

Technical Information

CENTUM CS 3000
Integrated Production Control System
System Overview



TI 33Q01B10-01E

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Introduction

CENTUM CS 3000 is an integrated production control system used to manage and control the operation of plants in a wide variety of industries:

petroleum refineries, petrochemical, chemical, pharmaceutical, food and beverages, paper and pulp, steel and non-ferrous metals, cement, power, gas, water and wastewater.

ProSafe-RS can be used as safety instrumented system for these plants.

Structure of This Manual

This manual provides a simple overview of the CENTUM CS 3000 system. After reading this manual, see the other documents, such as General Specifications, Instruction Manuals, and so forth, for more detailed coverage of various topics. This manual consists of 16 chapters. The first introduces Yokogawa's "Enterprise Technology Solutions" concept, CENTUM CS 3000 System Concepts, Yokogawa solutions, and related software packages. Chapters 2 through 16 introduce CENTUM CS 3000 System Configuration, Operation and Monitoring Functions, Control Functions, Subsystem Communication Functions, Engineering Functions, ProSafe-RS Safety Instrumented System, Advanced Control Functions, Batch Management Functions, Plant Resource Manager, FDA:21 CFR Part 11 Compliant Function, Online Manual, Sequence of Events Manager Function, and CENTUM CS 3000 related software packages. There's an index at the back of the manual.

Target Readership for This Manual

This manual is mainly intended for:

- Managers who are planning to purchase a new control system.
- Instrumentation, Power and Computer Engineers who are evaluating CENTUM CS 3000 and ProSafe-RS for purchase or who will be in charge of installation.

Representation of Panels in This Manual

- Panels are represented in this manual as illustrations; some features may be emphasized, and some simplified or omitted.
- The panel illustrations are to help you understand the functions; dimensions, labels and visible features may differ slightly from those of actual panels.

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CENTUM CS 3000

Integrated Production Control System

System Overview

TI 33Q01B10-01E 12th Edition

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1. System Overview

CENTUM CS 3000 is an integrated production control system for medium and large process control applications. This system is a synthesis of the latest technology with Yokogawa's experience and specialist know-how. This new system has the functionality, flexibility and reliability of our CENTUM CS, and is also based on the V net control bus.

1.1 Yokogawa's Enterprise Technology Solutions Concept

This section introduces Yokogawa's Enterprise Technology Solutions concept.



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Figure Enterprise Technology Solutions Logo

Enterprise Technology Solutions

- Enterprise: Enterprise viewpoint
- Technology: Latest technology
- Solutions: Optimum solutions

Yokogawa's "Enterprise Technology Solutions" provide management with systems that integrate control of both factory and business, allowing management to improve profits. We use the latest technology, and can provide optimum solutions which satisfy customer requirements. Yokogawa can provide complete solutions: sophisticated information and control systems, plant-simulation production support systems, the latest field instrumentation – complete packages of the latest equipment and software technology, plus a complete range of services: from plant design, installation and startup through maintenance.

1.2 System Concepts

CENTUM CS 3000 is Yokogawa’s flagship control-system platform for launching Enterprise Technology Solutions. Its open interfaces facilitate data access from supervisory systems such as Enterprise Resource Planning (ERP) Systems and Manufacturing Execution Systems (MES), and make it easy to create a strategic management information system for your enterprise. CENTUM CS 3000 is a scalable, compatible system-designed to work with your existing systems, and grow with your business, reducing total cost of ownership (TCO).

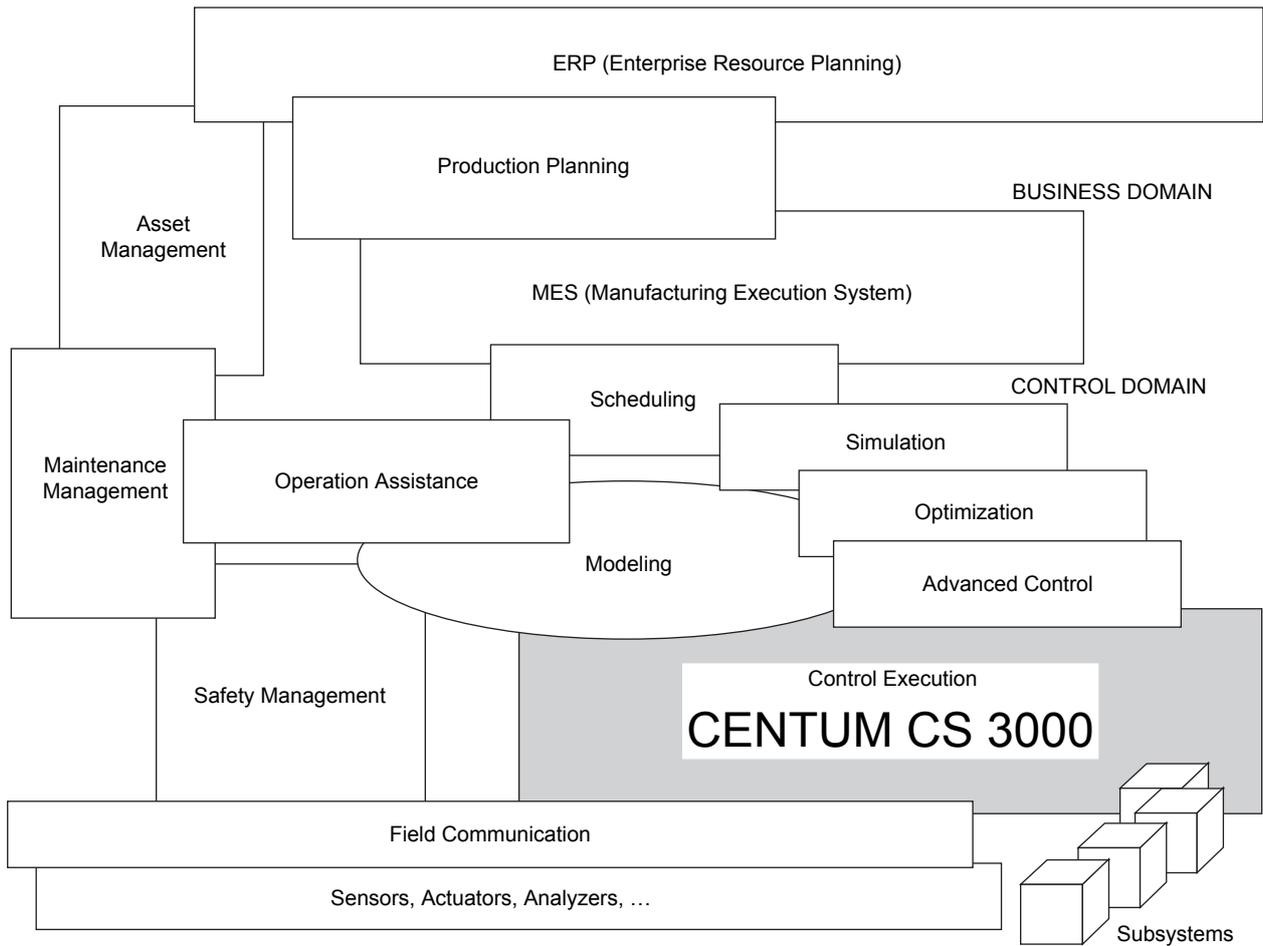


Figure Positioning of CENTUM CS 3000

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1.3 Solutions Incorporating CENTUM CS 3000

CENTUM CS 3000 is a key part of most of Yokogawa's Enterprise Technology Solutions, and features:

- Open environment for optimizing the whole enterprise,
- Optimal operating environment, hardware upgradeable to the latest technology,
- Flexible, durable system that can be optimized for your plant,
- Minimize total cost of ownership, increase profits,
- Powerful engineering functions,
- Improved Security and Safety for Plants.

1.3.1 Open Environment for Optimizing the Whole Enterprise

Easy Links to Information Systems (ERP, MES systems)

In the past, we used the DCS to optimize the plant on a standalone basis; now there are requests to optimize the plant operation from an Enterprise Resource Planning (ERP) or Manufacturing Execution System (MES) viewpoint.

The Human Machine Interface (HMI) of CENTUM CS 3000 is general-purpose PCs (IBM PC/AT compatibles), running Windows 2000 and Windows XP. Windows 2000 and Windows XP have superb networking functions, and OPC for interfacing with supervisory computers are standard – so supervisory computers can easily access the process, and you can optimize your company at the enterprise level. In addition to OPC for communicating between PCs, we can also provide communication with UNIX machines and the like.

Links to Factory Automation (FA) Systems

In a manufacturing environment, the process control system needs to be synchronized with subsystems including FA systems and Programmable Logic Controllers (PLCs) which control packaging, stock management and the like.

There are packages for creating optimum systems which integrate CENTUM CS 3000 and many types of subsystems.

1.3.2 Optimal Operating Environment, Hardware Upgradeable to the Latest Technology

The Operating Environment can incorporate the Latest Technology

Over the last few years, computer technology and networking technology have continued to progress at an astonishing rate, quickly obsoleting existing HMI hardware.

CENTUM CS 3000 uses general-purpose PCs running Windows 2000 and Windows XP as the HMI, so you can use the latest PC hardware. Windows includes network functions, and future enhancements to Windows will also result in an enhanced HMI.

Synthesis of DCS and Personal Computers

CENTUM CS 3000 is operated by a mouse, like general-purpose Windows software. However, the operating environment – control-specific screens, operation and operator keyboard – is designed to resemble conventional DCSes.

Integrating PCs and DCS provides a user-friendly operation environment.

Operation Environment Customizable to match Plant Configuration and Operating Procedures

Different plants require different operating environments.

CENTUM CS 3000 can support up to 4,000 user-defined windows, so you can customize the operation environment.

You can also use a dedicated operator keyboard and touch screen functions, the same as conventional DCSes, and operate the system with a mouse like an office PC. User applications written in Visual Basic, and third-party resources such as ActiveX controls can be used, so you can create various GUI operating environments.

1.3.3 Flexible, Durable System that can be Optimized for Your Plant

High-Reliability Controllers to Safeguard Your Plant

Controller reliability decides plant reliability, productivity, and business viability.

CENTUM CS 3000 can use high-reliability “pair and spare” dual-redundant controllers, which have been proven in CENTUM CS.

Choose the Type of Control Station Based on Plant Scale

You can select the control station hardware and software based on the size and requirements of your plant.

You can use standard control stations which handle a large number of I/O points, and compact control stations with I/O which can be distributed throughout the plant and can handle high-speed communications with subsystems.

Up to 256 control stations can be used in a system, so CENTUM CS 3000 is ideal for medium to large plants.

The easy-to-wire compact I/O modules – proven in CENTUM CS – can support direct thermocouple and RTD input signals.

Control Functions Support a Wide Range of Applications

The control functions include the wide range of proven CENTUM CS control functions. CENTUM CS 3000 supports basic PID and sequence control, as well as batch control and process management functions based on the ISA S88 specification, so can handle anything from multi-product variable-volume production to large volume production.

The control station is available in several versions with databases preconfigured for different mixes of continuous and sequence control, to effectively use the control-station resources and meet the needs of a wide range of applications.

Support for Intelligent Field Instruments

Not only Yokogawa but also many other field instrument vendors are releasing field instruments based on the new open standard, the Foundation Fieldbus.

Some such instruments – for example, valves – may incorporate internal control functions; others – such as sensors – may support multiple process variables, parameters, and also maintenance and status information which can be read by the DCS. By using intelligent Foundation Fieldbus devices in the field, you can distribute the control load, allowing control stations to be dedicated to performing more complex control tasks.

1.3.4 Minimize Total Cost of Ownership, Increase Profits

Continue to Use Existing User Resources (Hardware, Software, Know-how)

Replacement System

CENTUM CS 3000 is designed to be the optimum replacement for existing systems – it is inexpensive, so will improve competitiveness of your business.

Enhance and Integrate Existing Systems

You can enhance and integrate existing DCS systems.

CENTUM CS 3000 components are designed to be the same size as CENTUM CS and CENTUM-XL components. This makes expansion easy.

Compatible with Other Yokogawa Systems

CENTUM CS 3000 systems can be linked by bus converter to CENTUM CS 3000, CENTUM CS, CENTUM-XL, CENTUM V, CENTUM CS 1000 and μ XL. Also CENTUM CS 3000 and CENTUM CS can be linked to the same bus without bus converter.

CENTUM V and CENTUM-XL Migration to CENTUM CS 3000

CENTUM V and CENTUM-XL can be migrated to CENTUM CS 3000 without changing field devices and wiring connected to I/O cards in existing FCSes.

Hardware

CENTUM CS 3000 is designed to reduce total installation costs.

Remote I/O

Remote I/O units can be mounted near the plant, reducing cabling and installation costs.

Management Cost Reduction

Yokogawa offers an integrated device management tool called Plant Resource Manager (PRM). The PRM tool is designed to reduce the total cost of ownership (TCO) of the plant by fully utilizing the capacity of highly-functionalized field communication and devices and realizing efficient device management and maintenance – all in line with modern device management in field-bus era.

Maintenance Service

Yokogawa's Maintenance Service will keep your CENTUM CS 3000 running smoothly.

“BEST²” Maintenance System

You can choose the optimum maintenance support plan for your needs by combining various maintenance packages – with different types of maintenance checks and different maintenance check intervals – depending on your environment and needs.

1.3.5 Powerful Engineering Functions

Easy Function Configuration

No matter how good a system is, it cannot succeed if system configuration is extremely time-consuming and difficult.

CENTUM CS 3000 engineering functions are designed for efficient engineering – they are designed for ease of use, and software reusability; test functions are provided.

- Interactive builder running on general-purpose PC; few settings required to generate a working system.
- You can reuse existing Engineering Data, and edit it using general-purpose Windows software. Consistent engineering screens (“standardization”), and the ability for many people to proceed with work in parallel, mean higher quality engineering and much faster completion.
- You can test the operation of a created control station database on a “virtual system” using test functions which emulate (simulate) control stations running on a PC together with Human Interface Station software. You do not need control station hardware to perform such standalone tests.

Online Documentation

All the manuals are provided as electronic documents on CD-ROM. The file format is Adobe Portable Document Format (PDF), which is the de facto standard for portable documents on the Internet. You can read them sequentially like conventional documents, or search and print necessary parts of these electronic documents “on demand” during engineering, for example.

1.3.6 Improved Security and Safety for Plants

Integrated Safety Instrumented System for Processes

ProSafe-RS realizes the integrated safety solution with control system, achieving both safety and high availability.

Integration with Control System

IEC 61508 standard for functional safety sets the guidelines for separation of functions of control system and safety system. However, in the actual applications, operators often desire to use the same operational environments for both the control and the safety instrumented system. To respond to such demand, ProSafe-RS employs the same architecture as of CS 3000 in its basic architecture, and by connecting directly to CS 3000, it realizes the integrated operational environment.

Achievement of both Safety and High Availability

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

Safety Instrumented System

Safety instrumented system acts to prevent damage to plants in case of accidents (emergency shutdown) and to prevent aggravation of damage (fire and gas protection).

As a result of these functions which provide improved plant safety, safety instrumented system contributes to the overall protection of personnel, facilities and environments.

Acquisition of Certification Conforming to International Standard

ProSafe-RS is a safety instrumented system conforming to the safety integrity level SIL3 as defined by IEC 61508. It has been certified by TÜV Rheinland (TÜV), a German certification organization.

Improvement of Plant Safety

IEC 61508 defines a quantitative target for 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.

The concept of safety, on which this standard is formulated, is based on the idea that safety should be regarded as "Safety, 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 in cooperation with local society.

ProSafe-RS is a safety instrumented system providing "prevention layer" and "mitigation layer" in "protection layers."

2. System Configuration

This chapter introduces the CENTUM CS 3000 system configuration, and the main equipment that CENTUM CS 3000 consists of.

The system configuration diagram below shows representative devices in a basic CENTUM CS 3000 system.

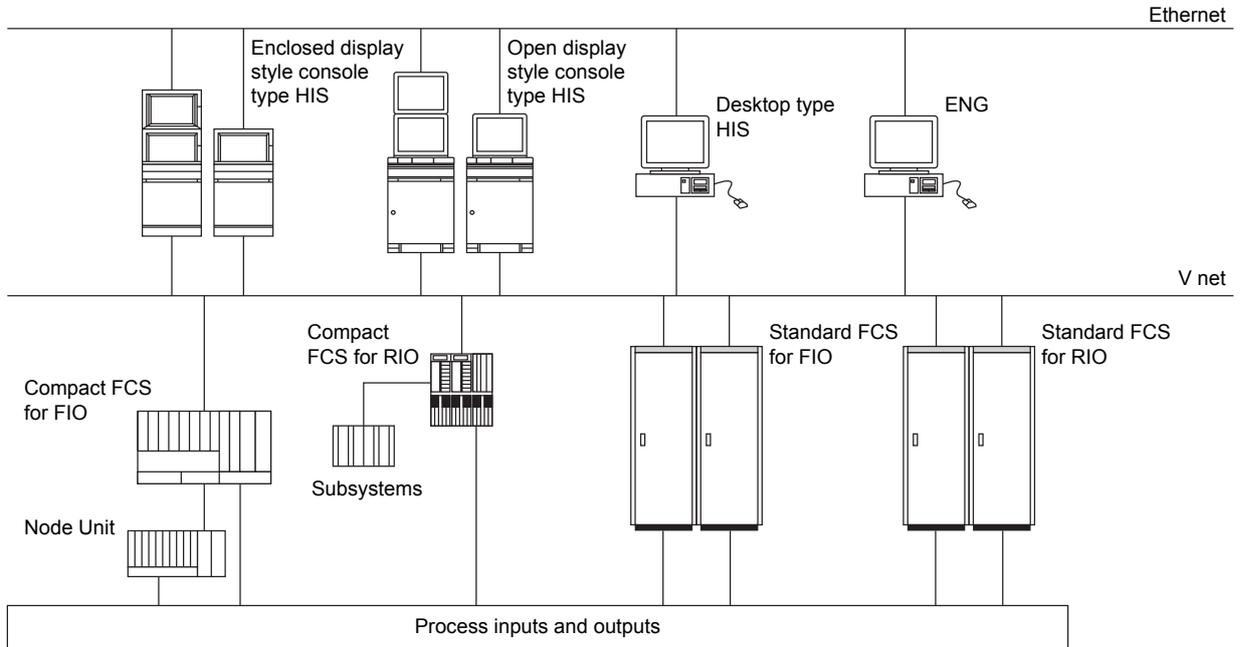


Figure CENTUM CS 3000 System Configuration (Basic)

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The figure below shows a large system linked to supervisory computers and previous CENTUM and μ XL systems – illustrating that CENTUM CS 3000 is an open, expandable system.

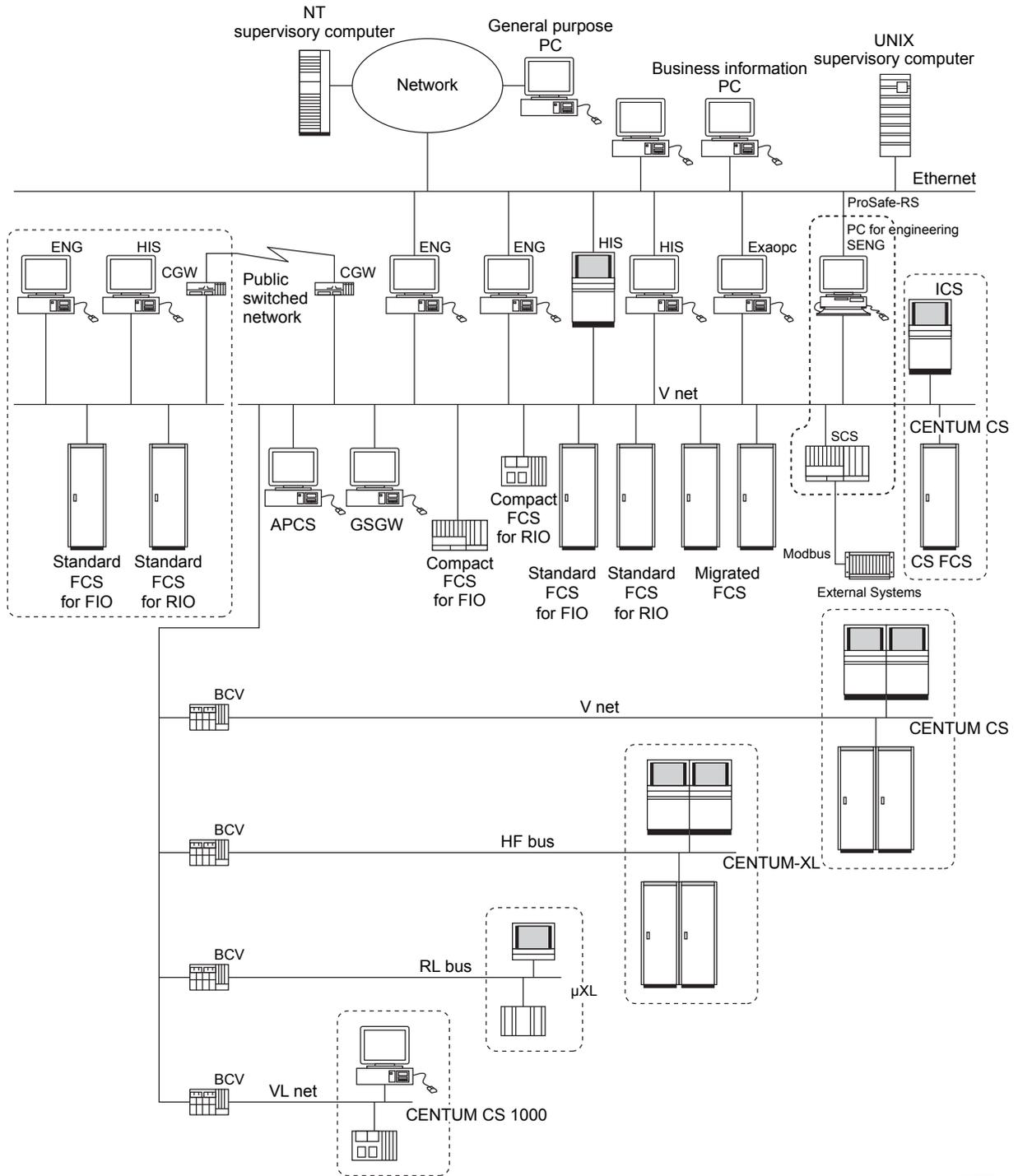


Figure CENTUM CS 3000 System Configuration

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2.1 System Configuration – CENTUM CS 3000 Equipment

Human Interface Station (HIS)

The HIS is mainly used for operation and monitoring – it displays process variables, control parameters, and alarms necessary for users to quickly grasp the operating status of the plant. It also incorporates open interfaces so that supervisory computers can access trend data, messages, and process data.

- Console Type HIS
This is a new console type human interface station, at which a general purpose PC is installed.
There are two types of console type HISs: one is enclosed display style, the appearance of which is usual style, and another is open display style, the configuration of which is selectable.
- Desktop Type HIS
This HIS uses a general purpose PC.

Field Control Station (FCS)

The FCS controls the plant. By the difference of used I/O modules, there are two models of the FCS; namely the FCS for FIO and the FCS for RIO. In addition to the above models, there is the Compact type FCS.

- FCS for FIO
This FCS uses the Fieldnetwork I/O (FIO) modules, which are compact and consist of various lineup such as the connector types and so forth. According to the application capacity, there are the standard model and the enhanced model.
- Compact FCS for FIO
This is a compact FCS with I/O modules integrated into the Field Control Unit.
- FCS for RIO
This FCS uses the Remote I/O (RIO) modules, which have many installation bases and M4 screw terminals to connect signal cables. According to the application capacity, there are the standard model and the enhanced model.
- Compact FCS for RIO
This controller is usually installed near the equipment or process it controls, and is ideal for communicating with subsystems.

Engineering PC (ENG)

This is the PC with engineering functions used to perform CENTUM CS 3000 system generation and maintenance management.

It can be the same type of general-purpose PC as the HIS, and can even be the same PC as the HIS.

By having HIS operation and monitoring functions on the same PC, you can use the test (control station emulation) functions to provide an efficient and easy-to-use engineering environment.

Bus Converter (BCV)

This links the V net system bus to another CENTUM CS 3000 domain or to an existing CENTUM or μ XL system.

Communications Gateway Unit (CGW)

This links the V net control system bus to an Ethernet bus (to a supervisory computer system or general purpose personal computer).

By CGW wide area communication function, you can also link two CENTUM CS 3000 V nets in different places using a dedicated telephone line.

Migrated Field Control Station (RFCS2)

You can leave the I/O cards and field wiring of a CENTUM-XL or CENTUM V system “as is”, and replace the CPU nest with an KFCS, which can be connected to the V net just like a CENTUM CS 3000 system FCS.

SI bus is used as a (dual-redundant) bus connecting existing FCS I/O units to new FCS CPU.

Advanced Process Control Station (APCS)

The Advanced Process Control Station (APCS) is a personal computer (PC) connected to the V net and applied to advanced process control and efficiency improvement.

Generic Subsystem Gateway Package (GSGW)

GSGW is a PC connected to V net. It uses OPC servers for subsystems, facilitating subsystem data acquisition and setting without creating specific communications programs.

Exaopc

This provides OPC Server functions to enable applications in a supervisory PC to access CENTUM CS 3000 data. It provides a link between control layer and business data processing layer.

Business Information PCs and Supervisory Computers

These can run MES and ERP integrated business management software. They can access the DCS via Exaopc or CGW.

Safety Instrumented System (ProSafe-RS)

ProSafe-RS is a dedicated system to prevent probability and spread of accidents when it is used as an interlock device, emergency shutdown system and fire and gas protection.

Safety Engineering PC (SENG)

This is a component equipped with engineering, test and maintenance functions to generate system and manage maintenance for safety control station (SCS).

Safety Control Station (SCS)

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

V net

The V net real-time control system bus links stations such as FCS, HIS, BCV and CGW. Dual-redundant V net support is standard.

Ethernet

Ethernet is used to link HIS, ENG and supervisory systems. It is also used for transferring data files to supervisory computers, and for HIS data equalization.

Fieldbus

The FOUNDATION Fieldbus is a multidrop digital communications bus for field instruments, and is expected to replace the conventional 4 to 20 mA analog interface.

2.2 System Specifications

CENTUM CS 3000 is a flexible system that can handle everything from small to quite large systems.

System Scale

The CENTUM CS 3000 system specifications are as shown below:

- No. of tags that can be monitored: 100,000 tags (expandable up to 1,000,000 tags)
- No. of stations that can be connected: 256 stations (max. 16 domains, 64 stations per domain) – however, HIS is limited to a maximum of 16 stations/domain.

When you reach the maximum of 64 stations in a domain, you can start a new domain and link the two domains using a Bus Converter.

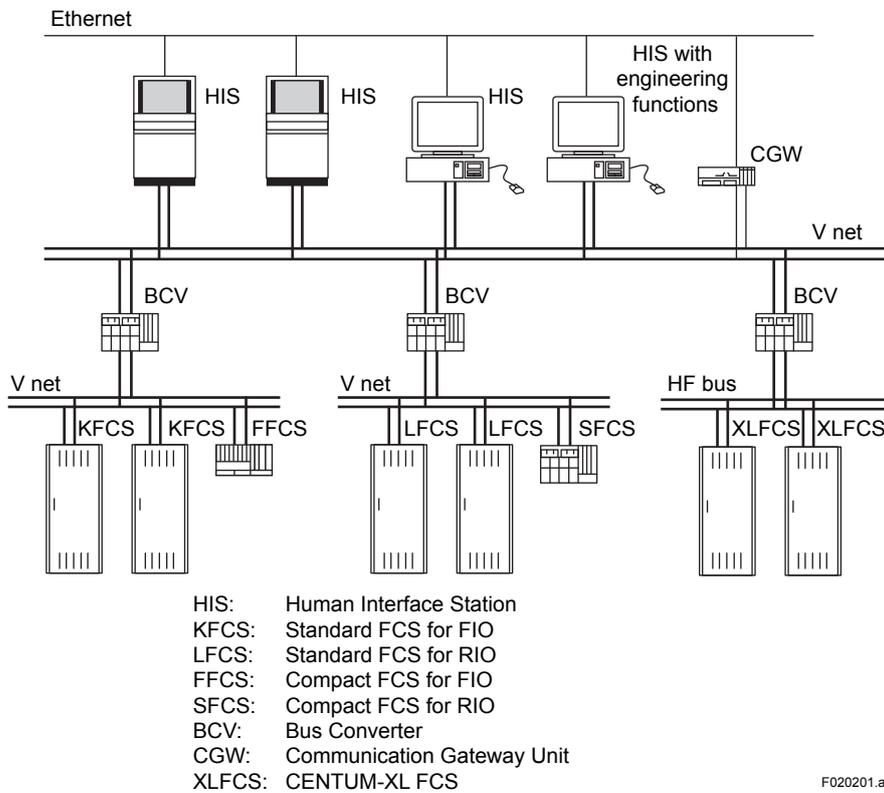


Figure Example of Large System Configuration

Domain

A domain is a logical V net bus segment. You can use a Bus Converter to link CENTUM CS 3000 domains, or link to previous systems (CENTUM CS, CENTUM-XL, CENTUM CS 1000, μ XL etc.). Support will be provided for integrating CS 3000 with previous systems.

Migration from CENTUM CS 1000 to CS 3000

Easy engineering operation can migrate the existing CENTUM CS 1000 system to the CENTUM CS 3000 system.

Single control bus is available when the CENTUM CS 3000 Entry class system is migrated from the CENTUM CS 1000 system. In that case, Ethernet is not required.

SEE ALSO Please refer to GS 33Q01B10-31E for whether the single control bus is allowed and whether Ethernet is required.

2.3 Human Interface Station (HIS)

HIS Function Specifications

**SEE
ALSO**

For the specifications of HIS functions, refer to GS 33Q02C10-31E.

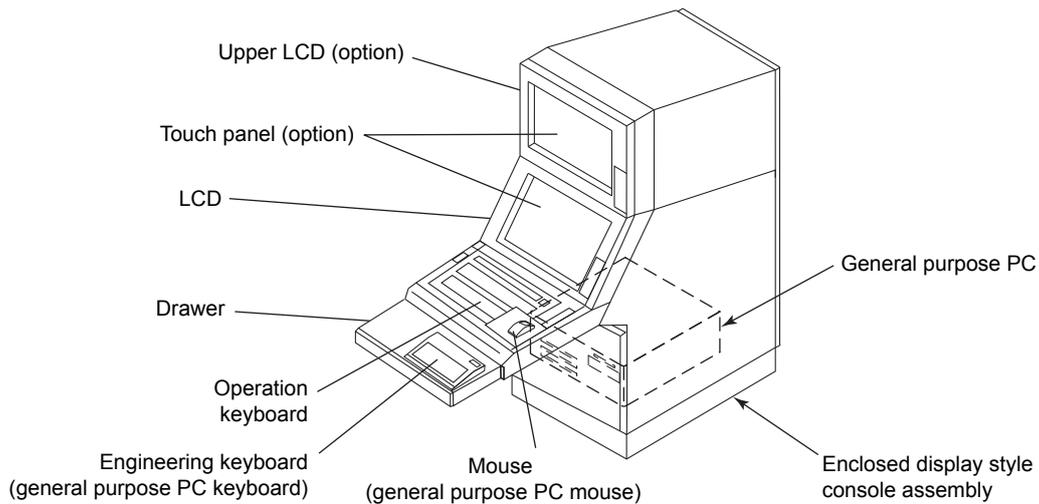
2.3.1 Console Type HIS

The console type HIS is composed of a console assembly and a general purpose PC. It is a new type of human interface station that can utilize the latest PC technology while succeeding the operability and functionality of the DCS.

It can be composed of dual stacked LCD, touch panel function, eight-control-key operation keyboard, and auxiliary contact I/O, and a number of console type HISes can be installed in a row.

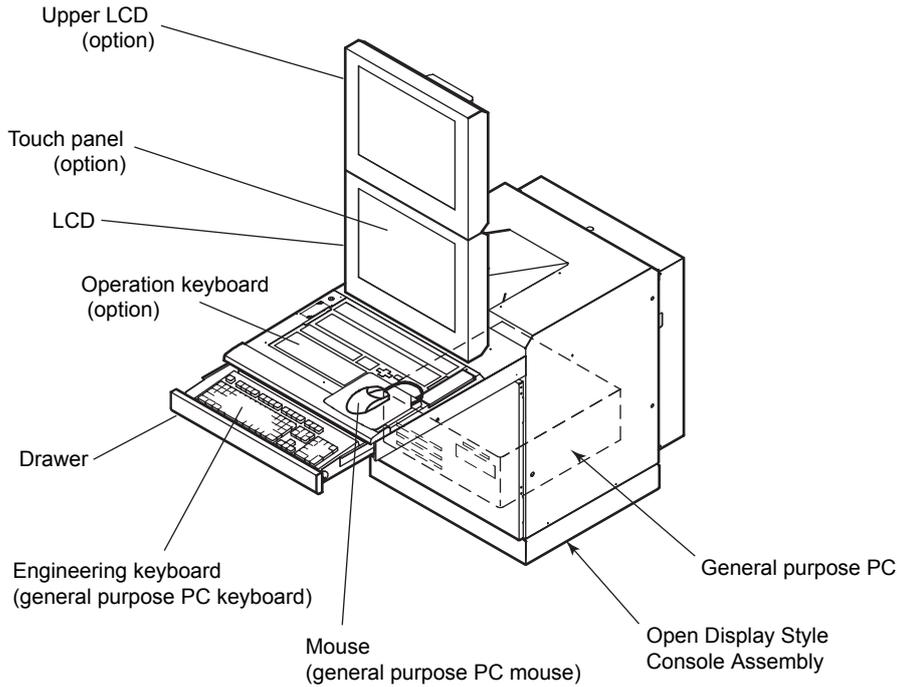
There are two types of console type HISes: one is enclosed display style console type HIS, the appearance of which is usual style, and another is open display style console type HIS, which is composed of LCD and the configuration of which is selectable.

The appearance of the console type HIS is shown below:



F020301.ai

Figure Enclosed Display Style Console Type HIS



F020303.ai

Figure Open Display Style Console Type HIS with LCD

Table Functions of Console Type HIS

| | | Enclosed Display Style Console Assembly | Open Display Style Console Assembly |
|--------------------|---|---|-------------------------------------|
| Display unit | Single LCD | Standard | Standard |
| | Dual stacked LCD | Option | Option |
| | Without LCD | No available | Standard |
| Touch panel | For lower display unit | Option | Option |
| | For upper display unit | Option | No available |
| RAS/Contact I/O | RAS | Standard(*1) | Standard(*2) |
| | Contact I/O | Standard | Standard |
| Operation keyboard | Eight-control-key operation keyboard (*3) | Standard | Standard |
| | One-control-key operation keyboard | No available | Standard |
| | Without operation keyboard | No available | Standard |
| | Drawer | Standard | Standard |

*1: Monitoring functions of ventilation fan operations and temperatures of the enclosure, and RAS functions provided in connection with the incorporated PC.

*2: RAS functions provided in connection with the incorporated PC.

*3: Not available for HIS without LCD.

2.3.2 Desktop Type HIS

The Desktop Type HIS uses a general purpose IBM PC/AT compatible.

2.3.3 Operation Keyboard

The dust- and drip-proof operation keyboard has functionally arranged flat keys, which enables one-touch operation. The keyboard is available in two types: one is designed for eight-control-key operation for use with console type HISes, and another for one-control-key operation for use with both console type HISes and desktop type HISes.

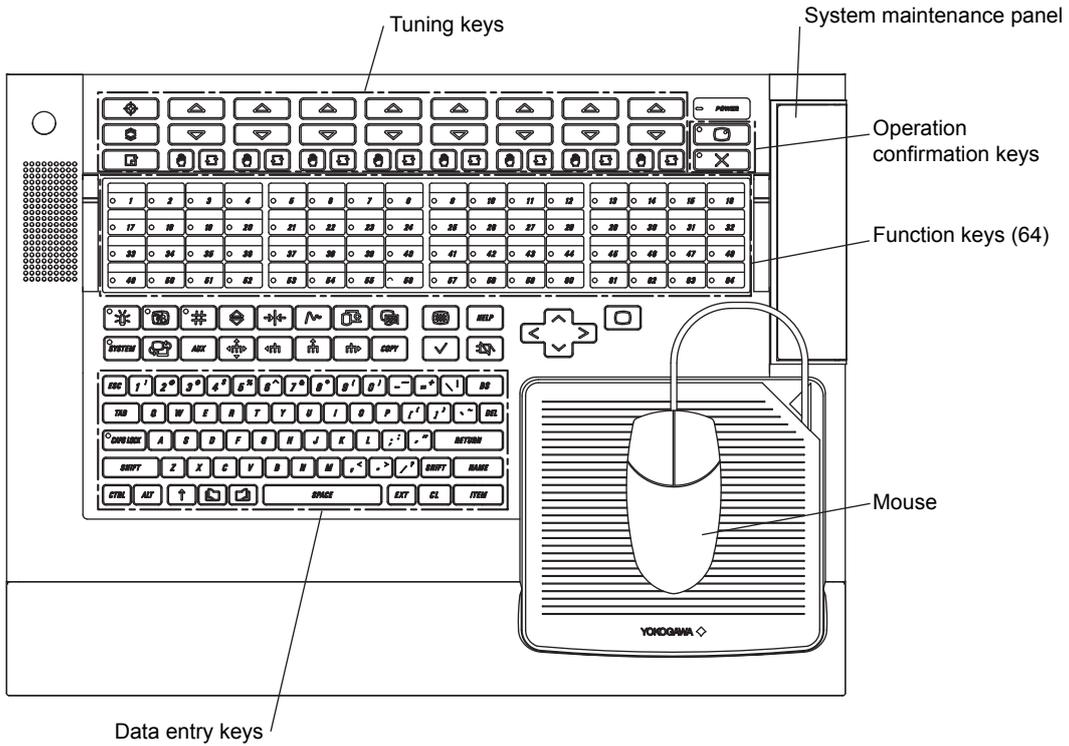
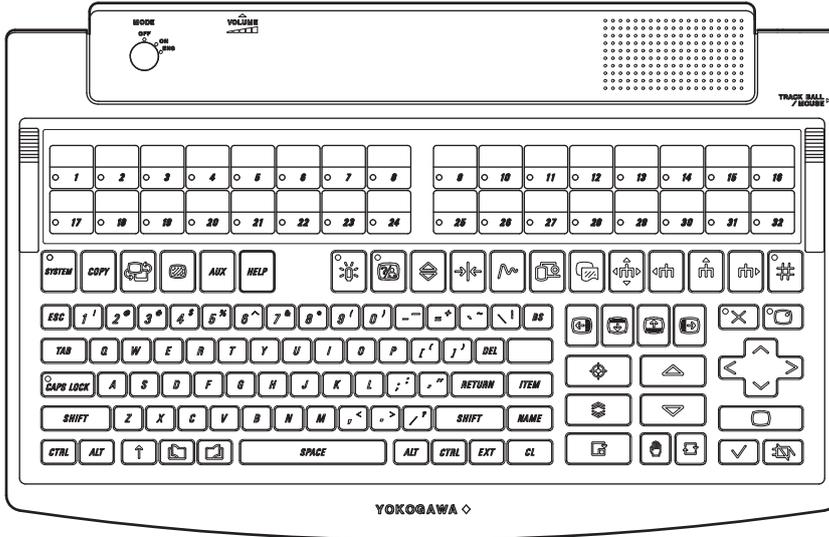


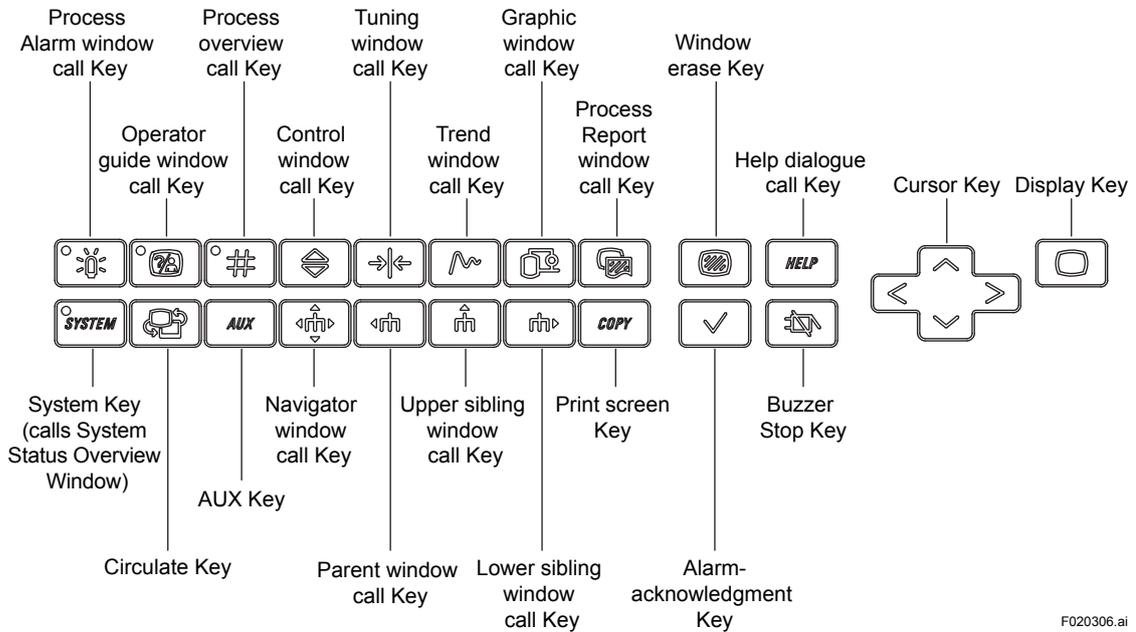
Figure Eight-control-key Operation Keyboard

F020304.ai



F020305.ai

Figure One-control-key Operation Keyboard



F020306.ai

Figure Operation Keys

2.4 Field Control Station (FCS)

The hardware architecture of the Standard Type Field Control Station for FIO (KFCS), the Enhanced Type Field Control Station for FIO (KFCS2), the Standard Type Field Control Station for RIO (LFCS), the Enhanced Type Field Control Station for RIO (LFCS2), and the Compact FCS (SFCS) is described below.

- KFCS, KFCS2:** The Field Control Unit (FCU) and the node are connected using ESB(Extended Serial Backboard) or ER(Enhanced Remote) bus.
- FFCS:** An FCS in which the FCU and a node unit are combined.
- LFCS, LFCS2:** The FCU and the node are connected using RIO bus.
- PFC□-H/-S/-E:** The FCU and the I/O units are connected to the same backplate.

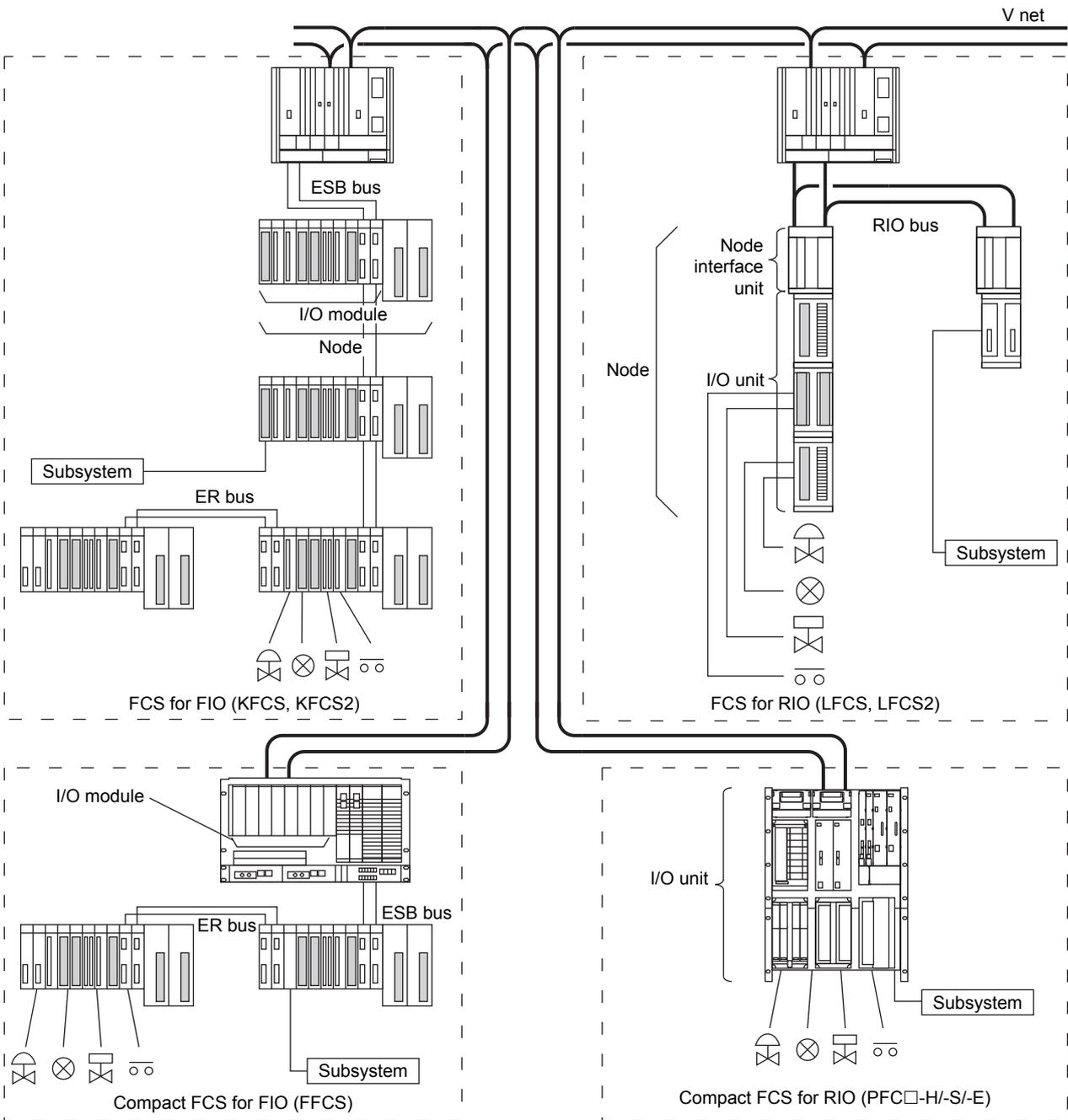


Figure Field Control Station Configuration

F020401.ai

2.4.1 FCS for FIO (KFCS, KFCS2, FFCS)

The FCS for FIO is composed of an FCU, ESB bus, ER bus and node units. CPU architecture and mounting combinations are available for optimum selection.

| | |
|-------------------|------------------------------------|
| CPU architecture: | Single or duplexed. |
| Mounting: | cabinet mounting or rack mounting. |
| ESB bus: | Single or dual redundant. |
| ER bus: | Single or dual redundant. |

Note: One node unit is integrated into an FFCS. FFCS's are rack-mounted only.

FCS for FIO Application Capacities

SEE ALSO

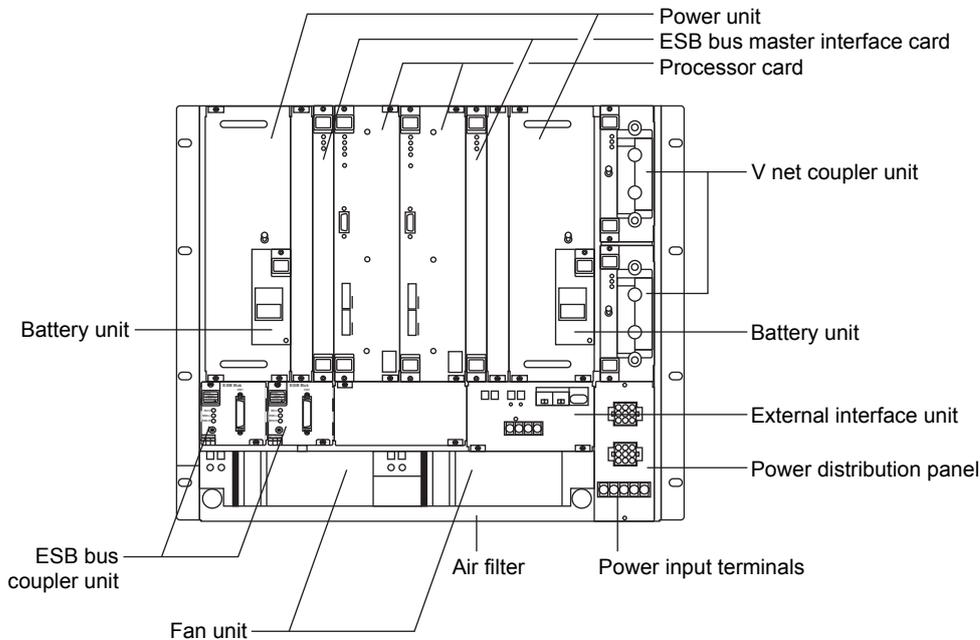
- For the application capacity of Standard FCS for FIO, refer to GS 33Q03K30-31E.
- For the application capacity of Enhanced FCS for FIO, refer to GS 33Q03K31-31E.
- For the application capacity of Compact FCS for FIO, refer to GS 33Q03K40-31E.

Field Control Unit (FCU)

The FCU consists of cards and units and executes control computation for the FCS. Each FCS is configured as shown in the figure below.

FCU Configuration in KFCS and KFCS2

For the duplexed FCU, the processor cards are duplexed, and power units, battery units and ESB bus interface cards are dual redundant.



F020402.ai

Figure Example of Rack Mounting Type FCU for FIO

FCU Configuration in FFCS

For a duplexed FCU, the processor modules, power modules, and I/O modules are all dual-redundant.

If node units are added, install a bus interface module in an I/O module slot. Use two modules for dual-redundant use.

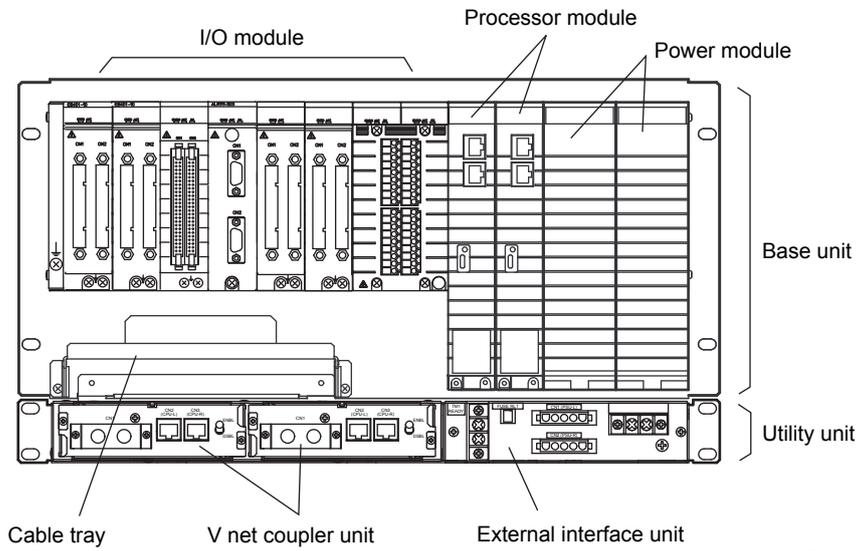


Figure Example of Compact FCU Configuration for FIO

ESB Bus and ER Bus

The ESB bus (Extended Serial Backboard bus) is a communication bus used in connecting the local nodes, which are installed in the same cabinet for FCU, with the FCU. This bus can be dual-redundant. Maximum transmission distance is 10 meters.

The ER bus (Enhanced Remote bus) is a communication bus used in connecting the remote nodes with the FCU by way of the ER bus interface module installed on the local node (*1). This bus can also be dual-redundant. Using this bus, the nodes can be installed in the same cabinet for FCU or at locations away from the cabinet. Its maximum transmission distance is 185 meters using a Ethernet-compatible 10BASE-2 coaxial cable or 500 meters using a 10BASE-5 coaxial cable, or up to 2 kilometers using general-purpose optical bus repeaters.

*1: A compact FCS for FIO allows the installation of an ER bus interface module in a node unit integrated into the FCU.

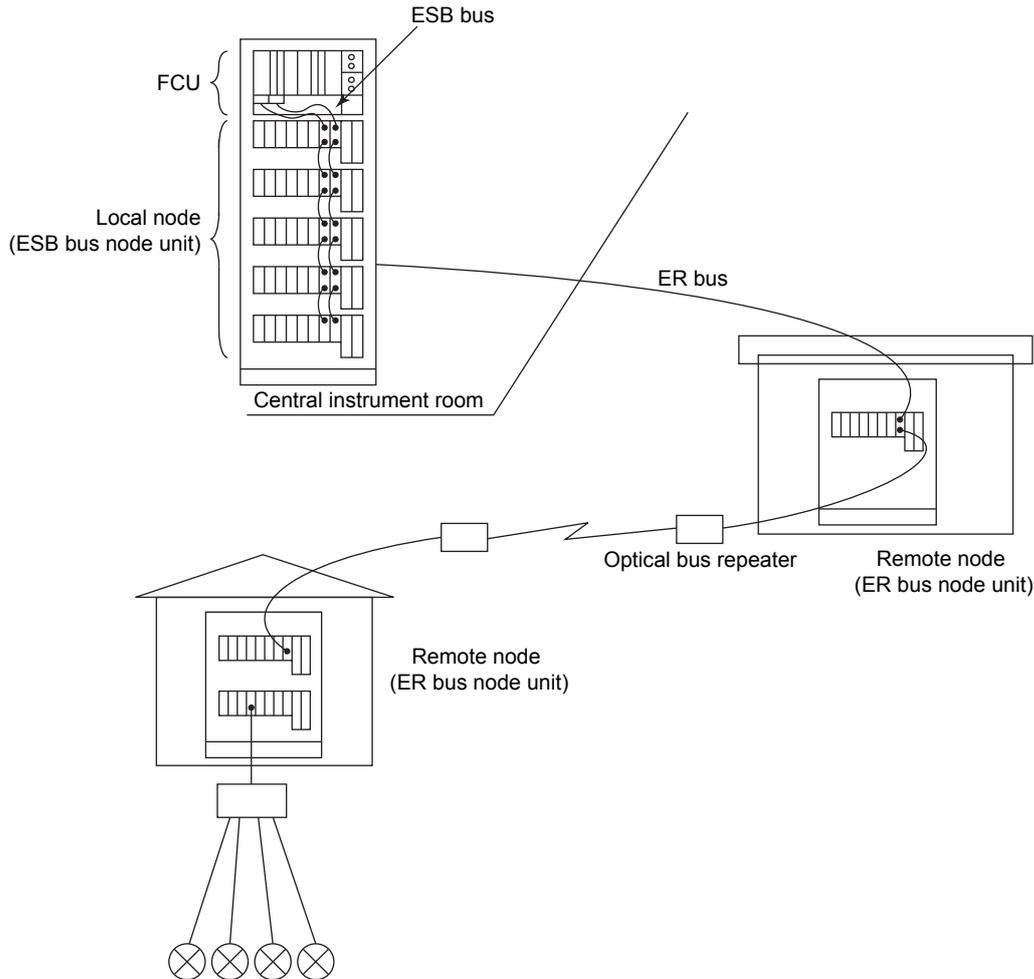


Figure Example of Distributed Node Units (KFCS, KFCS2)

F020403.ai

Node Units (NU) for FIO

The node units (NU) for FIO are signal processing units which convert and transmit analog or digital process I/O signals received from the field devices to the FCU for FIO.

The node units (NU) for FIO have ESB bus node units (local nodes) installed at the FCS station and ER bus node units (remote nodes) installed in cabinets and etc. on the plant-site. The node unit is composed of an ESB bus slave interface module or ER bus slave interface module and I/O modules. In addition, a compact FCS for FIO includes one node unit integrated into the FIO.

ESB Bus Slave Interface Module

This module is installed in the local node to enable communication with the FCU. The module can be duplexed.

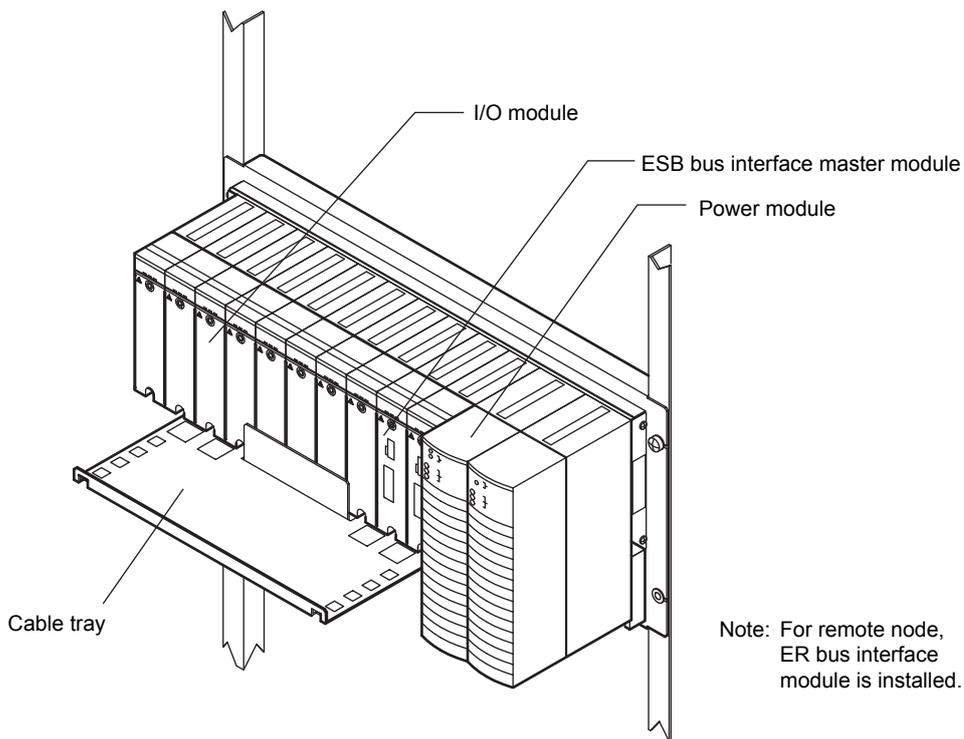
ER Bus Interface Module

This module has an interface master module, which is installed on the local node, and an interface slave module, which is installed on the remote node. Both modules can be dual-redundant.

Note: A compact FCS for FIO allows the installation of an ER bus interface master module in a node unit integrated into the FCU.

I/O Module

These modules input, convert, and output analog and digital field signals.



F020404.ai

Figure Local Node Configuration

Mounting of FCS for FIO

Mounting of KFCS and KFCS2

The FCU and node units (NU) for FIO are mounted in a dedicated cabinet, general-purpose racks or general-purpose cabinets.

Mounting and combinations of FCU and nodes are user definable. For example, the FCU and some node units are mounted in a dedicated cabinet and the remaining node units are mounted in general-purpose racks on the plant-site. Up to 10 node units for FIO can be connected to the FCU of each standard FCS for FIO (up to 15 for each enhanced FCS for FIO), and up to 8 I/O modules can be installed in each node unit.

- FCU for FIO Dedicated Cabinet
 - Front: 1 FCU, 5 node units
 - Rear: 4 node units
- I/O Expansion Cabinet
 - Front: 4 node units
 - Rear: 4 node units

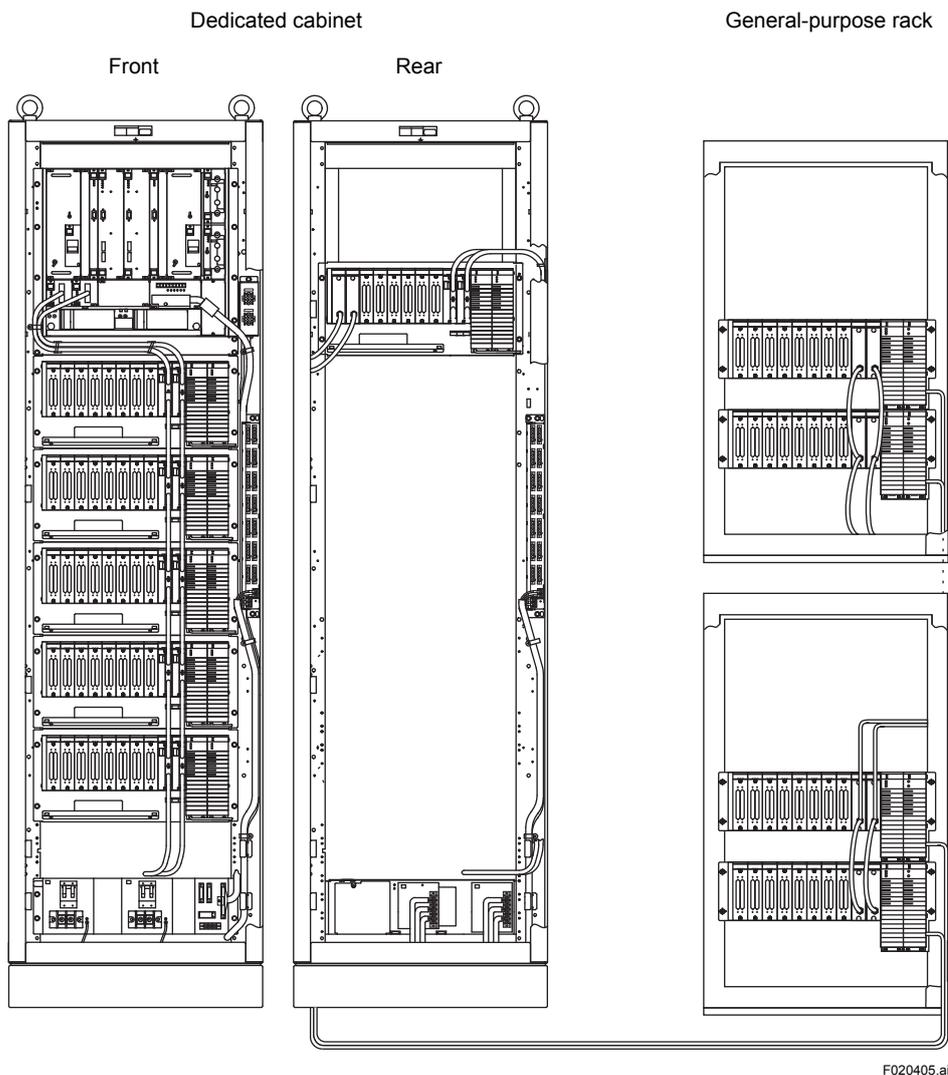


Figure Example of Mounting FCU and Node Unit using Dedicated Cabinet

Mounting of FFCS

An FCS on which FCUs and I/O modules are mounted can be mounted in a rack. Up to three node units (NUs) for FIO can be connected to an FCS. Up to eight I/O modules (*1) can be mounted on a node unit integrated into the FCU. Up to 30 I/O modules can be mounted on an FCS, adding to additional node units for FIO.

*1: If node units (NUs) are added, up to six I/O modules can be mounted on node units integrated into the FCU for installing communication modules for NU connection.

2.4.2 FCS for RIO (LFCS, LFCS2)

For the FCS for RIO, with the FCU connected by RIO bus to nodes, there are FCU CPU redundancy and RIO bus redundancy options, and cabinet or rack mounting options.

CPU redundancy: single or duplexed (dual redundant).

Mounting: cabinet mounting or rack mounting.

RIO bus: single or dual redundant.

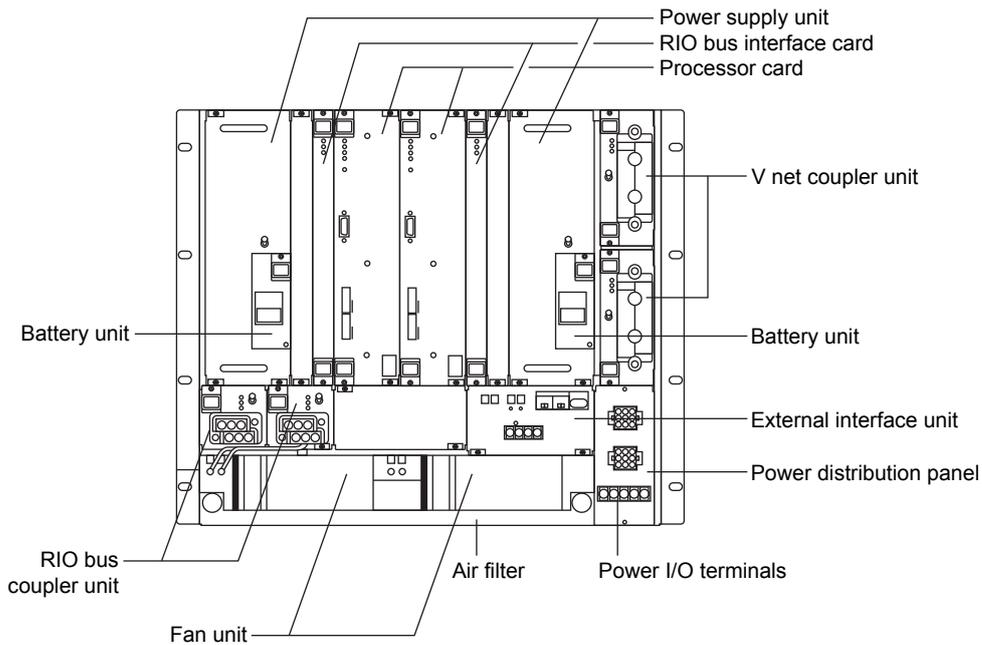
FCS for RIO Application Capacity

**SEE
ALSO**

- For the application capacity of Standard FCS for RIO, refer to GS 33Q03K10-31E.
- For the application capacity of Enhanced FCS for RIO, refer to GS 33Q03K11-31E.

Field Control Unit (FCU) for RIO

The FCU for RIO consists of processor, cards and units. For the duplexed (dual-redundant) FCU, the processor card, power unit, battery unit and RIO bus interface card are all dual redundant.

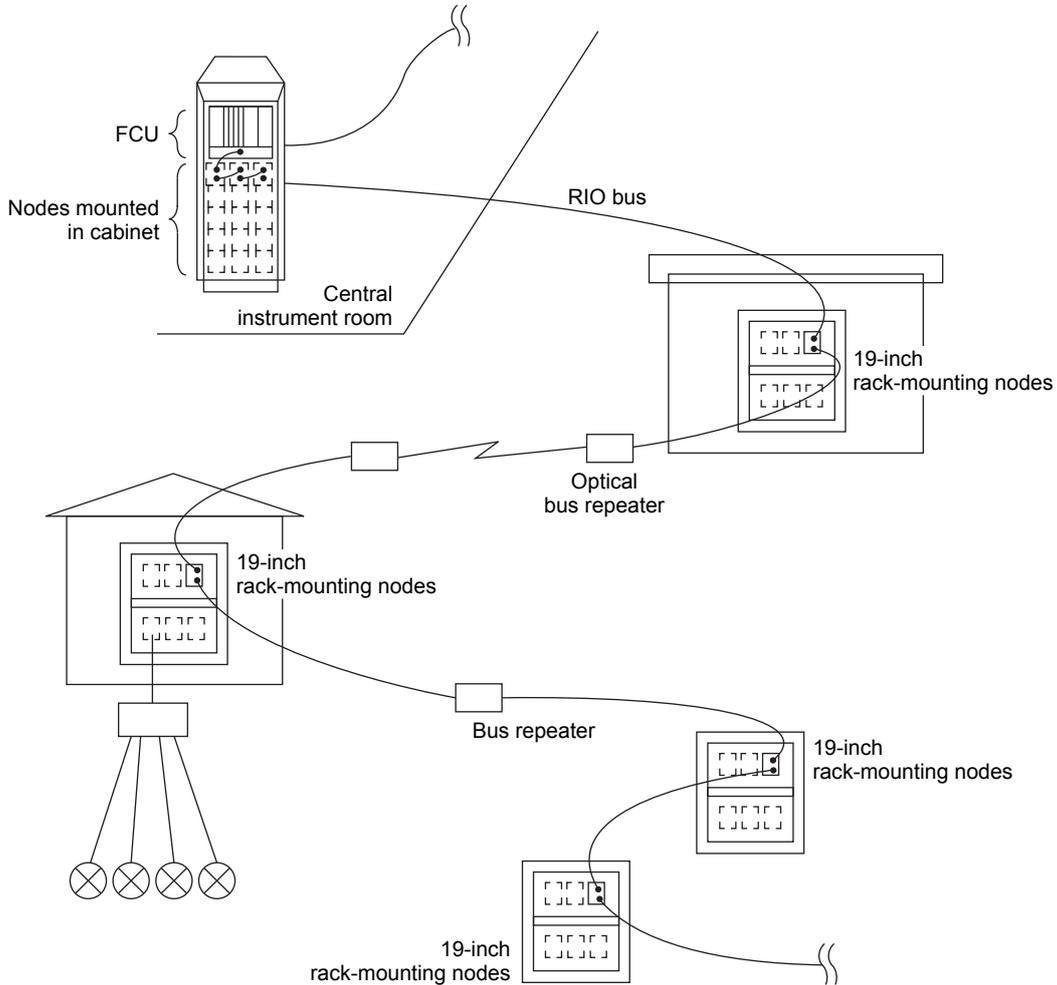


F020406.ai

Figure Example of Rack Mounting Type FCU for RIO Configuration

RIO Bus

The Remote I/O bus (RIO bus) connects the FCU to I/O nodes, and can be dual redundant. I/O nodes do not need to be in the FCU cabinet, they can be mounted remotely. Shielded twisted pair cable is used for distances up to 750 m, and bus repeaters or optical fiber links can be used for longer distances – up to 20 km. Bus repeaters and optical fiber links can be mixed, up to four in total.



F020407.ai

Figure Example of Distributed Nodes – Extending the RIO Bus

Nodes

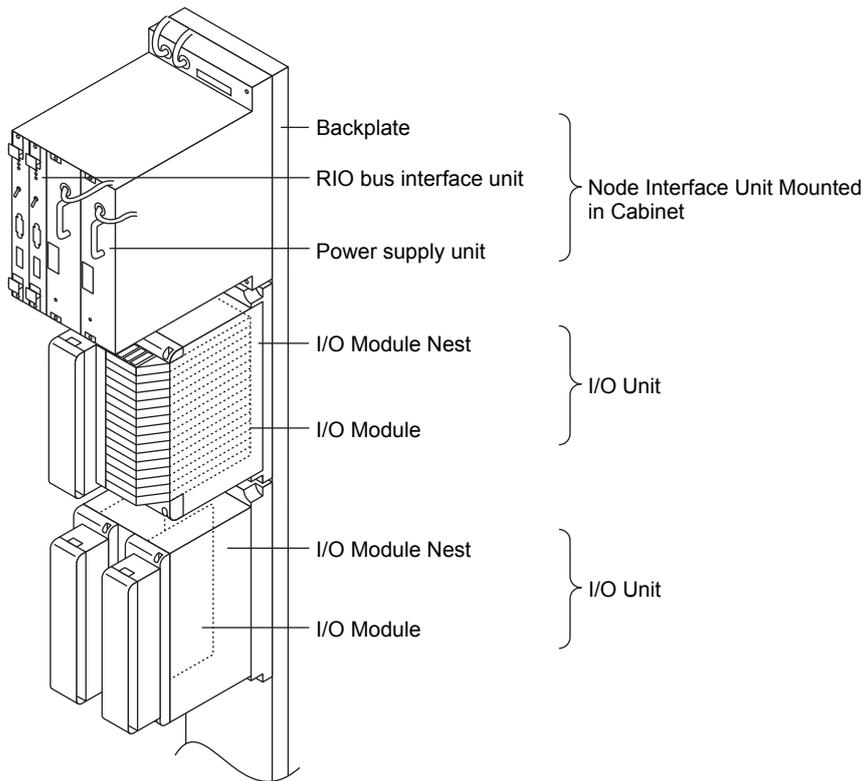
Nodes consist of I/O Units, which interface with analog and digital field signals, and Node Interface Units which communicate via the RIO Bus with Field Control Units (FCU).

Node Interface Units (NIU)

Node Interface Units consist of RIO bus communication cards and power cards, both of which can be dual redundant.

I/O Units (IOU)

I/O Units consist of I/O Module Nests containing I/O Modules, which connect to the process.



F020408.ai

Figure Cabinet Mounting

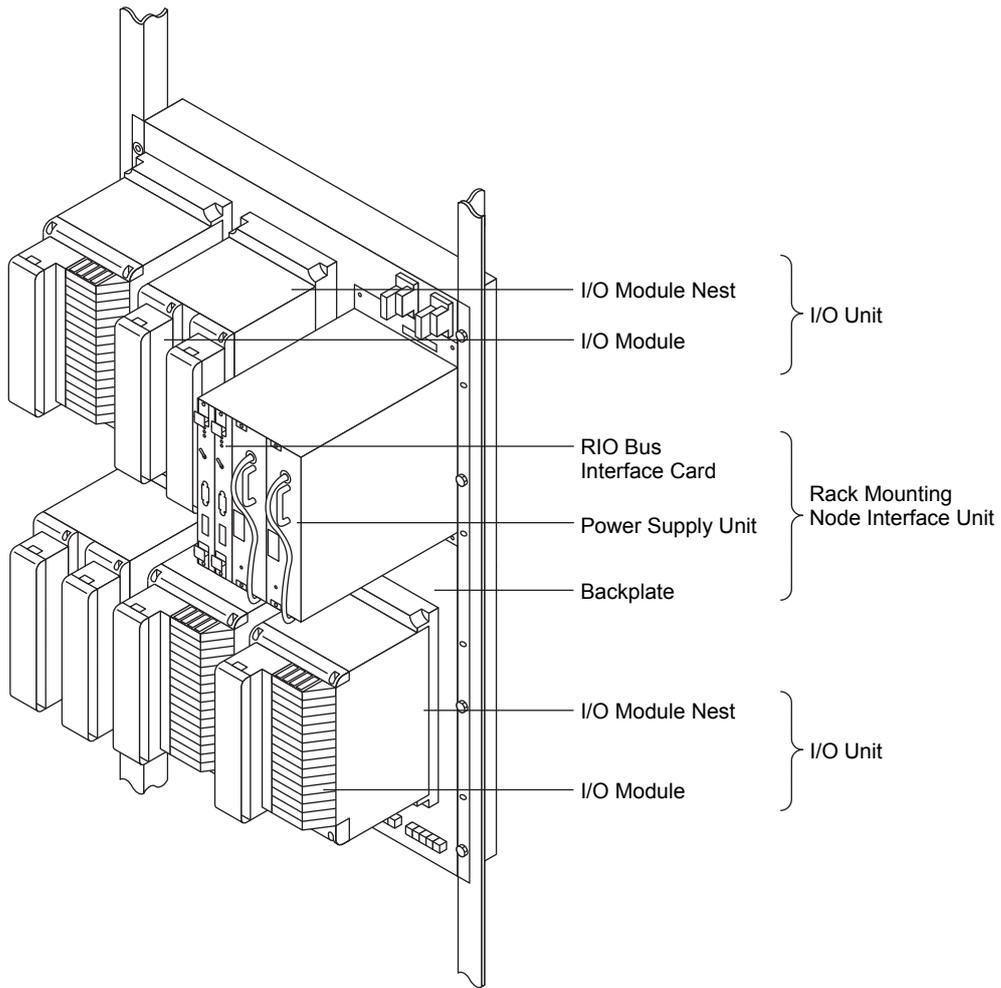


Figure Example of Rack Mounting

F020409.ai

Mounting of LFCS FCUs and Nodes

FCUs and nodes can be mounted in dedicated cabinets or in general-purpose 19-inch racks.

