT definitions in the project. Loading all of the Rockwell Automation Library definitions takes over 1 MB of memory, while loading the most common objects take much less memory. By default, the PSE assumes a base load of 380 KB. This is adjustable in the PSE system preferences, if needed.

  For more information, see the PlantPAx System Application Templates Quick Start, publication PROCES-QS001.

- Memory used by control strategies - See Monitoring Controller CPU Utilization on page 40.
- Memory to support communication - The defined control strategies have a number of visualization tags for each control strategy (inclusive of operation, maintenance, and debug activities). During operation, the controller uses controller memory to manage the connections to these tags as they are accessed. The amount of memory used varies, but the PSE estimates 16 bytes per tag.

When controller redundancy is used, memory usage increases and additional spare capacity is required to allow for run-time edits. The PSE sizing model accounts for these needs by increasing the estimated amount of memory used to enforce the same 75% of memory capacity limit for both simplex and redundant controller types.

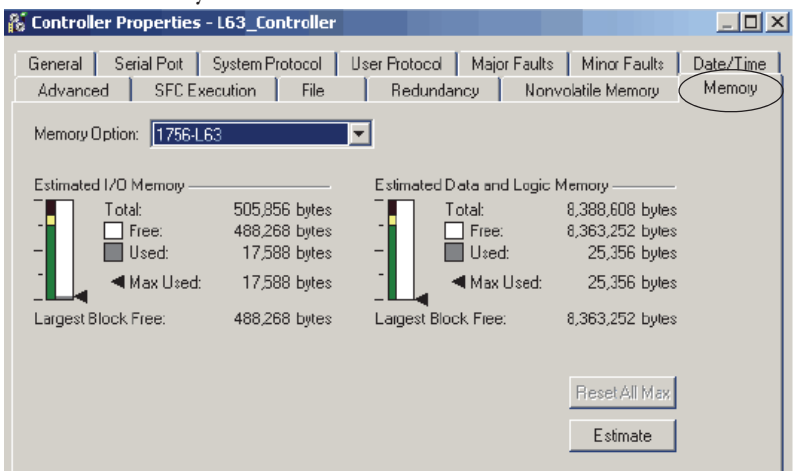
Estimate Memory Information Offline

To estimate how much controller memory your project requires, use the Memory tab of the Controller Properties dialog box. For each of the memory areas of your controller, the dialog box lets you estimate number of bytes for the following:

- Free (unused) memory
- Used memory
- Largest free contiguous block of memory

1. Using RSLogix 5000 software, click the controller properties icon to access the Controller Properties dialog box.

2. Click the Memory tab.



   In the 'Estimated Data and Logic Memory' section, view the memory information since the last estimate.

3. Click Estimate to re-estimate the amount of controller memory.

View Run-time Memory Information

When online with a controller, the Memory tab shows the actual memory usage of the controller. While the controller is running, it uses additional memory for communication. The amount of memory the controller needs varies depending on the state of the communication.

The Memory tab of the controller includes a Max Used entry for each type of memory. The Max Used values show the peak of memory usage as communication occurs.

Click Reset All Max on the Memory tab to reset values.

For more information, see Chapter 2 in the Logix5000 Controllers Information and Status Programming Manual, publication 1756-PM015.

Monitoring Controller Memory Utilization

We recommend that 50% of available logic and data memory be reserved for design time of communication, online editing, and handling of abnormal events. For simplex controllers, we recommend maintaining 25% of available logic and data memory to handle online editing and connection handling in operation.

For redundant controllers, we recommend that you maintain greater than 50% of logic and data memory available to handle online changes.

Memory usage can be monitored by using the L_CPU Add-On Instruction (see page 40) or the RSLogix 5000 software application (see page 44).

Intra-Controller Communication

There are two ways to set-up communications between controllers:

- Produced/consumed tags
- Messages

Table 21 - Compare Messages and Produced/Consumed Tags

Method	Benefits	Considerations
Read/write message	• Programmatically initiated • Communication and network resources used when only needed • Support automatic fragmentation and reassembly of large data packets, up to as many as 32,767 elements • Some connections can be cached to improve re-transmission time • Generic CIP message useful for third-party devices	• Delay can occur if resources are not available when needed • MSG instruction and processing impacts controller scan (system overhead time slice) • Data arrives asynchronous to program scan (use a programmatic handshake or an UID/UIE instruction pair to reduce impact, no event task support) • Can add additional messages online in Run mode
Produced/consumed tag	• Configured once and sent automatically based on requested packet interval (RPI) • Multiple consumers can simultaneously receive the same data from a single produced tag • Can trigger an event task when consumed data arrives • ControlNet resources are reserved up front • Does not impact the scan of the controller	• Support limited to Logix5000 and PLC-5 controllers, and the 1784-KTCS I/O Linx and a few third party devices • Limited to 500 bytes over the backplane and 480 bytes over a network • Must be scheduled when using ControlNet • Data arrives asynchronous to program scan (use a programmatic handshake or CPS instruction and event tasks to synchronize) • Connection status must be obtained separately • With RSLogix 5000 software version 17 and later, you can configure status information for a produced/consumed tag • On an EtherNet/IP network, you can configure produced/consumed tags to use multicast or unicast connections • Cannot create additional produced/consumed tags online in Run mode.

We recommend using an array or user-defined tag for produce-consume communication. As produce/consumed tags cannot be edited online, make sure to include extra capacity that can be populated by mapping logic so additional information can be shared as needed without requiring a download.

Table 22 - Process Controller Recommendations

Attribute	Recommendation
Produced and consumed tags	• A single produced and consumed tag can contain multiple combinations of data. For example, up to 120 REALs or 100 REALs and 640 BOOLs. • Group produced and consumed tags into a user-defined structure to reduce the number of connections to the controller. • Use the same data type for the produced and consumed tags in each controller that uses that data. • Make sure the number of consumers configured for a produced tag is the actual number of controllers consuming it to reduce the number of connections to the controller. • On produced tags, the maximum consumers configured counts against your total connection count so make it the actual number of connections or set it at the expected number to be in the future. • Always use a handshake when transferring data between controllers through health data or manually configured diagnostics.
Messaging	• There is a maximum of 32 cached message connections from message instructions and block-transfers combined. • Cache messages when the message needs only to be maintained all the time. If a message instruction is infrequent then make sure cached connection is unchecked. • Always use message reads, never do message writes. This makes it easier to troubleshoot code. • When messaging between controllers, use DINTs where possible. • Message instructions consume a connection when it is a CIP data table read, write, or generic (if selected).

Process Controller I/O Considerations

The requested packet interval (RPI) is a user-configured interval of time that determines when an I/O module's data is sent to a process controller. This interval defines the slowest rate that a module multicasts its data. When the specified time frame elapses, the module multicasts data to the controller.

Setting the RPI faster (specifying a smaller number) than what your application needs wastes network resources, such as ControlNet schedule bandwidth, network processing time, and CPU processing time.

Table 23 - I/O Considerations

Attribute	Consideration
I/O configuration properties	• Specify an RPI that is two times faster than task execution: – 250 ms task requires a 125 ms RPI – 100 ms task requires a 50 ms RPI • Often RPI defined by the inherent properties of the signal being measured. For example temperature measurement changes slower than pressure. • Use compatible module for keying option on I/O cards configuration. In a validated environment, you can use an exact match for keying.
ControlNet network	• Set the network update time (NUT) equal to or less than the fastest RPI of the I/O modules and produced-consumed tags in the system. For example, if your fastest RPI is 10 ms, set the NUT to 5 ms for more flexibility in scheduling the network. • Set the RPI to a binary multiple of the NUT. For example, if the NUT is 10 ms, select an RPI such as 10, 20, 40, 80, 160 ms, and so forth. • Use unscheduled I/O to be able to add ControlNet modules at runtime. (See I/O Module Runtime/Online Considerations.) Dedicate one ControlNet network to I/O communication only. • Unscheduled I/O requires a connection to each module, so the number of modules supported depends on the number of connections supported by the communication module. On the dedicated I/O network, make sure of the following: – No HMI traffic – No MSG traffic – No programming workstations – No peer-to-peer interlocking in a multi-processor system architecture
EtherNet/IP network	See Chapter 6 for infrastructure recommendations.

I/O Module Runtime/Online Considerations

Table 24 shows some of the modules that you can add to the Controller Organizer in RSLogix 5000 software when the controller is in Run mode.

Table 24 - Online Addition of Module and Connection Types

Module Type and Communication Method	In Local Chassis		In Remote Chassis via a ControlNet Network				In Remote Chassis via an EtherNet/IP Network	
	Offline	Runtime	Offline		Runtime		Offline	Runtime
			Scheduled	Unscheduled	Scheduled	Unscheduled		
Digital -direct	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Digital-rack-optimized	N/A	N/A	Yes	No	Yes	No	Yes	Yes
Analog - direct	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Generic third-party - direct	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
1756-DNB	Yes	No	Yes	No	No	No	Yes	Yes
1756-DHRIO	Yes	No	Yes	No	No	No	Yes	Yes
1756-CN*x* - no connection	Yes	Yes	Yes	Yes	No	Yes	N/A	N/A
1756-CN*x* - rack-optimized	N/A	N/A	Yes	N/A	N/A	N/A	N/A	N/A
Generic ControlNet third-party-direct	N/A	N/A	Yes	Yes	No	Yes	N/A	N/A
1788-EN2FFR linking device	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes
1788-CN2FFR linking device	N/A	N/A	Yes	Yes	No	Yes	N/A	N/A
1788-EN2PAR	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes
1788-CN2PAR	N/A	N/A	Yes	Yes	No	Yes	N/A	N/A
1715 Redundant I/O	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes
1756-EN*x* - no connection(1)	Yes	Yes	N/A	N/A	N/A	N/A	Yes	Yes
1756-EN*x* - rack-optimized(1)	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes
Generic EtherNet/IP third-party - direct	N/A	N/A	N/A	N/A	N/A	N/A	Yes	Yes
FLEX I/O™ and POINT I/O™	N/A	N/A	Yes	Yes	No	No	Yes	No

(1) 1756-EN2DN and 1756-EN2CN modules cannot be added online.

When you design your network, review these considerations if you are going to add I/O modules at runtime.

Table 25 - Adding I/O Modules at Runtime

Design Issue	Consideration
I/O modules	Currently, 1756 I/O and 1715 modules can be added at runtime. Leave space in the local chassis, remote chassis on a ControlNet network, or remote chassis on an EtherNet/IP network for the I/O modules that you want to add.
Input transmission rate	Make sure each RPI works for the data you want to send and receive. Make sure the added I/O does not depend on change-of-state data. When adding discrete input modules, unselect Change of State to reduce network traffic.
Network topology	On a ControlNet network, install spare taps so you can add 1756 I/O modules at runtime without disrupting the network. Each tap must be terminated so as to not ground out the system. Check the ControlNet system requirements to determine how many spare taps your network can support. • In a ControlNet network with redundant cabling, you can break the trunk and add a new tap, but redundant cabling is lost during the module installation. • In a ControlNet ring, add a new drop off the rung or add new nodes off the coax and disrupt only part of the network. • You could remove a single existing node and add a repeater off of the drop. Then re-add the existing node and add any new nodes off of the new segment. On EtherNet/IP, reserve some connection points on the switch so that you can connect additional nodes or switches in the future.
Network configuration	On a ControlNet network, plan communication that can be scheduled or can be unscheduled. On an EtherNet/IP network, all communication is Immediate and occurs based on a module's RPI (also referred to as unscheduled). If you know that you need a new chassis with digital modules in the future, configure the network and add it to the I/O configuration tree as rack-optimized. Inhibit the communication adapter until you need the chassis.
Network performance	You can add I/O modules at runtime until you impact the capacity of the communication module. Make sure you have sufficient communication modules for the connections you plan to add.

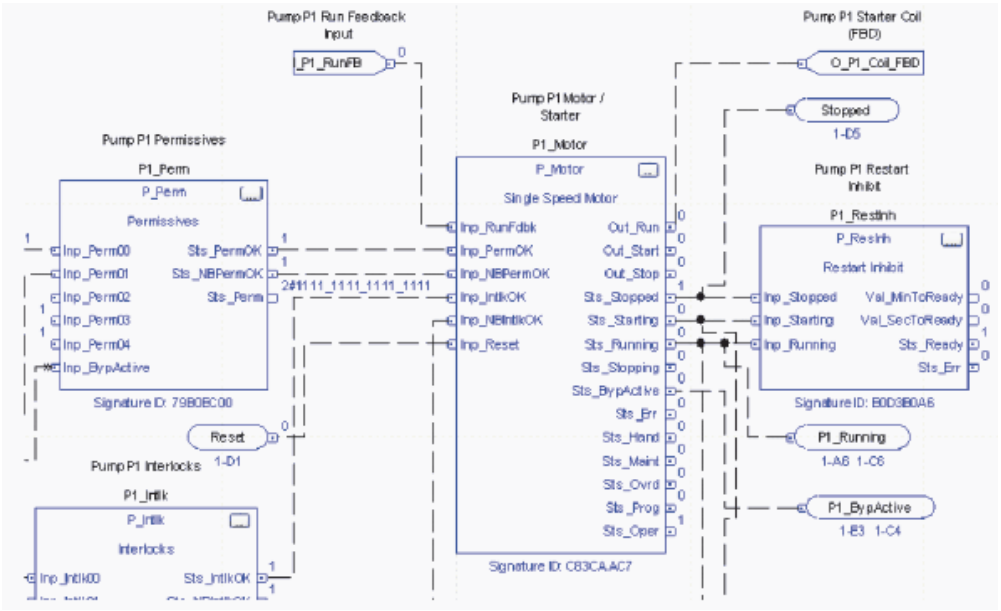
See the Logix5000 Controllers Design Considerations Reference Manual, publication 1756-RM094, for more information.

Using Add-On Instructions

Add-On Instructions are reusable code objects that contain encapsulated logic. Each object is provided as an importable Add-On Instruction that can be shared between projects to create a common library of instructions to accelerate engineering from project to project. Add-On Instructions also can be signed with a specific date and time, so that revisions of Add-On Instructions can be managed between projects.

This lets you create your own instruction set for programming logic as a supplement to the instruction set provided natively in the ControlLogix and CompactLogic firmware.

Add-On Instructions are defined once in each controller project, and can be instantiated multiple times in your application code as needed. In RSLogix 5000 software, you can view the routines within an Add-On Instruction instance online, animated with just that instance's value as if it were an individually defined routine.



Add-On Instructions can be source protected. Source protection does not let you edit the instruction's definition without a source key. To protect intellectual property, routines and local tags also can be hidden on protected Add-On Instructions.

Like a native instruction, the definition of an Add-On Instruction cannot be modified online. Therefore, we do **not** recommend the use of Add-On Instructions to implement control strategies. Control strategies are best developed in a program, built from Add-On Instructions and native instructions. It's also important that you fully test all configuration options before implementing an Add-On Instruction on your production system.

The Rockwell Automation Library of Process Objects uses Add-On Instructions. For related information, see page 53 and page 59.

FactoryTalk View Recommendations

For implementing FactoryTalk View SE software for a process system operator interface, follow these guidelines:

- Run FactoryTalk View Studio software on the EWS during runtime.
- Configure the FactoryTalk View SE servers to start automatically on start up on the PASS. Let the servers fully start up before starting the client computers.
- In FactoryTalk View Studio software, areas can be used to organize your distributed system. Configure an area for each server of any type. Areas can contain areas. However, do not put more than one server in the root location of an area. This helps prevent potential performance problems. In addition, this name hierarchy can be visible externally, such as in the historian or alarm database.
- Minimize the number of areas accessed on one display.
- Use global objects to display the status of a control module or device when the information to be displayed is stored in a tag structure within Logix (for example, UDT or AOI) and there are many identical instances. A global object is a display element that is created once and can be referenced multiple times on multiple displays in an application. When changes are made to the original (base) object, the instantiated copies (reference objects) are automatically updated. Use of global objects, in conjunction with tag structures in the ControlLogix system, can help ensure consistency and save engineering time.
- When using global objects, observe the following recommendations to be sure of optimal display call-up performance:
  - Base global objects are stored in FactoryTalk View in global object displays (.ggfx files). If you have a large number of base global objects defined, do not put them all in a single global object display. Try to organize your global object displays logically, trying to keep an average of 30 base global objects per global object display while minimizing the number of different global object displays referenced by a single standard display.
  - Limit the number of global object instances on a single display to 40 or less.
  - As global objects can be instantiated multiple times, the performance impact of their design is amplified by their number of instances. Therefore, design global objects carefully to reduce the number of objects, expressions and animations used within the base object.
- Limit the number of dynamic references on a display to 1,000 references (HMI or direct reference tags). Be aware that each global object instance can represent multiple references. This improves display call up performance.
- Use derived tags for complex expressions or alarm functions that are repeatedly used within graphic displays (for example, alarm expressions). This reduces HMI server load.

