Technical Information

Integrated Production Control System
CENTUM VP
System Overview (General Overview)

TI 33J01A10-01EN

[Release 6]

YOKOGAWA

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Introduction

CENTUM VP integrated production control system is applied to control and manage plant operations in various industries such as oil and gas, petrochemicals, chemicals, power, pulp and paper, pharmaceuticals, food, iron and steel, waste, and water and sewage treatment.

This document describes a general overview of the CENTUM VP system. Further details are available by the series of documents such as System Overview (HMI), System Overview (FCS), and General Specifications (GS) for individual products.

Relevant Manual

TI 33J01A11-01EN	CENTUM VP System Overview (HMI Overview)
TI 33J01A12-01EN	CENTUM VP System Overview (FCS Overview)
TI 32P01A10-01EN	ProSafe-RS System Overview

Target Readership for This Manual

This manual is mainly intended for:

Instrumentation, electric and computer engineers who are evaluating CENTUM VP for purchase or who will be in charge of installation.

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System Overview

TI 33J01A10-01EN 6th Edition

CONTENTS

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1. CENTUM VP Overview

Yokogawa is the world's first company that introduced the distributed control system (DCS) in 1975 - the first series of CENTUM Systems. Ever since, Yokogawa kept developing and enhancing the CENTUM series systems by complying with what customers (managers, operators, engineers, and so on) requirements. As the generations of CENTUM advanced Yokogawa kept improving its product quality achieving the highest level of reliability in the market. CENTUM systems have been adopted by customers around the world to control and monitor their industrial plants.

1.1 History of CENTUM

Innovations of operation in the process industries have come a long way since the age of panel-mounted loop controllers. In early 1970s, a panel operator was assigned for operation per panel. However, by the introduction of a DCS, operators' ways of working have drastically changed. Operators can grasp the plant-wide operation by sitting in a central control room (CCR). And their work scope has largely been extended.

The CENTUM systems kept evolving to increase productivity and improve plant operations in the past 40 years, and CENTUM VP is the 8th generation of the CENTUM Series. Yokogawa has adopted the latest state-of-the-art technologies of the time to develop the systems, keeping return on the investment (ROI) and the total cost of ownership (TCO) in minds.

Yokogawa has always been offering a smooth upgrade path from an existing CENTUM system into the latest one. It provides customers the benefits of using the existing system as long as they wish yet allows them to adopt the latest technologies with a minimum investment. Yokogawa's CENTUM systems have been replaced with the latest ones smoothly with minimum shutdown time.

Yokogawa continually endeavors to meet customers' needs by providing highly reliable control systems based on the leading edge technology.

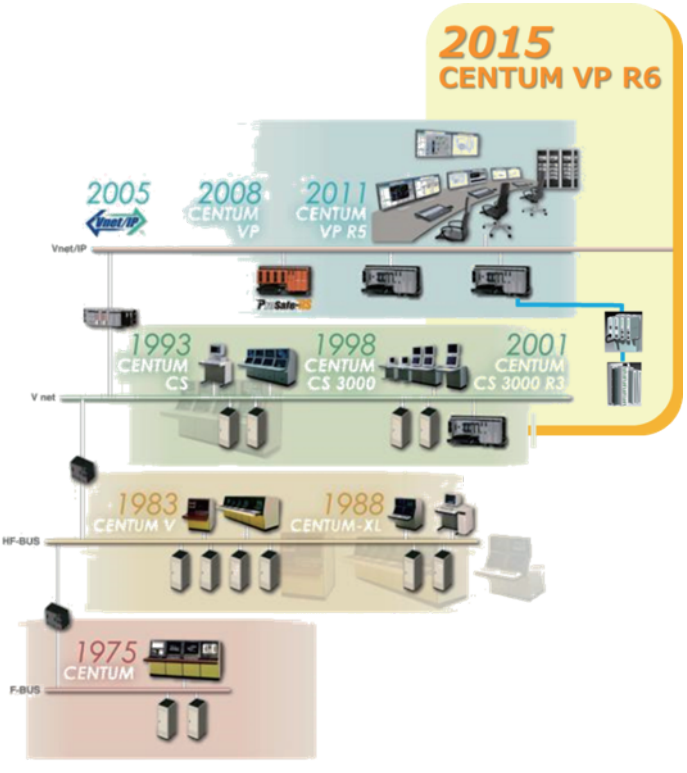

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Figure History of CENTUM

1.2 CENTUM at Work

Yokogawa has sold over 28,000 CENTUM projects in all kinds of industrial plants worldwide such as oil and gas, petrochemicals, chemicals, power, pulp and paper, pharmaceuticals, food, iron and steel, waste, and water and sewage treatment. The majority of the customers are from oil and gas, and petrochemical industries. It means that once the CENTUM system is delivered and start its operation, it has to be in operation non-stop.

In the past 40 years of experience, Yokogawa is reputed with the high reliability of the CENTUM system winning customer satisfactions. Yokogawa is engaged in the global purchase agreements with world major customers as their sole instrumentation supplier. Yokogawa needs only one project to convince customers of our capability and win trust. Once Yokogawa system is delivered, customers stay with Yokogawa.

As of March, 2019

Figure CENTUM at work

1.3 CENTUM VP Advantages

For Operations

- **Safe and unified plant operations**

  Universal interface for control, safety, and asset intelligence.
  Embedded mechanisms to prevent information overload

- **Non-stop improvement**

  Continuous systemization of operational best practices and context specific operational advisories.

For Engineering

- **Flexible system design is enabled by the new engineering environment**

  Automation Design Suite (AD Suite) is a new integrated engineering environment released from CENTUM VP R6, which enables to design and configure control applications independently from configurations of FCSs or I/O module assignments. The I/O design can also flexibly be changed even after designing the control applications.

For Controllers

- **Highly-reliable controllers**

  CENTUM's FCS is highly reliable: it hardly fails, keeps operating normally even if it is failed, and quickly recovers from failures. These features are the foundation of the long and stable operations of the plant.

  With CENTUM VP R6, a new controller complying with the N-IO (*1) has been released.

*1: A single type of I/O module handles all DI, DO, AI, and AO signals which are changeable by the software. For details, refer to System Overview (for FCS) (TI 33J01A12-01EN).

For Production Management

- **Faster Plan, Do, Check, and Act cycle for agile adaptation**

  MES and enterprise system integration is enabled by using S95 andB2MML standards

- **Secure and standard-based information integration**

  Built-in control network security certified by experts

For Maintenance

- **Continuous evolution without compromising asset availability**

  Evergreen evolution with online upgrades and modifications. It is the most reliable platform with no single point of failure

- **Long-term investment protection**

  Upgrade paths is incorporated before any new release. We have over 40 years of backward compatibility.

For Project

- **Faster project execution with fewer integration risks**

  Single-source integrated solutions for control system (DCS), safety instrumented system (SIS), embedded plant information management system (PIMS), intelligent RTU & SCADA, and turbine controller.

2. System Configuration

CENTUM VP has a simple & common architecture consisting of human machine interfaces called human interface station (HIS), field control stations (FCS), and a control network. These three basic components support facilities from the tiny to very large and complex with up to 1,000,000 tags.

The Design Concept of CENTUM VP System Configuration

CENTUM VP is designed based on the concept to keep the plant operation availability high. Customers expect Yokogawa products to perform its functions without failure so that the plant operations shall not stop. Yokogawa developed our own FCSs so that we can meet up with the customers' expectations. Quite a number of FCSs are still in operation even after 20 or more years passed since those are originally installed. It is owing to the high quality of the products themselves that has been supported by the total serviceability such as skilled manufacturing, quality control, after sales service and appropriate training.

Self-independent Controller

CENTUM VP's FCSs are designed to work without HIS. The fundamental controls can be done only by the FCSs, and all the process data, control logic, and procedures are contained in the controllers. HIS works only as a monitor screen under the normal condition. In Yokogawa's system configuration, FCSs are acting like servers and HISs as clients. The hardware availability of FCS (=server) is 99.99999% which comes from the basic policy in product designs. Our FCSs are designed; (a) not causing failures easily (fault-avoidance), (b) to continue controlling the plant even it fails (fault-tolerant), and (c) to recover from failures as quickly as possible (maintainability). It is the crystallization of Yokogawa's leading edge technology.

Why CENTUM VP does not have Client-Server Concept?

In a typical server-client configuration, when the server fails, all the client HMIs come to stop. It means that all the controls and the data of the plant are lost until the server is recovered. This is certainly not an acceptable situation for plant operations in reality. In order to prevent server down as much as possible, an expensive server machine is needed or to have a redundant configuration.

CENTUM VP's Field Control Stations (FCSs) are far superior to the PC servers on account of availability, even those with redundant configuration. Each FCS runs independently that hedges the risk of causing serious damage to the plant by a single failure.

PC servers become obsolete in a few years of cycles, but FCSs with appropriate maintenance runs for many years. The robustness of FCS saves the cost of repairs and damages to the plants as the plant does not fail. In the viewpoint of total cost of ownership (TCO), Yokogawa's FCS is more economical.

CENTUM VP Components

In this section, a term “PC” means an Intel x86-based computer which has inherited IBM PC/AT compatible machine, and it runs on the Microsoft Windows OS. The PC means not only a personal computer but also a workstation and a server.

Human Interface Station (HIS)

CENTUM VP uses a PC for its human machine interface. It is called HIS when the software packages for Operation and Monitoring Functions are installed there.