FCUs and nodes can be mounted together or separate – you can mount some nodes in the same cabinet (or on the same rack) as the associated FCU, and some in racks in the field, if you wish. Each FCU can connect to up to eight nodes, and each Node Interface Unit (NIU) can connect to up to five I/O units.

Dedicated Cabinets

- Cabinets which contain FCUs
 - Front: One FCU, three nodes (with up to four I/O units in each node).
 - Back: Up to three nodes (with up to five I/O units in each node).
- I/O Expansion Cabinets
 - Front: Up to three nodes (with up to five I/O units in each node).
 - Back: Up to three nodes (with up to five I/O units in each node).

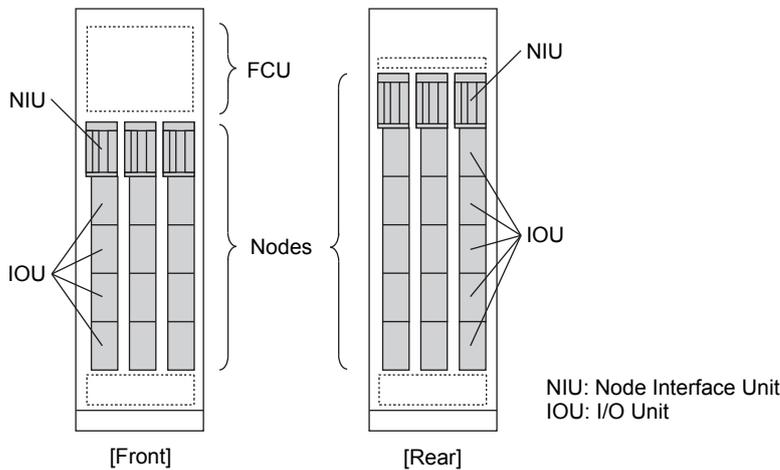


Figure Example of Cabinet with FCU

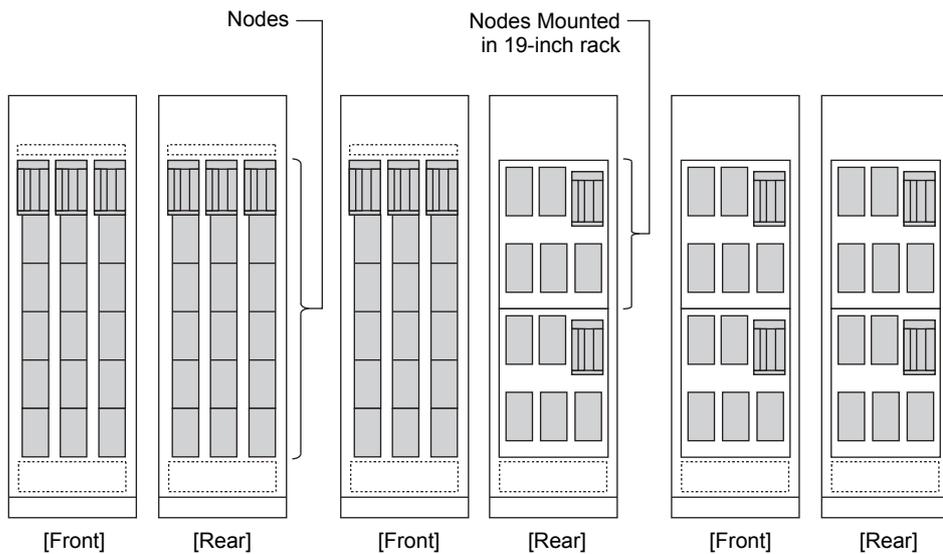


Figure Examples of I/O Expansion Cabinets

Rack Mountable Node

Up to five I/O Units may be connected to one node; they may be mounted in the same general-purpose 19-inch rack.

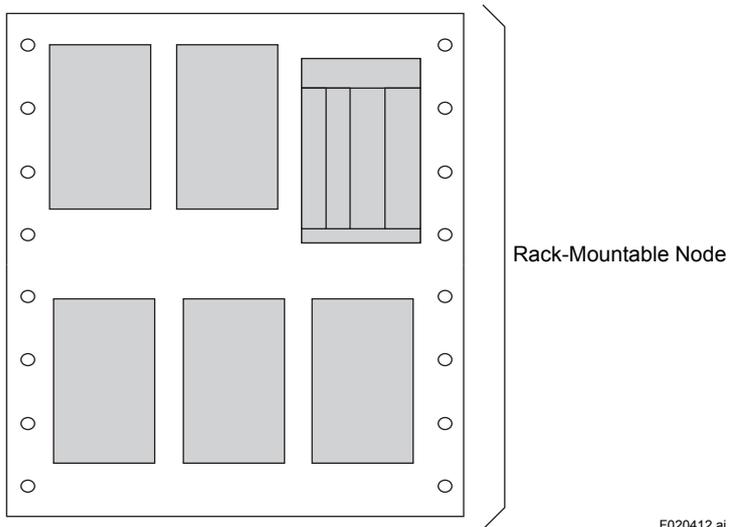


Figure Example of Rack-Mountable Node

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2.4.3 Compact FCS for RIO (PFC□-H/-S/-E)

Duplexed (dual redundancy) CPU is supported.

Dual redundant power supplies are also available.

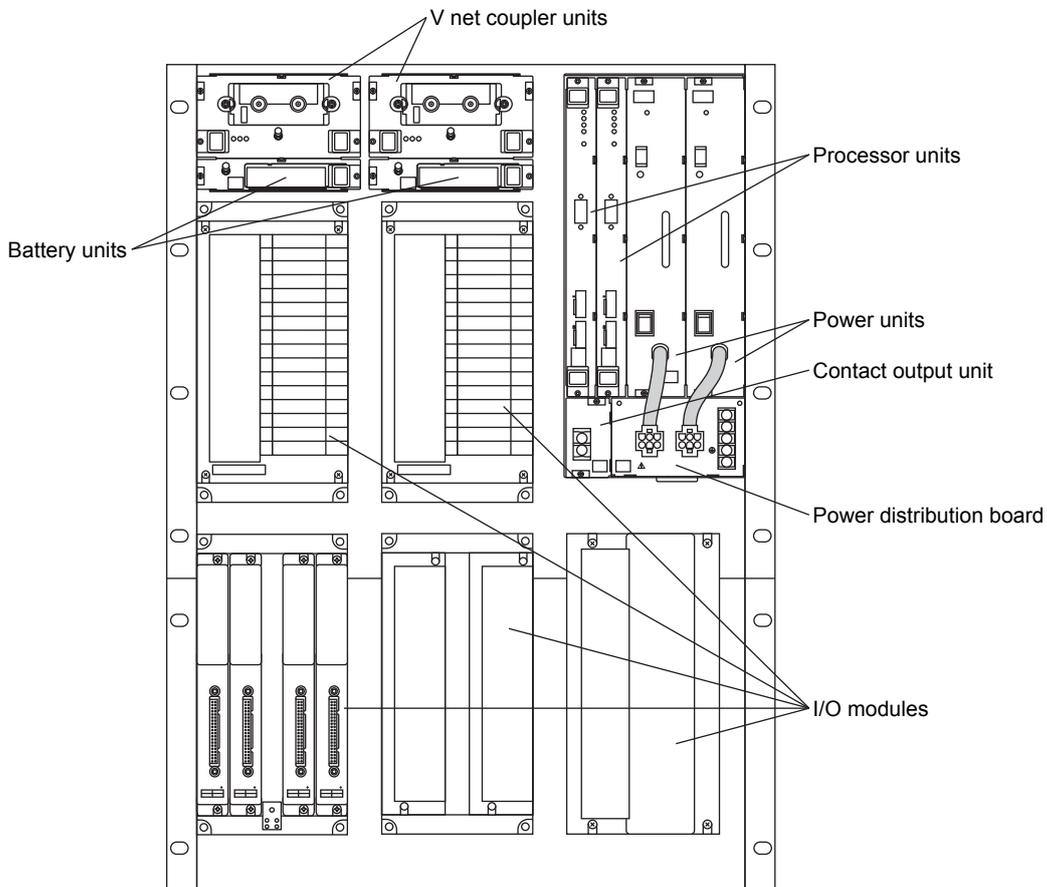
Application Capacity of Compact FCS for RIO

**SEE
ALSO**

For the Application Capacity of Compact FCS (PFC□-H) for RIO, refer to GS 33Q03K20-31E.

For the Application Capacity of Compact FCS (PFC□-S/-E) for RIO, refer to GS 33Q03K90-31E.

Configuration and Mounting of Compact FCS for RIO

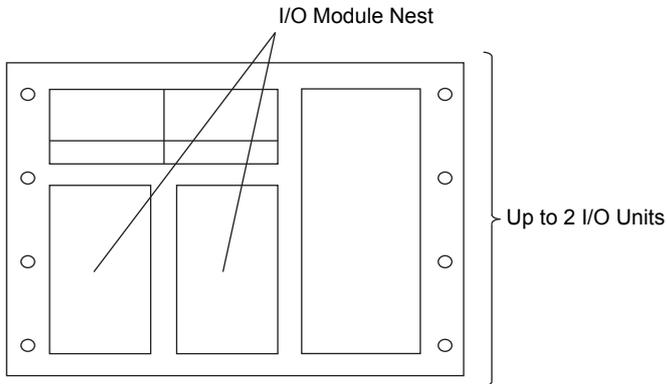


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Figure Example of Compact FCS Configuration

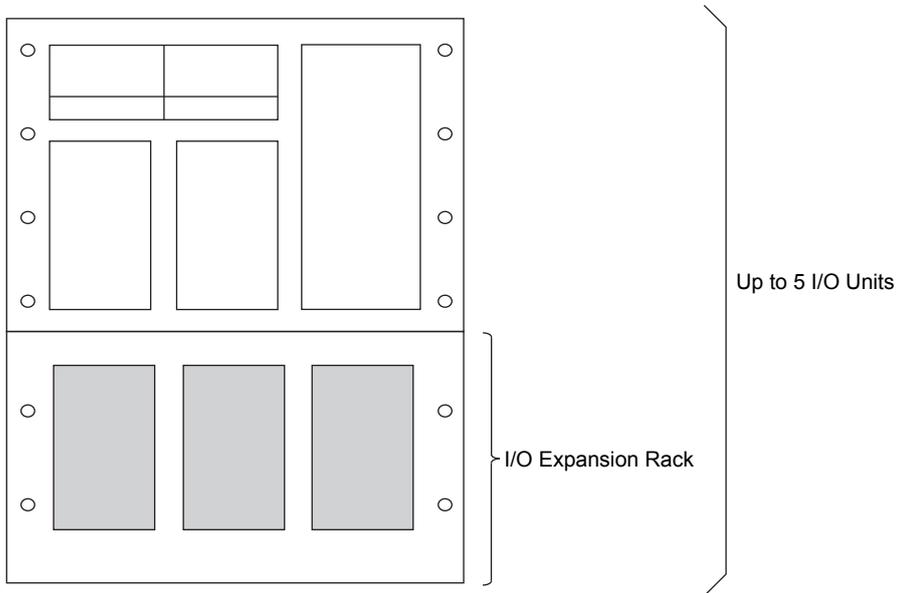
Mounting of I/O Units

The compact FCS mounts in a general-purpose 19-inch rack. One FCS is connected to up to five I/O Units.



F020414.ai

Figure Compact FCS with Two I/O Units



F020415.ai

Figure Compact FCS with Five I/O Units

2.5 I/O Module Nests and I/O Modules

This section describes input modules, which convert process signals to digital data format used in the FCS, and output modules, which convert the digital data to analog or contact signals.

For I/O modules, there are the Fieldnetwork I/O (FIO), which are compact and consist of various lineup, and the Remote I/O (RIO), which have many installation bases.

2.5.1 Fieldnetwork I/O (FIO)

The FIO modules are used in the FCS for FIO. They are compact and consist of the lineup of abundant variety, such as the connector types, the isolation types, and so forth, to correspond flexibly to the applications.

Table List of KFCS I/O Modules (1/2)

| Model | Name | I/O channels per Module | Connection Signal | | |
|---------------------------|---|-------------------------|-------------------------|------------------------------|-----------|
| | | | Pressure Clamp Terminal | Yokogawa-specific Cable (*1) | MIL Cable |
| Analog I/O Modules | | | | | |
| AAI141-S | Analog Input Module (4 to 20 mA, Non-Isolated) | 16 | x | x | x |
| AAI141-H | Analog Input Module (4 to 20 mA, Non-Isolated, HART protocol) | 16 | x | x | x |
| AAV141 | Analog Input Module (1 to 5 V, Non-Isolated) | 16 | x | x | x |
| AAV142 | Analog Input Module (-10 V to +10 V, Non-Isolated) | 16 | x | x | x |
| AAI841-S | Analog I/O Module (4 to 20 mA Input, 4 to 20 mA Output, Non-Isolated) | 8 input/8 output | x | x | x |
| AAI841-H | Analog I/O Module (4 to 20 mA, Non-Isolated, HART protocol) | 8 input/8 output | x | x | x |
| AAB841 | Analog I/O Module (1 to 5 V Input, 4 to 20 mA Output, Non-Isolated) | 8 input/8 output | x | x | x |
| AAV542 | Analog Output Module (-10 V to +10 V, Non-Isolated) | 16 | x | x | x |
| AAI143 | Analog Input Module (4 to 20 mA, Isolated) | 16 | x | x | x |
| AAI543 | Analog Output Module (4 to 20 mA, Isolated) | 16 | x | x | x |
| AAV144 | Analog Input Module (-10 V to +10 V, Isolated) | 16 | x | x | x |
| AAV544 | Analog Output Module (-10 V to +10 V, Isolated) | 16 | x | x | x |
| AAT141 | TC/mV Input Module (TC: JIS R, J, K, E, T, B, S, N /mV: -100 to 150 mV, Isolated) | 16 | x | — | x |
| AAR181 | RTD Input Module (RTD: JIS Pt100 ohm, Isolated) | 12 | x | — | x |
| AAI135-S | Analog Input Module (4 to 20 mA, Isolated Channels) | 8 | x | x | x |
| AAI135-H | Analog Input Module (4 to 20 mA, Isolated Channels, HART protocol) | 8 | x | x | x |
| AAI835-S | Analog I/O Module (4 to 20 mA, Isolated Channels) | 4 input/4 output | x | x | x |
| AAI835-H | Analog I/O Module (4 to 20 mA, Isolated Channels, HART protocol) | 4 input/4 output | x | x | x |
| AAT145 | TC/mV Input Module (TC: JIS R, J, K, E, T, B, S, N /mV: -100 to 150 mV, Isolated Channels) | 16 | — | x(*2) | — |
| AAR145 | RTD/POT Input Module (RTD: JIS Pt100 ohm /POT: 0 to 10 kohm, Isolated Channels) | 16 | — | x(*2) | — |
| AAP135 | Pulse Input Module (Pulse Count, 0 to 10 kHz, Isolated Channels) | 8 | x | x | x |
| AAP149 | Pulse Input Module for compatible PM1 (Pulse Count, 0 to 6 kHz, Non-Isolated) | 16 | — | x(*2) | — |
| AAP849 | Pulse Input/Analog Output Module for compatible PAC (Pulse Count Input, 4 to 20mA Output, Non-Isolated) | 8 input/8 output | — | x(*2) | — |

Table List of KFCS I/O Modules (2/2)

| Mode | Name | I/O channels per Module | Connection Signal | | |
|------------------------------|---|-------------------------|-------------------------|----------------------------------|-----------|
| | | | Pressure Clamp Terminal | Yokogawa-specific Cable (*1) | MIL Cable |
| Digital I/O Module | | | | | |
| ADV151 | Digital Input Module (24 V DC) | 32 | x | x | x |
| ADV551 | Digital Output Module (24 V DC) | 32 | x | x | x |
| ADV141 | Digital Input Module (100 V to 120 V AC) | 16 | x | x(*2) | – |
| ADV142 | Digital Input Module (220 V to 240 V AC) | 16 | x | x(*2) | – |
| ADV157 | Digital Input Module (24 V DC, Pressure Clamp Terminal Support Only) | 32 | x | – | – |
| ADV557 | Digital Output Module (24 V DC, Pressure Clamp Terminal Support Only) | 32 | x | – | – |
| ADV161 | Digital Input Module (24 V DC) | 64 | – | x(*2) | x |
| ADV561 | Digital Output Module (24 V DC) | 64 | – | x(*2) | x |
| ADR541 | Relay Output Module (24 to 110 V DC/100 to 240 V AC) | 16 | x | x(*2) | – |
| ADV859 | Digital I/O Module for Compatible ST2 (Isolated Channels) | 16 input /16 output | – | x(*2) | – |
| ADV159 | Digital Input Module for Compatible ST3 (Isolated Channels) | 32 | – | x(*2) | – |
| ADV559 | Digital Output Module for Compatible ST4 (Isolated Channels) | 32 | – | x(*2) | – |
| ADV869 | Digital I/O Module for Compatible ST5 (Common Minus Side Every 16-Channel) | 32 input /32 output | – | x(*2) | – |
| ADV169 | Digital Input Module for Compatible ST6 (Common Minus Side Every 16-Channel) | 64 | – | x(*2) | – |
| ADV569 | Digital Output Module for Compatible ST7 (Common Minus Side Every 16-Channel) | 64 | – | x(*2) | – |
| Communication Modules | | | | | |
| ALR111 | RS-232C Communication Module (1200 bps to 115.2 kbps) | 2 port | – | x(D-sub9 pin) (*2) | – |
| ALR121 | RS-422/RS-485 Communication Module (1200 bps to 115.2 kbps) | 2 port | – | x(M4 terminal block 5-pole) (*2) | – |
| ALE111 | Ethernet Communication Module (10 Mbps) | 1 port | – | x(RJ-45) (*2) | – |
| ALF111 | Foundation Fieldbus (FF-H1) Communication Module (31.25 kbps) | 4 port | x | x(*2) | – |
| ALP111 | PROFIBUS-DPV1 Communication Module | 1 port | – | x(*2) | – |

x: Can be connected.

–: Cannot be connected.

*1: Yokogawa-specific cable that connects I/O Module and a terminal board or the like.

*2: Can be connected directly with Yokogawa-specific cable, without a terminal block.

Table List of KFCS I/O Modules with Built-in Barrier

| Model | Name | I/O channels per Module | Connection Signal | | |
|----------------------------|---|-------------------------|-------------------------|------------------------------|-----------|
| | | | Pressure Clamp Terminal | Yokogawa-specific Cable (*1) | MIL Cable |
| Analog I/O Modules | | | | | |
| ASI133 | Analog Input Module (4 to 20 mA, Isolated) | 8 | x | – | – |
| ASI533 | Analog Output Module (4 to 20 mA, Isolated) | 8 | x | – | – |
| AST143 | TC/mV Input Module (TC: B, E, J, K, N, R, S, T /mV: -100 V to 150 mV, -50 to 75 mV, Isolated) | 16 | x | – | – |
| ASR133 | RTD/POT Input Module (RTD: Pt50, Pt100, Pt200, Pt500, Pt1000, Ni100, Ni200, Ni120 /POT: 0 to 10 K ohm, Isolated) | 8 | x | – | – |
| Digital I/O Modules | | | | | |
| ASD143 | Digital Input Module (NAMUR compatible, Isolated) | 16 | x | – | – |
| ASD533 | Digital Output Module (U>12 V at I=45 mA, Isolated) | 8 | x | – | – |

x: Can be connected.
 –: Cannot be connected.

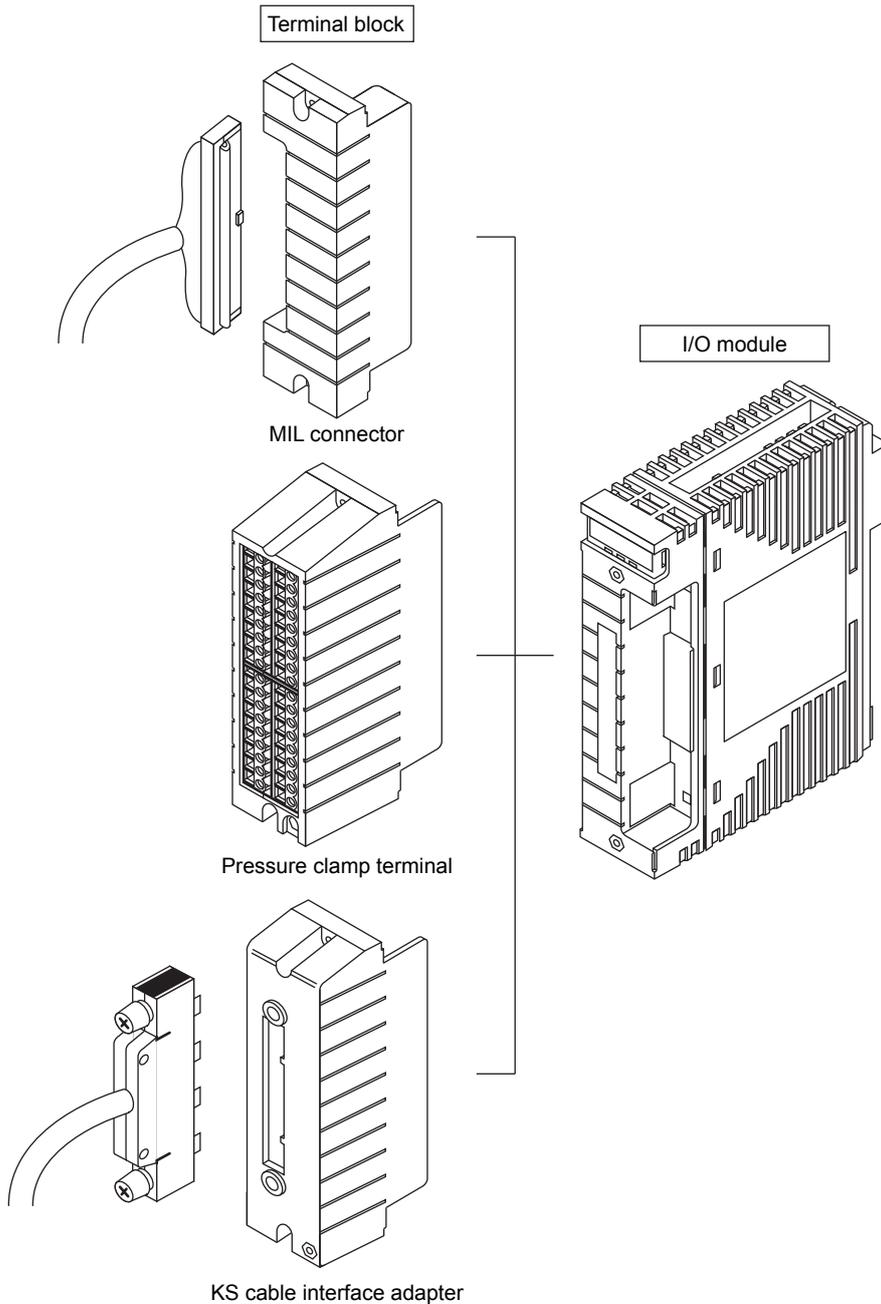
Combination of I/O Modules and Terminal Blocks

For connection between field devices and I/O modules, KS cable interface adapter and pressure clamp terminal block can be used. MIL cable, which is provided by user, is also available for the connection.

SEE ALSO

For pressure clamp terminals, terminal blocks and pin arrangement of MIL connector for I/O modules, refer to GS 33Q06Q50-31E Field Connection Specifications (for FIO).

Combination of I/O modules and terminal blocks is shown below.



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Figure Combination of I/O Modules and Terminal Blocks

Field Wiring Using Pressure Clamp Terminals

A field signal cable, with its end uncovered, can be connected directly to an analog or digital I/O module equipped with the pressure clamp terminal block. Two to three signal cables can be connected for every I/O channel.

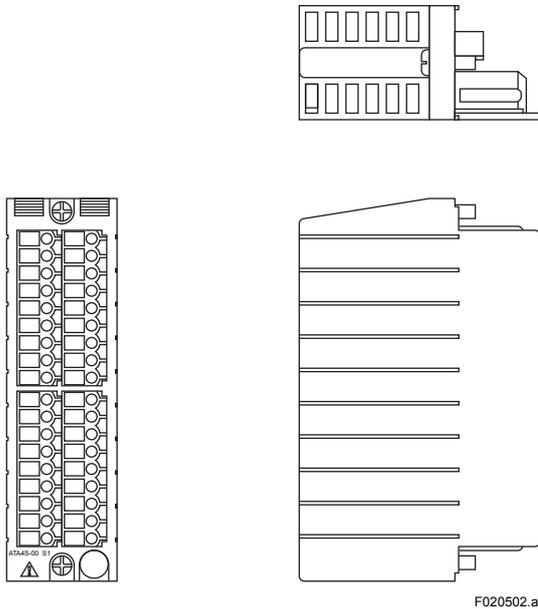


Figure Field Wiring Using Pressure Clamp Terminals

Field Wiring Using KS Cable Interface Adapter

An analog or digital I/O module equipped with the KS cable interface adapter can be connected with the terminal board using the KS cable and field signal cables are connected to the terminal board with M4 screws.

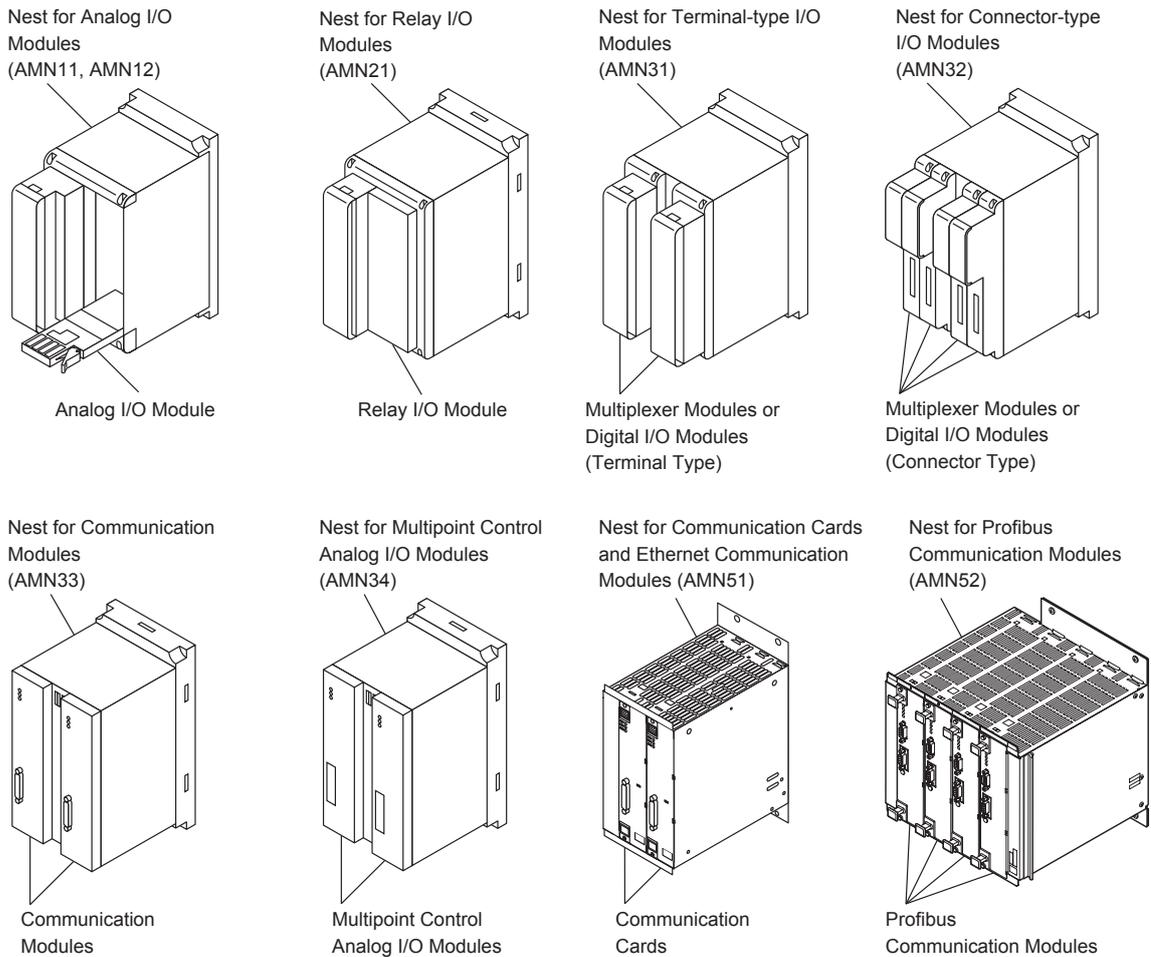
2.5.2 Remote I/O (RIO)

The RIO modules are used in the FCS for RIO and Compact FCS. They are field-proven by the many installation bases, and designed basically by the isolated channels and M4 screw connections. The RIO modules are installed in the I/O module nests.

I/O Module Nests

I/O Modules Nests are available in the following types:

- AMN11: Nest for Analog I/O Modules
- AMN12: High-Speed Nest for Analog I/O Modules (for LFCS only)
- AMN21: Nest for Relay I/O Modules
- AMN31: Nest for Terminal-type I/O Modules
- AMN32: Nest for Connector-type I/O Modules
- AMN33: Nest for Communication Modules
- AMN34: Nest for Multipoint Control Analog I/O Modules
- AMN51: Nest for Communication Cards and Ethernet Communication Modules (for Compact FCS only)
- AMN52: Nest for Profibus Communication Module (in Compact FCS only)



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Figure I/O Module Nest Configuration

I/O Modules

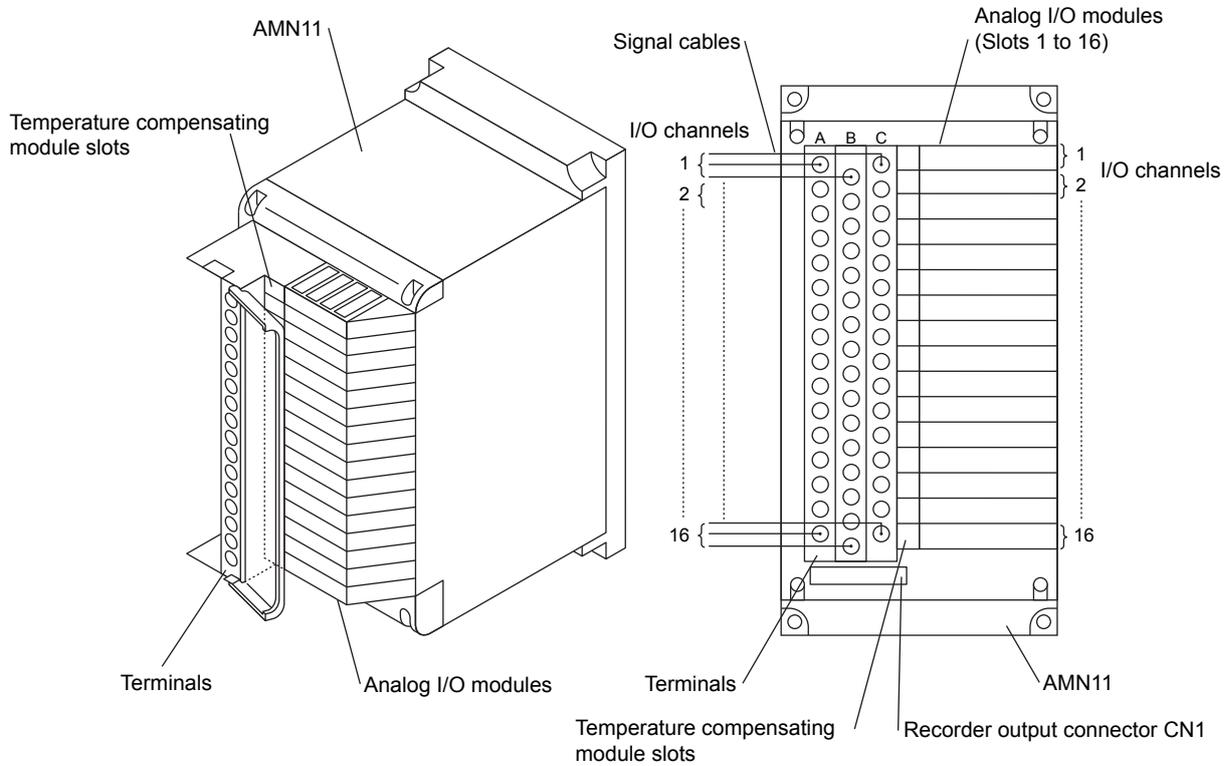
Input modules convert process signals to the digital data format used in the FCS. Output modules convert the digital data format used in the FCS to analog or contact signals. A list of I/O Modules is shown below:

Table List of I/O Modules

| Signal Type | Model | Module Type | I/O Points Per Module | Signal Connection | |
|-----------------------|---------|---|---|----------------------------|-----------|
| Analog I/O Modules | AAM10 | Current/Voltage Input Module (Simplified Type) | 1 | Terminals | |
| | AAM11 | Current/Voltage Input Module | 1 | | |
| | AAM11B | Current/Voltage Input Module (supports BRAIN) | 1 | | |
| | AAM21 | mV, Thermocouple, and RTD Input Module | 1 | | |
| | AAM21J | mV, Thermocouple and RTD Input Module (conforms to IEC584-1995, IEC751-1995) | 1 | | |
| | APM11 | Pulse Input Module | 1 | | |
| | AAM50 | Current Output Module | 1 | | |
| | AAM51 | Current/Voltage Output Module | 1 | | |
| | AMC80 | Multipoint Control Analog I/O Module | 8 input/8 output | Connector | |
| Relay I/O Modules | ADM15R | Relay Input Module | 16 | | |
| | ADM55R | Relay Output Module | 16 | | |
| Multiplexer Modules | AMM12T | Voltage Input Multiplexer Module | 16 | Terminals | |
| | AMM22T | Thermocouple Input Multiplexer Module | 16 | | |
| | AMM32T | RTD Input Multiplexer Module | 16 | | |
| | AMM42T | 2-Wire Transmitter Input Multiplexer Module | 16 | | |
| | AMM52T | Current Output Multiplexer Module | 16 | | |
| | AMM22TJ | Thermocouple Input Multiplexer Module (16 Points, Terminal Type, conforms to IEC584-1995) | 16 | | |
| | | AMM32TJ | RTD Input Multiplexer Module (16 Points, Terminal Type, conforms to IEC751-1995) | 15 | Connector |
| | | AMM22M | mV Input Multiplexer Module | 16 | |
| | | AMM12C | Voltage Input Multiplexer Module | 16 | |
| | | AMM22C | mV Input Multiplexer Module (16 Points, Connector Type) | 16 | |
| | | AMM25C | mV Input Multiplexer Module with Thermocouple Interface (15 Points, Connector Type, RJC Input port added) | 15 | |
| | | AMM32C | RTD Input Multiplexer Module (16 Points, Connector Type) | 16 | |
| | AMM32CJ | RTD Input Multiplexer Module (16 Points, Connector Type, conforms to IEC751-1995) | 16 | | |
| Digital I/O Modules | ADM11T | Contact Input Module (16 Points, Terminal Type) | 16 | Terminals | |
| | ADM12T | Contact Input Module (32 Points, Terminal Type) | 32 | | |
| | ADM51T | Contact Output Module (16 Points, Terminal Type) | 16 | | |
| | ADM52T | Contact Output Module (32 Points, Terminal Type) | 32 | | |
| | | ADM11C | Contact Input Module (16 Points, Connector Type) | 16 | Connector |
| | | ADM12C | Contact Input Module (32 Points, Connector Type) | 32 | |
| | | ADM51C | Contact Output Module (16 Points, Connector Type) | 16 | |
| | | ADM52C | Contact Output Module (32 Points, Connector Type) | 32 | |
| Communication Modules | ACM11 | RS-232C Communication Module | 1ch | Terminals | |
| | ACM12 | RS-422/RS-485 Communication Module | 1ch | | |
| | ACF11 | Fieldbus Communication Module | 1ch | | |
| Communication Cards | ACM21 | RS-232C General-purpose Communication Card | 1ch | Connector | |
| | ACM22 | RS-422/RS-485 General-purpose Communication Card | 1ch | Terminals | |
| | ACM71 | Ethernet Communication Module (for PFC□) | 1ch | RJ-45 (10BASE-T) Connector | |
| | ACP71 | Profibus Communication Module | 1ch | D-Sub 9 pin Connector | |

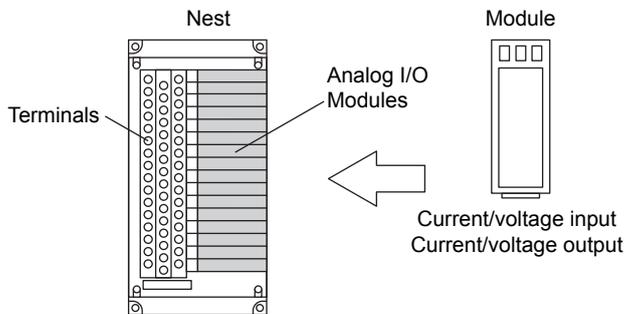
Analog I/O Module

An analog I/O module is installed in Model AMN11, Nest for Analog I/O modules. Up to 16 I/O modules are installed in one nest. Signal cables are connected by M4 screws to the terminals of analog I/O module nest. For each I/O channel, two signal cables or three (for RTD) are connected.



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Figure Analog I/O Module

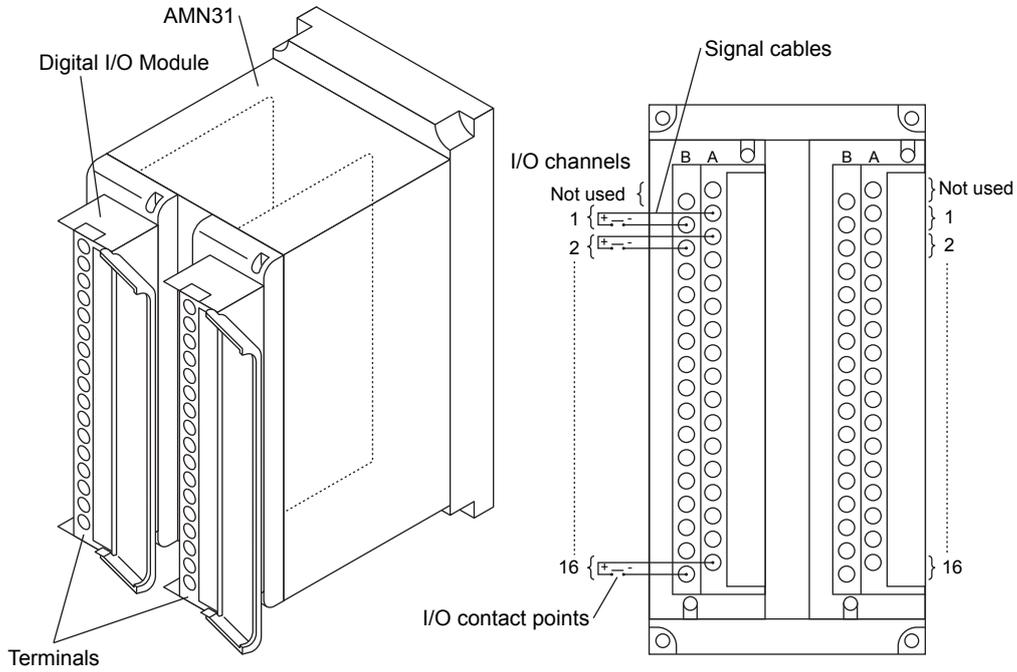


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Figure Analog I/O Module and Nest

Terminal Type Digital I/O Module

Up to two terminal type digital I/O modules can be installed in one Model AMN31 Nest for Terminal-type I/O Modules. Signal cables are connected by M4 screws to the terminals of modules. For each I/O channel, one or two signal cables are connected.



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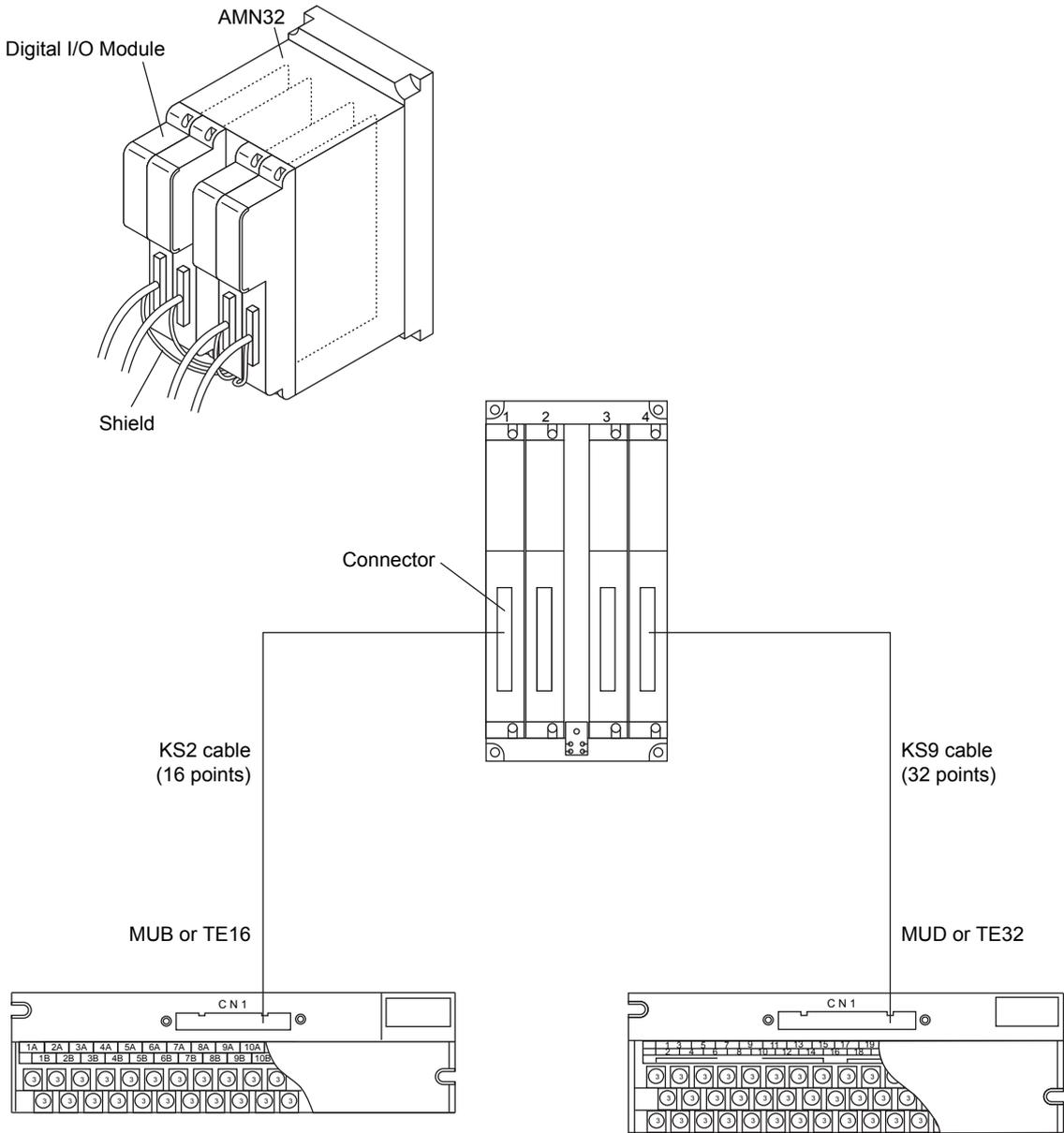
Figure Digital I/O Module (16-terminal type)

Connector Type Digital I/O Module

The Connector Type Digital I/O Module is installed in the Nest for Connector-type I/O Modules (AMN32). Up to four modules are installable in one nest. To connect to the MUB/MUD Terminal Board or TE16/TE32 Terminal Block, a KS2 cable is used for ADM11C and ADM51C 16-point modules and a KS9 cable for ADM12C and ADM52C 32-point modules.

Signal cables from field devices are connected by M4 screws to the terminal board or terminal block.

One or two signal cables are connected to each I/O channel.



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Figure Connector Type Digital I/O Module

Multipoint Control Analog I/O Module

AMC80 Multipoint Control Analog I/O Module is installed in the Nest for Multipoint Control Analog I/O Modules (AMN34). Up to two modules are installable in one nest. One module can process 8 inputs and outputs for control. Two modules installed in one nest may separately process different inputs and outputs or be dual-redundant. A KS1 cable connects the module to the MHM Signal Conditioner Nest. Compared with analog I/O modules, cost per point is less these for multipoint modules.

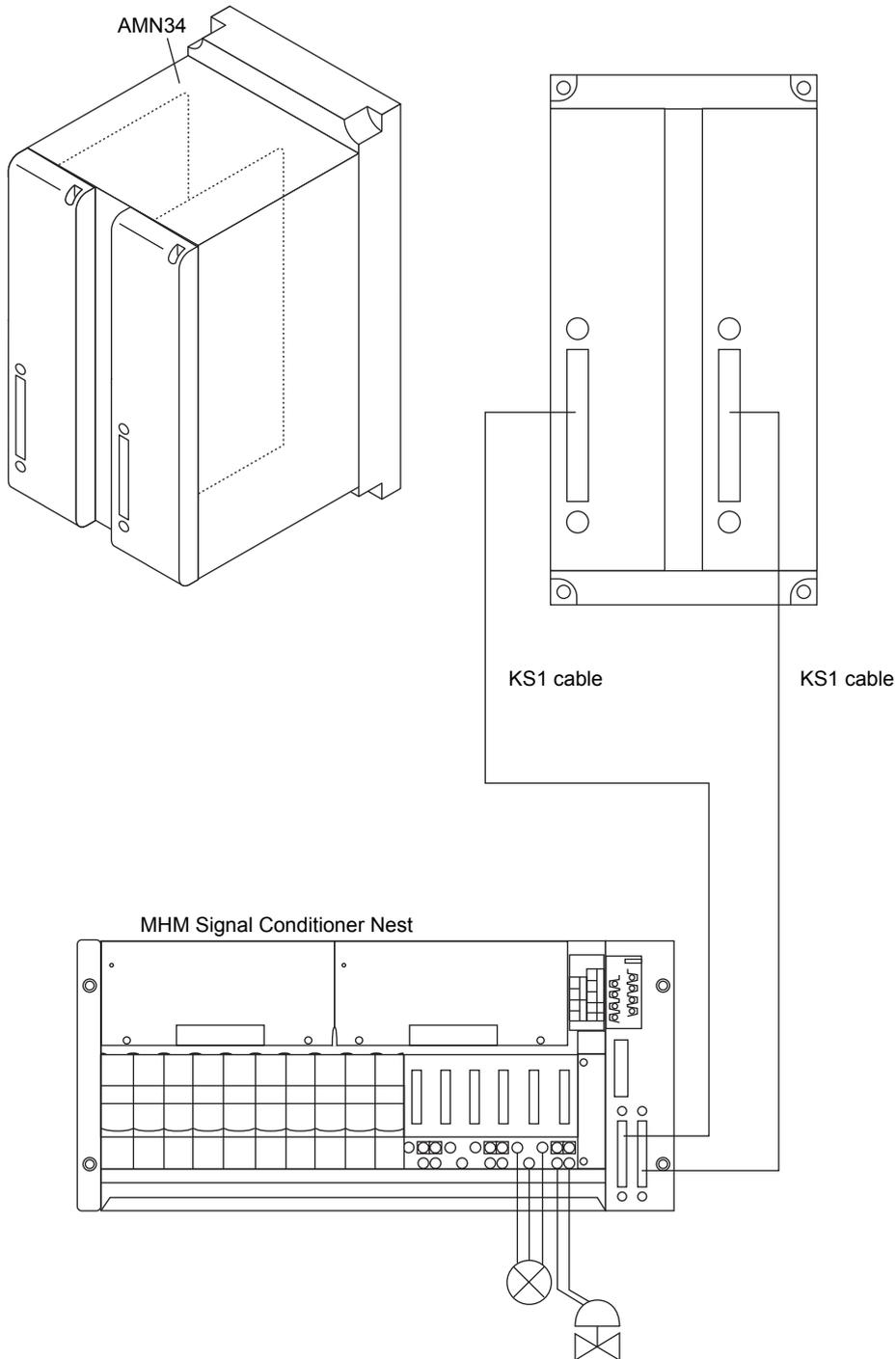


Figure Multipoint Analog Control I/O Module

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Terminal Type Multiplexer Module

The terminal type multiplexer module is installed in the Nest for Terminal-type I/O Modules (AMN31). Up to two modules can be installed in one nest. Signal cables are connected by M4 screws to the terminals of the module. Two or three signal cables are connected for each I/O channel.

Connector Type Multiplexer Module

The connector type multiplexer module is installed in the Nest for Connector-type I/O Modules (AMN32). Up to four modules can be installed in one nest. Using a KS2 cable (or a KU2 cable), connect it to Signal Conditioner Nest, MUB/MUD Terminal Board or TE16/TE32 Terminal Block.

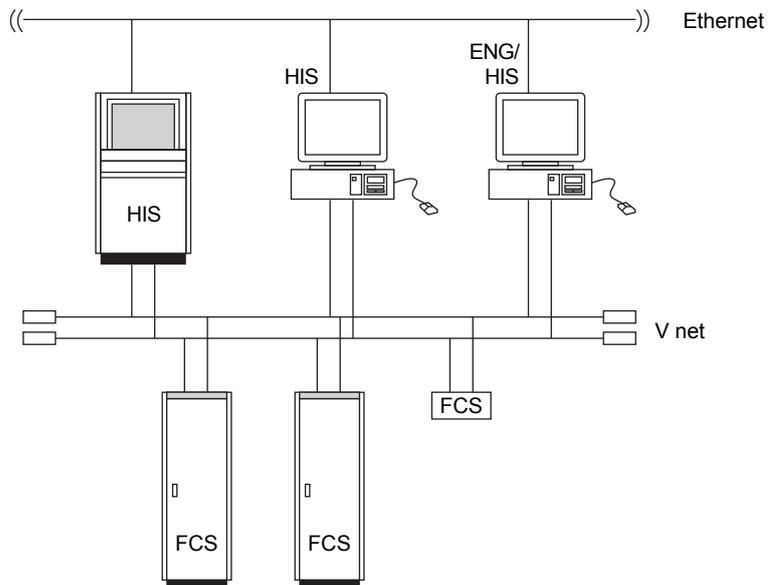
Connect signal wiring from the field to the terminals of the terminal board or the terminal block with M4 screws.

Relay I/O Module

The relay I/O module is installed in the Nest for Relay I/O Modules (AMN21). Only one module is installable in one nest. Signal cables are connected to the terminals of the module with M4 screws. Two or three signal cables are connected for each I/O channel.

2.6 Networks

CENTUM CS 3000 can be connected to V net and Ethernet networks.



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Figure Two Types of Networks

2.6.1 V net

V net is a 10 Mbps real-time control bus which links stations such as FCS, HIS, BCV and CGW. It can be dual redundant. There are two types of cable:

- YCB111 cable: Connects station other than HIS and FFCS (e.g. FCS other than FFCS, CGW). Length up to 500 m.
- YCB141 cable: Connects HIS and FFCS. Length up to 185 m.

YCB111 cable and YCB141 cable can be connected by cable converter unit or bus repeater.

When these cable types are combined, maximum length is computed as follows:

YCB141 cable length + YCB111 cable length \times 0.4 \leq 185 m

For example, if YCB141 = 5 m and YCB111 = 450 m, then the above equation becomes:

Effective length

= 5 m (YCB141 cable length) + 450 m (YCB111 cable length) \times 0.4

= 5 m + 180 m

= 185 m

So the condition that the total length of YCB141 should not exceed 185 m is satisfied.

Extending the V net

When the V net is extended, Field Control Stations distributed around a large plant can be monitored from HIS in a central control room. Bus repeaters and optical repeater pairs can be mixed, up to four sets in total, to extend the V net up to 20 km.

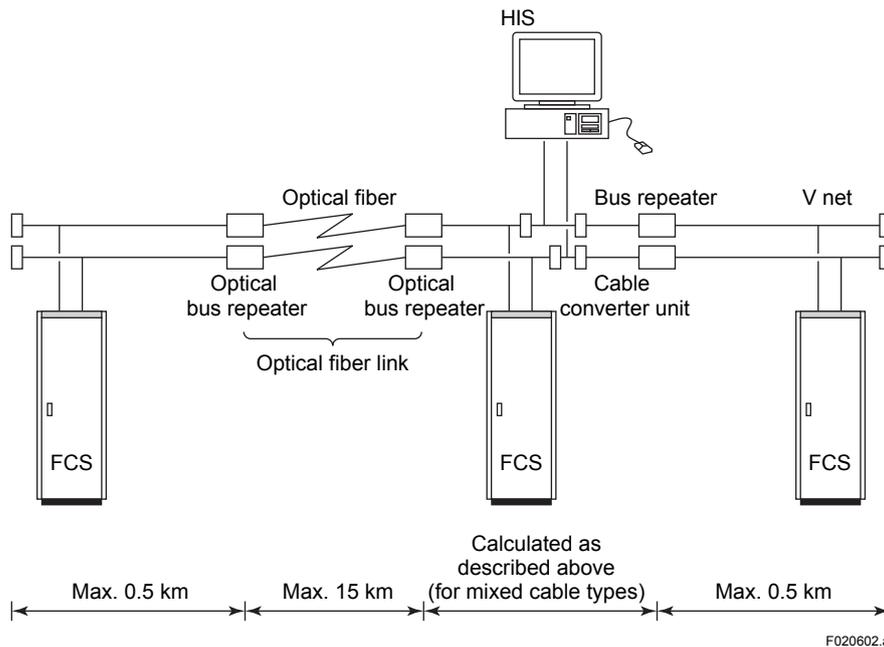


Figure Extending the V net

2.6.2 Ethernet

HIS and ENG, HIS and supervisory systems can be connected by an Ethernet LAN; supervisory computers CENTUM and personal computers on the Ethernet LAN can access messages and trend data in the CENTUM CS 3000 system. The Ethernet can also be used for sending trend data files from the HIS to supervisory computers, for equalizing HIS databases and for acquiring trend data for other stations, eliminating the load on the V net. A system with only a single HIS, with engineering functions installed, does not need Ethernet – but in general Ethernet (and corresponding network engineering) is required.

2.7 Fieldbus

Fieldbus is a bidirectional digital communication protocol for field devices. Fieldbus is a big innovation in process control systems technology and is expected to replace the standard 4 to 20 mA analog communication protocol that most current field devices employ.

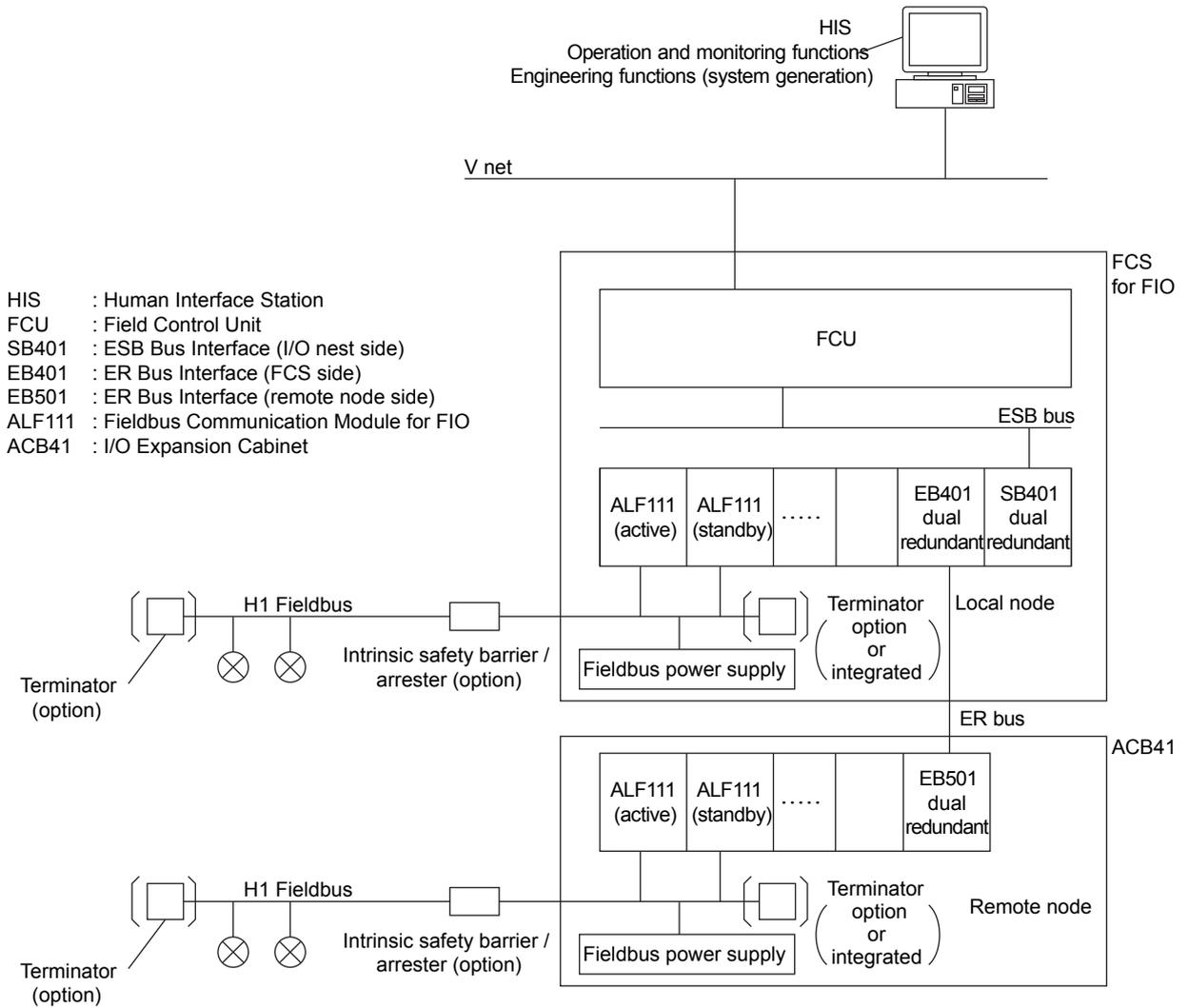
Fieldbus has the following features.

- A digital transmission protocol is used, ensuring high-accuracy information processing.
- High-accuracy information processing allows strict quality control.
- Multiplex transmission is supported, so that function block parameters of field devices can be also transmitted.
- Communication between field devices allows autonomous distributed control by the field devices.
- Interoperability enables devices from different manufacturers to be combined.
- A broad choice of devices from many manufacturers allows you to configure the optimum system for your needs.
- Various systems such as instrumentation, electrical, Factory Automation (FA), Business Automation (BA), Office Automation (OA) systems, and analyzers can be integrated.
- Some adjustments and inspections of field devices can be performed from a remote location, like the instrument room.

**SEE
ALSO**

For more details on the fieldbus, refer to the Fieldbus Technical Information (TI 38K03A01-01E).

Fieldbus Connection (FCS for FIO)



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Figure Example of System Configuration with Fieldbus (FCS for FIO)

Note: The ESB bus interface module model for a compact FCS for FIO is EC401. Only the module model is different, and a Fieldbus connection is made in the same way.

Fieldbus Connection (FCS for RIO, Compact FCS for RIO)

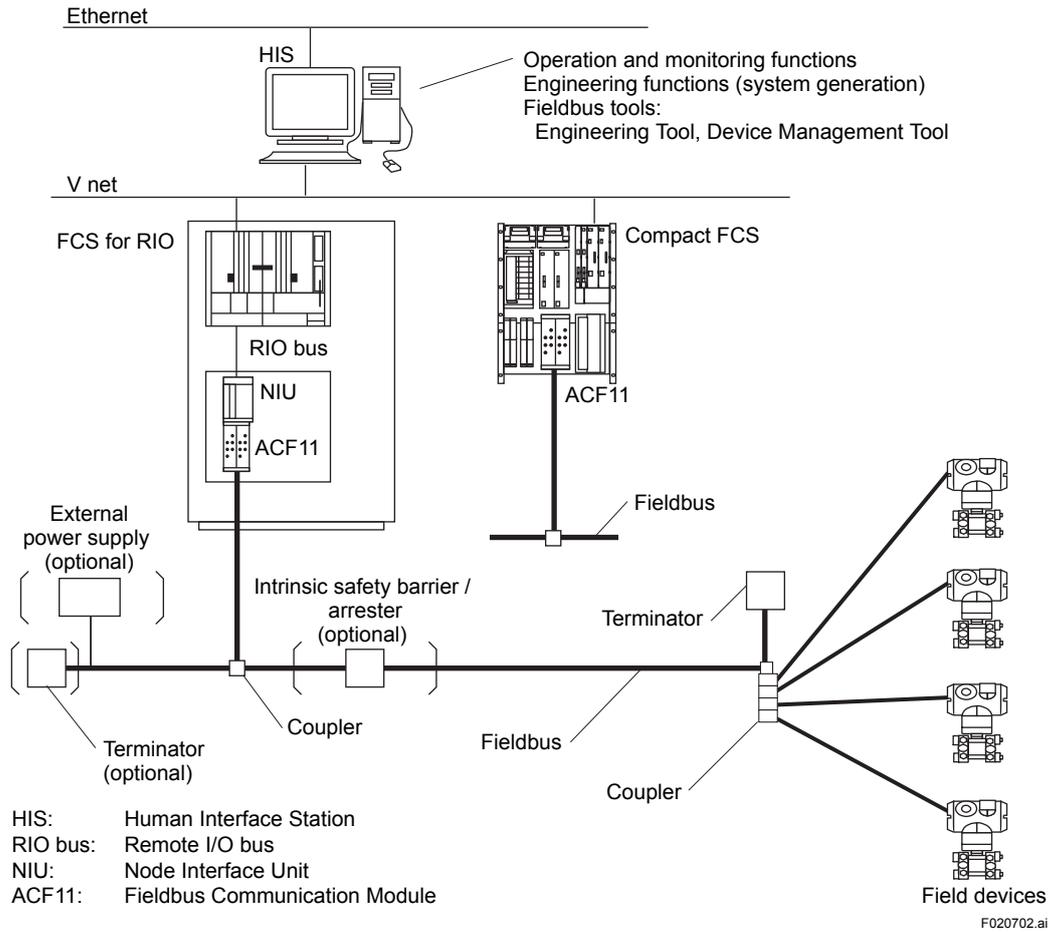


Figure Example of System Configuration with Fieldbus (FCS for RIO, Compact FCS for RIO)

2.8 Redundancy and Reliability

The FCS connects directly to the process, so it needs to have particularly high reliability (high availability), and data accuracy and reliability need to be assured. This section describes the redundancy and reliability of the FCS for FIO, compact FCS for FIO, FCS for RIO and compact FCS for RIO.

2.8.1 Redundancy and Reliability of the FCS for FIO, FCS for RIO

For the FCS for FIO and FCS for RIO, the dual redundant models are available. In these dual redundant FCS, the processor cards are duplexed (dual redundant) and V net couplers, power supply cards, bus interface cards, bus couplers and node internal buses are dual redundant. The duplexed (dual-redundant) processor cards (one active, the other standby) can switch from active to standby card without any interruption to control when active card breaking down.

A model with dual (redundant) power supplies is also available.

The FCS for FIO is equipped with ESB bus interface cards and couplers for its nodes, and the FCS for RIO with RIO bus interface cards and couplers.

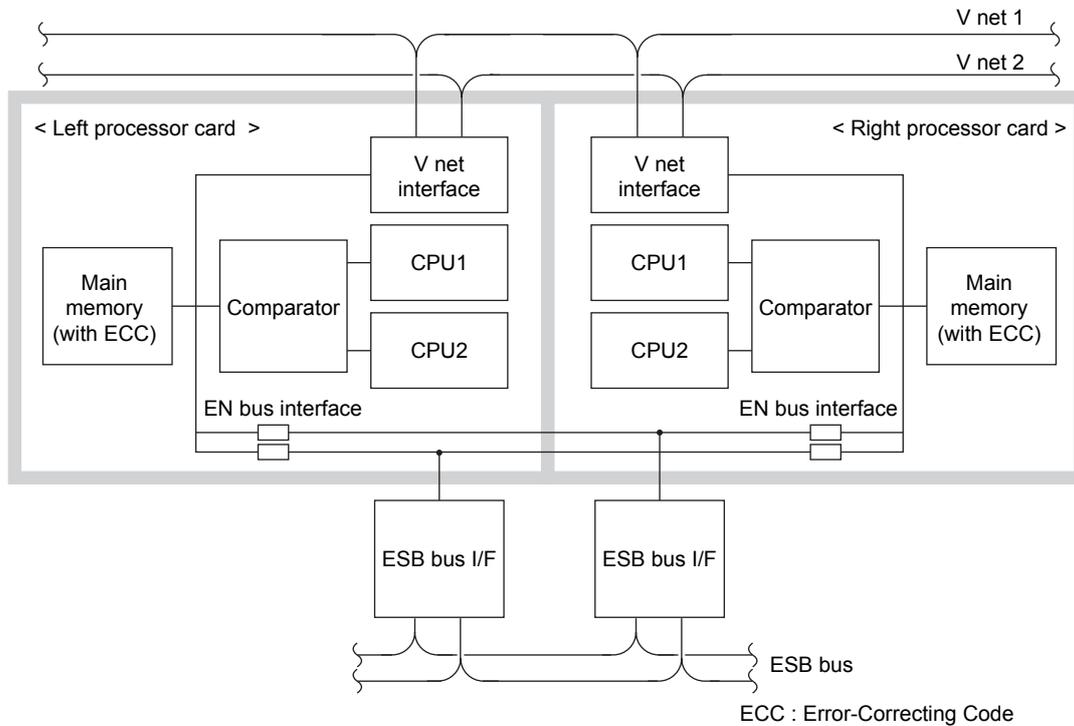


Figure Duplexed (Dual-redundant) Processor Card in Standard FCS (FCS for FIO, FCS for RIO)

Note: In the case of the FCS for RIO, RIO bus interface and RIO bus are used in place of ESB bus interface and ESB bus shown above.

Dual-redundancy methodology is described below.

CPU

- There are two processors on each processor card. Each CPU performs the same control computations, and the results are compared each calculation. If the results agree, then the card is assumed to be normal and the results are transmitted to memory and bus interface card. The main memory uses ECC (error-correcting code) which can correct transient reversed-bit errors.
- If the results from CPU1 and CPU2 do not agree, then the comparator takes this as “CPU abnormal”, and switches to the standby processor card.
- A Watch Dog Timer is used to detect if the active processor card is abnormal, which results in a switch from active to standby processor card.
- The standby processor card is performing the same computations as the active card, and when it is switched to active status then the results it has just computed are transferred to the bus interface there is no interruption in control.
- If a “CPU abnormal” error is detected in a CPU card, a self-diagnostic check is performed on the card; if the hardware is not abnormal, then the error is treated as a transient error and the card reverts from “abnormal” to “standby” status.
- The V net and V net interface are dual redundant.

ESB Bus

Two ESB bus interface cards (SB301) can be installed in the FCU to form dual redundant system. The two cards are controlled by software residing in the active CPU to determine their active and standby status. Normally the card on the active CPU side is given the active status and the other card the standby status. The SB301 in the active status, which is the ESB bus master, communicates with node units. The dual redundant ESB buses are used alternately; if an abnormality is detected in one bus then the other is used. The abnormal bus is tested periodically to see if it has returned to normal.

FIO Nodes

In nodes, the Node Interface Module and Node Power Module can be dual redundant. The I/O module bus from the Node Interface Module to each I/O Module can also be dual redundant.

RIO Buses

Dual-redundant (RB301) RIO bus interface cards can be installed in the FCU; the active (on-line) CPU card controls which is active (normally the one on the same side as the active CPU). The standby side “sleeps”, and performs only diagnostic communications.

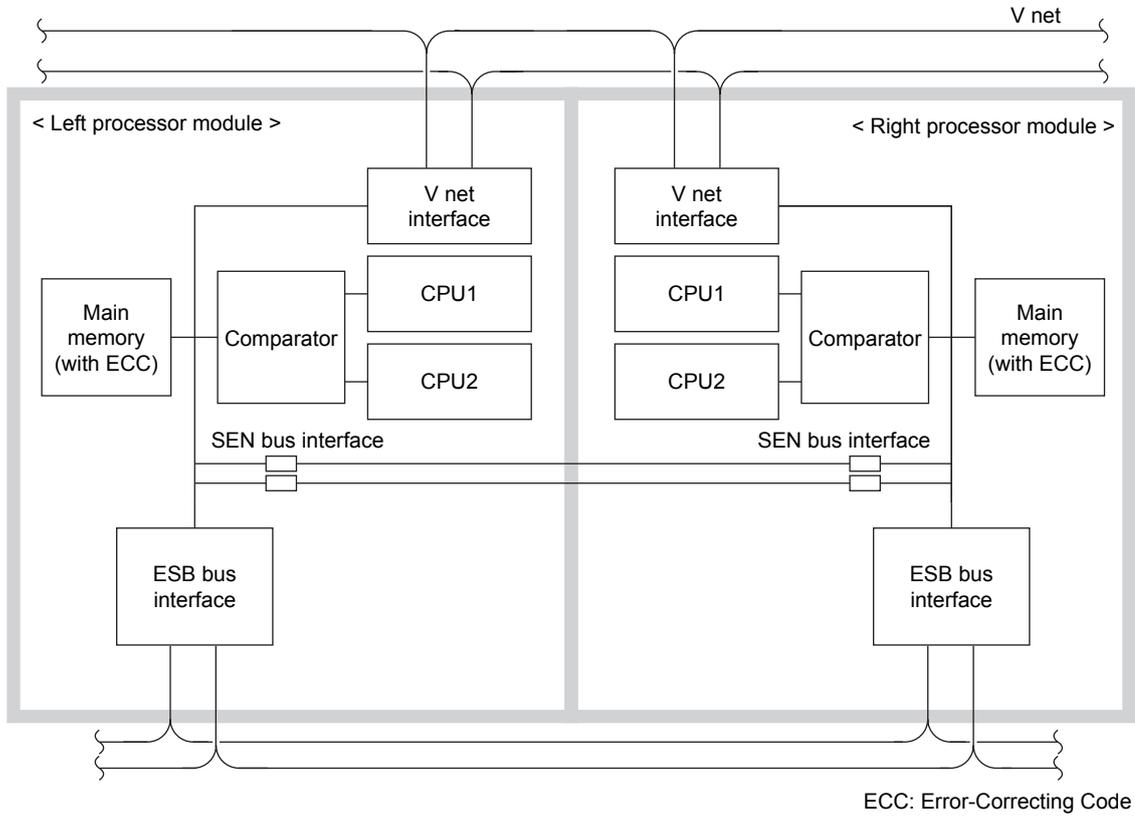
Dual-redundant RIO buses are used alternately; if an abnormality is detected in one bus then the other is used. The abnormal bus is tested periodically to see if it has returned to normal.

RIO Nodes

In nodes, the Node Interface Card and the Node Power Supply can be dual redundant. The I/O module bus from the Node Interface Unit to each I/O unit can also be dual redundant.

2.8.2 Redundancy and Reliability of the Compact FCS for FIO

For a compact FCS for FIO, a duplexed (dual-redundant) FCS is provided. For this FCS, the processor module, V net coupler, and power module are all dual-redundant. If an FIO node unit is added, install an ESB-bus coupler module or an ER bus interface module. Dual-redundant use in either module is also possible. (For a duplexed FCS, the ESB bus interface modules need to be dual-redundant.) Even if one side of the module becomes defective, the control right can be switched without any interruption in control.



ECC: Error-Correcting Code
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Figure Example of Duplexed (Dual-redundant) Processor Module Configuration (in Compact FCS for FIO)

Dual-redundancy methodology is described below.

CPU

- There are two processors on each processor module. Each CPU performs the same control computations, and the results are compared each calculation. If the results agree, then the module is assumed to be normal and the results are transmitted to memory and bus interface module. The main memory uses ECC (error-correcting code) which can correct transient reversed-bit errors.
- If the results from CPU1 and CPU2 do not agree, then the comparator takes this as “CPU abnormal”, and switches to the standby processor module.
- A Watch Dog Timer is used to detect if the active processor module is abnormal, which results in a switch from active to standby processor module.
- The standby processor module is performing the same computations as the active module, and when it is switched to active status then the results it has just computed are transferred to the bus interface there is no interruption in control.
- If a “CPU abnormal” error is detected in a CPU module, a self-diagnostic check is performed on the module; if the hardware is not abnormal, then the error is treated as a transient error and the module reverts from “abnormal” to “standby” status.
- The V net and V net interface are dual redundant.

ESB Bus

Each processor module incorporates ESB-bus interface functions and can be dual-redundant. Normally, the ESB-bus interface functions on the active CPU side are given the active status and on the other side, the standby status. If an abnormality is found in the ESB functions on the active CPU side, the standby CPU side is switched into use. An active ESB-bus interface function, which is an ESB bus master, communicates with node units. The dual-redundant ESB buses are used alternately; if an abnormality is found in one bus, the other bus will then be used for communication. The abnormal bus is tested periodically to see if it reverts to normal.

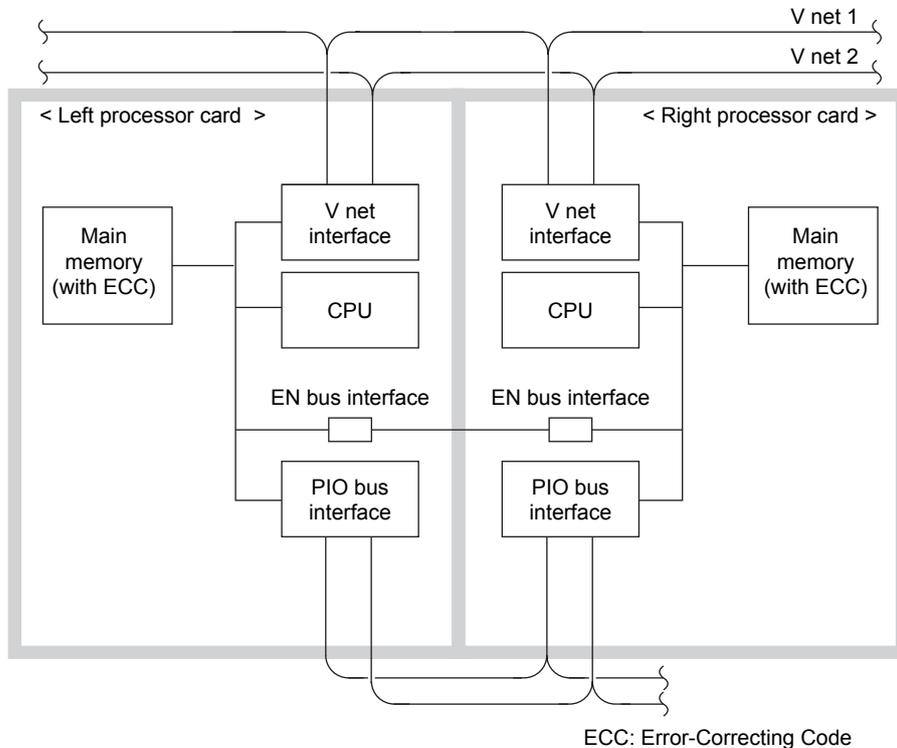
FIO Nodes

For FIO nodes, refer to Section 2.8.1.

2.8.3 Redundancy and Reliability of the Compact FCS for RIO

For the Compact FCS, the processor card, V net coupler, power supply card, and process I/O interface are all dual redundant.

The duplexed (dual-redundant) processor cards (one active, the other standby) can switch from active to standby card without any interruption to control.