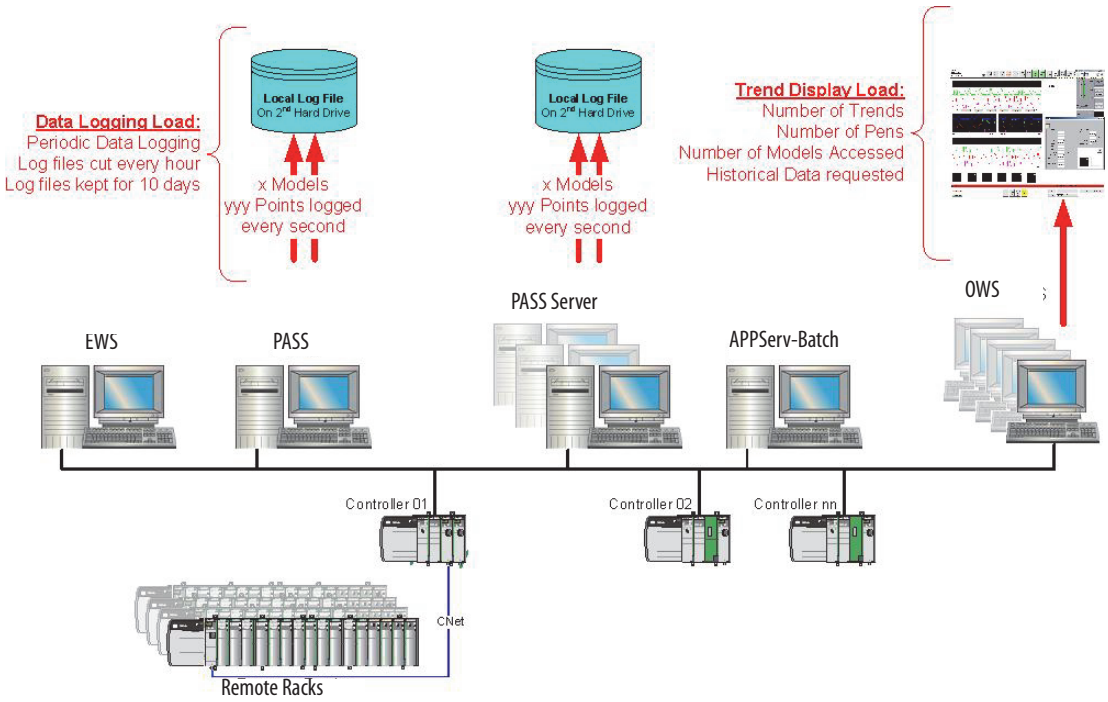
- Do not create derived tags that depend on the results of other derived tags. Derived tag processing is not sequential.
- Avoid use of VBA when possible. VBA runs as a single-threaded process so it's possible the application written in VB does not allow the HMI to perform predictably.

Data Log Recommendations

Data logging uses the FactoryTalk View SE application data log capability. We recommend that logging be used for short-term data retention only (typically less than a 24-hour period). Data is stored on the PASS of operator-defined process variables to aid in controlling the process. Data logging is for storing a minimal number of data (for example, no more than 50 data log points per controller). For long-term data storage or to collect a large number of data points, use the FactoryTalk Historian software.

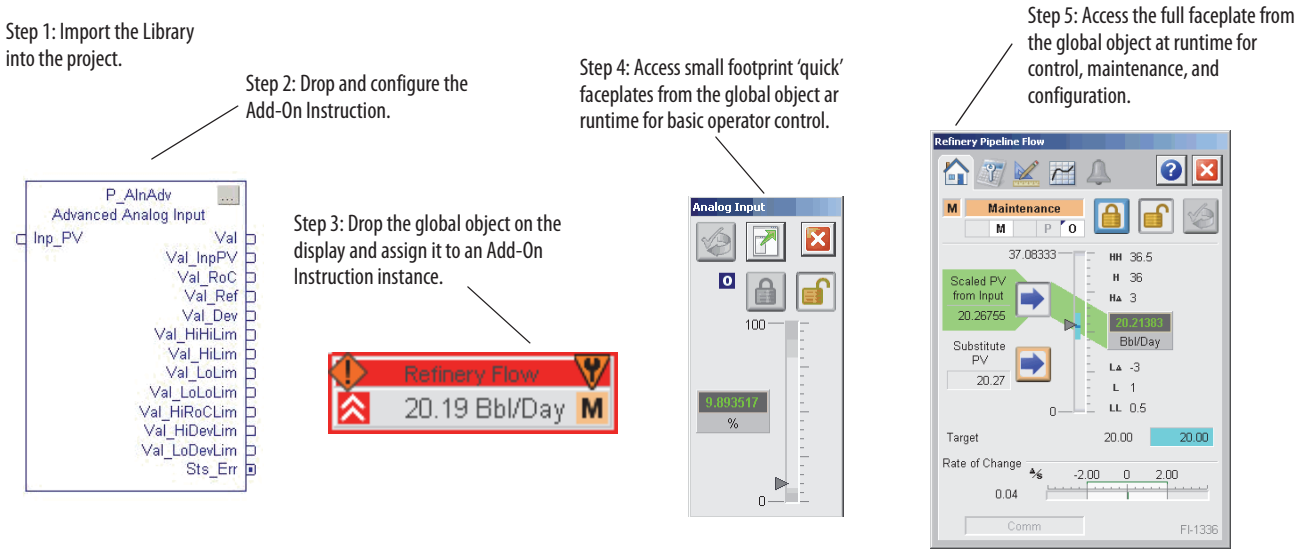
Consider the following when data logging:

- Log to a separate physical drive from the system drive (for example, file set, absolute path is D:\Logfiles) This keeps data logging from affecting system performance.
- Delete oldest file after 10 days to conserve disk space, if necessary
- Set logging to periodic for a consistent system load
- Set to logging to on change for infrequently changing data
- Set interval to 1 second or greater
- Defragment data drive (usually drive D) daily with a third-party package for better retrieval performance.



Rockwell Automation Library of Process Objects

The Rockwell Automation Library of Process Objects is a predefined library of controller code (Add-On Instructions), display elements (global objects), and faceplates that let you quickly assemble large applications with proven strategies, rich functionality, and known performance.



Add-On Instructions provide modules of code, with pre-defined functionality, to create device-level instructions. When coupled to display elements and faceplates in the FactoryTalk View Studio software program, these objects streamline device configuration in a drag-and-drop environment (as shown in the above illustration).

The display elements (global objects) have an associated faceplate that appears when the display element is clicked. The faceplates do not require additional configuration, including even when objects have additional support functions, such as Run Time Monitor, Interlock Block, and so forth. The faceplates for these extended functions are accessible from the faceplate.

The Library of Process Objects is supported through Technical Support as long as the Add-On Instructions have not been modified from the original deployment.

You can use library objects other than those provided by Rockwell Automation. For example, you can develop your own library or use the process objects as guides. By using a library of consistent elements, you improve the maintainability and efficiency of your PlantPAx system.

For details on initiating objects and HMI displays, see the Rockwell Automation Library of Process Objects Reference Manual, publication PROCES-RM002.

Additional Application Resources

The following resources are available for use to assist with developing your application.

Topics and Tools	Description	Where To Find Information
PlantPAx System Application Templates Quick Start	Procedures for applying application templates to start developing your PlantPAx system.	In Literature Library, see publication PROCES-QS001
FactoryTalk Diagnostic sample displays	Sample graphics to display RSLinx Enterprise sample counters.	See the Knowledgebase Answer ID 30148 at http://rockwellautomation.custhelp.com.
Server status displays	Sample code is provided to determine a server's current status and state by using VBA and displaying the status on the HMI screen.	See the Knowledgebase Answer ID 44624 at http://rockwellautomation.custhelp.com.
Rockwell Automation Integrated Architecture tools	These tools can assist you in understanding, planning, and configuring an Integrated Architecture System.	http://www.rockwellautomation.com/solutions/integratedarchitecture/resources.html
Rockwell Automation sample code	Sample code and tools for configuring and programming Rockwell Automation products, including Rockwell specific faceplates.	http://samplecode.rockwellautomation.com/idc/groups/public/documents/webassets/sc_home_page.hcst
FactoryTalk Batch implementation tools	Batch tools for collecting, organizing, reporting, and visualizing FactoryTalk View data.	See the following Knowledgebase Answer IDs at http://rockwellautomation.custhelp.com: • 62367 • 62372 • 67642

Alarm System Recommendations

In the process industries, alarms are a critical function of a control system. Effective alarm systems alert the operator to abnormal situations, providing for a quick response. Effective alarm handling improves the productivity, safety, and environment of a process plant.

There are industry standards that govern alarm management design and engineering practices to guide you in developing effective alarm systems (for example ANSI/ISA-18.2-2009, Management of Alarm Systems for the Process Industries). This section does not cover the practices that are defined by these standards, but does cover recommendations for implementing alarms on the PlantPAx system within the context of these standards.

The following table describes where to find specific information.

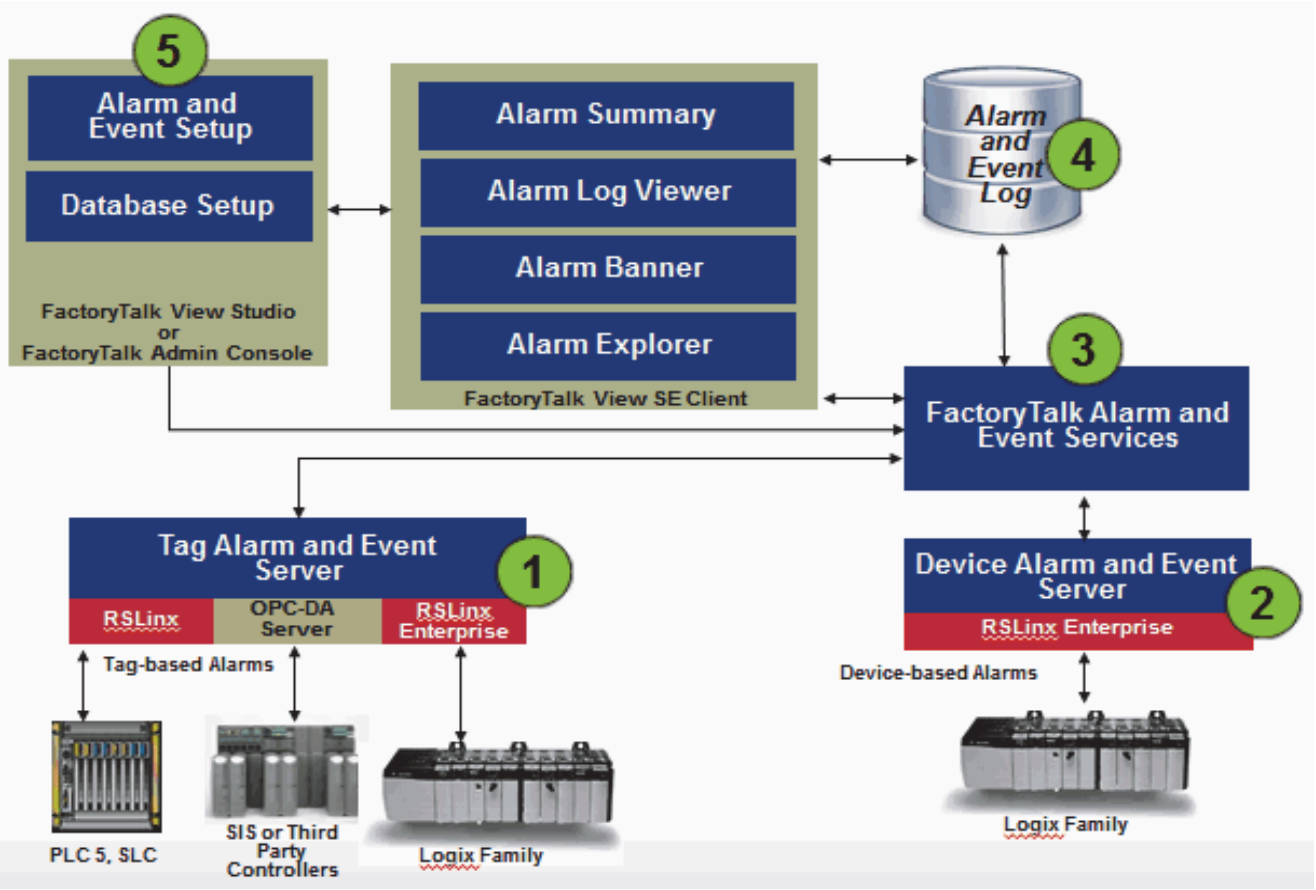
FactoryTalk Alarms and Events Software

The primary method for generating alarms in the PlantPAx system is FactoryTalk Alarms and Events software, herein referred to as the alarm system. The alarm system supports device-based alarms (ALMA and ALMD instructions in the controller) and tag-based alarms (digital, level, or deviation alarms).

Device-based and tag-based alarms co-exist in an application. PlantPAx system sizing rules and critical system attributes are based on the use of tag-based alarms. While device-based alarms can be used, we recommend limiting their use to enhance system performance.

See page 57 for more information.

Figure 3 - FactoryTalk Services Platform



Alarm Characteristics	Description
1. Tag-based alarm monitoring	Tag-based alarms (digital, level, or deviation) are configured in a Tag Alarm and Event server. When an alarm condition is detected by a controller, the server publishes the information to FactoryTalk Alarms and Events services.
2. Device-based alarm monitoring	The PlantPAx system sizing rules and critical system attributes are based on the use of FactoryTalk Alarms and Events tag-based alarms. While device-based alarms can be used, we recommend a limited usage to enhance system performance. Device-based alarms, such as ALMA, ALMD, are programmed via RSLogix 5000 software and then downloaded to Logix5000 controllers. The controller detects alarm conditions and notifies RSLinx Enterprise of alarm states. A Rockwell Automation device server (RSLinx Enterprise software) extracts the alarm information and publishes it to FactoryTalk Alarms and Events services.
3. FactoryTalk Alarm and Events services	Both device-based and tag-based alarms and events are published to FactoryTalk Alarms and Events services, which then routes the information to FactoryTalk Alarms and Events objects that are hosted in FactoryTalk View software. The information also routes to the alarm and event history log, and to diagnostic logs and audit logs.
4. Alarm and Event log	The Alarm and Event log is a component that installs silently as part of the alarms and events software. It manages connections between alarm servers and databases and logs data from each alarm server to an alarm history database. You can use the Alarm and Event Log Viewer to view and print data from alarm history databases. Third-party database tools can also retrieve, view, analyze, and print alarm history information. To use alarm and event logging, install Microsoft SQL Server separately, or use an existing Microsoft SQL Server database.
5. Alarm and event setup and monitoring	FactoryTalk Alarms and Events includes a number of software components that let engineers and operators define alarm conditions, configure alarm servers, view and interact with alarm conditions, and view and run reports on historical alarm information.

FactoryTalk Alarm and Event Features

As shown in Figure 3 on page 56, FactoryTalk Alarm and Event services have a complete set of visualization components (alarm summary, alarm log viewer, alarm banner, alarm status explorer).

Additional features include the following:

- Up to 10 alarm servers on the system to allow for logical segregation by operator area; each server can be made redundant for fault tolerance
- Native ability to log alarm history to SQL database
- Ability to associate up to four additional tags with each alarm to store additional process information with each alarm occurrence
- Ability to associate FactoryTalk View commands with alarms. For example, a command can be used to open the process display associated with the alarm from the Alarm and Event Summary or from the Alarm and Event Banner
- Language switching for alarm messages
- Logs alarm in UTC time

The alarm system does not support PanelView™ Plus terminals, but the Library of Process Objects supports mixed architectures (PanelView Plus terminals plus distributed HMI) while managing the alarm state in the controller. See page 59 for more on the Library.

FactoryTalk Alarm and Event Recommendations

- When possible, allocate plant areas to separate PASS/alarm servers. When you create alarm displays, configure the alarm objects, such as an alarm summary, to subscribe only to required alarm servers.
- You can have up to 10 alarm servers in a PlantPAx system.
- The number of alarms per alarm server is limited to 10,000.
- Set tag-based alarm name based on the associated controller tag. For example, controller tag MC101.Alm_FailToStart from a motor instruction can be tied to tag-based alarm MC101_Alm_FailToStart.
- If you want to view a rolled up indication of alarms by role or display within or across alarm servers, consider adding a prefix to the alarm name on the server to identify the role or display. Alarm expressions can be used to retrieve alarm counts by alarm name and alarm server. For example, AE_InAlmUnackedCount('T1*') returns a count of unacknowledged alarms with tag names starting with T1.