Engineering Station (ENG)

ENG is a computer with Engineering Function software packages of AD Suite. AD Suite consists of Automation Design Server (AD Server), Automation Design Organizer (AD Organizer), and VP Builder. ENG allows you to use AD Organizer and VP Builder of AD Suite.
For details on AD Server, AD Organizer, and VP Builder, refer to Chapter 3.

Field Control Station (FCS)

FCS is a high reliability controller designed and manufactured by Yokogawa. It performs control computation functions for each function block and input/output functions for process and software inputs/outputs. FCS hardware can be selectable from a cabinet type or a rack-mountable type. It consists of a field control unit (FCU) and node units to mount input/output modules. It enables to configure a scalable system by connecting several node units in a FCS in accordance with the I/O points.

Generic Subsystem Gateway (GSGW)

GSGW is a station for operation and monitoring subsystems. By using a PC as a platform, it establishes subsystem communications via OPC DA(*1) interface defined by the OPC Foundation. Subsystem data is assigned to the GSGW’s function blocks to be controlled and monitored via HIS in the same manners as other control stations.

*1: Open Product Connectivity, Data Access

System Integration OPC Station (SIOS)

SIOS is a station to integrate CENTUM VP and the third-party process control systems (PCSs). It enables CENTUM VP to exchange data with and receives alarms and events from the third-party PCS via OPC interface.

Unified Gateway Station (UGS/UGS2)

UGS/UGS2 is a station exclusively used for Vnet/IP to integrate CENTUM VP and subsystem controllers such as STARDOM controllers (FCN/FCJ) and other third-party programmable logic controllers (PLCs). Its standard function allows CENTUM VP to communicate with subsystem controllers via various communication protocols such as OPC DA, OPC A&E (*1), Modbus, Ethernet/IP, or IEC 61850 IED. UGS/UGS2 enables CENTUM VP to control and monitor those subsystems in the same way as CENTUM VP FCS. UGS/UGS2 can be configured in dual-redundant using 2 computers.

*1: Open Product Connectivity, Alarms and Events

Advanced Process Control Station (APCS)

APCS performs advanced control and computation functions for improving plant operation efficiencies.

Bus Converter (BCV)

BCV relays CENTUM VP communications with other CENTUM VP and older CENTUM systems such as CENTUM CS 3000, CENTUM CS 1000, CENTUM CS, CENTUM-XL, CENTUM V, and μXL.

V net Router (AVR)

AVR connects and transmits control communications between the Vnet/IP and V net domains. The control data can be sent and received in both ways between the Vnet/IP and V net domains. It enables control and monitoring of the control stations among other domains.

Wide Area Communication Router (WAC Router)

WAC Router is a relay equipment to connect 2 Vnet/IP domains via Wide Area Network (WAN). Operations and monitoring that are distributed in remote areas can be realized.
Satellite communication can also be used as a WAN.

Layer 2 Switch (L2SW)

L2SW relays communications among devices connected to the Vnet/IP network. The Vnet/IP domain refers to the Vnet/IP system area connected by L2SW. Use L2SW with 1 Gbps communication speed in the Vnet/IP domain.

Layer 3 Switch (L3SW)

L3SW relays communications among Vnet/IP domains. Use L3SW with 1 Gbps communication speed.

Control Network (Vnet/IP)

“Vnet/IP” is an IEEE802.3 Ethernet compliant, 1Gbps redundant network. The control network links stations such as HIS, FCS and BCV. It incorporates Yokogawa’s technology to achieve deterministic, reliable, and secure communications.

Digital Fieldnetworks

CENTUM VP supports FOUNDATION fieldbus, HART, PROFIBUS-DP, PROFINET, DeviceNet, Modbus, Modbus/TCP, Ethernet/IP, and ISA100.11a field wireless network.

Network-based Control System (STARDOM)

Yokogawa’s intelligent-hybrid remote telecommunication controllers are ideal for the oil and gas upstream market. They can be seamlessly integrated, via the UGS, to CENTUM VP.

- **Autonomous Controller (FCN/FCJ)**

  These controllers utilize the global Standard IEC 61131-3 as the engineering tool.

- **Versatile Data Server Software (ASTMAC VDS)**

  VDS is a SCADA software which uses Web browser (Internet Explorer) for HMI display.

Safety Instrumented System (ProSafe-RS)

This is Yokogawa's TÜV SIL3 certified premier safety instrumented system. It incorporates Yokogawa's own Pair and Spare and Vnet/IP technologies and offers unprecedented synergy with CENTUM VP.

- **Safety Control Station (SCS)**

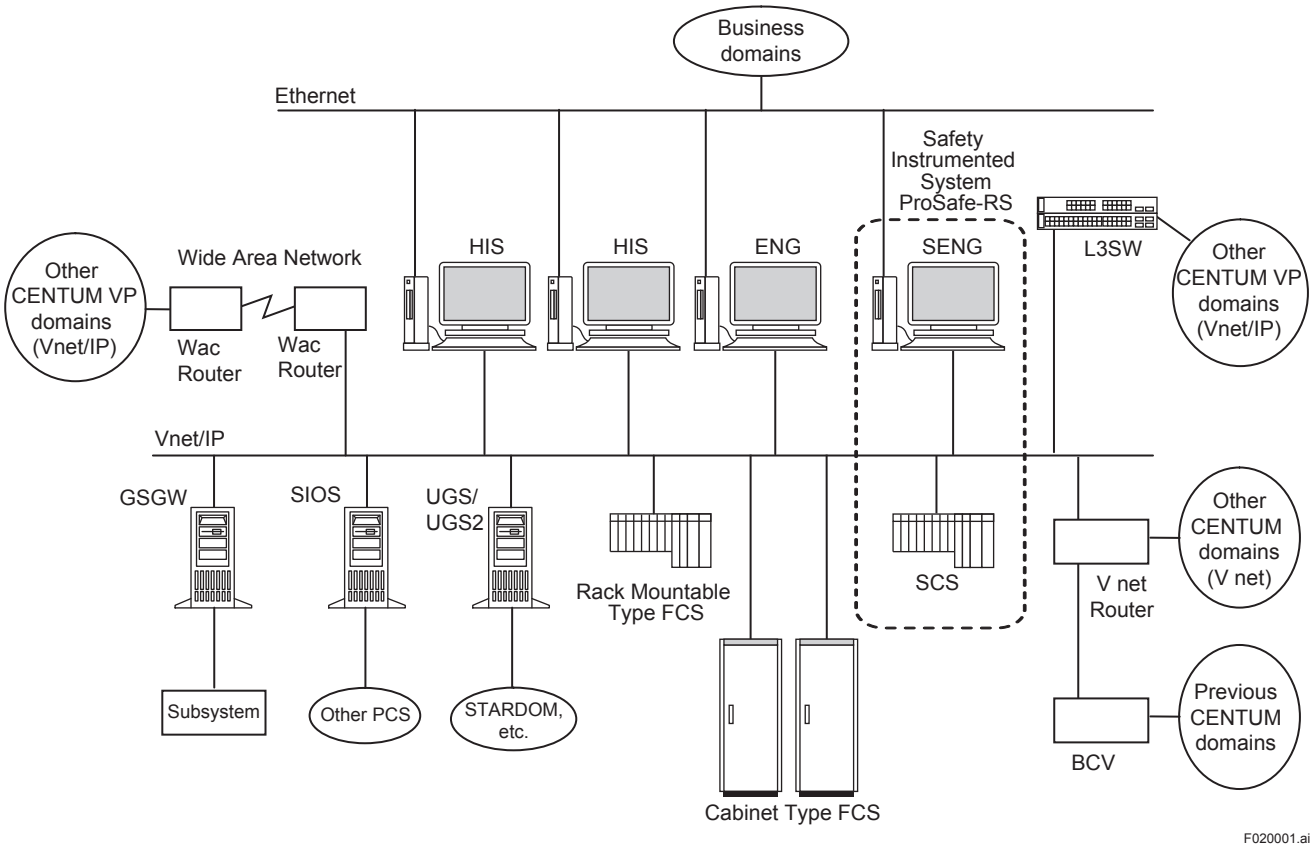
  SCS is a Yokogawa manufactured safety controller that executes logics for systems including interlock, emergency shutdown and fire and gas protection.

- **Safety Engineering Station (SENG)**

  An off-the-shelf PC that performs SCS generation and maintenance management.

Overall System Configuration

The below drawing shows an overall system configuration of the CENTUM VP integrating previous CENTUM system, the ProSafe-RS safety instrumented system, and other subsysems.



CENTUM VP system specifications are shown below.

- Number of tags that can be monitored: 100,000 tags
- Number of stations that can be connected: 256 stations

CENTUM VP can expand the specifications for a very large system.

- Number of tags that can be monitored: 1,000,000 tags
  (When using VP6H4000 Million Tag Handling Package. See GS 33J05K10-01EN.)

If an expansion of the number of stations is required, please contact to Yokogawa's sales representative.

Solution Product

Yokogawa provides system products for solutions which collaborate with CENTUM VP. The following solution products are able to integrate with CENTUM VP.

OPC Interface Package (Exaopc)

Exaopc provides an OPC (Open Product Connectivity) interface bridge between the control room and the outside world. Exaopc is an OPC server running on a Microsoft Windows platform which can be connected to a variety of PCSs (Process Control Systems) providing OPC clients with process data and alarm events.