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Figure Compact FCS Duplexed (Dual-redundant) Processor Card Configuration

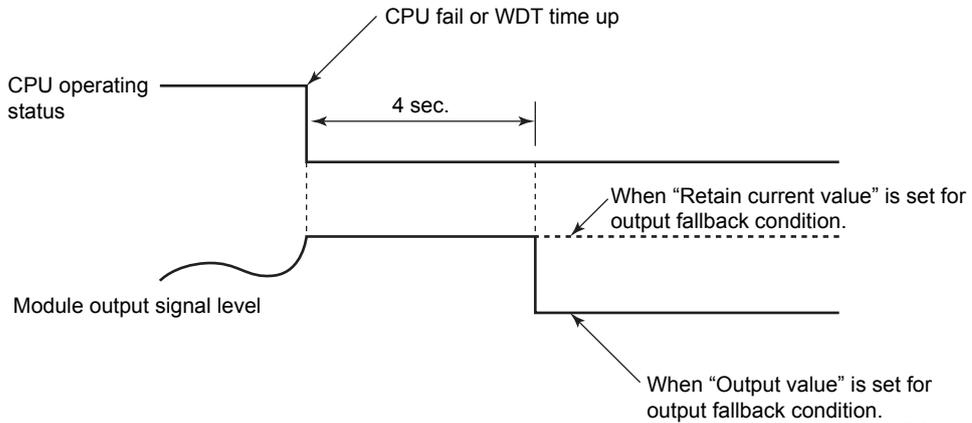
- The duplexed (dual-redundant) processor cards (active and standby) perform control computations in sync, and switchover from active to standby causes no interruption in control. ECC main memory is used, for automatic correction of transient bit errors.
- If an invalid (active or standby) CPU memory access is detected, the invalid data is not used, and the corresponding CPU is stopped. If the error occurs in the active CPU, switchover from active to standby causes no interruption in control.
- A Watch Dog Timer is used to detect if the active processor card is abnormal, which results in a switch from active to standby processor card.
- Each CPU performs I/O via a PIO (Process I/O) interface card. Both the active and standby sides check that the PIO bus interface is normal. If an abnormality is detected in the active side, the standby side is switched into use.
- There are dual-redundant V net interfaces, and dual-redundant V net buses.

2.9 CPU Failure

If the CPU fails and access to the I/O module stops, or if the WatchDog Timer (WDT) times out, then after four seconds the output of the I/O module falls back: the current value is held, or the value changes to a preset value (as set in the builder).

It resumes to output the real output value upon recovery from CPU operation termination.

This fallback action is illustrated below:



F020901.ai

Figure I/O Module Fallback

2.10 Compliance with Various Standards

Safety Standard Compliance

CENTUM CS 3000 complies with the following international safety standards:

- For 100 to 120 V: CSA standard C22.2 No. 1010.1
- For 220 to 240 V: EN standard EN 61010-1

CE Mark Compliance (Electrical and electronic equipment without CE mark approval can't be sold in Europe)

CE mark compliance requires that EMC and LVD directives be satisfied.

- EMC (Electromagnetic Compatibility) directive
All electrical and electronic equipment must satisfy this directive. Restrictions on electromagnetic interference (electromagnetic fields which affect the functions of the electrical or electronic equipment) are specified in EN 55011 Group 1 Class A, EN 61000-3-2 and EN 61000-3-3, and immunity (ability to function under electromagnetic fields without deteriorating quality) is specified in EN 61000-6-2.
- LVD (Low Voltage Directive (General Safety))
This applies to equipment that operates from an AC voltage source in the range 50 to 1000 V or a DC voltage source in the range 75 to 1500 V, and is intended to insure operator safety. Restrictions are specified in EN 61010-1.

C-Tick Mark Compliance (Electrical and electronic equipment without C-Tick mark can't be sold in Australia and New Zealand)

The C-Tick mark indicates EMC compliance in Australia and New Zealand; it corresponds the CE mark used in Europe.

The C-Tick mark EMC specifications are equivalent to the CE mark specifications.

Functional Safety Standards

ProSafe-RS conforms to IEC 61508 (EN 61508, JIS C 0508). (*1)

Programmable Controller Standards

ProSafe-RS conforms to IEC 61131-2 and EN 61131-2.

Application Standards

ProSafe-RS conforms to EN 298, EN 50156-1, NFPA 85, EN 54-2, NSPA 72 and IEC 61511 (EN 61511). (*2)

*1: Chapter 7 of this manual (Safety Instrumented System (ProSafe-RS)) uses IEC 61508 to represent all applicable functional safety standards, i.e., IEC 61508, EN 61508 and JIS C 0508.

*2: IEC 61511 is equivalent to the US functional safety standard ISA S84.00.01.

Programming Language Standard

ProSafe-RS conforms to FBD, LD, ST (*1) and SFC (*1) of IEC61131-3.

Overview

- FBD: Function Block Diagram
- LD: Ladder Diagram
- ST: Structured Text
- SFC: Sequential Function Chart

*1: Supported by ProSafe-RS R1.03.00 or later.

SIL3 Certification Acquired from TÜV

ProSafe-RS has acquired certifications from the independent German certification body TÜV (Technische Überwachungs Verein) as a safety instrumented system which can be applied up to SIL3 (SIL: Safety Integrity Level) as defined by IEC 61508.

Standards for Hazardous Location Equipment

For ProSafe-RS Standards for Hazardous Location Equipment FM Non-Incendive and devices complying with Type “n”, refer to General Specification for ProSafe-RS.

Marine Standards (*2)

ABS (American Bureau of Shipping)

BV (Bureau Veritas)

Lloyd's Register

*2: Supported by ProSafe-RS R1.01 or later.
For details, refer to General Specification for ProSafe-RS.

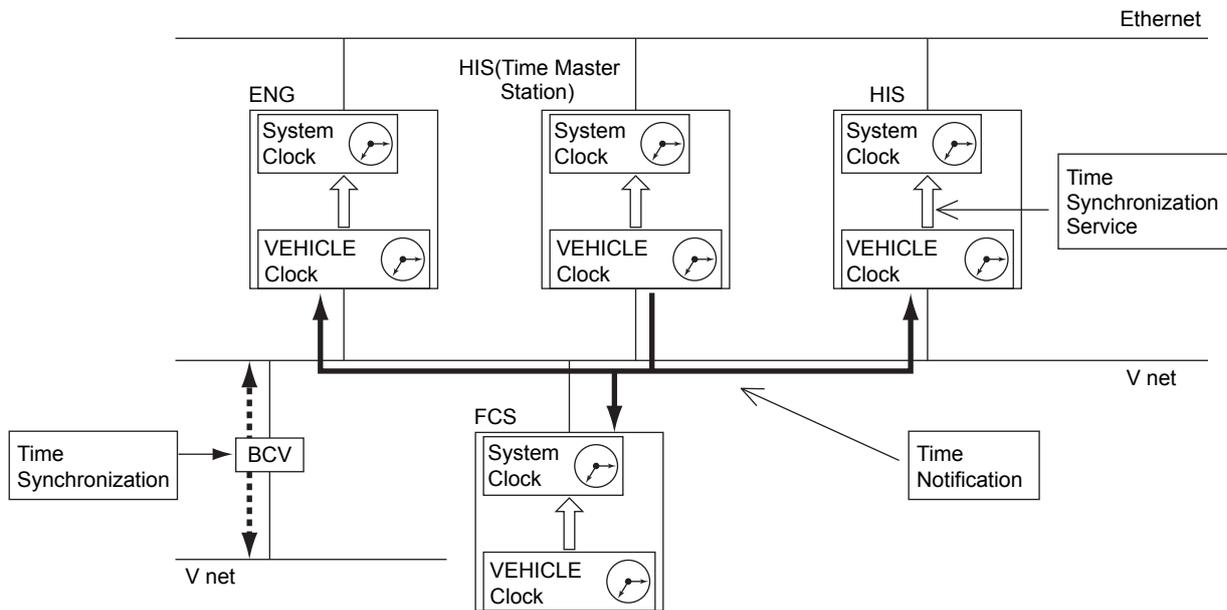
2.11 Time Management

CENTUM CS 3000 has a capability to synchronize the time of stations within a domain.

2.11.1 Time Synchronization Scheme

Besides the system clocks, the stations on V net also have VEHICLE clock which is a V net firmware clock. All the VEHICLE clocks in the same domain are managed together so as to keep the same clock time.

In one domain, there is a time master station. Since the time master station is automatically assigned, user does not need to know the whereabouts of the time master station. The reference time is broadcasted from the time master station periodically on the network (per 10 seconds). All the VEHICLE clocks in other stations will correct the time based on the reference time sent from the time master.



F021101.ai

Figure Time Synchronization Scheme

2.11.2 System Clock and VEHICLE Clock

For the stations in a domain, the time of the VEHICLE clock takes higher priority. All stations check the discrepancies of the system clocks and VEHICLE clocks, and adjust the clock in accordance with the time of VEHICLE clocks.

The accuracy of the VEHICLE clock is ± 240 seconds per month.

2.11.3 Time Adjustment

When a station receives the time synchronization signal, the station adjusts its VEHICLE clock, depending on the degree of discrepancy.

Smoothly Synchronize

When a station receives the time synchronization signal and the time discrepancy is less than one second, the clock will not be adjusted at once but smoothly tuned only in 0.005 ms (0.05%) at 10 ms interval.

Drastically Synchronize

When a station receives the time synchronization signal and the time discrepancy is greater than one second, the clock will be adjusted drastically to the reference time.

2.11.4 Time Discrepancy

It takes the times shown below for the time master station to generate the time notification signal, and for the slave stations to receive that signal, in order to adjust the time to that of the time maser station; thereby causing a time discrepancy between one station (HIS, ENG or FCS) and the other.

- A maximum of a 5-millisecond discrepancy in the time of the VEHICLE clock is generated between stations.
- It takes maximum 50 milliseconds for synchronization of dual-redundant FCSs.
- The time synchronization service adjusts the time discrepancy of the HIS's system clock and its VEHICLE clock so that the time discrepancy is no greater than 500 milliseconds.

In a steady-state manner, the time discrepancy between stations is as shown below:

Between HISs: 1010 milliseconds maximum

Between HIS and FCS: 560 milliseconds maximum

Between FCSs: 110 milliseconds maximum

2.11.5 Cautions

In a control system, the first HIS that completed startup will automatically become the time master station. If a VEHICLE clock in a HIS is manually adjusted, this HIS will become the time master station.

In any case, if the time master station fails, another HIS will automatically take over. User does not need to know which one had become the time master station.

The time of VEHICLE clock in a HIS is the reference time of the HIS. Using the Control panel to change the system time will be meaningless. It is necessary to adjust the VEHICLE time on the Time Setting dialog box.

See Section 3.5.5 for details of the Time Setting dialog box.

2.11.6 Time Synchronization of the Stations Not Connected on V net

Time synchronization of the stations not connected on V net cannot be performed automatically. Thus manually adjust the system clock.

2.11.7 Time Synchronization in Different Domains

In a CENTUM CS 3000 control system that contains multiple domains, the bus converter (BCV) placed to link the domains has time synchronization capability to synchronize the clocks of the multiple domains. The time synchronization performed by BCV consists of the two actions, time notification and time synchronization.

Time Notification

BCV passes the time adjustment information from one domain to the other. When a clock of a HIS in a domain is adjusted on time setting dialog box, BCV will notify the new time to all the other domains.

Time Synchronization Between Domains

BCV periodically scans the time differences between the linked domains per two minutes. The time of one domain is used as reference time, when the time difference of the other domain is greater than 5 seconds and continued for consecutive two scans, BCV synchronizes the clocks of the domains according to the reference time.

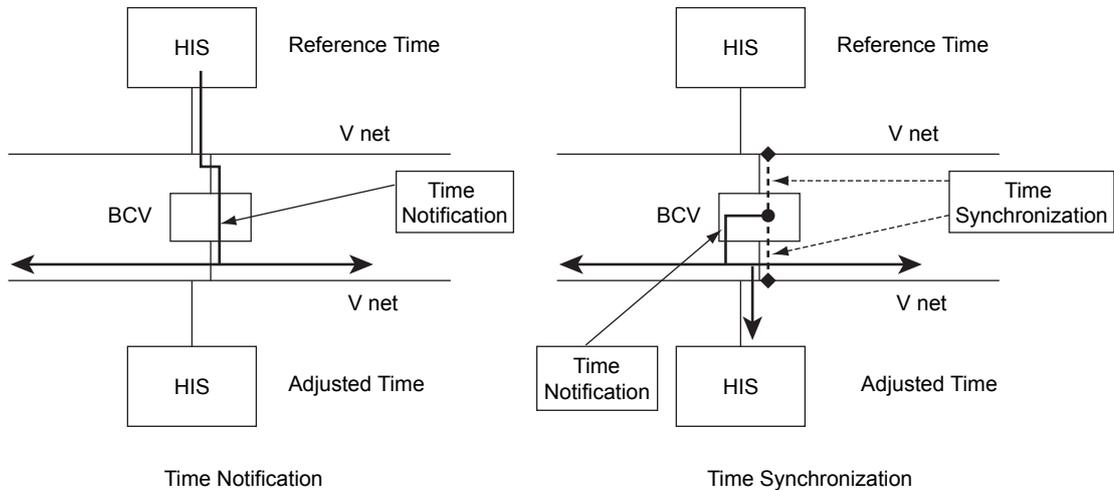


Figure BCV Time Synchronization Scheme

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BCV Settings

With two option boxes on BCV builder, which domain's time is reference time and which direction the time notification to be performed can be defined for 4 patterns of BCV behavior.

| | |
|-----------|---|
| Pattern 1 | No option is checked |
| | No time synchronization between domains. |
| Pattern 2 | [Transfer Lower] is checked |
| | Upper domain has reference time. Lower domain clock should be adjusted. |
| Pattern 3 | [Transfer Upper] is checked |
| | Lower domain has reference time. Upper domain clock should adjusted. |
| Pattern 4 | Both [Transfer Upper] and [Transfer Lower] are checked |
| | Time notification is sent in both directions when either an upper domain clock or lower domain clock is manually adjusted. However, upper domain time is the reference time for time synchronization. |

3. Operation and Monitoring Functions

Windows-Based Open Interface

The HIS software runs on a Windows based general purpose PC. Not only CENTUM CS 3000 HIS software but also general Windows application software (such as Microsoft Excel) can be run on the machine. In addition, open software interface OPC (OLE for Process Control) is supported. You can use the operator station not just for operating, but can also run office applications on it to write reports and memos, and to analyze process data.

Support for Latest PC Hardware

Personal computer (PC) technology is progressing very quickly. CPU and network speeds are increasing, CPU and memory prices are falling. Since a general purpose PC (IBM PC/AT Compatible) is used, you can incorporate the latest hardware in your system.

Enclosed Display Style Console Type HIS

The Enclosed Display Style Console Type HIS is composed of a console assembly and a general purpose PC. It is a new type of human interface station.

It can be composed of dual stacked LCD, touch panel function, eight-control-key operation keyboard, and auxiliary contact I/O while succeeding the operability of the existing human-machine interface.

Open Display Style Console Type HIS

The Open Display Style Console Type HIS is composed of a console assembly and a general purpose PC. It is a new type of human interface station.

It is composed of LCD. As the options, dual stacked LCD, touch panel function, eight-control-key operation keyboard, and auxiliary contact I/O can be selected, so that its configuration is selectable.

One-touch Multi-window Display Functions

Multiple windows (related windows) can be displayed simultaneously; dynamic window set functions allow you to register a group of windows and display them with the touch of a key.

High-speed Data Update

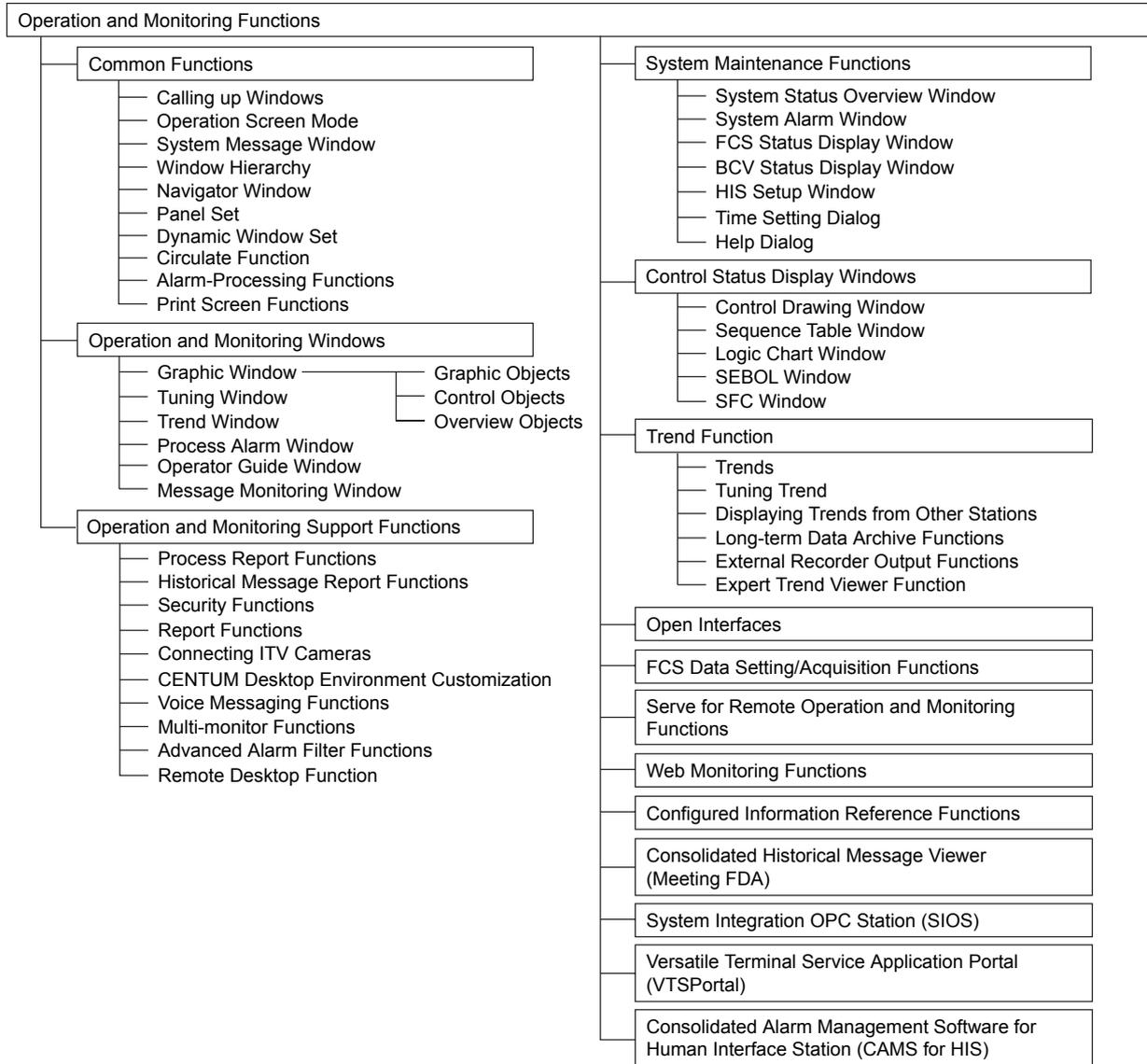
Data acquisition functions allow display updating as fast as 1 sec. This level of performance is required for manual control of pressure and flow.

Multi-monitor Function

The multi-monitor function enables one general purpose PC to use two monitors, permitting to display more information.

3.1 Configuration of Operation and Monitoring Functions

The configuration of operation and monitoring functions is shown below



F030101.ai

Figure Configuration of Operation and Monitoring Functions

3.2 Common Operation and Monitoring Functions

This section describes the following common Operating and Monitoring functions:

- Window call-up
- Screen mode (“Window” or “Full screen”)
- System message window
- Window sizing
- Window hierarchy
- Navigator window
- Panel set
- Dynamic window set
- Circulate key function
- Alarm processing functions
- Print screen functions

3.2.1 Window Call-up

You can use a mouse, or similar pointing device, or the operator keyboard to call up windows. You can also use pull-down menus.

Using a Mouse or Similar Pointing Device to Call up Windows

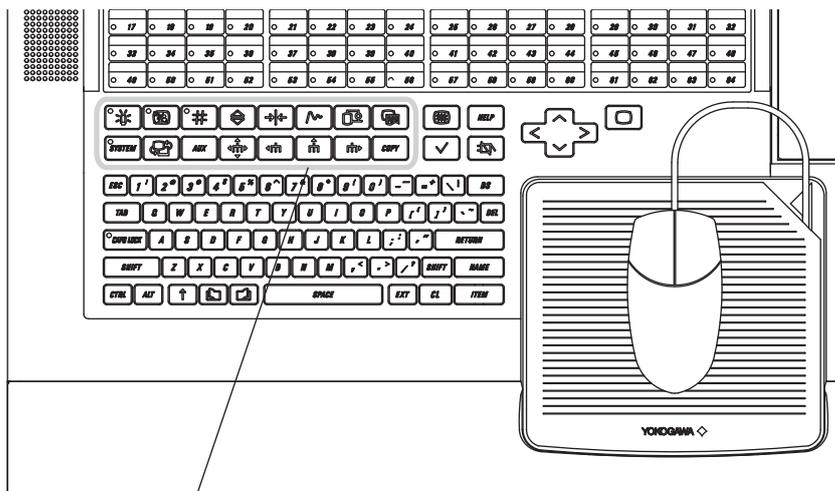
You can call various types of windows using the window menu in the system message window.

You can also call up the toolbox in the system message window and click the appropriate button in the toolbox.

Using Operator Keyboard to Call up Windows

You can call various types of windows using the dedicate window-call keys on the operation keyboard. (The same icons are used on the dedicated window-call keys as in the toolbox).

The figure below shows the operator keyboard.



Window call keys

F030201.ai

Figure One-control-key Operation Keyboard

3.2.2 Operating Screen Mode

You may choose Multi-Window or Full-Screen modes.

Full-Screen Mode

This mode provides the dedicated full-screen operation and monitoring windows – which resemble CENTUM and μ XL screens – found in control rooms. You can use a dedicated operation keyboard to provide essentially the same environment as in a conventional operator station.

The following three types of windows are displayed:

System Message Window

Always displayed at the top of the screen, this displays the latest alarms and a variety of buttons. This window cannot be obscured by other windows, so there is no possibility of overlooking alarm messages.

Main Window

The rest of the screen (apart from the system message window) displays the main window. If you call up another (main) window, it overwrites this window.

Auxiliary Windows

Auxiliary windows are called up from the main window or from the system message window, and are displayed on top of the main window.

An example of a full-screen-mode screen is displayed below.

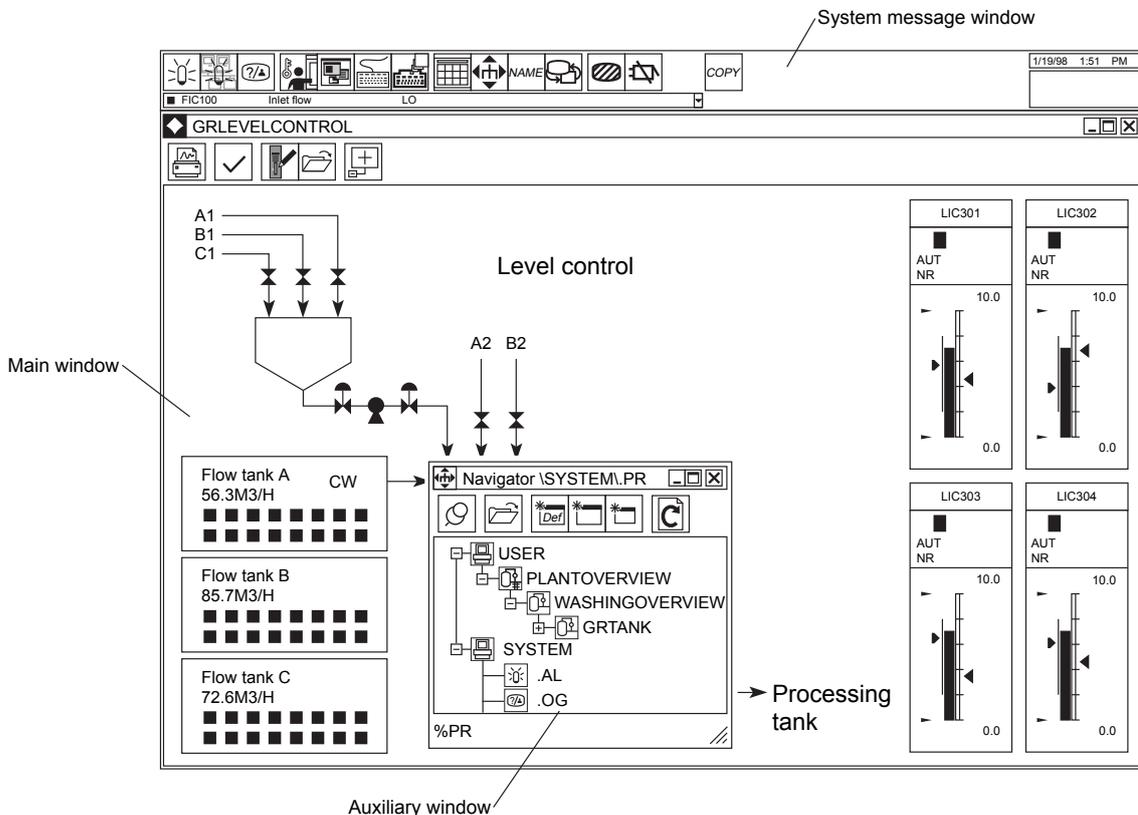


Figure Full-screen Mode

F030202.ai

Multi-window Mode

This resembles the multi-window mode seen in an office PC. The operation and monitoring windows representing current plant status are updated in real time even in an office environment, and data can be easily analyzed, so this mode is ideal for research labs. This multi-window mode allows you to run general office applications as well as perform HIS operation and monitoring functions.

System Message Window

This is normally displayed at the top of the screen, but can be dragged to another position (floating window display). This window is always displayed as the front window, and cannot be obscured by other windows.

Multi-window Display

In multi-window mode, there's no distinction between "main" and auxiliary windows, and these windows may be overlapped. Up to five operation and monitoring windows may be displayed simultaneously. (In addition to these five operation and monitoring windows, general-purpose Windows applications can be displayed at the same time.)

An example of multi-window mode is displayed below.

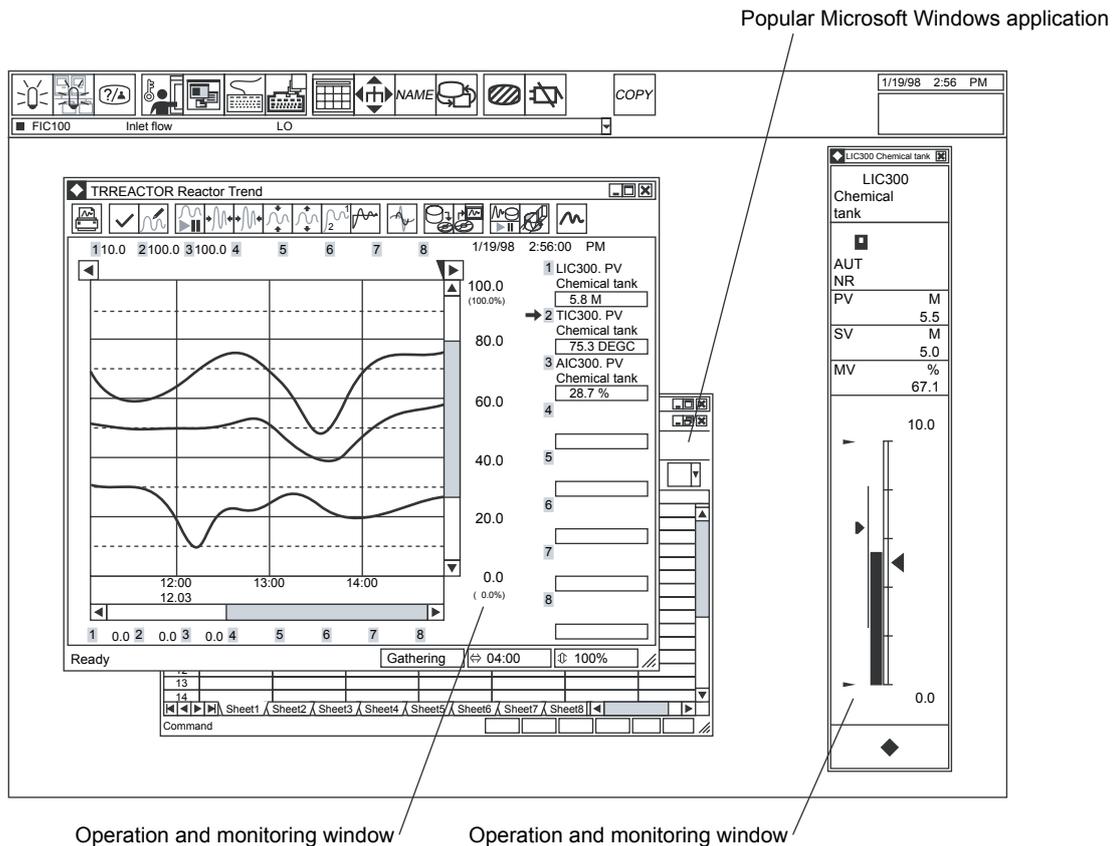


Figure Multi-window Mode

F030203.ai

3.2.3 System Message Window

The system message window displays the latest alarms, and allows you to call up various operation and monitoring windows. The system message window is always displayed at top, so can not be obscured by other CENTUM CS 3000 windows or by general-purpose Windows applications.

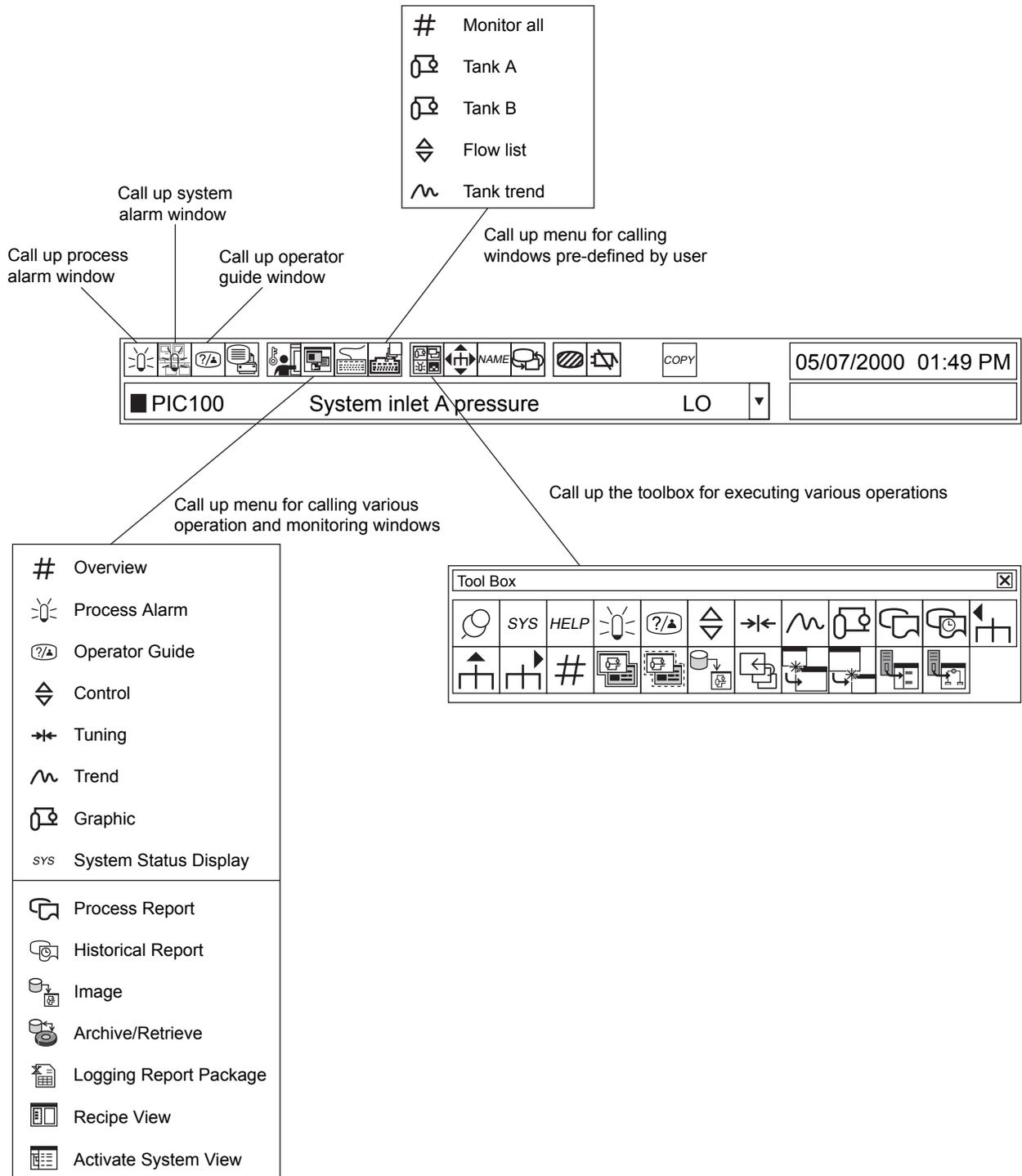


Figure System Message Window

F030204.ai

3.2.4 Window Sizing

The operation and monitoring windows come in three sizes: “full-size”, “half-size”, and “special”. Half-size windows have the same display information as full-size windows; up to four can be displayed simultaneously, so a single HIS can display the equivalent of four operator station screens of data simultaneously. The display size of these window types in full-screen mode and in multi-window mode is shown below. The percentage expresses the ratio of height and width to full-screen mode “full-size”. Some types of windows come in only some sizes:

For example,

Faceplate windows: come only in special sizes (see below),

Historical message report windows: come in full-size and half-size only,

System message windows: can't specify display size.

Table Display Size of Operation and Monitoring Windows

| Operating Screen Mode | Window size | | |
|-----------------------|-------------|-----------|---------------------------|
| | Full size | Half size | Special |
| Full-Screen Mode | 100 % | 50 % | Same size as when created |
| Multi-Window Mode | 80 % | 50 % | Same size as when created |

Special Size

Special size means the same size as when the window was originally created in the builder. If the whole window does not fit in the display, then a scroll bar appears on the window. Some system windows such as Process Alarm Window can be displayed as dialogs, and some you can display in compact format, with fewer lines displayed.

3.2.5 Window Hierarchy

By organizing several (types of) operating and monitoring windows in a hierarchy, it makes it easy to zoom from a graphic or overview to an individual instrument.

Previous systems organized screens by type (graphic, overview, control group etc.) but now you can create separate hierarchies (containing different types of windows) for separate units or processes, for more intuitive operation.

You can maintain the same window-type hierarchy as before, with the alarm status of graphic and overview windows at the top of the hierarchy reflecting the status of lower-level windows.

You can also use windows shortcuts to enable a particular window to be accessed from several different window hierarchies.

An Example of Window Hierarchies

An example of a window hierarchy is illustrated below. You can proceed from higher-level supervisory windows to lower-level windows, and proceed from lower-level windows to higher-level windows. You can also move between sibling windows at the same level in a hierarchy.

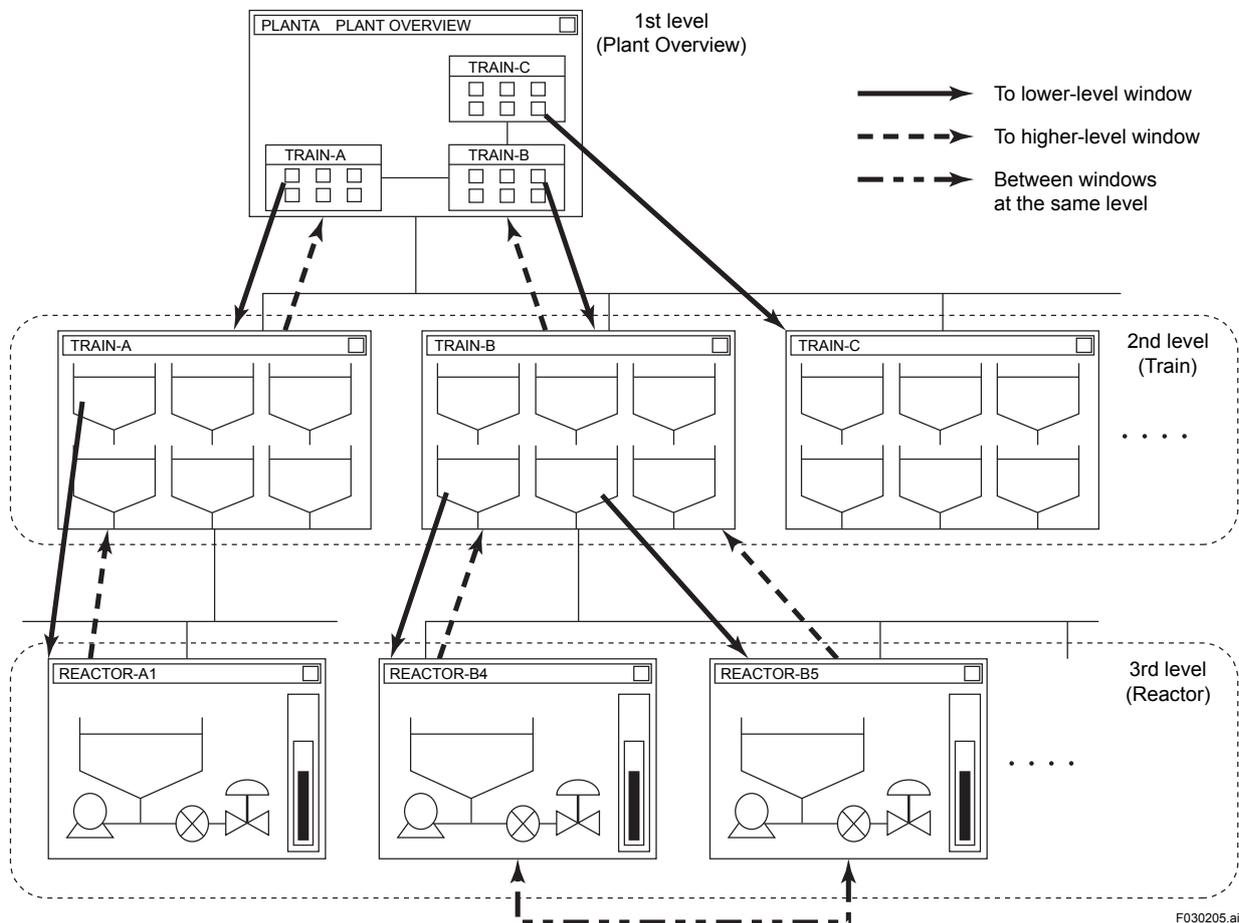


Figure Hierarchical Windows

F030205.ai

Alarm Status Transfer up Window Hierarchy

The figure below shows an example of how an alarm status can be transferred up the window hierarchy. For example, if an alarm occurs in the window REACTOR-A1, you can have the alarm status transmitted to the supervisory window TRAIN-A. You can also have the alarm status transferred to its supervisory window, PLANTA.

The system would normally be designed so that when alarms occur in a lower-level window, the alarm status is transferred to (visible in) higher level windows in the hierarchy.

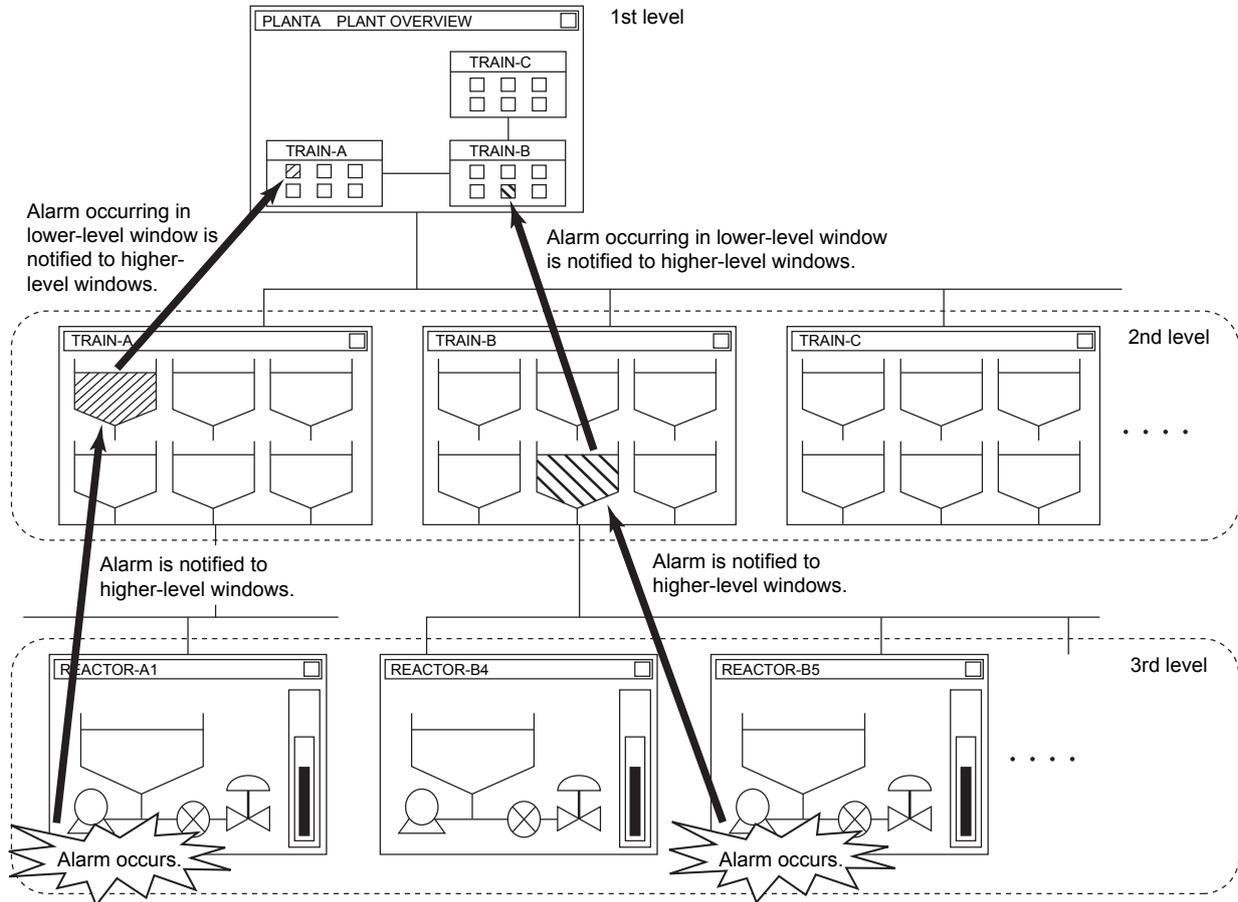
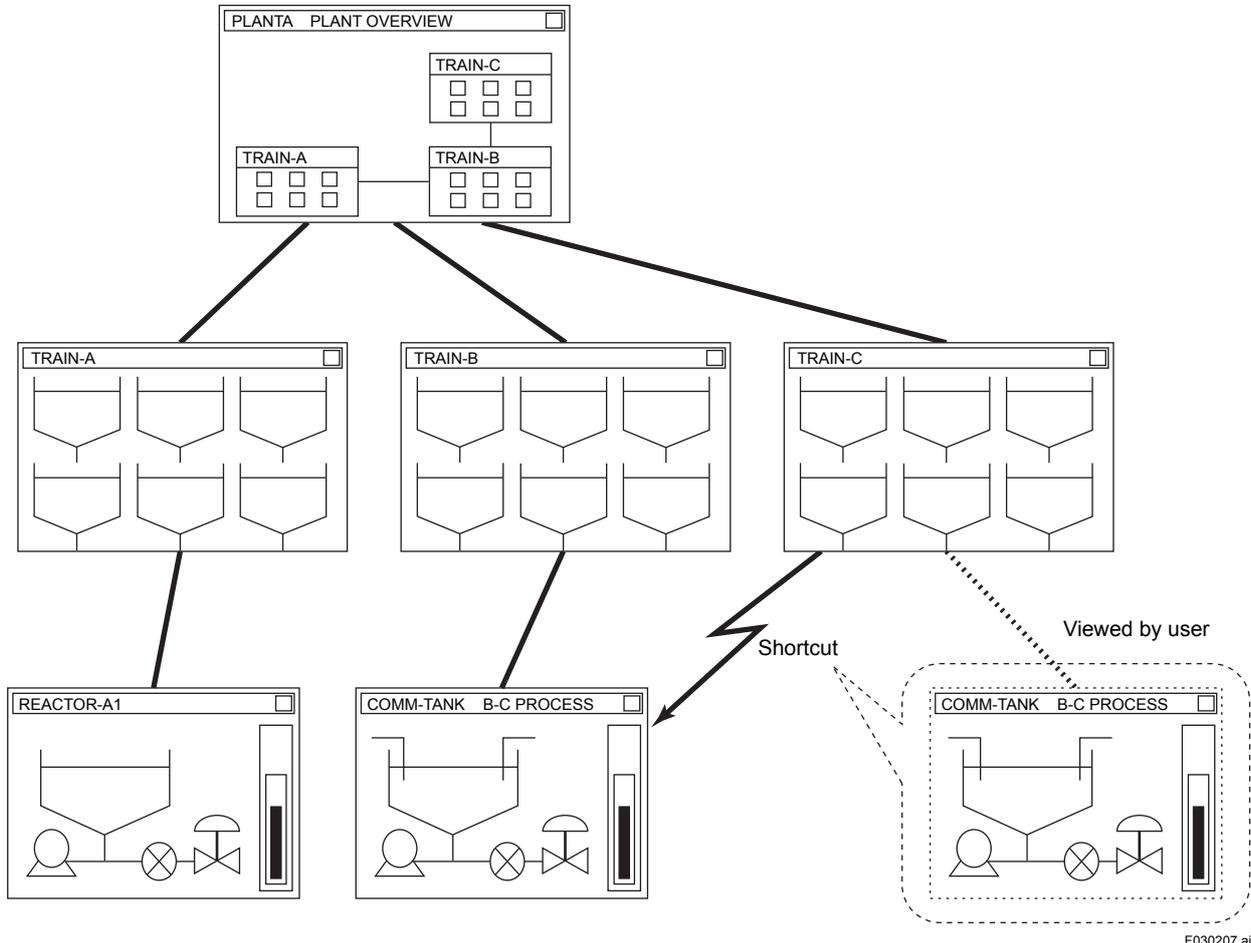


Figure Alarm Status Transfer up Window Hierarchy

Shortcut Functions

You can use Windows shortcut functions to include a window in more than one window hierarchies. Viewed by the user, the same window appears in several window hierarchies – but in fact there is only one original of the window. For example, in the figure below, the window COMM-TANK appears below both TRAIN-B and TRAIN-C windows (the original is actually under TRAIN-B).



F030207.ai

Figure Shortcut Functions

Navigator Function

The user can freely determine the configuration of the window hierarchy.

The operator cannot necessarily memorize the whole window hierarchy, and may want to call up a specific window directly, without navigating the hierarchy. The Navigator window resembles Windows Explorer, and enables you to directly call a particular window. See the next section for more information about the Navigator window.

3.2.6 Navigator Window

The Navigator window is a Windows Explorer-like hierarchical view of the operation and monitoring windows. Simply select the name of the window you want to view, and call it up. Icons next to window names represent the type of window – graphic, control or trend window, for example. If an alarm occurs, the corresponding windows will change color, making it easy to call up a detailed display.

The diagram below illustrates the operation of the Navigator window.

Upper or lower sibling window keys on the operation keyboard or in the Toolbox (accessed from the System Message window) move from the currently-displayed window to the next one of the same type at the same level (above or below it in the Navigator display) in the current window hierarchy. The separate “same type” window groupings are: Graphic and Overview windows, Control windows, Trend windows.

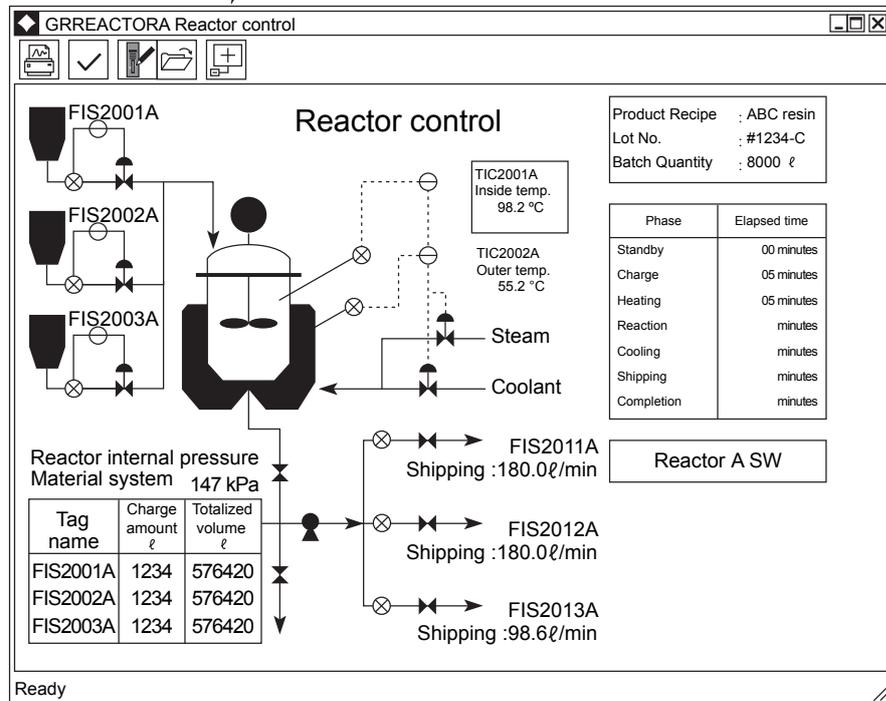
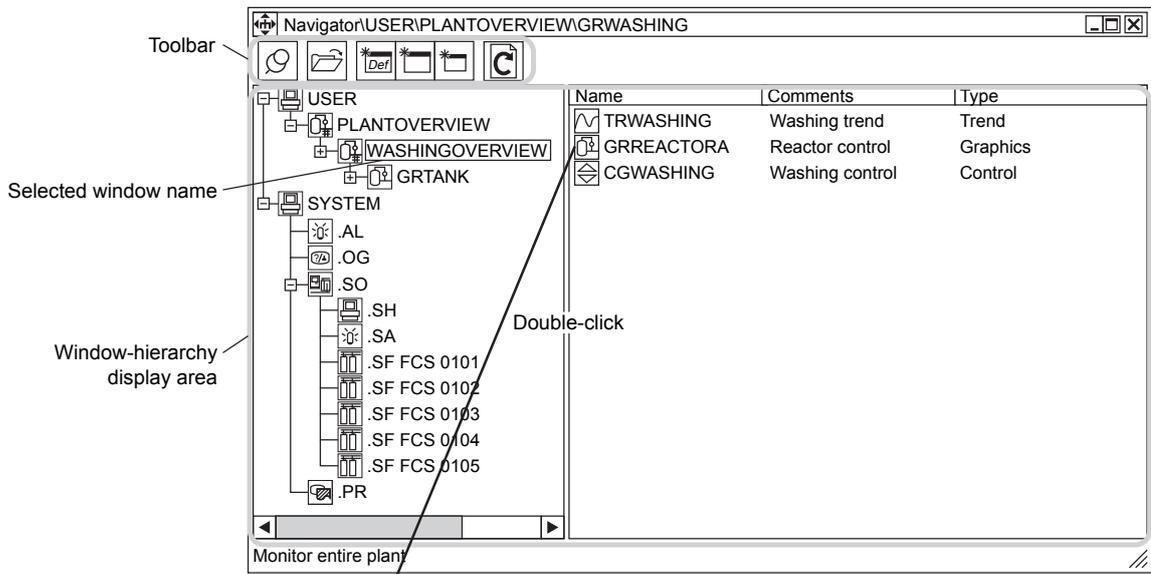
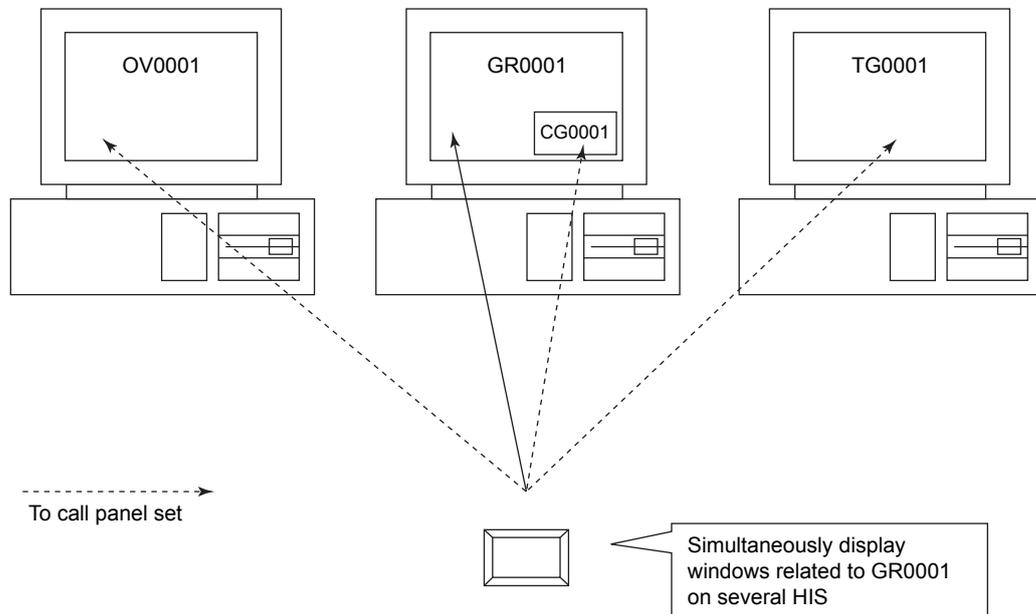


Figure Navigator Window

F030208.ai

3.2.7 Panel Set

You can display a set of windows on different (e.g. adjacent) HIS at the touch of a key. In normal operation, you might display a set of related panels such as graphic window, trend display and instrument faceplates. The panel set functions allow you to register such frequently-used panel sets in the builder. Each panel set can consist of up to five windows, and up to 200 different panel sets may be defined in each HIS.



F030209.ai

Figure Displaying Several Windows in a Panel Set

3.2.8 Dynamic Window Set

While panel sets are defined in the builder, dynamic window sets are defined by the operator during online operation. The operator defines a representative window and simply clicks the dynamic window set function icon to register and save the window set. Next time the representative window is displayed, the other windows in the set are displayed automatically. Up to 30 window sets can be defined.

The figure below illustrates the operation of the dynamic window set functions.

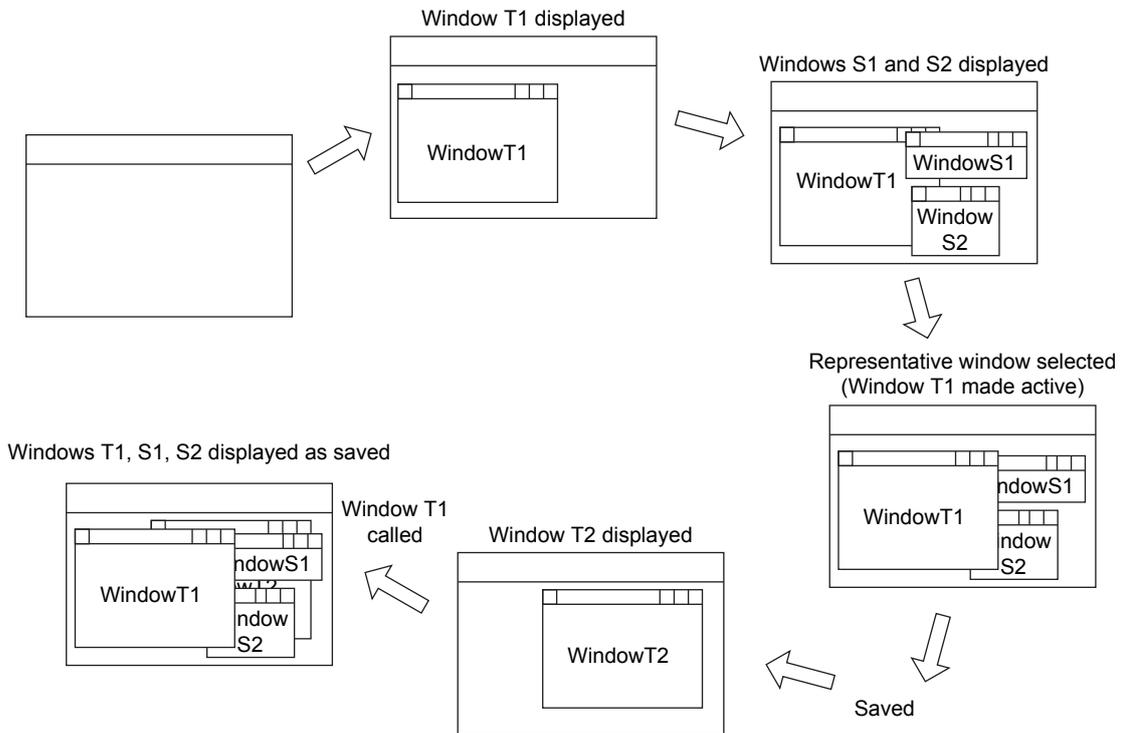


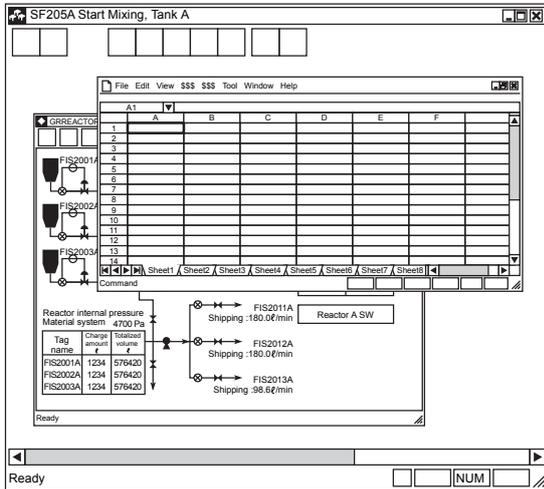
Figure Dynamic Window Set

F030210.ai

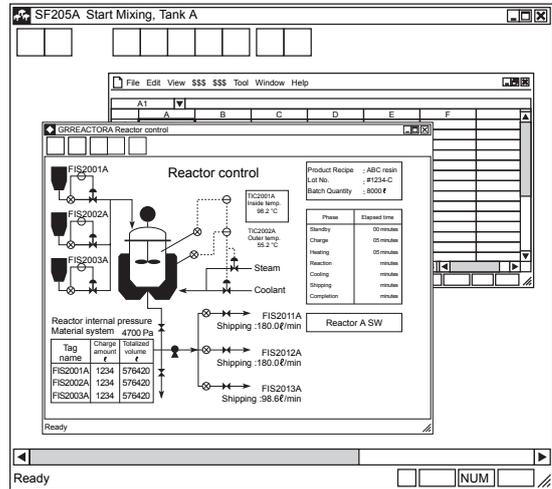
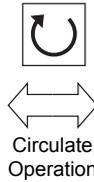
3.2.9 Circulate Functions

The operation and monitoring functions can execute concurrently with general-purpose Windows application software (Microsoft Excel, etc.). In this case, the HIS-related windows and the Windows general-purpose application related windows may both be displayed at the same time.

The circulate key (button) allows you to alternatively switch the HIS-related group of windows or the Windows general-purpose application related group of windows to the front.



Using Windows Software



Using CENTUM CS 3000 Operation and Monitoring Window

Figure Circulate Operation

F030211.ai

3.2.10 Alarm Processing Functions

The alarm processing functions display alarms and annunciator messages, in the order they occur, and sound distinctive audible alarms. A new alarm is displayed in the system message window, and you can call up the corresponding process alarm window, and directly call up related windows from there – so the system is designed for fast, efficient alarm processing. An example is shown below.

.AL Process Alarm

| Priority | Time | Tag Name | Description | Priority | Value | Unit | Priority |
|----------|-------------------|----------|--|----------|----------|------|----------|
| 1 | 12/12 10:18:15 AM | FIC005 | Flowrate control 5 | NR | 33.0M3/H | NR | |
| 2 | 12/12 10:18:15 AM | FIC005 | Flowrate control 5 | LO | 33.0M3/H | NR | |
| 3 | 12/12 10:18:15 AM | | Transfer tank level error | NR | | | |
| 4 | 12/12 10:17:45 AM | FIC005 | Flowrate control 5 | LO | | | |
| 5 | 12/12 10:17:45 AM | | Transfer tank level error | ALM | | | |
| 6 | 12/12 10:17:45 AM | | Purification tank level error | ALM | | | |
| 7 | 12/12 10:17:15 AM | | Caution: High temperature in Processing tank A | NR | | | |
| 8 | 12/12 10:17:15 AM | | Caution: High temperature in Processing tank A | ALM | | | |
| 9 | 12/12 10:17:05 AM | FIC004 | Flowrate control 4 | | | | |
| 10 | 12/12 10:16:45 AM | FIC003 | Flowrate control 3 | | | | |

Ready Range: All

GRREACTORA Reactor control

Product Recipe : ABC resin
Lot No. : #1234-C
Batch Quantity : 8000 €

| Phase | Elapsed time |
|------------|--------------|
| Standby | 00 minutes |
| Charge | 05 minutes |
| Heating | 05 minutes |
| Reaction | minutes |
| Cooling | minutes |
| Shipping | minutes |
| Completion | minutes |

Reactor internal pressure: 4700 Pa
Material system: 4700 Pa

| Tag name | Charge amount | Totalized volume |
|----------|---------------|------------------|
| FIS2001A | 1234 | 576420 |
| FIS2002A | 1234 | 576420 |
| FIS2003A | 1234 | 576420 |

Reactor A SW

Call related window

F030212.ai

Figure Opening Related Window when Alarm Occurs

To notify the operator of process alarms, the HIS displays alarm marks in the system message area, sounds an electronic tone, and can flash a keyboard lamp and output a voice message. Alarm details can be displayed on the alarm window, graphic window, and status display window.

You can distinguish between system alarms (such as hardware and system abnormality alarms) and process alarms.

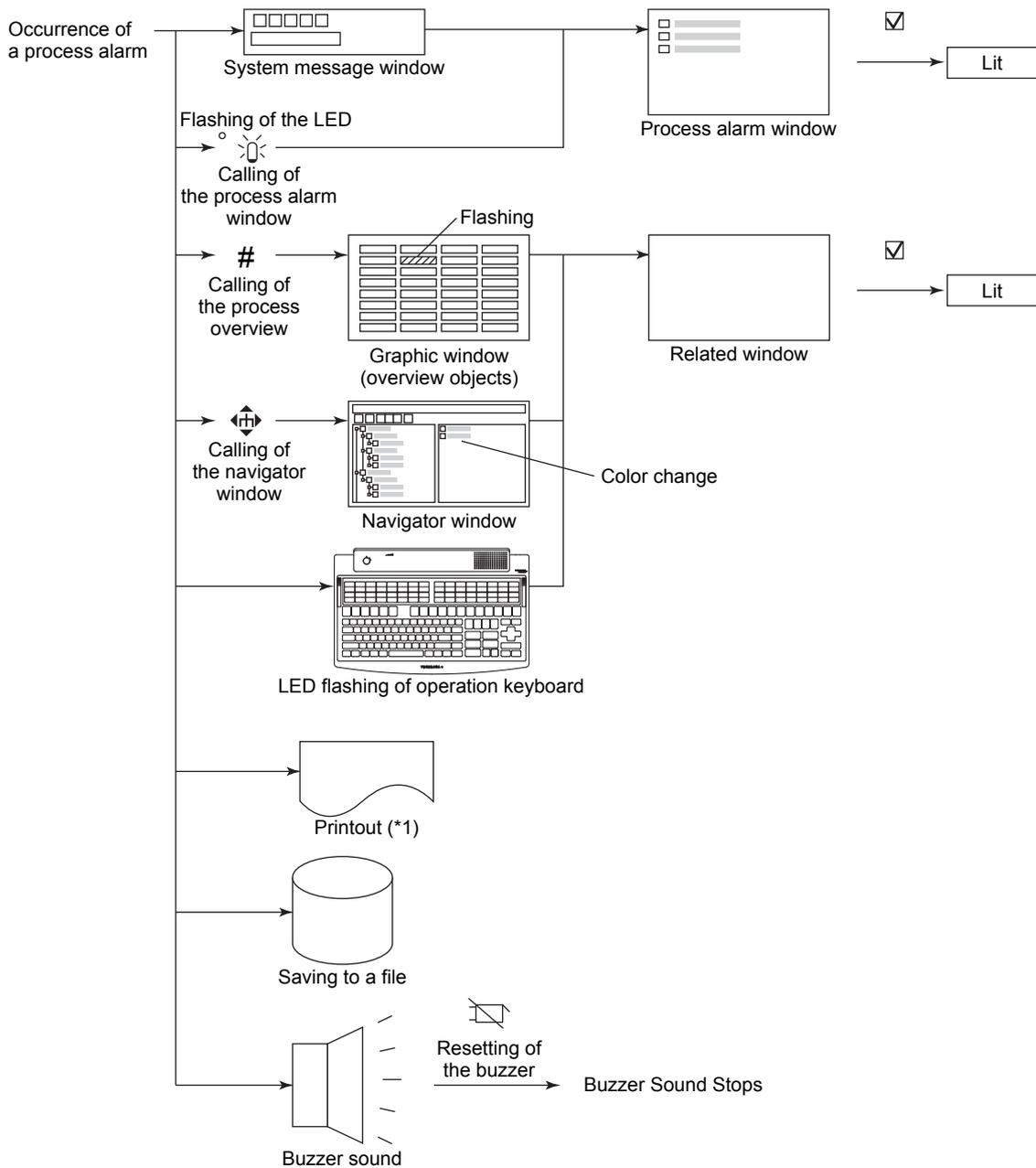
Alarm Priority Levels

Any of five alarm priority levels ranging from high-priority, medium-priority, low-priority, recording level to reference level can be specified to each tag. This allows high-priority alarms to be displayed on top and low-priority alarms display to be controlled.

Repeating Alarms

You can specify that an alarm will repeat at a preset interval if the alarm status has not recovered (regardless of whether the alarm has been acknowledged). You can specify “repeat alarm if status has not recovered” for high-priority alarms.

Opening Windows and Acknowledging Process Alarms



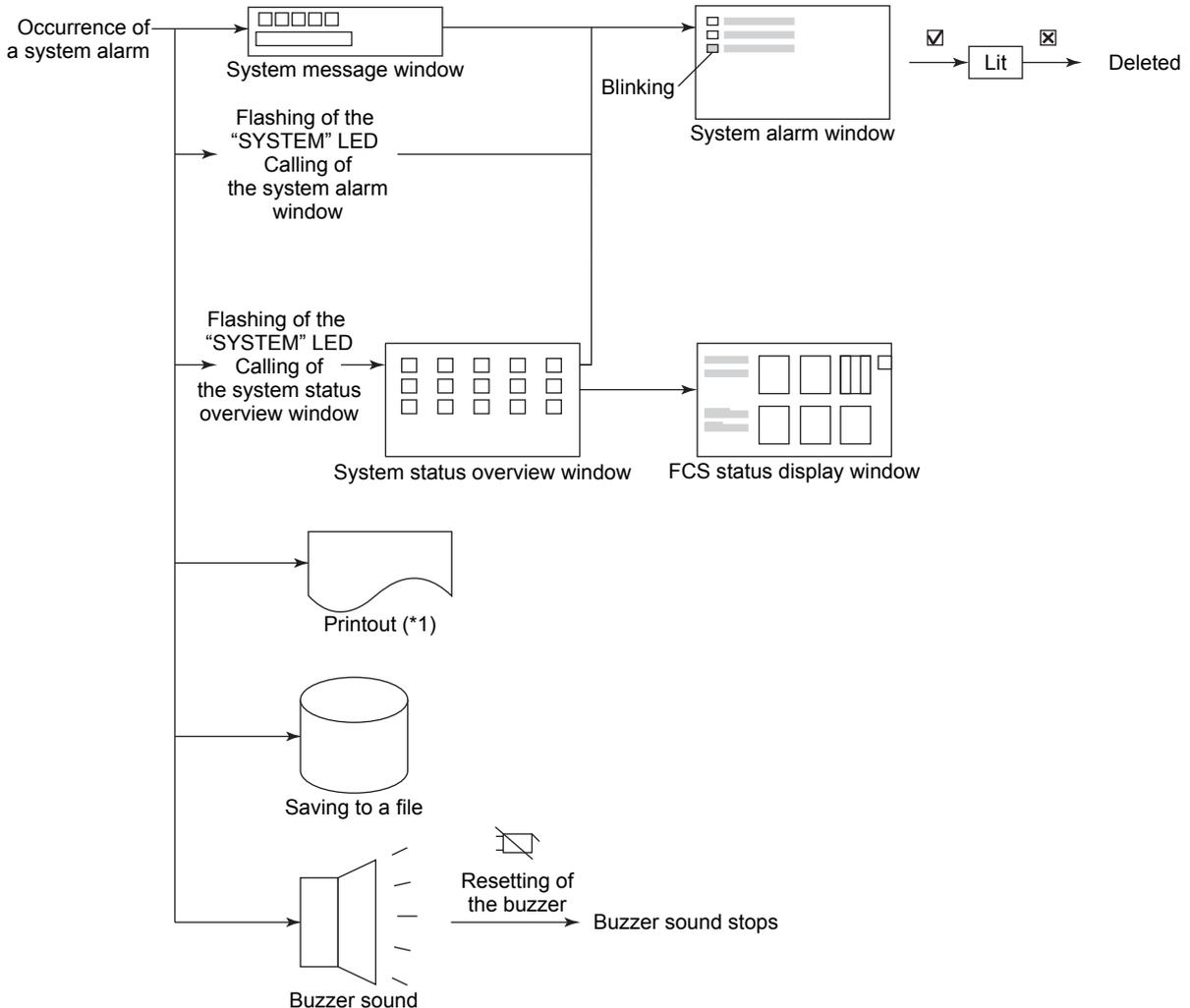
*1: When enough messages to fill a printer page have been generated, the page is automatically printed. Immediate message printing functions can be assigned to a function key, so you can printout at any time by pressing the key. A dot impact printer (ESC/P command set) can be used to print individual messages as they occur. (option)

F030213.ai

Figure Opening Process Alarm Window to Acknowledge Alarm

Opening Windows and Acknowledging System Alarms

An example of how system alarms are notified to the operator is illustrated below.



*1: When enough messages to fill a printer page have been generated, the page is automatically printed. Immediate message printing functions can be assigned to a function key, so you can printout at any time by pressing the key. A dot impact printer (ESC/P command set) can be used to print individual messages as they occur. (option)

F030214.ai

Figure Opening System Alarm Window to Acknowledge Alarm

3.2.11 Print Screen Functions

Graphic and trend windows may be printed using the print screen functions. Click the print screen button in the system message window or press the print screen key on the operation keyboard to print out the window on your color printer or laser printer. You can reverse black and white. You can save a window image as a file, for later printing.

3.3 Operation and Monitoring Windows

This section describes the use of the following windows for process monitoring and operation:

- Graphic windows
- Tuning windows
- Trend windows
- Process alarm windows
- Operator guide windows
- Message monitoring windows

3.3.1 Graphic Windows

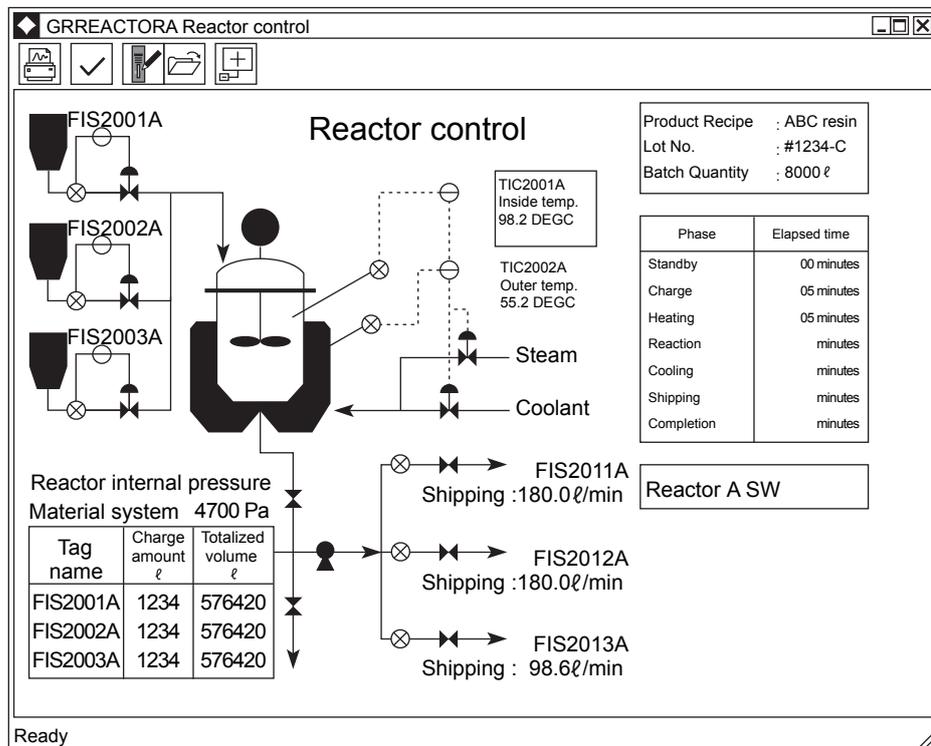
Graphic windows use graphic objects to provide an intuitive view of the plant.

Graphic windows can display graphic objects, control objects, overview objects, or a combination of these types of objects.

Graphic Objects

These display a graphical representation of the plant status, providing an intuitive operating and monitoring environment. You can also call up various windows from a graphic window.

An example of graphic objects is shown below.