  See the FactoryTalk View Site Edition User's Guide, publication VIEWSE-UM006, for more information on alarm expressions.
- Using alarm expressions adds load to the alarm server. If multiple OWSs need to display rolled-up indicators, use derived tags. Executing and storing counts this way reduces load from duplicate requests on alarm servers.

- Don't use alarm class for grouping by operator area (a prefix to the name can be used for this purpose). Use an alarm class to identify alarms that share common management requirements (for example, testing, training, monitoring, and audit requirements). Do not use alarm class to identify alarms by operator role or display because you cannot retrieve an alarm count by class by using alarm expressions in FactoryTalk View software. However, you can filter by class on the alarm displays.
- Use import and export features in FactoryTalk View SE software when you need to configure a large number of alarms. The Library of Process Objects includes the Alarm Builder tool that can help create your alarm server configuration.

  For more information, see the Rockwell Automation Library of Process Objects Reference Manual, publication PROCES-RM002.
- Be aware that controller scan time and memory usage is variable with the use of the ALMA or ALMD instructions, depending on the states of the controller. Large alarm bursts can have a significant impact on controller CPU utilization.

  For example:

  Controller memory used for buffering by each subscriber (topic in the data server) = 100 KB

  Example execution times:

  – ALMD in a 1756-L73 controller with no alarm state changes: 7 µs
  – ALMD in a 1756-L73 controller with alarm state changes: 16 µs

  In redundant controller configurations, crossloading of redundancy can add up to 70 µs per ALMD instruction.
- We recommend that you reserve the use of ALMA and ALMD instructions for the most critical alarms. Although there are no hard-coded limitations, we recommend limiting the number of instructions to the following:

  – 250 per redundant controller (1756-L6*x* or 1756-L7*x*),
  – 1000 per 1756-L6x simplex controller
  – 2000 per 1756-L7x simplex controller.

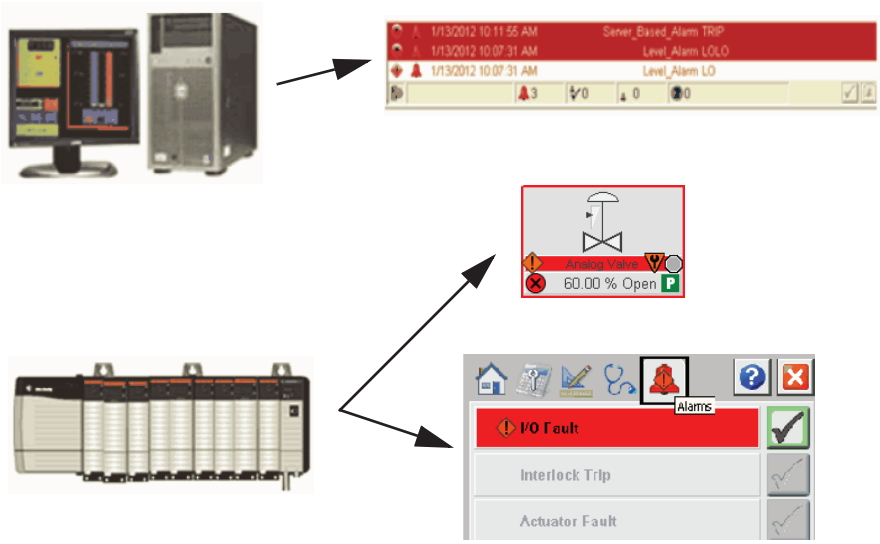
  You can use the PSE for sizing the number of alarm instructions for a more accurate limit based on your specific configuration. Be sure to add for additional memory that is required to maintain the alarm subscription as it is not accounted for in the PSE memory calculations.

Using the Library of Process Objects for Alarms

The Library of Process Objects uses a dedicated Add-On Instruction, named P_Alarm, for each alarm in each device for alarm detection and to provide an interface to the tag-based alarm. Documentation is provided with the Process Library to describe how to connect the Add-On Instruction instances with the Tag Alarm and Event Server.

Following this method, P_Alarm is responsible for managing state and providing status to process displays and faceplates. Each P_Alarm that is being used is linked to a Digital Alarm on the alarm server to provide status to alarm displays and alarm history.

Figure 4 - Alarms in PlantPAx Library



The Library of Process Objects approach includes the following advantages:

- Integration of alarms into library objects (Add-On Instructions, global objects, and faceplates) for ease of engineering and deployment
- Supports mixed architectures (PanelView Plus terminals plus distributed HMI) while managing the alarm state in the controller
- Flexible alarm management techniques are built-in into the P_Alarm instruction

When using the Library of Process Objects, both the controller and server maintain alarm information to provide status information where needed. For this reason, proper configuration is critical.

Prior to FactoryTalk View 8 and PlantPAx Library 3.0, severity needed to be managed carefully as it required configuration in both the controller, to drive information on the process display, and the server, to drive the information on the alarm summary and banner. With FactoryTalk View 8 and Library of Process Objects 3.1 and later, severity in the server is linked to the configured severity in the object.

Alarm State Model

The alarm system provides three mechanisms to prevent prolonged indications of an alarm in the alarm summary: Suppress, Shelve, and Disable.

The Shelve and Suppress states let you clear the alarm from the alarm summary or banner while you are resolving a known alarm, without continuing to view the alarm information once the alarm is acknowledged.

The Shelve state has a configurable timeout, after which the alarm is automatically Unshelved and returned to the alarm summary. The Suppress state does not have an automatic timeout. If the alarm is unacknowledged at the time it is Shelved or Suppressed, it continues to appear on the alarm summary and banner until it has been acknowledged, and subsequently removed from these lists.

A Shelved or Suppressed alarm is still able to transition alarm status (except becoming unacknowledged), send alarm state changes to subscribers, log state changes in the historical database, and is responsive to other programmatic or operator interactions. Follow these rules:

- When an alarm is Suppressed or Shelved, it continues to function normally, monitor the In parameter for alarm conditions, and respond to Acknowledge requests. All subscribers are notified of this event, and any alarm messages generated while the alarm is in the Suppressed or Shelved state include the Suppressed or Shelved status. An alarm cannot become Unacknowledged while Shelved or Suppressed.

- When an alarm is Unsuppressed or Unshelved, all subscribers are notified and alarm messages to subscribers no longer include the Suppressed or Shelved status. If the alarm is active when Unsuppressed or Unshelved and Acknowledge is required, the alarm becomes Unacknowledged.

Disable an alarm to take the alarm out-of-service in the control program. A disabled alarm does not transition alarm status or gets logged in the historical database. If the alarm is unacknowledged at the time it is Disabled, it continues to appear on the alarm summary and banner until it has been acknowledged, and subsequently removed from view. A disabled alarm can be re-enabled in the Alarm Status Explorer in FactoryTalk View SE software:

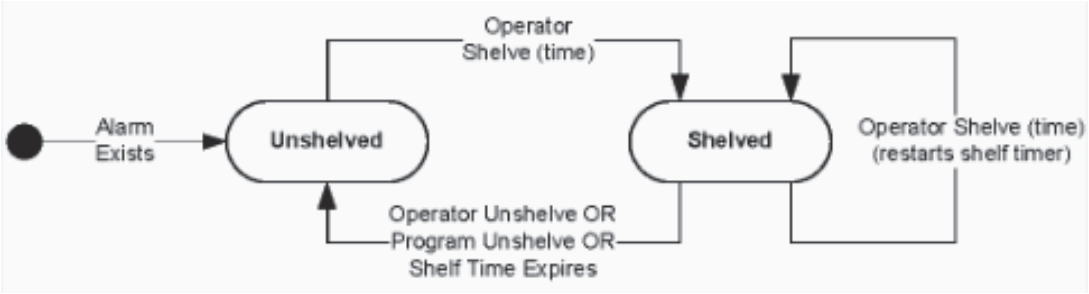
- When an alarm is Disabled, all of its conditions are inactivated (InAlarm is cleared) except the acknowledged status if unacknowledged. The In parameter is not monitored for alarm conditions, but responds to an acknowledged event. All subscribers are notified of this event.

- When an alarm is Enabled, it begins to monitor the In parameter for alarm conditions. All subscribers are notified of this event. If the alarm is active when Enabled and acknowledge is required, the alarm becomes unacknowledged.

Shelve, Suppress, and Disable states are all methods to suppress indication of alarms, following ANSI/ISA-18.2-2009, Management of Alarm Systems for the Process Industries. You can use Shelve, Suppress, and Disable functionality to differentiate operator-initiated actions from design-initiated actions and maintenance actions. See the following examples and accompanying notes.

Operator Actions

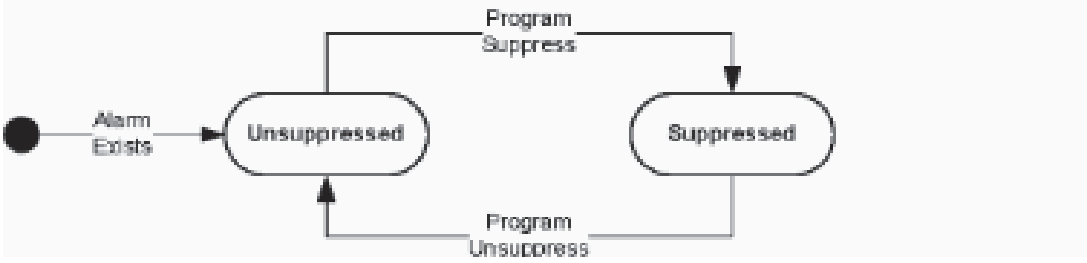
Use the Shelve state to initiate this action by the operator (equivalent to the Shelve state in ISA 18.2).



The Program Unshelve command is provided so that the user has a means, by using a small amount of programming, to Unshelve alarms based on an event, for example End of Shift.

Program Actions

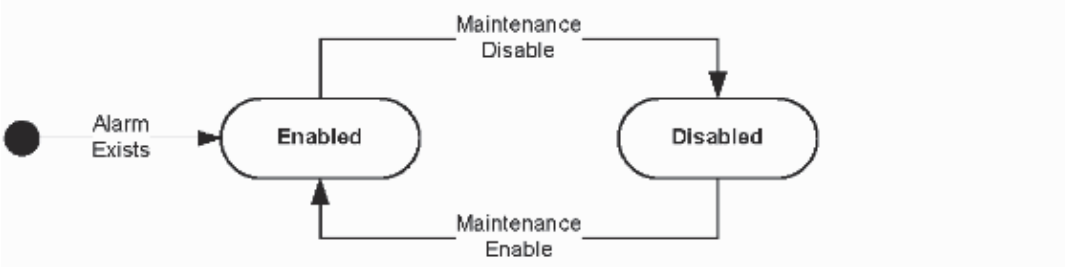
The controller must use the Suppress state to programmatically inhibit operator notification (equivalent to the Suppress-by- Design state in ISA 18.2).



The Suppress state is intended for Suppress-By-Design functionality under control of logic in accordance with ANSI/ISA-18.2-2009. If logging of alarm transitions during suppression is not desired, use logic to suppress the input condition to the alarm, or use the P_Alarm Add-On Instruction in the Library of Process Objects, which does not generate new alarm transitions in the Suppress state.

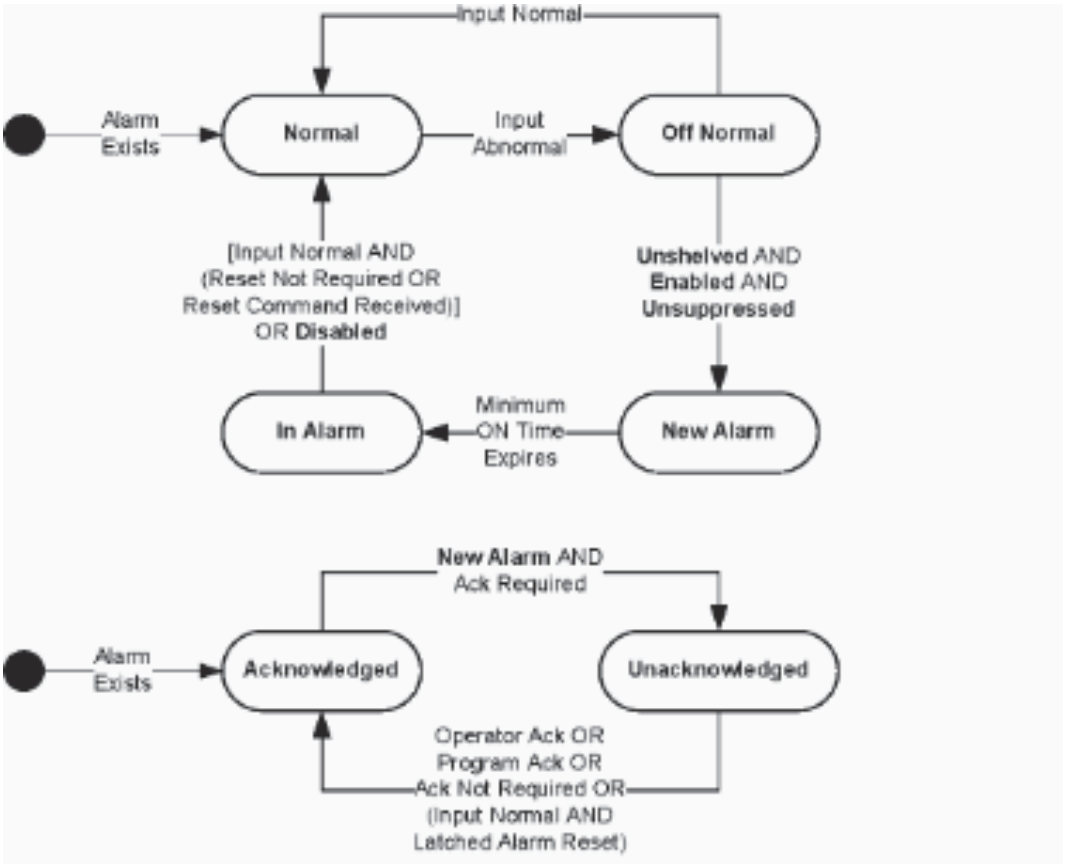
Maintenance Actions

Use the Disable state to inhibit the alarm for maintenance purposes (equivalent to Out-of-Service state in ISA 18.2).



The Disable state is intended for Out-of-Service functionality under control of maintenance in accordance with ANSI/ISA-18.2-2009. If logging of alarm transitions during Disable is desired, the Suppress state of the ALMA or ALMD can be used instead if not required for Suppress-by-Design functionality under control of logic.

Alarm, Return to Normal, Latching, and Acknowledgement



While Disabled, Suppressed, or Shelved, an acknowledged alarm does not become unacknowledged.

While Disabled, Suppressed, or Shelved, if acknowledge is required, an unacknowledged alarm remains unacknowledged until it is acknowledged.

An alarm becomes unacknowledged if the alarm is InAlarm when an alarm changes state to Enabled, Unsuppressed, and Unshelved.

Monitoring Your Alarm System

By using the alarm status explorer, you can browse all of your configured alarms on a server or the entire system. Alarms also are filtered by the Shelved, Suppressed, and Disabled options. The alarm explorer can be preconfigured as a Shelved alarm display to let operators view a list of alarms.

ISA 18.2 provides alarm performance metrics and example target values that are summarized in a single table of section 16.9 of the standard. Some key metrics include the following:

1. Alarm rates: annunciated alarms per operator:
   a. < 150 - 300 alarms per day
   b. Average of 6...12 per hour
   c. Average 1...2 per 10 minutes
2. Contribution of the top 10 most frequent alarms to the overall alarm load: ~<1...5% maximum, with action plans to address deficiencies
3. Number of alarms that remain in effect continuously for more than 24 hours (stale alarms): Less than 5, with plans to address

When using the FactoryTalk VantagePoint software with the alarm system, reports are provided based on the above metrics.

1. Hourly Alarms Report (active count of alarms over 1- hour samples)
2. Alarm Distribution Report (percentage contribution of top 10 most frequent alarms)
3. Alarm Frequency Report (top 10 most frequent alarms)
4. Standing Alarms Report (top 10 currently active alarms by duration)
5. Alarm Duration Report (top 10 alarms by duration)

Alarms can be filtered in FactoryTalk VantagePoint software by class, alarm name, or alarm source so they can be broken down by operator role if required. More information on these reports can be found on the Rockwell Automation Knowledgebase Answer ID 68296 at http://www.rockwellautomation.custhelp.com.