Plant Information Management System (Exaquantum)

Exaquantum is a Plant Information Management System (PIMS) product that provides business benefits to users in the Hydrocarbons, Chemicals, Power & Utilities, Pulp & Paper and many other industries. The main function of Exaquantum is the acquisition of data from all facets of a business and the subsequent transformation of that data into easily usable, highvalue, widely-distributed information. The data then becomes an integral part of the set of tools used by the business in vital decision-making processes.

Exaquantum is the business intelligent gateway between the operational Process Control System (PCS) and the business Enterprise Resource Planning (ERP) system. It uses the latest, proven, Microsoft based open technology sets, designed to have low administration costs, and be robust to future IT trends.

Operation Efficiency Improvement Package (Exapilot)

Exapilot is an operating efficiency improvement support package aimed at automating the tasks manually performed by operators such as unsteady state operations, steady state operations, or abnormal situation operations in a plant.

Exapilot makes it easy to create semi-automatic sequences that incorporate the know-how of skilled operators, and thus greatly reduce manual operation.

Event Analysis Package (Exaplog)

The Exaplog Event Analysis Package is designed to provide managers, engineers and supervising operators with tools to analyze the historical plant operation record file of a DCS, so that the production process can be improved. It can generate trend graphs for quantitative analysis, as well as pie charts and tables for analyzing distributions and classifying events. It can help you eliminate unnecessary alarms, improve inefficient operation sequences, and thus improve production processes.

Plant Resource Manager (PRM)

Plant Resource Manager (PRM) is an asset management software tool for the digital network era. The PRM software manages field devices and maintenance work efficiently, and help reduce total cost of ownership (TCO) in an industrial plant.

These packages support intelligent devices such as FOUNDATION fieldbus, HART, PROFIBUS, and field wireless (conforms to ISA100.11a) devices as well as conventional analog devices.

3. Engineering Function (ENG)

AD Suite, new engineering methods, provides CENTUM VP's engineering functions in addition to the conventional ones adopted for up to CENTUM VP R5.
In addition to the descriptions in General Specification (GS), more details about the AD Suite can be found in this chapter.

Engineering Function Overview

The Standard Engineering Function is a license to use AD Organizer and VP Builder. In addition, optional functions to the AD Suite such as Module-based Engineering and licenses for the VP Builder such as Graphic View Creation and Test functions are available for engineering.

3.1 AD Suite Overview

The AD Suite is an engineering environment aiming for configuring and maintaining of overall instrumentation of plant instrumentation, safety instrumentation, and maintenance management.

Since the AD Suite centrally manages all the CENTUM VP's engineering data on the Automation Design Server (AD Server) database, the latest design information is always available when expanding, modifying, or maintaining the system, which prevents unnecessary engineering work to confirm inconsistencies between the design information and the actual information stored in the system.

AD Suite Standard Function Overview

The followings are the AD Suite standard functions.

Module-less Engineering

Module-less engineering is a way to determine the hardware configuration first and then perform engineering for each piece of the hardware. This engineering method uses the conventional VP builder that was implemented by CENTUM VP R5 or earlier.

History Management

Changes made in the AD Organizer or VP Builder can be saved in the AD Server. AD Organizer is used for viewing the change history in the AD Organizer.

AD Suite Optional Function Overview

The following optional functions can be used in the AD Suite.

Module-based Engineering

Modules are independent software components which represent design patterns containing integrated customer information and knowledge in the past, which also include components, such as the control logic, alarm attribute, and design information.

Module-based engineering refers to an engineering method which transforms the control logic and design information into modules and it designs control applications and alarms by combining the modules in the AD Suite.
By reusing of modules created in previous projects, engineering efficiency is improved, quality of engineering becomes consistent, and the project period is reduced.
When the document generation function of the module-based engineering package is used, the design information which is generated from a module and all kinds of engineering data can be automatically integrated into a single document file all together.

Tuning Parameter Management

This is a supportive function for module-based engineering.
The designed tuning parameter values can be compared with the FCS's current tuning parameter values, and the designed tuning parameter values can be set on the FCS.
Moreover, FCS's current tuning parameter values can be reflected to application module's setting values in the AD server.

Bulk-Editing

This is a supportive function for module-based engineering.
This function collectively edits setting items such as control logics and alarm attributes of multiple modules designed when creating control applications. Functions to help perform bulk editing and data consistency check for setting items such as defined tag names and detailed definitions of functional blocks are provided as well.

Change Control

This support function can be used either in the module-based engineering or module-less engineering, which manages the changes made during the engineering work.
This function allows engineers to avoid making mistakes at work such as forgetting to make changes to applications, or plan and implement changes and keep records of test results.

Dependency Analysis

This support function can be used either in module-based engineering or module-less engineering, which analyzes the extent of impacts caused by changes made during the engineering work. Dependency Analysis Tool provides a function to analyze which control logic, I/O, or graphic tags are connected to which tags. Furthermore, if tags are connected to which tags in multiple layers can be analyzed.

3.2 Software Configuration of AD Suite

The AD Suite consists of an AD Server, an AD Organizer, and a VP Builder.

Software Configuration of the AD Suite

AD Server

AD Server performs functions to collectively manage all engineering data and change history of a CENTUM project on the database using the engineering server function.

The AD Server has the following functions:

- Automation Design Master Database (ADMDB) stores all the CENTUM VP engineering data.
- Automation Design Server Management Tool (ADS Management Tool) is software to manage the AD Server.

AD Organizer

The AD Organizer, the main software for engineering for module-based engineering, performs engineering work in the AD Suite.

The AD Organizer is included in the Standard Engineering Function.

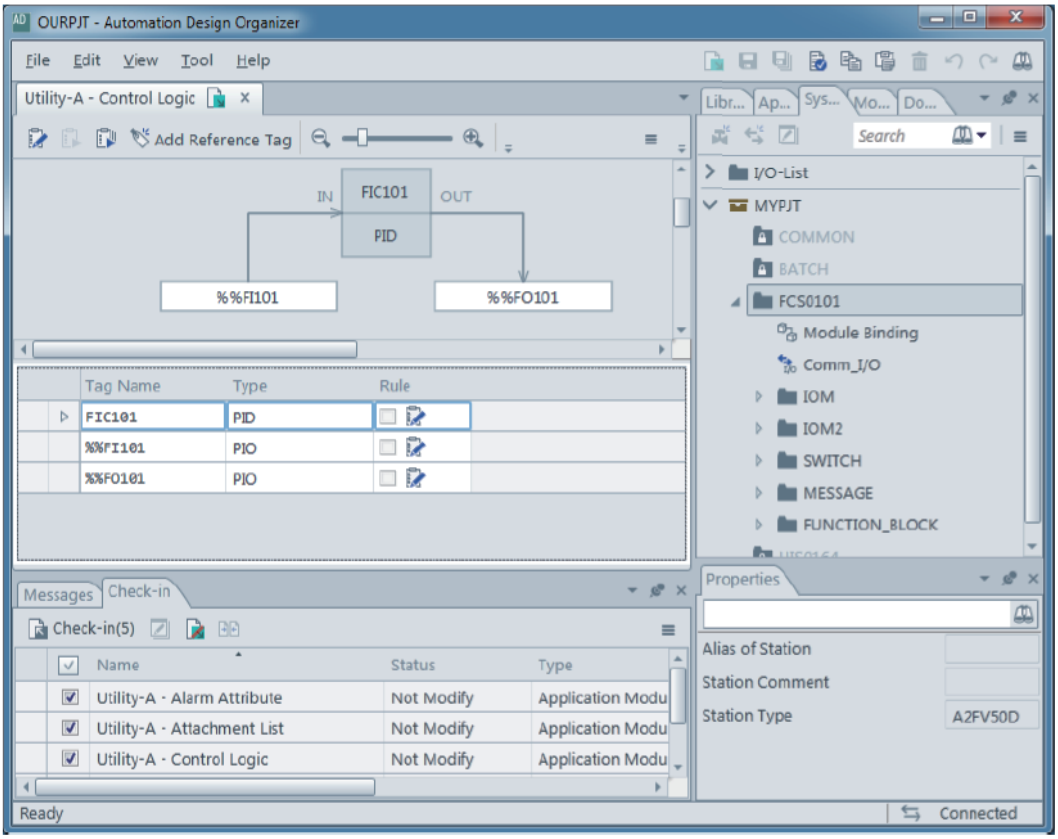


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Figure AD Organizer

VP Builder

The VP Builder, the main software for performing module-less engineering, is a generic name for System View, Recipe View, and other builders launched from these Views.
Module-based engineering on stations other than FCS is also performed using this software. The VP Builder is included in the Standard Engineering Function.