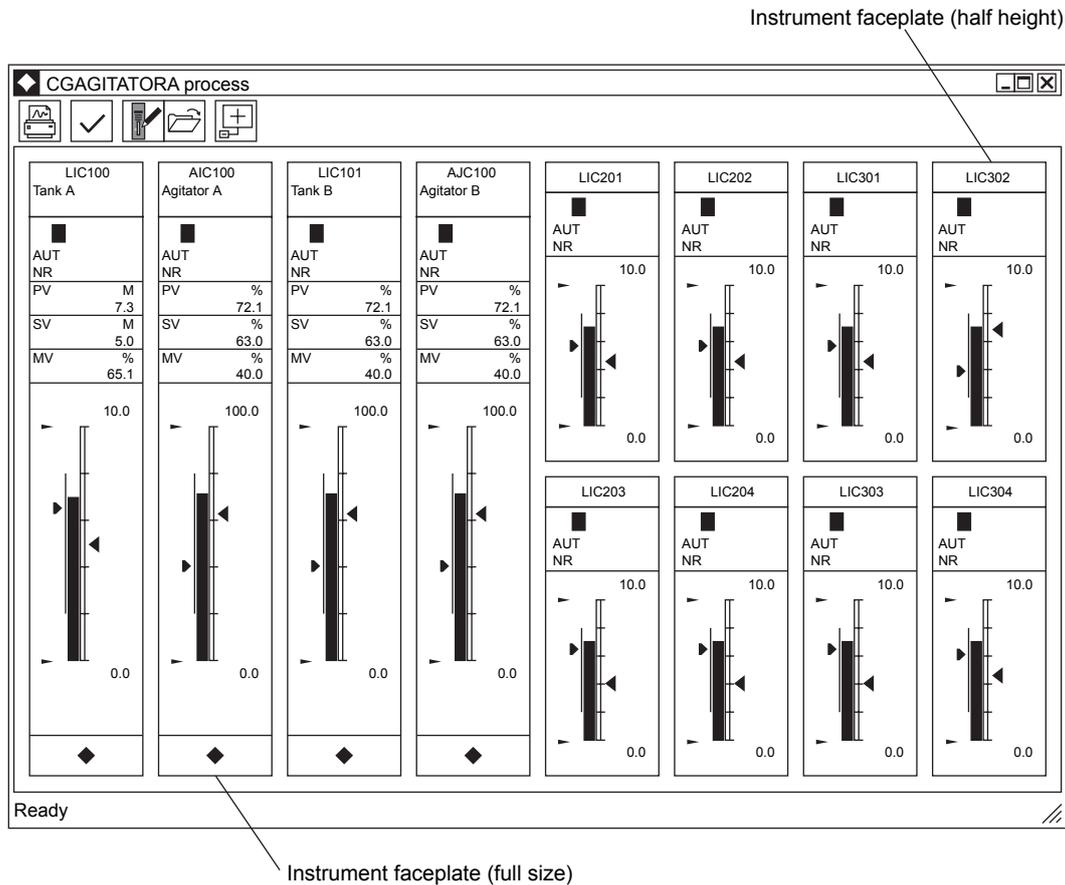
F030301.ai

Figure Graphic Window (Graphic Objects)

Control Objects

Instrument faceplates can display the status of function blocks, and can be used to monitor and operate the function blocks. Faceplates come in two sizes, eight full-size faceplates or 16 half-height faceplates may be displayed in a window. Different size faceplates may be mixed, and faceplates can be called up individually.

An example of control objects is displayed below.



F030302.ai

Figure Graphic Window (Control Objects)

Instrument Faceplates

Instrument faceplates are compact graphical display elements that represent data values, the mode of function blocks, status of contact inputs, and the like. They can be displayed on graphic (control) windows and faceplate windows. On graphic windows, they can be displayed as full-size or compact faceplates.

Some representative instrument faceplates are shown below.

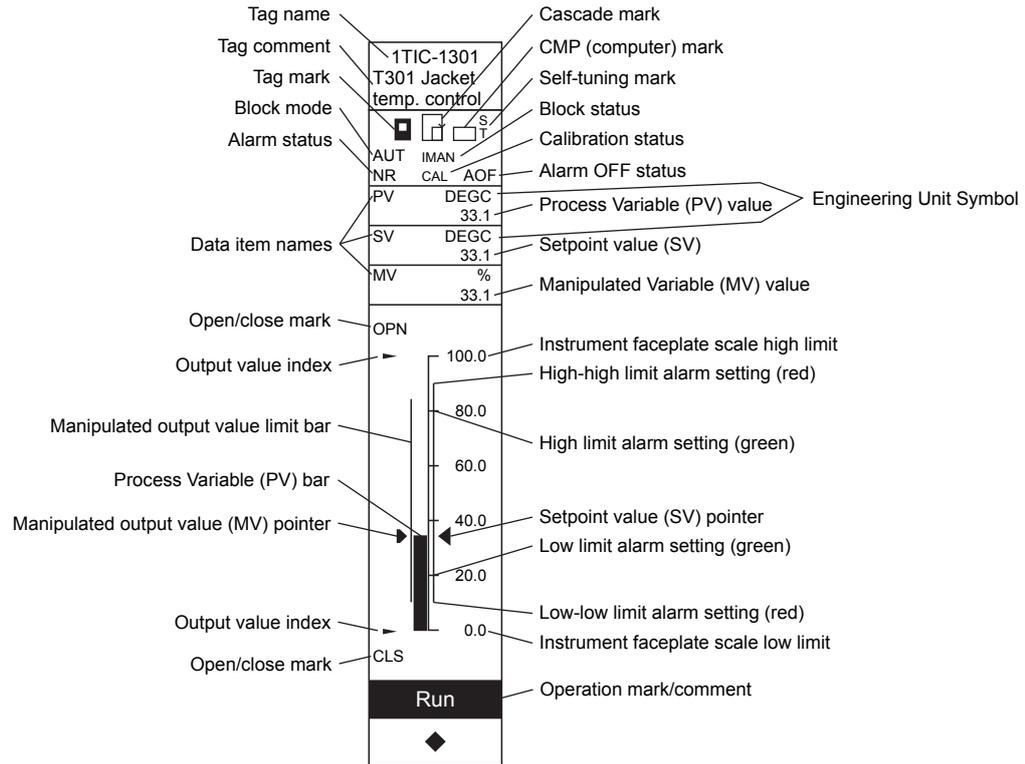


Figure PID Controller Block

F030303.ai

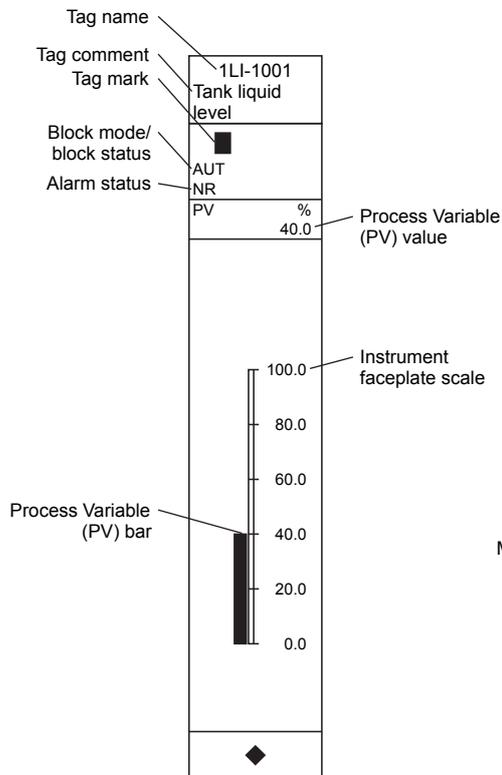


Figure PVI Input Indicator Block

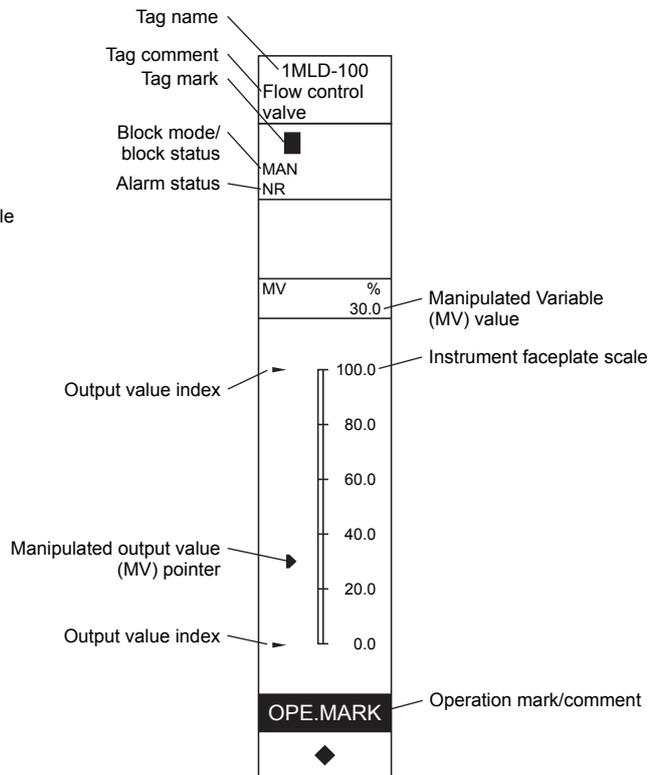


Figure MLD Manual Loader Block

F030304.ai

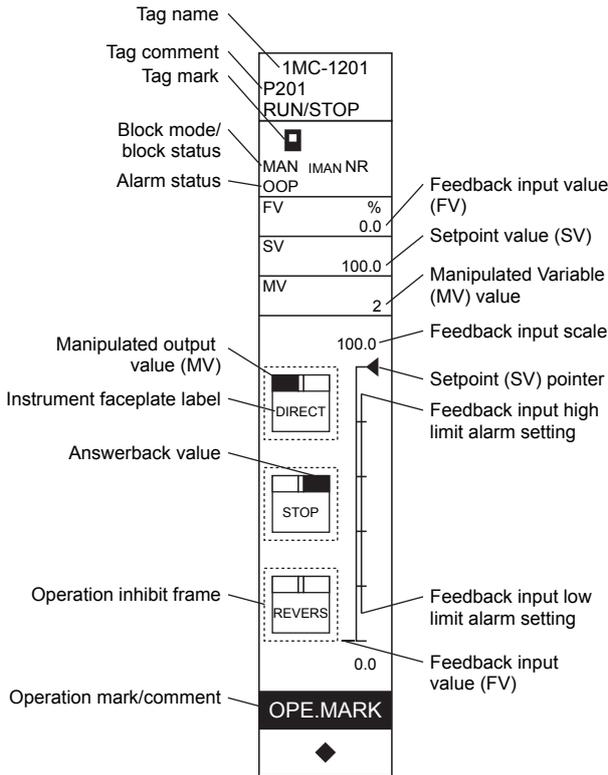


Figure MC-2 Two-Position Motor Control Block

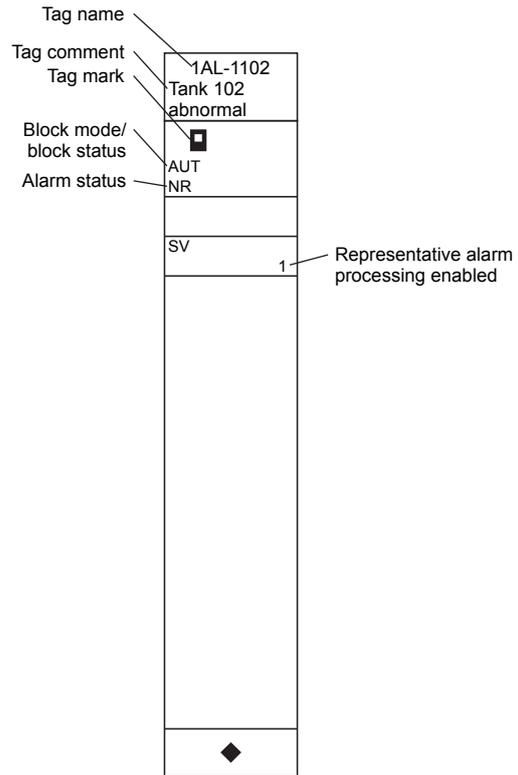


Figure ALM-R Representative Alarm Block

F030305.ai

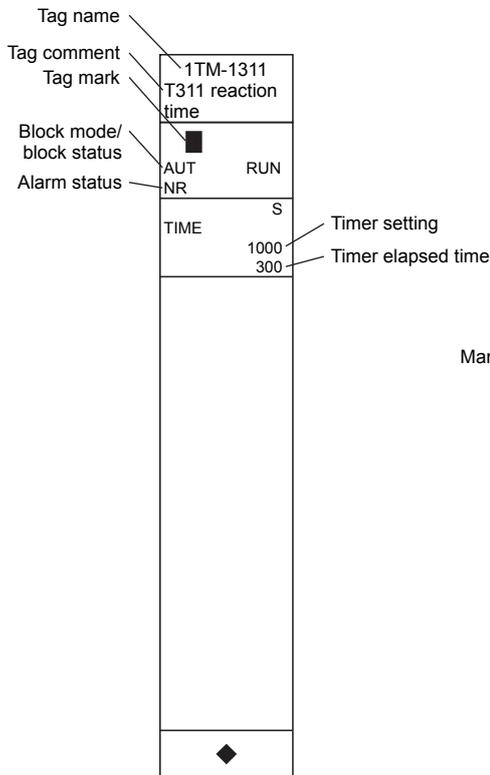


Figure TM Timer Block

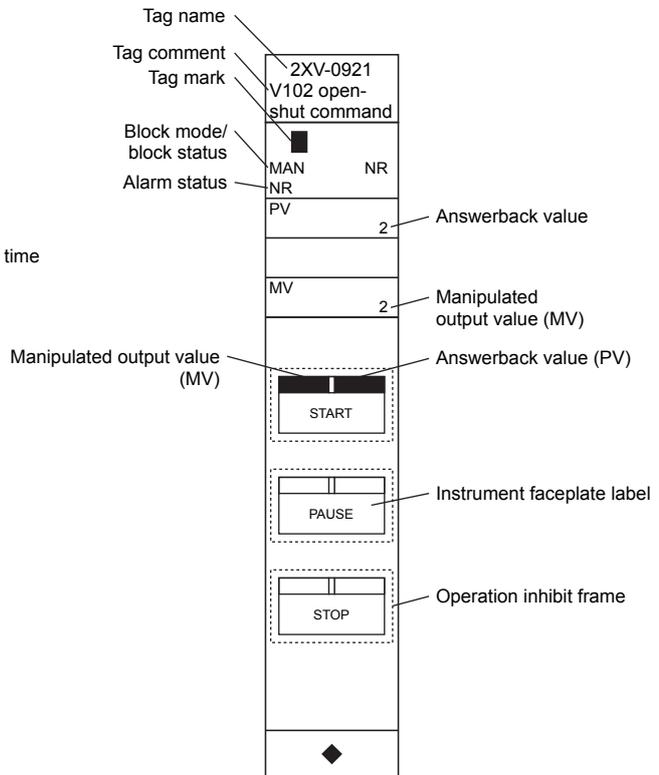


Figure SIO-12 Switch Instrument Block with 1 Input, 2 Outputs

F030306.ai

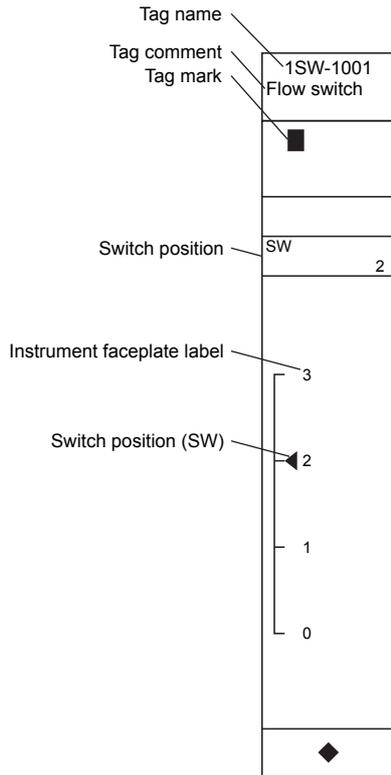


Figure SW-33 Three-Pole Three-Position Selector Switch Block

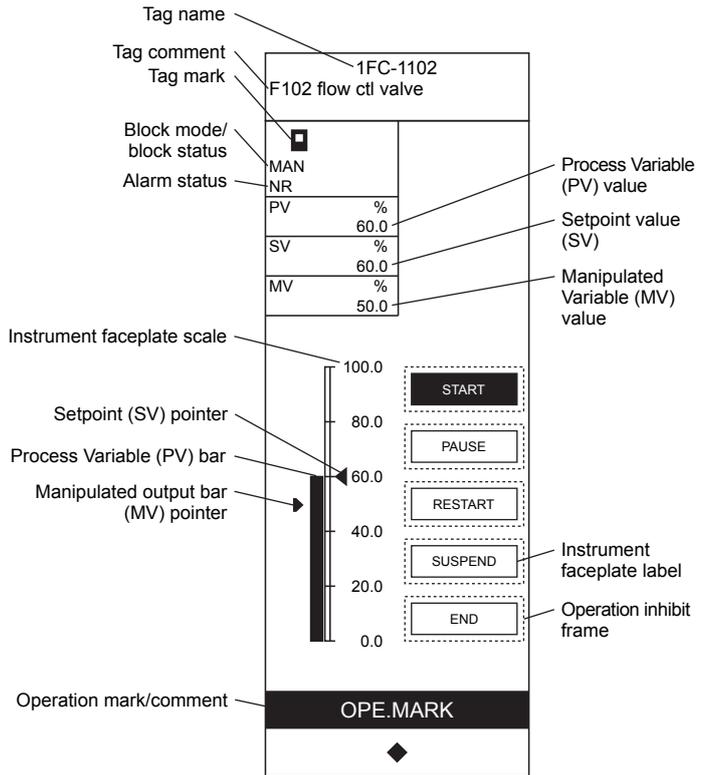


Figure HAS3C Extended Hybrid Manual Station Block

F030307.ai

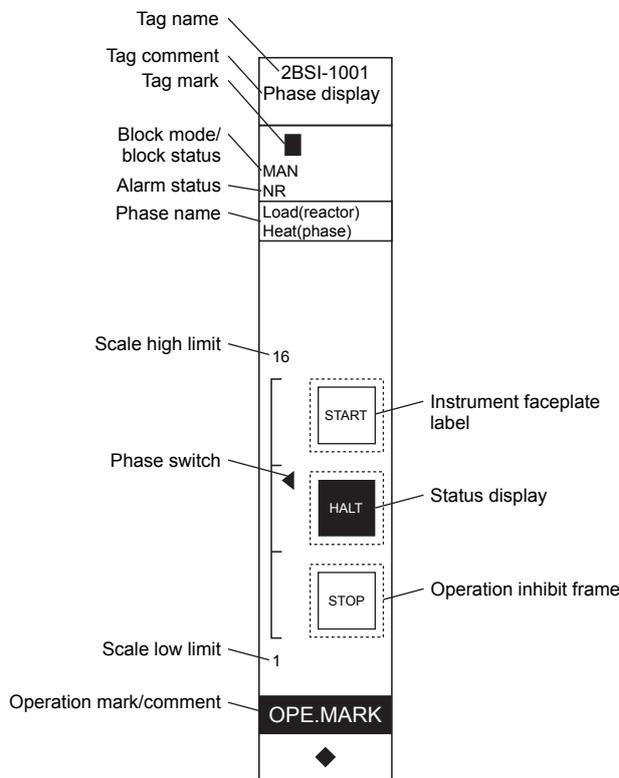


Figure BSI Batch Status Indicator Block

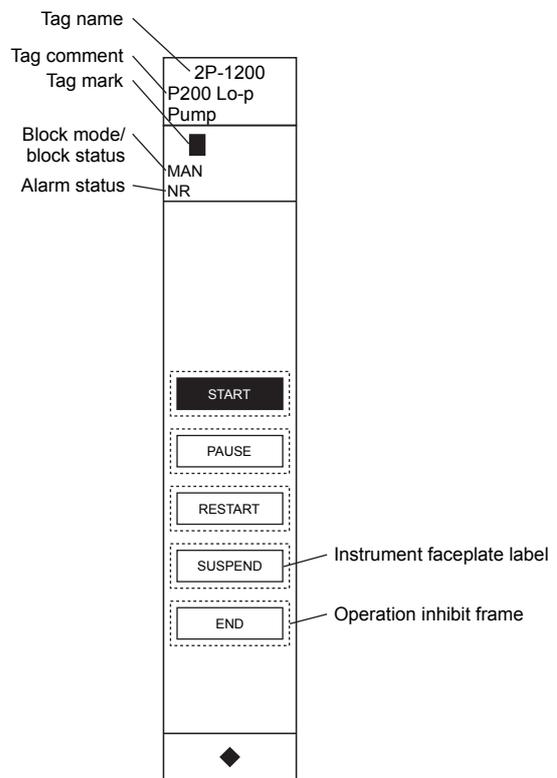


Figure PBS5C Extended 5-Push-Button Switch Block

F030308.ai

Overview Objects

These allow you to display a group of alarm statuses. They provide a top-level overview of the plant as a whole, and allow you to call up related windows, so can be used as menus providing access to the whole plant.

An example of overview objects is shown below.

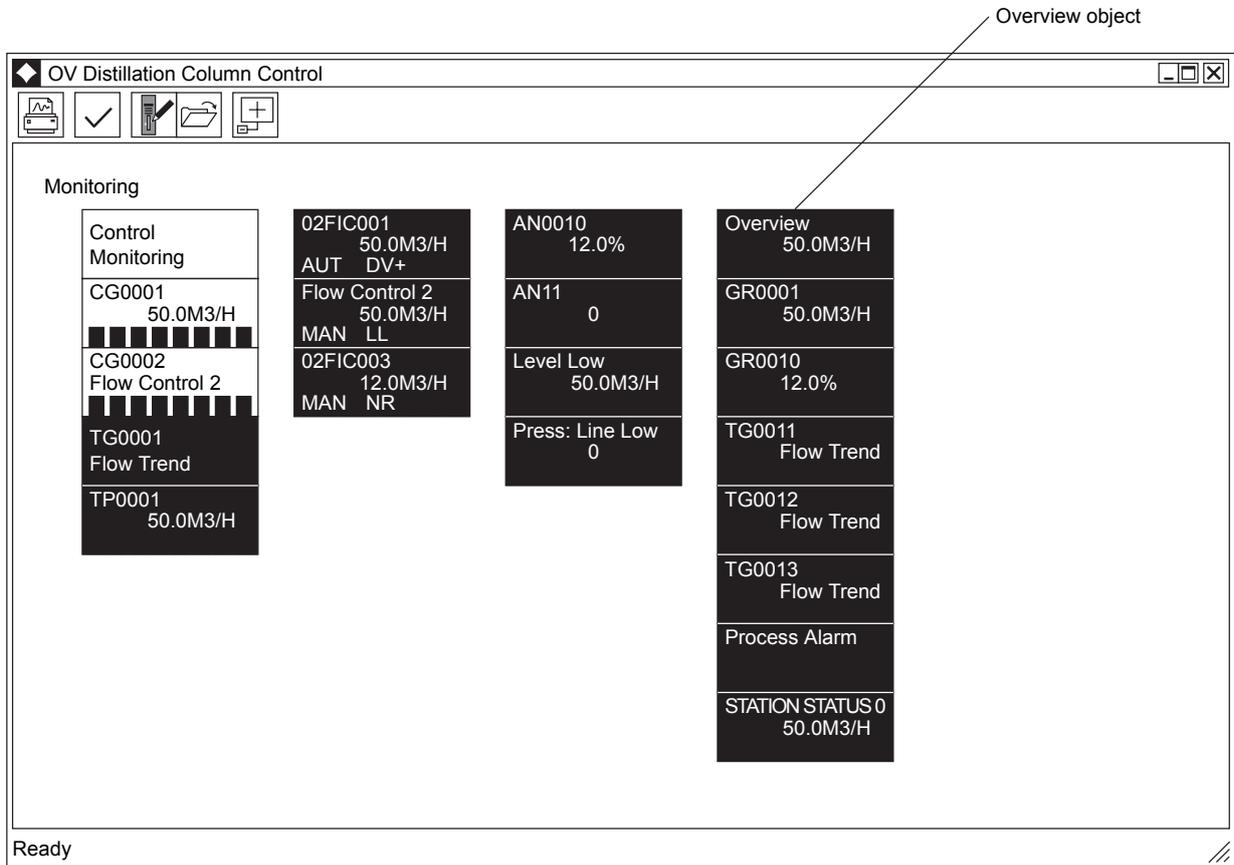


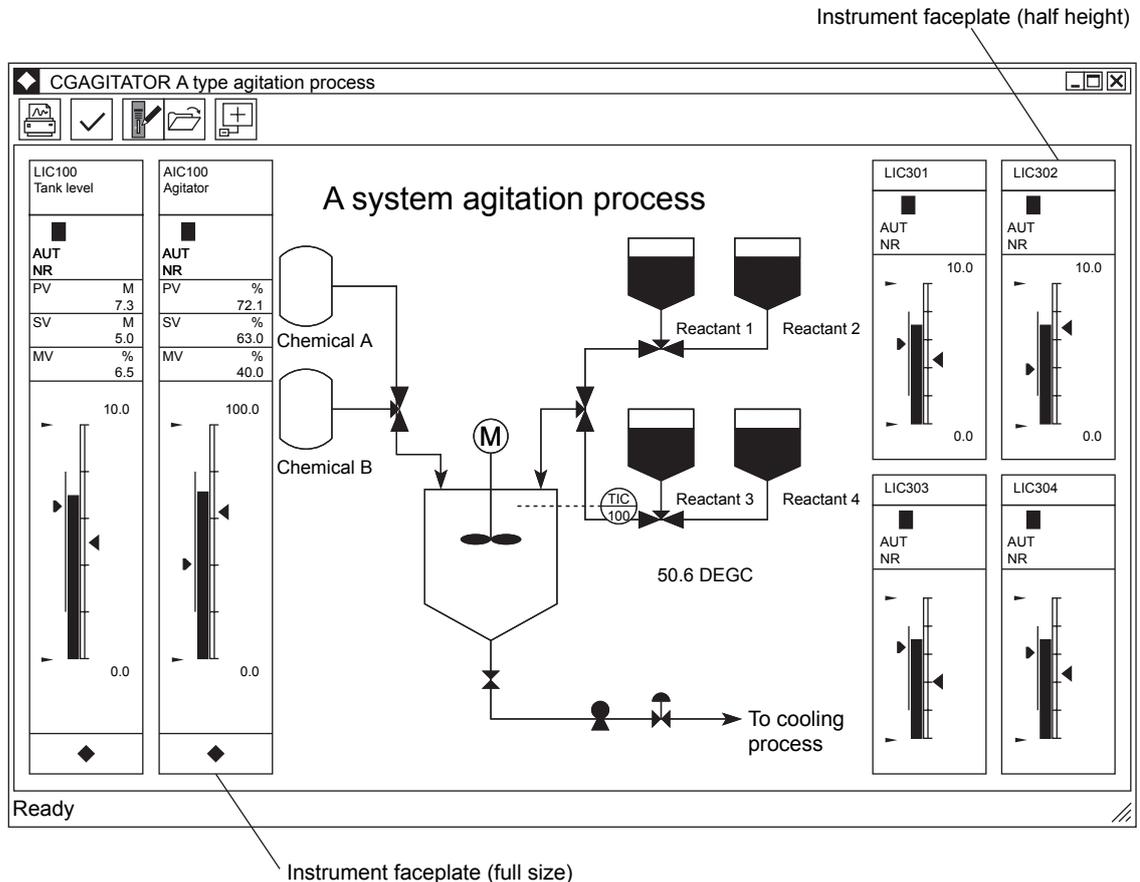
Figure Graphic Window (Overview Objects)

F030309.ai

Multi-function Graphics

You can create a graphic window which contains graphic objects, instrument faceplates, and overview objects.

An example of a multi-function graphic is shown below.



F030310.ai

Figure Multi-function Graphics

Container Functions

Container functions allow you to attach ActiveX controls, created in Visual Basic, to windows. ActiveX controls are each treated as a single graphic object. You can use commercially-available ActiveX controls.

Data Binding Functions

Data binding functions allow you to associate data with a generic name in a graphic window. Usually parts displayed in a graphic window are tag numbers associated with fixed data, but generic names can be assigned. This allows you to use one graphic to supervise several identical pieces of equipment simply by switching the data tables associated with the generic name.

3.3.2 Tuning Window

The tuning window displays all the tuning parameters for one instrument, plus a trend display. You can change the time axis and data axis scales.

An example of a tuning window is shown below.

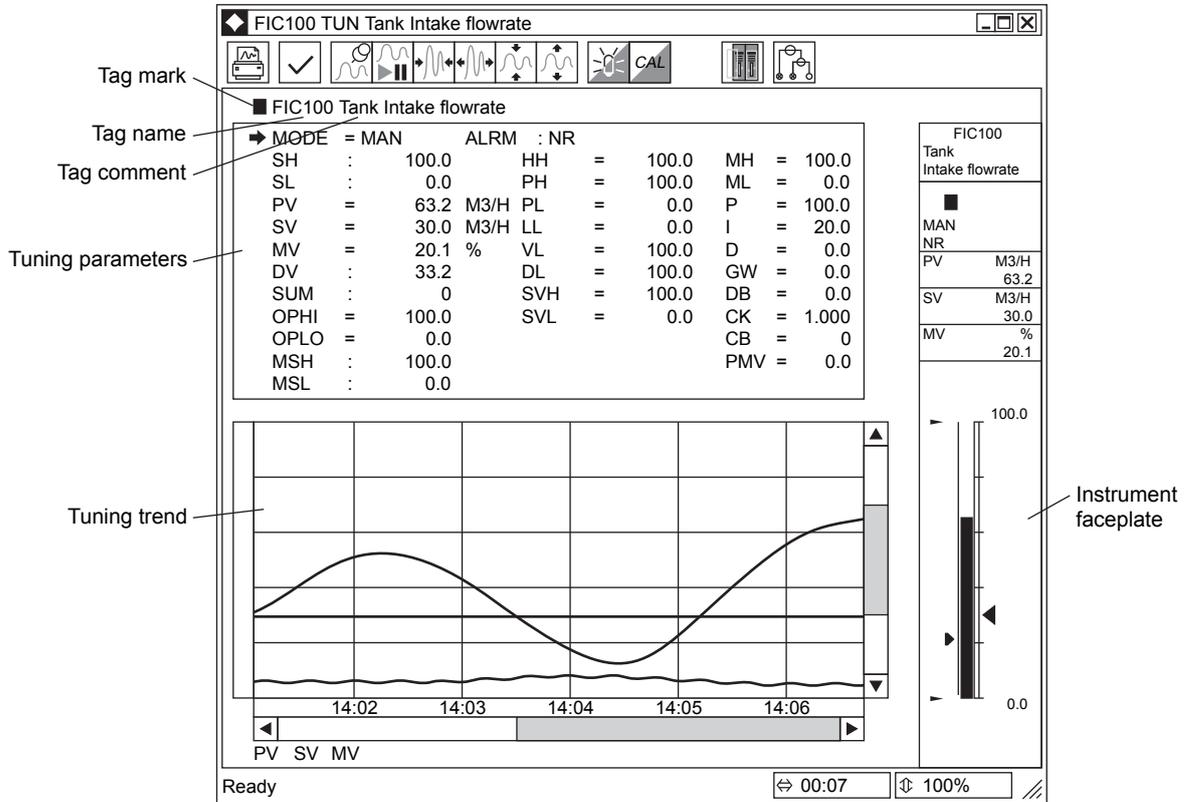


Figure Tuning Window

F030311.ai

3.3.3 Trend Window

Trend functions acquire process data, store it as time-series trend data, and display it as time-series trend charts. Each trend window can display, superimposed, up to eight color-coded "pens" (traces) representing trend data.

An example of a trend window is shown below.

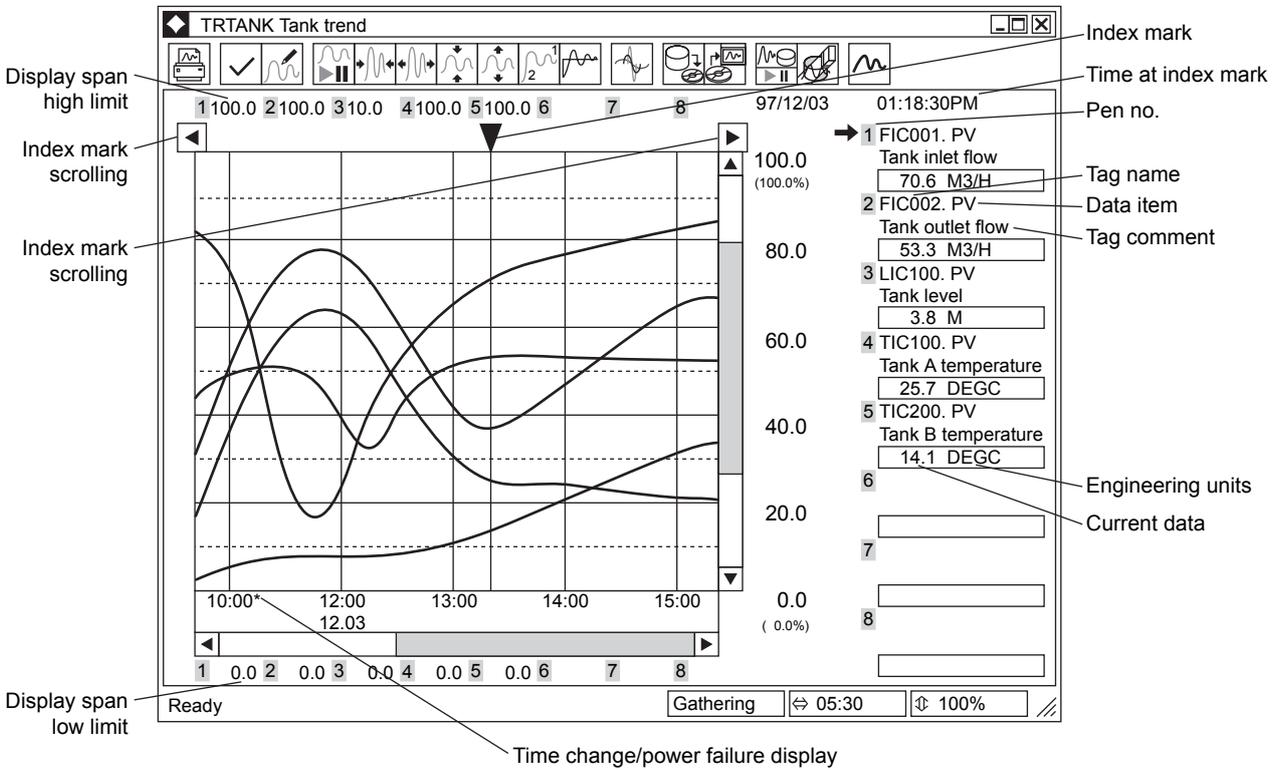


Figure Trend Window

F030312.ai

3.3.4 Trend Point Window

The trend point window displays one of the up-to-eight trend data “pen traces” allocated to a trend window. It is a one-pen view of the trend window, created automatically when process data is allocated to a trend window.

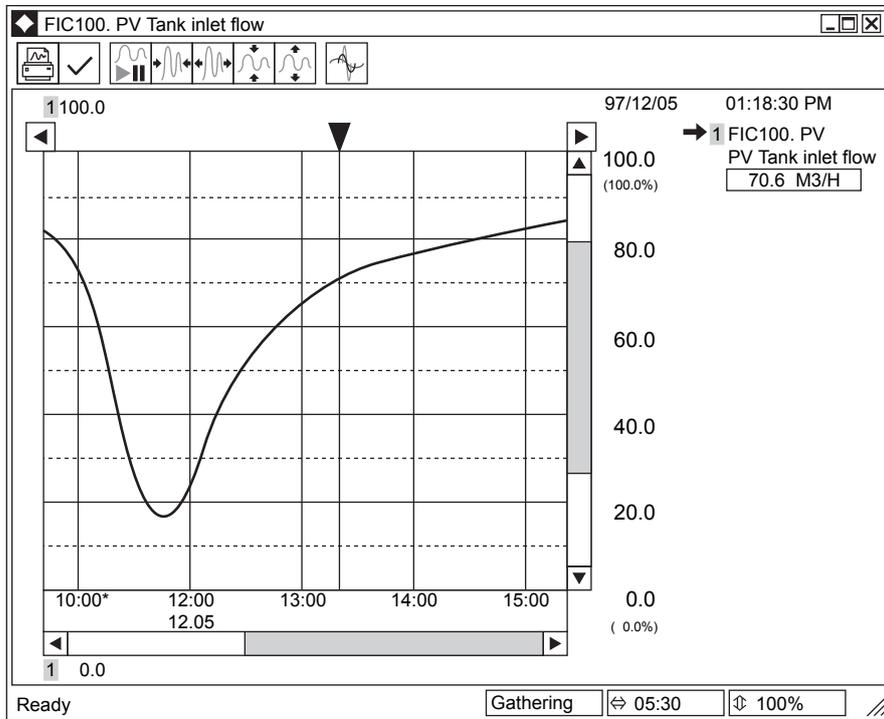


Figure Trend Point Window

F030313.ai

3.3.5 Process Alarm Window

The process alarm window displays annunciator messages and alarms (e.g. HI/LO alarms) in the order they occur. By using the buttons of toolbar, you can also select to be displayed or not for each alarm priority level (high priority, medium priority, low priority). You can search for such events by field control station or related tag name. Acknowledged and not-yet-acknowledged messages and alarms can be distinguished, and related windows displayed. The system can be configured to either acknowledge alarms individually or to acknowledge all at once.

By clicking the [SCS Alarm Occurrence Notification] button on the toolbar, it is possible to display process alarms specific to ProSafe-RS and/or all process alarms, including those of CS 3000 and ProSafe-RS, separately in the upper and lower sections of the message display area, respectively.

This allows focusing only on ProSafe-RS process alarms directly linked to plant failures.

An example of a process alarm window is shown below.

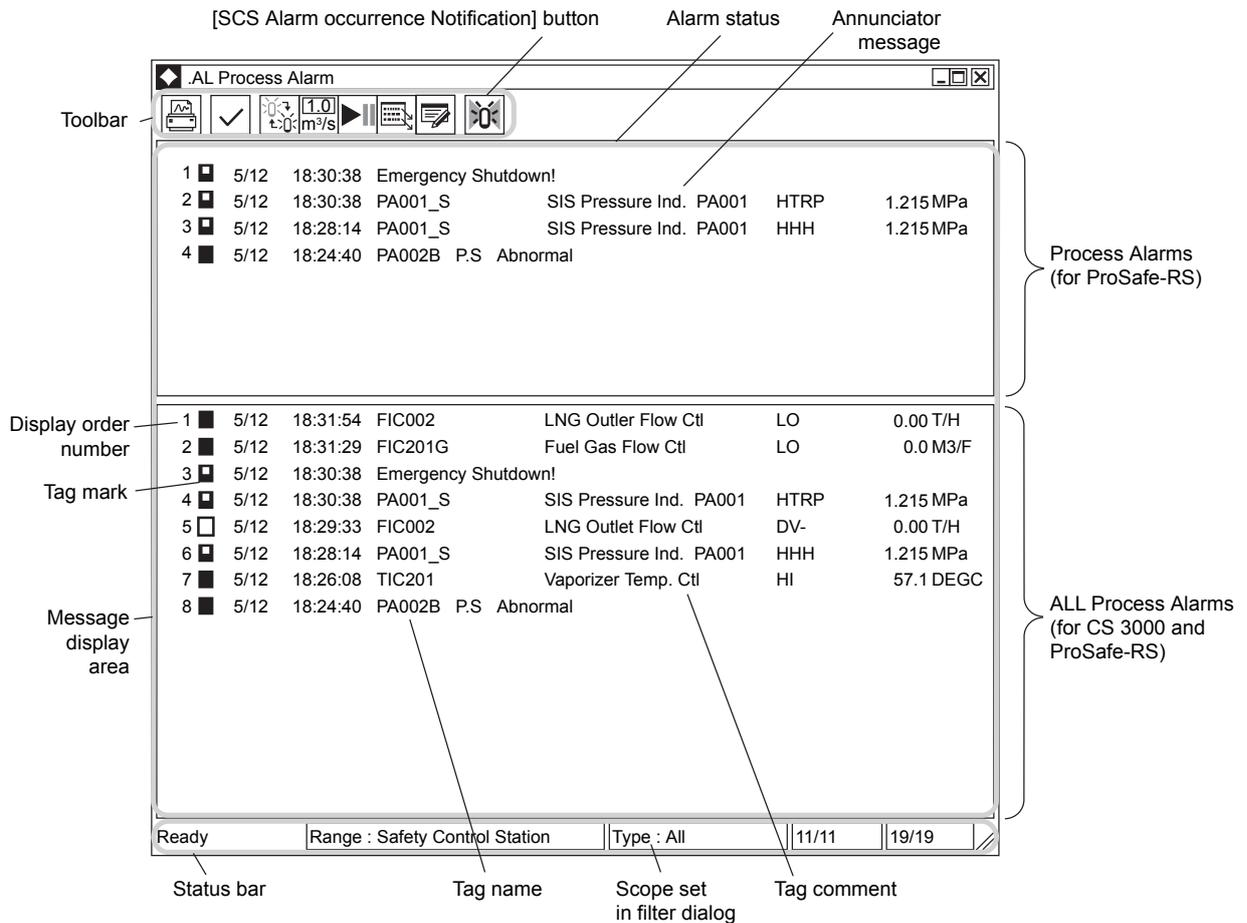


Figure Process Alarm Window

F030314.ai

3.3.6 Operator Guide Window

The Operator Guide window displays operator guide messages in the order they occur. The same as for new process alarms, new and unacknowledged operator guide marks appear, flashing, in the system message window. You can search for operator guide messages by field control station name or by related tag name. The operator guide window can display the production phase status, or instructions to the operator to enter data or confirm an action.

An example of an operator guide window is shown below.

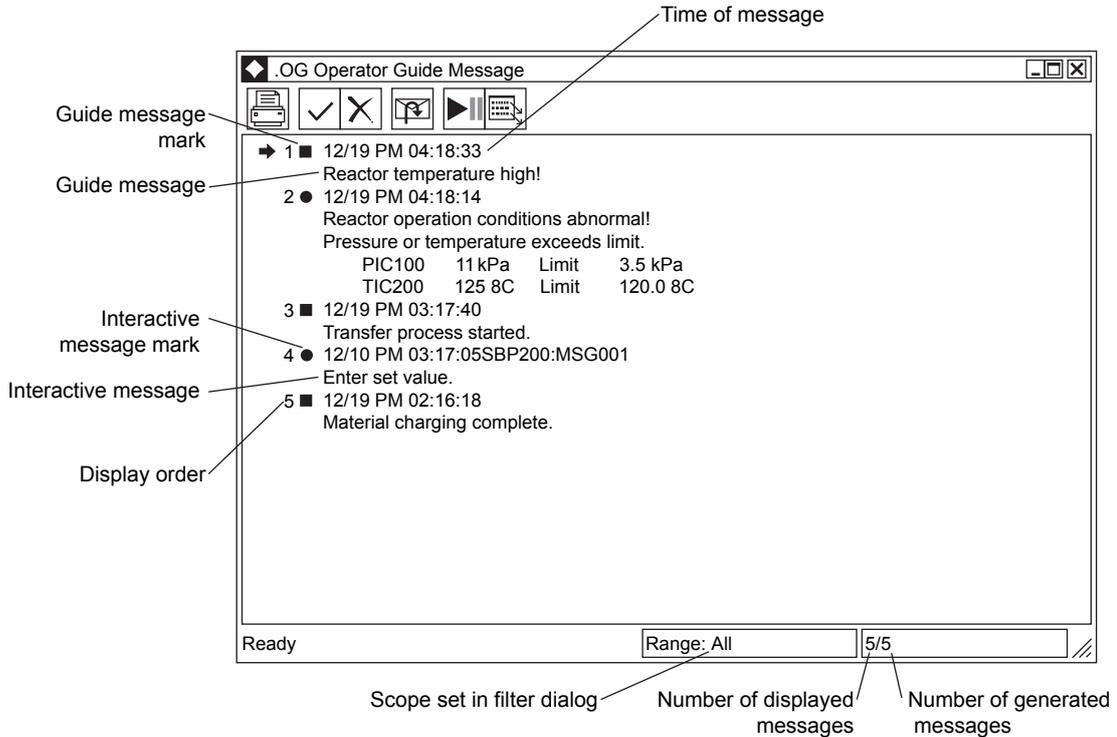


Figure Operator Guide Window

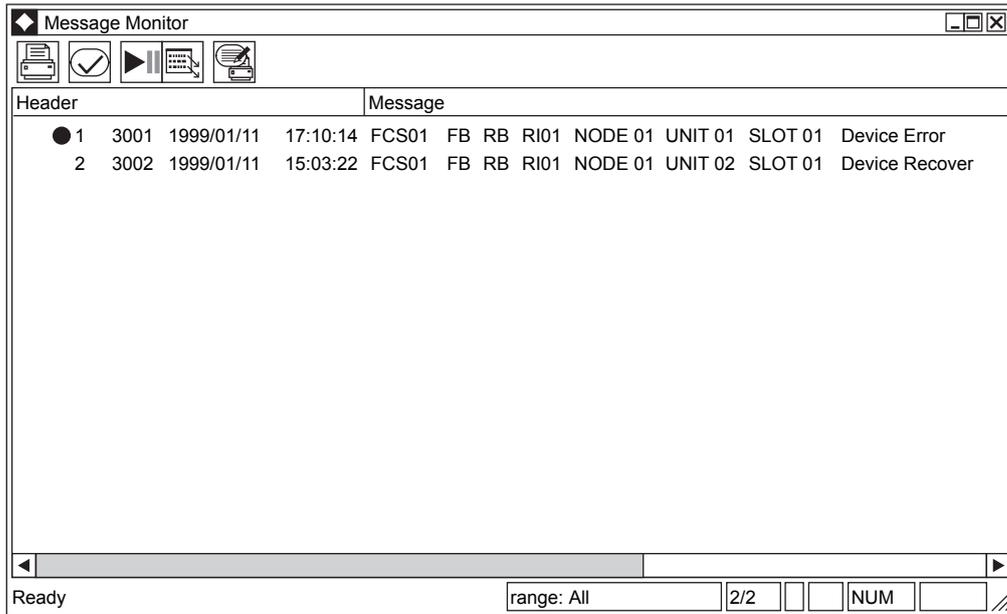
F030315.ai

3.3.7 Message Monitoring Window

The message monitoring window displays messages in the order they occur. You can specify the types of messages (such as sequence messages, operational record messages and fieldbus messages) to be acquired and displayed depending on your needs, and check messages in real time.

The message monitoring window displays newest messages first. You can specify the number of messages to be saved in the message registration dialog. When this number is exceeded, the oldest already-acknowledged message is deleted. When there are no already-acknowledged messages, the oldest not yet acknowledged message is deleted.

An example of a message monitoring window is shown below.



F030316.ai

Figure Message Monitoring Window

3.4 Operation and Monitoring Support Functions

The following operation and monitoring support functions are provided as standard:

- Process reports
- Historical message reports
- Security functions
- Report functions (option)
- Connecting ITV cameras
- CENTUM desktop environment customization
- Voice messaging functions
- Multi-monitor functions
- Advanced alarm filter function
- Remote Desktop function

3.4.1 Process Reports

The process report functions are used to acquire, display, and print various system operation status information.

Tag Report

Tag report functions display current (values of) function block alarm status, mode and process data on a per-tag basis. You can search for reports by station name, tag name, alarm status etc.

I/O Reports

I/O reports provide a digital display of I/O status on a per-element basis. You can search by station name, element type, etc.

3.4.2 Historical Message Reports

You can search the stored process alarms and operation logs containing process and system events, and display or print selective historical message reports.

3.4.3 Security Functions

Security functions help prevent operator errors and preserve system safety, restrict operation to authorized personnel, and restrict the range of operation and monitoring functions that may be performed. Security functions (such as user group and alarm processing level setting) can be used to hide alarms that are not relevant to the operator.

Overview of Security Functions

The operator can define the following operation and monitoring function attributes:

- User name (described in detail below)
An operation history is recorded for each user.
- User group (described in detail below)
This restricts the scope of FCS data that can be monitored and changed by group members.
- User permissions (described in detail below)
These restrict the range of operation, monitoring, and engineering functions that can be performed.

When the user logs on, the corresponding user group and user permissions are checked, which determines the range of operation and monitoring functions and permissions.

The flow of the security functions is illustrated below.

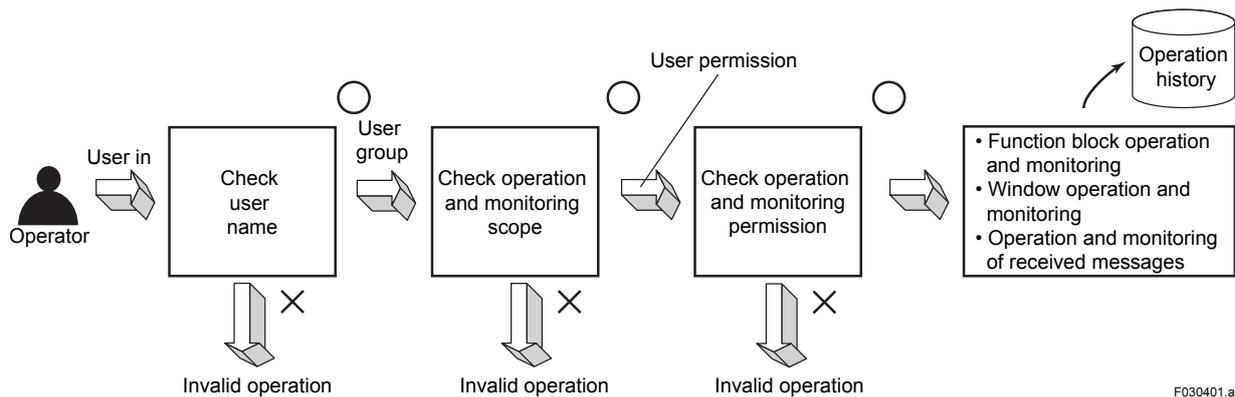


Figure Flow of Security Functions

F030401.ai

User Name

This is a user-specific user name which uniquely determines who the operator is. Historical (operation) logging and the like will include this user name. A password is associated with each user name. Passwords are defined on a per-HIS basis. The operation and monitoring functions manage passwords separate from the Windows security functions. Thus the HIS user name does not agree with the Windows log-on user name.

User Groups

The User Group which the user belongs to determines the scope of operation and monitoring functions that can be performed. The user group determines which FCS can be monitored, which FCS can be operated, and which windows can be displayed. You can restrict the items which can be monitored and operated by specifying the corresponding station name and drawing name, for example. You can specify certain groups in certain plants, for example.

User Permissions

You can subdivide a user group into several levels of user permission (restriction): ordinary operator, senior operator, engineering personal, etc. The default is three such levels – S1, S2, and S3 – per user group. The default user permissions for these three levels are as shown below.

User-defined user permissions U1 to U7 are also possible.

Table Standard User Permissions

| Permission level | Monitoring | Operation | Engineering |
|------------------|-------------|-----------|-------------|
| S1 | x | – | – |
| S2 | x | x | – |
| S3 | x | x | x |
| U1 to U7 | Set by user | | |

X: enabled
–: disabled

Security on a Per-Function-Block Basis

You can require confirmation when setting data in important function blocks, to prevent inadvertent data entry. Using operation marks, you can also change temporarily the operations are available or not.

For each individual function block, you can specify:

- User restrictions
User restrictions on changing settings such as SV, MV or alarms.
- Confirmation of settings
The need for confirmation of settings (to help prevent errors).
- Alarm processing
The type of alarm (blinking, need for acknowledgment, repeat alarms).
- Tag mark
The tag mark corresponding to an individual function block can also be specified by the user, to indicate tag importance (priority).

Table Tag Priority Levels

| Tag priority | Tag mark |
|-----------------|---|
| Important tag |  |
| Ordinary tag |  |
| Auxiliary tag 1 |  |
| Auxiliary tag 2 |  |

Security on a Per-Window Basis

For each window, you can set three categories of authorizations for operation and monitoring:

- Ordinary windows
- Important windows
- System operation windows

3.4.4 Report Functions (Option)

The report package enables you to create a daily or monthly report. You can use Microsoft Excel to format the report. Reports can be defined using the daily or monthly report templates included in the package, or you can create new templates from scratch. The types of data you can read in and display include:

- Closing data (average values, totals, maximums, minimums)
- Historical trend data
- Historical alarm event messages
- Tag information
- Process data (instantaneous values)
- Batch data

An overview of the reporting functions is displayed below:

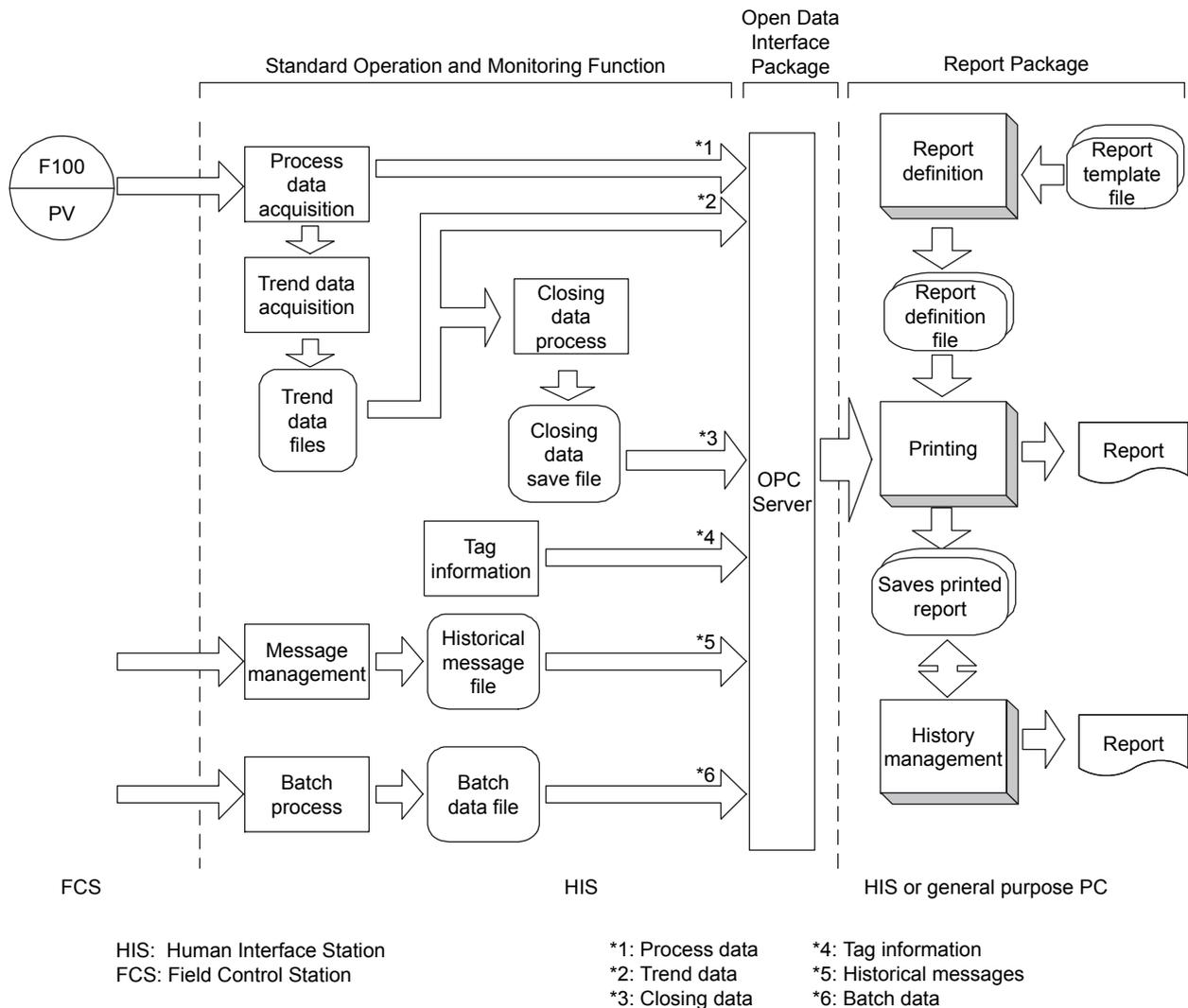


Figure Overview of Reporting Functions

F030402.ai

An example of a daily report template is shown below. You define tag numbers and process data to be logged, and the daily report format is created.

| XXXXXX Daily Report | | | | | | | Date : yyyy/mm /dd | |
|---------------------|----------|----------|-------------------|-------------------|-------------------|----------------|--------------------|----------|
| TIC100 | TIC200 | TIC300 | FIC100 | FIC200 | FIC300 | FIC400 | FIC500 | |
| PV | PV | PV | PV | PV | PV | SUM | SUM | |
| Temp.1 | Temp.2 | Temp.3 | Flow1 | Flow2 | Flow3 | Total | Total | |
| DEGC | DEGC | DEGC | m ³ /h | m ³ /h | m ³ /h | m ³ | m ³ | |
| 00:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 01:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 02:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 03:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 04:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 05:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 06:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 07:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 08:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 09:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 10:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 11:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 12:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 13:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 14:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 15:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 16:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 17:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 18:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 19:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 20:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 21:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 22:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| 23:00 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| Ave. | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| Total | | | | 000.0 | 000.0 | 000.0 | 00000.0 | 00000.0 |
| Max. | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| Min. | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00.0 | 00000.0 | 00000.0 |
| Time for Max. | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 |
| Time for Min. | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 | 00:00:00 |

F030403.ai

Figure Report Template Example

Starting Printing

Printing may be started as follows:

- Automatic printing at preset interval/specified time
- Automatic printing when sequence message received
- Manual printing when function key (on operation keyboard) pressed
- Manual printing when button on graphic window clicked
- Manual printing from Microsoft Excel
- Printing from application program (using Visual Basic)

Report Printing from Other PC

The report package supports the open data interface OPC (OLE for Process Control). This allows Windows-based machines on the network to access report data and use Microsoft Excel to print report data.

3.4.6 CENTUM Desktop Environment Customization

CENTUM Desktop Environment Customization controls functions not required for operation and monitoring, such as standard Windows functions and the Auto Run function from Explorer or CD-ROM, providing an optimal operating environment (CENTUM Desktop).

Customization (profiles):

- All Desktop Icons (My Computer, Trash Can, etc.) can be hidden.
- Unnecessary items on the start menu (Explorer, Shutdown, etc.) can be hidden.
- Auto Run from CD-ROM can be disabled.

You can use the HIS utility to switch between the Windows standard desktop and CENTUM desktop.

3.4.7 Voice Messaging Functions

Annunciators and operator guide messages are displayed and buzzers are sounded to inform process status and abnormalities. By using the voice messaging functions, operator can farther confirm the process status and abnormalities. In addition to voice messaging, this function can generate combined messaging of voice and animation, and buzzer messaging.

3.4.8 Multi-monitor Functions

The Multi-monitor functions enable one general purpose PC to use two monitors, permitting to display more information. Switching between two monitors can be done by mouse or function key previously assigned. This function is available with both console type HIS and desktop type HIS. The two monitors, which are designated as main and sub monitors, can be set up in the following display modes:

Table Combination of the main and sub-monitor screen modes

| Main monitor | Sub monitor |
|-------------------|-------------------|
| Full-screen mode | Full-screen mode |
| Full-screen mode | Multi-window mode |
| Multi-window mode | Full-screen mode |
| Multi-window mode | Multi-window mode |

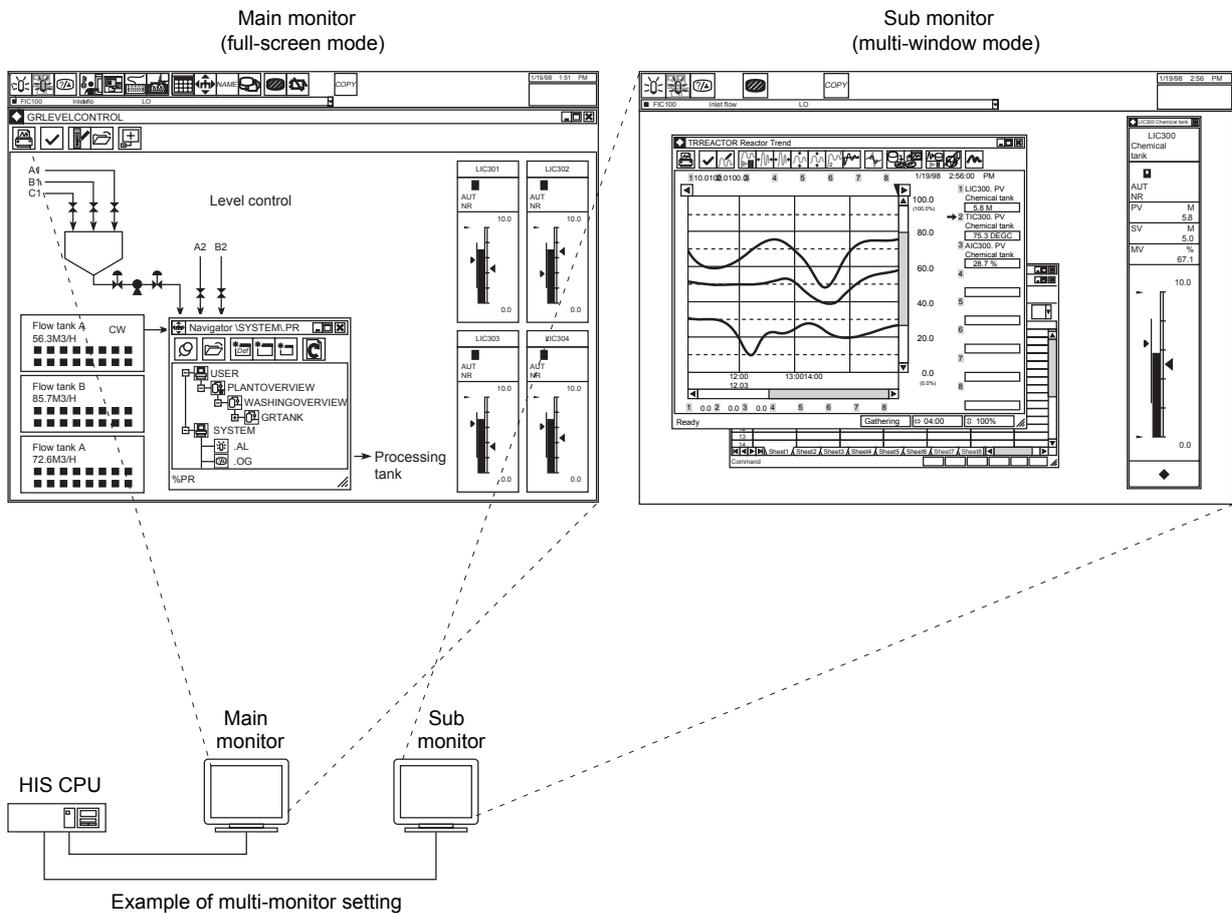


Figure Multiple Monitors in Full-screen and Multi-window Modes

F030405.ai

3.4.9 Advanced Alarm Filter Function

This function selects the alarms to be displayed on the HIS, and notices only the necessary alarms. In addition to the range in charge such as the station names, tag names and so forth, it can also select from the alarm names and the color of alarms. Therefore it can select the alarms according to the roles of operator, equipment maintenance person and such. Furthermore, by using the logic operations, the more detail filter setting can be performed. The items used for selections are shown below.

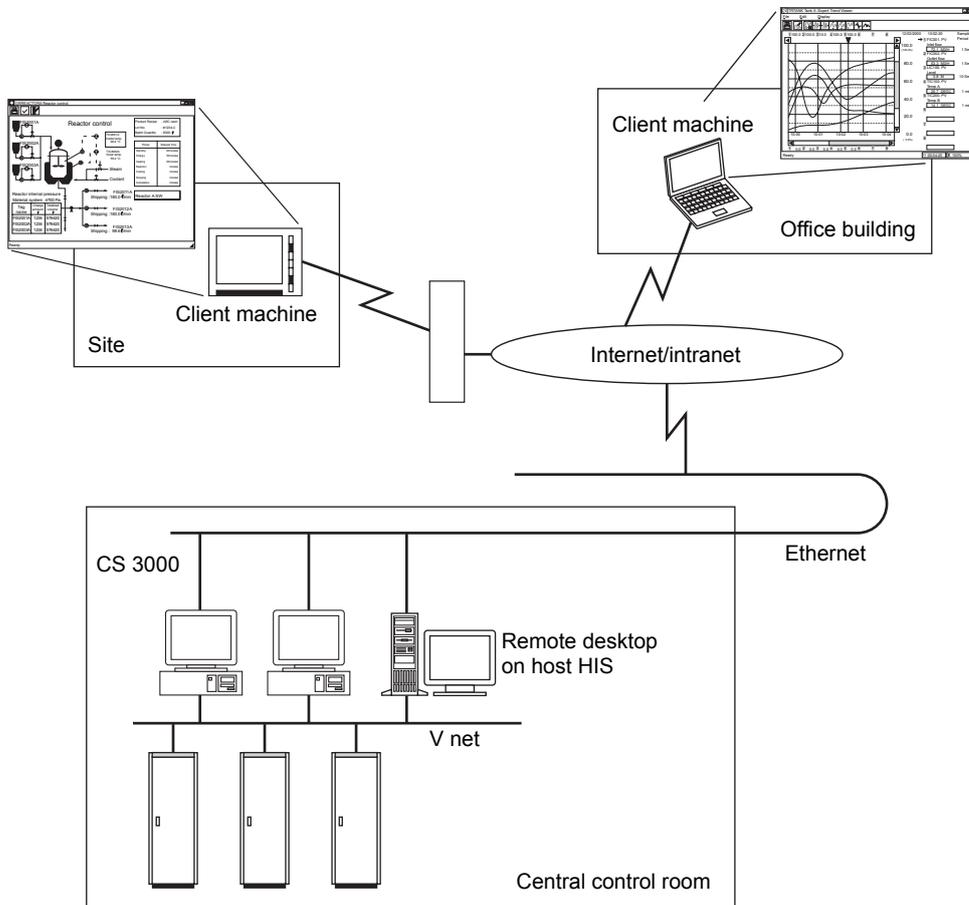
- The kind of messages: process alarm, operator guide message and annunciator message
- Message number
- Station names
- Tag names
- Alarm priority levels: high priority, medium priority and low priority
- The color of alarms
- Alarm names: HI (high alarm), IOP (input open alarm) and so forth.

3.4.10 Remote Desktop Function

The standard remote desktop feature of Windows XP enables the functions of the CENTUM CS 3000 to be accessed from a distant location. Logging on from a client machine to a host machine, such as via the Internet, enables HIS operation and monitoring functions as well as builders for system generation to run on a client machine.

Benefits

- Only an Ethernet or dial-up connection is required. No need of connection to the V net control network.
- Uses a Windows XP standard feature. No special software is required.
- Even a low-speed connection such as at a rate of 128 kbps is sufficient.
- The number of client PCs that can simultaneously access the host PC is one.



F030406.ai

Figure Examples of Remote Desktop Connections

3.5 System Maintenance Functions

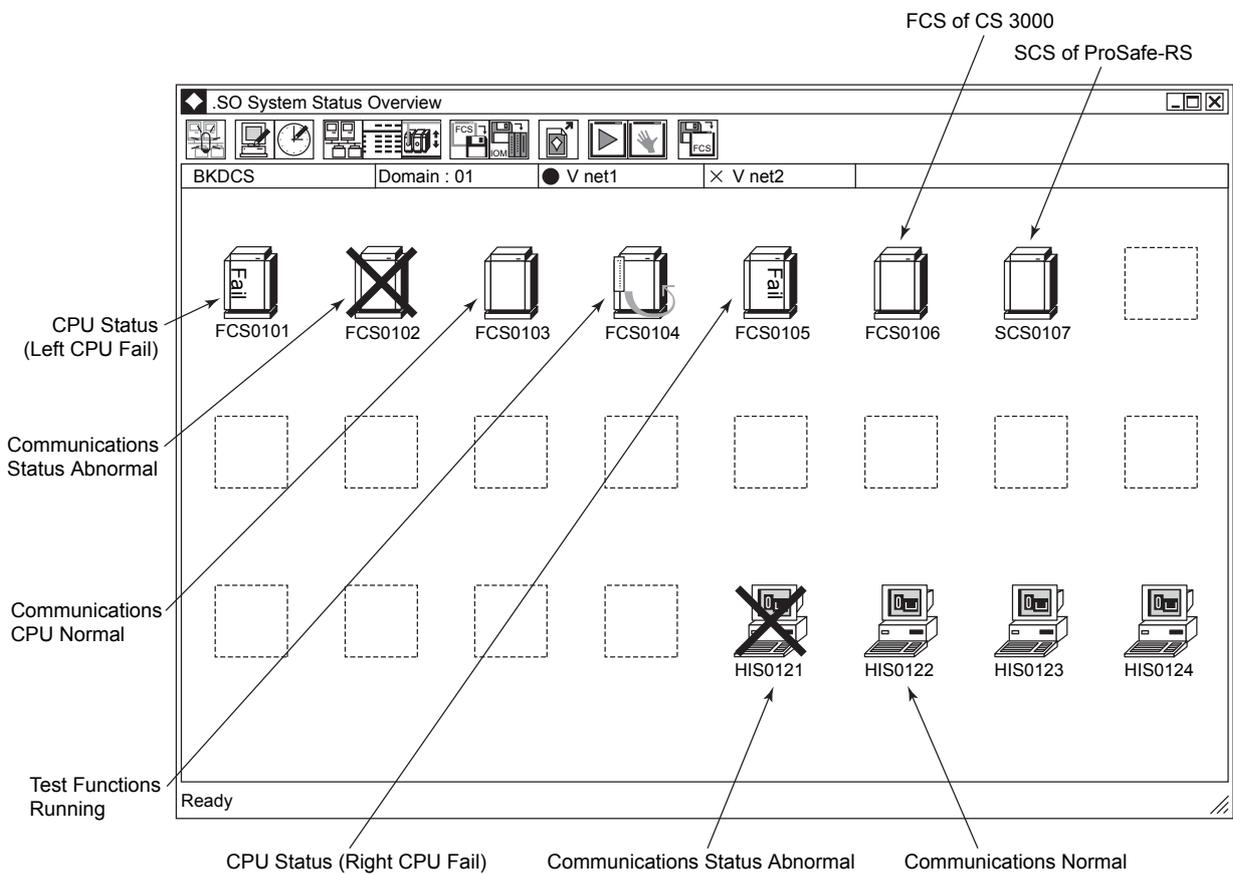
This section describes windows and dialogs for system status confirmation and system maintenance.

- System status overview window
- System alarm window
- FCS status display window
- HIS setting window
- Time setting dialog
- Help dialog

3.5.1 System Status Overview Window

The system status overview window displays the status of stations on the V net.

An example of a system status overview window is shown below.



F030501.ai

Figure System Status Overview Window

3.5.2 System Alarm Window

The system alarm window displays system alarm messages such as system hardware abnormalities and communication abnormalities. You can obtain a simple explanation of system alarm messages and how to resolve them using the HELP button.

System alarm messages are not defined by the user, they are part of the system software.

By clicking the [SCS Alarm Occurrence Notification] button on the toolbar, it is possible to display system alarms specific to ProSafe-RS and/or all system alarms, including those of CS 3000 and ProSafe-RS, separately in the upper and lower sections of the message display area, respectively.

This allows focusing only on ProSafe-RS system alarms.

Note that all SCS diagnostic information, including ProSafe-RS field wiring checks (short-circuit failure and disconnection failure), is notified to an HIS as system alarms.

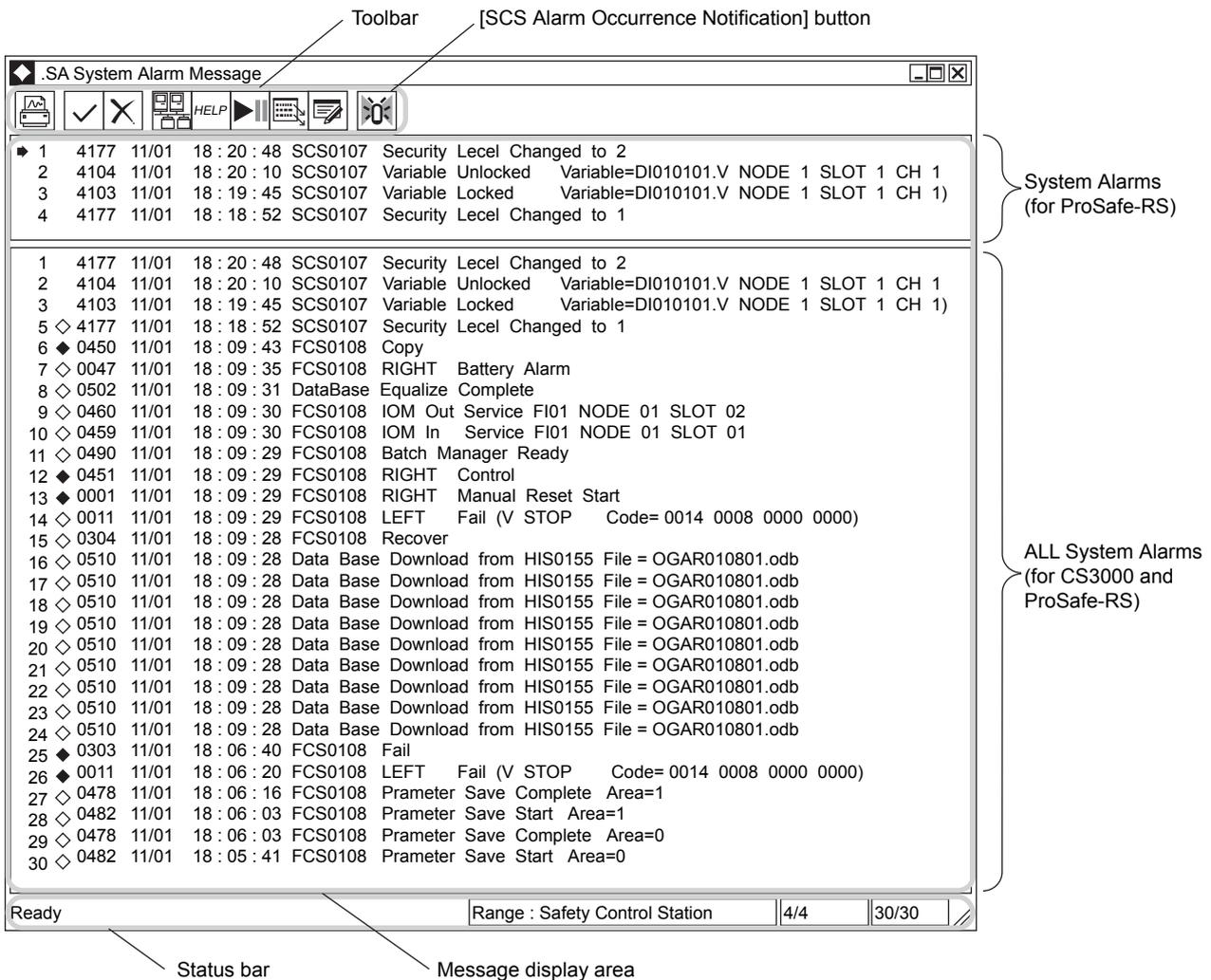


Figure System Alarm Window

F030502.ai

3.5.3 FCS Status Display Window

The FCS status display window displays FCS station information, hardware configuration and status, and communications bus status. You can start or stop the displayed FCS, download I/O Module configuration information, and save tuning parameters. The window display is different for a standard FCS for FIO (KFCS) with multiple nodes than for a compact FCS for RIO with no remote nodes and a compact FCS for FIO.

An example of a status display window for a standard FCS for FIO (KFCS) is shown below.