Notes:

Infrastructure Recommendations

The PlantPAx system infrastructure is built on an IT infrastructure based on commercial off-the-shelf technologies, such as Microsoft Windows, and open network technologies to allow for seamless integration between system elements and to higher-level business systems.

This chapter outlines recommendations for setting up virtual or traditional, physical infrastructure components to achieve optimal performance of the PlantPAx system.

The following table describes where to find specific information.

Virtualization Advantages

Virtualization is basically a consolidation of a number of physical servers onto a more powerful machine that is capable of handling the increased load. Generally physical servers use a small portion only of the total CPU, RAM, and I/O; it makes sense to get more out of your hardware.

Table 26 - Reasons to Use Virtualization

Consideration	Description
Cost	Among the top reasons to use a virtualized system is to save money, including hardware, human resource, or energy-related savings. An ideal virtualization plan can result in lower equipment, power, management, and hardware costs. Most businesses review their current situation and determine where they can save money.
Performance	Many dedicated servers are using about 20% of their computing capacity. This is a waste of usable resource and a top consideration for using virtualization. Using your hardware to its full potential is more difficult with a dedicated server environment.
Managing time	Many of the virtualization products have advanced management tools that help you to monitor and review information quicker across more servers. This can reduce the human resource needed and less third-party software that you have to learn along with less errors. When you have more items to manage, the risk of making mistakes also increases.
Disaster recovery	Most virtualization software comes with a number of features that can increase server up-time. If one virtual server fails, it opens instantly on another machine. Load balancing is also easier. Many packages come with their own data backup solutions, such as 'snapshots' to protect data. For a physical server, we have to opt for other backup and recovery options.
Point of failure	One of virtualization's selling points is the ability to load balance servers easily.

Table 26 - Reasons to Use Virtualization

Consideration	Description
Security	Setting up a security plan for a virtual server environment is easier because you can focus on a universal security model rather than security for more hardware.
Ease in IT growth	Adding a new server or increasing RAM, CPU, or hard disk in a virtual environment is as easy as pressing a few buttons. When you have to add a new physical server to your environment it takes some planning. You have to purchase equipment and then load the operating system, security patches, and plan out physically connecting the server to your network. Using virtualization you typically can access another server within minutes by using a copy of a virtual server.
Migration	Many virtualization products include software that helps you migrate applications from your older dedicated servers to new virtual servers. System upgrades can be smoother as long as you stay with similar virtualization products.

Virtualization Overview

Computer virtualization is the process of constructing a virtual (instead of physical) computer hardware platform by executing virtual software tools between the actual hardware and operating system (OS). By abstracting the OS from the physical hardware, multiple virtual machines act like a 'real computer' but can run different operating systems and applications from varying locations on the same server.

A virtual machine (VM) behaves exactly like a physical computer because the VM contains its own 'virtual' CPU, RAM, hard disk drive, and network interface card. The VM runs as an isolated guest OS installation. The terms 'host' and 'guest' help distinguish the software that is running on the actual machine (host) and the software that is running on the VM (guest).

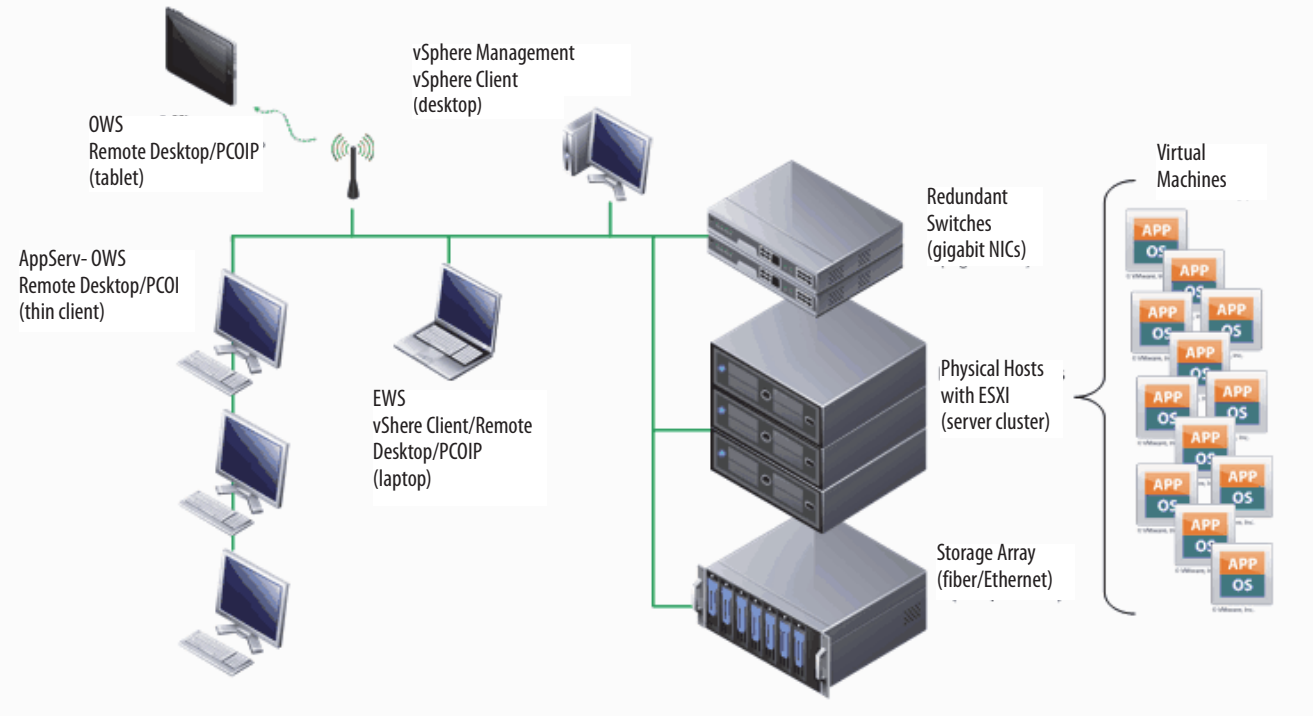
A layer of software, called a hypervisor, is inserted directly on the computer hardware or on a host OS. A hypervisor, such as VMWare ESXi, lets multiple operating systems (guests) run concurrently on a host computer (the actual machine that the virtualization takes place). It presents a virtual operating platform to the guest operating system and manages the execution of the guest operating system.

A major benefit of a virtualized workstation is that critical hardware is not exposed to harsh plant conditions. If a thin client is damaged, it is easily replaced without any impact to the remote virtual machine. In contrast, if a traditional desktop workstation is damaged, you likely have to rebuild the software and hardware, costing time as well as money. In a virtualized setting, you have the ability to upgrade hardware without replacing the operating system on individual workstations.

Rockwell Automation supports virtualization on VMWare's ESXi architecture for the PASS, EWS, OWS, AppServ-OWS, and application servers. The software images are available on the PlantPAx Virtual Image Templates that are delivered as an Open Virtual Format (OVF). This format lets you deploy the templates by using any virtualization platform.

IMPORTANT The PlantPAx system does not require the use of the virtual image templates, nor does their use merely indicate that you are operating a PlantPAx system.

Figure 5 - PlantPAx Virtualization Topology



In an extreme case it is theoretically possible to consolidate an entire simple automation system virtually on to one physical machine. This is contingent upon having a sufficiently powerful processor and adequate memory, as well as an application that does not overtax the configuration.

In all practicality, a basic virtualized automation system generally uses three or more host physical machines, or servers. This is preferred to distribute the processing load, and more importantly, to provide a pool of available hardware so that VMs could be restarted elsewhere in the event of a server failure. By increasing the available pool of servers, you can extend the system into a higher availability configuration.

Before designing a virtualized PlantPAx system, we recommend that you have a general understanding of the PlantPAx control system architectures and sizing guidelines.

For more information, see the following:

- PlantPAx Process Automation System Selection Guide, publication PROCES-SG001 -- Provides descriptions of system elements, architectures, and sizing guidelines for procuring a PlantPAx system
- Virtual Images Templates User Manual, publication 9528-UM001 -- Contains procedures for configuring virtual machines

Table 27 - Virtual Image Templates Software

Category	Cat. No.	Description
Virtual templates	9528-PAXVTENE	USB device that contains three virtual image templates (PASS, EWS, and OWS). Each template contains a Microsoft Windows operating system, with all required Rockwell Automation software pre-installed but not activated. A Microsoft full-packaged product license is included.
	9528-APPOWSENE	USB device that contains the virtual image template for AppServ-OWS. The template contains a Microsoft Windows operating system, with all required Rockwell Automation software pre-installed but not activated. A Microsoft full-packaged product license is included. **IMPORTANT:** Each client connecting to APPServ-OWS must have a valid client license.
	9528-APPHISTENE	USB device that contains the virtual image template for AppServ-Hist. The template contains a Microsoft Windows operating system, with all required Rockwell Automation software pre-installed but not activated. A Microsoft full-packaged product license is included.

Virtual PlantPAx Configuration Recommendations

Once the basic architecture is developed, a virtualized PlantPAx system benefits from a number of fundamental VMware configuration choices. Most of these choices start with automatic settings, with adjustments made as required to increase speed and improve redundancy.

Servers

The latest Intel™ processors offer on-board virtualization support. The Intel Virtualization Technology in the BIOS must be switched on to take advantage of the performance gains. To use Windows 7 as a VM operating system, the host must be ESXi 4.0 Update 2 or ESXi 4.1 or later.

Hosts in the same cluster that have different processors are recommended to have Enhanced vMotion Compatibility (EVC) enabled to support the vMotion between hosts. EVC is enabled at the Datacenter/Cluster level. EVC is a fundamental technology that facilitates virtual machine migrations between different generations of CPUs, while vMotion is the utility used to make the migrations. The ability to migrate VMs between servers while they are running with the process completely transparent to any users is one of the leading benefits of virtualization.

Storage

Network attached storage uses a software network adapter to connect with iSCSI storage through Ethernet. Enable jumbo frames at the physical switch level and also at the virtual switch port level. Jumbo Ethernet frames carry up to 9,000 bytes of payload (as opposed to the normal 1,500) and can offer increased data throughput with reduced CPU utilization, but the network must be configured to support jumbo frames from end to end.

When configuring the physical NICs on a host, set up NIC teaming in the virtual switch configuration to enable greater bandwidth for storage traffic.

Each virtual hard drive on a network is assigned a logical unit number (LUN) for unique identification. A LUN is a logical unit number of a virtual partition in a storage array. When assigning virtual hard drives from VM's to a LUN, be sure to balance intensive and non-intensive I/O applications. This improves performance by balancing I/O traffic across multiple hard drives. A typical LUN size is between 400 GB and 800 GB. The maximum number of virtual machine hard disks (VMDK) on a LUN can not exceed 30, as more VMDKs could impact the performance because of disk queuing.

The LUN size is calculated by adding the total capacity (GB) of storage required plus VM Swap File requirements and additional room for VM Snapshots. When dividing the storage array into LUNs, the following equation can be used to determine appropriate sizing.

Calculated LUN Size = GB Capacity + VM Swap File Requirements + Snapshot Reservations

= 30*(average VM virtual disk size) + 30*(average VM RAM) + 15% of (30 x average disk size).

Virtual Networks

Connect VMs residing on the same ESXi server and same VLAN to use the same virtual switch. If separate virtual switches are used and connected to separate physical NICs, traffic routes separately through the wire and incur unnecessary CPU and network overhead.

Speed and duplex settings mismatches are common issues that can cause network problems. For ESXi, VMware recommends autonegotiate for both devices on the ends of a network link. It is also acceptable to set both ends for '1000 MB / Full Duplex' or '100MB / Full Duplex' if required by the network hardware.

IMPORTANT If you connect a manually-configured device to an autonegotiate device (duplex mismatch), a high rate of transmission errors can occur.

VMware systems demand a high level of network performance by nature, so any methods to reduce bottlenecks are to be explored. One such method is NIC teaming, where a single virtual switch can be connected to multiple physical Ethernet adapters. A team defined in this way can share the traffic load and provide a means of failover.

There are several options available for load balancing. The default is 'route based on the originating virtual switch port ID', where traffic from a given virtual Ethernet adapter is consistently sent to one physical adapter (unless there is a failover). Another option lets the virtual switch to load balance between multiple physical adapters. This is set by configuring EtherChannel link aggregation on the Cisco switch and the load balancing setting is set to 'route based on IP hash' in the virtual switch.

A combination of NIC teaming and the Cisco Switch load balancing settings are recommended for improved performance when accessing networked storage.

Resource Pool Allocation

Resource pools group virtual machines (VMs) to provide dynamic allocation of CPU and memory resources. Resource pools also contain child resource pools, enabling very fine-grained resource allocation.

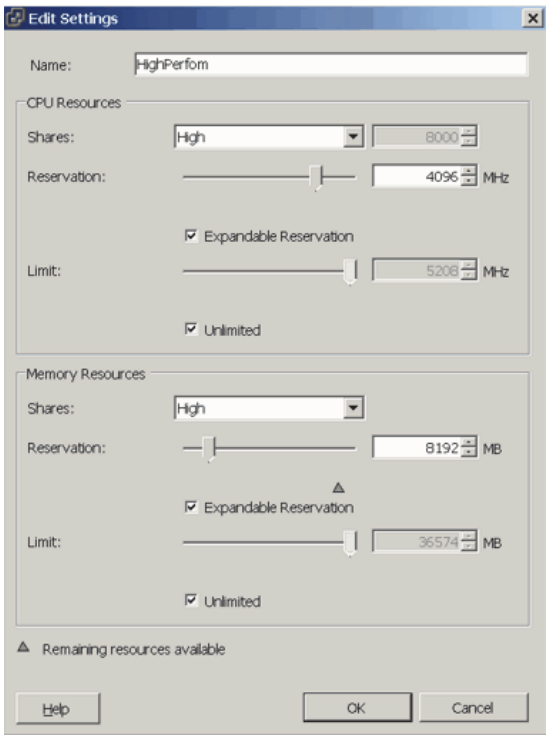
Resource allocation is done on an individual VM basis by using shares, reservations, and limits. Setting these values on every VM is time-consuming, can be error-prone, and doesn't scale effectively. Setting these values on a resource pool is much more efficient, and the values dynamically readjust as VMs and host resources are added and removed.

Generally, the hypervisor provides excellent scheduling. And, if hosts have sufficient resources, you can leave the default settings alone. If you wish to control the VMs that receive more priority or resources, it's more effective and less error-prone to allocate the VMs at a resource pool level.

IMPORTANT In a PlantPAx system, make sure that the PASS and Historian servers have higher priority for consistent performance.

For each resource pool, you set CPU and memory shares, reservations, expandable reservations, and limits, as shown in Figure 6.

Figure 6 - Setting Resource Pool Allocation



We recommend that you build three resource pools with the server-type allotment shown in Table 28.

Table 28 - Server Resource Pool Allocation

Resource Pool Name	CPU Shares	CPU Reservation	Memory Shares	Memory Reservation	Server or Workstation
High	High	50% of available host CPU Hz	High	Minimum as specified for each virtual template	PASS AppServ-Hist
Normal	Normal	Zero (0)	Normal	Zero (0)	EWS OWS AppServ-Asset AppServ-Batch AppServ-Info AppServ-OWS
Low	Low	Zero (0)	Low	Zero (0)	FactoryTalk Directory Domain Controller

An allocation of zero (0) means that no resources get locked from being used by the hypervisor resource allocation algorithm. The Expandable and Unlimited checkboxes need to be checked.

The CPU or memory shares are relative to any sibling resource pools or VMs. Shares are used only during periods of contention and are always bound first by any reservations or limits. In a well-designed PlantPAx system, sufficient resources are available to all VMs in the resource pool, therefore, we suggest that shares never be invoked. They are built to make sure the PASS and Historian can consistently supply data in the case of contention.

Resource Pool Sizing Example

This example shows how to allocate resources based on system requirements.

System:

- 1 server with 2 quad-core CPUs (each core is 2.0 GHz)
- 32 GB of RAM
- Server has a total of 16 GHz of CPU to allocate to virtual machines

PlantPAx system:

- 4 PASS servers and 1AppServ-Hist — High resource pool
- 1 AppServ-OWS, 1 EWS, and 1 AppServ-Asset — Normal resource pool
- 1 FactoryTalk Directory and 1 domain controller — Low resource pool

Following the guidelines above, the High resource pool with get 50% of the CPU allocated, or 8 GHz. These 8 GHz are further divided into 5 shares of 20% automatically for each server in the resource pool. Each server receives roughly 1.6 GHz (8 GHz/5 servers) of CPU minimum allocation. The minimum memory for each server used in the High resource pool is 4 GB. Minimum memory allocated is 20 GB (4 GB x 5 servers).