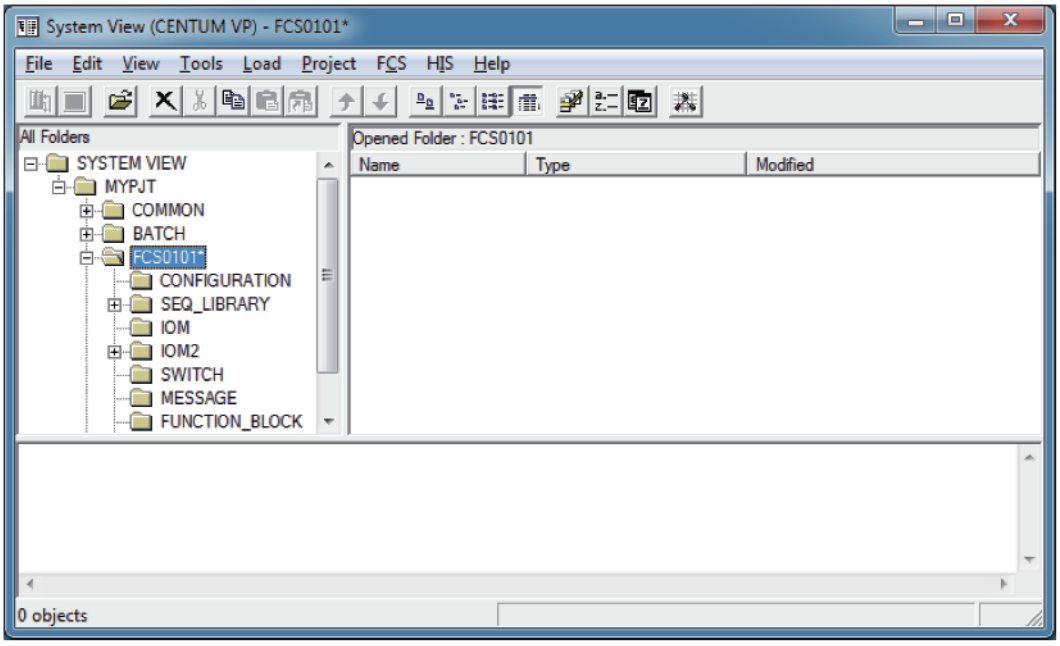

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Figure System View

The figure below shows the software configuration diagram of the AD Suite.

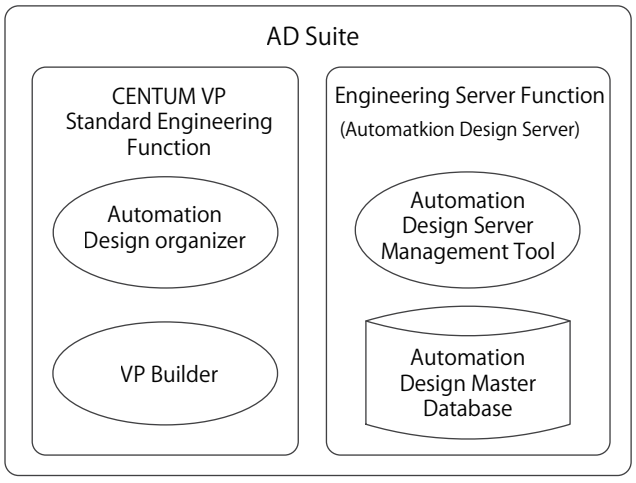

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Figure Software Configuration of the AD Suite

Projects used in AD Suite

CENTUM VP manages engineering data of FCS and HIS by the unit of a “project.” Engineering data in the AD Suite is stored in the following projects.

Automation Design Project

Automation Design Project (AD project) stores engineering data edited in the AD Organizer. An AD project is created in ADMDB of an AD Server. Multiple AD projects can be created in ADMDB.

VP Project

VP project stores engineering data edited in the VP Builder. A VP project is created on a PC with engineering function or on a file server. A VP project is registered to the AD project to use(*1).

*1: Multiple VP projects can be registered to a single AD project.

The figure below shows the data flow of the AD Organizer, the VP Builder, an AD project, and a VP project.

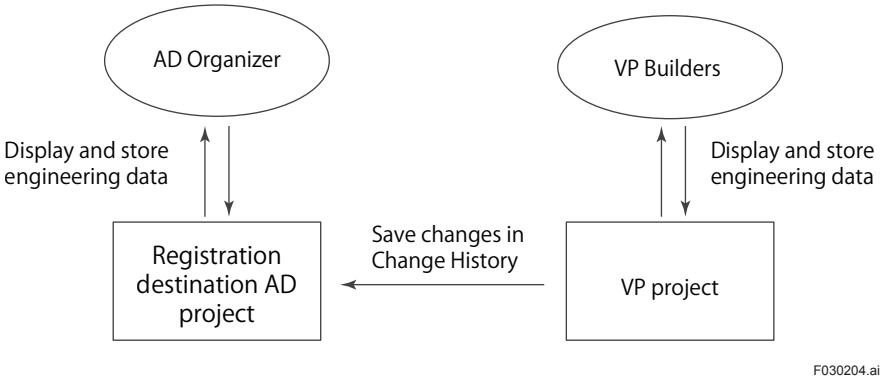

Figure Flow of Engineering Data

3.3 Engineering Environment of AD Suite

ENG, AD Server, and HIS can be installed on a single computer or separate computers.

Configuration of installing Engineering Function and Operation and Monitoring Function on a single computer

The figure below shows a sample system configuration to install AD Server, Engineering Function, and Operation and Monitoring Function on a single computer.

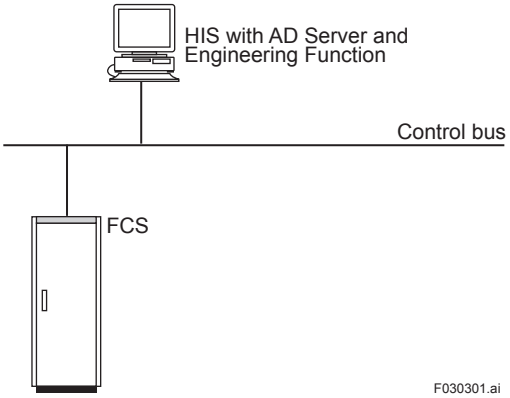

Figure A sample system configuration with Engineering Function and Operation and Monitoring Function installed on a single computer

A Configuration with independent engineering function

The figure below shows a sample system configuration where AD Server, Engineering Function, and Operation and Monitoring Function are installed on different computers.

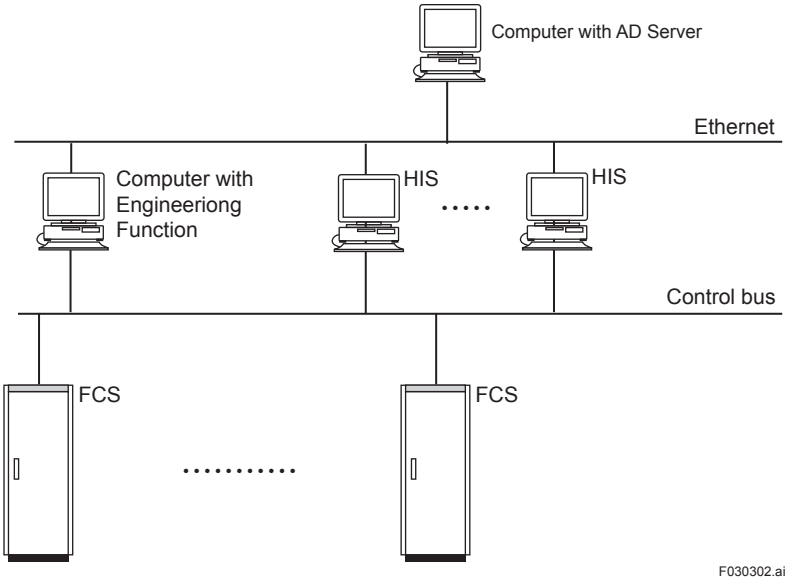

Figure A sample system configuration where Engineering Function of AD Server and Operation and Monitoring Function are installed on separate computers

A sample system configuration of collectively managing multiple VP Projects

The following figure shows a sample system configuration that a single computer with AD Server manages multiple VP projects.

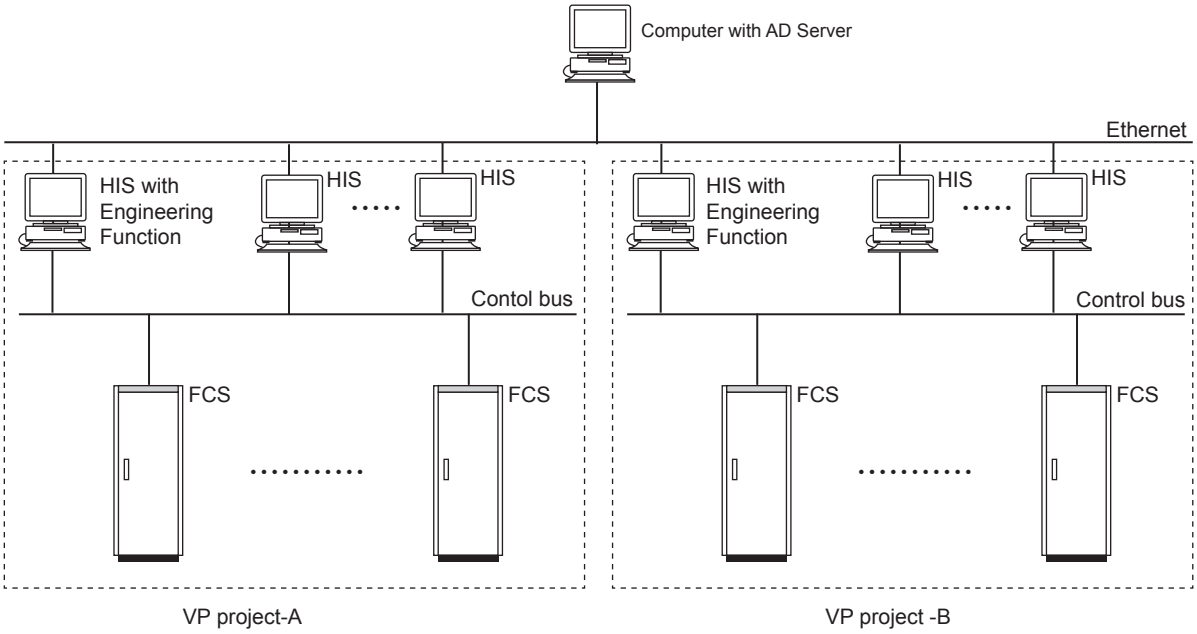

Figure A sample system configuration to collectively manage multiple VP Projects

In the above case, engineering of the VP project A is performed on the HIS with Engineering Function that belongs to VP project A. Engineering of VP project B cannot be performed on the HIS with Engineering Function that belongs to VP project A, and vice versa. In addition, multiple VP projects that are connected can be managed by a single computer with an AD server.
Note that the IT security model of CENTUM VP systems connected to a single AD server must be the identical.