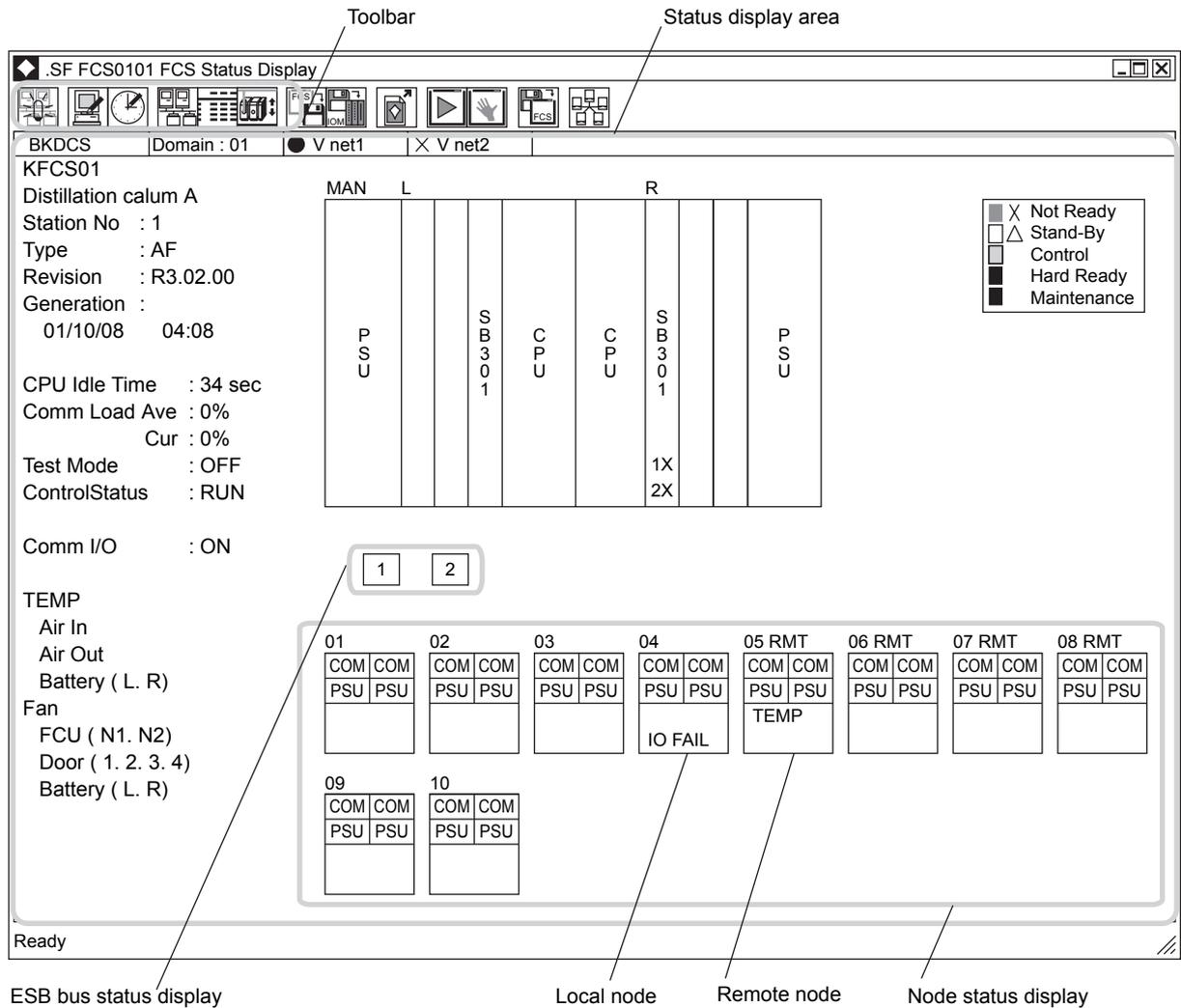


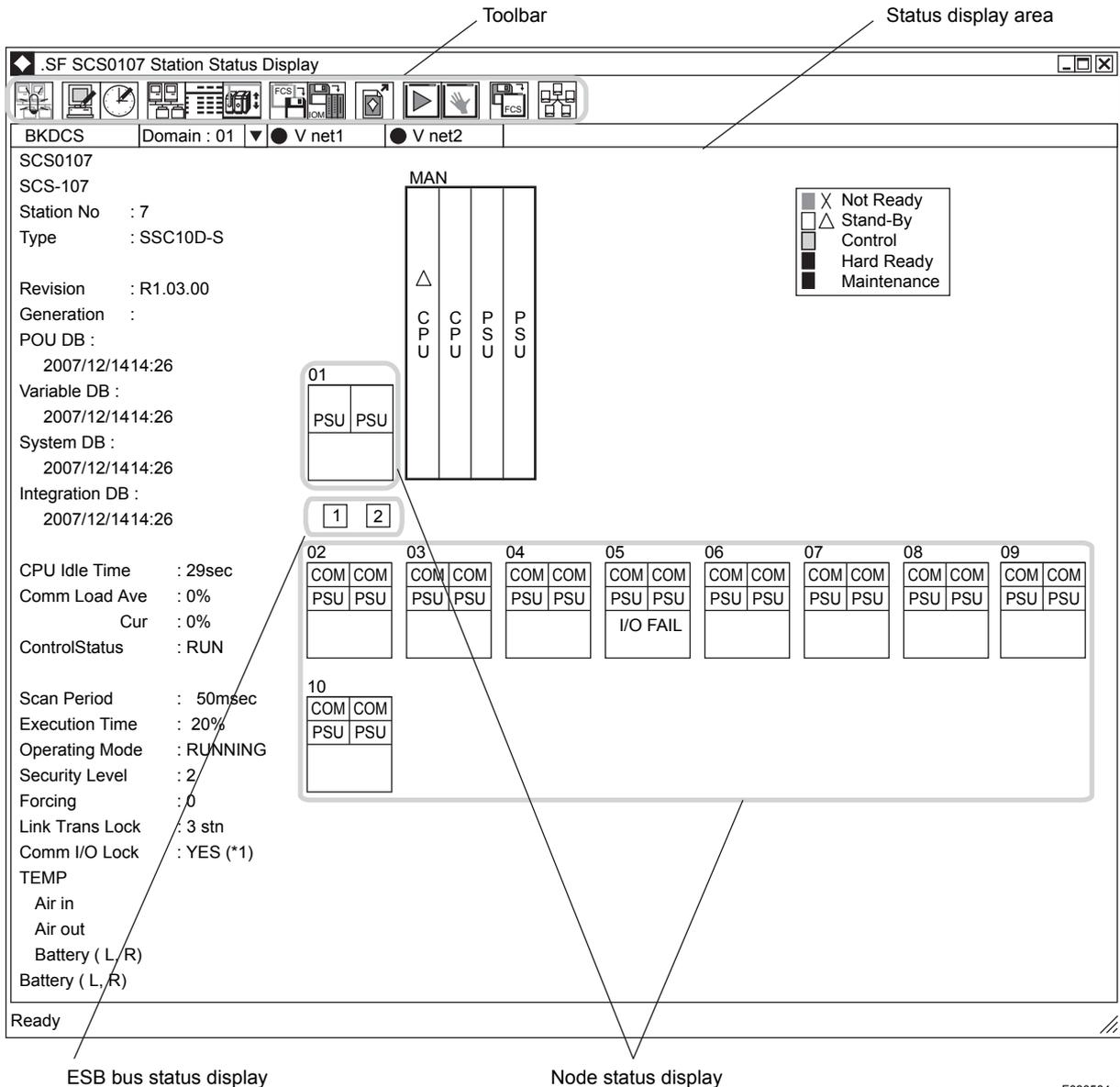
Figure FCS Status Display Window

F030503.ai

3.5.4 SCS Status Display Window

The SCS status display window displays SCS station information, hardware configuration, hardware status, communication bus status, operating mode, security level, number of forcing operations, etc., in a list.

An example of the SCS status display window is shown below.



*1: Displayed in the versions of R1.01.30 or later.

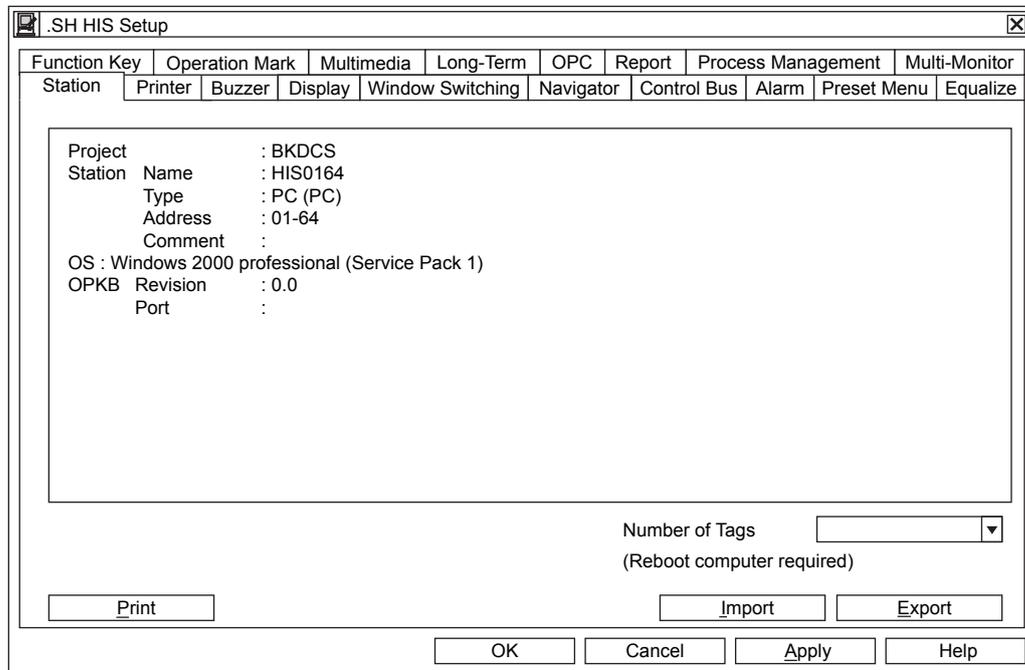
Figure SCS Status Display Window

F030504.ai

3.5.5 HIS Setting Window

The HIS setting window displays station information and operating environment for the HIS. The operating window allows use to set window size, printer settings, screen mode setting, and operation/monitoring function specific settings.

An example of an HIS setting window is displayed below.



F030505.ai

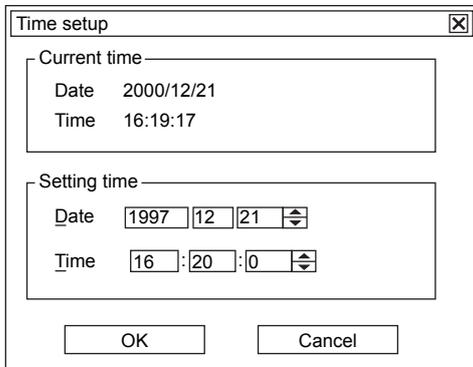
Figure HIS Setting Window

Table HIS Setting Tab Sheet Items

| Tab Sheet Name | Contents |
|---------------------------------------|--|
| Station Tab Sheet | Shows station information such as the project name and HIS software revision, and is used to set the security policy (password change request and intrusion count check settings). |
| Printer Tab Sheet | Settings for printing messages & reports; print screen functions. |
| Buzzer Tab Sheet | Sets buzzer volume, tone, source, etc. |
| Display Tab Sheet | Switches between full-screen & windowed modes, sets font size, etc. |
| Window Switching Tab Sheet | Sets size of windows launched from system message window, automatic opening of window when alarm occurs, etc. |
| Navigator Tab Sheet | Sets the preferences for the Navigator window. |
| Control Bus Tab Sheet | Shows control bus communications status. |
| Alarm Tab Sheet | Sets process alarm display mode, method of alarm confirmation, etc. |
| Preset Menu Tab Sheet | Determines preset menu settings. |
| Equalize Tab Sheet | Performs equalization, sets equalize environment. |
| Function Key Tab Sheet | Assigns function keys on operation keyboard. |
| Operation Mark Tab Sheet | Operation mark settings. |
| Multimedia Tab Sheet | Sets multimedia functions. |
| Long Term Data Tab Sheet (option) | Settings for long-term data (archiving) package. |
| External Recorder Tab Sheet (option) | Sets External Recorder Output. |
| OPC Tab Sheet (option) | Selects need or not for operation logs in process data logging. Sets quality codes. |
| Report Tab Sheet (option) | Specifies printers for report output. |
| Process Management Tab Sheet (option) | Sets the simultaneous unit formula dialog call mode, selects whether to display batch-related trend windows, and is used to customize Product Overview toolbar buttons. |
| Multi-monitor Tab Sheet (option) | Sets dual stacked monitor for console type HIS and two monitors for desktop HIS. |

3.5.6 Time Setting Dialog Box

The time setting dialog sets the system date and time. This sets the date and time for the whole CENTUM CS 3000 system on the V net. The same system date and time is set (at Windows operating system and operator station levels).



F030506.ai

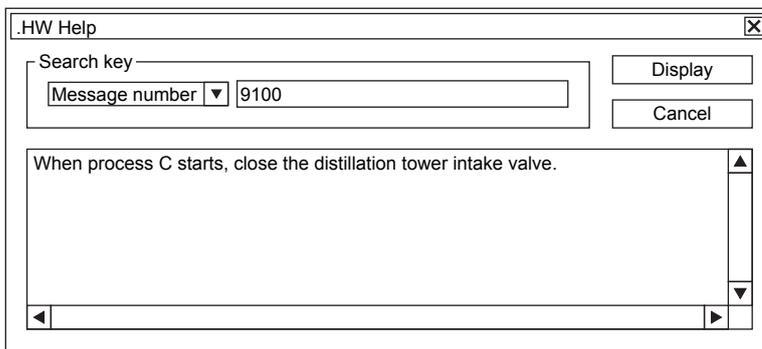
Figure Time Setting Dialog

3.5.7 Help Dialog Box

The help dialog box can display predefined (system) or user-defined help messages to assist the operator with plant operation and monitoring.

Only one help dialog can be associated with each operation and monitoring window.

An example of a help dialog box is shown below.



F030507.ai

Figure Help Dialog Box

3.6 Control Status Display Window

The control status display windows are intuitive, color-coded display of the status of control functions. Depending on the way to generate a system, the following displays are available:

- Control drawing window
- Sequence table window
- Logic chart window
- SEBOL window
- SFC window

3.6.1 Control Drawing Window (Option)

The control drawing window provides an interactive display of control status on a control drawing. It provides an overview of data values and alarm status related to the selected control loop. It is continuously updated.

A sample of a control drawing window is shown below.

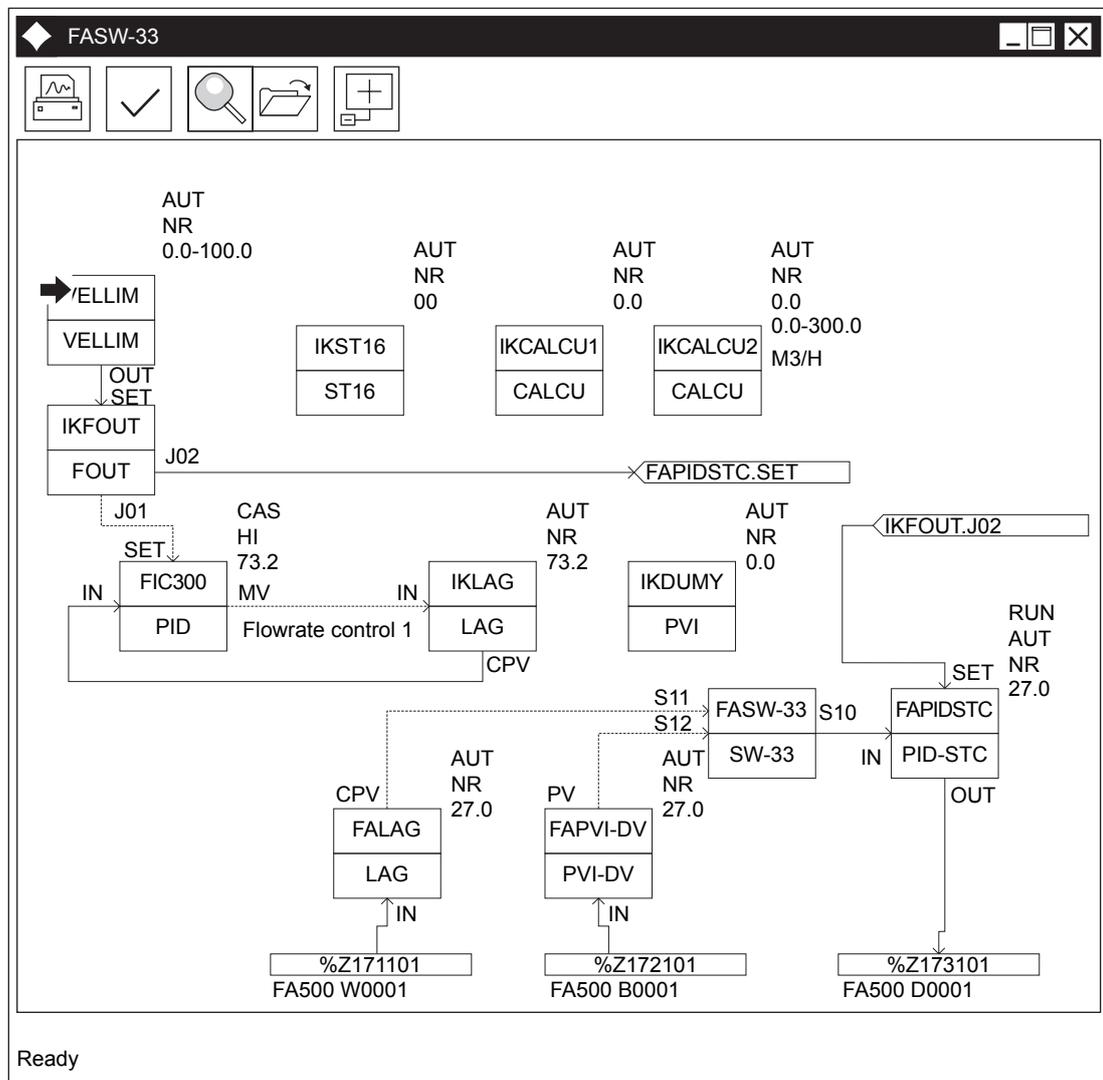
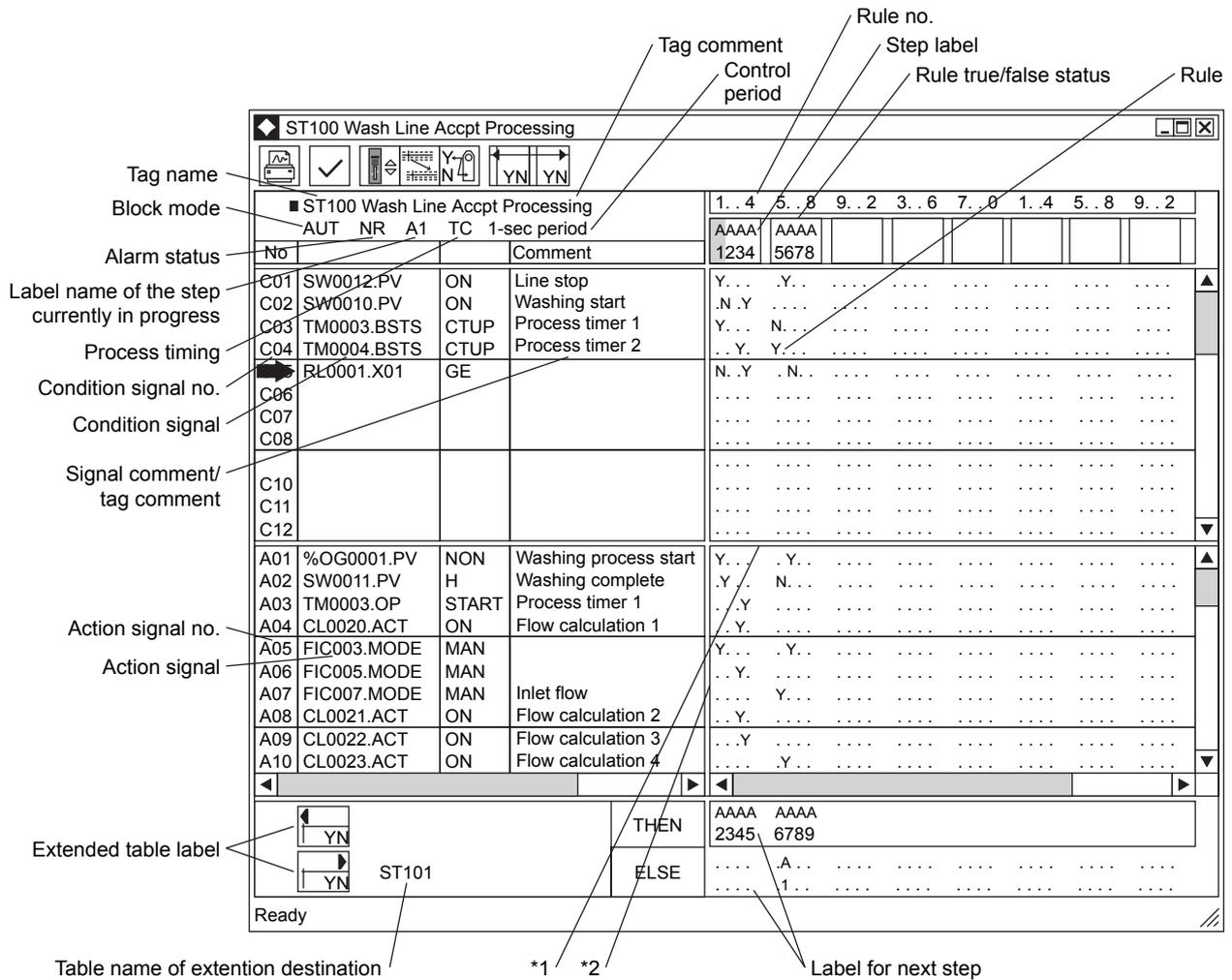


Figure Control Drawing Window

3.6.2 Sequence Table Window

The sequence table window provides a detailed display of the status of sequences in sequence table blocks. Sequence table scan status, rule true/false status and sequence progress are displayed.

An example of a sequence table window is shown below.



- *1: Can drag to change (relative) display area for conditions/actions
- *2: Can drag to change display area for signals & comments/rules

Figure Sequence Table Window

F030602.ai

3.6.3 Logic Chart Window (Option)

The logic chart window displays logic chart block details and status. Logic chart scan status, logic true/false status, and other control progress can be monitored.

A logic chart window display example is shown below.

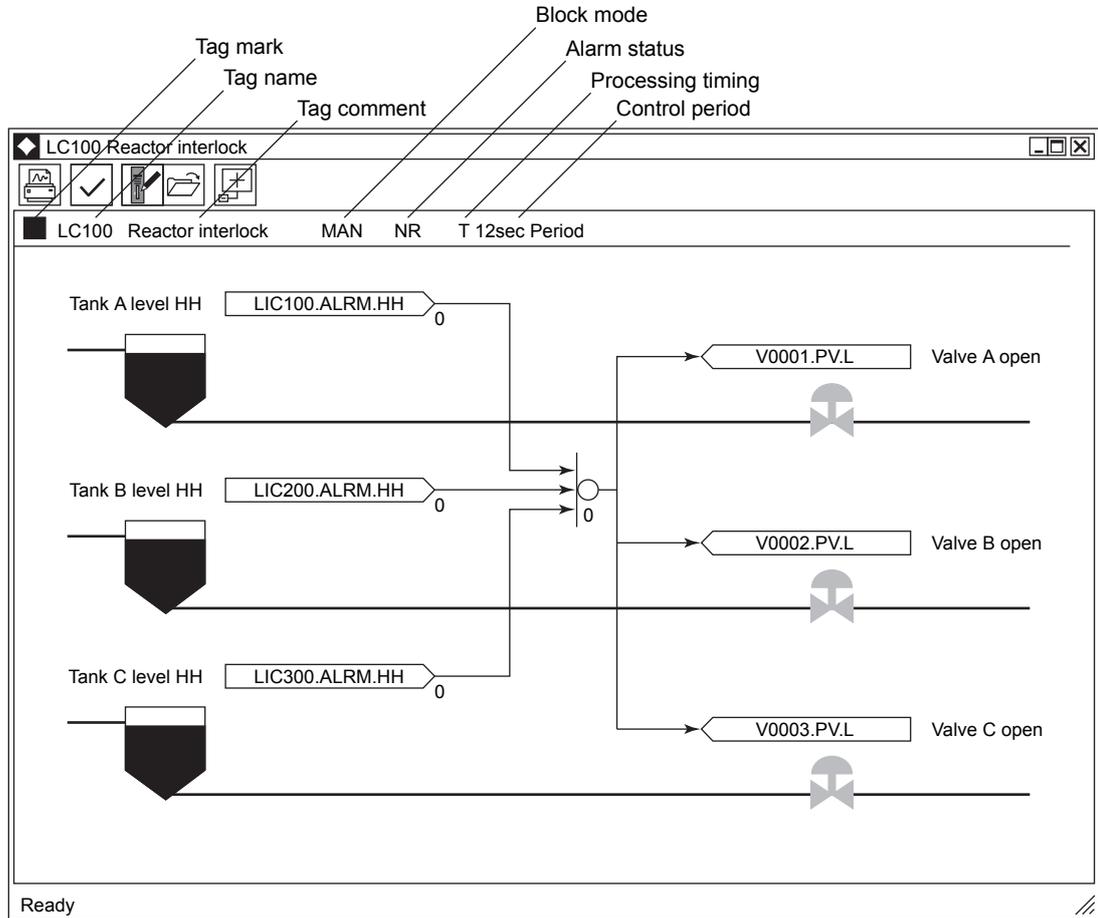


Figure Logic Chart Window

3.6.4 SEBOL Window

The SEBOL window displays a SEBOL program and current program status. You can also display details of the currently-executing SEBOL statement in a SEBOL detail window.

An example of a SEBOL window is shown below.

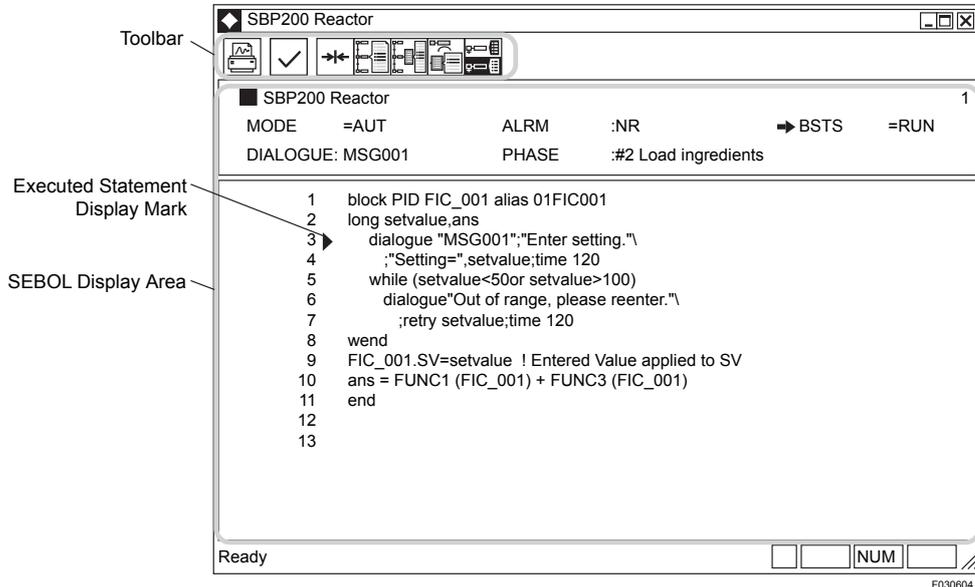


Figure SEBOL Window

3.6.5 SFC Window

This window displays SFC block status. From here, you can call up a detail window which displays each step in a phase, and from paused status force a jump to another step, etc.

An example of an SFC window is displayed below.

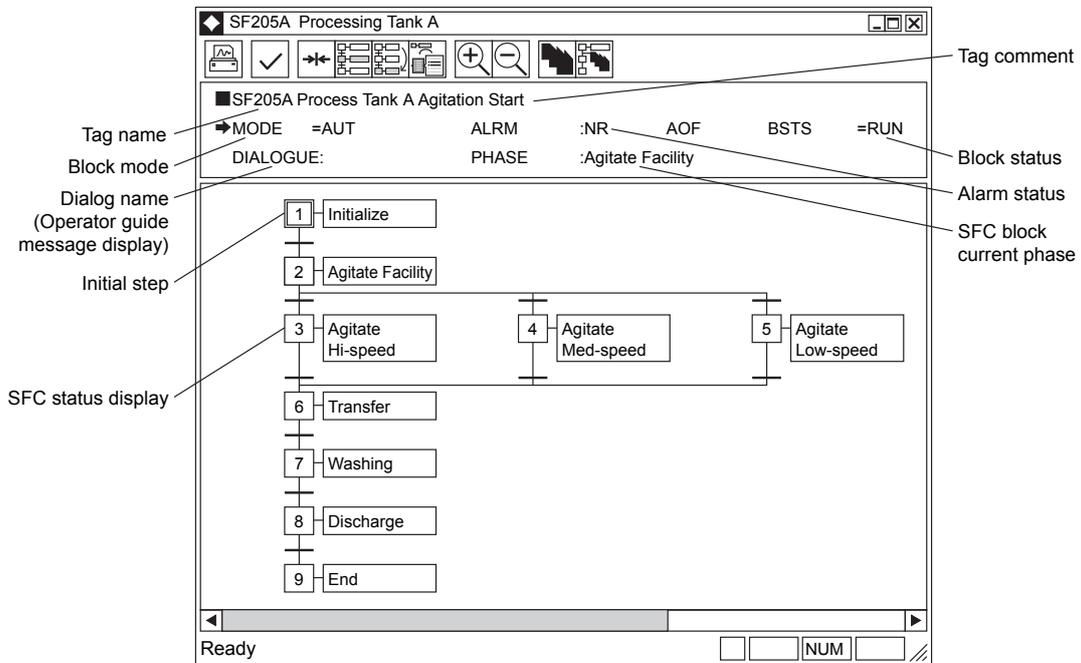


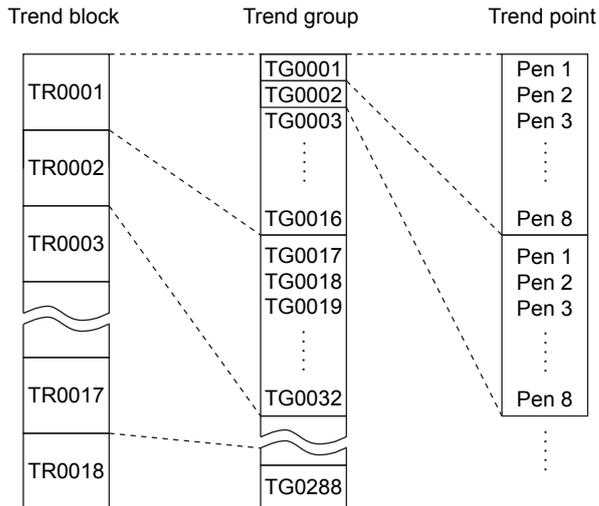
Figure SFC Window

3.7 Trend Functions

The trend recording functions acquire and record process data, and process status can be monitored by displaying and viewing trend recordings.

3.7.1 Trends

To capture a trend, you must specify the data to be acquired and the type of trend, as well as scan interval and recording time span. Data is acquired in "trend blocks" of 128 items. Acquired data is captured to a hard disk file, and can be displayed and viewed.



TR00nn (nn: 01 to 18) : Trend block name. Fixed for system.
 TG0xxx (xxx: 001 to 288) : Trend group name.

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Figure Hierarchy of Trend Functions

The trend specifications are as follows:

Table Trend Specifications

| Item | | Specifications | | | | | |
|------------------------|------------|---|---------|--------|--------|---------|---------|
| Data to be recorded | | Numeric data (PM, SV, MV, FV etc.) | | | | | |
| Scan period | | 1 sec | 10 sec | 1 min | 2 min | 5 min | 10 min |
| Recording span | | 48 min | 8 hours | 2 days | 4 days | 10 days | 20 days |
| No. of points acquired | | Max. 2304 points. For 1 sec. or 10 sec. scan period, max. 256 points. | | | | | |
| Acquisition type | Continuous | Rotary type | | | | | |
| | Batch | Rotary type, One shot type | | | | | |

Data acquired by the trend functions may be used to create closing data. Closing processing may include calculation of totals and average value, maximum and time it occurred, and minimum and time it occurred. This data is in a convenient form for use in statistical processing. Using the OPC interface package, this data may be read into a spreadsheet or similar external report generation package.

3.7.2 Tuning Trend

The tuning trend is displayed in a tuning window. Tuning trend acquisition starts when the tuning window is displayed, and stops when the window is closed. You may start the “reserve” function to continue recording even after the window is closed. The “reserved” (continued) recording data is displayed next time the window is opened. You can change the trend graph axes.

The specifications of the tuning trend are as follows:

Table Specifications for Tuning Trend

| Item | Specifications |
|------------------------|--|
| Data to be recorded | PV (CPV), SV, MV, FV, SW |
| Acquisition period | 1 sec. |
| Recording timespan | 48 minutes (2880 samples) |
| No. of points acquired | Depends on no. of tuning windows displayed |
| Recording type | Continuous (Rotary) |
| Reserve functions | 16 points |

3.7.3 Displaying Trends from Other Stations

Trend data acquired at any HIS can be displayed at other HIS. You can define the data to be displayed, in 128-point trend block units, using the engineering functions. An HIS can access and display up to 6400 points, including locally-acquired data.

Trend specifications for remote trend data are the same as for local trend data.

3.7.4 Long-term Data Archive Functions (Option)

For the standard trend and historical message functions, when the acquired data reaches capture file capacity the oldest data is overwritten. If you want to keep recording data to disk, use the long-term data archive functions. The following data can be saved:

- Trend data (in units of trend blocks),
- Closing data (in trend pen units),
- Historical data (in day units).

The open data interface is used to access long-term data. Long-term trend data is displayed in a standard trend window.

Saving to other Media

You can save long-term record of plant data and operation logs to other media such as MO, and restore them from media to hard disk.

Disk Capacity

The disk capacity used depends on how long data should be saved. Typical capacities are shown below.

Table Typical Figures for Disk Capacity

| Data type | Save data time-span | | Disk capacity used | Notes |
|--------------------|---------------------|-----------|--------------------------------|--|
| Trend | High speed | 24 hours | 194.4 MB | for High speed 256 points, 1-sec. period 2 blocks or Low speed 768 points, 1-min. period 6 blocks |
| | Low speed | 100 days | 1036.8 MB (total 1231.2 MB) | |
| Closing data | Hourly | 100 days | 22.5 MB | For 200 points |
| | Daily | 50 months | 14.5 MB | |
| | Monthly | 10 years | 1.2 MB (total 38.2 MB) | |
| Historical message | | 100 days | 50.0 MB | Assuming 0.5 MB / day |

Disk capacity : approx. 1.5 GB

3.7.5 External Recorder Output Functions (Option)

Process data acquired by HIS can be output to external recorder by this function.

- Can be used on any platform with operation and monitoring functions.
- 8 points per group, up to 4 groups (max. 32 points) can be output.
- 8 points per group, and security can be set for each group.
- Yokogawa's FA-M3 PLC is use as D/A converter, making a simple but expandable hardware configuration. FA-M3 allows for a low-cost hardware configuration.

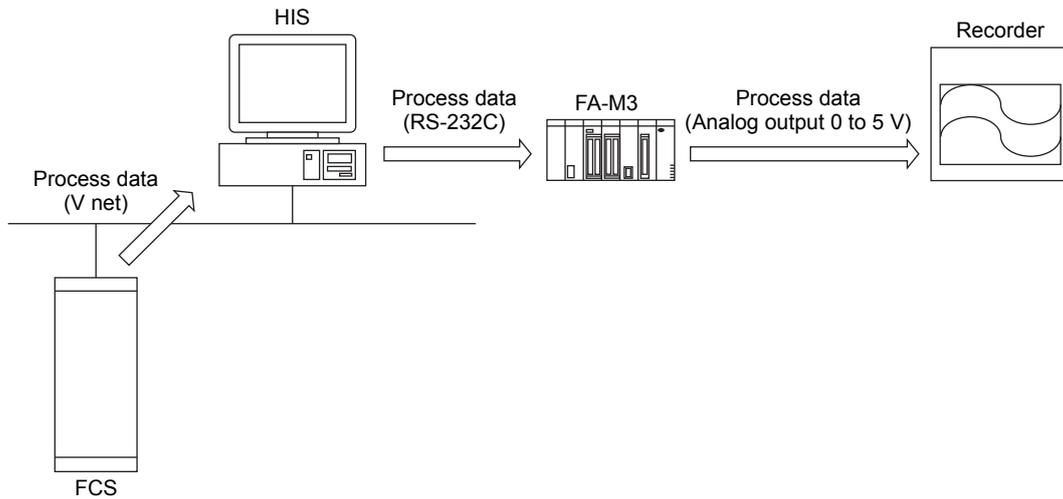


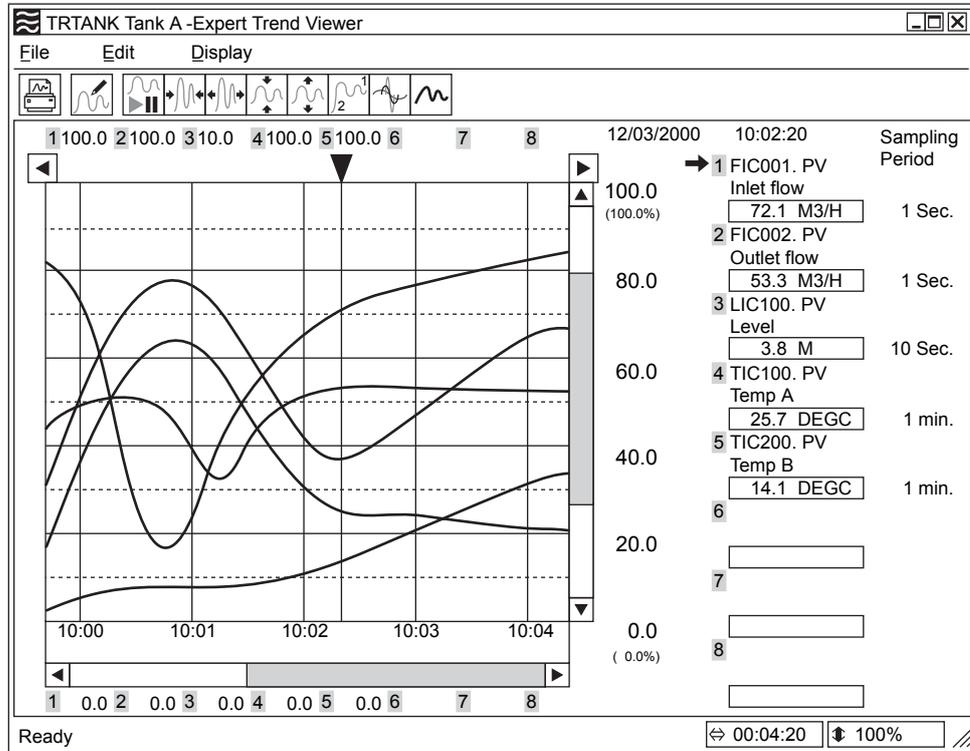
Figure External Recorder Output Function

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3.7.6 Expert Trend Viewer Function (Option)

On an expert trend window, the trend data gathered with different sampling periods can be displayed together.

Displaying is irrelevant to the limit for the number of windows that can be displayed on one HIS. However, only one expert trend window can be displayed and it is displayed as a window even in full-screen mode.



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Figure Expert Trend Window

3.8 Open Interfaces (Option)

The HIS interface for supervisory computers is compatible with OPC (OLE for Process Control) Foundation specifications.

HIS offers the following OPC standard interface:

Data Access (DA) Server Function

This function enables reading and writing process data.

Alarms & Events (A&E) Server Function

This function is used to notify occurring alarms and events asynchronously.

CENTUM Data Access Library

The CENTUM data access library processes the OPC communication protocol within the library, providing a simplified interface. Normally, the complex OPC communication protocol needs to be coded, which requires expertise and much time, for the communication with an OPC server. The use of this library enables the user to develop an application simply and efficiently. The library offers a wide range of interfaces as shown below, which include Yokogawa's original functions, in addition to OPC interfaces.

Station Information

Acquisition of various station data (model, operation status, etc.) registered in the system configuration.

Process Data Information

Acquisition and setting of tag data item (scale, etc.) process data.

Alarm & Event Information

Recognition of asynchronous alarms and events. The following messages are supported:

- System alarm messages
- Process alarm messages
- Mode/status change messages
- Sequence messages
- Operation guide messages
- Engineering maintenance messages
- Operational record messages

Historical Message Information

Acquisition of historical messages.

Trend Data Information

Acquisition of historical trend data.

Closing Data Information

Acquisition of closing data (total value, average value, etc.)

Common Block Information

Acquisition and setting of common block data and acquisition data items.

Recipe Information

Acquisition of recipe header information (recipe name, recipe product name, etc.) and batch ID.

3.9 FCS Data Setting/Acquisition Functions (PICOT) (Option)

Using the PICOT(Process Information Controller) function, the setting data for function blocks on the control station is given from an Microsoft Excel file on the HIS. Process data is also read into an Microsoft Excel file. The function is convenient for frequent data setting and/or modification, for example, for recipe management.

Features

- Data setting to FCS function blocks
- Data acquisition from FCS function blocks
- Microsoft Excel file macro execution
- Starts programs (Windows general-purpose software, application created by Visual Basic)

Flow of Process

To use the function, the three Microsoft Excel files must be prepared as definition files in advance.

- Procedure Definition File
The file is used to define procedures (orders) to be executed in the order of execution. A procedure consists of operation orders called commands. Commands include "Download (for data setting)" and "Upload (for data acquisition)."
- Grade Definition File
The file is used for data setting. It defines function block information and setting items.
- Acquisition Product Definition File
The file is used for data acquisition. It defines function block information to be acquired. The acquired data is put in the file.

The following figure shows the flow of the process.

The following figure shows the flow of the process.

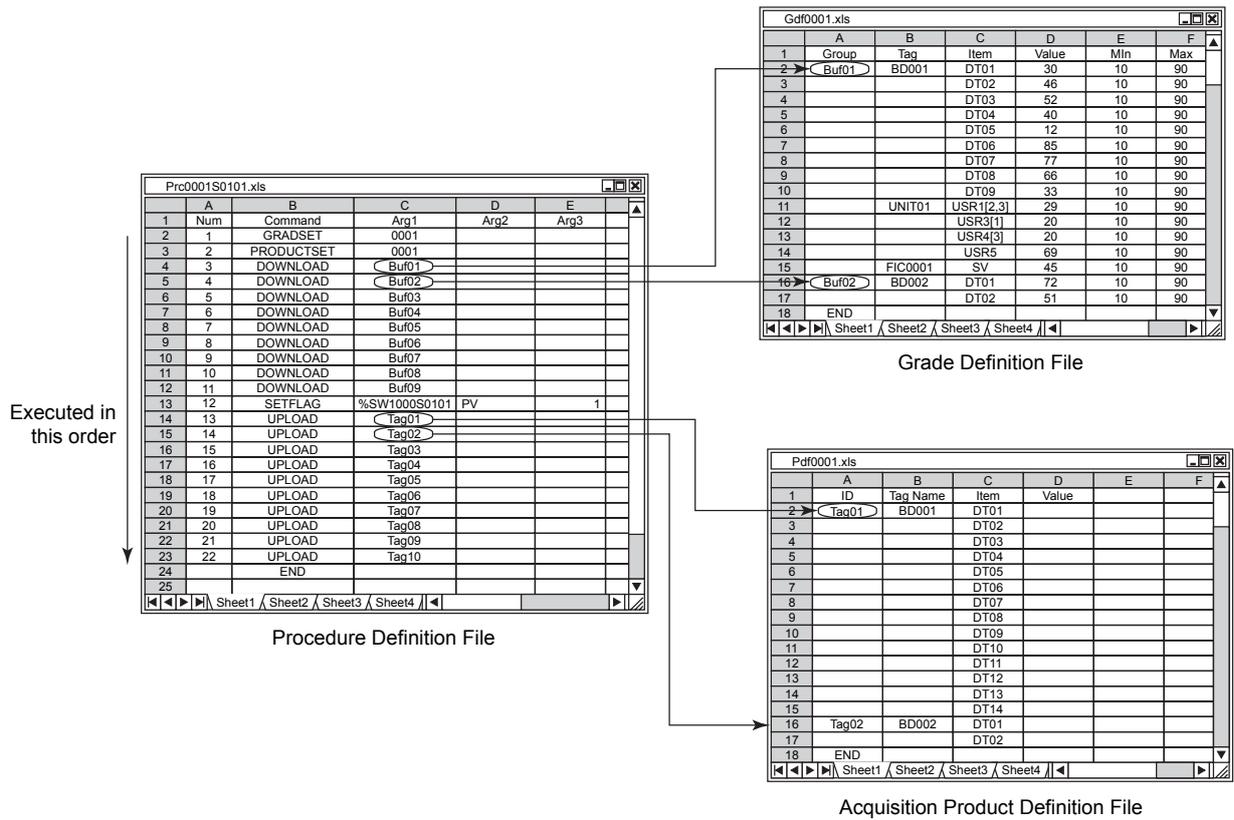


Figure Definition Files

Receiving a sequence message notification from the control station, the function on the HIS executes according to the Procedure Definition File corresponding to a message. When "Download" or "Upload" is specified, it refers to the Grade Definition File or Acquisition Product Definition File for processing data.

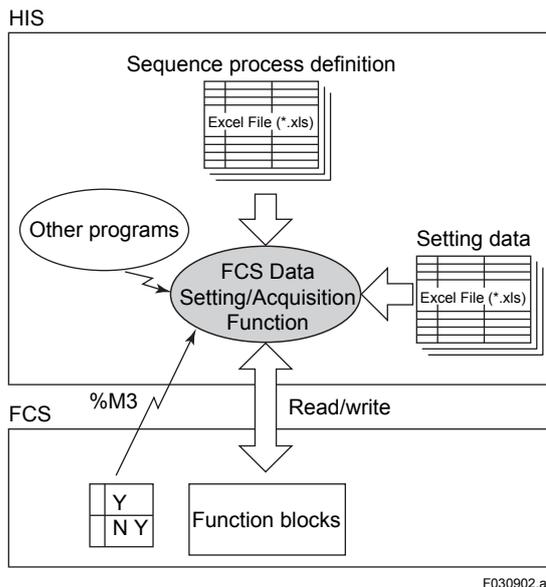


Figure FCS Data Setting/Acquisition Function

3.10 Server for Remote Operation and Monitoring Function (Option)

With Windows Server 2003 Terminal Services, CENTUM CS 3000 Server for Remote Operation and Monitoring Function allows a remote PC(*1) with no CENTUM CS 3000 operation and monitoring functions to monitor plant operations, and allows a remote PC(*1) with no CENTUM CS 3000 engineering functions to perform engineering.

If a PC(*1) that is located away from the instrument room is connected to the network, it can display windows approximately equivalent to HIS windows though some functions are not available, allowing the monitoring of plant operations.

*1: It is called a client PC.

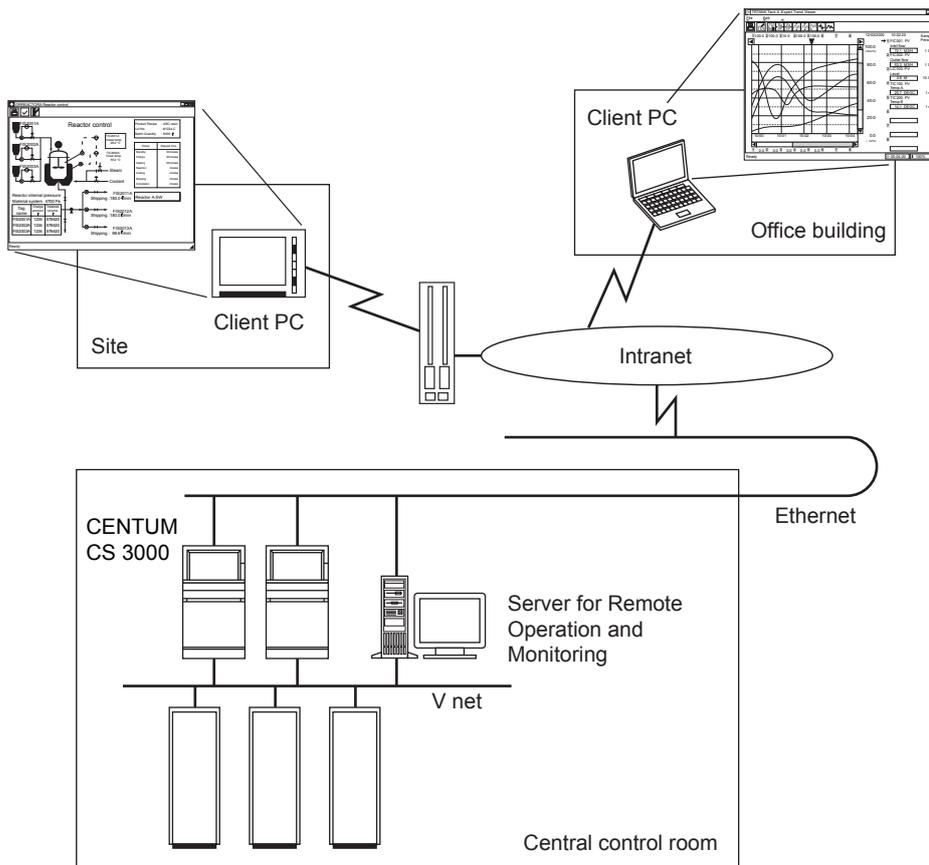
This function can be used by Ethernet or a dial-up connection only. Control network (Vnet) connection is not required.

The package for the operation and monitoring function or for the engineering function need not be installed in the client PC.

A maximum of eight simultaneous sessions (a session being the period of time on the server from log-on to logoff) can be run on one server for remote operation and monitoring.

A client PC can individually display different screens regardless of the screens displayed on the server for remote operation and monitoring or on other clients.

It is available even on low-speed line (128 kbps).

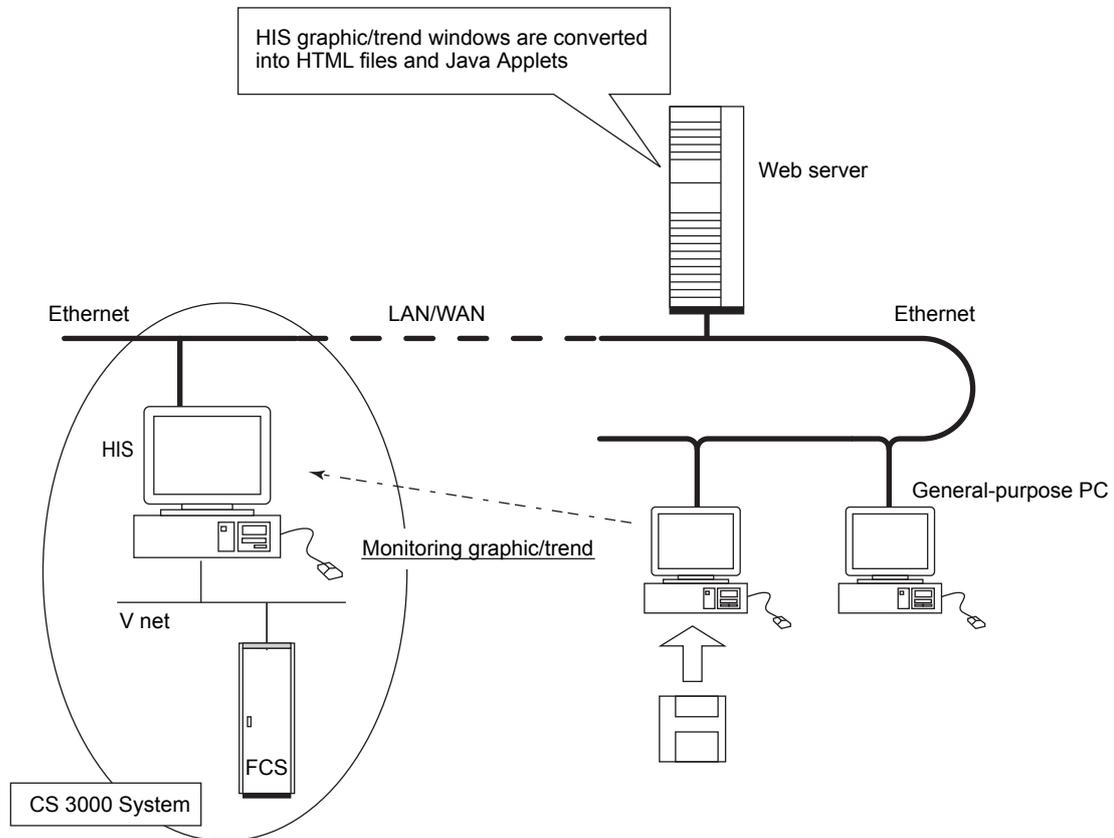


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Figure Examples of Server for Remote Operation and Monitoring Connections

3.11 Web Monitoring Functions (Option)

Web Monitoring Function makes it possible to display HIS graphic windows (graphic objects) and trend windows on a general-purpose WWW browser. By converting HIS files into HTML files and Java Applets, remote monitoring for graphic/trend windows in offices far from the instrument room is possible.



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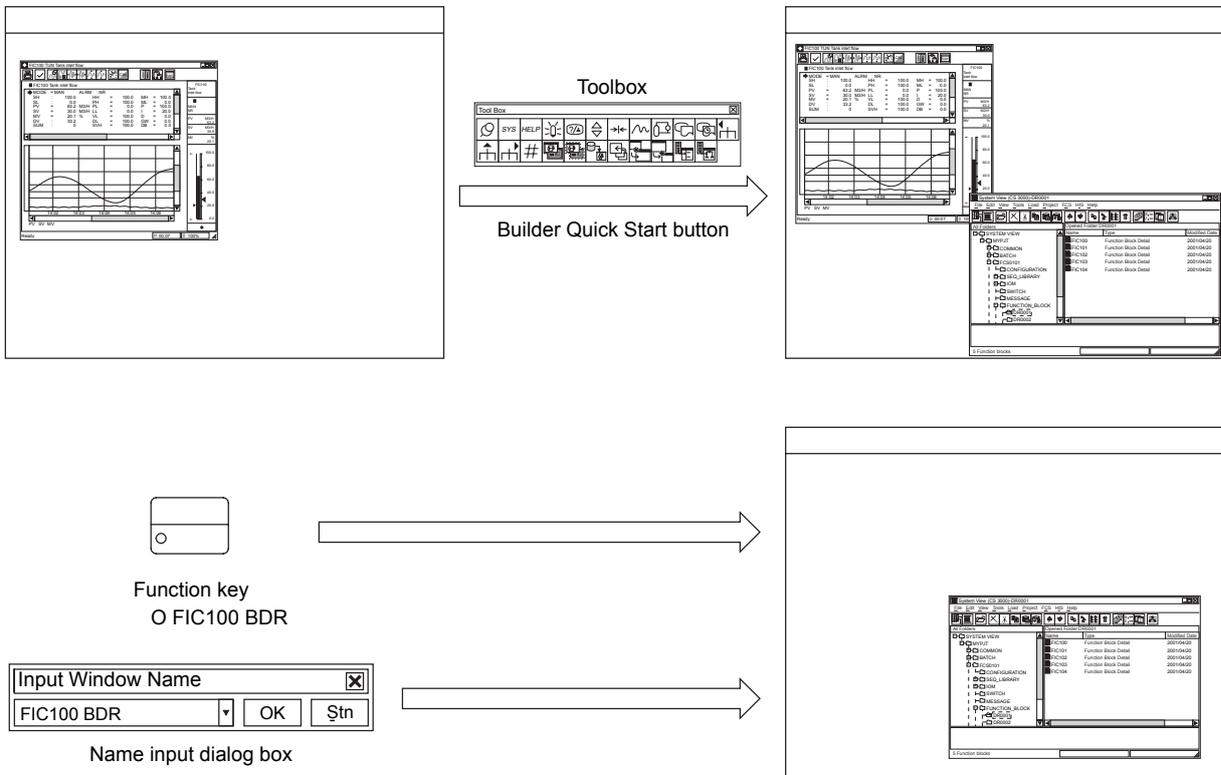
Figure Web Monitoring Function

3.12 Configured Information Reference Function (Option)

The builder window relevant to the operation and monitoring window currently displayed on an HIS can be accessed instantly. Users can thus refer to configuration information during operation and monitoring with a one-touch operation, which boosts efficiency of engineering such as debugging of graphic windows and troubleshooting of problematic computational expressions.

Access to Relevant Builders

There are two ways to access builder windows relevant to the currently displayed operation and monitoring window: by clicking the Builder Quick Start button in the toolbox, or by entering the window name (or the tag name) in the name input dialog box.



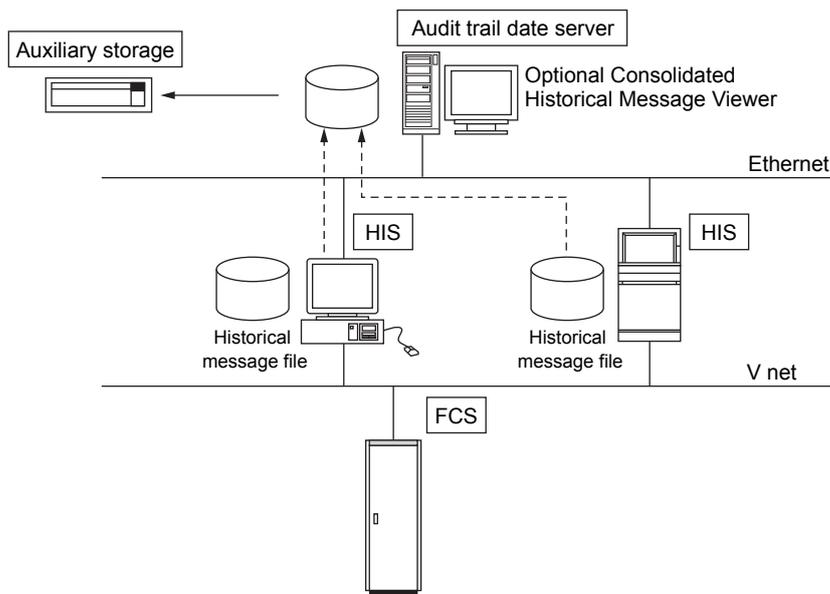
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Figure Accessing Relevant Builders

3.13 Consolidated Historical Message Viewer Meeting FDA Regulations (Option)

Consolidated Historical Message Viewer embodies integrated management of historical messages collected at each HIS in a CENTUM CS 1000 system, using a personal computer. Consolidated Historical Message Viewer enables the following:

- Referencing and permanent retention of multiple HISs' historical messages at a single PC. The message area size is fixed in an HIS and used as a rotary buffer in such a way that the oldest message will be deleted whenever a new message occurs, once the area has become full. Consolidated Historical Message Viewer integrates the historical messages distributed at multiple HISs into a single PC having a sufficiently large disk capacity, and allows the multiple historical message files to be referenced and retained permanently.
- Searching and display of the historical messages that match particular conditions, at the PC for consolidated message management. This facilitates the audit trail (historical message) management required by FDA's 21 CFR Part 11.
- Retention of historical messages as electronic records (PDF files), including application of electronic signatures to these electronic records, with joint use of Adobe Acrobat 5.0 from Adobe Systems Incorporated.



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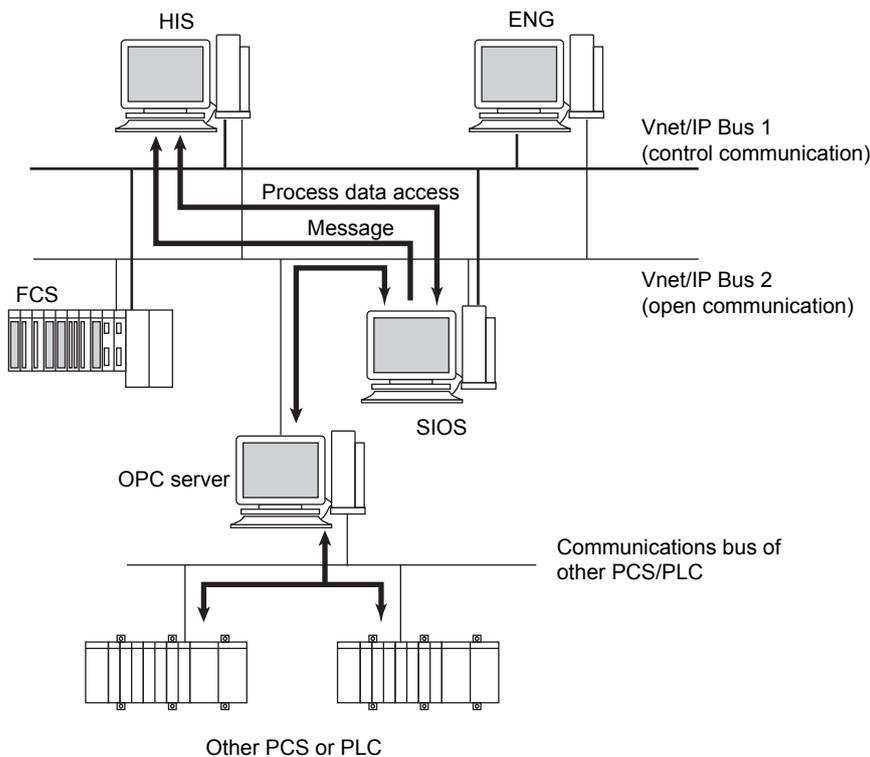
Figure Consolidated Message Management Meeting FDA Regulations

3.14 System Integration OPC Station (SIOS) (Option)

The System Integration OPC Station (hereinafter referred to as SIOS) integrates process control systems (PCSs) from other into the CENTUM CS 3000 system. It allows the CENTUM CS 3000 to exchange data with other PCSs and to receive alarms and events generated at the other PCSs through the OPC server.

System Configuration

SIOS is a general-purpose PC-based station where the basic functions of SIOS are installed. It operates as a gateway that connects the CS 3000 system and the OPC server to PCSs. SIOS is connected to the control bus (V net or Vnet/IP) as a CS 3000 station. SIOS and the OPC server are connected through Ethernet or Vnet/IP open communications (on the bus 2 side). Moreover, the OPC server and SIOS can be configured on the same PC. SIOS exchanges data between other PCSs, and acquires alarms and events through the OPC server to access the other systems according to the OPC DA 2.0 interface stipulated by the OPC Foundation.



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Figure System Configuration

Functions of SIOS

The SIOS provides the following functions.

Process Data Access Function

We can operate and supervise other system's function blocks from HIS like CS 3000 function blocks. In order to make other systems' function blocks responding to that of CS 3000, detailed information concerning other systems' function blocks is needed.

For STARDOM, information required for responding to function blocks is available in standard packages.

Message Functions

SIOS can send the following messages to the CS 3000 side.

- Notification of events detected by SIOS (system alarms):
Messages such as start or stop of SIOS operation, communications errors with the OPC server, or communications recovery are notified to HIS as system alarms.
- Notification of events from the OPC server (sequence messages):
Alarms and events on the side of systems from other, which are notified by the A&E server, are all notified to the HIS as arbitrary character-string of sequence messages, regardless of event types or categories.

Operation and Monitoring

Data acquired via SIOS can be displayed on the following HIS screens:

- Graphic windows (with control, overview and graphic attribute)
- Trend window (trends at one-second intervals cannot be displayed)
- Faceplate window, tuning window, and the like

SEE ALSO Please refer to GS 33Q05P10-31E for The System Integration OPC Station.

3.15 Versatile Terminal Service Application Portal (VTSPortal)

The primary objective of the Yokogawa Versatile Terminal Service Application Portal (VTSPortal) enables you to put CENTUM CS 3000, Exaplog, Exapilot, Exaquantum, and PRM on the web site via the Windows terminal service.

General of VTSPortal

VTSPortal is to provide an integrated Human-Machine Interface (HMI) framework that promotes the idea of digital independence for all Yokogawa solutions. Digital independence is the ability to connect to any Yokogawa HMI application, over any network connection. The VTSPortal are for operational staff, engineering staff, and plant management staff in new or existing plants that deploy a mixture of Yokogawa products and who now wish to extend the reach of those applications to support remote or web access. Access is provided in the form of a Portal Web Site with customizable content on a peruser basis.

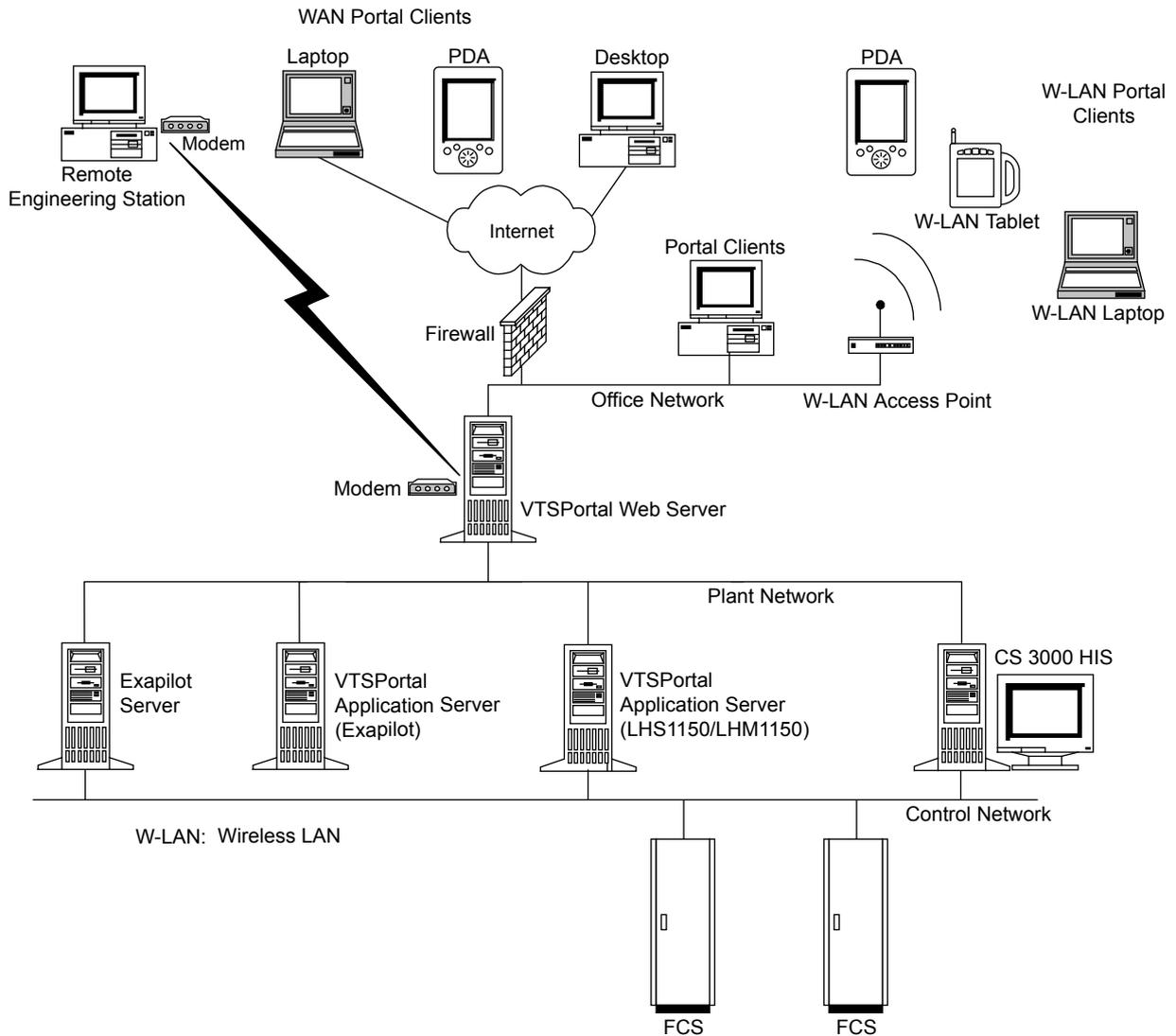
Potential Features of VTSPortal

- Support remote maintenance or engineering work for CS 3000 installations via a dialup or other WAN connection.
- Support remote monitoring and operation for unmanned control areas.
- Support connection of mobile field devices to a control room server for CS 3000 installations.
- Support an aggregated access point for all applications.
- Support application deployment on dedicated thin-client hardware.

SEE ALSO Please refer to GS 33Q02N81-31E for the VTSPortal.

VTSPortal System Architecture

The VTSPortal can be deployed in an internal LAN environment (e.g. intranet), a WAN environment with remote access capabilities (e.g. internet), or in a mixture that provides both LAN and WAN access.



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3.16 Consolidated Alarm Management Software for Human Interface Station (CAMS for HIS) (Option)

CAMS for HIS deliver optimal alarm to the right person at the right time. CAMS for HIS representative functions are shown in the following:

General of CAMS for HIS

Consolidated Alarm Management Software (hereinafter called CAMS for HIS) is optional software which operates on HIS of CENTUM CS 3000 (hereinafter called CS 3000). It acquires various kinds of alarms and events in real-time which occur in CS 3000 system and other systems connected to CS 3000. Those alarms and events are notified to an operator with identifiers (e.g., purposes, user name, allowed time for response and alarm priority) used for sorting and value-added information

(e.g., cause of alarms and how to handle them). Operators sort by identifiers a wide variety of alarms and events used at plants, using CAMS for HIS filtering and sort functions, so that they can receive only information they need in the most suitable timing. As a result, operators are able to perform safer, more efficient operation.

This package offers environment in which engineering can be done in accordance with EEMUA No.191 (a guideline concerning engineering, management and procurement of alarm system, issued by EEMUA).

Functions of CAMS for HIS

CAMS for HIS representative functions are shown in the following:

Acquire a Wide Variety of Alarms and Events

It acquires alarms and events given out from CS 3000 as well as PRM, STARDOM and ProSafe-RS which connected to CS3000, and integrate them on HIS.

Normalize/Standardize Alarms and Events

It standardizes information necessary to integrate and manage alarms and events: standardize alarm titles unique to each system; standardize notation system for time stamp; standardize alarm priority and plant hierarchy.

Re-classify Alarms and Events

As acquired alarms and events sometimes include alarms like events and events like alarms, they are re-classified.

Define Alarms and Events Attribute

For acquired alarms and events, it additionally defines value-added information including each attribute used for message filtering and sorting, cause of alarms and countermeasures as new attributes.

Suppress Unnecessary Alarms and Events Issuance

It is a function to suppress unnecessary alarm and event issuance. Suppressed alarms and events here are not displayed on CAMS for HIS message monitor.

Supervise Alarm and Event Messages

By using CAMS for HIS, operators can integrate process alarms, system alarms and operation guide messages, which used to be supervised on different windows, on one window.

Test (EEMUA No.191 Compliant)

A function to give out virtual alarms and events to test if an alarm system is designed properly or not.

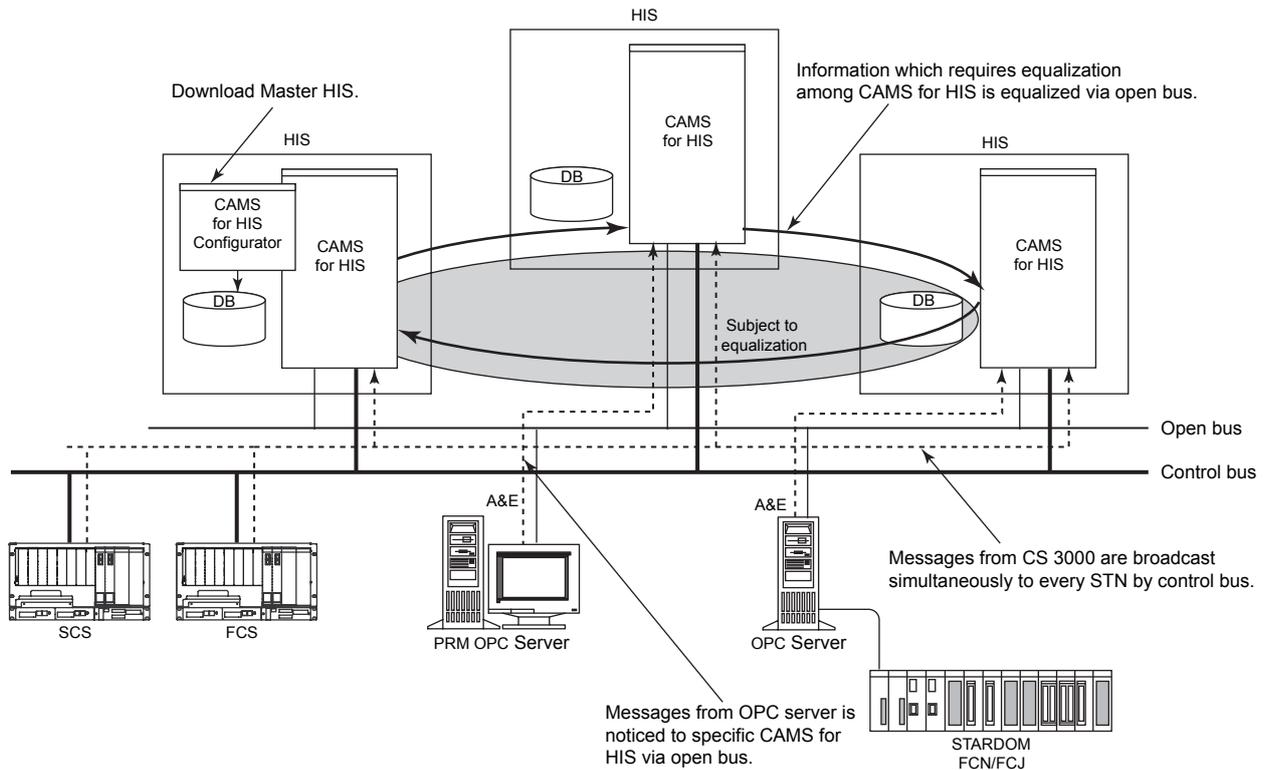
System Configuration Using CAMS for HIS

An example of system configuration using CAMS for HIS is shown below.

CAMS for HIS, connected to OPC A&E server, manages messages given out not only from CENTUM but also from STARDOM and PRM.

Alarms and events can be equalized among more than one HIS in which CAMS for HIS is installed. It is possible to specify the range of HIS where alarms and events are equalized. In specified HIS, every alarm and event including alarms via OPC is equalized.

There is only one download master for CAMS for HIS Configurator. Database is equalized and managed by Download Master.



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SEE ALSO Please refer to GS 33Q02N03-31E for the CAMS for HIS.

4. Field Control Station Control Functions

The Field Control Station (FCS) handles process control functions in CENTUM CS 3000. It can perform control functions – such as continuous control, sequence control, calculation – in continuous and batch processes, in a wide range of industries. This section describes the CENTUM CS 3000 FCS control functions.

The FCS features include:

Four Types of FCS to Choose from, for Flexible System Configuration

You can choose the FCS for FIO, FCS for RIO, Compact FCS for FIO or Compact FCS for RIO, according to your application requirements – for system expansion or replacement.

Subsystem Integration Functions

Subsystems such as Programmable Logic Controllers (PLCs), data acquisition units, analyzers and the like can be transferred to the FCS by communication functions, integrating these subsystems with the FCS.

Support for Next-generation Field Instruments with Open Fieldbus

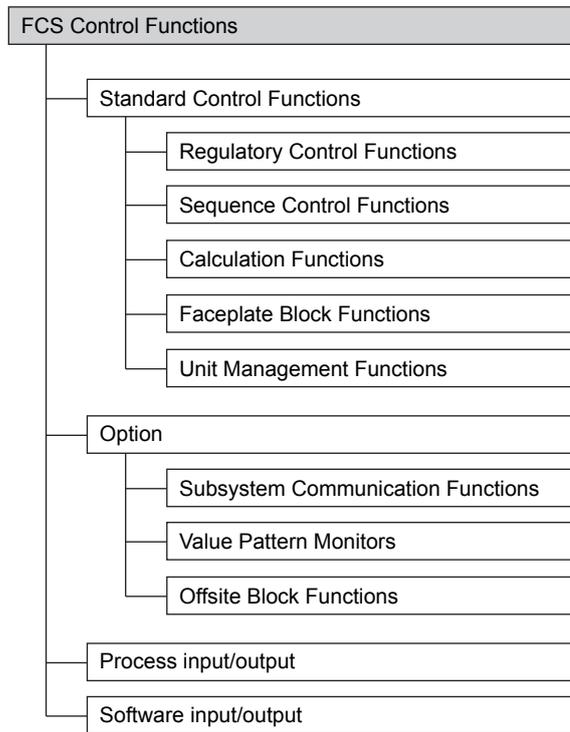
CENTUM CS 3000 supports the next-generation Foundation Fieldbus.