The remaining 8 GHz CPU and 12 GB of RAM is used by the hypervisor resource allocation algorithm to use where needed. The Normal resource pool has priority over the Low resource pool, but there is no minimum resource allocation due to the zeroes used for CPU and memory reservation.

VM Optimization Recommendations

Consider these recommendations when configuring VMs with Rockwell Automation applications:

- VMware offers options for manually assigning CPUs to VMs, called CPU affinity. There can be situations that required this granular level of control, but a general practice is to set VM CPU affinity when necessary only. Accepting default settings generally results in the best performance.
- If it's necessary to use a 32-bit guest operating system as a VM on a 64-bit server, select the CPU/MMU virtualization to use software for the instruction set, and Memory Management Unit (MMU) virtualization for improved performance.
- Various options are available for hard drive controllers when provisioning a Windows 2008 VM. Make sure to select the SCSI controller as LSILogic Parallel, because by default it is LSILogic SAS. The hard drive still is virtually handled, but Parallel is the recommended setting.
- While it's possible for VMs to communicate with each other via the host by using the network layer, this adds communication overhead. A better option for VMs that must communicate frequently is to enable VM Communication Interface (VMCI) on each VM. VMCI is recommended for all PlantPAx system element VM's. VMCI offers fast and efficient communication between VMs, and can approach speeds that are five times greater than a normal internal network.
- There is an option to specify a provisioning policy when a VM or a virtual disk is created. The provisioning policy can be 'thick' where the required disk space is initially allocated, or it can be 'thin' where the disk space starts small and is allocated as needed. However, for a VM to be compatible with fault tolerance, it's recommended that the VM use Eager Zero Thick Provisioning.
- Migrating a powered-on VM from one host to another that contains a snapshot is not a supported function. See Antivirus and Backup Recommendations for more information on snapshots.
- Enable the hardware acceleration feature under the advanced graphical display settings to improve the mouse movement. We recommend that you set the power options for high performance, with no sleeping or hibernating.
- Encryption, backup, and defragment services are all examples of components that can be disabled.
- VMware offers an optimization guide with a comprehensive list of services, along with recommendations on which to disable. This guide is called VMware View Optimization Guide for Windows 7.
- Another key is to maintain VMware Tools up-to-date inside each guest operating system. When migrating or converting a VM from an older version ESX server, a best practice is to remove the old Tools and install the latest version.

Antivirus and Backup Recommendations

VMs are susceptible to virus attacks just like their physical counterparts. Of course, the same antivirus and malware applications used to help protect physical machines can be deployed on VMs. When it comes to antivirus, malware, and backup issues, VMs offer some significant benefits.

VMs are effectively 'sandboxed' from each other and the host, but it is possible for services such as shared folders and network folders to facilitate VMs infecting each other or the host. By defending the guest systems, protection programs help ensure the integrity of the entire system.

In most installations, an antivirus package software program is required. The PlantPAx system specifies Symantec Antivirus software and is the only antivirus package that is qualified for use with the system.

The antivirus software must be configured on the VM in an optimal way to maximize performance. The virus scans can be scheduled to take place during the off-peak hours, and staggered to avoid the collision of application requests for resources. Real-time virus scanning greatly impacts the performance of the servers, so this feature can be disabled if possible. Excluding files such as databases and swap files from virus scans further improves performance.

VMware is capable of taking VM 'snapshots' that capture the entire state of the VM, including the memory and files. Snapshots are not considered to be a proper backup strategy, but they can be used to restore a VM or file to a known 'good' point during testing or development. Snapshots can consume as much disk space as the VM itself, and by using snapshots negatively impacts VM performance, so care must be taken with their use.

Because a VM is really just a series of bundled files, it's easier to back them up than it is to back up a physical machine. VMware backups to disk are fast to make as well as to restore. Options are available to back up VMs from the host level, or to execute full, differential, and incremental backups from within the VM. If running the backup agent in the VM, we suggest that it be scheduled to run during off-peak hours.

Just like a physical system, in the event that malware damages files or causes data loss, you need to have a solid backup and restore plan in place to allow the VM or its contents to be reverted to a known 'good' state.

VMware Converter Best Practices

In some cases, the virtualized automation system is created from scratch, but in many other instances, migration from an existing PlantPAx system is required.

VMware vCenter Converter Standalone is the software tool used to convert physical machines and third-party disk images into a VM format ready to deploy in a virtualized system. The latest version of VMware Converter must always be used.

We suggest that you use the following best practices when making conversions:

- Running vCenter Converter as a local administrator is fundamental to avert any permission issues. Remote conversions are possible, but one must still log in as administrator.
- As with all software installations, it is recommended to stop as many running programs as possible. In particular, databases such as SQL must have their services and applications stopped to avoid data file corruption. Disabling real-time antivirus scanning is also recommend as it removes another possible cause of conflict during the process.
- If the destination is an ESXi host, then connection to it can be made by using the actual IP address instead of the DNS host name to circumvent any connection issues. The source disk needs at least 200 MB of space to support snapshot features used by Converter, and if the source partition is larger than 256 GB, then it's necessary to increase the destination datastore's block size above the 1 MB default.
- Never convert diagnostic or recovery partitions, or unrecognized file systems. Also, refrain from modifying the recommended systems settings, such as resizing partitions or adjusting network interface card (NIC) quantities.
- Before running the application for the first time after conversion, adjust the number of virtual NICs, customize the computer name, and assign the IP addresses as needed for unique identification. Remove any unnecessary virtual devices such as COM ports, floppy drives, and USB controllers.
- Start the VM in Safe Mode, and use the normal Windows functions to remove any unnecessary devices, drivers, and other items. The idea is to streamline the instance to the greatest extent possible. Restart in Normal Mode and check the Event Log for any error messages that need to be addressed.
- With the newly converted VM up and running normally, install VMware Tools, and restart if required. For some systems it can be necessary to customize the VM's identity further through the use of the Microsoft SysPrep utility. In any case, be sure that the VM boots normally, and confirm any static IP addresses, as well as reconnect any disconnected virtual NICs.

- Pay attention to the virtual disk type. Many times the conversion default is for the VM to use an IDE virtual disk that can cause degraded performance or even an initial failure to boot. The solution is to convert the virtual IDE disk to a virtual SCSI disk. Follow detailed VMware Knowledgebase instructions (at kb.vmware.com, search for 'convert virtual IDE to SCSI') for the procedures.
- If any difficulties are experienced with the conversion process, try again but reduce the number of optional settings. The latest specifics of VM converting can be found by searching the VMware Knowledgebase for topics such as 'Converter Best Practices'.

Operating System Recommendations

The following recommendations apply regardless if you are using a virtual or traditional environment and the size or complexity of the system operation.

Domains and Workgroups

We recommend that PlantPAx servers and workstations be members of a Windows domain. However, workgroups are supported for systems with 10 or fewer workstations and servers.

Configuration	Details
Workgroup - decentralized administration (allowed if 10 or fewer computers)	Workgroup advantages: • No domain controller (Windows Server OS) to purchase or maintain. • Recommended for small PlantPAx applications only where user accounts do not change often Workgroup rules: • All workstation and server system elements in a single PlantPAx system must be members of the same workgroup • All users participating in the workgroup must be members of the Administrators group • Create the same set of user accounts and passwords on every computer in a FactoryTalk View application
Domain - centralized administration (recommended)	Domain advantages: • One place to manage users, groups, and security settings • Recommended for larger PlantPAx applications, or environments with changing user accounts Domain rules: • All workstation and server system elements in a single PlantPAx system must be members of the same domain • PlantPAx server system elements must not be used as domain controllers. • Required for systems with more than 10 computers • The domain controller must be its own independent computer with no other application software.

Domain Recommendations

We recommend that all PlantPAx system servers and workstations be a member of a domain. Follow these additional recommendations:

- Windows Active Directory (AD) domains include the concept of a 'forest' that can consist of a single 'domain tree' or multiple domain trees.

  TIP A domain tree can consist of a single (parent) domain or multiple (child) domains. A single forest, single tree, single domain configuration is recommended. In a Windows 2008 Active Directory, both domains and forests have individual functional levels.

- We recommend configuring at least two domain controllers in the domain. These domain controllers replicate automatically to provide high availability and an online configuration backup. If you have a single domain controller, and it goes offline, your system goes offline.
- The domain servers also must be configured to include Domain Name Service (DNS) that lets you identify devices by name rather than IP addresses.
- Configure time synchronization throughout a domain.

- New and existing active directory domains must have operations verified by using Microsoft's Domain Controller Diagnostics (Dcdiag.exe) utility. This utility is included with the Windows support tools on the operating system CD and can also be downloaded from Microsoft.

IMPORTANT Do **not** install the Windows domain controller on the PlantPAx PASS server or application servers.

Windows Workgroup Recommendations

The PlantPAx system can use a Windows workgroup network environment for systems with 10 or fewer computers. However, if you are using a Windows XP operating system you must turn off simple file sharing and fast user switching on each PlantPAx server and workstation in the workgroup.

Complete these steps to turn off simple file sharing in the Windows XP operating system.

1. On the desktop or in Windows Explorer, right-click My Computer and choose Explore.
2. From the Tools menu, click Folder Options.

   The Folder Options dialog box appears.
3. Under Advanced settings, click the View tab and clear the Use simple file sharing checkbox.

Complete these steps to turn off fast user switching in the Windows XP operating system.

1. Open the Windows Control Panel, and double-click User Accounts.
2. Click the Change the way Users Log on and Off link.
3. Clear the Use Fast User Switching checkbox.
4. Click Apply Options.

Internet Information Server (IIS)

The Internet Information Server (IIS) provides graphics displays and other file-based components from the HMI server on the PASS to OWS and EWS workstations by using Web-based Distributed Authoring and Visioning (WebDAV). WebDAV is an extension to the HTTP protocol that facilitates editing and managing files across multiple users and workstations.

In addition, when OWS and EWS workstations issue FactoryTalk View commands that must be run on the HMI server, the commands are sent by using the IIS platform.

Therefore, the IIS software is a required component on the PASS. We recommend against the installation of IIS on any other system elements.

See Chapter 2 of the FactoryTalk View Site Edition Installation Guide, publication VIEWSE-IN003, for more information.

Server and Workstation Time Synchronization

System time synchronization is important so that the internal clocks in the controllers, workstations, and servers reference the same time for any event or alarm that occurs. Configure the PASS, App-servers, OWS, and EWS to use a single server (for example, a domain controller) as their time reference and keep their clocks tightly synched to it.

Computer Time Synchronization

The Windows Time service uses the network time protocol (NTP) to synchronize computer clocks on the network from the domain controller. Each computer in the process system uses the domain controller as the authoritative time source and synchronizes their clock to it. Check the Event Viewer System log of each computer to verify that the time is updated properly.

After configuring the domain controller for time synchronization, you can use the Windows w32tm command line tool to identify any time difference between an individual computer and the domain controller. This command measures the time difference.

w32tm /stripchart /computer:<target>[/period:<refresh>] [/dataonly]

Parameter	Identifies
computer:<target>	The computer to measure the offset against.
period:<refresh>	The time between samples, in seconds. The default is 2 s.
dataonly	To display the data only without graphics.

The w32tm/resync command manually forces a computer to resynchronize its clock to the domain controller as soon as possible and resets error statistics.

Operating System Optimization

The following recommendations enhance the performance of your operating system:

- Turn off Windows automatic updates to prevent compatibility issues with existing PlantPAx components on your workstations.

  See Maintenance Recommendations for more information on how to apply Microsoft patches to your PlantPAx system.
- Disable operating system themes that provide personalized computer effects such as sounds and icons. These types of elements diminish processor speed when running some FactoryTalk View SE graphic components, such as alarm summaries.
- Disable or uninstall all third-party firewalls on a workstation before installing FactoryTalk View SE software, which is compatible only with the built-in Windows operating system firewall.
- Activate Data Execution Prevention (DEP) for workstations running FactoryTalk View SE components. This security feature protects against viruses and other security threats by preventing unauthorized programs from running executable program code.
- Remove Enhanced Security Configuration (ESC) from workstations running FactoryTalk View SE software. The Windows 2008 security settings protect servers by limiting how users can browse the Internet on a computer, but can hinder FactoryTalk clients connecting to application servers.

Network Recommendations

The Ethernet network provides the communication backbone for the supervisory network for the workstations, servers, and the controllers:

- Configure all communication interfaces to operate at the fastest speed possible for your hardware configuration, full duplex for 10/100 network adapters. See Important below for autonegotiate.

IMPORTANT The speed and duplex settings for the devices on the same Ethernet network must be the same to avoid transmission errors.

- Fixed speed and full duplex settings are more reliable than autonegotiate settings and are recommended for some applications.
- If the module is connected to an unmanaged switch, leave Autonegotiate port speed and duplex checked or communication can be impaired.
- If you force the port speed and duplex with a managed switch, the corresponding port of the managed switch must be forced to the same settings or the module fails.
- If you connect a manually-configured device to an autonegotiate device (duplex mismatch), a high rate of transmission errors can occur.

- Disable power saving for the Network Interface Card (NIC) that connects a workstation to other devices on the network. The power-saving feature turns off the network card when not in use, which can interfere with network throughput.
- If multiple DCOM protocols are installed and set up on a workstation, to make sure that DCOM communication functions correctly, remove all protocols other than TCP/IP.
- Use static IP addresses.
- Consider cable type for environmental conditions.

Type	Details
Fiber-optic	• Long distances • Near high magnetic fields, such as induction-heating processes • For extreme high-noise environments • For poorly grounded systems • For outdoor applications
Shielded twisted pair	• Use Category 5e, 6, or 6a cables and connectors • Use termination sequence 568A for industrial applications

Refer to these publications for additional information:

- For correcting a duplex mismatch, see Troubleshoot EtherNet/IP Networks, publication ENET-AT003.
- For fiber cable specifications and an example of dB loss, see Appendix C in the EtherNet/IP Modules Installation Instructions, publication ENET-IN002.
- For selecting architecture, see the EtherNet Design Considerations Reference Manual, publication ENET-RM002, or the PlantPAx Selection Guide, publication PROCES-SG001.

Ethernet Switches

The supervisory network must have managed switches that direct specific messages to multicast groups. Do not use unmanaged switches. The behavior of an unmanaged switch is to flood multicast packets to all ports within the same VLAN.

The first switch that Rockwell Automation equipment touches must have IGMP snooping enabled. IGMP snooping enables switches to forward multicast packets to ports that are only part of a particular multicast group.

IMPORTANT All applications require proper configuration to achieve the best system performance. If you do not configure the managed switch, it's possible that system performance can be adversely affected. We recommend that you contact your system administrator if there are any doubts on the installation and configuration.

Select the switch depending on the network functionality.

If	Then	Recommended Media
• Supervisory • Routing information to other networks	Layer 3 switches • Stratix 8300 • Cisco Catalyst 3560G or equivalent • Cisco Catalyst 3750*x* or equivalent • Cisco Catalyst 3850	Fiber(1)
• Connecting control hardware, sensors, and workstations • Isolated networks	Layer 2 switches Stratix 8000™ Stratix 6000™ Stratix 5700™ Cisco Catalyst 2960G or equivalent Layer 2/3 Services Router Stratix 5900™ Layer 2 Wireless Access Point/Workgroup Bridge Stratix 5100™	1585-series copper media
High availability at switch level	Layer 3 switch • Cisco Catalyst 3750*x* or equivalent • Cisco Catalyst 3850	Fiber(1)

(1) For uplink cables between Layer 2-3, fiber is recommended for 1 GB connectivity.

For more information, see these resources:

- Ethernet switches -- Ethernet Design Considerations Reference Manual, publication ENET-RM002
- Ethernet switch configuration -- Converged Plantwide Ethernet (CPwE) Design and Implementation Guide, publication ENET-TD001

Notes:

Field Device Integration Recommendations

Modern field devices, such as drives and flow transmitters, are often microprocessor-based. These smart devices provide digital data that is used for commissioning, maintenance, troubleshooting, and most importantly, control.

Smart field devices use two-way, digital protocols for communication. Common field device communication options on the PlantPAx system include EtherNet/IP, ControlNet, DeviceNet, FOUNDATION Fieldbus, PROFIBUS PA networks or by using HART.

This section provides general recommendations for configuring tools on the networks and HART protocol mentioned above to gather real-time information and diagnostics to make well-informed business decisions.

Additionally, many other networks and I/O protocols can be integrated into the PlantPAx system. For more information on Encompass™ third-party products, see http://www.rockwellautomation.com/encompass.

The following table describes where to find specific information.