3.4 Standard Functions of AD Suite

The AD Suite's Standard Functions works in all the CENTUM VP systems.
The following functions can be performed by the Standard Functions.

- Module-less Engineering
- History Management
- AD Server and AD Project Management

The figure below shows the engineering data flow in the Standard Function.

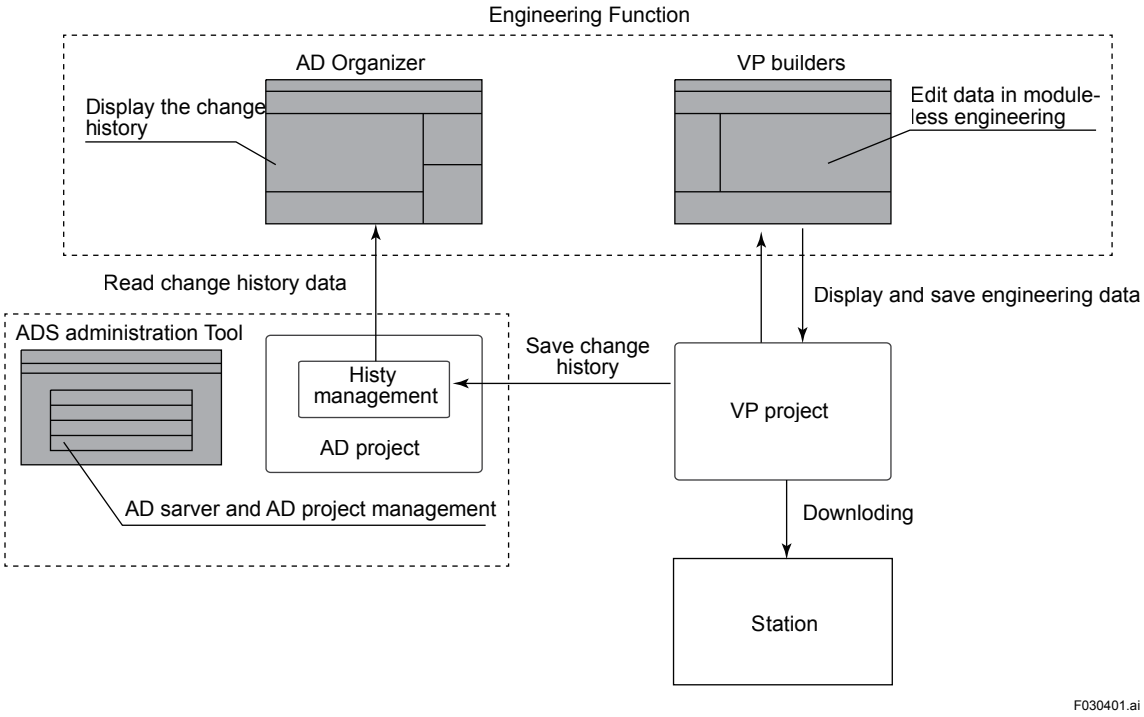

Figure Engineering Data Flow of the Standard Function of AD Suite

Module-less Engineering

Module-less engineering is a method that uses no module for engineering. This method determines the hardware configuration such as FCSs and I/O modules first, and then performs engineering for each piece of hardware. The module-less engineering can be performed with an FCS which is not applicable for module-based engineering or one defined by n ENG without using the module-based engineering package.
Note that module-less engineering can be performed for FCSs which supports the module-based engineering package by selecting the module-less engineering method. In this case select if module-based engineering or module-less engineering is performed for the FCS. The engineering method cannot be changed after the FCS is created.

Change History Management

Changes to the VP projects are saved in History Management. Every time a VP project file is updated, changes are automatically saved to the History Management of AD Server.

Changes saved to History Management can be displayed on the AD Organizer.

AD Server and AD Project Management

The AD server and AD projects are managed by the ADS Management Tool.

The following functions are available to manage the AD server.

- Optional settings for AD Server
- Backup and restore ADMDB

The following functions are available for managing the AD projects.

- AD project creation and deletion
- Changing properties of the AD projects
- AD projects access control
- Import/Export from/to the AD project database
- Prohibit /allow changes to the AD project data

3.5 Optional Functions of AD Suite

The AD Suite performs the module-based engineering, tuning parameter management, bulk-editing, change control, or dependency analysis functions by using various optional packages exclusively provided for the AD Suite.

Module-based Engineering

The module-based engineering enables designing the system independently from I/O module assignment information or FCS setting. I/O design can also be changed after control applications are designed.

For module-based engineering, the Module-based Engineering Package is required.

Module Components

A module is a design patterns configured into an independent software component. In the module-based engineering, a component such as control logic, alarm attribute, design information, or attached document is regarded as one module. The modules for the module-based engineering contain the following components.

Table Module Components

Module component	Overview
Design information (functional specifications, etc.)	Design information such as functional specification can be defined as a module component. Design information consists of texts that describe modules, images, and tables.
Control logic	Control logic consists of a control drawing and detailed functional block definitions.
Tuning parameter	Tuning parameters for a function block defined by the Control Logic Editor can be defined. A tuning parameter management package is required to include the tuning parameters in the module.
Alarm attribute	Alarm attributes of functional blocks and alarm attributes handled in CAMS for HIS can be defined as module components.
Attached file	An arbitrary electronic file can be attached as a module component.

Types of Modules

Modules are classified into two types depending on the applications; one is a class module and the other is an application module.

- **Class Module**
  A class module is a template for a module. An application module that acts as an actual control application can be created based on the class module. The relationship between a class module and an application module created based on the class module can be maintained, and changes to the class module can be applied to the application module. Multiple application modules can be created from a single class module.
  Creating an application module from the class module is called instantiation.
- **Application Module**
  An application module is a module that acts as an actual control application.
  An application module is created by creating a class module as needed, and then an application module is created from the class module; or directly without using a class module.

Group module

The following group class module and group application module are collectively referred to as a group module.

- **Group class module**
  A grouping of class modules is referred to as a group class module. A large-scale application can be reused more easily by grouping class modules. Each class module in a group class module is referred to as a child class module, which has only reference information to the original class module.
- **Group application module**
  A group application module is created by instantiating a group class module. Each application module in a group application module is referred to as a child application module. It is possible to specify not to instantiate some of child class modules when instantiating. This makes it possible to create multiple group application modules that differ only in part, so modules can be reused more easily.

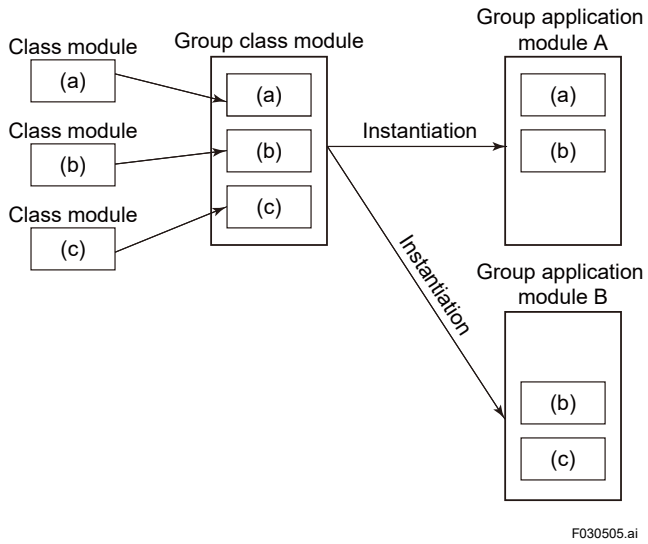

Figure Relationship of class module, group class module, and group application module

Group modules allow multiple modules to be combined and allow complex loops that span multiple control drawings to be managed as a single group.

The scope of the module-based engineering in the batch control can be expanded to the control unit level, by using the group module together with FCS sequence library created by the AD organizer.

Group module is supported by CENTUM VP R6.07 or later.