It supports multiple devices, and fast, accurate transfer of multiple data items per device.

Foundation Fieldbus faceplate blocks are a kind of regulatory control blocks. Foundation Fieldbus faceplates support 15 of the fieldbus function blocks as defined by the Fieldbus Foundation. Advanced fieldbus communications allow distributed control with fieldbus devices and optimum control in combination with an FCS.

4.1 Configuration of FCS Control Functions

The configuration of FCS control functions is shown in the figure below.



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Figure Configuration of FCS Control Functions

4.1.1 Function Blocks

Function blocks are the basic unit for performing control and calculations. Continuous control, sequence control (sequence tables and logic charts) and calculations are performed by function blocks. Continuous control blocks, calculation blocks, and sequence control blocks are interconnected in a manner similar to the conventional instrument flow diagrams.

4.1.2 Control Drawings (Option)

A control drawing consists of two or more control blocks representing a control function, and makes it easy to perform engineering and maintenance. The control drawing makes it easy to monitor process phases, and the status of related groups of devices, rather than monitoring on an individual-device basis.

Refer to Item 3.6.1 for an example of a control drawing display.

The features of control drawings are described below.

You can mix Continuous and Sequence Control

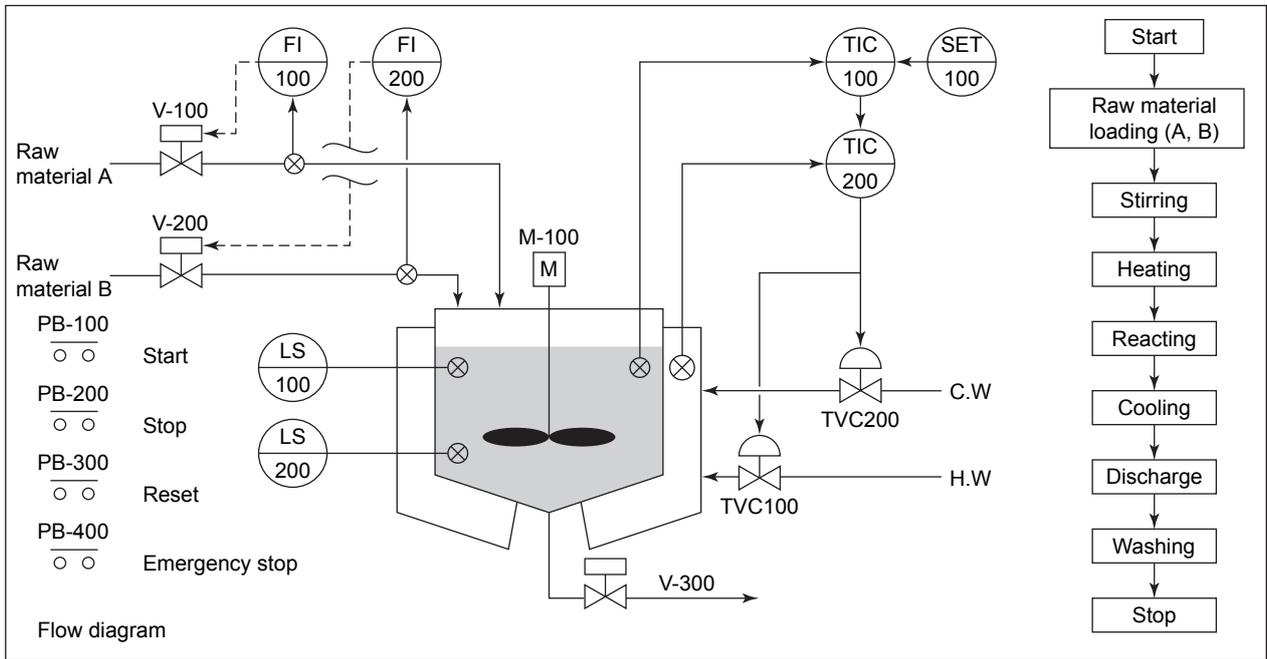
You can mix continuous and sequence control in a control drawing, and create control functions which match your process.

Free Signal Flow between Control Drawings

Function block I/O signals may extend outside a control drawing to another control drawing. Functionally this is the same as signals between function blocks on a single control drawing.

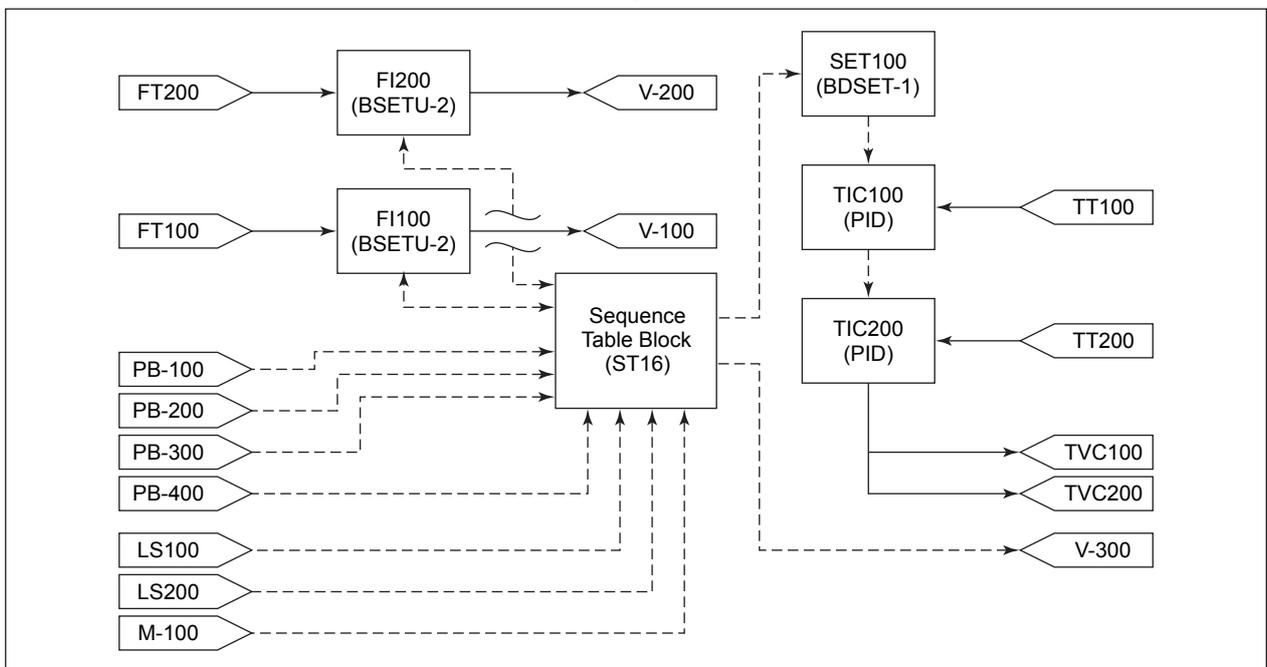
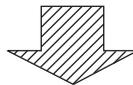
Control Drawing Examples

Examples of the instrument flow diagram and control drawing for a simple reactor process are shown below.



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Figure Reactor Process Flow Diagram



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Figure Example of Control Drawing

4.1.3 Regulatory Control Functions

These functions support continuous-process feedback control. Function blocks which support continuous processes are provided.

Regulatory Control Blocks

These control blocks are for controlling analog (continuous) process variables.

Some representative regulatory control function blocks are shown below. The labelled boxes on the outside of the function block represent I/O terminals. Symbols in circles, and lists of items in brackets, represent data items.

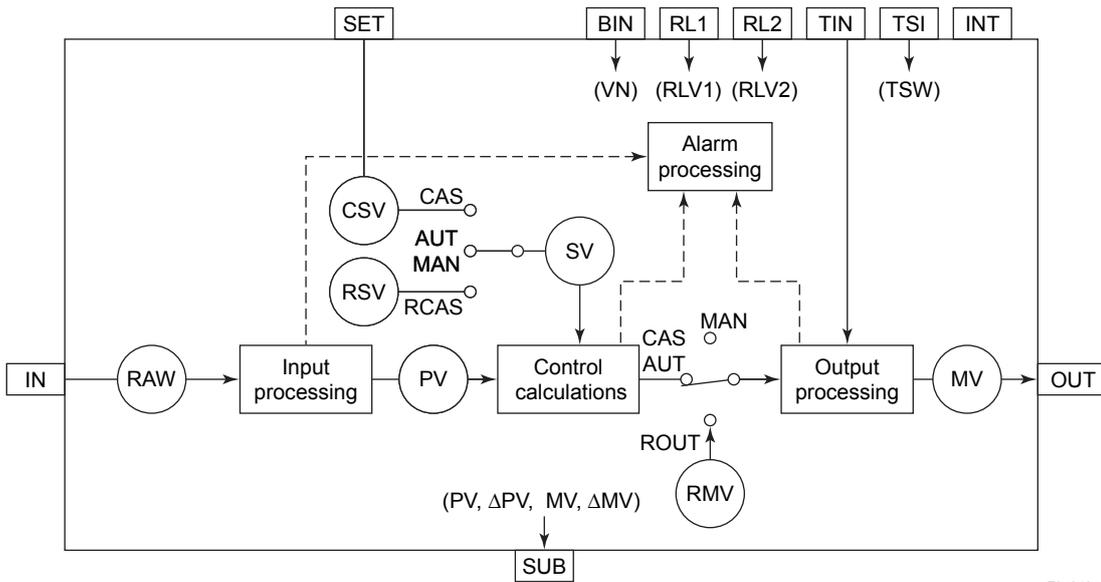


Figure Signal Flow in Regulatory Control Blocks

For regulatory control blocks, process variable inputs, cascade set points, manipulated variable outputs – such inputs and outputs to / from the block are expressed as 0 to 100%, as illustrated in the figure below. (Thermocouple and RTD temperature data are in temperature units.)

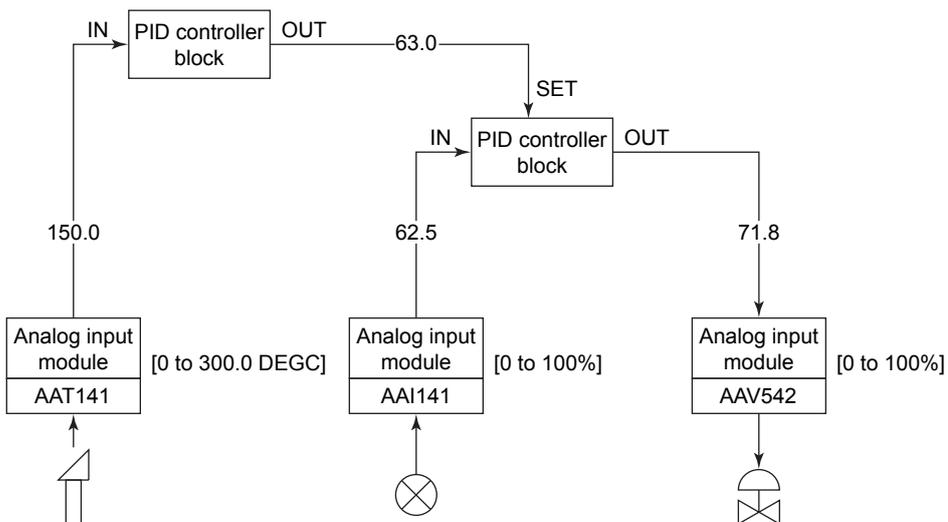


Figure Continuous Control Block I/O Data Example

4.1.4 Sequence Control Functions

Sequence control performs several control steps in a predefined sequence.

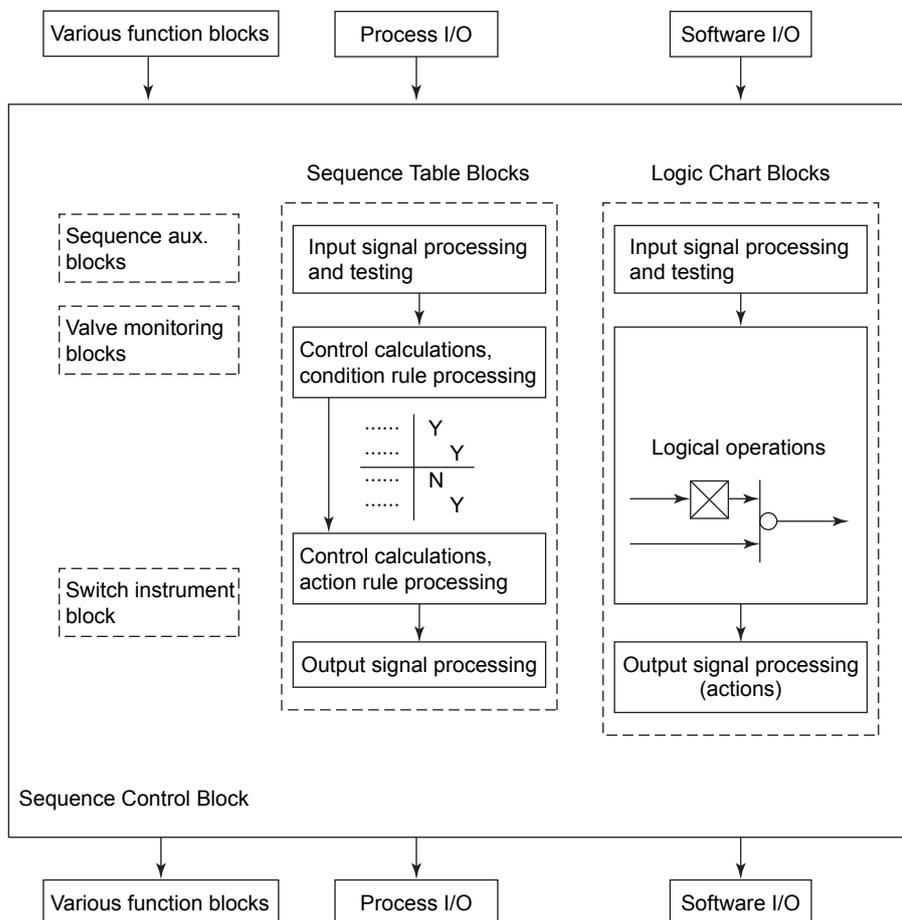
Types of Sequence Control

- Program control (multi-phase type):
Performs control according to a predefined program.
- Conditional control (supervisory type):
Monitors the process status and performs conditional control.

Methods of Representing Sequences

You can create a sequence control program to run in the FCS using sequence tables, Sequence Flow Charts (SFC), and logic charts. The relationship between sequence control blocks and other function blocks, process I/O and software I/O is illustrated below.

The figure below shows how sequence control blocks (which contain the sequence control functions) relate to other function blocks, process I/O, and software I/O.



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Figure Relationship of Sequence Control Block to other Control Functions

Sequence Table Block

Sequence table blocks are decision-table-format function blocks with input signal logic and output signal logic represented by Y/N patterns. They can connect to other function blocks, and are ideal for creating monitoring sequences or phase progress sequences.

Refer to item 3.6.2 for an example of a sequence table block display.

An example of a sequence table block is shown below.

| Symbol | Rule number | | 01 | 02 | 03 | 04 | 05 | 06 | Step name |
|-----------------------|---------------------|---------|----|----|----|----|----|----|----------------|
| | Step label | Comment | A1 | | A2 | | | A3 | |
| PB001.PV.ON | Start button | | Y | | Y | | | | Condition |
| SWA.PV.ON | Switch A (Level HI) | | N | Y | Y | | | | |
| SWB.PV.ON | Switch B (Level LO) | | Y | | | Y | | | |
| VLVA.PV.H | Valve A | | Y | N | | | | | Action |
| VLVB.PV.H | Valve B | | | | Y | N | | | |
| | | | | | | | | | |
| Step label to move to | THEN | | | A2 | | A1 | | | Next step name |
| | ELSE | | | | | | | | |

Figure Sequence Table Block

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Logic Chart Blocks

A logic chart consists of function blocks of interlock block diagram type, which describe the relationship between input signals (condition signals) and output signals (action signals) with logic-operation elements. The main function is to control interlock sequences.

Refer to item 3.6.3 for an example of a logic chart block display.

The following figure shows an example of a logic chart.

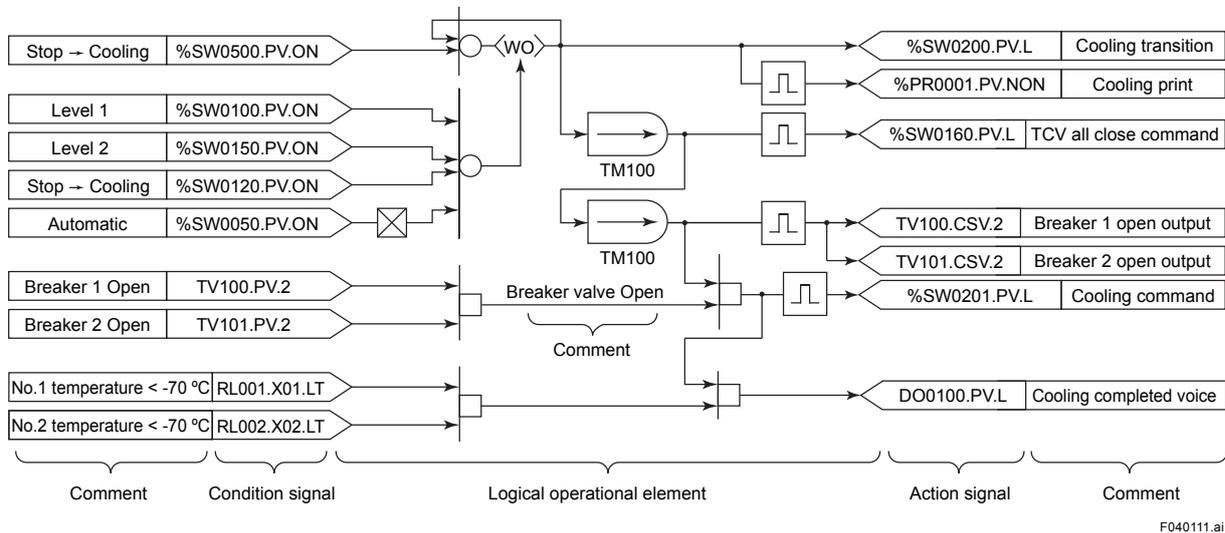


Figure Example of Logic Chart

Switch Instrument Blocks

Switch instrument function blocks are used for monitoring, for starting and stopping motors and valve actuators, and opening/shutting ON/OFF valves. In general, they are used with sequence table blocks or logic chart blocks.

Sequence Element Blocks

Sequence Element Blocks include timers, counters and code conversion blocks, and are mainly used for sequence I/O signal processing.

Valve Monitoring Blocks

Valve monitoring blocks are used for monitoring the ON/OFF status of valves and for comparing the manipulated output signal with the answerback signal from the valve.

SFC Block Functions

SFC Block Functions execute application programs expressed as Sequential Function Charts (SFCs). SFC Blocks are used for large-scale sequence control and device control. Phase progress management (status display) is easy. When an SFC program is created, each program step represents a group of actions. Each step of the SFC may be a sequence table or a SEBOL program (see Figure).

Refer to Item 3.6.5 for an example of a SFC block display.

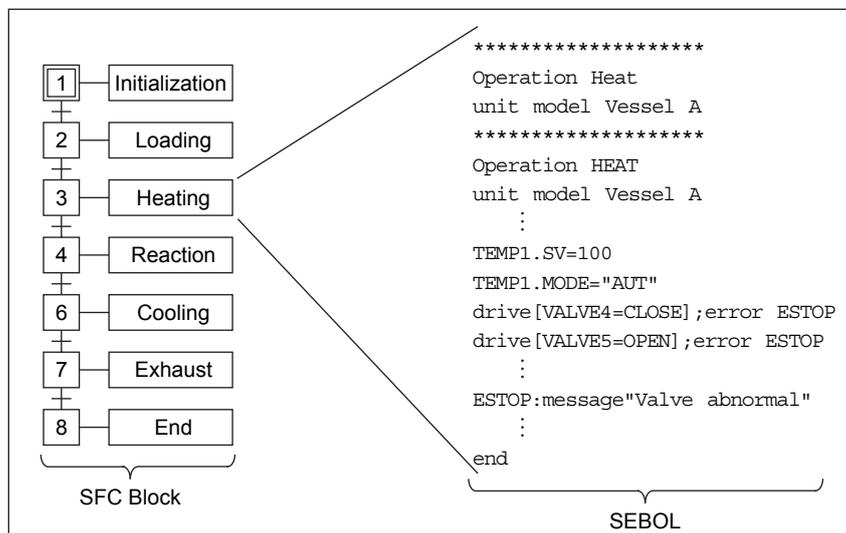
SEBOL Functions

SEBOL (SEquence and Batch Oriented Language) is used to write application programs. The I/O from other function blocks (continuous control blocks, sequence control blocks, and calculation blocks, etc.) as well as process I/O data and soft I/O data can be input to a SEBOL block, and computed outputs returned to such function blocks. SEBOL can handle quite sophisticated sequences effortlessly.

Refer to Item 3.6.4 for an example of a SEBOL program.

Applications of SEBOL:

- Executing multi-phase sequences
- To construct instruments which handle complex combinations of sequential control and logical computation
- To communicate with subsystems such as sequencers
- To combine sequence processing and data processing
- To create hybrid applications which perform functions that can't be handled by standard function blocks.



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Figure SFC Blocks and SEBOL

4.1.5 Calculation Functions

Calculation blocks can process analog signals and contact signals used in continuous control functions and sequence control functions.

The following five types of calculation blocks are supported:

Arithmetic Calculation Blocks

Arithmetic calculation blocks handle a fixed number of input and output points, and use a fixed algorithm to perform an arithmetic calculation.

Analog Calculation Blocks

Analog calculation blocks are mainly used to modify the characteristics of the plant, and can handle process I/O signals as well as analog signals from other function blocks.

Logic Operation Blocks

Logical operation blocks handle a fixed number of input and output points (contact and relay signals, and internal switches), and use a fixed algorithm to perform a logical operation.

General-Purpose Calculation Blocks

General-purpose calculation blocks handle a fixed number of input and output points, and use a user-defined algorithm to perform a general-purpose calculation.

Auxiliary Blocks

Auxiliary blocks are used for performing auxiliary control calculations.

4.1.6 Faceplate Block Functions

Multiple functions blocks may be treated as a single tag, a single faceplate block. Function blocks include the following:

Analog Faceplate Block

A multi-block control loop may be treated as a single tag (faceplate).

An analog faceplate block is used for monitoring and controlling a continuous control application.

Sequence Faceplate Block

A sequence faceplate block is used for displaying current sequence phase, and operating the sequence-e.g. with push buttons.

Hybrid Faceplate Block

This combines analog faceplate block and sequence faceplate block functions.

4.1.7 Unit Management Functions

The Unit Management Functions apply to groups of control functions representing major control process units such as furnaces and reactors and their associated control devices. A unit control instrument allows you to operate the whole group of process equipment and control devices that represent the unit. For example, for a batch process in a chemical plant, the process equipment and control devices representing each stage of the process – e.g. reactor and crystallization stages – can each be operated from a corresponding unit instrument. This is much simpler than representing the unit as a number of tags, and operating it as such. Unit Management Functions can be used for various types of sequence control, in conjunction with batch and continuous process control.

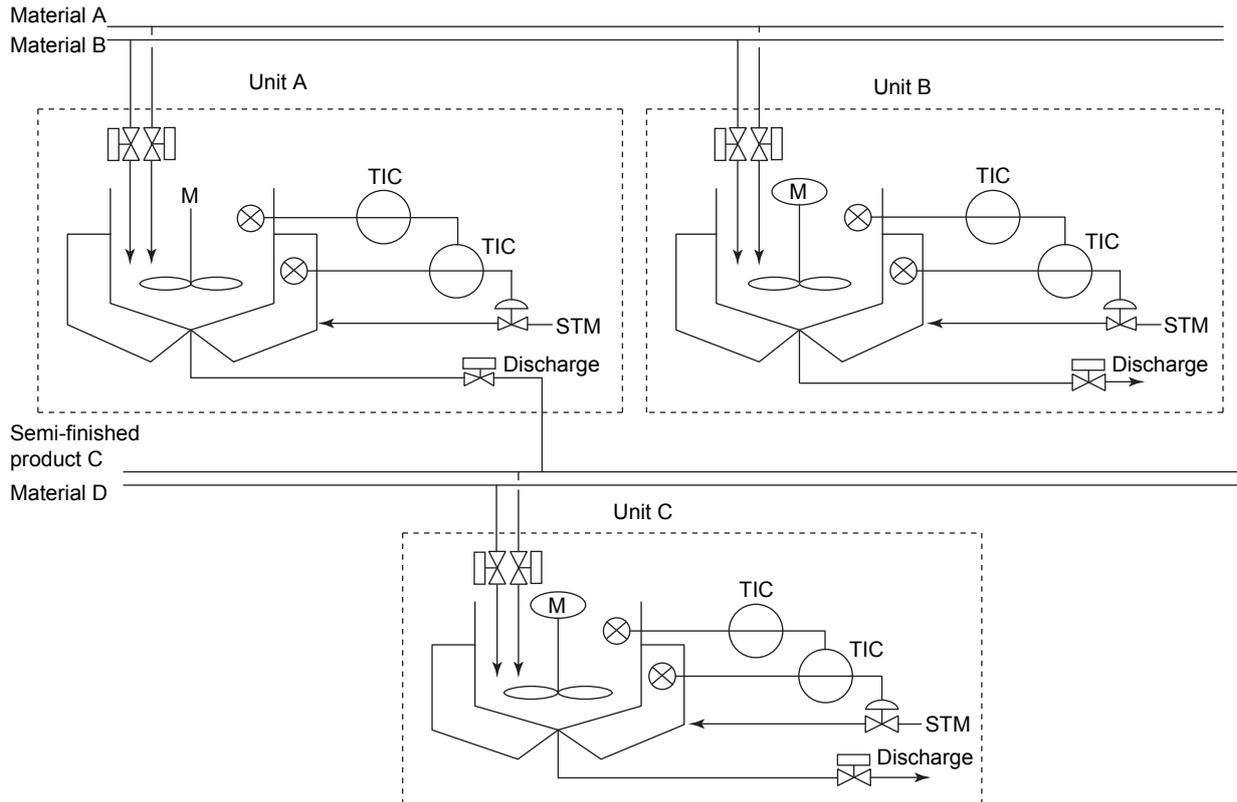
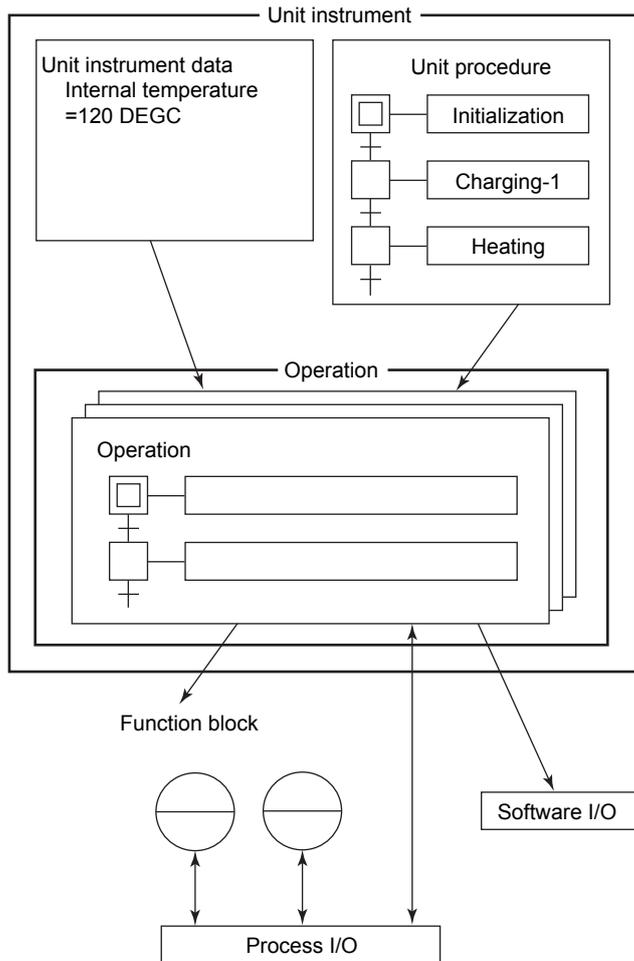


Figure Examples of Units

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Figure Configuration of Unit Management Functions

Unit Instruments

Unit instruments perform control according to data settings and control algorithms.

Unit procedures, which represent the procedures for processing product recipes, can manage the execution sequence of multiple operations. For example, you may define operations such as initialization, charging 1, charging 2, and heating, and define a unit procedure to execute these operations in turn.

Operations

An operation represents a control process unit such as initialization, charging 1, charging 2, and heating.

Generic Name

In the unit instrument, not a tag name but a generic name can be used. The relationship between tag name and generic name can be defined for each unit instrument, so the same generic name may represent different tag names in different unit instruments. Operators can write a program without depending on a tag name, which enables easy-to-reuse program description.

4.1.8 Valve Pattern Monitors (Option)

The valve pattern monitor is a function block running in a Field Control Station (FCS). One valve pattern monitor can monitor up to 512 valves simultaneously in a transfer-system plant. An application program (written in SEBOL), created through the operation of a unit instrument, is used to monitor valves.

4.1.9 Offsite Block Functions (Option)

The offsite block is a function block that controls the flow rate and batch quantity for offsite blending and shipment control at oil refineries. This block is used in combination with motor control blocks, switch instrument blocks, or enhanced switch instrument blocks for offsite batch shipment control or blending control of products.

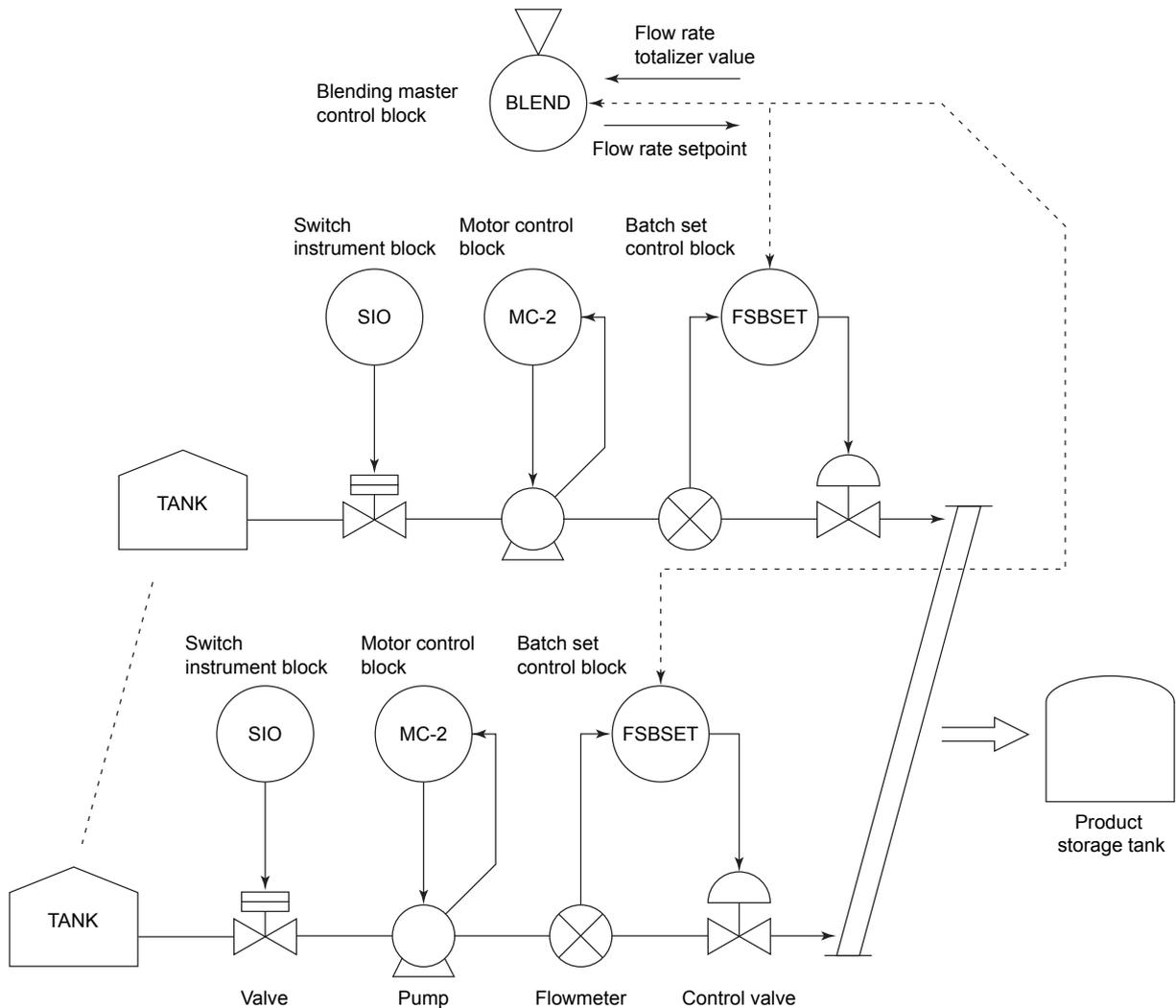


Figure Example of Application with Offsite Blocks

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4.1.10 List of Function Blocks

Regulatory Control Blocks

Regulatory control blocks perform calculation using analog process values for process control and monitoring.

Table List of Regulatory Control Blocks (1/2)

| Block Type | Model | Name |
|--------------------|----------|--|
| Input Indicator | PVI | Input indicator block |
| | PVI-DV | Input indicator block with deviation alarm |
| Controller | PID | PID controller block |
| | PI-HLD | Sampling PI controller block |
| | PID-BSW | PID controller block with batch switch |
| | ONOFF | Two-position ON/OFF controller block |
| | ONOFF-G | Three-position ON/OFF controller block |
| | PID-TP | Time-proportioning ON/OFF controller block |
| | PD-MR | PD controller block with manual reset |
| | PI-BLEND | Blending PI controller block |
| | PID-STC | Self-tuning PID controller block |
| Manual Loader | MLD | Manual loader block |
| | MLD-PVI | Manual loader block with input indicator |
| | MLD-SW | Manual loader block with Auto/Man SW |
| | MC-2 | Two-position motor control block |
| | MC-3 | Three-position motor control block |
| Signal Setter | RATIO | Ratio set block |
| | PG-L13 | 13-zone program set block |
| | BSETU-2 | Flow-totalizing batch set block |
| | BSETU-3 | Weight-totalizing batch set block |
| Signal Limiter | VELLIM | Velocity limiter block |
| Signal Selector | SS-H/M/L | Signal selector block |
| | AS-H/M/L | Autoselector block |
| | SS-DUAL | Dual-redundant signal selector block |
| Signal Distributor | FOUT | Cascade signal distributor block |
| | FFSUM | Feedforward signal summing block |
| | XCPL | Non-interference control output block |
| | SPLIT | Control signal splitter block |
| Pulse Count Input | PTC | Pulse count input block |

Table List of Regulatory Control Blocks (2/2)

| Block Type | Model | Name |
|--|----------|--|
| YS Instrument | SLCD | YS controller block |
| | SLPC | YS programmable controller block |
| | SLMC | YS programmable controller block with pulse-width output |
| | SMST-111 | YS manual station block with SV output |
| | SMST-121 | YS manual station block with MV output lever |
| | SMRT | YS ratio set station block |
| | SBSD | YS batch set station block |
| | SLCC | YS blending controller block |
| | SLBC | YS batch controller block |
| | STLD | YS totalizer block |
| Foundation Fieldbus Faceplate Blocks | FF-AI | Foundation Fieldbus analog input block |
| | FF-DI | Foundation Fieldbus discrete input block |
| | FF-CS | Foundation Fieldbus control selector block |
| | FF-PID | Foundation Fieldbus PID control block |
| | FF-RA | Foundation Fieldbus ratio block |
| | FF-AO | Foundation Fieldbus analog output block |
| | FF-DO | Foundation Fieldbus discrete output block |
| | FF-OS | Foundation Fieldbus output splitter block |
| | FF-SC | Foundation Fieldbus signal characterizer block |
| | FF-IT | Foundation Fieldbus integrator (totalizer) block |
| | FF-IS | Foundation Fieldbus input selector block |
| | FF-MDI | Foundation Fieldbus multiple discrete input block |
| | FF-MDO | Foundation Fieldbus multiple discrete output block |
| | FF-MAI | Foundation Fieldbus multiple analog input block |
| | FF-MAO | Foundation Fieldbus multiple analog output block |
| | FF-SUNV | Foundation Fieldbus simplified universal block |

Sequence Blocks

Sequence blocks perform calculation using logic values for control instrument level sequence control, such as the control of interlock and process monitoring sequences.

Table List of Sequence Blocks

| Block Type | Model | Name |
|--------------------|--|---|
| Sequence Table | ST16 | Sequence table block Total of 64 input and output signals and 32 rules |
| | M_ST16 | Sequence table block (M-size) (*1) Total of 96 signals (32-64 input and 32-64 output signals) and 32 rules |
| | L-ST16 | Sequence table block (L-size) (*1) 64 input and 64 output signals and 32 rules |
| | ST16E | Rule extension block |
| | M_ST16E | Rule extension block (for M_ST16) (*1) |
| | L_ST16E | Rule extension block (for L_ST16) (*1) |
| Logic Chart | LC64 | Logic chart block |
| SFC | _SFCSW | Three-position switch SFC block |
| | _SFPCB | Pushbutton SFC block |
| | _SFCAS | Analog SFC block |
| Switch Instrument | SI-1 | Switch instrument block with 1 input |
| | SI-2 | Switch instrument block with 2 inputs |
| | SO-1 | Switch instrument block with 1 output |
| | SO-2 | Switch instrument block with 2 outputs |
| | SIO-11 | Switch instrument block with 1 input 1 output |
| | SIO-12 | Switch instrument block with 1 input 2 outputs |
| | SIO-21 | Switch instrument block with 2 inputs 1 output |
| | SIO-22 | Switch instrument block with 2 inputs 2 outputs |
| | SIO-12P | Switch instrument block with 1 input 2 one-shot outputs |
| SIO-22P | Switch instrument block with 2 inputs 2 one-shot outputs | |
| Sequence Element 1 | TM | Timer block |
| | CTS | Software counter block |
| | CTP | Pulse train input counter block |
| | CI | Code input block |
| | CO | Code output block |
| Sequence Element 2 | ALM-R | Representative alarm block |
| | RL | Relational expression block |
| | RS | Resource scheduler block |
| | VLVM | Valve monitoring block |

*1: Can be used in RFCS2.

Calculation Blocks

Calculation blocks perform the calculation of analog and contact signals.

Table List of Calculation Blocks (1/2)

| Block Type | Model | Name |
|-----------------------------|-------------------|---|
| Arithmetic Calculation | ADD | Addition block |
| | MUL | Multiplication block |
| | DIV | Division block |
| | AVE | Averaging block |
| Analog Calculation | SQRT | Square root block |
| | EXP | Exponential block |
| | LAG | First-order lag block |
| | INTEG | Integration block |
| | LD | Derivative block |
| | RAMP | Ramp block |
| | LDLAG | Lead/lag block |
| | DLAY | Dead-time block |
| | DLAY-C | Dead-time compensation block |
| | AVE-M | Moving-average block |
| | AVE-C | Cumulative-average block |
| | FUNC-VAR | Variable line-segment function block |
| | TPCFL | Temperature and pressure correction block |
| | ASTM1 | ASTM correction block: Old JIS |
| | ASTM2 | ASTM correction block: New JIS |
| Logic Operation | AND | Logical AND block |
| | OR | Logical OR block |
| | NOT | Logical NOT block |
| | SRSI-S | Set-dominant flip-flop block with 1 output |
| | SRSI-R | Reset-dominant flip-flop block with 1 output |
| | SRS2-S | Set-dominant flip-flop block with 2 outputs |
| | SRS2-R | Reset-dominant flip-flop block with 2 outputs |
| | WOUT | Wipeout block |
| | OND | ON-delay timer block |
| | OFFD | OFF-delay timer block |
| | TON | One-shot block (rising-edge trigger) |
| | TOFF | One-shot block (falling-edge trigger) |
| | GT | Comparator block (greater than) |
| | GE | Comparator block (greater than or equal) |
| | EQ | Comparator block (equal) |
| | BAND | Bitwise AND block |
| BOR | Bitwise OR block | |
| BNOT | Bitwise NOT block | |
| General-Purpose Calculation | CALCU | General-purpose calculation block |
| | CALCU-C | General-purpose calculation block with string I/O |

Table List of Calculation Blocks (2/2)

| Block Type | Model | Name |
|------------|----------|---|
| Trend | TR-SS | Snap-shot Trend Block |
| Auxiliary | SW-33 | Three-pole three-position selector switch block |
| | SW-91 | One-pole nine-position selector switch block |
| | DSW-16 | Selector switch block for 16 data |
| | DSW-16C | Selector switch block for 16 string data |
| | DSET | Data set block |
| | DSET-PVI | Data set block with input indicator |
| Batch Data | BDSET-1L | One-batch data set block |
| | BDSET-1C | One-batch string data set block |
| | BDSET-2L | Two-batch data set block |
| | BDSET-2C | Two-batch string data set block |
| | BDA-L | Batch data acquisition block |
| | BDA-C | Batch string data acquisition block |

Faceplate Blocks

Faceplate blocks are man-machine interfaces to let the operator operate a group of function blocks as a single tag.

Table List of Faceplate Blocks

| Block Type | Model | Name |
|--------------------|---------|---------------------------------------|
| Analog Faceplate | INDST2 | Dual-pointer indicating station block |
| | INDST2S | Dual-pointer manual station block |
| | INDST3 | Triple-pointer manual station block |
| Sequence Faceplate | BSI | Batch status indicator block |
| | PBS5C | Extended 5-push-button switch block |
| | PBS10C | Extended 10-push-button switch block |
| Hybrid Faceplate | HAS3C | Extended hybrid manual station block |

Unit Instruments and Operations

Unit instruments handle the operation and control of a process unit. Operations handle operation and control of individual phases of a unit.

Table List of Unit Instruments and Operations

| Block Type | Model | Name |
|-------------------------------|---------|--|
| Resident Unit Instrument | _UTSW | Unit instrument with three-position switch |
| | _UTPB | Unit instrument with five-pushbutton switch |
| | _UTAS | Analog unit instrument |
| Non -resident Unit Instrument | _UTSW-N | Non-resident unit instrument with three-position switch |
| | _UTPB-N | Non-resident unit instrument with five-pushbutton switch |
| | _UTAS-N | Analog non-resident unit instrument |
| Operation | OPSBL | SEBOL operation |
| | OPSFC | SFC operation |
| | OPSF1 | SFC operation with floating-data parameters |
| | OPSF2 | SFC operation with character-data parameters |
| | OPSF3 | SFC operation with floating/character-data parameters |
| | OPSF4 | SFC operation with integer/character-data parameters |
| | OPSF5 | SFC operation with floating/integer-data parameters |

Enhanced MC/Switch Instrument Blocks

These are enhanced function blocks; they are for functions incorporated in ON/OFF controller blocks, motor control blocks, and switch instrument blocks. In addition to general instrument functions, these blocks allow the connection of two discontinuous contact inputs and outputs, providing functions that stop the detection of answer-back inconsistency alarm masks over a constant period of time from the switching operation.

Table List of Enhanced MC/Switch Instrument Blocks

| Block Type | Model | Name |
|-----------------------------------|---|--|
| Enhanced MC/ Switch Instrument | ONOFF-E | Enhanced two-position ON/OFF controller block |
| | ONOFF-GE | Enhanced three-position ON/OFF controller block |
| | MC-2E | Enhanced two-position motor control block |
| | MC-3E | Enhanced three-position motor control block |
| | SI-1E | Enhanced switch instrument block with 1 input |
| | SI-2E | Enhanced switch instrument block with 2 inputs |
| | SO-1E | Enhanced switch instrument block with 1 output |
| | SO-2E | Enhanced switch instrument block with 2 outputs |
| | SIO-11E | Enhanced switch instrument block with 1 input 1 output |
| | SIO-12E | Enhanced switch instrument block with 1 input 2 outputs |
| | SIO-21E | Enhanced switch instrument block with 2 inputs 1 output |
| | SIO-22E | Enhanced switch instrument block with 2 inputs 2 outputs |
| | SIO-12PE | Enhanced switch instrument block with 1 input 2 one-shot outputs |
| SIO-22PE | Enhanced switch instrument block with 2 inputs 2 one-shot outputs | |

Valve Pattern Monitors (Option)

Valve pattern monitors are function blocks for monitoring valve-open and -closed statuses.

Table List of Valve Pattern Monitors

| Block Type | Model | Name |
|-----------------------|---------|---|
| Valve Pattern Monitor | VPM64 | 64-data valve pattern monitor |
| | VPM128 | 128-data valve pattern monitor |
| | VPM256 | 256-data valve pattern monitor |
| | VPM512 | 512-data valve pattern monitor |
| | VPM64A | 64-data valve pattern monitor with alarm |
| | VPM128A | 128-data valve pattern monitor with alarm |
| | VPM256A | 256-data valve pattern monitor with alarm |
| | VPM512A | 512-data valve pattern monitor with alarm |

Offsite (Option)

Offsite block is a function block used for batch blending and shipment control performed offsite at oil refineries and other plant facilities.

Table List of Offsite

| Block Type | Model | Name |
|------------|--------|-------------------------------|
| Offsite | FSBSET | Batch set control block |
| | BLEND | Blending master control block |

4.1.11 Process Input/Output and Software Input/Output

The Field Control Station (FCS) exchanges data between FCS function blocks and field devices outside the FCS through process inputs/outputs, communications inputs/outputs or field-bus inputs/outputs. Direct connections between function blocks allow data exchanges inside an FCS or between FCS's; data exchanges through software inputs/outputs are also possible.

Process Input/Output

Process I/O stands for the signal communication interface between field devices and field control stations. Process I/Os are classified into two types according to the signals to be exchanged: analog I/O and contact I/O signals.

Analog input: Current input, voltage input, mV input, thermocouple input, resistance temperature detector (RTD) input, potentiometer input, and pulse-train input.

Analog output: Current output and voltage output.

Contact input: Status input and pushbutton input.

Contact output: Status output, pulse-width output and time-proportioning on/off output.

Communications Input/Output

Communications I/Os are inputs and outputs for accessing various data incorporated in subsystems. Data communications are carried out using the communication I/O module that interconnects the FCS and subsystems. For communications with subsystems, refer to Chapter 5, later in this document.

Field Bus Input/Output

Field bus I/Os are inputs and outputs for accessing various data used in field devices.

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ALSO**

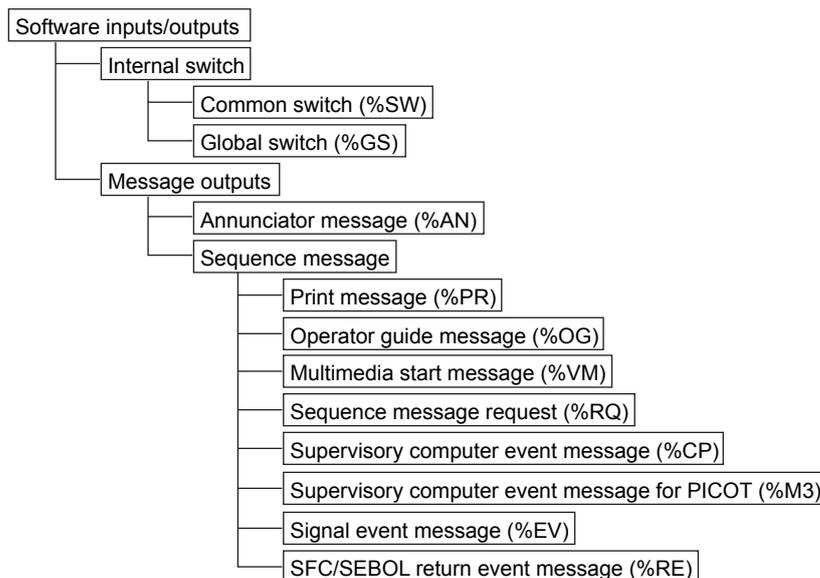
For more details on the fieldbus, refer to the Fieldbus Technical Information (TI 38K03A01-01E).

Software Input/Output

Software inputs/outputs are virtual inputs/outputs that are provided by the FCS's internal software.

Two types of software inputs/outputs are available: an "internal switch," which is used to exchange logical values between function blocks or other application functions; and a "message output," which is used to inform the occurrence of an event.

The organizational structure of software inputs/outputs is as shown below.



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Figure Structure of Software Input/Output

Internal switches include the following:

Common switches (%SW): These switches are internal switches used by various control functions to save shared logical values in an FCS.

Global switches (%GS): These switches are internal switches with the same logical value on all stations in the same domain.

Message outputs include annunciator messages and sequence control messages that are further classified according to the functions used.

Annunciator message output (%AN): HIS annunciator functions simulate the annunciator instrument panel. Along with printout messages (%PR), messages with process data are also displayed.

Printout message output (%PR): Print message outputs print data corresponding to an event that has occurred in the process.

Operator guide message output (%OG): Operator guide message outputs alert the operator to the operator guide window in real-time.

Multimedia function start message (%VM): This message starts the HIS multimedia function from the FCS.

Sequence message request (%RQ): Sequence message requests enable the operator to start user programs or a batch trend.

Supervisory computer message output (%CP): This message is used to output FCS event messages to the supervisory computer connected to the system.

Supervisory computer event message output for PICOT (%M3): This message is used to output FCS event messages to the FCS Data Setting/Acquisition Package (PICOT) running on the HIS.

Signal event message output (%EV): This message output enables a function block to inform the SEBOL control functions of event changes.

SFC/SEBOL return-event message output (%RE): This message output enables a function block to inform the SFC block or SEBOL program of event changes performed by the SEBOL program.

5. Subsystem Communication Functions

Recently plant equipment or large motors have increasingly incorporated PLCs for equipment monitoring and automatic operation. In addition, analytical equipment, weighing equipment, and various measuring instruments are being made “intelligent,” and data exchanges through communications prevail over the use of analog or contact signals.

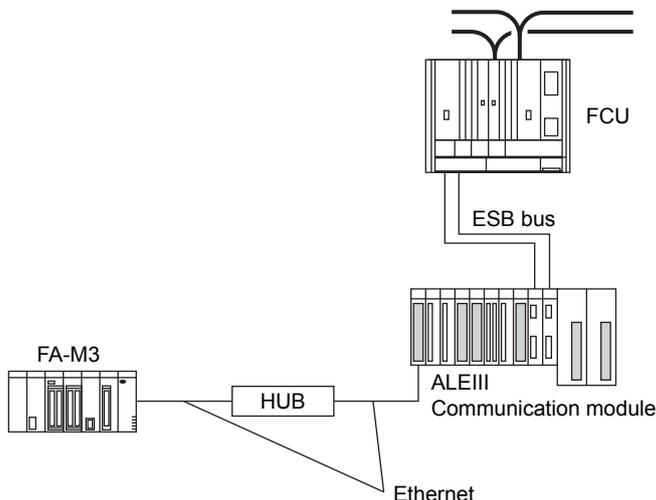
CENTUM CS 3000 systems communicate with subsystems that handle communication data in two ways: using PLCs through an FCS and using an OPC server.

5.1 Communications with Subsystems Through an FCS (Option)

Communication I/O modules and subsystem communication packages are used to handle subsystem data similarly to function block data, as in regulatory control blocks or sequence control blocks, allowing operation monitoring from an HIS. In addition, for a subsystem’s redundancy structure, dual-redundant functions are provided to handle communication data as control data.

5.1.1 Connecting Subsystems

The FCS for FIO and compact FCS for FIO use communication I/O modules that are incorporated in a local node installed in an FCS or incorporated in a remote node installed in a cabinet mounted near the field for connecting subsystems. The FCS for RIO and compact FCS for RIO use a communication I/O module built into an I/O module nest installed in the FCS to connect subsystems. For these connections, RS communications cables (RS-232C modem cables, RS-232C null modem cables, or RS-422/RS-485 cables) or Ethernet cables are used.



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Figure FA-M3 Example of Connection

5.1.2 Supported Subsystem Communication Packages

To communicate with subsystems, download the optional supported subsystem communication packages into the communication I/O module.

Subsystem communication packages that are supported are:

- FA-M3 communication package (for Yokogawa's FA-M3 and FA500)
- DARWIN/DAQSTATION communication package (for Yokogawa's DARWIN and DAQSTATION)
- MELSEC communication package (for Mitsubishi general-purpose MELSEC sequencers)
- MELSEC-A communication package (for Mitsubishi general-purpose MELSEC-A sequencers)
- PLC-5/SLC 500 communication package (for Rockwell Automation's PLC-5/SLC 500 family of programmable controllers)
- Modbus communication package (for Yokogawa's STARDOM, Schneider's Modicon and Yaskawa Electric Corporation's Memocon-SC)
- Siemens communication package (for Siemens' SIMATIC S5)
- SYSMAC communication package (for OMRON's SYSMAC Series)
- YS communication package (for Yokogawa's YS100 SERIES and YEWSERIES 80)
- YS communication package with direct connection (for Yokogawa's YS100 SERIES)
- Gas chromatography communication package (for Yokogawa's gas chromatograph)

Table Supported Subsystems and Communication Packages (Types of FCS and Specific Connection Cables)

| Subsystem | FCS for FIO/compact FCS for FIO | | FCS for RIO/compact FCS for RIO | | Note |
|------------------------------|---------------------------------|-------------------------|---------------------------------|-------------------------|---|
| | Serial communications | Ethernet communications | Serial communications | Ethernet communications | |
| FA-M3 | xx | xx | x | x | |
| DARWIN/DAQSTATION | | xx (*1) | – | x | –: RS-232C cable connection only |
| MELSEC-A | xx | xx | x | x | |
| MELSEC | | xx | | | |
| PLC-5/SLC 500 | x | xx | – | x | –: RS-232C cable connection only for SLC500 |
| Modbus | xx | xx | xx | xx | |
| Siemens | | | x | | |
| SYSMAC | | | x | | |
| YS100 and YEW SERIES 80 | – | | – | | –: RS-485 cable connection only |
| YS100 with direct connection | – | | | | –: RS-485 cable connection only |
| Gas chromatograph | | | – | | –: RS-232C cable connection only |

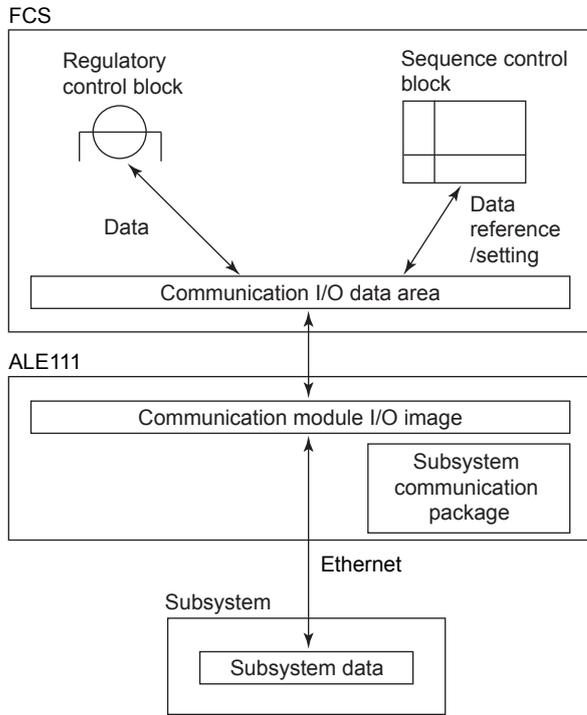
- X: Communications packages available.
 XX: Communications packages and redundant functions available.
 –: Communications packages available, but limited in use.
 *1: Redundancy is possible only for communication with DARWIN.

FOUNDATION Fieldbus or Profibus devices can be connected. For details, refer to Section 2.7.

Communications are also possible with subsystems that are not described above.
 Communication programs meeting communications requirements are created and supplied.

5.1.3 Data Flow between Function Blocks and Subsystems

Subsystem data are stored in the communication module I/O image area in the communication I/O module and sent to the FCS. Those data stored in the communication I/O data area in the FCS can be connected to function block I/O terminals as in general-use analog/digital I/O signals.



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Figure Data Flow Between Function Blocks and Subsystem (When ALE111 Communication I/O Module is used)

5.1.4 Redundant Communication Functions

A configuration meeting the redundancy on subsystems is possible with redundant communication I/O modules. The FCS for FIO and compact FCS for FIO incorporate redundant serial communications functions.

Switchover between the control side and stand-by side of redundant communication I/O modules is performed on a per communication I/O module basis. Although each communication I/O module has two ports, redundancy is not established for each port; communication redundancy requires two modules. Therefore, if there is a failure in one port, control is switched on a module basis even if the other port in the same module is not defective.

Data Reading

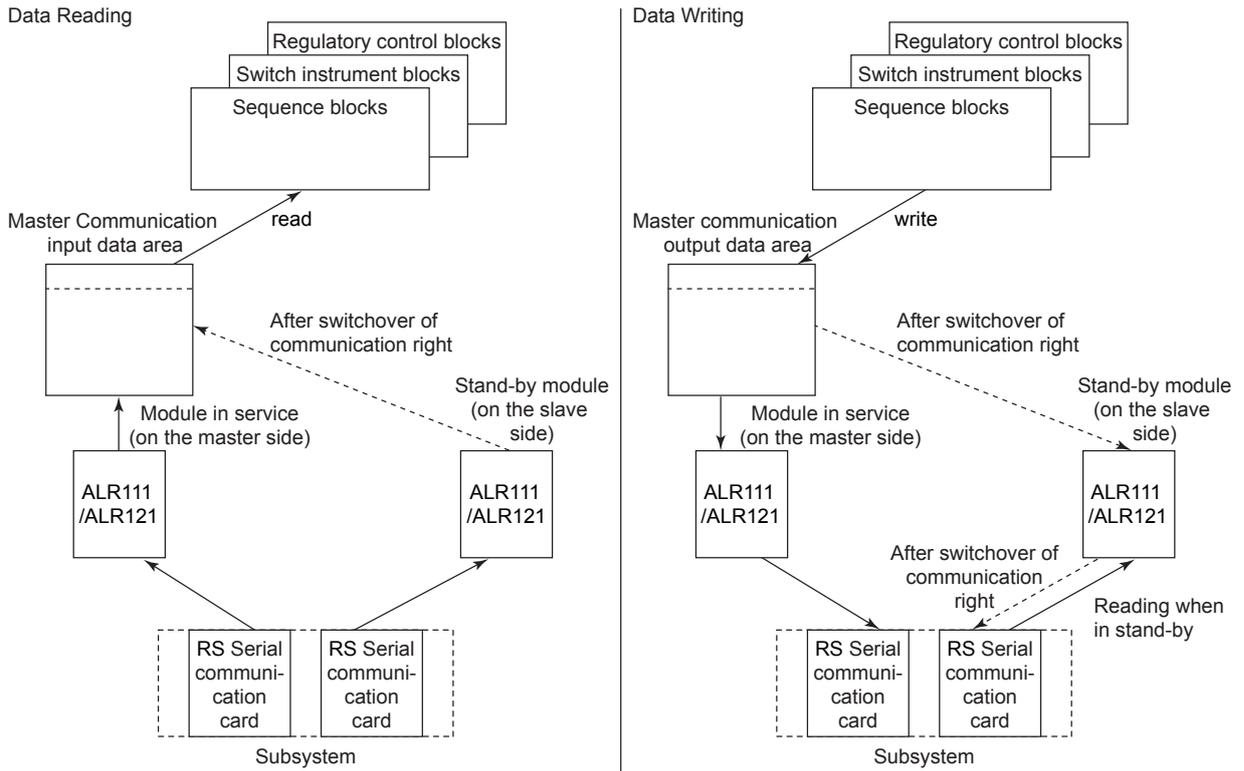
A pair of communication I/O modules perform constant data reading access from subsystems asynchronously. Data on the control side (the module in service) of the communication I/O module is set to the master communication data area while the stand-by communication I/O module performs data reading access but does not write the read data to any communication input data area. If a failure is detected in the master-side communication I/O module or there is an error in communicating with subsystems, control is switched.

Data Writing

The data from function blocks are written to the master communication data area. Normally, data writing access is performed from the master side for the data set. If a failure is detected on the master side, control is switched, data are overwritten on the new control side, and thus data writing access is performed.

Hardware Configuration

Communication I/O modules are installed in contiguous odd- and even-numbered slots (odd-numbered slot + 1 slot number) on the same unit. Normally, odd-numbered slots are for the master side and even-numbered slots for the slave side.



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Figure Redundant Subsystem Communications (Models ALR111/ALR121 Communication I/O Modules are used)

5.2 Generic Subsystem Gateway Package (Option)

The Generic Subsystem Gateway (GSGW) package is an operation and monitoring station for subsystems such as PLCs. With its general-use PC platform, GSGW can communicate with subsystems using a general-use OPC DA interface through an OPC server. Subsystem data are assigned to GSGW function blocks, and the assigned function blocks can be operated and monitored from a human interface station (HIS), like FCS.

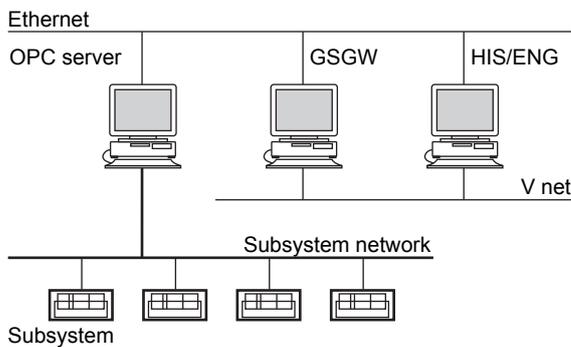
GSGW is addressed to monitor subsystem data. It does not incorporate control function blocks such as PID blocks and the like.

System Configuration

GSGW is connected to a V net and Ethernet. For OPC servers, PLC supplier or third-party vendor servers are used. Connections to an OPC server are classified in two types as given below:

When GSGW is on a PC separate from the OPC server

Connection to the subsystem network is made through an OPC server through Ethernet. PCs for OPC server and GSGW are needed when connecting to multiple OPC servers.



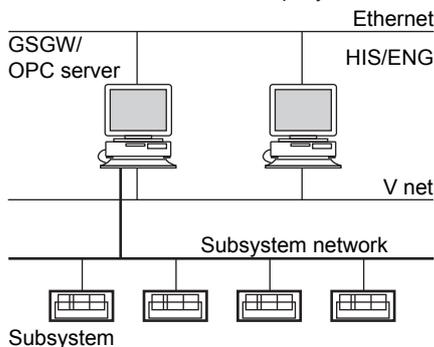
F050201.ai

Figure System configuration where GSGW is on a PC separate from the OPC server

When GSGW and the OPC server are on the same PC

The subsystem network is connected directly to GSGW. Insert an interface card connected to the subsystem network into GSGW.

Note: If an OPC server of third-party vendor runs on the same PC as GSGW, make sure that it will cause no problem beforehand.

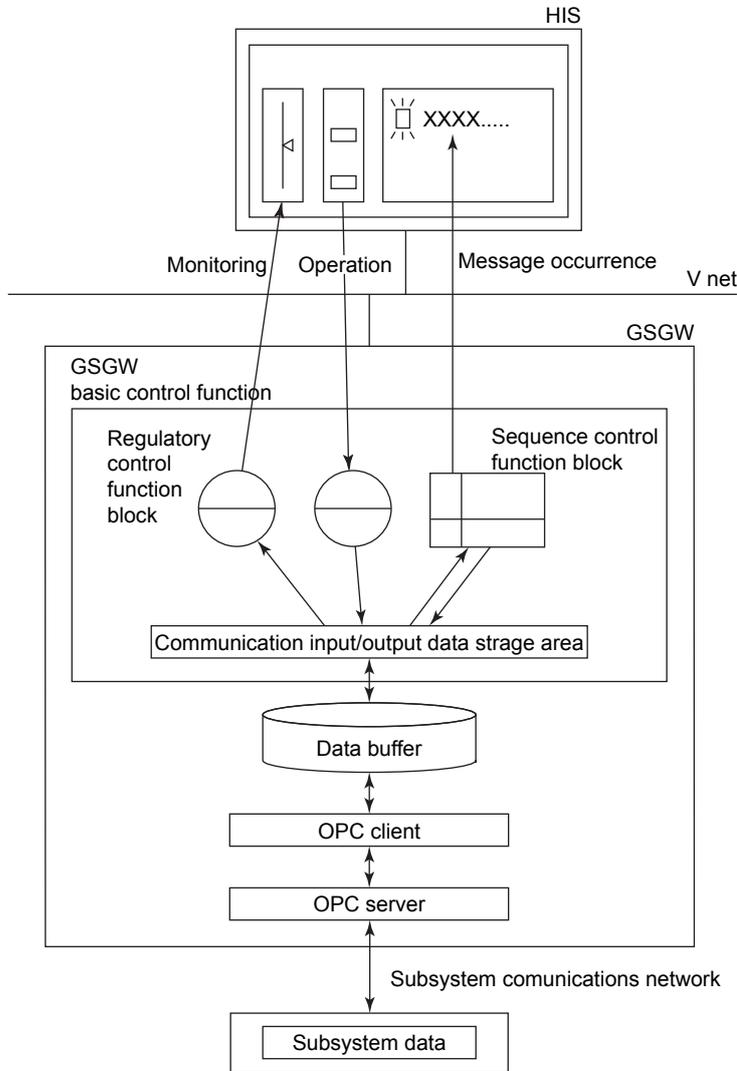


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Figure System configuration where GSGW and the OPC server are on the same PC

Summary of Communications with Subsystems

Communications in cases where GSGW basic functions and the OPC server are on the same PC are summarized below: Subsystem data acquired via an OPC DA server are stored in the buffer. Data stored in the data buffer are assigned to the communication input/output data storage area. These assigned data can be accessed from the function blocks or sequence tables in the same process as in a normal FCS.



F050203.ai

Figure Data Flow of Subsystems

6. Engineering Functions

The CENTUM CS 3000 engineering functions are used for system generation – for creating the databases necessary for monitoring, operation and control – and for maintenance.

The engineering functions are described below.

Run on General Purpose PC

- Like the operation and monitoring functions, the engineering functions run on Windows on a general purpose PC. A special, dedicated machine is not required. You can even run the engineering functions on an HIS – together with operation and monitoring functions – and easily switch between operation/monitoring and engineering windows.

Concurrent Engineering

- Using Windows File sharing, several people can share an Engineering database on a network; concurrent engineering is possible. Alternatively, engineering databases created on separate machines can be merged.

“Virtual Test” Functions

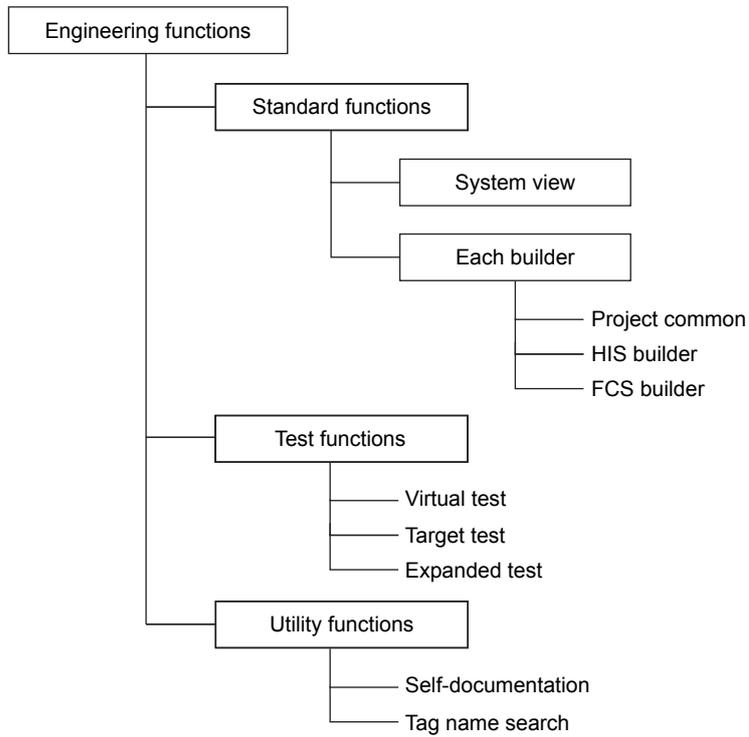
- The control functions can be simulated on a PC. Actual FCS hardware is not required, tests can be performed on an Engineering HIS (ENG) (you can switch between monitoring/operation and engineering windows). So you can perform tests to validate each program segment immediately after you complete it, if you wish.

Reusable Engineering Data

- Necessary fragments of engineering data can be easily reused in another station or another project. So you can reuse special control know-how, reduce engineering, and standardize control.

6.1 Configuration of Engineering Functions

The figure below shows the configuration of Engineering Functions.



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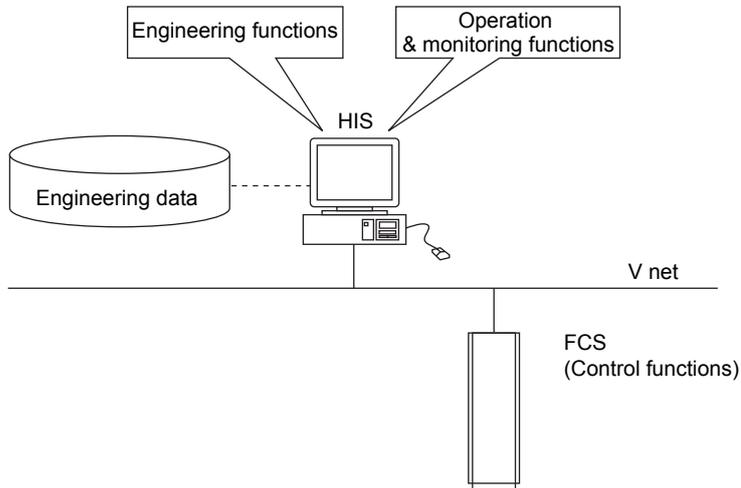
Figure Configuration of Engineering Functions

6.2 Engineering Environment

Different operating environments for the Engineering Functions are illustrated below.

Engineering and Operation/Monitoring Functions on the same PC

When Engineering and Operation/Monitoring Functions share the same PC:

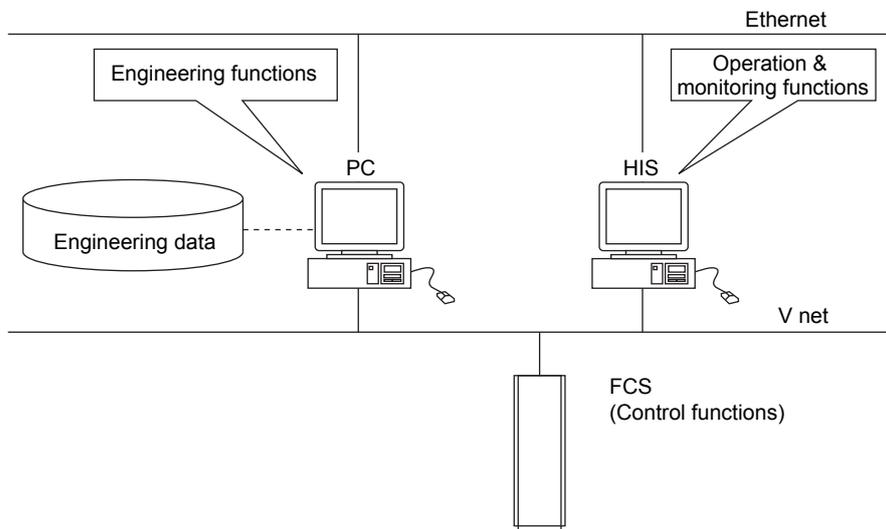


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Figure Engineering and Operation/Monitoring Functions on the same PC

Engineering Functions on dedicated PC

When using Engineering Functions on a dedicated PC:



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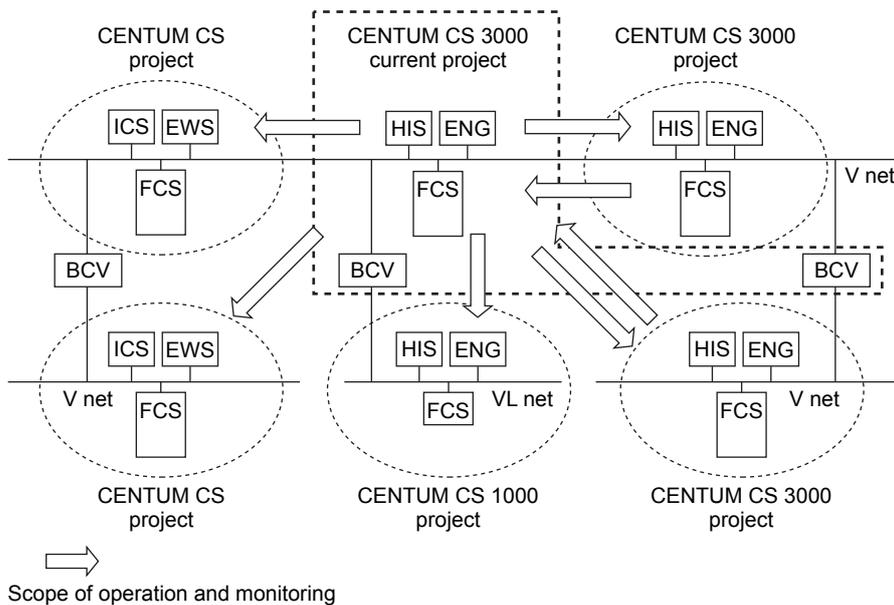
Figure Engineering Functions on a dedicated PC

Multiple Project Connection Functions (Option)

From CENTUM CS 3000 operation and monitoring functions (HIS), you can totally operate and monitor plants configured by CENTUM CS, CS 1000 and CS 3000. When defining the CENTUM CS 3000 project as the upper-level project, you can operate and monitor multiple lower-level projects (CENTUM CS, CS 1000 and CS 3000 projects) from operation and monitoring functions (HIS) defined in the upper-level project.

In previous multiple project connections, part of the lower-level project database (tag list) could be read into the upper-level database and operated/monitored by tag number. In this function, the upper-level project operation and monitoring functions keep the connected lower-level project database (data necessary for operation and monitoring), so the scope of operation and monitoring functions is much wider.

A multiple project connection example is shown below.



F060203.ai

Figure Multiple Project Connection Example

In the CENTUM CS, CS 1000 and CS 3000 project databases, various name-data (definitions) exist. Representative data includes tag name, station name, plant hierarchy names and engineering units.