Device Configuration Options

There are several options for configuring field devices, including the following:

- Handheld devices for selected field device networks or protocols
- Manually configuring some instruments by using the local interface
- Enterprise-wide solution by using FactoryTalk AssetCentre

FactoryTalk AssetCentre for Enterprise Solution

FactoryTalk AssetCentre software can be used as a centralized tool that lets you manage field devices from multiple vendors, networks, and protocols from one common platform. FactoryTalk AssetCentre software leverages FDT technology that standardizes the communication interface between field devices and host systems. This functionality lets any device to be accessed from FactoryTalk AssetCentre software regardless of the communication method.

The FDT interface also enables FactoryTalk AssetCentre software to integrate many different kinds of devices, including handheld diagnostic tools.

For more information, see the following publications:

- FactoryTalk AssetCentre Product Profile, publication FTALK-PP001
- FDT website at http://www.fdtgroup.org

EtherNet/IP Recommendations

The EtherNet/IP protocol is a multi-discipline, control, and information platform for use in industrial environments and time-critical applications. EtherNet/IP uses standard Ethernet and TCP/IP technologies and an open, application layer protocol that is called the Common Industrial Protocol (CIP).

A growing number of field devices, including flow transmitters and drives, are available that support EtherNet/IP.

Table 29 - EtherNet/IP Interfaces

Category	Product	Description
ControlLogix controller interface	1756-EN2T, 1756-EN2TR,1756-EN3TR, 1756-EN2F 1756-ENBT 1756-EN2TSC	ControlLogix EtherNet/IP bridge.
	1756-EWEB	Same as the 1756-ENBT but does not support Ethernet I/O control nor produced/consumed tags.
	1788-EN2FFR	EtherNet/IP to FOUNDATION Fieldbus linking device. Supports H1 FOUNDATION Fieldbus network. Compatible with ControlLogix redundancy. Built-in functionality for the Ethernet DLR.
	1788-EN2PAR	EtherNet/IP to PROFIBUS PA linking device. Supports PA media. Compatible with ControlLogix redundancy. Built-in functionality for the Ethernet DLR.

EtherNet/IP I/O Communication Options

Follow these guidelines for EtherNet/IP networks:

Network

- Configure all communication interfaces to operate at the fastest speed possible for your hardware configuration, full duplex for 10/100 network adapters. See the Important below for autonegotiate.

IMPORTANT	The speed and duplex settings for the devices on the same Ethernet network must be the same to avoid transmission errors. • Fixed speed and full duplex settings are more reliable than autonegotiate settings and are recommended for some applications. • If the module is connected to an unmanaged switch, leave Autonegotiate port speed and duplex checked or communication can be impaired. • If you force the port speed and duplex with a managed switch, the corresponding port of the managed switch must be forced to the same settings or the module fails. • If you connect a manually-configured device to an autonegotiate device (duplex mismatch), a high rate of transmission errors can occur.

- When expanding the I/O configuration tree, make sure your I/O module RPI is two times faster than the periodic task that you are using.
- As you expand the I/O configuration tree, devices will affect the CIP/TCP count differently. Never use more than 80% of the available connections for the bridge modules.
- I/O packets per second (pps) describes an implicit message rate (Class 1). An I/O Comms Utilization value approaching or above 80% can necessitate an adjustment to the RPI.
- HMI packets per second (pps) describes an explicit message rate (Class 3). RSLinx connections and message instructions generate CIP traffic. HMI traffic is TCP-based, not UDP-based.
- The combination of implicit and explicit messaging provides a total utilization for a device. If you add implicit messaging (I/O), it takes bandwidth from the HMI because it has higher priority than HMI messaging. The combination of CIP implicit (highest priority) and CIP explicit (second priority) cannot exceed 100% use.

Devices

- Consider packets per second (see notes above) for performance if using many devices.
- Use compatible keying on Ethernet communication modules. In a validated environment, you can use an exact match for keying.

See the documentation listed in Additional Resources on page 10 for more information.

ControlNet Recommendations

The ControlNet network is an open, control network that combines the functionality of an I/O network and a peer-to-peer network, providing high-speed performance for both functions.

ControlNet I/O Communication Options

In a PlantPAx system, the ControlNet network supports controller downlinks and connections to remote I/O and field device interfaces. The network is unaffected when devices are connected or disconnected from the network.

Table 29 - ControlNet Interface

Category	Product	Description
ControlLogix controller interface	1756-CN2, 1756-CN2R 1756-CNB, 1756-CNBR	ControlLogix ControlNet scanner.
	1788-CN2FFR	ControlNet to FOUNDATION Fieldbus linking device. Supports H1 FOUNDATION Fieldbus networks. Compatible with ControlLogix redundancy and redundant ControlNet media.
	1788-CN2PAR	ControlNet to PROFIBUS PA linking device. Supports redundant PROFIBUS PA media and redundant ControlNet media. Compatible with ControlLogix redundancy.

Follow these guidelines for ControlNet networks:

Network

- When configuring the ControlNet network with RSNetWorx™ for ControlNet software, select Optimize and re-write the schedule for all connections.

  If changes are made to the ControlNet configuration, upload the configuration to make sure it gets backed up to the RSLogix 5000 project.
- Use a maximum of five controllers with a rack-optimized, listen-only connection to the module.
- Use a maximum of 64 I/O modules on an unscheduled remote I/O ControlNet network.
- Use a maximum of 20 ControlNet interface modules per controller.

Devices

- A ControlNet node can transmit 480 bytes of scheduled data in a single network update time (NUT).
- I/O modules on ControlNet can be unscheduled to allow adding I/O online.
- Do not leave any ControlNet node addressed 99 (this is the default address on some new devices).

See the documentation listed in Additional Resources on page 10 for more information.

DeviceNet Recommendations

The DeviceNet network is an open, device-level network that provides connections between simple industrial devices (such as sensors and actuators) and higher-level devices (such as PLC controllers and computers).

DeviceNet Communication Options

In a PlantPAx system, the DeviceNet network connects networked control devices.

Table 30 - DeviceNet Interface

Category	Product	Description
ControlLogix controller interface	1756-DNB	ControlLogix DeviceNet scanner.

Follow these guidelines for DeviceNet networks:

Network

- Connect up to 48 devices to the scanner when an average amount of data input and outputs is used.
- Use a maximum of 80% of the available scanner input and output memory.
- If you use more input and output device data, we recommend that you reduce the number of devices. For example, an MCC device, such as a soft starter, with all the available data enabled can use up to 40 bytes for input and 40 bytes for output. In this scenario, the maximum devices that we recommend connecting to the scanner is 10.
- To make sure the network is within limits, calculate the amount of input and output memory that the scanner needs.
- We recommend disabling Auto Address Recovery. If enabled, in some scenarios like a power outage, two devices can auto-recover to the same address.
- Store EDS files in a common location so they can be installed on engineering workstations.

Scanner

- Keep DeviceNet communication modules in the local chassis. If the communication module is in a remote chassis, set the input and output sizes to match the data configured in RSNetWorx for DeviceNet software.
- Never have any device set to the default node address of 62 (reserved for personal computer) or 63 (reserved for new device to be configured).
- Set the scanner address to node 0.
- Keep the Interscan Delay ≥ 5 ms.
- Set DeviceNet scanner RPI time to half the scan rate of the fastest task in the controller that uses the DeviceNet network, but not less than 2 ms.
- Use Background poll when possible. Keep (Foreground to Background Poll Ratio) * (Interscan Delay) > 75 ms.

See the documentation listed in Additional Resources on page 10 for more information.

HART Recommendations

HART is an open protocol designed to provide digital data over 4...20 mA analog signals.

HART Communication Options

The PlantPAx system interfaces both directly and via remote I/O modules to provide a single termination point to gather analog process variables and the additional HART digital data.

Table 31 - HART Interface

Category	Product	Description
Chassis-based I/O modules	1756-IF8H, 1756-OF8H 1756-IF16H	ControlLogix analog I/O modules with the following: • Standard profiles in RSLogix 5000 software • DTMs
	1756-IF8IH, 1756-OF8IH	ControlLogix analog isolated I/O modules.
	MVI56-HART	ProSoft Technology(1), HART multi-drop communication interface module for ControlLogix system for use in FactoryTalk AssetCentre Process Device Configuration or other asset management system based on FDT Technology (IEC-62453, ISA103).
Distributed I/O modules	1734sc-IE4CH, 1734sc-IE2CH	Spectrum Controls(1), analog and Ethernet I/O with HART for POINT I/O™ modules.
	1734sc-OE2ICH	Spectrum Controls, isolated analog output with HART for POINT i/O modules.
	1769sc-IF4IH, 1769sc-OF4IH	Spectrum Controls, isolated analog input and output modules with HART for Compact I/O.
	1794-IE8H, 1794-OE8H 1794-IF8IH, 1794-OF8IH 1797-IE8H, 1797-OE8H, IF8IHNFXT	Rockwell Automation, analog I/O with HART for FLEX™ I/O and FLEX Ex™ I/O modules. See the Technical Data and Selection Guide, publications 1794-TD018, 1794-SG002.
Multiplexers/gateways	WirelessHART gateway	PepperI+Fuchs(1), wireless HART gateway.
Network configuration	Field Xpert SFX350, Field Xpert SFX370	Endress+Hauser(1), handheld configurations and diagnostic devices.

(1) For more information on Encompass™ third-party products, see http://www.rockwellautomation.com/encompass.

Follow these guidelines for connectivity to a HART I/O card:

Network

- For 8-channel HART cards, only enable HART data on the channels that are connected to HART devices and you want to receive HART data. Enabling unused channels reduces system resources and performance.
- For 16-channel HART cards, there is no decrease in system performance by enabling all channels.

Devices

- If using HART data for control, check the data quality bits.
- For controlling fast loops, use only the 4...20 mA output of the instrument for control instead of the extended HART data.

For more information, see the following resources:

- E+H Instruments via HART to PlantPAx User Manual, publication PROCES-UM002
- Documentation listed in Additional Resources on page 10

FOUNDATION Fieldbus Recommendations

The FOUNDATION Fieldbus network is a digital, two-way, multi-drop communication link among multiple intelligent field devices and automation systems.

FOUNDATION Fieldbus Communication Options

The PlantPAx system communicates with FOUNDATION Fieldbus devices through EtherNet/IP and ControlNet linking devices.

Table 32 - FOUNDATION Fieldbus Interface

Category	Cat. No.	Description
EtherNet/IP interface	1788-EN2FFR	EtherNet/IP to FOUNDATION Fieldbus linking device. Supports H1 FOUNDATION Fieldbus network. Compatible with ControlLogix redundancy. Built-in functionality for the Ethernet DLR.
ControlNet interface	1788-CN2FFR	ControlNet to FOUNDATION Fieldbus linking device. Supports H1 FOUNDATION Fieldbus networks. Compatible with ControlLogix redundancy and redundant ControlNet media.
FOUNDATION Fieldbus network components	Power conditioning	Both linking devices have built-in power conditioning.
	1788-FBJB4R	Intelligent junction box supports redundancy, includes four drop ports.
	1788-FBJB6	Intelligent junction box with six drop ports.
	Network components	PepperI+Fuchs(1), FOUNDATION Fieldbus components including the following: • Terminators • Segment protection • Power products

(1) For more information on Encompass™ third-party products, see http://www.rockwellautomation.com/encompass.

Follow these guidelines for FOUNDATION Fieldbus networks:

Simplex controllers

- We recommend a maximum of 32 fieldbus segments.
- Use 8...12 devices per segment.
- Use only two terminators per bus segment to prevent distortion and signal loss. Some linking devices have built-in terminators but typically terminators are placed at the ends of the trunk.

Redundant controllers

- We recommend a maximum of 16 fieldbus segments.
- Use 8...12 devices per segment.
- Use only two terminators per bus segment to prevent distortion and signal loss. Terminators are placed at the ends of the trunk.

IMPORTANT Each linking device, whether configured with a simplex or redundant controller, can support one H1 segment.

Network

- To make sure the fieldbus network is within limits, add up your field device connections per segment to estimate controller I/O memory.
- Ground the network cable only to the distribution side. Do not connect either conductor of the linking device to ground to prevent communication loss.
- Amount of load and voltage drop determine maximum cable length. For example, the more field devices and junction boxes added to the cable increases the load, which increases signal attenuation. Likewise, the bigger the load and longer the cable, the bigger the voltage drop.
- The voltage specification for the H1 segment is 9...32V DC. We recommend that you use a 24V DC, 1 A Fieldbus Foundation power supply and be sure to keep the voltage above 13V DC at the farthest end of the segment.
- Signal quality can be adversely affected by placing the cable near motors, high-voltage, or high-current cables.
- The update time (macrocycle) for the H1 network is determined by the bandwidth that each device fills. This data is provided in the device's DD files.

Devices

- The linking device is a direct link between field devices on a Logix platform and the EtherNet/IP or ControlNet networks.
- Each linking device in the scanner uses four CIP connections in the controller.
- Built-in power conditioners reduce installation space requirements and open- and short-circuit protection guards against line faults.
- The RSLogix 5000 Add-On Profile (AOP) and graphical user-interface provides for online device configuration. New devices are automatically shown in the Live List.
- Add-On Profile (AOP) diagnostics that include an on-board oscilloscope report linking device and network statistics, such as noise and signal level and bad termination.
- Multiple levels of device and media redundancy are supported, including ring and dual trunk.

See the documentation listed in Additional Resources on page 10 for more information.

PROFIBUS PA Recommendations

The PROFIBUS PA network connects automation systems and process control systems with field devices such as flow, pressure, and temperature transmitters.

PROFIBUS PA Communication Options

The PlantPAx system communicates with PROFIBUS PA devices through EtherNet/IP and ControlNet linking devices.

Table 33 - PROFIBUS PA Interface

Category	Cat. No.	Description
PROFIBUS interface	1788-EN2PAR	EtherNet/IP to PROFIBUS PA linking device. Supports redundant PROFIBUS PA media and redundant ControlNet media. Compatible with ControlLogix redundancy. Built-in functionality for the Ethernet DLR.
	1788-CN2PAR	ControlNet to PROFIBUS PA linking device. Supports redundant PROFIBUS PA media and redundant ControlNet media. Compatible with ControlLogix redundancy.
PROFIBUS network components	Power conditioning	Both linking devices have built-in power conditioning.
	1788-FBJB4R	Intelligent junction box supports redundancy, includes four drop ports.
	1788-FBJB6	Intelligent junction box with six drop ports.
	Network components	Pepperl+Fuchs, PROFIBUS PA components including the following: • Terminators • Segment protection • Power products See the Encompass website for Pepperl+Fuchs product offerings.

Follow these guidelines for PROFIBUS PA networks:

Simplex controllers

- We recommend a maximum of 32 PROFIBUS segments.
- Use 15...20 devices per segment.

Redundant controllers

- We recommend a maximum of 16 PROFIBUS segments.
- The PROFIBUS PA segment is split between two physical ports. Use up to 10 devices per port.

Network

- PROFIBUS PA is a master-slave network.
- To make sure the PROFIBUS network is within limits, add up your field device connections per segment to estimate controller I/O memory.
- Ground the network cable only to the distribution side. Do not connect either conductor of the linking device to ground to prevent communication loss.
- Amount of load and voltage drop determine maximum cable length. For example, the more field devices and junction boxes added to the cable increases the load, which increases signal attenuation. Likewise, the bigger the load and longer the cable, the bigger the voltage drop.

- The voltage specification for the PROFIBUS PA segment is 9...32V DC. We recommend that you use a 24V DC PA power supply and be sure to keep the voltage above 13V DC at the farthest end of the segment.
- Signal quality can be adversely affected by placing the cable near motors, high-voltage, or high-current cables.

Devices

- The linking device is a direct link between PROFIBUS PA devices and the EtherNet/IP or ControlNet networks, with no intermediate PROFIBUS DP (decentralized peripherals) layer required.
- Each linking device in the scanner uses four CIP connections in the controller.
- Built-in power conditioners reduce installation space requirements and open- and short-circuit protection guards against line faults.
- The RSLogix 5000 Add-On Profile (AOP) and graphical user-interface provides for online device configuration. New devices are automatically shown in the Live List.
- Add-On profile (AOP) diagnostics that include an on-board oscilloscope report linking device and network statistics, such as noise and signal level and bad termination.
- Multiple levels of device and media redundancy are supported, including ring and dual trunk.

See the documentation listed in Additional Resources on page 10 for more information.

Motor Control Recommendations

Rockwell Automation offers two low-voltage motor control centers (MCC) that integrate control and power in one centralized location. The CENTERLINE® 2100 or CENTERLINE 2500 MCCs can house starters, soft-starters, and drives to meet IEC, UL, and NEMA standards.