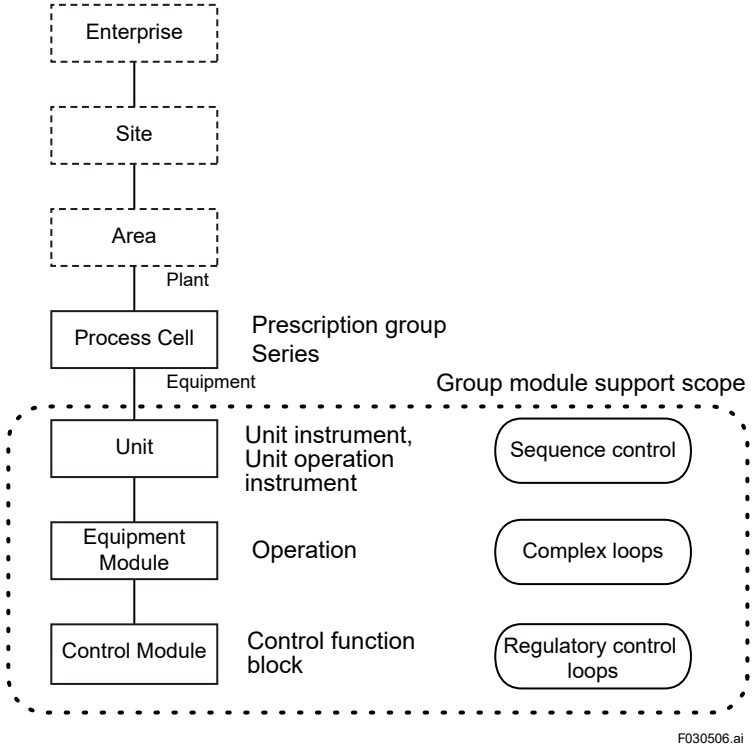

Figure Group module support scope (for batch control)

Group module components

Group module components contain the following elements.

Table Group Module Components

Group module component	Overview
Design information	Contents to freely describe design information such as group module function specifications.
Attachments	Documents such as the test procedure for group modules, test data, or guidelines, and data files can be attached to modules.
Allocation	Information that indicates to which control drawing a child application module is allocated to.
Group module hierarchical structure	Group module can be managed hierarchically because folders can be created in group module. The hierarchical management of group modules makes it possible to position reusable child class modules and child application modules according to their purpose and make maintenance easier.

Engineering the FCS sequence library

Engineering of FCS sequence libraries using AD Organizer can be performed, by specifying both [Module-based Engineering] and [Define the SEQ libraries in AD Suite] in the properties of FCS. By engineering the FCS sequence libraries such as SEBOL user function, SFC sequence, and unit procedure using AD Organizer, data is consolidated. Also, the created FCS sequence library can be reused when expanding or renovating the plant.

Software for Module-based Engineering

Module-based engineering is performed using two pieces of software, AD Organizer and VP Builder.
Engineering for I/O and control logic on FCS is performed in the AD Organizer.

The following module-less engineering can be handled by using VP Builder.

- System configuration and VP project common items
- Engineering of FCS except I/Os and control logics
- Engineering of HIS, UGS, SIOS, GSGW

Engineering Data Flow of the Module-based Engineering

Engineering data edited in the VP Builder is stored in the VP project.
Engineering data for I/O and control logic in the AD Organizer is stored in the AD project.
Thus, engineering for the I/O and control logic can be performed independently of the system configuration.
Engineering data of the I/O and control logic engineered independently of the system configuration is eventually assigned to FCS, converted to the engineering data of the VP project by bulk conversion, and saved to the VP project.

The figure below shows the module-based engineering's engineering data flow.

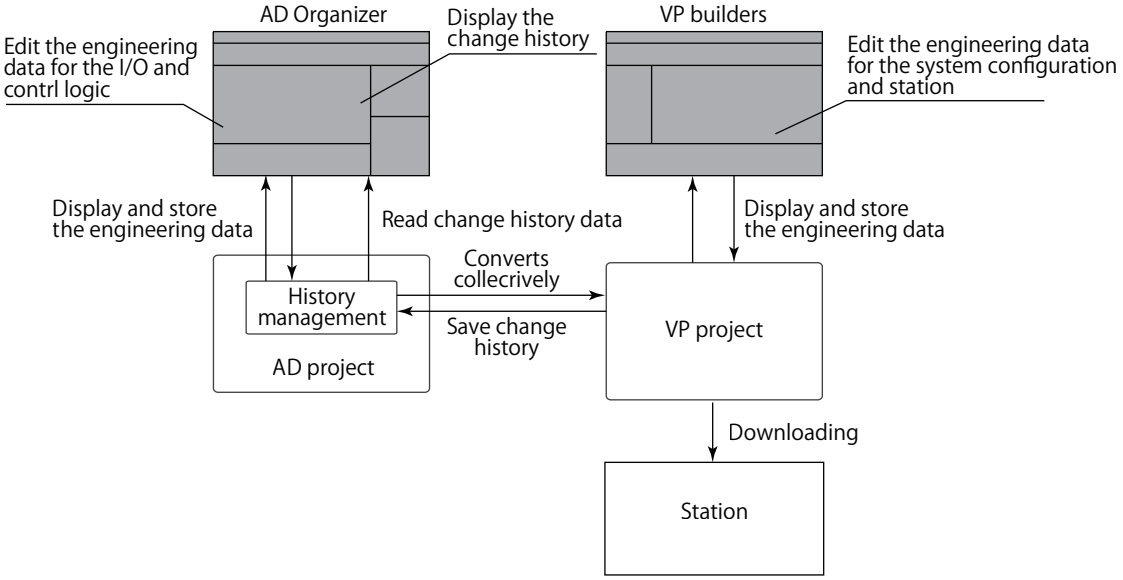

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Figure Engineering Data Flow of Module-based Engineering

History Management of Module-based Engineering

Changes to the engineering data edited in the AD Organizer are saved to history management of the AD Server. Changes to all the VP project engineering data as shown below are also saved to history management of the AD Server.

- Engineering data edited in VP Builder
- Engineering data edited and collectively converted into the AD Organizer

Changes saved to the History Management can be displayed in the AD Organizer.

Document Generation

The document generation function creates document summarizing the engineering results, of which function can be used only with the module-based engineering.
Any inconsistencies between the actual system and the design specifications or other documents can be confirmed.

Tuning Parameter Management

The tuning parameter values of function blocks designed when creating a control application (“design values”) and the tuning parameter values actually used on the field control station (“current values”) are managed by this function. Both of the parameter values can be compared, and the designed tuning parameter values can be set on an FCS.
Tuning parameters are data items or alarm setting values of function blocks that can be set and referred to from HIS.

Two types of tuning parameters are handled by this function.

- Tuning parameters of class modules and application modules (configurable data items of function blocks defined in class modules and application modules)
- Alarm-related tuning parameters (alarm setting values)

Tuning Parameter Management performs the following tasks.

- Defining the design values of the tuning parameters
- Collectively setting the defined tuning parameters on FCS
- Comparison and setting of the design values and the current values of the tuning parameters

A module-based engineering package and tuning parameter management package (for module-based engineering) are required to use tuning parameter management. Furthermore, an operation and monitoring standard function package is required to compare and reflect the design values and the current values of the tuning parameters.

Defining the Design Values of Tuning Parameters

The design values of the tuning parameters of class modules and application modules can be defined.

Collective setting of defined Tuning Parameters on FCS

Design values of the defined tuning parameters can be collectively set on an FCS.
This function can be used for the tuning parameters and alarm-related parameters of application modules.

Comparison and setting of design values and current values of tuning parameters

Current values of tuning parameters can be obtained from an FCS and compared with the design values of tuning parameters of application modules. Furthermore, the design values of tuning parameters of application modules can be selected individually and set them on the FCS. This function can be used for the tuning parameters and alarm-related parameters of application modules.

Bulk Editing

This is a function to collectively edit setting items of control logic and alarm attributes designed and to collectively edit general names for unit instruments when designing a control application.

This function can be used to perform the following functions.

- Bulk editing in Mass Editor
- Bulk editing and consistency check of setting parameters in Grid Rule

The module-based engineering package and the bulk editing package (for module-based engineering) are required to use the batch editing function.

Bulk Editing by Mass Editor

The Mass Editor is table format editor for collectively editing setting parameters of control logics and alarm attributions and generic names of unit instrument blocks.
The Mass Editor consists of three editors: Control Logic Mass Editor, Alarm Attribute Mass Editor, and Generic Name Mass Editor. (*1)
The Control Logic Mass Editor and the Alarm Attribute Mass Editor enable to collectively edit setting parameters of control logics and alarm attributions of multiple application modules designed when creating a control application without launching the control logic editor and the alarm attribute editor respectively.
The Editors have sorting and filtering functions to enable efficient editing of setting parameters.
Generic Name Mass Editor enables to collectively edit setting the function block tag name and operation name for tag generic name and operation generic name that are defined in the Function Block Detail Builder of the unit instrument.

*1: Generic Name Mass Editor is supported by CENTUM VP R6.07 or later.

Bulk Editing and Consistency Check of Parameters by Grid Rule

Grid Rule is a support function to use simple programming to automate the execution of bulk editing of parameter values for setting of application modules such as defined tag names and detailed function block definitions; and automate the execution of a consistency check to determine whether the set conditions are met.

Change Control

Change Control manages the process of changing the engineering data by editing the Modification Package (ModPack).

The ModPack is a form which summarizes a group of information related to a change. One ModPack contains various change information such as an ID(*1), status, a person in charge, a place, and a test method.

*1: This ID is recorded together when changes are saved in the change history. When referring to the details of the change saved in the change history, the ID is used as a reference.

Change Control manages a change according to the following procedure.

1. Register a change request to the ModPack.
2. Analyze the extent of impact of the change and input the change to the ModPack.
3. Assign and register a person in charge of the change to the ModPack.
4. Change the engineering data and register the change to the ModPack.
5. Test the change and record the test results to the ModPack.
6. Confirm the content of the change and record the results to the ModPack.

A change control package is required to use the change control function which can be used when both module-based engineering and module-less engineering are performed.

Dependency Analysis

The extent of impacts to changes requested during engineering can be analyzed. Analysis of interconnections of control logic, I/O, and graphic tags are provided.