The Multiple Project Connection Functions add an ID prefix to distinguish duplicate names in multiple projects. So project connection does not change the original names. Other features are as follows:

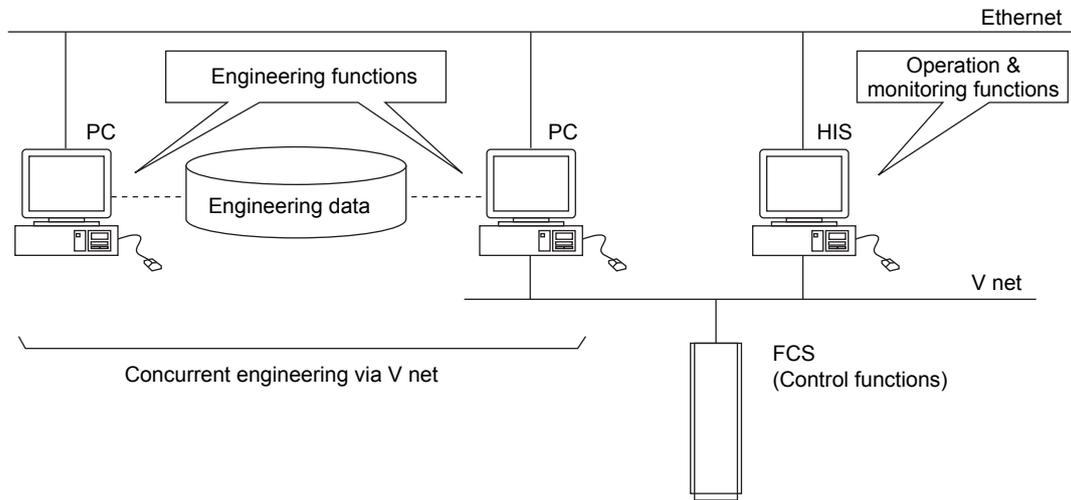
- Multiple systems on the same control bus, connected by communication gateway (CGW) or bus converter (BCV) are supported.
- Changes to lower-level project tag lists (tag names added/changed/deleted) are automatically reflected in the upper-level project.
- System statuses and FCS statuses of lower-level project can be displayed.
- Lower-level project control statuses (control drawings, logic charts, etc.) can be displayed and monitored.

This function facilitates large-scale plant distributed engineering and plant expansion, reducing the time involved.

6.2.1 Concurrent Engineering

Using Windows File sharing, several people can share an Engineering database on a network; concurrent engineering is possible. Alternatively, engineering databases created on separate machines can be merged.

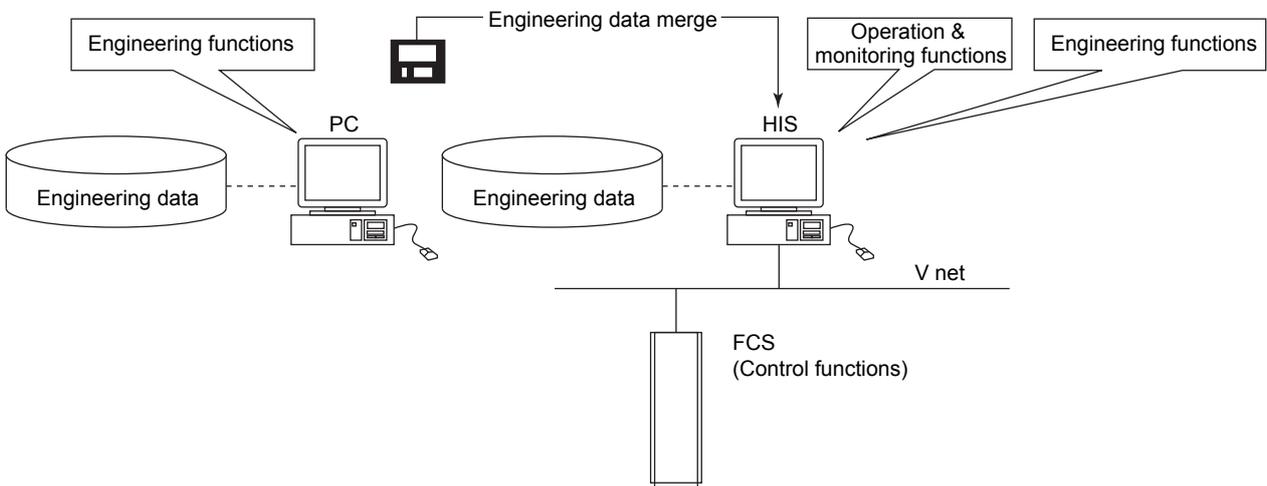
Concurrent Engineering on a Network



F060204.ai

Figure Concurrent Engineering on a Network

Merging of Engineering Data

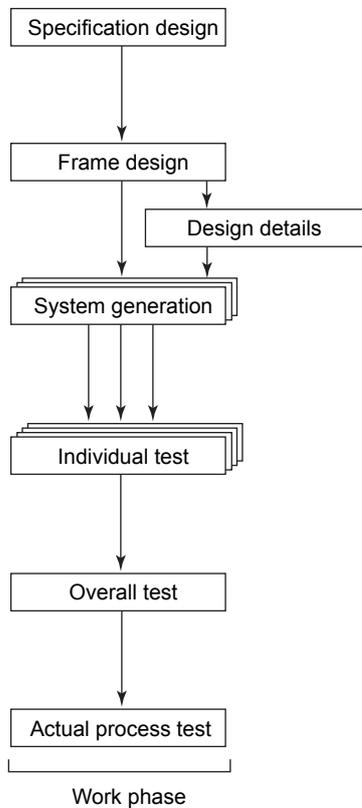


F060205.ai

Figure Merging of Engineering Data

6.3 Engineering Procedure

The following figure illustrates the flow of engineering work involved in creating a new project.



F060302.ai

Figure Flow of Engineering Work

System Generation

If the design of detailed specifications is not required, start from this stage. A number of engineers can work on the system generation concurrently (Concurrent engineering).

Individual Test

This test uses the virtual test function. A number of engineers can perform testing simultaneously.

Overall Test

This test uses the target test function with a real FCS, though this does not require field wiring, and checks the individually-checked functions on the above test and execution timing.

6.4 Standard Engineering Functions

The Standard Engineering Functions consist of system view (a tree view of the database) and the builder programs that define each of the functions.

6.4.1 System View

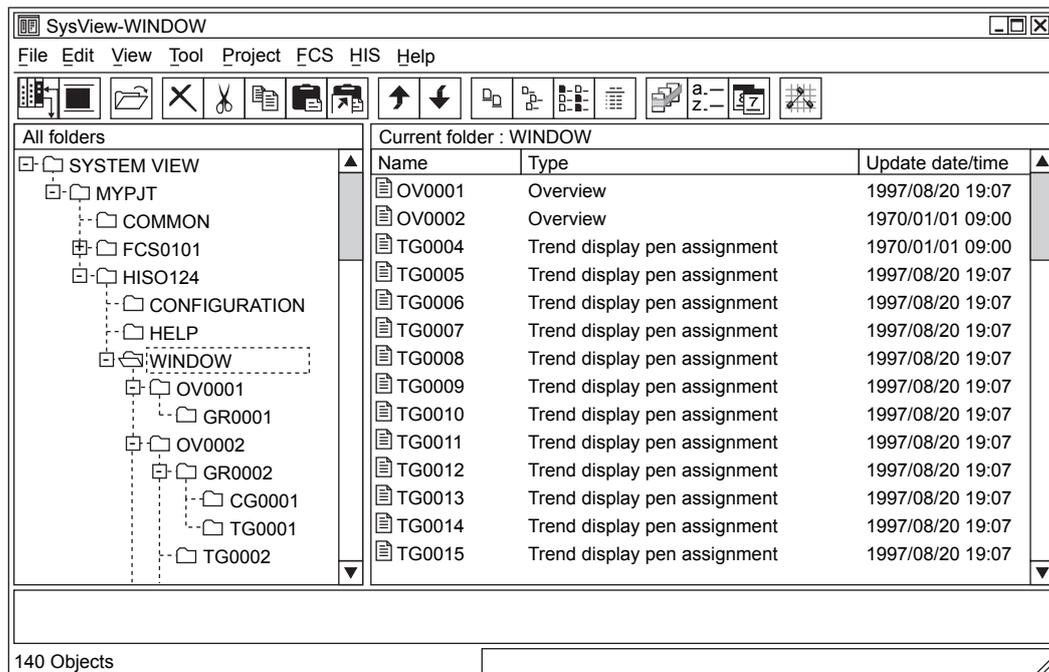
The System View provides a hierarchical (tree) view of components (FCS, HIS etc.) in the engineering database. Simply double clicking an item in the tree view launches the corresponding builder program.

The main functions of the system view are as follows:

- Displays a hierarchical view of the engineering data,
- Allows you to execute individual builder functions,
- Allows you to execute test functions to validate the database,
- Allows you to execute self-documentation functions,
- Allows you to create new engineering data for projects, FCS and HIS,
- Allows you to download a database to the corresponding FCS or HIS,
- Allows you to save FCS tuning parameters.

Projects

A project is an individual system configuration database containing configuration information for all FCS and HIS stations in the system. You can create several different projects for a system, one of which is the configuration of the current running system. This is called the current project. When changing or expanding the current configuration, you can create a new project (based on the current project) – so that the current database is not affected – and perform configuration, and virtual testing, on the new project.



F060301.ai

Figure System View

6.4.2 Builder

The builder contains programs to generate project common functions, operation and monitoring functions, and control functions. Specialized builder programs handle each of these functions. A list of builder programs is shown below.

Table List of Builder Programs (1/2)

| Category | Builder Name | Description |
|--|--|--|
| Project Common | Station configuration viewer | Displays station addresses and models in the system. |
| | Security | Defines security such as HIS user management and access rights for tags. |
| | Operation mark | Defines operation marks used on an HIS. |
| | Multiple project connection | Defines multiple project connection. |
| | Plant hierarchy | Defines plant hierarchy. |
| | Engineering unit symbol | Defines engineering unit symbol. |
| | Switch position label | Defines switch position label. |
| | State transition matrix | Defines state transition matrix. |
| | Alarm processing table | Defines alarm processing table. |
| | Alarm priority level | Defines alarm priority level. |
| | System-specific status character string viewer | Displays system-specific data status, block mode, block status, and alarm status character strings. |
| | User-defined status character string | Defines user-defined status character string. |
| | Status change command character string | Defines status change command character string. |
| Operation and Monitoring Functions (for HIS) | HIS constant | Defines various constant values on an HIS. |
| | Graphic window | Performs Graphic windows definition. |
| | Trend data acquisition pen assignment | Assigns data items to trend record pens. |
| | Trend record | Defines the trend block data acquisition cycle and the number of samples. |
| | Trend display pen assignment | Displays the trend display pen assignment. |
| | Scheduler | Defines the schedule of Windows applications. |
| | Sequence message request | Defines the processes of sequence messages sent from FCS. |
| | Function key assignment | Defines the function key assignment. |
| | Panel-set | Defines the windows combination for panel-set. |
| Help dialogue | Defines Help for tags and windows. | |
| Control Functions (for FCS) | FCS constant | Defines various constant values on an FCS. |
| | IOM | Defines the specifications for terminals of an input/output module. |
| | Communication input/output | Defines each point of devices connected to communication module. |
| | Common switch | Defines common switches. |
| | Annunciator | Defines annunciator messages. |
| | Operator guide | Defines operator guide messages. |
| | Printout message | Defines printout messages. |
| | Signal event | Defines signal events. |
| | Global switch | Defines global switches. |
| | Function block list | Defines the order of execution, tag name, model of each function block. |
| | Control drawing | Defines the order of execution, tag name, model and connection of each function block in a graphical format. |
| | Function block details | Defines the detailed specifications of each function block. |
| | Status display | Edits control drawing or logic chart status display file. |
| | SEBOL user function | Defines SEBOL user functions. |
| | SFC sequence | Defines SFC sequences. |
| Unit procedure | Defines unit procedure. | |

Table List of Builder Programs (2/2)

| Category | Builder Name | Description |
|-----------------------|-----------------------------------|---|
| Bus converter | BCV constants tag list generation | Defines various BCV constants. Defines tag lists and messages of existing FCSes. |
| Communication Gateway | CGW constants | Defines various CGW constants. |
| Batch functions | Process management function | Defines process management functions. |
| | Common block | Defines common block. |
| | Unit common block | Defines the common block used by unit instruments. |
| | Product control | Defines product control window. |
| | Train | Defines Train. |

6.5 Test Functions (Option)

The Test Functions allow combinations of monitoring/operation and control functions to be tested before being put into operation. Virtual test functions and target test functions allow system configuration and testing time to be greatly reduced; testing of a completed module can be performed while another module is being configured.

Virtual Test Functions

The virtual test functions use FCS simulation (virtual FCS) to test the system configuration on a single Personal Computer. You can operate several virtual FCS at the same time. The main functions are as follows:

Virtual control stations can be started and stopped, and offer the following debugging support functions:

One-shot Execution Functions

Function blocks may be executed just one time, then stopped.

Messages may also be generated just one time.

You can check that calculations are being executed properly, and confirm that (sequence trigger) messages are being generated.

Step Execution

After a function is executed a specified number of times (at the control period) it stops. You can confirm the control operation.

Breakpoint Functions

You can specify a break condition for a function block. When the break condition becomes true, the station is stopped. This is useful for investigating problems. You can set up to eight break conditions.

Receiving Communications from Other Stations

Virtual control stations can send messages to other control stations. In addition, virtual control stations start/stop other FCS's on a per FCS basis, allowing the confirmation of communication functions.

Tuning Parameter Save Functions

Tuning parameters used in a virtual test can be saved.

PID control block parameters, alarm settings, and other settings, can be validated and saved each time you change the system configuration.

Snapshot Functions

Using snapshot functions, tuning parameters, annunciator status, common switch status, and I/O status can be saved or retrieved.

Virtual test function is shown below.

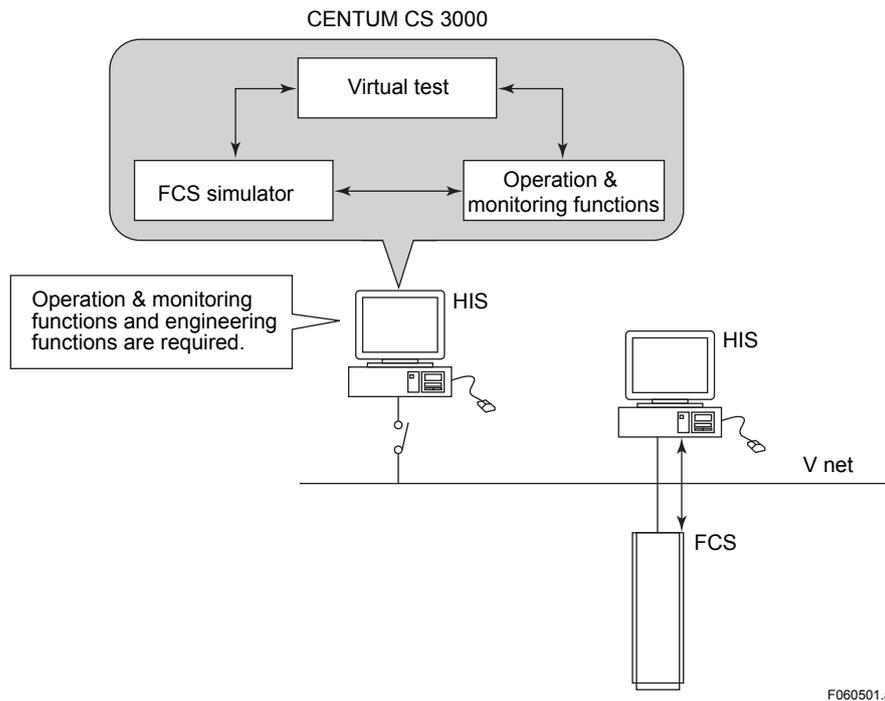


Figure Virtual Test Functions

Target Test Functions

These use actual HIS and FCS for the test. Actual field wiring is not required, or – if it exists – you can specify that it be ignored (I/O switching).

You can also simulate a virtual process in an FCS. The virtual process receives the control output from the FCS, and the response of the virtual process is connected to the FCS process variable input. The virtual process may use first order lag and the like to model the actual process.

As well as virtual test functions there are debug support functions. The main functions are summarized below.

One-shot Execution Functions

Step Execution

Breakpoint Functions

Tuning Parameter Save Functions

Profiler Display Functions

CPU usage and FCS internal status are displayed.

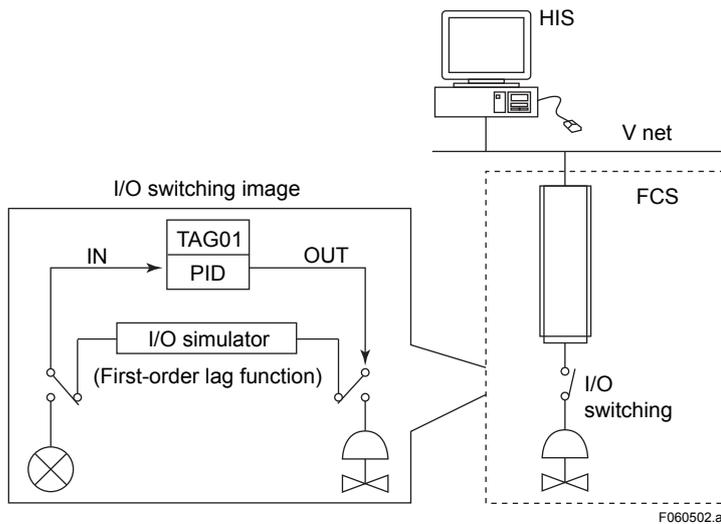


Figure Target Test Functions (I/O Switching)

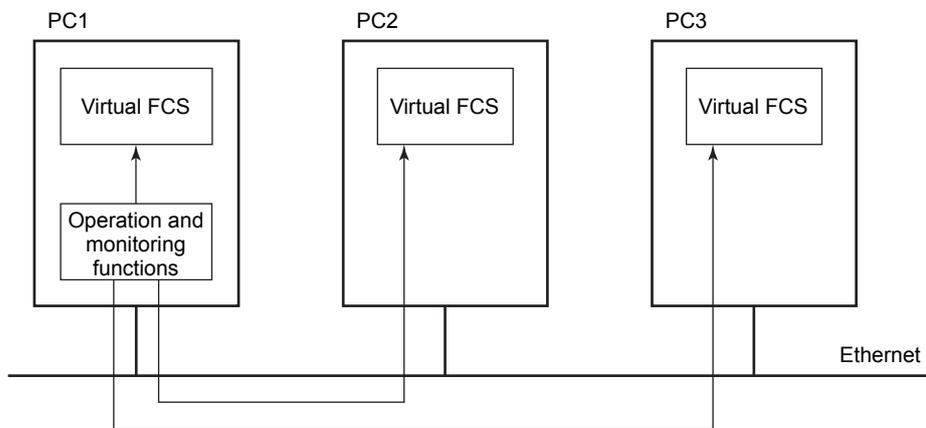
Expanded Test Functions

Expanded Test Functions can be used with standard test functions to allow FCS simulation, operation and monitoring functions, and engineering functions to be used among several PCs utilizing communications. You can improve engineering efficiency by the following engineering and tests:

- Test multiple virtual FCSes from multiple PCs.
- Operate same virtual FCS from multiple PCs.
- Distributed engineering of FCS.

Test Multiple Virtual FCSes from Multiple PCs

Virtual FCSes distributed over multiple PCs resemble an actual plant, and several virtual FCSes can be tested simultaneously.

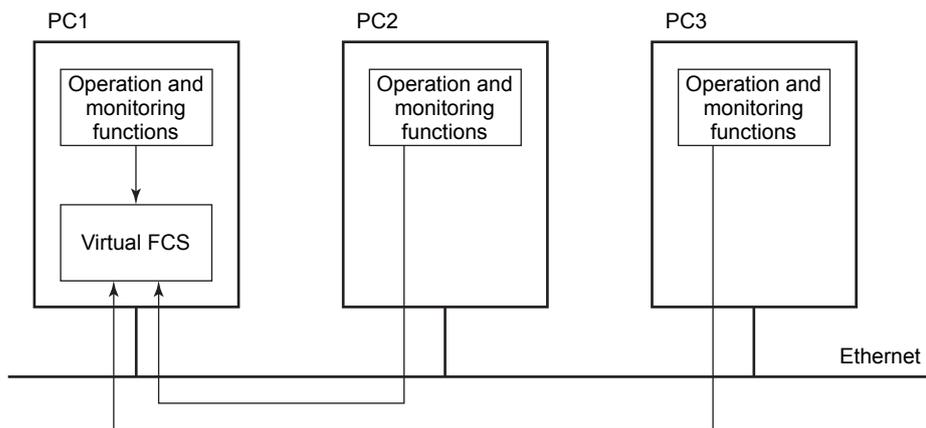


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Figure Testing Multiple Virtual FCSes from Multiple PCs

Operating Same Virtual FCS from Multiple PCs

A virtual FCS on a PC can be operated from multiple PCs.

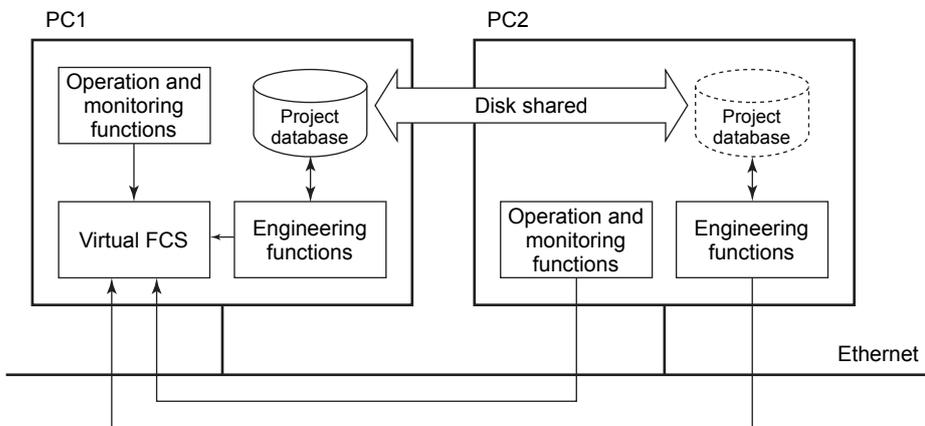


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Figure Operating Same Virtual FCS from Multiple PCs

Distributed Engineering of FCS

Engineering of a single virtual FCS may be performed simultaneously from multiple engineering functions.



F060405.ai

Figure Distributed Engineering of FCS

6.6 Utility Functions

Some utilities are provided for use from the System View, and some utilities are regular Windows NT applications.

Resource Usage Status Display

This displays the resource usage status for function blocks.

Tag Name Search

This searches for tag names within a specified range, and displays references.

Self Documentation (Option)

These functions print engineering data for final document.

Print All Data

This function prints all data in the project.

Printout of Individual Items

This prints separately for each builder. You can print a station unit, or by modification date.

Tuning Parameter Printout

This prints tuning parameters.

Edit Headers, Footers

This allows you to edit headers and footers.

Edit Table of Contents

This allows you to freely assign a section number to each station.

Specify Type of Printing

You can specify any of the following types of printing:

- Normal printing: Undefined fields are printed as blanks.
- Simple printing: Only defined fields are printed out.
- Detail (setting item) printing: Even tag-level items are printed.

A printout example is shown below:

Function Block Lists

| XXXXXXXXXXXXX Header XXXXXXXXXXXXXXXX | | | | | | |
|---------------------------------------|-------------------|--------|--------------------------|---------------------------|----------------|--|
| Function block detail definitions | | | | | | |
| Comment | | | | | | |
| No. | Tag Name | Model | Tag comment | Scale LO limit | Scale HI limit | |
| | Output connection | | | Setpoint input connection | | |
| 001 | PGTCA101 | PG-L13 | A1 Inner temp Program | 0 | 0 | |
| | TCA101.SET | | | | | |
| 002 | TCA101 | PID | A1 Inner temp Control | 0.0 | 150.0 | |
| | TCA102.SET | | | | | |
| 003 | TCA102 | PID | A1 Outer temp Control | 0.0 | 150.0 | |
| | STTCA102.SET | | | | | |
| 004 | STTCA102 | SPLIT | A1 Temp regulation Split | 0 | 0 | |
| 005 | LIA100 | PVI | A1 Level | 0.0 | 100.0 | |
| 006 | LIA101 | PVI | AS1 Level | 0.0 | 100.0 | |
| 007 | XVA1001 | SIO-11 | A1 Bottom valve | 0 | 0 | |
| | XVA1001OUT | | | | | |
| 008 | XVA1002 | SIO-11 | A1 Pull out valve | 0 | 0 | |
| | XVA1002OUT | | | | | |
| 009 | XVA1003 | SIO-11 | A1 N2 Push valve | 0 | 0 | |
| | XVA1003OUT | | | | | |
| 010 | XVA1004 | SIO-11 | A1 Drain valve | 0 | 0 | |
| | XVA1004OUT | | | | | |
| 011 | XVA1005 | SIO-11 | A1 Steam valve | 0 | 0 | |
| | XVA1005OUT | | | | | |
| 012 | XVA1006 | SIO-11 | A1 Cold Water valve | 0 | 0 | |
| | XVA1006OUT | | | | | |
| 013 | XVA1007 | SIO-11 | A1 Jacket dren valve | 0 | 0 | |
| | XVA1007OUT | | | | | |
| 014 | XVA1008 | SIO-11 | A1 Air open valve | 0 | 0 | |
| | XVA1008OUT | | | | | |
| 015 | XPA1001 | SIO-11 | A1 Pull out P | 0 | 0 | |
| | XPA1001OUT | | | | | |
| 016 | XGA1001 | SIO-11 | A1 Agitator | 0 | 0 | |
| | XGA1001OUT | | | | | |
| 017 | XVAS1001 | SIO-11 | AS1 Bottom valve | 0 | 0 | |
| | XVAS1001OUT | | | | | |
| 018 | XLAS1001 | SI-1 | AS1 Empty exam & notic | 0 | 0 | |
| XXXXXXXXXXXXX Footer XXXXXXXXXXXXXXXX | | | | | | |

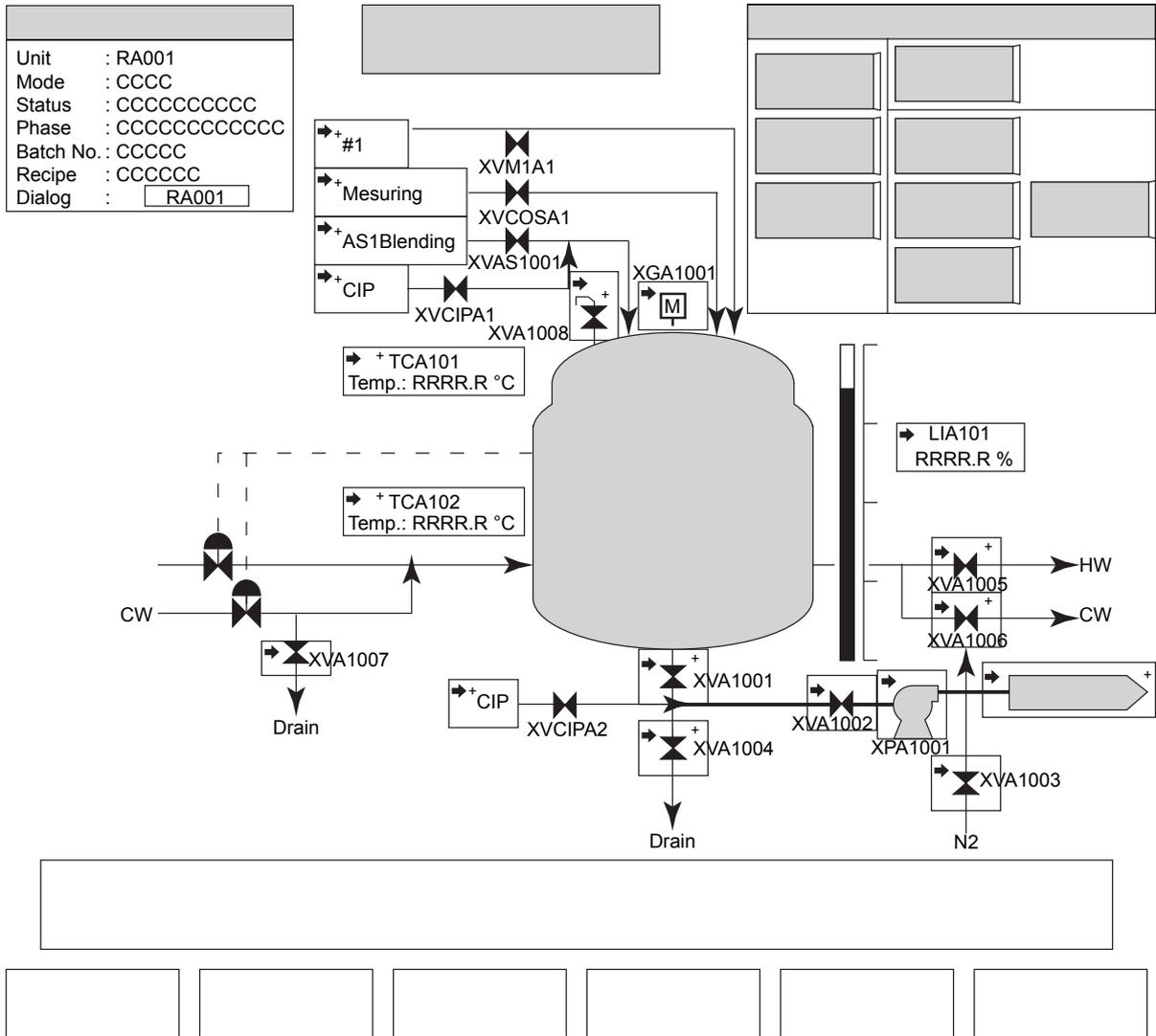
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Figure Example of Self-Documentation for Function Block Detail Definitions

Graphic Definitions

XXXXXXXXXXXXX Header XXXXXXXXXXXXXXXX

Panel type: Graphic window
 Size: 1024 x 686
 Window update period: 1 second



XXXXXXXXXXXXX Footer XXXXXXXXXXXXXXXX

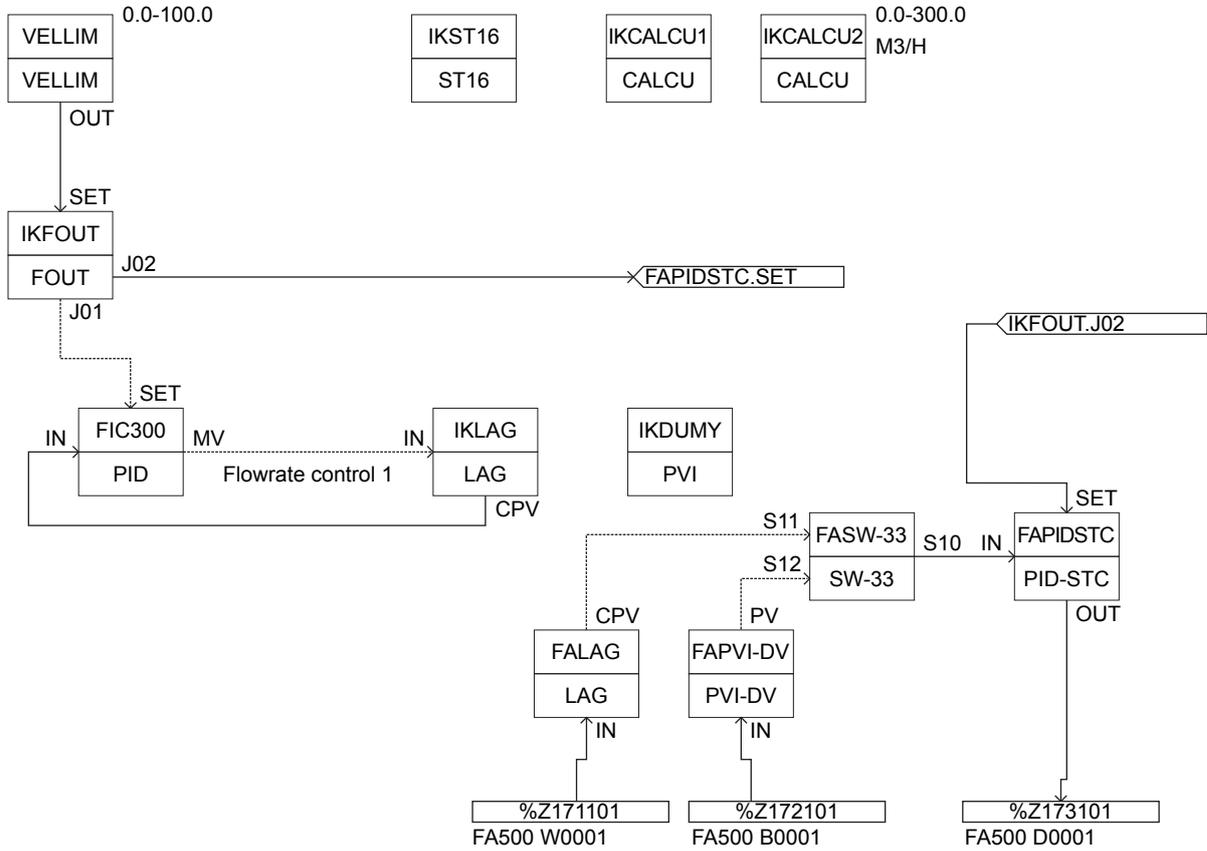
F060603.ai

Figure Self-Documentation for Graphic Windows

Control Drawing Definitions

XXXXXXXXXXXXX Header XXXXXXXXXXXXXXXX

Panel type: Status display window
 Size: 800 x 536
 Window update period: 5 seconds



XXXXXXXXXXXXX Footer XXXXXXXXXXXXXXXX

F060602.ai

Figure Self-Documentation for Control Drawings

6.7 Online Maintenance Functions

The online maintenance functions allow you to modify the control functions during online control, without any effect on other than the modified functions – i.e. the effect on plant operation is minimized. Apart from items which would affect the continuity of control, most settings can be modified using online maintenance functions. To change the following functions requires that the CPU be stopped (i.e. offline maintenance only):

- FCS power switching from single to dual-redundant
- Fast scan period
- MC (Motor Control) instrument block pulse width setting
- MC instrument block start interval
- MLD-SW block auto mode (AUT/CAS) setting
- SEBOL statement “Drive” statement operation type
- SS-DUAL PV update during deviation alarm
- Alarm notify action when all AOF released
- User-defined status character string
- Alarm processing table
- Alarm priority level
- Status change command character string
- State transition matrix

6.8 Remote Maintenance (Option)

Using this function, your CENTUM CS 3000 system can be connected to Yokogawa’s service section support system in a public network for remote maintenance within the scope of specified user-security. Yokogawa’s service section experienced systems engineers diagnose the overall operating condition of your system.

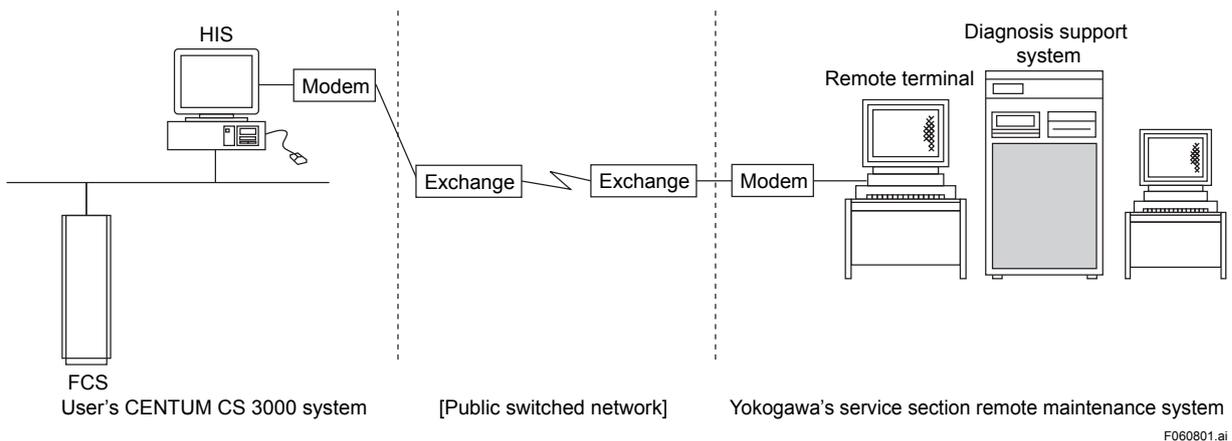


Figure Remote Maintenance

6.9 Coordination with SmartPlant Instrumentation

SmartPlant Instrumentation is Intergraph Corporation's instrumentation design and information management tool that manages a database on plant instrumentation.

CENTUM CS 3000 has the interface function with SmartPlant Instrumentation, which enables the CS 3000 builder and SmartPlant Instrumentation to reuse the common data such as the tag name and the span each other.

If the database of SmartPlant Instrumentation is set a master, the SmartPlant Instrumentation side can consolidate the management of the plant engineering data including the engineering data of DCS, CS 3000. Consolidating the management of the database and providing the interactive interface between SmartPlant Instrumentation and CS 3000 prevent overlap of inputting the same data into SmartPlant Instrumentation and CS 3000 and omission or mistake of correction, and realize an efficient engineering work.

Engineering Data Exchange Function

The CS 3000 engineering function exchanges the engineering data with SmartPlant Instrumentation interactively, which allows the correction of the database of SmartPlant Instrumentation to be reflected in the data of CS 3000. Also, CS 3000 can reflect the engineering data in SmartPlant Instrumentation when SmartPlant Instrumentation is introduced newly.

Applicable Data for Data Exchange

- FIO Data
- FOUNDATION fieldbus Device Data

Data Transfer Unit

The data transfer unit can be selected from the following

- FCS
- The node
- The I/O Card
- Drawing

Export Function

The Export function converts the database of CS 3000 into a form that allows it to be loaded into the SmartPlant Instrumentation side. It is used to transfer the database on the CS 3000 side to the master when SmartPlant Instrumentation is introduced.

Import Function

This function detects the difference between the databases on the SmartPlant Instrumentation side and on the CS 3000 side and reflects the difference in the CS 3000 side.

**SEE
ALSO**

Please refer to GS 33Q02B30-31E for coordination with SmartPlant Instrumentation.

6.10 DevicePanel Functions

DevicePanel is a function included in the fieldbus engineering function package.

It facilitates applying the device database created in the engineering work to an actual device. Moreover, the field devices can be replaced efficiently.

- This function manages the actual state of the device connected with the fieldbus segment (whether the engineering database is reflected in the actual machine, whether it is combined to the CS 3000 system, whether there is any communication abnormality) and can take the appropriate responses to the device state.
- The information on the device connected with the segment can be visually displayed.
- The database created in the engineering work can be applied to the actual device easily and easy replacement work of the devices can be realized.
- It is available in the field because it operates even on the PC not connected directly with the control bus. (using the Server for Remote Operation and Monitoring Function)

Relation to Other Functions

- This function is called a device information list display function by the CS 3000 fieldbus builder.
- This function allows the software downloading function to work. The software downloading results are reflected in PRM via HIS.

7. Safety Instrumented System (ProSafe-RS)

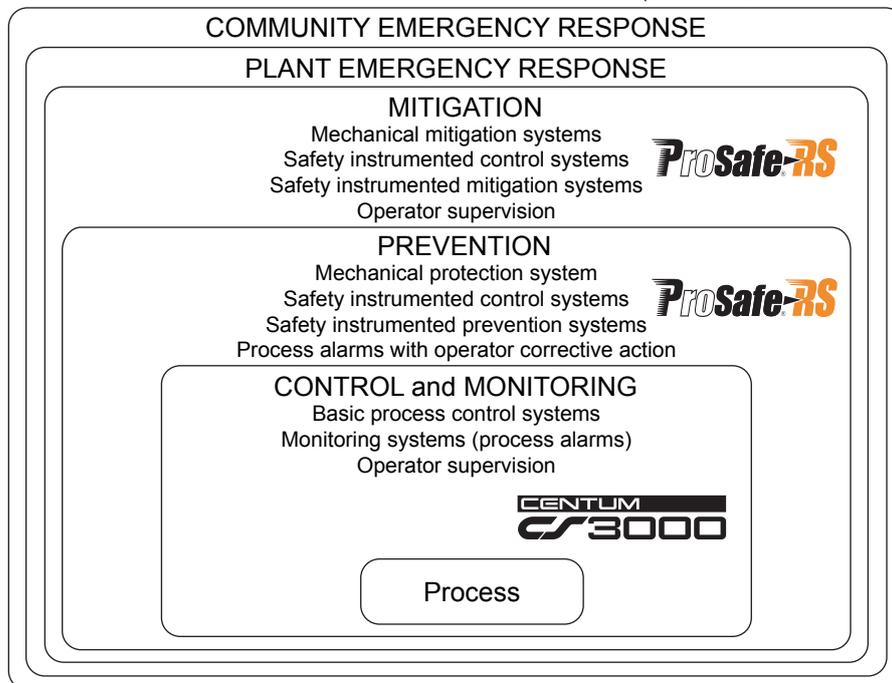
ProSafe-RS is a safety instrumented system conforming to IEC 61508. This chapter explains the various features and functions of safety instrumented systems that ProSafe-RS provides.

Protection Layers of Plant and Safety Instrumented System

IEC 61511 utilizes the concept of protection layers in order to achieve safety, freedom from unacceptable risk. Each protection layer is required to set quantitative risk reduction goals as well as means of achieving these goals independently without interfering with other layers.

According to this idea of protection layers, safety instrumented system is positioned within the mitigation and prevention layers.

(IEC 61511, ISA S84.00.01)



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Figure Protection Layers and Positioning of Safety Instrumented Systems

Safety Life Cycle

IEC 61508 specifies the management of safety-related systems in terms of lifecycles. In the safety lifecycle, the tasks involved, from the conceptual stage in which a basic safety system is designed to the decommissioning of the system, are divided into 16 phases as shown in the figure below, and the required tasks to be achieved in each phase are defined. The purpose of these definitions is to minimize the likelihood of human-induced errors. For example, "Hazard and risk analysis" shown in the third frame sets requirements to clarify the hazards and hazardous events that may occur in a plant and its control devices (e.g., DCS).

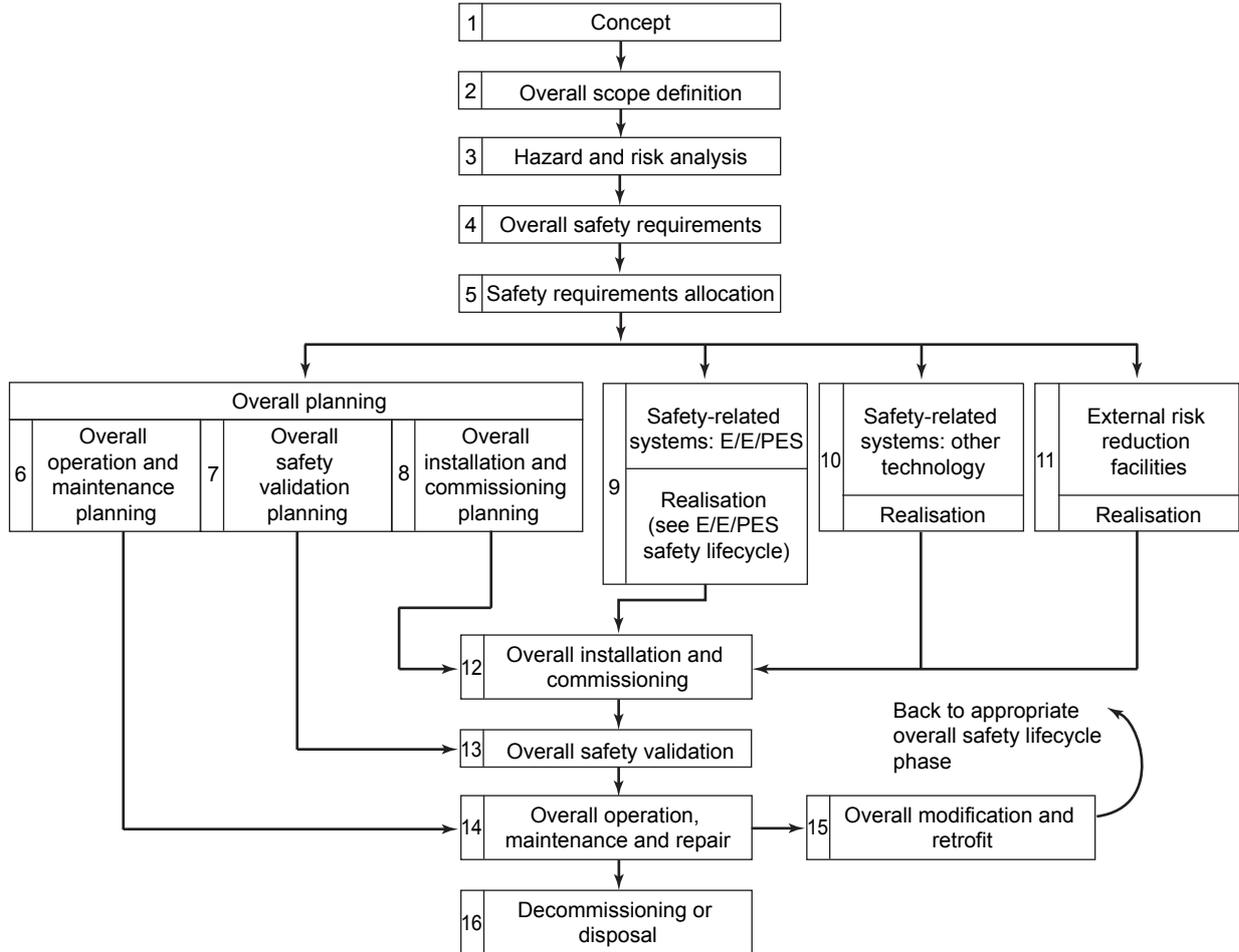


Figure Safety Lifecycle

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Scales of Safety Evaluation

IEC 61508 introduces the concept of Safety Integrity Level (SIL) as a method for showing the safety integrity requirements. The safety integrity level is classified into four levels according to the value of Probability of Failure on Demand (PFD). PFD is the malfunction probability of a safety instrumented system due to a failure when actuation of the system is requested. The higher the SIL level, the higher the risk reduction level of the plant.

Table Safety Integrity Level (SIL)

| SIL | PFD |
|-----|-------------------------------|
| 4 | $\geq 10^{-5}$ to $< 10^{-4}$ |
| 3 | $\geq 10^{-4}$ to $< 10^{-3}$ |
| 2 | $\geq 10^{-3}$ to $< 10^{-2}$ |
| 1 | $\geq 10^{-2}$ to $< 10^{-1}$ |

For example, specifying SIL3 as the safety integrity requirement for a safety instrumented system means requiring the safety instrumented system to ensure that the frequency of risk occurrence is reduced to less than 1/1000 under the current conditions.

7.1 Features of ProSafe-RS

ProSafe-RS is a safety instrumented system conforming to safety rating SIL3 as defined by IEC 61508. It not only satisfies requirements to be used in safety instrumentation by itself, but also achieves higher efficiency of operations through integration with CS 3000.

Implementation of Control System Technologies

ProSafe-RS employs the CS 3000 architecture in its base technologies. Because of this, the following advantages can be expected.

- Basic concepts, such as hardware installation and maintenance methods, can be shared with CS 3000.
- Since connection via V net or Vnet/IP is possible, system construction and interface design are made simpler, allowing an improvement of the total engineering efficiency, including design and installation costs.

Achievement of Safety Rating SIL3 with Single Configuration

ProSafe-RS has built-in dual-redundant system matching and self-diagnosis mechanisms embedded within one CPU module and one input/output module, thus making it conform to SIL3 as defined by IEC 61508 in a single component. This allows implementing SIL3 safety loop in a single configuration together with the CPU module and input/output module.

Achievement of High Availability by Redundancy

ProSafe-RS allows selecting dual-redundant module configurations in order to achieve high availability. Since it achieves SIL3 with a single configuration, the safety level of SIL3 can be maintained even if a CPU module or input/output module on one side fails in the dual-redundant configuration.

Integrated Monitoring with CS 3000

ProSafe-RS is equipped with functions for integration with CS 3000, which provide a communication interface for accessing SCS of ProSafe-RS via V net or Vnet/IP from HIS and FCS of CS 3000. These functions allow monitoring SCS operation using the same interface (window) as of monitoring FCS from HIS. FCS can read data of SCS. This can be done by the same interface (tag name) as of reading data of one FCS from other FCS.

Connection with Other Systems

It is possible to read data of SCSs from the host computer using OPC and SOE-OPC. It is also possible to connect to other DCSs and PLCs via subsystem communication (Modbus communication method).

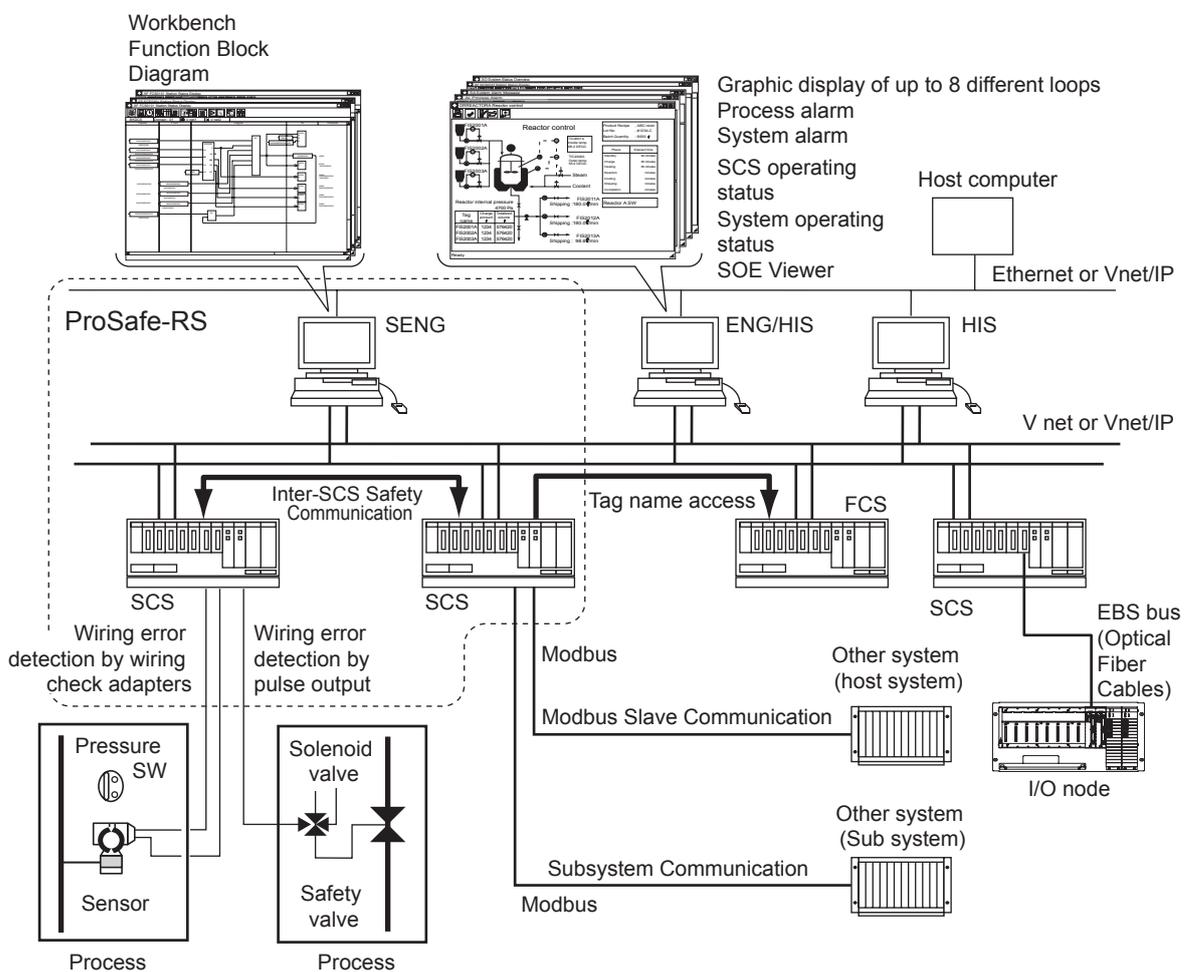
7.2 System Configuration of ProSafe-RS

ProSafe-RS is comprised of SENGs (safety engineering PCs) equipped with engineering and maintenance functions and controller SCSs (safety control stations) for safety. The minimum configuration involves one SENG and one SCS. It is possible to have a structure where ProSafe-RS is integrated with CS 3000 and a configuration where ProSafe-RS is connected to systems other than CS 3000 via Modbus.

7.2.1 System Overview

In ProSafe-RS, CPU modules and input/output modules comprising an SCS are placed in single configuration and can be applied to applications of up to IEC 61508 SIL3. If it is desired to improve the availability, modules in required areas are made dual-redundant.

By using inter-SCS safety communication, it is possible to configure SIL3 safety loops across multiple SCSs via V net or Vnet/IP.



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Figure ProSafe-RS System Configuration (for ProSafe-RS/CS 3000 Integration Structure)

- In a ProSafe-RS/CS 3000 integration structure, it is possible to monitor operations of both FCS and SCS with HIS.
- SCS engineering is performed from SENG and engineering of FCSs and HISs is performed from an ENG. Engineering of CS 3000 integration functions is performed from both SENG and ENG. The SENG, ENG and HIS functions can be installed in a single PC or separate PCs.

- Host computer that performs production control can access data of FCSs and SCSs via an OPC interface by installing the Exaopc OPC interface package of CS 3000 (for HIS). By using the SOE OPC interface package of ProSafe-RS, it is also possible to access SOE information of SCS from a host computer.
- In a ProSafe-RS/CS 3000 integration structure, it is necessary to connect SENG, ENG and HIS via Ethernet during the engineering.
- In a ProSafe-RS/CS 3000 integration structure, it is possible to connect only HIS to ProSafe-RS. In this case, the configuration is the same as the system configuration without CS 3000 FCS.
- Using the external communication function blocks prepared in ProSafe-RS, it is possible to communicate with external devices without interfering the safety functions of an SCS. In case of a ProSafe-RS/CS 3000 integration structure, it is possible to write data in an SCS from HIS and FCS.

Note that external communication function blocks are required when writing data to an SCS from external devices.

- It is possible to connect an SCS with other systems using serial communication (Modbus). SCSs support subsystem communication functions that allow the SCS side to connect to other systems as a communication master, and Modbus slave communication functions that allow other systems to establish connections as Modbus communication masters. In both cases, serial communication interface modules are mounted on SCS nodes and used to connect with other systems.
Note that Modbus communication cannot be used in safety loops (they shall be used as interference-free applications).

Inter-SCS Safety Communication

ProSafe-RS allows constructing systems in which both safety communication and CS 3000 control communication can be performed on V net or Vnet/IP.

Dedicated function blocks for performing inter-SCS safety communication are provided: secure safety communication is realized by describing logic using these function blocks.

Overview of Inter-SCS Safety Communication

An SCS can perform inter-SCS safety communication with other SCSs in the same domain or different domains. This allows creating safety loop across two SCSs.

The inter-SCS safety communication function is achieved by dedicated function blocks. It is necessary to use these function blocks to perform inter-SCS safety communication.

Mechanism of Inter-SCS Safety Communication

Function blocks on the sending side (producing side) add data to be written as well as data for guaranteeing the communication quality, which is then sent to the communicating SCS via V net or Vnet/IP. The communication is not limited to communication routes between SCSs in the same domain; routes between SCSs in different domains can also be used. Function blocks on the receiving side (consuming side) perform various inspections for checking the validity of received data and output only data whose quality can be guaranteed. If data received from the network is judged incorrect as a result of these inspections, the function blocks on the receiving side output the pre-determined fail-safe values.

SCS Link Transmission (*1)

SCS link transmission function makes it possible to bilaterally transmit and receive data in stations in the same domain by broadcasting.

Communication between two SCS is called SCS Link Transmission Safety Communication, and communication between SCS and FCS is called SCS Global Switch Communication.

SCS Link Transmission Safety Communication

Boolean data can be safely communicated from one SCS to many other SCS by using special I/O function block.

SCS Global Switch Communication

Interference-Free communication can be done between SCS and FCS by using a special database.

*1: Supported by ProSafe-RS R1.03.00 or later.

7.2.2 System Scale and Hardware Implementation Requirements

This section explains limitations on system scale and implementation requirements of hardware such as input/output modules.

System Scale

The following restrictions on system scale apply to ProSafe-RS systems.

Number of Stations

The maximum number of stations that can be connected in the entire system is as follows for both ProSafe-RS single system configuration and CS 3000 integration structures.

- Number of domains that can be connected to hierarchical layers: 16
- Number of stations that can be connected within a domain: 64
- Number of stations that can be connected to hierarchical layers: 256
- Hierarchical layers: 3 (by using two layers of bus converter; three layers for control bus)

Note that the maximum number of stations per domain is limited to 16 in case of CS 3000 HIS. When using multiple domains, bus converter (BCV) and CS 3000 ENG functions are required.

Number of SENGs

At least one SENG is required.

Number of SCSs

The number of SCSs needs to be within the limitation of the number of stations.

Hardware Implementation Requirements

The following requirements apply to the implementation of SCS hardware.

See 7.3.1 for “Hardware Configuration of SCS.”

- An SCS can connect up to nine I/O nodes to a CPU node to expand inputs and outputs.
- When expanding inputs and outputs, it is necessary to duplicate ESB bus coupler modules and mount them.
- In addition to the requirements above, implementation requirements due to power supply capacity and operation ambient temperature conditions (60 to 70°C) apply to the implementation of input/output modules.
- Up to four serial communication modules (ALR111 and ALR 121) can be mounted per SCS as communication master modules (two pairs in case of dual-redundant configuration) and up to two modules as Modbus slave communication modules.

Note that it is not allowed to perform both subsystem communication and Modbus slave communication in the same serial communication module.

7.2.3 Hardware Configuration Devices

Safety Engineering PC (SENG)

SENG is a device used for performing engineering tasks such as editing, downloading and testing applications as well as carrying out maintenance tasks on safety control stations (SCSs). General-purpose PC is used for a SENG. It is also possible to use a PC with HIS operation and monitoring functions implemented for performing the SENG functions.

Safety Control Station (SCS)

SCS is comprised of a safety control unit (CPU node) and a safety node unit (I/O node). The basic configuration of them is as follows.

- Safety control unit
 - CPU module
 - Power supply module (dual-redundant configuration)
 - ESB bus coupler module (dual-redundant configuration)
 - Devices related to V net or Vnet/IP communication (dual-redundant configuration)
- Safety node unit
 - Power supply module (dual-redundant configuration)
 - ESB bus slave interface module (dual-redundant configuration)

Input/Output Modules

ProSafe-RS provides the input/output modules shown in the table below. Input/output modules can be placed in dual-redundant configuration in order to improve the availability.

Table Types of Input/Output Modules

| Model | Name | I/O Channels per Module | Signal Connection | | | |
|------------------------------|--|-------------------------|-------------------------|-----------|------------------------------------|-----------------------|
| | | | Pressure Clamp Terminal | MIL Cable | Yokogawa-specific Cable (*1) | |
| No option code (*3) | Option code (*4) | | | | | |
| Analog Input Module | | | | | | |
| SAI143-S03 (*6) | Analog input module (4 to 20 mA, Isolated, General-purpose cables (*1)) | 16 | x | x | - | |
| SAI143-S33 (*6) | Analog input module (4 to 20 mA, Isolated, Yokogawa-specific Cables (*2)) | 16 | - | - | x KS1-□□*B | x KS1-□□*B/ SAI143 |
| SAI143-H03 (*6) | Analog input module (4-20 mA, Hart Communication, Isolated, General-purpose cable (*1)) | 16 | x | x | - | |
| SAI143-H33 (*6) | Analog input module (4-20 mA, Hart Communication, Isolated Yokogawa-specific cable (*2)) | 16 | - | - | x KS1-□□*B | x KS1-□□*B/ SAI143 |
| SAV144-S03 (*6) | Analog input module (1 to 5 V/1 to 10 V, Isolated, General-purpose cable (*1)) | 16 | x | x | - | |
| SAV144-S33 (*6) | Analog input module (1 to 5 V/1 to 10 V, Isolated, Yokogawa-specific Cables (*2)) | 16 | - | - | x KS1-□□*B | x KS1-□□*B/ SAI144 |
| SAI533-H03 (*6) | Analog output module (4-20 mA, Hart Communication, Isolated, General-purpose cable (*1)) | 8 | - | - | - | |
| SAI533-H33 (*6) | Analog output module (4-20 mA, Hart Communication, Isolated, Yokogawa-specific cable (*2)) | 8 | - | - | x KS1-□□*B | x KS1-□□*B/ SAI533 |
| Digital I/O Module | | | | | | |
| SDV144-S13 (*6) | Digital input module (no-voltage contact, Isolated, General-purpose cable (*1)) | 16 | x | x | - | |
| SDV144-S33 (*6) | Digital input module (no-voltage contact, Isolated, Yokogawa-specific cables (*2)) | 16 | - | - | x AKB331-M□□□ | x AKB331-M□□□/SDV144) |
| SDV521-S33 (*6) | Digital output module (24 V DC/2 A, Isolated, Yokogawa-specific cable (*2)) | 4 | - | - | x AKB651-M□□□ | x AKB651-M□□□/SDV521) |
| SDV531-□23 (*6) | Digital output module (24 V DC, contact, Isolated, General-purpose cable (*2)) | 8 | x | x | - | |
| SDV531-S33 (*6) | Digital output module (24 V DC, contact, Isolated, Yokogawa-specific cables (*2)) | 8 | - | - | x AKB331-M□□□ | x AKB331-M□□□/DV531) |
| SDV531-L33 (*6) | Digital output module (24 V DC, Isolated, Yokogawa-specific cable (*2)) | 8 | - | - | x AKB331-M□□□ | x AKB331-M□□□/SDV53L) |
| SDV541-S23 (*6) | Digital output module (24 V DC, contact, Isolated, General-purpose cables (*1)) | 16 | x | x | - | |
| SDV541-S33 (*6) | Digital output module (24 V DC, contact, Isolated, Yokogawa-specific cables (*2)) | 16 | - | - | x AKB331-M□□□ | x AKB331-M□□□/SDV541) |
| Communications Module | | | | | | |
| ALR111 (*7) | Serial communication module (RS-232C, 2-port, 1200 bps to 115.2 k bps) | Two ports | - | - | (D-Sub 9-pin connector) (*5) | |
| ALR121 (*7) | RS-232C communication module (RS-422/PS-485, 2-port, 1200 bps to 115.2 k bps) | Two ports | - | - | (M4-terminal block, 10 poles) (*5) | |

X: Can be connected.

-: Cannot be connected.

*1: General-purpose cables are pressure clamp terminals and MIL cables.

*2: Yokogawa-specific cables are special cables for connecting input/output modules to terminal boards.

*3: If no option code is selected, a wrong connection to I/O modules with different signals cannot be avoided.

*4: If option codes associated with I/O modules are selected, a wrong connection to I/O modules with different signals can be avoided.

*5: A Yokogawa-specific cable can be connected without using a terminal block.

*6: Safety (SIL3)

*7: Interference-free (not safety)

Products Related to Input/Output Modules

Pressure Clamp Terminal Blocks

Pressure clamp terminal blocks are used when wiring input/output modules to field devices directly. They come in two types: for single and dual-redundant configurations.

- For single configuration
 - STA4S: Pressure clamp terminal block for analog signals (16-channel, with ISA Standards G3)
 - STB4S: Pressure clamp terminal block for digital I/O (16-channel input or 8-channel output, with ISA Standards G3)
- For dual-redundant configuration
 - STA4D: Dual-redundant pressure clamp terminal block for analog signals (16-channel, with ISA Standards G3)
 - STB4D: Dual-redundant pressure clamp terminal block for digital signals (16-channel input or 8-channel output, with ISA Standards G3)

Dedicated Cable

There are the following types of dedicated cable.

- Signal Cable (40-40 pin) (KS1)
Use KS1 cables to connect to SEA4D in combination with SAI143, SAV144 and SAI533
- Signal Cable (50-50 pin) (AKB331) (for connection between SDV144, SDV531 or SDV541 and terminal board)
Use AKB331 cables to connect to SED4D, SRM53D and SRM54D in combination with SDV144, SDV531 and SDV541
- Signal Cable (AKB651) (for connection between SDV521 and terminal board)
Use AKB651 cables to connect to SED2D in combination with SDV521

Terminal Boards

There are the following two types of terminal boards, each supporting single and redundant configurations.

- SEA4D: Analog terminal board (single and dual-redundant, 16-channel)
- SED4D: Digital terminal board (single and dual-redundant, 16-channel input or 8-channel output)
- SED2D: Digital terminal board (single and dual-redundant, 4-channel, 4x4-channel output)

Relay Boards

Relay boards for dry contact outputs that are equipped with safety relays are provided. They support both single and redundant configurations.

They allow reading back outputs by connecting with digital input modules.

- SRM53D: 8x2 Dry Contact Outputs (safety relay built in type, M4 terminals)
- SRM54D: 16 Dry Contact Outputs (safety relay built in type, M4 terminals)

Wiring check Adapters

Wiring check adapters are used to detect disconnection and short-circuit failures in field wiring between digital input modules and field devices.

There are the following two types of wiring check adapters.

- SCB100: For detecting disconnection failures
By mounting this adapter in parallel with a sensor switch, it is possible to detect disconnection failures that occur while inputting OFF signals.
- SCB110: For detecting short-circuit failures
By mounting this adapter in series with a sensor switch, it is possible to detect failures due to short-circuit with a power supply line that occur while inputting ON signals and failures due to short-circuit with other channels.

The figure below shows the shapes of SCB100 and SCB110.



Figure Shapes of SCB100 and SCB110

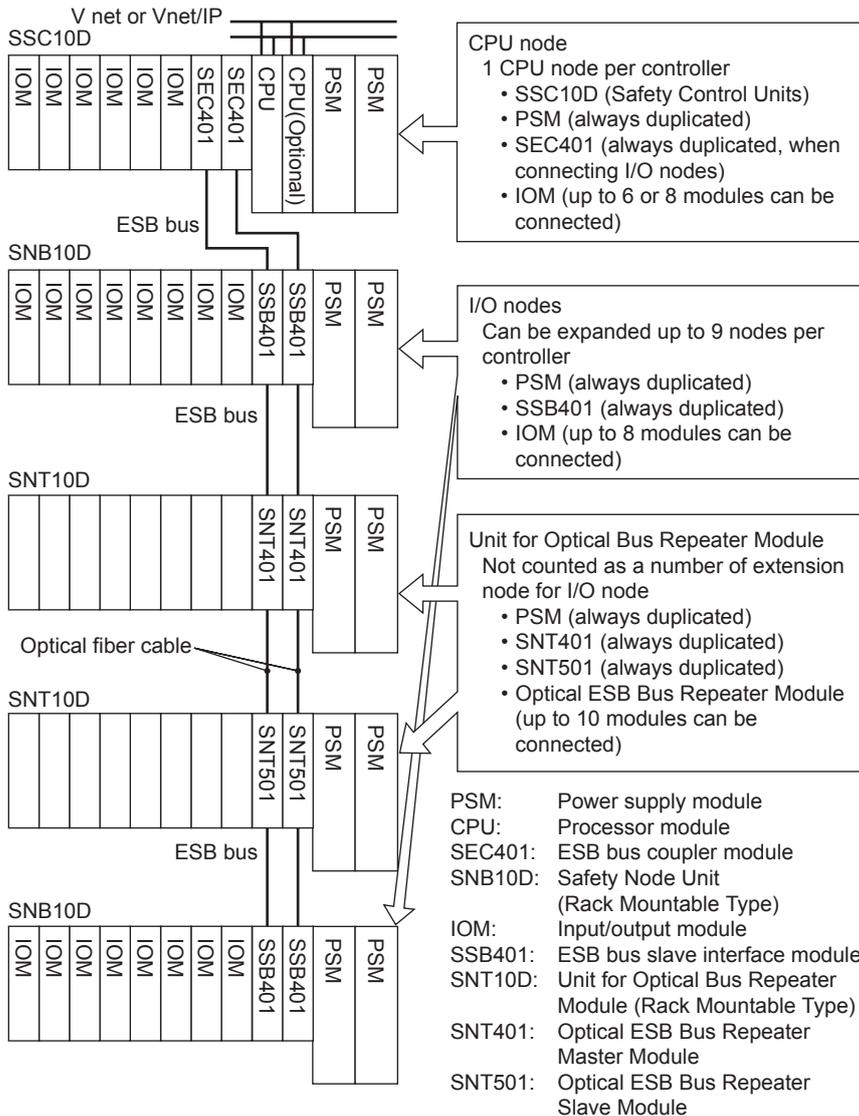
7.3 Safety Control Station (SCS)

This section explains the hardware and software of a safety control station (SCS).

7.3.1 Hardware Configuration of SCS

SCS is configured with one safety control unit (CPU node) and up to nine safety node units (I/O node).

Safety node units are connected by ESB buses.



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Figure Hardware Configuration of SCS

Configuration of Safety Control Units

Safety control units come in two types: Standard (ambient temperature: -20 to 50°C) and wide range temperature (ambient temperature: -20 to 70°C).

The figure below shows a standard type safety control unit in dual-redundant configuration. In the case of single configuration, processor module is mounted in a slot on the left side and dummy cover is mounted on the right side. Power supply modules are always used in dual-redundant configuration. When connecting a safety node unit, ESB bus coupler modules are used in dual-redundant configuration.

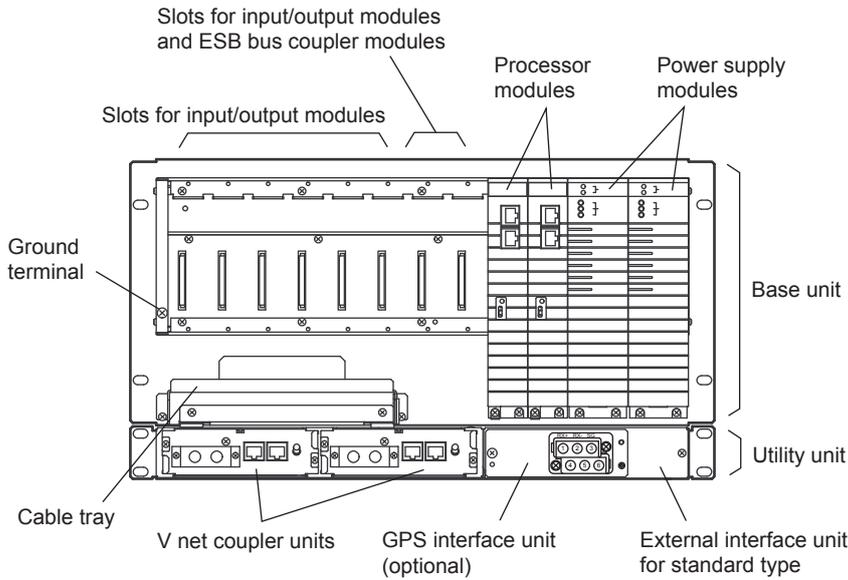


Figure Configuration of Safety Control Unit (standard type)

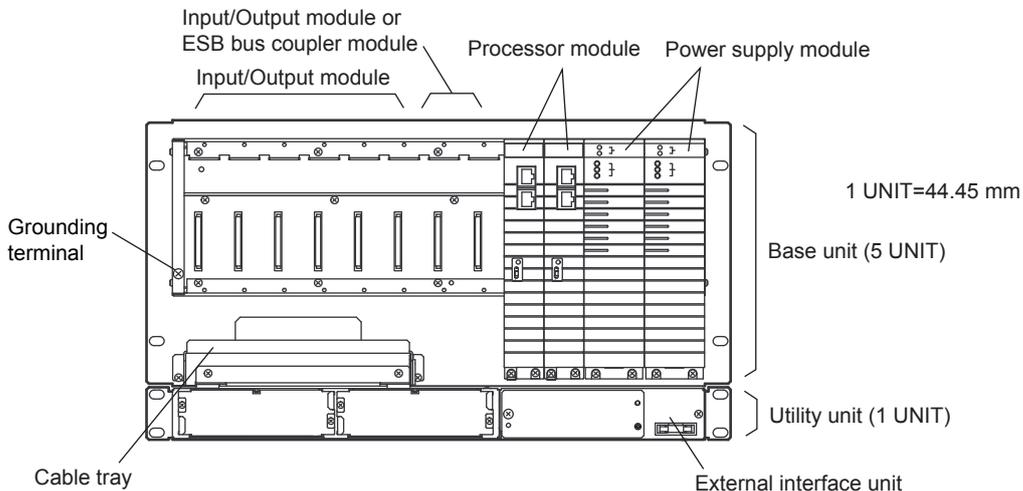
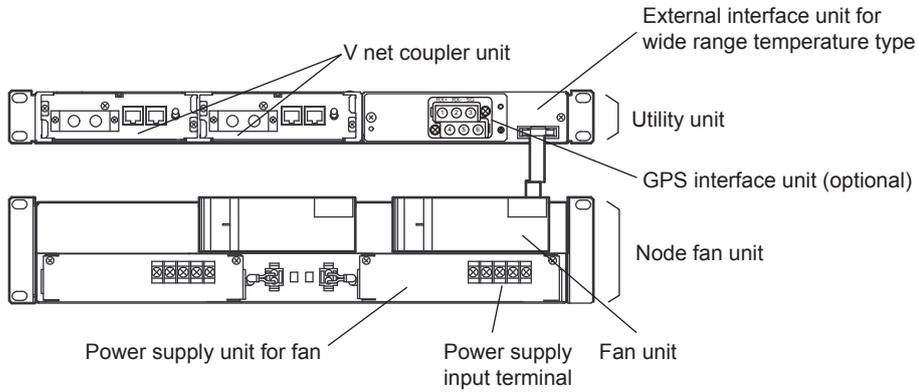


Figure Configuration of Safety Control Unit for Vnet/IP (standard type)

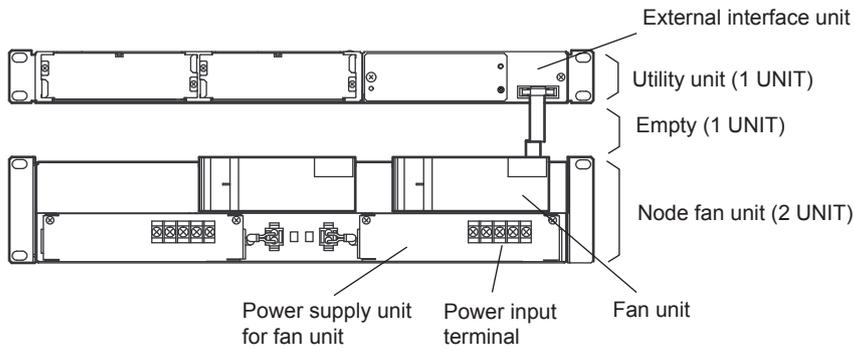
Wide range temperature type safety control units are configured in the same way as the standard type units, but are equipped with an additional node fan unit in order to support a wider range of ambient temperatures (-20 to 70°C).

The figure below shows a utility unit and node fan unit that comprise a wide range temperature type safety control unit. The base unit is omitted in the figure.