Devices

- Each MCC Ethernet/IP device consumes one TCP and CIP connection. Using the 1756-EN2TR module, the maximum connections supported are 256 CIP connections and 128 TCP connections.
- Following the 1756-EN2TR module guidelines, we cannot exceed 80% of the maximum connections. Therefore, it's not recommended to use more than 100 MCC Ethernet/IP devices in a single 1756-EN2TR bridge module.

  If it is necessary to use more than 100 MCC Ethernet/IP devices, it is recommended to add one more 1756-EN2TR bridge module, splitting the communication to balance the bridges' load.
- It is not recommended to use more than 150 devices in a single Simplex controller. Considering this limit, the expected CPU load is almost in recommended limits. In this scenario, we are using only the MCC Ethernet/IP components with the Rockwell Automation Library of Process Objects.

  But, in a typical application, it is necessary to have other devices and objects in the same controller. This means there is a possibility that you cannot achieve the maximum 150 Ethernet/IP MCC components. It depends on your specific application. The PSE helps to determine these loads.
- Another important consideration is to use an adequate requested packet interval (RPI) to each device. We recommend that the RPI is half-speed of the task that is using the device. The default RPI timing can sometimes overuse the communication resources.

Notes:

Batch Management and Control Recommendations

PlantPAx batch management and control includes two options for a scalable solution:

- Controller-based single unit or multiple independent unit solution, called Logix Batch and Sequence Manager (LBSM)
- AppServ-Batch for a comprehensive batch solution (FactoryTalk Batch)

LBSM is the controller-based solution consisting of controller code and visualization elements for use on Logix5000 and FactoryTalk View software.

Refer to the PlantPAx Selection Guide and Knowledgebase Answer ID 62366 at http://www.rockwellautomation.custhelp.com for more information on LBSM.

AppServ-Batch uses FactoryTalk Batch software for a comprehensive, server-based solution that leverages Logix functionality (PhaseManager™). This chapter provides basic setup information for a comprehensive batch solution by using FactoryTalk Batch software.

The following table describes where to find specific information.

FactoryTalk Batch Critical System Attributes

The following critical system attributes (CSA) were used to verify performance for FactoryTalk Batch during process system characterization.

Table 34 - FactoryTalk Batch CSA

Batch Critical System Attribute	Performance
Idle state - start command	The time from the start command to the first scan of the running routine is no more than 1 second.
Running state - hold command	The time from the hold command to the first scan of the holding routine is no more than 1 second.
Running state - stop command	The time from the stop command to the first scan of the stopping routine is no more than 1 second.
Running state - abort command	The time from the abort command to the first scan of the aborting routine is no more than 1 second.
Held state - restart command	The time from the restart command to the first scan of the restarting routine is no more than 1 second.
Held state - stop command	The time from the stop command to the first scan of the stopping routine is no more than 1 second.
Held state - abort command	The time from the abort command to the first scan of the aborting routine is no more than 1 second.
Phase fail transition	The time from the phase failure initiation to the held state is no more than 1 second.
Phase transition time	The time from for one phase to complete and another to start is no more than 1 second.

Batch Guidelines for Logix

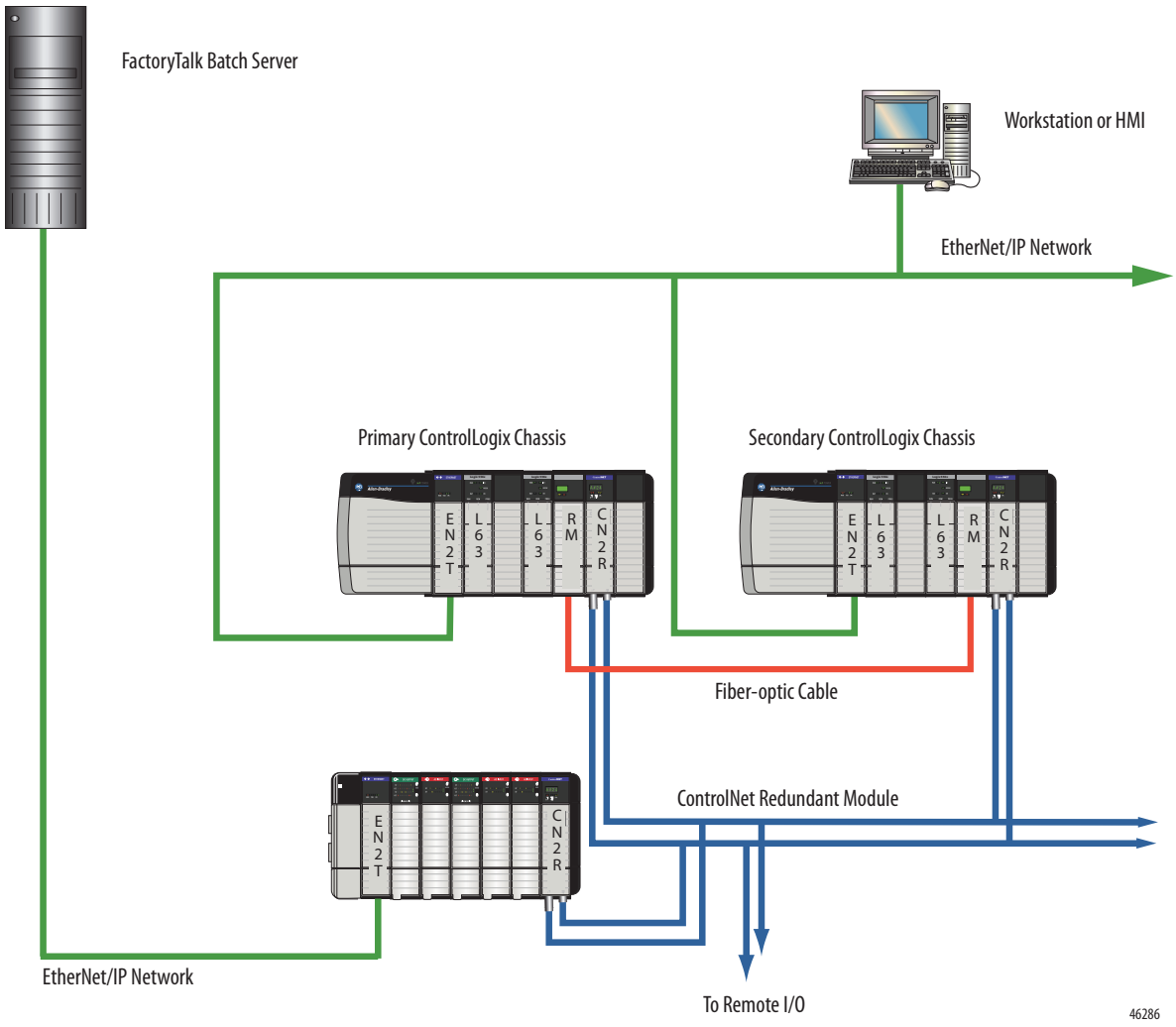
Phases can be developed by using PhaseManager to provide maximum modularity and reusability.

- In each phase, the running routine can keep track of what step it is executing by using a step index variable (part of the equipment phase user-defined structure).
- If you are using sequencer logic (SFC) for state logic programming, the restarting state routine must reset the running SFC back to a specific sequence step, based on the step the running SFC was in when the phase received the Hold command, and on what actions the Holding state routine took with the equipment controlled.
- A Prestate routine is a state that can be added to each phase and always evaluated. The Prestate routine can be used to keep active or enable functionality (for example, a phase that runs an agitator that does not stop when Held, but you must keep track of the time the agitator ran).
- For SFC, any conditional code that is required for transitions (such as a transition to the next step on a timer done) can be implemented by using separately defined phase tags as opposed to step tag attributes. This prevents errors when copying sequencer logic.
- For more information, see these resources:
- PhaseManager User Manual, publication LOGIX-UM001.
  - Instructions on setting up and using a Logix5000 controller with equipment phases.
- Factory Talk Batch PhaseManager Users Guide, publication BATCH-UM011.
  - Specifics on using PhaseManager with FactoryTalk Batch software.
- Tips on Using PhaseManager with FactoryTalk Batch, publication FTALK-WP001.
  - White paper with best practice for PhaseManager.

Using a Redundant System with a FactoryTalk Batch Server

If your system requirements include the batch not going to hold on a controller switchover, you need to use both a ControlNet bridge module and an EtherNet/IP bridge module to connect to the FactoryTalk Batch server. If batch hold upon controller switchover is acceptable, you can connect to the FactoryTalk Batch server directly from an EtherNet/IP module placed in the redundant chassis.

This illustration demonstrates one method of bridging the ControlNet network of the redundant system to the EtherNet/IP network that the FactoryTalk Batch server is running on.



Notes:

Information Management Recommendations

Information Management application servers (AppServ-Info) are used for data collection (such as a FactoryTalk Historian server) or decision support (such as a FactoryTalk VantagePoint server).

IMPORTANT We recommend that you host FactoryTalk Historian and FactoryTalk VantagePoint applications on separate information management servers.

The following table describes where to find specific information.

FactoryTalk Historian Overview

This section provides fundamental best-practice guidelines for implementing FactoryTalk Historian Site Edition (SE) software on PlantPAx systems.

The FactoryTalk Historian SE product is a co-developed with OSIsoft and, while it shares many of the same features and functionality available in their Plant Information ('PI') product, the development, documentation, and support of the FactoryTalk Historian SE software is owned by Rockwell Automation. With that in mind, references to 'OSIsoft' and 'PI' are included in the product and the documentation.

In a PlantPAx system, the FactoryTalk Historian SE software collects, stores, and manages data from the plant in the PlantPAx system. The software includes these hardware and software components:

- **Data Sources -** Plant floor devices and instruments that generate data, typically controllers. Other Data Sources can include external databases.
- **Historian SE Interfaces -** Compresses and stores the collected data and acts as a data server for Microsoft Windows-based client applications. It's also possible to use the Historian SE server to interact with data that is stored in external systems.

- **Historian SE Server -** Compresses and stores the collected data and acts as a data server for Microsoft Windows-based clients applications. It is also possible to use the Historian SE Server to interact with data that is stored in external systems.
- **Historian SE Clients -** Microsoft Windows-based applications that are used by plant personnel to visualize the Historian SE data.

Tips and Best Practices

For access to the collection of tips and best practices, refer to Knowledgebase Answer ID 56070 - FactoryTalk Historian SE Tips and Best Practices TOC at https://www.rockwellautomation.custhelp.com

Architectural Best Practices

The following distributed system is representative of how the components can be configured:

- AppServ-Info Historian: Historian SE Server
- PASS: Historian SE Interface, FTLD
- AppServ-Info Reporting: Historian SE Client
- AppServ-OWS, OWS, EWS: Historian SE Client

FactoryTalk VantagePoint Overview

This section provides fundamental best-practice guidelines for using FactoryTalk VantagePoint software on a PlantPAx system.

FactoryTalk VantagePoint provides unified access to virtually all manufacturing and plant data sources, and produces web-based reports, such as dashboards, trends, X-Y plots, and Microsoft Excel software reports. The FactoryTalk VantagePoint Trend tool and add-on alarm reports provide users of the PlantPAx system with advanced analytics.

Tips and Best Practices

For access to the collection of tips and best practices, refer to Knowledgebase Answer ID 59149 - FactoryTalk VantagePoint EMI Tips and Best Practices TOC at https://www.rockwellautomation.custhelp.com.

Maintenance Recommendations

Good maintenance practice keeps your PlantPAx system running efficiently. This chapter provides some recommendations for monitoring and maintaining your PlantPAx system.

The following table describes where to find specific information.

Maintaining Your System

When installing PlantPAx system elements, we recommend that you use the operating systems and Rockwell Automation software versions and firmware revisions as specified in the PlantPAx Selection Guide, publication PROCES-SG001. The selection guide specifies the optimal performance in accordance to sizing criteria.

The software versions for PlantPAx System Release 3.0 are listed on page 18.

Microsoft Updates

Microsoft releases a range of security updates, operating system, and other software updates. Rockwell Automation qualifies certain MS updates that potentially impact Rockwell Automation software products. The results of these patch qualifications are published on Knowledgebase Answer ID 35530 at http://www.rockwellautomation.custhelp.com.

We recommend that you do not apply or install Microsoft updates until they are qualified by Rockwell Automation. Before implementing qualified MS updates, we recommend that you verify them on a non-production system, or when the facility is non-active, to be sure there are no unexpected results or side effects.

You can contact Rockwell Automation Technical Support if additional information or details are required.

Antivirus Software

It is best practice to have antivirus software installed on your PlantPAx servers and workstations. See Knowledgebase Answer ID 35330 at http://www.rockwellautomation.custhelp.comfor more information on compatibility and considerations when installing antivirus software.

Rockwell Automation Software/Firmware Updates

We recommend that you periodically review and update the available software patches and firmware updates for the Rockwell Automation components on your PlantPAx system. Before implementing Rockwell Automation updates, we recommend that you verify them on a non-production system, or when the facility is non-active, to be sure there are no unexpected results or side effects.

For Rockwell Automation software (that is, FactoryTalk View, Factory Talk Batch, FactoryTalk Historian SE, and FactoryTalk AssetCentre), Rockwell Automation provides the Patch Validator tool. This tool verifies the current file version installed, the expected file version (based on the version of Patch Validator used), and completes installation of patch roll-up.

The Patch Validator tool is available for download via the Knowledgebase Answer ID 30393 at http://www.rockwellautomation.custhelp.com.

For Rockwell Automation firmware, Rockwell Automation provides a System Ferret tool that can be installed on the EWS to collect device serial numbers, and revisions of all devices through RSLinx Classic software. System Ferret is available through ab.com as an Integrated Architecture Productivity Tool; see http://www.ab.com/go/iatools.

The devices and firmware listed can be compared against the latest firmware compatible with your Logix firmware revision by reviewing the firmware compatibility. You also can download the latest firmware release at http://www.rockwellautomation.com/support/ControlFlash/.

Use the ControlFLASH™ Utility through RSLogix 5000 software to update firmware as documented in the ControlFLASH Firmware Upgrade Kit User Manual, publication 1756-UM105.

Considerations when Upgrading Software and Firmware

When installing a new PlantPAx system, we recommend that you use the specifications in the PlantPAx Selection Guide, publication PROCES-SG001.

When updating software versions or firmware revisions, we recommend that you verify the impact on performance and memory utilization before implementing the upgrade on the production system. For FactoryTalk View or ControlLogix platforms, we recommend that you review the release notes and verify the impact of the upgrade on performance and memory utilization.

You also can verify the compatibility of the upgraded version with the other software and operating systems in use on your PlantPAx system. See the Product Compatibility and Download Center at www.rockwellautomation.com.

Another tool (http://www.rockwellautomation.com/compatibility/#/scenarios) lets you compare features and compatibilities of different products and firmware revisions. You can contact Rockwell Automation Technical Support for assistance.

Monitoring Your System

Certain system attributes can be monitored to determine the health of the PlantPAx system. The table below provides monitoring recommendations.

Table 35 - PlantPAx System Monitoring Recommendations

System Attribute	How To Monitor	Description
FactoryTalk View HMI Server Status	In FactoryTalk View Studio, in the Explorer window, right-click the HMI server's icon, and then choose Server Status. You also can create a server monitoring screen as described in Knowledgebase Answer ID 44624 at http://rockwellautomation.custhelp.com.	Make sure the Primary server status is active. Changes made by using FactoryTalk View Studio software always occurs on the 'active' server. If the Primary HMI server computer is or was down, then the Secondary could be the active server. You do not want your HMI server project edits to occur on the Secondary HMI server computer because the replication operation works only in one direction, from the Primary HMI server to the Secondary HMI server. If you accidently do your editing on the Secondary HMI project, when you eventually replicate the Primary HMI server project, it overwrites the Secondary HMI server project and all the editing done is overwriten and lost.
Windows Event Logs	Event Viewer (Windows Administration Tools)	Browse the following logs looking for errors or warnings: • Application Event Log • Security Event Log • System Event Log
FactoryTalk Diagnostics	Event Viewer (Windows Administration Tools) or FactoryTalk Tools Diagnostic Viewer	Browse looking for errors or warnings.
IIS Logs	Default location is c:\Windows\system32\Logfiles\W3SVC1, but the actual location can be determined from the Internet Information Server Manager.	Look for return codes 400-404 or 500-503. (IIS - Troubleshooting HTTP error codes) See the Knowledgebase Answer ID 39618 at http://rockwellautomation.custhelp.com.