This function analyzes the following three types of dependency using the tag name of control logic, I/O, graphic, etc. as a key (“analytical key”).

- Control logic dependency
- Logical and physical relationship
- Graphic dependency

The dependency analysis function can be used when both module-based engineering and module-less engineering are performed.
A dependency analysis package is required to use the dependency analysis function.

Concept of Displaying the Dependency Analysis

The concept of displaying the control logic dependency analysis is explained here.

A list of tag names of connection destination of analytical keys is displayed in the control logic dependency analysis. Furthermore, a list of destination beyond the connection destinations can also be displayed using the connection destinations as new analytical keys in a hierarchical format.
The figure below shows a conceptual diagram of the dependency analysis, which displays the first-layer tags (FIC01, GR01, TR01, and ST01) that are connected using the TIC02 tag as an analytical key and the second-layer tags (%Z02, %Z05, and %OG01) that are connected using new tags FIC01 and ST01 as analytical keys.

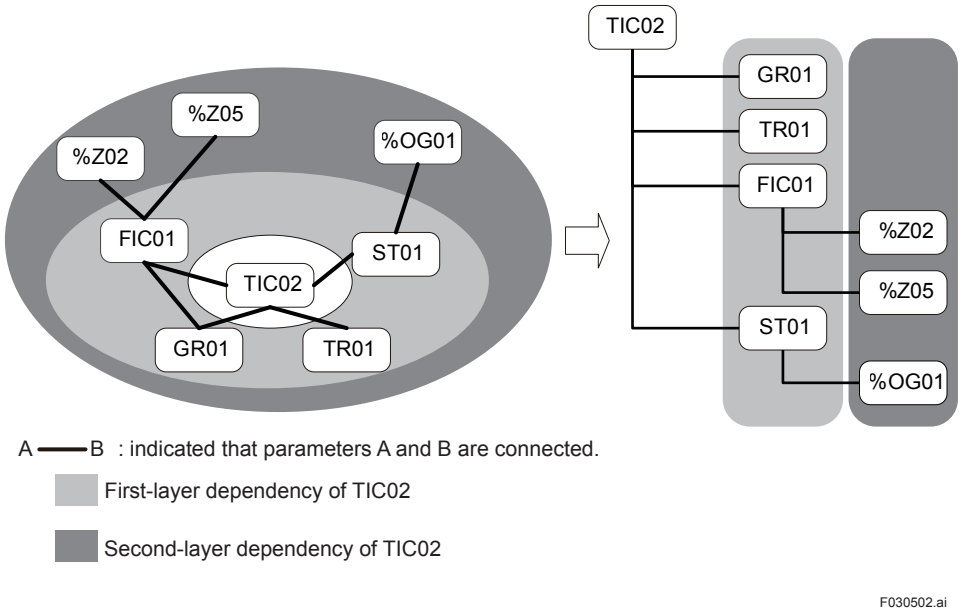

Figure Conceptual Diagram Displaying Dependency (Control Logic Dependency)

Control Logic Dependency Analysis

A list of tag names connection destination of analysis keys is displayed in the control logic dependency analysis. Furthermore, a list of destination beyond the connection destinations can also be displayed using the connection destinations as new analytical keys in a hierarchical format. Each of the dependency elements displayed in a hierarchical format can be collapsed or expanded as needed.

Analysis key (control logic dependency)

- Tag name
- Tag name.data item name
- User-defined label name

The dependency is displayed in a hierarchical format with the analysis key on the top as shown in the following figure.

<Tag name> (Analysis key)
- <Tag name>.<Data item name> (Item related to the analysis key)
- <Element name>.<Data item name> (Item related to the analysis key)

<Tag name> (Analysis key)
- <Tag name>.<Data item name> (Item related to the analysis key)

<Tag name>.<Data item name> (Analysis key)
- <Tag name>.<Data item name> (Item related to the analysis key)
- <Element name>.<Data item name> (Item related to the analysis key)

<Tag name> (Analysis key)
- <Tag name>.<Data item name> (Item related to the analysis key)
- <Element name>.<Data item name> (Item related to the analysis key)

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Logical and Physical Relationship Analysis

The logical attributes and physical assignment of I/Os can be displayed in a logical and physical analysis function view.

Analysis key (logical and physical relationship)

- Application module name
- Tag name
- P&ID tag name
- Station name
- I/O module name

The table below shows the items displayed in a logical and physical relationship view.

Table Display Items in Logical and Physical Relationship View

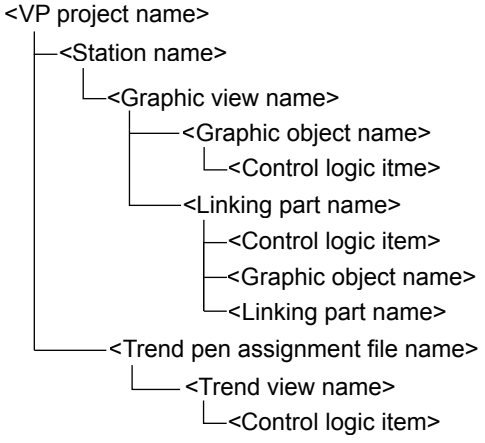
Category	Display item	Description
Logic	Flag display	Displays the cause flag and impact flag.
	P&ID tag	Displays the P&ID tag name.
	I/O tag name	Displays the I/O tag name or user-defined label name.
	Module	Displays the application module name to which the I/O is connected.
Physical	Flag display	Displays the cause flag and impact flag.
	VP project	Displays the VP project name.
	Station	Displays the station name.
	Train	Displays “IOM” for the I/O of an FIO module. N-IO Displays “IOM2” for the I/O of an N-IO module.
	Node	Displays the node number.
	I/O module	Displays the model of the I/O module.
	Unit	Displays the unit number. Blank for the I/O of an FIO module.
	Terminal	Displays the terminal number.

Graphic Dependency Analysis

The following graphic objects including the analytical key can be displayed in a hierarchical format in a graphic dependency analysis view in the same way as with the control logic dependency analysis.

- Analysis key (graphic dependency)
- VP project name
- Station name
- Window name
- Trend file name
- Tag name
- Graphic object name

The graphic objects including the analyticalsis key are displayed in a hierarchical format as follows.



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4. Control Function (FCS)

All field control stations (FCSs) in the CENTUM series, including software and hardware, have been developed by Yokogawa. We know every single bit of software and hardware to maintain a 99.99999% availability service record.

The state-of-the-art Field Control Station (FCS)

For over 40 years, Yokogawa has been delivering stable, high quality CENTUM systems. The CENTUM VP controller features outstanding processing performance and a large application storage capacity, yet inherits the same quality and stability that are the hallmark of the CENTUM series. It has been optimized to take full advantage of advances in field digital technology that will help plants operate with increased efficiency and stability.

Compact Design

Compact components reduce the overall “footprint” of the control system, allowing savings from smaller equipment rooms. For convenience, both the FCS and its I/O node units can be placed in remote classified locations (IEC Zone2/Class I Div. 2), providing installation savings.

Ultimate flexibility

The next-generation software configurable smart I/O, reduces footprint, lowers marshalling costs and allows flexible I/O binding.
Matched with the Field Mate Validator, our commissioning tool, this allows for significantly faster project completion and reduced costs without compromising on quality.

Online Maintenance

FCS applications can be modified without interrupting process control from the engineering station.

Function Blocks

The CENTUM VP provides function blocks for monitoring, control, manipulations, calculations, logic functions, and sequence control. Not only regulatory control but also advanced control, complicated sequence control, and batch control are all executed in a redundant, secure, and reliable controller environment. Plant systems can be flexibly designed, ranging from small- to large-scale, through the combination of these control blocks.

Unit Supervision

The multiple devices of a process facility which would previously have been handled individually can now be defined, operated, and monitored as a single unit, simplifying operation. Unit supervision can be applied to batch processes and continuous control processes that require complex management, expediting overall plant operation.

Guarantees the Highest Reliability

CENTUM VP contributes to the long-term stability of plant operations and reduces total cost of ownership.

Designed for High Availability

Yokogawa's CENTUM series achieves high availability thanks to a dual-redundant design, online maintenance capability, and other advanced features. The FCS processor module, power supply, I/O modules, and I/O networks are all dual redundant. Active and stand-by processor modules work in synchronization: even if a failure occurs, control switches over seamlessly to the stand-by module and the FCS continues running. Failed modules can be replaced online, ensuring that not even a hardware failure will interfere with the process control.

CENTUM : the DCS solution with an incredibly high 99.99999% availability!

Designed for Stable Process Control and Increased Plant Productivity

The CENTUM series employs a pair & spare architecture that improves the stability of process control. Each processor module has redundant CPUs that execute the same computations simultaneously. Their outputs are constantly compared and a bump-less switchover to the stand-by processor module is initiated if any anomalies caused by electronic noise or other phenomena are detected. This minimizes the likelihood that errors will have any impact on process control.

All of these technologies help to make CENTUM VP the most reliable solution for enhanced safety in plant operations.

Open Structure and High Reliability

Yokogawa is committed to reduce costs for our customers by enabling the use of commercial off-the-shelf technology where appropriate. Plant reliability is in no way compromised as the communication response is guaranteed (deterministic as opposed to probabilistic) thanks to Yokogawa's renowned reliability, dedicated protocol, and redundant configuration.

Subsystem Integration and Digital Fieldnetworks Support

To meet the growing need for communication with manufacturing equipment including variable speed drives, PLCs, and "smart" motor protection relays for operation and monitoring, as well as with analyzers, weighing machines, smart instruments, and other instruments used for product inspection, CENTUM VP supports a wide variety of communication interfaces and digital fieldnetworks such as FOUNDATION fieldbus, PROFIBUS-DP, PROFINET, Modbus RTU, Modbus TCP/IP, and DeviceNet.

5. Human Machine Interface (HIS)

CENTUM VP has a new HMI (human machine interface) that makes information access quicker and more intuitive. We changed the design of operation window intending to provide universal color design based on the ergonomics studies.

True Integration of Safety Excellence, Asset Excellence, and Production Excellence

CENTUM VP achieves the operational excellence that is the focus of Yokogawa's Safety Excellence, Asset Excellence, and Production Excellence initiatives. It offers integrated viewing and data handling functions. For example, alarms from the ProSafe-RS Safety Instrumented System and Plant Resource Manager, Yokogawa's Asset Management product, can be seen and handled seamlessly in the HIS. All plant process data, device data, and others documents are handled by CENTUM VP.

No Single Point of Failure

The HIS runs on Windows and offers customers the convenience of using commercial-off-the-shelf hardware. Although the reliability of a PC is relatively low, it does not affect the total reliability of the process operator function. Within CENTUM VP the HIS is not server-client dependent. Therefore multiple HISs can support each other and there is no single point of failure. The CENTUM VP supports multiple operator console configurations: desktop, open-bay console, hardened enclosed-bay console, and custom consoles.

Various Display Types

CENTUM VP supports both wide (16:10) and standard (4:3) size monitors. Multiple operation windows can be displayed on a single monitor. And, multiple monitors can be configured to display operation windows. With a click of a mouse, those operation windows can be moved from one to another monitor.

EEMUA Guidelines for Alarm System Design

Based on the latest edition of the EEMUA (*1) #191 guidelines, Yokogawa has developed a Consolidated Alarm Management Software for the process operator in the HIS.

*1: Engineering Equipment & Materials Users' Association

6. Integration with ProSafe-RS

ProSafe-RS is primarily intended to be used for the following safety applications. The use of ProSafe-RS conforming to the standards for each application is also certified by TÜV Rheinland.

- **ESD (Emergency Shutdown System) / PSD (Process Shutdown System)**
- **F&G (Fire and Gas detection System)**
- **BMS (Burner Management System)**

ProSafe-RS realizes the integrated safety solution with production control system (CENTUM VP) and achieves both safety and high availability.

Integrated Operation Environment

A guideline for functional safety defined by IEC 61508 standard calls for separation of control and safety system functions. However, operators often desire to use the same operation environments for both control and monitoring of the plant and the safety instrumented system in the actual applications. ProSafe-RS adopted the same architecture as the CENTUM VP and realizes the integrated operational environment by connecting CENTUM VP directly.

Achieving both Safety and High Availability

ProSafe-RS ensures shutting down of the plants safely as well as reducing the probability of stopping plant operation due to internal failures (low false trip rate or high availability).

Conforms to International Standard

ProSafe-RS conforms to the safety integrity level 3 (SIL3) defined by IEC 61508 and certified by TÜV Rheinland a German certification organization.

Plant Safety Improvement

IEC 61508 defines a quantitative target of risk reduction in the context of industrial safety, sets guidelines for achieving the goals by specific means, and stipulates to manage safety related systems based on safety lifecycles. This safety concept is based on the idea that safety should be regarded as "… freedom from unacceptable risk." The concept of "protection layers," in which independent safety measures are in layer structure from outside (local area) to the subject "plant (factory)," is required as a safety measure to materialize this allowable safety. It is required to introduce the concept of "protection layers" to achieve allowable safety, considering emergency measures not only in plant but also in cooperation with local society. ProSafe-RS provides "prevention layer" and "mitigation layer" in "protection layers."

Reliable Security

ProSafe-RS obtained the ISASecure EDSA (*1) certification of the ISCI (*2) in January 2014. This is a certification program for guaranteeing the security of control equipment, and Yokogawa is the first control equipment vendor in Japan to have obtained this certification. Since cybersecurity measures are implemented, ProSafe-RS can be used with confidence by customers in critical infrastructure industries such as oil, petrochemical, natural gas, electric power, etc.

*1: Embedded Device Security Assurance
*2: ISA Security Compliance Institute

7. Openness and Interoperability

The technological innovation enabled CENTUM VP to achieve fast, open, reliable, and real-time communication. CENTUM VP maintains the true interoperability.

Global Host Interoperability Support Test (HIST) Network

In the arena of FOUNDATION fieldbus, manufacturers are bringing new devices to market all the time, in addition to upgrading older instrumentation. Therefore, interoperability has always been a key issue with Yokogawa. To facilitate project management on a global basis, Yokogawa has formed a global HIST network. Test sites in Japan, the Netherlands, Houston (USA), and Singapore make sure the interoperability between Yokogawa systems and non-Yokogawa devices is acceptable. All test results are reported to Japan. This information is disclosed at http://www.yokogawa.com/fbs/Interoperability/fbs-hist-en.htm

1 Gbit, World's Fastest Open Control Network

The real openness of a control network does not just come from using TCP/IP technology. Yokogawa's Vnet/IP provides open, reliable, and real-time broadband communications. Both CENTUM and non-CENTUM components can be connected to the network. The Yokogawa system guarantees data updates every second in the HIS, even with a large-scale project. Vnet/IP offers five millisecond time synchronization among all stations on Vnet/IP.

True Interoperability

Interoperability of Yokogawa CENTUM systems with the "outside world" begins with OPC. CENTUM VP utilizes an OPC server that meets the demands of information flow, advanced control, and alarm/event management. Our customers enjoy solid performance and wide flexibility of our OPC server for their integration projects. Yokogawa maintains interoperability with all intelligent instrumentation and deployed fieldbuses.

8. Plant Lifecycle

CENTUM VP brings cost down over the lifecycle of a plant. Maintenance is less frequent, software upgrade is easy, expansion is smooth, and even revamp is speedy.

Precise Project Cost Estimation

In CENTUM VP, the FCS application load can be quickly calculated in the design stage and easily monitored when on-line. During engineering design, the precise number of FCSs required is known. As the project progresses, with engineering changes, cost changes are minimized due to the simple licensing structure incorporated into CENTUM VP. This covers both the addition of stations and tags. To provide the most economical system, CENTUM VP has only two tag license boundaries: the 8,000 tags for entry level and small system architectures, and the 100,000 tags for medium to large scale plant systems. When linking multiple plants together, then we have a one-time 1,000,000 tags.

Virtual Test Function

A virtual FCS and HIS environment is available where both the control and operator functions of the CENTUM database can be tested without FCS hardware. Application testing and engineering time are dramatically reduced, accelerating project progress and reducing engineering cost. For system expansion and modification, applications can be tested and verified without any impact on the actual plant operation. Where ProSafe-RS is also a part of the system, then virtual testing is also available together with CENTUM VP. Our virtual test function is also a key component in building an operator training system (OTS).

Software Upgrading

As part of lifecycle cost management, Yokogawa has paid particular attention to upgrading all CENTUM systems. It is simple, quick, and direct. All CENTUM VP stations that are PC-based can be upgraded with one mouse click. For the FCS, if you are not using any new functions, then upgrading is not needed. Where the latest functions are desired, it takes just one mouse click to execute an FCS upgrade.

Multiple Project Connection

Customers are demanding different sites to be linked together so that bi-directional operation can be made more efficient. Yokogawa provides a multiple system connection function to connect several CENTUM VP sites together and link older CENTUM sites.

Update/Migration

Yokogawa provides various tools and engineering methodologies for update/migration to CENTUM VP. Depending on the project type, you can retain field cables, I/O modules, controllers, and the control network in order to minimize your investment. A step-by-step update/migration starting with the HMI is easy to carry out. Software conversion tools are available for legacy Yokogawa and third-party DCSs.

RIO (*1) System Upgrade

An FCS using RIO on CENTUM CS, CENTUM CS 1000/CS 3000, and CENTUM VP can upgrade to the latest FCS (A2FV70□) for RIO system upgrade. The existing field wirings are utilized as they are without changing interfaces with the field devices, which is helpful to shorten the period for upgrading work.

*1: "RIO" stands for "Remote I/O".

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Revision Information

- Title : Integrated Production Control System CENTUM VP System Overview (General Overview)
- Manual No. : TI 33J01A10-01EN

July 2019/6th Edition
1.2 Updated CENTUM at Work
2 Added “PROFINET” at Digital Fieldnetworks.
3.5 Added group module and Engineering of the FCS sequence library to Module-based Engineering of Optional Functions of AD Suite.
3.5 Added Generic Name Mass Editor to Bulk Editing of Optional Functions of AD Suite.
4 Added “PROFINET” at Subsystem integration and digital fieldnetworks supports.

Dec. 2018/5th Edition
Front page Changed logo mark
Introduction Deleted VigilantPaInt from ■Trademarks.
1.3 Deleted the chapter (Explanation of Vigilant plant)

Sep. 2016/4th Edition
2. Added UGS2 to the Unified Gateway Station in CENTUM VP components.
2. Changed the figure of gateway stations in overall system configuration, and added UGS2 to it.

June 2016/3rd Edition
5. Added a description to the lead sentence
8. Added the item of RIO System Upgrade

Nov. 2015/2nd Edition
2. Integrated the system configurations into one
3. Added a description to the Tuning Parameter Management paragraph

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