Table 35 - PlantPAx System Monitoring Recommendations

System Attribute	How To Monitor	Description
Server and Workstation CPU Utilization	Windows Administration Tool PerfMon (Performance Monitor) See Knowledgebase Answer ID 31196 at http://rockwellautomation.custhelp.com .	The CPU utilization for the PASS, App-Servers, and OWS computers is recommended to be 40% or less during steady-state operation. In PerfMon, CPU Utilization is \\<Computer Name>\Processor_Total\% Processor Time
Server Paging File Utilization	Windows Administration Tool PerfMon (Performance Monitor) See Knowledgebase Answer ID 31196 at http://rockwellautomation.custhelp.com . Windows Alerter and Messenger services See Knowledgebase Answer ID 64958 at http://rockwellautomation.custhelp.com .	Paging File Utilization can be found in the Microsoft Performance Monitor tool, but monitoring: \\<ComputerName>\Paging File(\??\C:\pagefile.sys)\% Usage Paging is the process of locating a page of data in physical memory that is currently not being used and transferring it to virtual memory to free up memory for active processing tasks. But, this process of moving pages of data back-and-forth between memory and virtual memory can slow down a system. Generate an alert if Paging Utilization exceeds 90 percent. See Check Paging Utilization on page 107 for details.
Controller CPU Utilization	L_CPU or RSLogix 5000 Controller Properties or RSLogix 5000 Task Monitor	Free CPU time is required to handle communication, abnormal conditions, and other transient loads. • Outside of production environment (before connecting FactoryTalk View and Historian clients), we recommend 50% free CPU time. • When in production environment (while FactoryTalk View and Historian are connected), we recommend 15% free CPU time for online edits and connection handling. Only use periodic tasks.
Controller Memory Utilization	L_CPU or FactoryTalk View Predefined or RSLogix 5000 Controller	For simplex controllers, follow these guidelines: • Outside of production environment (before connecting FactoryTalk View and Historian clients), we recommend 50% free memory to support communication and handling of abnormal conditions. • When in production environment (while FactoryTalk View and Historian are connected), we recommend 30% free memory to support handling of abnormal conditions. Maintain greater than 50% free memory available at all times for redundant controllers.
Controller User Tasks (last scan, max scan, overlap)	L_TaskMon or RSLogix 5000 Task Properties Window	Make sure you are not experiencing task overlap by verifying the task overlap count is 0. Task overlap indicates that the controller could be overloaded and not executing as expected.
Controller Minor Faults	RSLogix 5000 Controller Properties Window	Make sure you are not experiencing any minor faults. This can slow your controller execution time or can indicate some other problem with your user logic.
Packets per Second	L_CPU or RSLinx Enterprise pre-defined tags	Make sure the packets per second is less than 300 on the 1756-L7*x* controller and less than 200 on the 1756-L6*x* controller. If you have more than one data server topic pointing to the controller, you have to add the packets per second for each topic to get a total.

Check Paging Utilization

Virtual memory is the use of hard disk space to supplement the amount of physical memory (RAM) that is available to the computer. Windows cannot process data directly from virtual memory. If Windows needs to process data that is in virtual memory, it must move the page containing the needed data from virtual memory into physical memory. This process is called paging.

Windows must use CPU cycles and even a portion of RAM just to manage the paging process. Furthermore, hard disk access times are measured in milliseconds, as opposed to RAM access times that are measured in nanoseconds. Therefore, the paging process can waste a lot of server resources to move pages of data back and forth between memory and virtual memory.

Thrashing is a term for nearly constant paging. If the hard disk is running constantly with no visible results and a very sluggish response time, the system is thrashing. Paging Utilization percentage can be used to bring this condition to your attention.

The appropriate Paging Utilization percentage can depend on the virtual memory set up on the server. It is best to baseline the paging file performance and set alert limits when performance significantly deviates from this baseline. For example, generate alert if Paging Utilization > 90%.

Additional Monitoring Resources

The Counter Monitor tool is installed with the FactoryTalk Services Platform (FTSP) on the PASS. It is on the drive where FTSP is installed under Program Files/Common Files /Rockwell/ countermonitor.exe.

Counter Monitor provides the ability to monitor the runtime values of counters and strings that are made available by network clients for diagnostic purposes. You also can use the Counter Monitor tool to take a snapshot of the current status and submit it to Rockwell Automation Technical Support.

Rockwell Automation also provides tools to collect log files for submission to technical support.

The Rockwell Software Data Client program can browse the FactoryTalk directory to see all tags in the directory. It can also get live data from any tag. The Rockwell Software® Data Client program does not automatically load the application. Before you use it, you must make sure the application is open by either opening the application from any computer with RSView® Studio or by running an RSView SE Client™.

For more information, see these references depending on your operating system:

- Knowledgebase Answer ID 31073 - Log Reader Tool (XP, Windows 2003)
- Knowledgebase Answer ID 453900 - (Windows 7, Server 2008)

Services and Support

System Support offers technical assistance that is tailored for process automation systems. These services are available through TechConnect^{SM} contracts. Some of the features include the following:

- Highly experienced team of engineers with training and systems experience
- Process support at a systems-level provided by process engineers
- Unlimited online support requests
- Use of online remote diagnostic tools
- Access to otherwise restricted TechConnect Knowledgebase content
- Technical Reference Library DVD
- 24-hour, seven days per week, 365 days per year of phone-support coverage upgrade option.

For more information, contact your local distributor or Rockwell Automation representative or visit http://www.rockwellautomation.com/support.

System Element Software Components

Table 36 shows the typical software for the system element components that comprise your PlantPAx system.

Table 36 - System and Software Requirements

Element	Category	Description
PASS	Operating system	• Windows 2008 R2 SP1 operating system, 64-bit • Microsoft SQL 2008 server R2 Express • Microsoft .NET Framework 4
	Rockwell Automation software	• FactoryTalk Services Platform software, version 2.70.00 • FactoryTalk Diagnostic software, version 2.70.00 • FactoryTalk View Site Edition Server software, version 8.00.00 • FactoryTalk Activation Manager software, version 3.62.01 • FactoryTalk Alarm and Event software, version 2.70 • Rockwell Automation x64 Driver, version 1.1.15 • RSLinx Enterprise software, version 5.70.00 • FactoryTalk Historian SE 4.00 Live Data Interface Suite software, version 1.03.114
EWS	Operating system	• Windows 7 Professional SP1 operating system, 64-bit • Microsoft SQL 2008 server R2 Express • Microsoft .NET Framework 1.1 • Microsoft .NET Framework 4
	Rockwell Automation software	• FactoryTalk View SE Studio and Client software, version 8.00.00 • FactoryTalk Services Platform – FactoryTalk Services Platform software, version 2.70.00 – RSLinx® Classic software, version 3.60.00 – RSLinx Enterprise software, version 5.70.00 • FactoryTalk Activation software, version 3.62.01 • RSLogix™ 5000 Professional software, version 20.00.00(1) – RSNetWorx™ for DeviceNet software – RSNetWorx for ControlNet software – RSNetWorx for Ethernet software – RSLogix Architect software – ControlFLASH™ software – RSLogix 5000 Fuzzy Designer software (activated separately) – RSLogix Emulate 5000 software • FactoryTalk Asset Centre Client software, version 5.00.00 – Process Device Configuration software, version 4.00.00 – Rockwell Automation DTM Collection • FactoryTalk Historian SE 4.00 Management Tools, version 1.03.114 • Microsoft Excel 2010 en-US, 32-bit (optional)(2)
OWS	Operating system	• Windows 7 Professional SP1 operating system, 64-bit • Microsoft .NET Framework 4
	Rockwell Automation software	• FactoryTalk View SE Client software, version 8.00.00 • FactoryTalk Services Platform software, version 2.70.00 • FactoryTalk Activation software, version 3.62.01 • FactoryTalk Historian Connectivity software, version 1.4.2.15

(1) Multiple versions of RSLogix 5000 software can coexist on the EWS. Therefore, additional versions also can be installed, if necessary.

(2) Provides use of FactoryTalk Historian Add-In.

Table 36 - System and Software Requirements

Element	Category	Description
AppServ-OWS	Operating system	• Windows 2008 R2 SP1 operating system, 64-bit • Microsoft .NET Framework 4
	Rockwell Automation software	Same requirements as listed for OWS Rockwell Automation software
AppServ-Info (Historian)	Operating system	• Windows 2008 R2 SP1 operating system, 64-bit • Microsoft SQL Server 2008 R2 Express • Microsoft .NET Framework 4
	Rockwell Automation software	• FactoryTalk Services Platform software, version 2.60.00 • FactoryTalk Diagnostics software, version 2.60.00 • FactoryTalk Historian Site Edition software, version 4.00.00 • FactoryTalk Activation Manager software, version 3.60.00
AppServ-Info (VantagePoint)	Operating system	• Windows 2008 R2 SP1 operating system, 64-bit • Microsoft SQL Server 2008 R2 Standard • Microsoft .NET Framework 4.5
	Rockwell Automation software	• FactoryTalk Services Platform software, version 2.60.00 • FactoryTalk Diagnostics software, version 2.60.00 • FactoryTalk Activation Manager software, version 3.60.00 • FactoryTalk Historian SDK software, version 1.4.2.445 • OPC Core Components (x86), version 105.1 • Microsoft Excel 2010 en-US, 32-bit • FactoryTalk VantagePoint server software, version 6.00.00
AppServ-Asset	Operating system	• Windows 2008 R2 SP1 operating system, 64-bit • Microsoft SQL Server 2008 R2 Standard • Microsoft .NET Framework 1.1 • Microsoft .NET Framework 4
	Rockwell Automation software	• FactoryTalk Services Platform software, version 2.60.00 • FactoryTalk Diagnostic software, version 2.60.00 • FactoryTalk Asset Centre Server software, version 5.00.00 • FactoryTalk Activation Manager software, 3.60.00 • FactoryTalk Alarm and Event software, version 2.60.00 • Rockwell Automationx64 Driver, version 1.1.11 • RSLinx Enterprise software, 5.60.00 • RSLinx Classic software, version 3.60.00 • FactoryTalk Asset Centre Client software, version 5.00.00 (optional) – Process Device Configuration software, version 4.00.00 – Rockwell Automation DTM Collection

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here, refer to the Allen-Bradley Industrial Automation Glossary, publication AG-7.1.

Add-On Instruction Add-On Instructions are reusable code objects that contain encapsulated logic that can streamline implementing your system. This lets you create your own instruction set for programming logic as a supplement to the instruction set provided natively in the ControlLogix firmware. An Add-On Instruction is defined once in each controller project, and can be instantiated multiple times in your application code as needed.

alarm An audible and/or visible means of indicating to the operator an equipment malfunction, process deviation, or abnormal condition requiring a response.

alarm event A push notification from the alarm object to the alarm subscriber indicating a change in alarm state.

alarm management The processes and practices for determining, documenting, designing, operating, monitoring, and maintaining alarm systems.

alarm object The alarm system element that owns the alarm; it is responsible for indentifying alarms, managing the state, and generating alarm events.

alarm priority An attribute of In-Alarm event that informs you of the salience of the event.

alarm system The collection of hardware and software that detects an alarm state, communicates the indication of that state to the operator, and records changes in the alarm state.

application server The application server (AppServ) is a server in addition to the Process Automation System Server (PASS) that is typically a FactoryTalk Directory client of the PASS. Examples are AppServ-Batch for a FactoryTalk Batch application or AppServ-History for an Historian application.

architecture An architecture is a representation of a control and software system, as well as the process and discipline for effectively implementing the designs for such a system. An architecture conveys the information content of the related elements comprising a system, the relationships among those elements, and the rules governing those relationships.

characterization A characterization is the operation and collection of performance data for a representative process system to determine scalability, stability, and usability of a specific system configuration. A characterization is the following:

- Aimed at defining a complete system
- Used to determine if the system is performing at specified level
- Used to identify usability issues
- Used to check and create rules, relationships, limits, and recommendations for system elements

client A client is hardware (personal computer) and software that provides an interface with a link into a system server application. In the Rockwell Automation architecture, a client is a computer loaded with runtime software.

control strategy A control strategy is a system footprint to show the complexity of the following:

- Data servers
- Information storage
- Operator interface (graphics, faceplates)
- Control code (sequence, procedure, phases)
- I/O

Control strategies are used to determine a set of comprehensive process system footprints that establish a representative system loading that can be measured to identify a process system's boundaries and limitations (implementation rules).

critical system attribute (CSA) A critical system attribute (CSA) is a customer-facing characteristic that defines or identifies whether the system is performing as expected. CSAs are specific, visible indicators of overall system performance and usability.

CSAs have specified parameters that must be maintained and that set the base operational requirements for the system. These parameters determine pass or fail (follow up) of a system test. For example, screen paint time < 2 seconds and screen refresh < 1 second.

There are many other attributes associated with system elements such as controller loading, computer loading, and network settings that must be configured properly to maintain system CSAs.

development software Development software is a program application that is used to configure various system components and not required at runtime. For example, RSLogix 5000 software, FactoryTalk View Studio software.

display object A display object is a functional group of display elements with animations.

engineering workstation (EWS) The engineering workstation (EWS) provides system configuration, development and maintenance functions of the PlantPAx system. The EWS contains development software, including FactoryTalk View SE Studio and RSLogix 5000 software.

FactoryTalk directory software FactoryTalk Directory software defines were system data is stored for access. FactoryTalk Directory software provides a common address book of factory resources that are shared among FactoryTalk-enabled products.

FactoryTalk services platform The FactoryTalk Services Platform (FTSP) is a service-oriented architecture (see SOA) that delivers value through FactoryTalk-enabled products. This platform reduces the customer learning curve and project engineering time through commonality and reuse. For example, activation, FactoryTalk Directory, security, diagnostics, audit, live data, and alarms and events.

global object An object that is created once and can be referenced multiple times on multiple displays in an application.

historian An historian is a data collection system with the following components: collection, storage, compression, retrieval, reports, and analysis. Historian functions include raw sampling, compression, storage, retrieval, reconstitute, analyze, summarize, and present (reports and displays).

historical data Historical data is data that is used for the long term analysis of past operation.

Integrated Architecture (IA) Integrated Architecture (IA) is the identifying name of Rockwell Automation group of products that use Rockwell Automation core-enabling technologies. The PlantPAx Process Automation System is a defined set of IA products configured in a prescribed way to provide optimal performance as a process automation system.

operator workstation (OWS) The operator workstation (OWS) provides the graphical view and interface into the process. The workstation is a client of either a PASS or AppServ-HMI.

PlantPAx Process Automation System The PlantPAx system has all the core capabilities expected in a world-class distributed control system (DCS). The system is built on a standards-based architecture by using Integrated Architecture components that enable multi-disciplined control and premier integration with the Rockwell Automation® intelligent motor control portfolio.

Process Automation System Server (PASS) The Process Automation System Server (PASS) is the core PlantPAx system server allowing central administration throughout the PlantPAx system. The PASS is a required component.

RSLinx software RSLinx software is the communication driver (data server) for computer-based programs to access information in Rockwell Automation controllers. There is RSLinx Classic software and RSLinx Enterprise software. FactoryTalk View SE software uses RSLinx Enterprise software to directly access tags in a controller.

server Software component that serves data to an application (for example, data server). Typically, server software components are installed on server-class computers.

system attribute A system attribute is an operational functionality that can be manipulated or measured and is used to establish the operational boundaries or system capability. For example workstation memory, number of parameters on a screen, and number of control loops. A system attribute can be independent or dependent.

system element A system element is a distinctive system entity made up of a combination of hardware and software products that support an identifiable system function or role. A system element can be manipulated to vary system operation or capability. For example, engineering workstation (EWS), operator workstation (OWS), process automation system server (PASS), and controller.

system infrastructure System infrastructure is the commercial off-the-shelf hardware and software required to enable system elements to work together as a system. For example, network switches, computers, and so forth.

system server A system server expands the scope of a system by providing support for additional system capacity or optional system functions. For example, the Process Automation System Server (PASS) is a required component for all centralized and distributed process systems. The PASS provides central name resolution and system-wide, FactoryTalk services. The PASS provides the capability to distribute information to the OWS and add to optional application servers to increase the scope of the process system.

User -defined Data Type (UDT) Tag types that you create once and reuse in multiple tag templates, multiple times.

workstation A workstation is a computer running development, configuration, and optional maintenance software. A workstation is not a server.

N

O

P

R

S

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support you can find technical and application notes, sample code, and links to software service packs. You can also visit our Support Center at https://rockwellautomation.custhelp.com/ for software updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/services/online-phone.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/rockwellautomation/support/overview.page, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to help ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation Feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete this form, publication RA-DU002, available at http://www.rockwellautomation.com/literature/.

Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page.

Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Publication PROCES-RM001I-EN-P - September 2014
Supersedes Publication PROCES-RM001H-EN-P - June 2013