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Figure Configuration of Safety Control Unit (wide range temperature type)



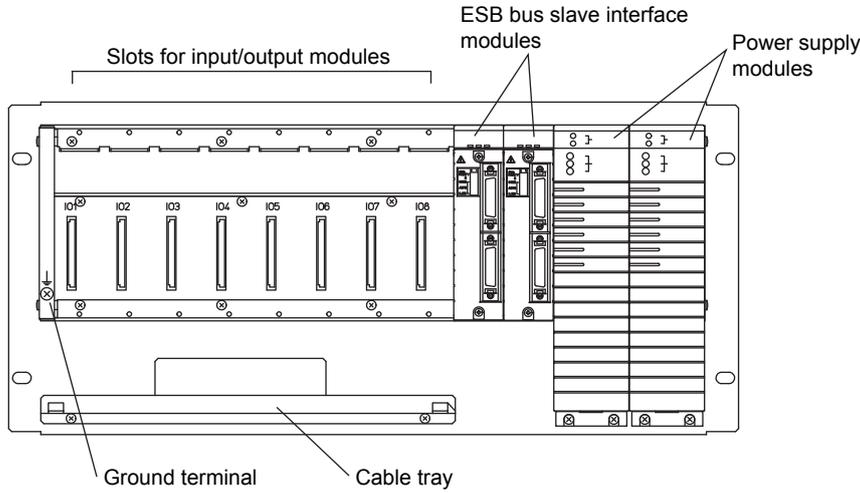
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Figure Configuration of Safety Control Unit for Vnet/IP (wide range temperature type)

Configuration of Safety Node Units (SNB10D)

The figure below shows a safety node unit.

Power supply modules and ESB bus slave interface modules are always used in dual-redundant configuration.



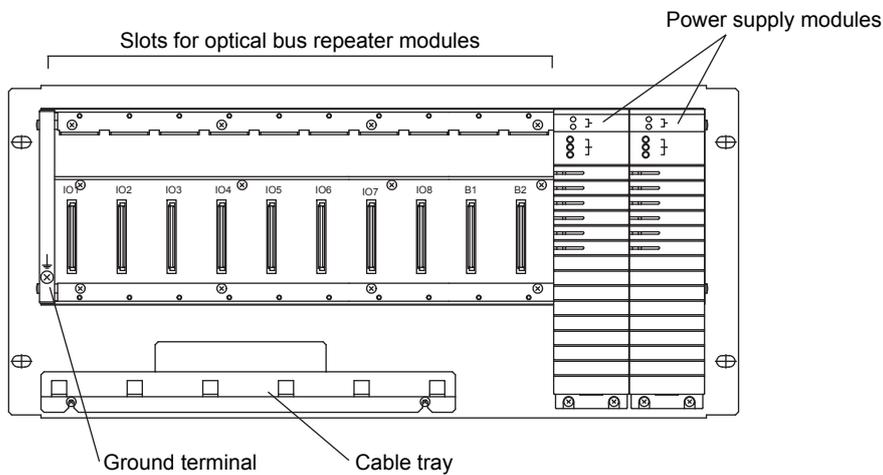
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Figure Configuration of Safety Node Unit

Unit for Optical Bus Repeater Module (Rack Mountable Type) (SNT10D)

The figure below shows a Unit for Optical Bus Repeater Module (Rack Mountable Type).

Power supply modules are always used in dual-redundant configuration.



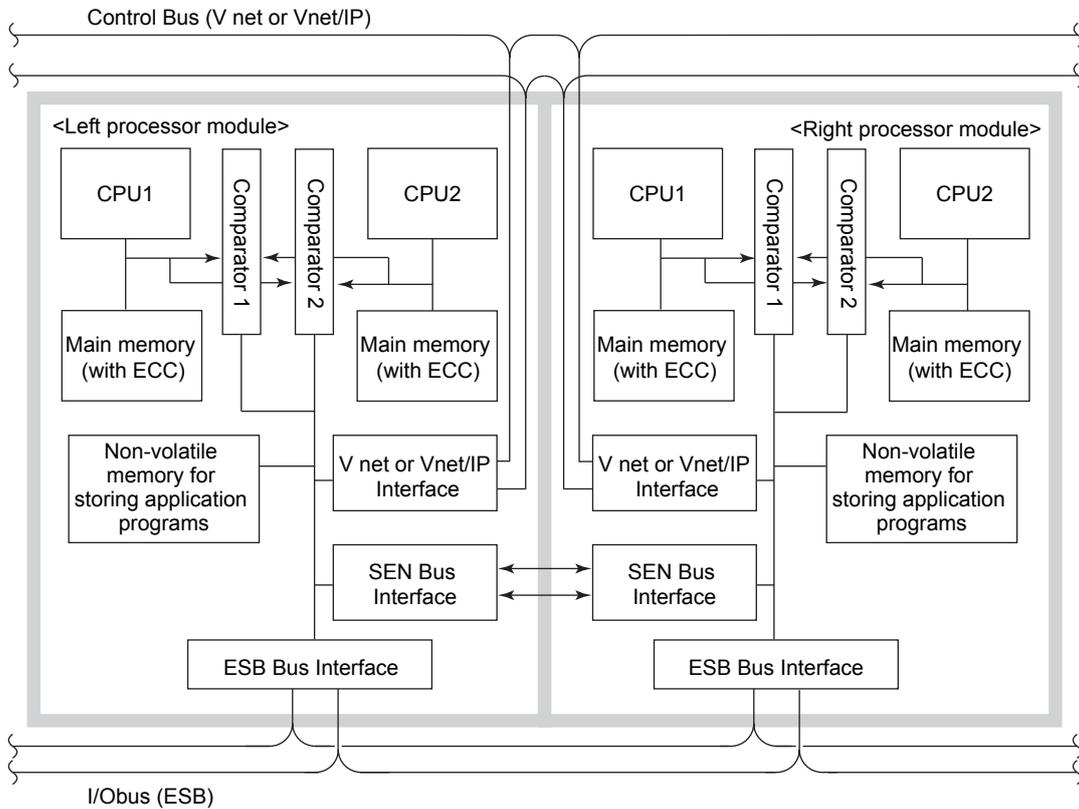
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Figure Configuration of Unit for Optical Bus Repeater Module (Rack Mountable Type)

7.3.2 Dual-redundant SCS and Reliability of SCS

Dual-redundant SCSs are provided. A dual-redundant SCS contains a full set of duplicate components such as processor modules, V net couplers (for V net) and power supply modules. When connecting additional node units, ESB bus coupler modules need to be mounted. ESB bus coupler modules are always used in dual-redundant configuration.

The dual-redundant processor cards (one active, the other standby) can switch from active to standby card without any interruption to control when active card breaking down.



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Figure Configuration of Dual-redundant Processor Modules (SCS)

How an SCS is made dual-redundant is explained below.

CPU

- Each processor module has two CPUs and two main memories. Each CPU module (CPU1 and CPU2) performs the same operation and the operation results are compared by two comparators for each operation cycle. If the operation results of both CPUs match, the operation is regarded as normal and the data is sent to the main memory and bus interface modules. The main memory modules are equipped with ECC (Error Correcting Code); these codes are used to correct temporary bit-reverse errors that occur in the main memories.
The main memory modules with ECC are dual-redundant as well, and if their values are different, a matching error occurs and the control right is passed to the processor module on the standby side.
- The operation results of CPU1 and CPU2 are compared by the two comparators. If either one of the comparators detect inconsistency, it is considered an “operation error” and the control right is passed to the processor module on the standby side.
- Each processor module is equipped with a WDT (Watch Dog Timer) and monitors that the safety functions are operating normally. If it detects that the safety functions are not working normally, the control right is transferred to the standby side as well.
- The processor module on the standby side synchronizes with the processor module on the control side to ensure that the same operations are performed. The control right can thus be switched without interrupting the operation. When the processor module obtains the control right, it immediately starts sending operation data to the bus interface modules.
- A processor module conducts self-diagnosis if an operation error occurs. If there is no abnormality in CPU hardware as a result of diagnosis, it regards the error as a temporary operation error and recovers from the abnormal status to the standby status.
- A processor module is equipped with communication interfaces that can support dual-redundancy on CPUs and V net or Vnet/IP interfaces are connected to dual-redundant control buses.

ESB Buses

See Section 2.8.2 for the explanation of ESB buses.

7.3.3 States and Operations of SCS

Depending on the operating mode and security level, SCS can be in one of several states. Operations of SCS include forcing, override, output enable operation and download.

The figure below shows a rough overview of the relations among these states and operations.

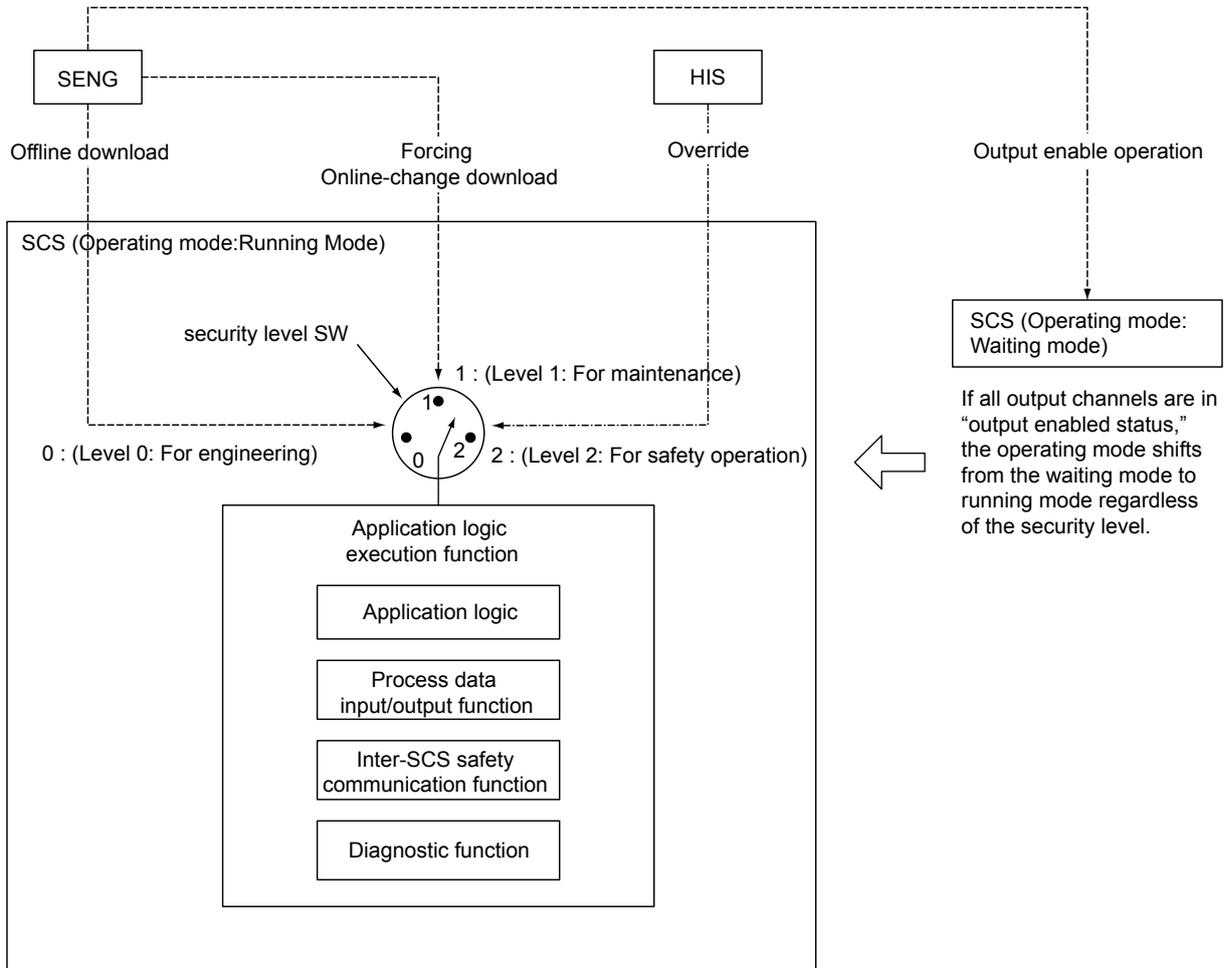


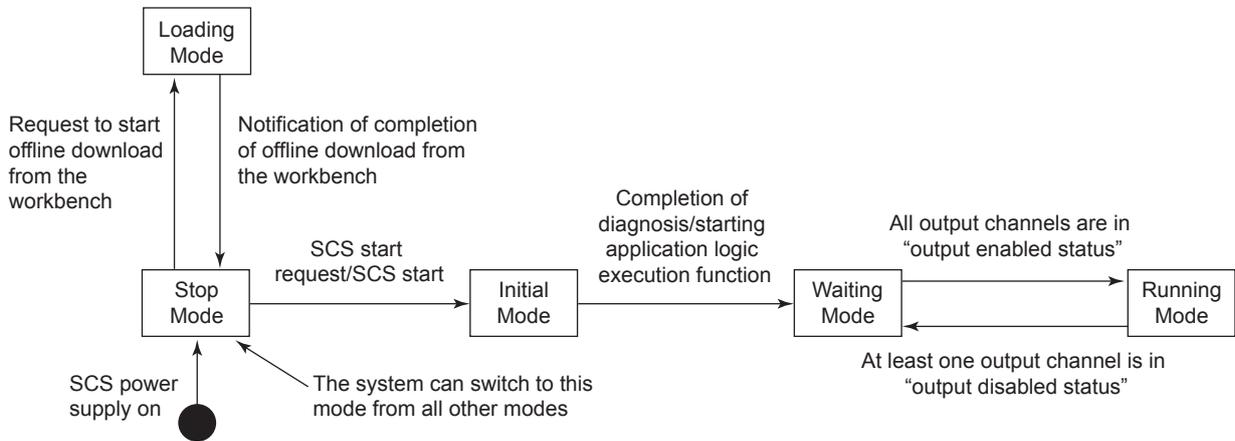
Figure States and Operations of SCS

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Operating Modes

Operating modes indicate the different running states of an SCS. The operations carried out by the system program of an SCS are determined by the operating mode.

There are five operating modes of an SCS: stop mode, loading mode, initial mode, waiting mode and running mode.



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Figure Transition of Operating Mode

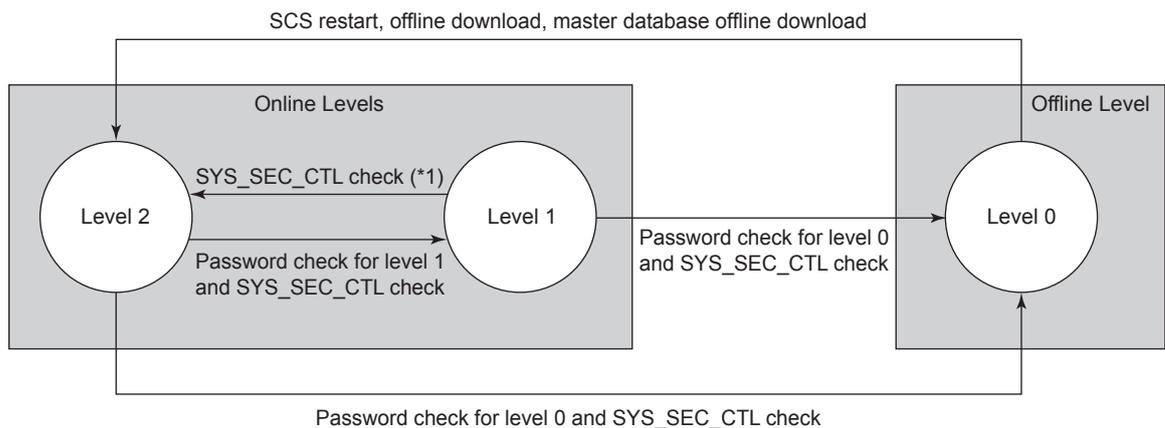
Security Levels

An SCS is equipped with a function to protect internal data from being overwritten by external devices. It always monitors attempts to write data from outside and judges whether user operations should be enabled or disabled according to the security level of the SCS. The security level indicates to what degree the SCS memory is protected from data writing attempts from outside.

There are two levels for the security level: a level (online level) used during constant operation of an SCS and a level (offline level) used when the SCS is not operating.

Security level is protected by password so that it cannot be changed.

The status of the security level changes as shown below.



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*1: Regardless of the security level change permission status set by SYS_SEC_CTL, it is always possible to shift from security level 1 to security level 2 by entering an RST input in a SYS_SECURE block. Using SYS_SEC_CTL block, it can be decided whether security level is changeable or not by contact input of a foreign key switch.

Figure Transition of Security Level

Forcing and Override

Overview of Forcing Function

The forcing function provides a user interface for fixing channel inputs and outputs of input/output modules and variables in application logic to constant values (variable lock), forcibly changing variable values (variable value setting) and so forth for the purpose of SCS maintenance and debugging I/O loop check applications. This function is used by an SENG to forcibly fix input/output variables and internal variables of an SCS and allows fixing all input/output values of each input/output module at the same time as well.

Additionally, it is possible to use SYS_FORCE function blocks to monitor the lock status within the application logic and forcibly cancel locking. The forcing function can also be used when performing maintenance tasks.

Overview of Override

Override is a function used to temporarily overwrite values of variables of application logic in an SCS from an HIS in case of ProSafe-RS/CS 3000 integration structure. It is used for performing tasks in states where variable values of application logic are temporarily changed.

The override function is used when performing system maintenance and similar.

Differences between Forcing and Override

The table below shows differences between forcing and override.

Table Differences between Forcing and Override

| Item | Forcing | Override |
|--|--|---|
| Purpose | Maintenance of SCS and debugging applications from SENG | Maintenance of SCS from HIS in ProSafe-RS/CS 3000 integration structure |
| SCS security level | Can be performed at level 1 or lower | Can be performed at level 2 as well |
| Necessity of programming | No need for programming | Necessary to use override FB to create application logic |
| Specification of output value | Possible to specify values to be output using the I/O Lock window and so forth | If override is performed while executing an application, pre-programmed values are output as override values. |
| Requirement for setting variable values | Whether or not forcing can be performed depends on the security level of SCS | Possible to create application logic that allows switching override permission with a mechanical key switch, etc. |
| Grouping Override (*1) | — | More than one override function block (hereinafter referred to as override FB) are managed as a logical group and a function to enable only one override FB to override can be selected in the group. |

*1: Supported by ProSafe-RS R1.03.00 or later.

7.3.4 SOER

SOER (Sequence of Events Recorder) is a function for acquiring and saving analog inputs, discrete inputs, discrete outputs and variables of application logic as event information. This event information can be viewed using SOE Viewer.

A time synchronization function is provided in order to maintain the accuracy of the time at which an event occurs.

Event Acquisition

It is possible to acquire not only discrete inputs (DI) but also changes of discrete outputs (DO) and analog input values as event information. By creating function blocks for SOER, changes in application logic can be acquired as event information as well. This also allows registering changes in communication data with other SCSs.

Saving Events

Event information is saved in an SCS, which eliminates the need to prepare a PC for storing events or keeping the power supply to an SENG turned on at all times.

Event information before and after trip signals, which is particularly important, is saved in a different location. This information is notified to users without fail.

Viewing Events with SOE Viewer

- Event logs (SOE event information and diagnostic information messages) saved in an SCS are uploaded to an SENG via V net / Vnet/IP and displayed as event messages by means of the SOE Viewer function of the SENG.
- Event logs of up to eight SCSs can be displayed at the same time.
- It is possible to filter event messages so that only desired messages are displayed.
- Trip reports are generated. Generated trip reports can be exported to printers and CSV format files.
- In the case of ProSafe-RS/CS 3000 integration structure, SCS process alarm messages can be displayed together by using the HIS historical information.

Time Synchronization Function

An SCS has a function to synchronize time information among SCSs as well as between CPUs and DI modules in order to maintain a high accuracy of the event generation time records.

Time Synchronization Method of SCSs Connected to V net

ProSafe-RS allows selecting from two synchronization methods: V net time master method (default), where all stations synchronize to the V net time, and GPS time master method (optional), where the time is acquired from an external source via the IRIG-B interface.

V net Time Master Method (Default)

The V net time is set by an SENG or HIS specified as time master. The time of each device connected via V net is synchronized according to the time information of the time master.

GPS Time Master Method (Optional)

In this method, a commercially available GPS receiver is used to acquire time information of the IRIG-B format and use this in an SCS designated as the time master. The standard time (date, hour, minute, second) and the synchronization timing are delivered to each connected SCS. Synchronization among individual SCSs is achieved at this synchronization timing. Since GPS is used, it is possible to acquire events with high time accuracy.

Time Synchronization Method of SCSs Connected to Vnet/IP

The time synchronization method of SCSs connected to Vnet/IP is fixed to the synchronization with Vnet/IP time. If an SNTP server is installed, it is possible to achieve highly accurate time synchronization with the standard time.

The time synchronization status can be checked in the SCS State Management window of the SCS Maintenance Support Tool on the SENG, or in the SCS Status Display window on the CS 3000 HIS.

7.3.5 Subsystem Connection (Modbus)

An SCS supports a subsystem communication function that allows the SCS side to connect to other systems as the communication master, and a Modbus slave communication function that allows other systems to connect to the SCS as the Modbus communication master. In both functions, serial communication interface modules are mounted in SCS nodes in order to allow connections with other systems.

Note that Modbus communication cannot be used for safety loops (they shall be used as interference-free modules).

There are the following two types of subsystem communication modules.

- RS-232C serial communication module (ALR111)
- RS-422/RS-485 serial communication module (ALR121)

Subsystem Communication Function

The subsystem communication function is used for reading and writing input/output data within subsystems from an SCS. SCSs support the Modbus communication protocol.

It is possible to connect to LED outputs and PLCs by accessing data of other systems via subsystem communication from SCSs.

Modbus Slave Communication Function

With this function, an SCS is able to function as a Modbus slave device. The Modbus slave connection function of an SCS allows the Modbus master (external device) to read and write data in the SCS via the Modbus protocol. The Modbus master requests to access data in the SCS using the Modbus device name as the interface. Not only control stations of CS 3000, but also DCSs made by other manufacturers can connect to an SCS as the Modbus master.

7.3.6 Operation at SCS Errors

There are three error levels for SCSs: fatal errors, major errors and minor errors. SCSs are able to recover from errors by conducting recovery tasks corresponding to each error level.

Operations at Fatal Error Occurrence

At this error level, hardware and software are unable to function. CPU (both sides for redundancy) stops and output values of all output modules are set to fail-safe values.

Operations at Major Error Occurrence

At this error level, some hardware is unable to function. Operations to be performed at abnormality, which are defined by users in advance, are performed for the failed areas. It is necessary to define such operations at occurrence of major errors individually for a given application.

Operations at Minor Error Occurrence

At this error level, there is no impact on the application logic execution functions themselves. Such situations include when one side of dual-redundant hardware modules fails.

If one hardware side in a dual-redundant configuration fails, the control right is switched to the standby side to continue processing. Such errors are treated as minor errors. The hardware continues to operate in the same way as if it were placed in a single configuration.

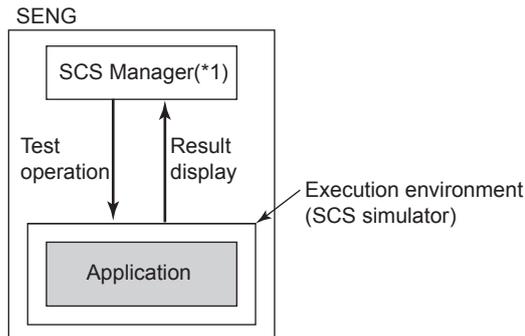
7.4 Test Functions

The test functions of ProSafe-RS are used for effective debugging of applications, and useful in debugging when you create or change applications.

There are two types of tests, virtual tests and target tests.

7.4.1 Virtual Tests

In a virtual test, an application is executed using an SCS simulator on an SENG, which allows debugging application logic of each SCS. In a virtual test, it is possible to execute test functions on the SCS simulator regardless of the security level.



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*1: A function that controls system engineering and maintenance tasks of an SCS, such as definition of applications to be executed on the SCS, database generation test functions, etc.

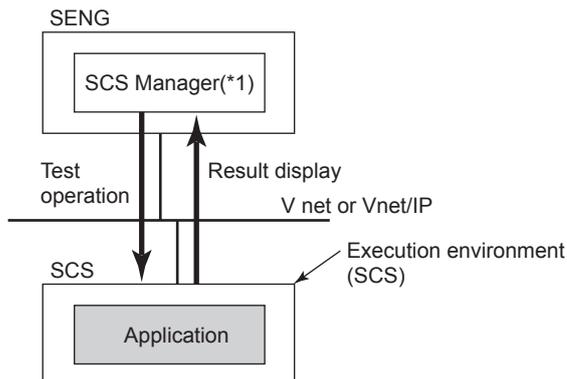
Figure Virtual Test

7.4.2 Target Tests

In a target test, an application is executed on an actual SCS.

It is possible to execute tests in a status where inputs/outputs are disconnected, i.e., without any input/output modules connected, using the forcing function.

In a target test, the tests that can be executed are limited by the security level of an actual SCS.



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*1: A function that controls system engineering and maintenance tasks of an SCS, such as definition of applications to be executed on the SCS, database generation test functions, etc.

Figure Target Test

7.5 ProSafe-RS Related Packages

Various packages are provided in order to improve the integration with CS 3000 and systems made by other manufacturers as well as efficiency in operations/monitoring via integration.

SOE Viewer Package

The SOE Viewer Package provides functions to display event logs (event information, diagnostic information) acquired in an SCS with the sequence of event recorder (SOER) function using a CS 3000 HIS or general PC (with V net or Vnet/IP interface card). SOE Viewer allows viewing event logs of a specified SCS. It also provides event log filtering, trip report generation and other functions.

Engineering Function for CENTUM CS 3000 Integration

This package runs on an SENG and is used to integrate ProSafe-RS and CENTUM CS 3000. In a system integrating ProSafe-RS and CS 3000, it is possible to perform the following tasks on an SCS from an HIS and FCS.

- It is possible to use tag names to operate and monitor data of an SCS from an HIS using the same interface as for FCSs. It is also possible to read data of an SCS from CS 3000 FCS.
- It is possible to manage generation/recovery of process alarms and alarms from the annunciator detected by an SCS in the process alarm window of an HIS.
- It is possible to monitor system alarms generated on an SCS in the system alarm window of an HIS.
- It is possible to display the status of an SCS in the SCS status display window of an HIS.

SOE OPC Interface Package

This package provides functions for installing an OPC server on an HIS of CENTUM CS 3000 or SENG and notifying event logs (event information and diagnostic information) acquired by the SOER function of the SCS to OPC clients via the OPC interface.

Modbus Communication Package

This is the Modbus communication package used for SCSs to communicate with subsystems. With this package, an SCS is able to communicate with subsystems such as PLCs via interference-free serial communication modules (ALR111, ALR121) mounted on a safety control unit or safety node unit using the Modbus protocol. This package allows reading and writing subsystem data from application logic of an SCS.

7.6 Comparison of HIS Operation and Monitoring

The table below shows a comparison between CS 3000 and ProSafe-RS in terms of HIS operation and monitoring features.

Table Comparison of HIS Operation and Monitoring between CS 3000 and ProSafe-RS

| Classification | HIS function | CS 3000 | ProSafe-RS | Remarks for ProSafe-RS |
|--|---|---------|-------------------------------|---|
| Common Operation and Monitoring Functions | Window Call-up | X | X | |
| | Operating Screen Mode | X | X | |
| | System Message Window | X | X | |
| | Window Sizing | X | X | |
| | Window Hierarchy | X | X | |
| | Navigator Window | X | X | |
| | Panel Set | X | X | |
| | Dynamic Window Set | X | X | |
| | Circulate Functions | X | X | |
| | Alarm Processing Functions | X | X | |
| Print Screen Functions | X | X | | |
| Operation and Monitoring Windows | Graphic Windows | X | X | See "Table Mapping Blocks and Elements" for the assigned tags. 1-second trends cannot be created. |
| | Tuning Window | X | X | |
| | Trend Window | X | X | |
| | Trend Point Window | X | X | |
| | Process Alarm Window | X | X | |
| | Operator Guide Window | X | – | SCSs do not generate operation guide messages. (*1) |
| | Message Monitoring Window | X | X | SCSs do not generate sequence messages. (*1) |
| Operation and Monitoring Support Functions | Process Reports | X | X | |
| | Historical Message Reports | X | X | |
| | Security Functions | X | X | |
| | Report Functions(Optional) | X | X | |
| | Connecting an ITV Camera | X | X | |
| | CENTUM Desktop Environment Customization | X | X | |
| | Voice Messaging Functions | X | – | SCSs do not support %VM (voice messages). (*1) |
| | Multi-monitor Functions | X | X | |
| | Advanced Alarm Filter Function | X | X | |
| Remote Desktop Function | X | | Inhibited for safety reasons. | |
| System Maintenance Functions | System Status Overview Window | X | X | |
| | System Alarm Window | X | X | |
| | FCS Status Display Window | X | – | |
| | SCS Status Display Window | – | X | |
| | HIS Setting Window | X | X | |
| | Time Setting Dialog Box | X | X | |
| | Help Dialog Box | X | X | |
| Control Status Display Window | Control Drawing Window (Option) | X | – | SENGs support this function with a multi-language editor of Workbench. |
| | Sequence Table Window | X | – | |
| | Logic Chart Window (Option) | X | – | |
| | SEBOL Window | X | – | |
| | SFC Window | X | – | |
| Trend Functions | Trends | X | X | 1-second trends cannot be created. See "Table Mapping Blocks and Elements" for the assignable tags. |
| | Tuning Trend | X | X | |
| | Displaying Trends from Other Stations | X | X | |
| | Long-term Data Archive Functions (Option) | X | X | |
| | External Recorder Output Functions (Option) | X | X | |
| | Expert Trend Viewer Function (Option) | X | X | |
| Individual package | Open Interfaces (Option) | X | – | Supported by the SOE OPC interface package. |
| | FCS Data Setting/Acquisition Functions (PICOT) (Option) | X | X | Only data settings from external devices (elements) can be used. (*2) |
| | Server for Remote Operation and Monitoring Function (Option) | X | X | |
| | Web Monitoring Functions (Option) | X | X | |
| | Configured Information Reference Function (Option) | X | – | |
| | Consolidated Historical Message Viewer Meeting FDA Regulations (Option) | X | X | |
| | System Integration OPC Station (SIOS) (Option) | X | X | Only data settings (elements) from external devices can be used. (*2) |
| | SOE package | X | X | Can be supported by SOE Viewer. |
| | Generic Subsystem Gateway Package (Option) | X | X | Only data settings (elements) from external devices can be used. (*2) |
| Plant Resource Manager (PRM) | X | – | | |

X: Can be operated Blank: Cannot be operated –: No function
 *1: See "Table Software Inputs and Outputs that can be used with SCSs" listed later.
 *2: See "Table Mapping Blocks and Elements" listed later.

The table below shows a list of mapping blocks and elements.

Table Mapping Blocks and Elements

| Classification | Description | Application Logic Definition | | Mapping block/element | |
|-----------------------------------|---|------------------------------|-----------|-----------------------|----------------------------|
| | | Classification | Type name | Type | Type name/ element name |
| Internal variable | BOOL type | Internal variable | BOOL | Mapping element | %WB |
| | Integer-type (32-bit) | Internal variable | DINT | Mapping element | %WB |
| | Real number-type(32-bit) | Internal variable | REAL | Mapping element | %WB |
| Input/output variable | Discrete | I/O structure | IO_BOOL | Mapping element | %Z |
| | Analog | I/O structure | IO_REAL | Mapping element | %WB |
| Data setting from external device | Data settingn (BOOL) | FB | ECW_B | Mapping element | %WB |
| | Data settingn (integer) | FB | ECW_I | Mapping element | %WB |
| | Data settingn (real number) | FB | FB | Mapping element | %WB |
| Analog input indication | Analog input FB with data status | FB | ANLG_S | Mapping block | S_ANLG_S |
| Analog input indication | Analog input | FB | ANLG_S | Mapping block | S_ANLG_S |
| | Velocity limit alarm | FB | ANLGI | Mapping block | S_ANLGI |
| Velocity limit | Velocity limit alarm | FB | VEL | Mapping block | S_VEL |
| Annunciator | Annunciator | FB | ANN | Mapping element | %AN |
| Override from HIS | BOOL-Type Data Override | FB | OVR_B | Mapping block | S_OVR_B |
| | INTEGER-Type Data Override | FB | OVR_I | Mapping block | S_OVR_I |
| | REAL-Type Data Override | FB | OVR_R | Mapping block | S_OVR_R |
| | IO_BOOL-Type Data Override | FB | OVR_IB | Mapping block | S_OVR_IB |
| | IO_REAL-Type Data Override | FB | OVR_IR | Mapping block | S_OVR_IR |
| | BOOL-Type Data Grouping Override (*1) | FB | GOV_B | Mapping block | S_OVR_B |
| | IO_BOOL-Type Data Grouping Override (*1) | FB | GOV_IB | Mapping block | S_GOV_IB |
| Manual operation | BOOL-Type data manual operation FB with two-position answerback | FB | MOB_11 | Mapping block | S_MOB_11 |
| | BOOL-Type data manual operation FB with three-position answerback | FB | MOB_21 | Mapping block | S_MOB_21 |
| | Auto-reset BOOL-Type data manual operation | FB | MOB_RS | Mapping block | S_MOB_RS |
| | Analog-Type data manual operation | FB | MOA | Mapping block | S_MOA |
| Password | Password entry | FB | PASSWD | Mapping block | S_PASSWD |
| Subsystem communication I/O | Subsystem communication input (BOOL) | FB | SCI_B | Mapping element | %WB |
| | Subsystem communication input (integer) | FB | SCI_I | Mapping element | %WB |
| | Subsystem communication input (real number) | FB | SCI_R | Mapping element | %WB |
| | Subsystem communication output (BOOL) | FB | SCO_B | Mapping element | %WB |
| | Subsystem communication output (integer) | FB | SCO_I | Mapping element | %WB |
| | Subsystem communication output (real number) | FB | SCO_R | Mapping element | %WB |

*1: Supported by ProSafe-RS R1.03.00 or later.

The table below shows software inputs and outputs that can be used with SCSs.

Table Software Inputs and Outputs that can be Used with SCSs

| Name | Support by SCS | Element |
|---|----------------|---------|
| Common switches | x | &SW |
| Global switch | x (*1) | %GS |
| Annunciator | x | %AN |
| Printout message (both printed and historical message) | | %PR |
| Printout message (no printed message, historical messages only) | | %PR |
| Operation guide message | | %OG |
| Multimedia start message | | %VM |
| Sequence message request | | %RQ |
| Supervisory computer event message | | %CP |
| Supervisory computer message output for PICOT | | %M3 |
| Signal event message | | %EV |
| SFC/SEBOL return event message output | | %RE |

x: Supported

Blank: Not supported

*1: Supported by ProSafe-RS R1.03.00 or later.

FCS can refer to data of SCS global switch only from %GS001 to %GS128.

Data after %GS129 is counted as invalid.

Special function block is used for SCS transmission and reception.

8. Advanced Control Functions

The CENTUM CS 3000 is lined up with the Advanced Process Control Station (APCS) for advanced process control.

This station is designed to periodically perform advanced process control and efficiency-improving computations when incorporated in a plant operated highly reliably by CENTUM FCS.

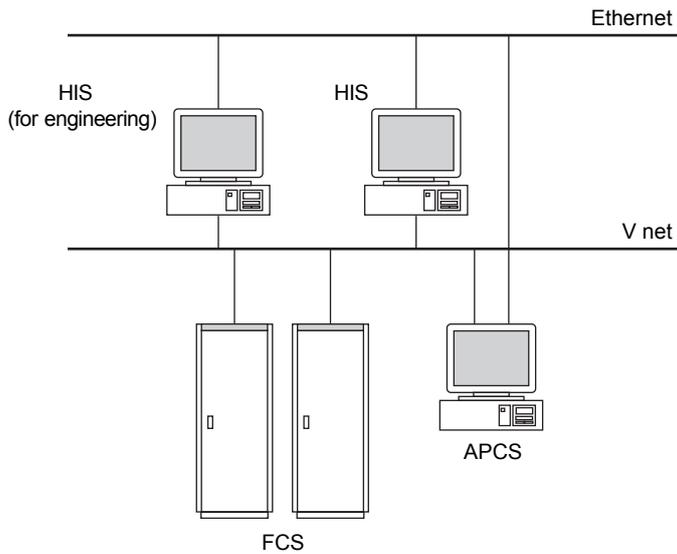
The CENTUM CS 3000 system can take advantage of advanced control functions of the APCS, which is also connectable to an existing CENTUM CS or CENTUM-XL system.

8.1 APCS Overview

The APCS (Advanced Process Control Station) performs advanced control and computations to improve the plant efficiency. The FCS executes set-point control, in which set-point is changed only a little, in one-second cycle. In the long control scan period, the APCS is used mainly in the following examples of control applications:

- Control applications in which many computations are required.
- Sophisticated control applications in which many additional and corrective actions are needed according to the change of the seasons or the plant conditions.

However the APCS has same function blocks as the FCS, it does not take the place of the FCS. It supports process control which the FCS performs, and it executes efficiency improvement.



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Figure Example of APCS System Configuration

8.2 Features of the APCS

The APCS has the following features:

A General Purpose Server Platform

A general purpose server PC (personal computer) is employed, utilizing its high speed and large capacity for highly flexible control computations.

Wide-ranging Standard Function Blocks

A wide range of control, monitoring, and other function blocks, which are used by the FCS, are available.

Unified Operation Procedures

The APCS can be operated and monitored at the HIS, and its advanced control functions and computations can be managed as tags similar to FCS function blocks, so that alarms, which are occurred according to the advanced computations, can be operated and monitored at the same display of the FCS.

Close Connection with FCS

The APCS is connected to the V net, enabling to share FCS function block data – in other words, APCS and FCS function blocks can be cascade-connected. The APCS inherits the bumpless and limit-check functions of the FCS and that ensures safer FCS connection compared to data-setting executed by a supervisory computer.

Online Maintenance

Advanced computations (function blocks) of the APCS can be added, deleted and changed at online, so that system maintenance can be performed without changing algorithms of the FCS.

Unique Testing Environment

The APCS action can be simulated for testing by APCS simulator, similar to the FCS. Also, a combined application of APCS and FCS simulators enables to simulate a plant environment using only the engineering HIS (ENG).

8.3 APCS Control Functions

APCS Function Specifications

SEE ALSO For APCS function specifications, refer to GS 33Q03M10-31E.

8.3.1 Scan Period

The APCS performs PID and other standard function blocks periodically. The FCS acts in one-second cycle and the APCS executes advanced control in long scan period. For APCS scan period, see below.

For standard block:

Basic scan period: selected from 4, 8, or 16 seconds.

High-speed scan period: 1 second

8.3.2 Function Blocks

Standard Blocks

A wide variety of control, monitoring, and other standard function blocks available with the CS 3000 FCS can be used with the APCS. That permits control computation using General-Purpose Calculation (CALCU) blocks and SEBOL.

SEE ALSO For details on standard function blocks, refer to 4.1 Configuration of FCS Control Functions.

8.3.3 Input and Output of APCS

The APCS uses a personal computer as its hardware and it can not access directly process I/O data, nor communicate with subsystems. Via communication, it acquires input data from the FCS and sends output data to the FCS. It thus can easily perform the advanced control computations for the set-point control executed by the FCS.

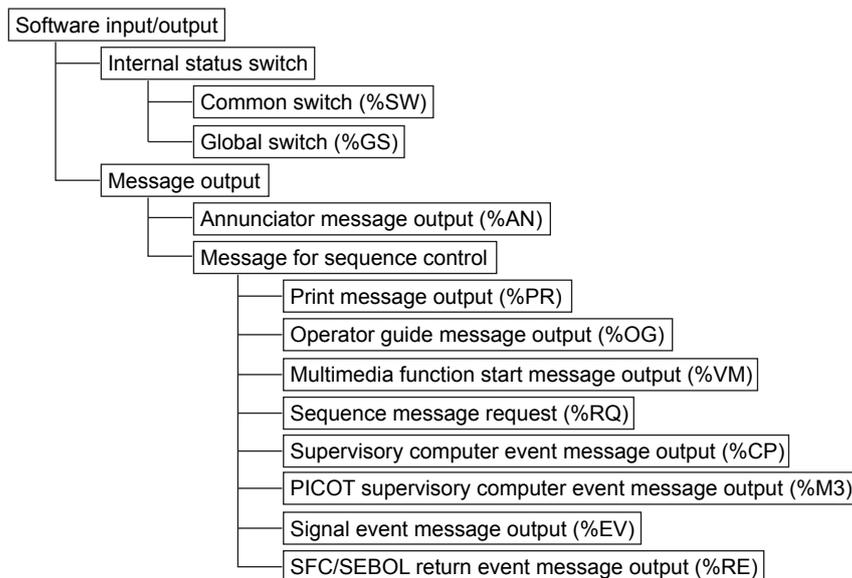
The APCS provides an I/O capability that permits inputting the FCS function block data required for advanced control, performing advanced computation using the data as parameters, and outputting the results to the FCS function blocks.

Interface with FCS

Data items and I/O terminals of FCS function blocks can be easily connected to the I/O terminals of APCS function blocks.

Software Input and Output

Common switch and other software I/O are applicable to the APCS similar to the FCS. The software I/O configuration is shown below.



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Figure Software Input/Output Configuration

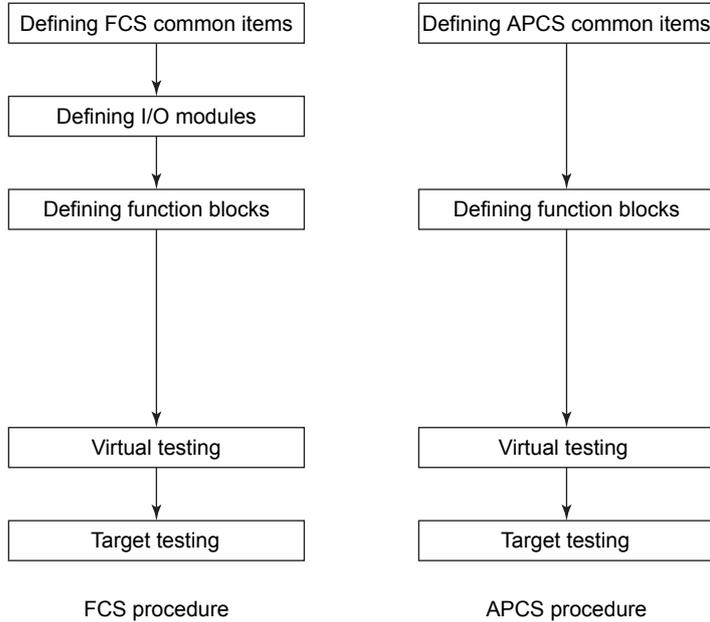
8.4 APCS Operation and Monitoring

The HIS operation and monitoring function permits to the operation and monitoring of the APCS using the same interface as the FCS. From the standpoint of the operation and monitoring function, the APCS is a station executing the control function in accordance with the function blocks connected in the V net similar to the FCS.

The APCS status can also be monitored on the system status overview window.

8.5 APCS Engineering

The APCS can be engineered using the system generation function in the same procedure as the FCS. APCS user applications can be created in accordance with the function blocks similar to the FCS.



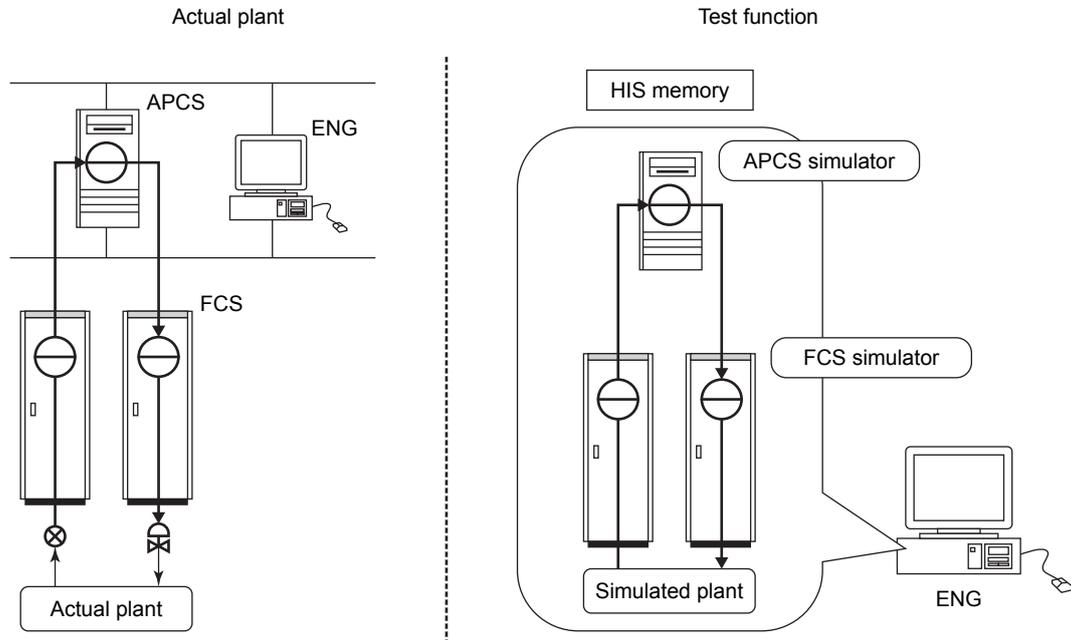
Engineering with CS 3000 engineering functions

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Figure FCS & APCS Engineering Procedures

8.5.1 APCS Simulation Testing

Similar to the FCS, the APCS operation can be simulated for testing. Additionally, APCS and FCS simulators can be used in combination to simulate a plant environment using only the engineering HIS (ENG). In the simulation test, FCS process data are acquired, the data are computed using them as parameters, the computed results are set at the FCS, and the set data are applied to the simulated operation in the simulated plant environment.



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Figure APCS Testing

9. Batch Management Functions (Option)

The powerful CS Batch 3000 batch process control package design considerations were ease of use, maintainability, and reusability.

9.1 Requirements for a DCS for Batch Processes

General requirements for a DCS for batch processes.

Support for Multiple Products

To make multiple products in one process unit, the DCS must store multiple recipes internally.

Recipes mainly consist of both procedures to manufacture products (phase control of process), and data (such as charge and temperature setting).

A DCS must handle multiple recipes, and particularly multiple different procedures, flexibly, and make it easy to add new recipes. The design concept is based on the ISA S88.01 standard that requires the separation of the product-related information and the equipment control-related information.

Easy Operation

It may be tempting to create custom operating screens for different recipes involving different procedures, but it is preferable – from the viewpoint of consistent operator interface – to use standard operation screens. Since each batch process typically corresponds to a dedicated control unit, support for unit instrument views of batch process is desirable.

Open Environment

It must be easy to download recipes and schedules from a supervisory computer, and to upload batch production data to the computer.

Support for International Standards

The standardization of batch processes is now in progress in the United States (ISA SP88) and Europe (NAMUR). For the internationalization of production, makers must support international batch process control standards.

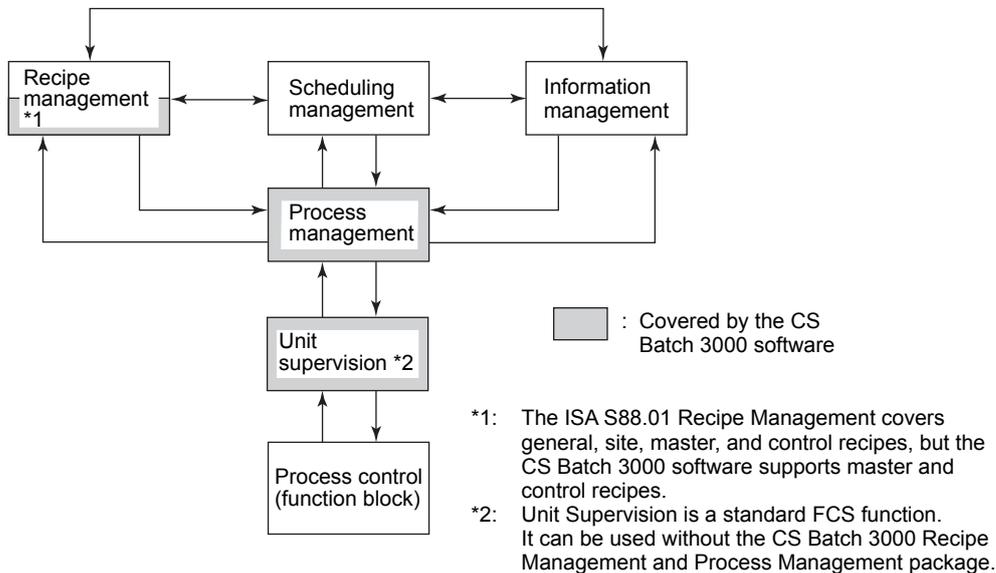
Higher Engineering Efficiency

It is said that no two batch processes are the same, and that it takes at least four times as long to program a batch process as it does to program a continuous process. In fact, considerable man power is required to maintain, modify, and expand conventional batch programs. Users now demand greater efficiency in programming and maintenance of batch programs using hierarchical programs, shared libraries, and reusable parts.

The CS Batch 3000 Management Packages are designed to automate and systemize batch processes to fulfill these demands.

9.2 Main Functions of CS Batch 3000 Package

The functions of this package correspond to the Control Activity Model of ISA S88.01 as follows:



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Figure ISA S88.01 Control Activity Model & CS Batch 3000

SEE ALSO

For detail information of CS Batch 3000, refer to "Batch Management Package CS Batch 3000." (TI 33Q01B30-31E)

A recipe is created and managed by the recipe management function. The created recipe is called a master recipe. When the master recipe is used in an actual process, the master recipe is converted into a form usable in an actual process (Recipe setup). The "set up" recipe, called a "control recipe" is downloaded to the FCS and then it's ready for use. Batch process status can be observed in the special batch management monitoring window. After a recipe is executed, results data are acquired and can be output as batch reports.

As described above, the product-related information (recipe procedures, formulas, etc) and the equipment-related information (sequence control, etc) can be managed separately, so that the practical batch plants can be realized, permitting production for multi-product/variable volumes and frequent recipe changing.

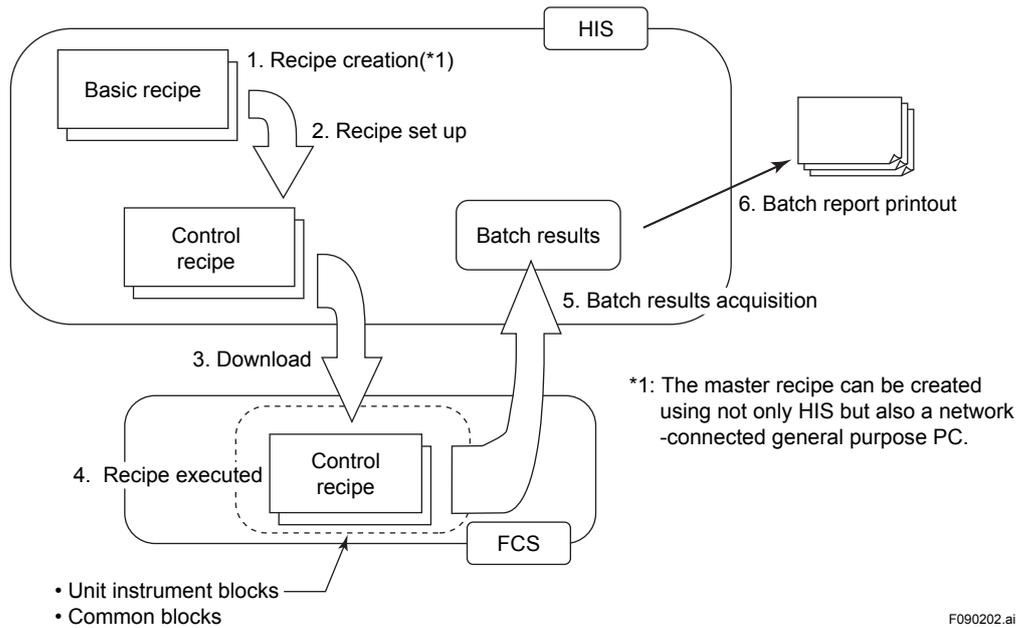


Figure Flow of CS Batch 3000

Recipe Management Functions

Recipes can be organized into recipe groups, and up to one thousand recipes can be created in a group. Up to 16 recipe groups per project can be created.

A recipe consists of the following four elements:

- Recipe header (management information)
- Procedure (manufacturing procedure)
Described by SFC
First use standard builder to create a unit sequence to be called from SFC.
- Formula (recipe data)
This consists of parameters such as charge and temperature setting.
Common block (user-definable variable block) is used.
- Equipment requirement
Choose generic process units corresponding to the requirement.
At set-up time, assign actual units to be used.

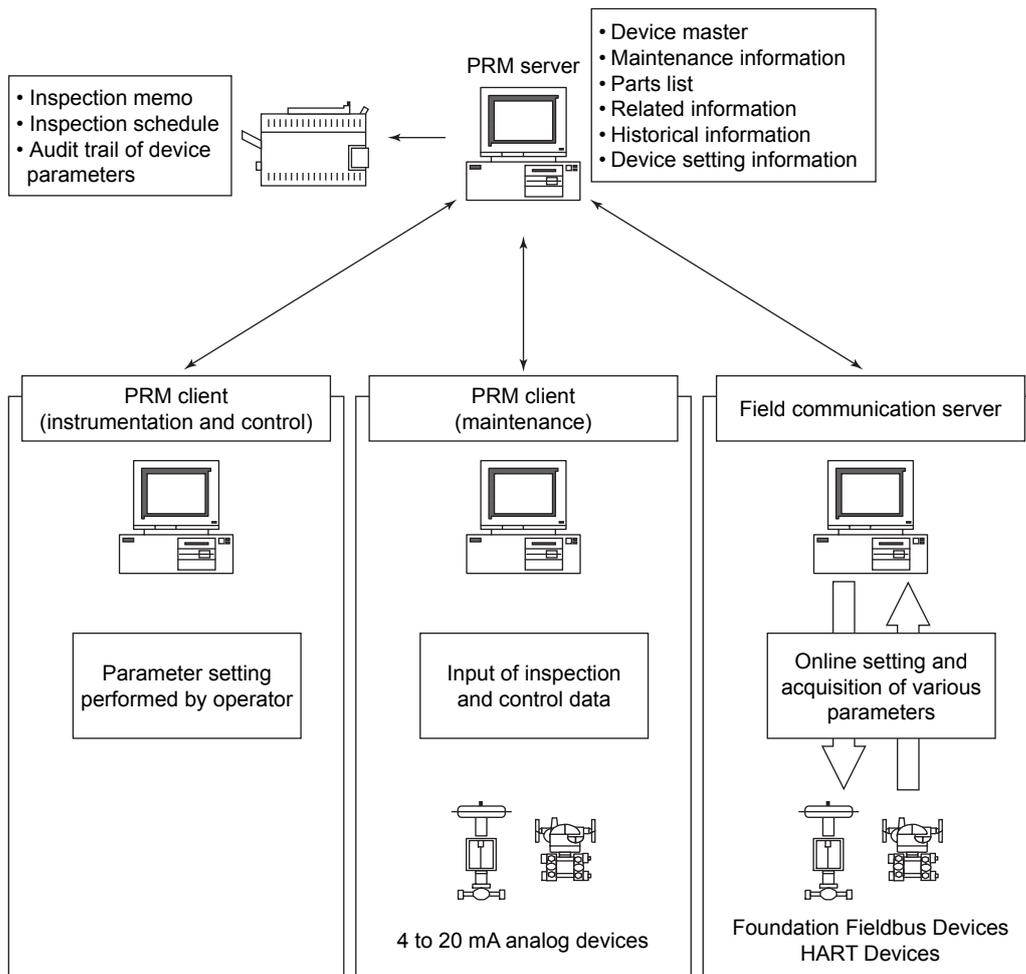
As described above, not only parameters but also sequence procedures in FCS are defined and managed on a per-recipe basis.

Process Management Functions

- (1) Recipe setup
Set up a recipe using process management functions after completing the corresponding master recipe.
Set Batch ID (ID to add a control recipe) and assign a unit that meets requirements (Unit assignment). Then, execute recipe setup and create control recipe.
- (2) Download
Download control recipe to FCS. Use standard builder to create unit instrument block in FCS as download target beforehand. There are two methods for downloading: manual either manually download from the process management window, or using SEBOL, or use automatic download after recipe setup.
- (3) Recipe execution
As for downloading, there are two methods: manual start from the special batch management window or automatic start after download. You can monitor and control batch process status using the special batch management window.
- (4) Batch results acquisition
Batch results are acquired after recipe execution. Batch results consist of the formula used for execution and a log of messages generated. These batch results can be printed out as batch reports. These batch result data are acquired in relation to the batch ID.

10. Plant Resource Manager (PRM)

PRM (Plant Resource Manager), which contributes to enhance the efficiency of maintenance management of field devices, has the features, such as the capability of the preventive maintenance management and so on, corresponding to the bi-directional digital field networks represented by Foundation Fieldbus. It classifies and manages the device maintenance information, such as inspection schedules, inspection memos, and configuration information of devices, in various aspects, so that it is available for the versatile maintenance ways. It can also acquire the operation information of field devices from a remote area via the remote bus, so that utilizing above information as the field device maintenance information is easy. Furthermore, It contributes to saving of maintenance cost and reduction of TCO (Total Cost of Ownership) by the utilization of field device information.



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Figure Plant Resource Manager (PRM) Overview

**SEE
ALSO**

For details on Plant Resource Manager (PRM), refer to GS 33Y05Q10-31E.

10.1 Maintenance Information Managed by PRM

The maintenance information items managed by PRM are shown below.

Table Maintenance Information Items

| Information Managed by PRM | Contents |
|----------------------------|--|
| Device master | Device tag names, device types, manufacturer names, revisions and so forth |
| Maintenance information | Inspection schedules, inspection memos |
| Parts list | Parts list including spare parts information, and so forth |
| Related information | Device specification sheets, parts composition |
| Historical information | Events of device, operation history of setting, calibrations, diagnoses and so forth |
| Device setting information | Setting data to devices |

These information items are identified and related with each other, by the device ID assigned to device, so that you can call the information items easily. The historical information reserves the history of the items affecting to device, such as operation history of setting /calibration and so forth, events from device, and maintenance work records into the database. In addition to the data, it can record together who operated and what was the purpose. Especially, besides record reservation, data restoration ability, which can easily and safely restore the past operation parameters by the parameter comparison function, is also available.

10.2 Device Navigation Function

To get the necessary information from many devices in understandable way, PRM use the Device Navigation Function shown in below table.

Table Device Navigation Function

| Kind of view | Function |
|--------------|---|
| Plant view | Display according to the logical position (plant hierarchy). In accordance with the use status, display in the categories of running devices at the plant, spare devices, devices under repair and so forth. |
| Network view | In accordance with field network configuration, display devices with the wiring conditions. |
| Class view | Display devices in the each type, such as vender, device type, revision and so forth. |

In the plant according to its size, there are from tens to thousands of devices, and the spare devices, devices under calibration and broken-down devices, as well as running devices. By using this function, you can easily identify the status and type of devices.

10.3 Support of Maintenance Inspection Works

Device Status Monitoring

By using the device status monitoring function from a remote place, you can confirm the device status immediately when abnormality occurred, and save the monitoring works at the plant-floor.

- Can confirm the device parameters under abnormality, as well as the device status (normal or abnormal).
- Can confirm the contents of abnormality by the alarm event notice corresponding to abnormal condition of device.

These functions enable the system to present the information regarding the influence degree for plant operation when the device abnormality occurred, countermeasures, parts replaced for broken-down device, and availability of the spare device.

Calibration of Device

For the field devices compliant with Foundation Fieldbus and HART, the following functions are available as the remote calibration function.

- The parameter setting function (display, comparison and setting of parameter)
- The method execution function (execution of specific calibration procedure of field device)
- The PLUG-IN application function (execution of specific tool of field device)

Valve Diagnosis

Among the field devices, a valve manipulates directly process, so that the diagnosis of the valve is important. By the enhanced function of valve positioner, the high accuracy diagnosis of valve has become available.

PRM provides the execution environment of diagnosis program by the tool prepared in each device, as the specific PLUG-IN application of device. By the environment, the most suitable diagnosis to device is executed, and the history of start and finish is also managed and unified. By acquisition and store of the valve information, the statistical preventive maintenance of valve is available. The preventive maintenance enhances not only the efficiency of maintenance works but also the availability of plant operation by the prolongation of inspection period. Furthermore, the appropriate tuning based on storing information enhances the valve accuracy. The improvement of valve accuracy contributes to improve the quality and output-rate.

Support of Record and Report of Maintenance Inspection Result

The management of the maintenance inspection result as work records is the effective information source of next inspection. The device information acquired online is effective for making inspection records of device. PRM provides following functions as support of record and report of maintenance inspection result.

- Make the inspection records according to inspection schedule.
- Display explicitly the work status by the approval function for completion of inspection work.
- Print the device information and maintenance inspection records in the unified format (self documentation function).

11. FDA: 21 CFR Part 11 Compliant Function (including option)

This function is compliant with 21 CFR Part 11 (Electronic Records; Electronic Signatures, hereinafter referred to as Part 11), issued by the Food and Drug Administration (FDA), for providing criteria of acceptance by FDA that electronic records and electronic signatures are equivalent to paper records and handwritten signatures executed on paper. Part 11 specifically describes the “Security” and “Integrity” of electronic record. CENTUM CS 3000 provides Access Control Function and Audit Trail Management Function to be compliant with its requirements.

Access Control Function (Personnel Authentication)

- To protect systems and data from any break-ins
- To control individual operations by authenticating an operator, an instrumentation engineer, and a recipe engineer

Audit Trail Management Function

- Automatically record the history of Operation, Recipe Creation, and System Maintenance (When, Who, What, Where, Why, How?)

Users are classified into HIS group operators, and engineering group engineers (instrumentation engineers, recipe engineers and operators with user rights of reporting).

Access control and the realization of audit trails, as well as setting locations, vary according to each user.

FDA-related packages and responses in those package functions are shown in the table below:

Table Optional Packages and Responses in Individual Group Functions

| Optional package | HIS group, access control/audit trail | Engineering group (system builder, recipe builder, report builder) access control/audit trail |
|--|--|---|
| Access Administrator Package (FDA: 21 CFR Part 11 compliant) | -([*] 1) | x |
| Consolidated Historical Message Package (meeting FDA) ([*] 3) | x([*] 2) | - |

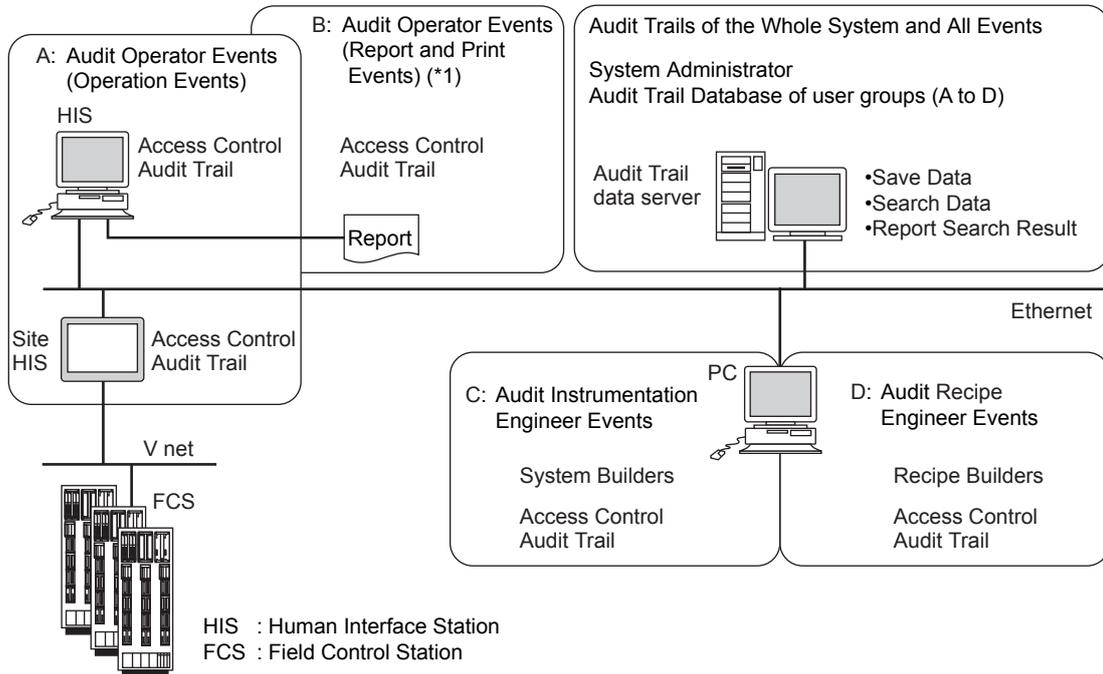
*1: If access control is realized in an HIS, no optional package is required because access control is included in the standard security function.

*2: If an Exaquantum/Batch is installed as a historical message management server for HIS audit trail management, this package is not required.

*3: The LHS6510 Long-term Data Archive Package stores trend data, closing data, and historical messages over a long term on the HIS in which the package is installed. However, the LHS6510 does not cover such functions as the creation of reports retrieved from archived files and output as PDF files.

SEE ALSO For details on FDA: 21 CFR Part 11, refer to TI 33Q01A61-01E.

The example of system configuration is provided in the below. The summarized and excerpted regulations from Part 11 regarding Data "Security" and "Integrity"; individual solution in CENTUM CS 3000 system are provided in the following pages.



Note: Do not install engineering builder to HIS.

F110001.ai

Figure Example of a System Configuration

11.1 Data Security

Data security is assured with tight restrictions for access rights. The contents of “Data Security” in Part 11 is classified into three major parts as below:

- Making sure users only have authorized access into the system
- Making sure users have accessed are authorized to carry out their roles
- Making sure only the actual person has authorized performs operation

Excerpted clauses from Part 11 regarding Data Security are listed below. Also, CENTUM CS 3000 provides following functions to meet the regulations.

Table Clauses Regarding Data Security and Solution in CENTUM CS 3000

| Clauses Excerpted from Part 11 | | Solution in CENTUM CS 3000 |
|--------------------------------|---|---|
| §11.10 (d) | Limiting system access (personnel authentication) | Control by user ID and password. |
| | | Control by user ID and fingerprint. (*1), (*2) |
| §11.10 (g) | Authority checks | Identify by user ID, password, and/or fingerprint at operation (*1) |
| | | Add classification of roles to users |
| | | Add functional limitation to the object to be operated (Instrument, Window) |
| §11.50 | Manifestation of Electronic Signature and Electronic Records | Security builder and its print. |
| §11.200 (a) | Electronic signatures that are not based upon biometrics | Automatic recording of Audit trail. |
| | | Identify by user ID and password. |
| | | Only password entry is required from second log in |
| §11.200 (b) | Electronic signatures based upon biometrics | Identify by user ID and fingerprint. (*1), (*2) |
| §11.300 (a) | Uniqueness of each combined identification code and password | Double registration check when user ID is registered |
| | | Privilege is required for the registration of user ID |
| | | Audit trail records automatically when user ID is registered. (*2) |
| §11.300 (b) | Periodically check of identification code and password issuance | Setting the validity of password. |
| §11.300 (d) | Detection and report function for unauthorized access | Alerting system alarm when wrong operations are performed continuously more than the number of times set previously. (*2) |
| | | Automatically record audit trail of alarm |

*1: For the fingerprint authentication device, we utilize 3rd party product.

*2: Only the solution for operators is available. The solution for engineers is in phased-plan.

11.2 Data Integrity

To assure the data integrity, an appropriate measure must be prepared. The data integrity verification includes providing log of not only the intentional data falsification and deletions but also accidental operations.

In CENTUM CS 3000 systems, electronic records include operational record and meta-data. Meta-data includes raw data, file translation information, and audit trail that are used for assuring its operational records. Audit trail automatically records log whenever a user changes electric records in the system. Moreover, audit trail does not allow any changes, fixes, and deletions after the log is recorded. Another integral part of data integrity verification by audit trail is accurate time data. To verify the operation result data has not been changed, meta-data such as the audit trail with time-stamps or system-configuration modified record is demanded.

Electronic Records

Operation records

- Operation result data
- Alarm data
- Trend data
- Recipe data

Meta-data

- Raw data
- Audit trail of operation
- Audit trail of system maintenance
 - Audit trail regarding system configuration file (application file) after validation
- Audit trail of recipe management

Excerpted clauses from Part 11 regarding Data Integrity are listed below. Also, CENTUM CS 3000 provides following functions to meet the regulations.

Table Clauses Regarding Data Integrity and Solution in CENTUM CS 3000

| Clauses Excerpted from Part 11 | | Solution in CENTUM CS 3000 |
|--------------------------------|--|--|
| §11.10 (b) | Records in both human readable and electronic form | Retrieval function of historical message Output in general file formats (CSV, PDF, XML) |
| §11.10 (c) | Archive and protection of records | <ul style="list-style-type: none"> • Retrieval of date and time, personnel, batch ID, systems, messages, and the like, according to specific retrieval conditions • Output retrieval results and retrieval conditions together as PDF files • Check functions of disk spare memory capacity in data archive function • Check functions of CPU load, communication capacity, and memory capacity used in a DCS system |
| §11.10 (e) | Audit trail | Audit trail (when, who, what, where, why, how) records automatically, when following operation is performed. <ul style="list-style-type: none"> • Plant operation performed by operators • System maintenance performed by system engineers • Recipe creation performed by recipe engineers • Report creation by operators with user rights of reporting |
| §11.10 (h) | Device checks | |
| §11.10 (k-1) | Audit trail over system | |
| §11.10 (k-2) | Controls over system documentation for maintenance | |

12. Online Manual

All manuals are provided as electronic documents on CD-ROM. Adobe PDF file format, the de facto standard for distributing electronic documents on the Internet, is used. The manual may be displayed and printed on demand. You can jump to related documents from the document map. Using whole-text search functions, it is easier to find information in electronic documents than in paper documents - and electronic document save storage space.

12.1 Running Online Manual Viewer

From Windows Start Menu

You can select the online manual and start the PDF viewer from the Windows Start Menu. You can select (start from) "Read me", "Document Map", "Reference Index" or "Using Online Manual".

From Help Menu of Builder

You can select an online manual from the Help Menu of any of the builder component programs. You can select (start from) "Using Online Manual", "Engineering Basic Operation", "Builder Definition Items List", or "Reference Index".

12.2 Convenient Ways to Use Online Manual

Here we explain some convenient (PDF-specific) ways of using the online manual.

Using Table of Contents and Index

The table of contents and index contain clickable links that allow you to jump to the corresponding page.

List of Builder Definition Items

If you select “List of Builder Definition Items” from the help menu of any builder program, then a list of builder definition items for the current builder is displayed. Click any item to jump to the corresponding page in the reference manual.

Search Functions

The manual provides the following search functions available on its search window:

Find all: Search is made in the entire online manual.

Definition item search: Search is made for a builder definition item.

Page search: Search is made in the page displayed.

Additional Search Functions

Retrieval search: Search is made in the previously searched results.

Search history: Up to 20 latest searched results are saved.

Favorites

Frequently accessed pages can be registered for easy later retrieval. Registered pages can be rearranged or de-registered as favorites in web browser.

13. Sequence of Events Manager (SEM) Function (Option)

The Sequence of Events Manager (SEM) provides the Sequence of Events (SOE) recording feature, which captures the events at the fast speed of 1ms potentially resulting in a plant trip and allows the acquired event data to be stored, displayed, and managed.

The SEM applies trip signals from a device, such as a turbine, compressor, fan, or pump, that has serious impact on the plant operation to the sequence of events (SOE) input modules, thereby allowing SOE data to be acquired automatically at the specified trigger signal. A time-stamp synchronizing with an external master clock is added to SOE data acquired by the SOE input module, and the SOE data is displayed on the SOE Viewer in chronological order. The SOE data is output as a trip report or can be output to an external historian through an OPC. This feature will be effective for analysis of trip causes and data management.

13.1 System Configuration

The basic system configuration of SEM is shown in the figure below.

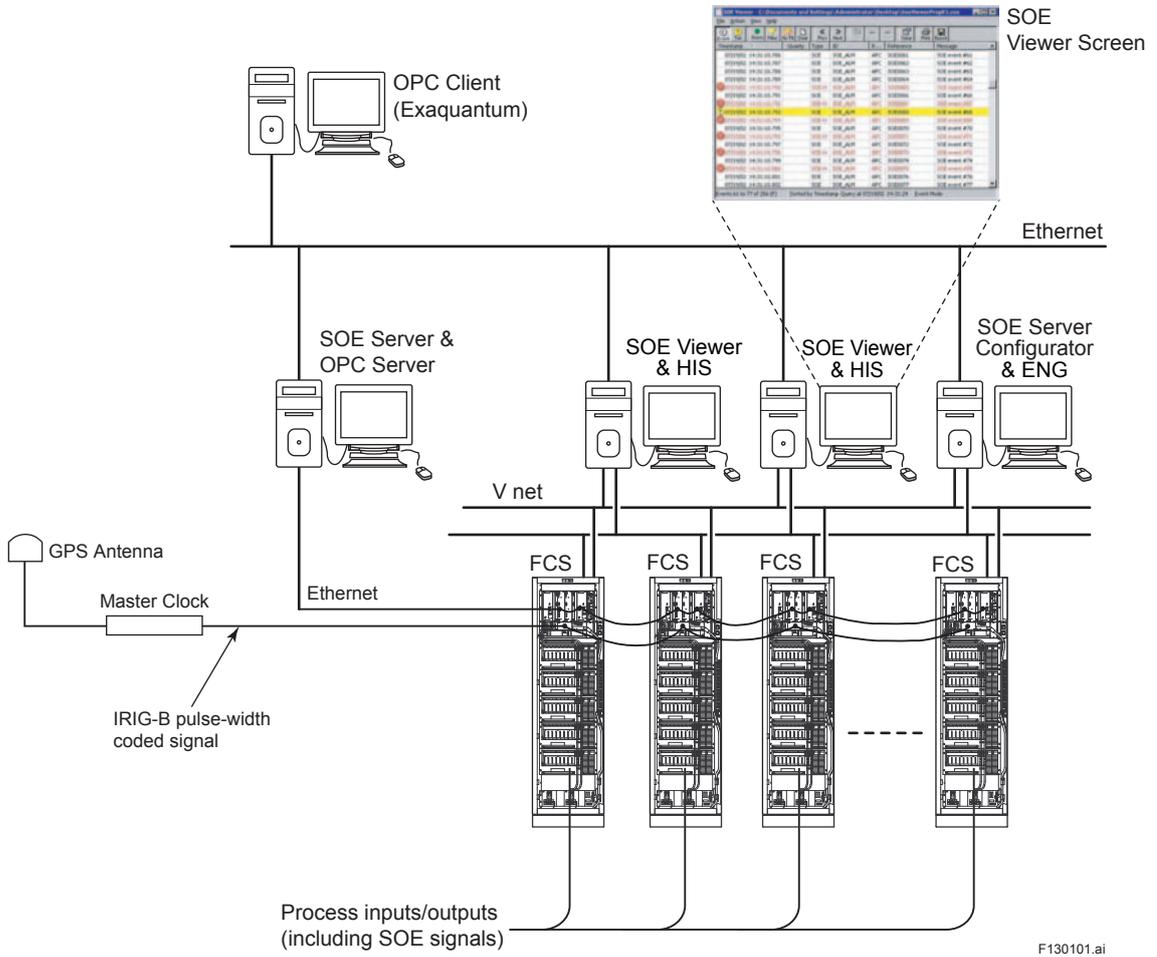


Figure SEM Basic System Configuration

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13.2 Functional Configuration

The SEM consists basically of a sequence of events (SOE) input module that captures plant event signals, an FCS with an SOE interface module (SB311), an SOE server that acquires SOE data from the FCS via Ethernet and stores them, the SOE viewers that display stored data under specified conditions, and an SOE server configurator that defines SOE server system configuration. The SOE data is time-stamped in the SOE input module and sent to the SOE server via the SOE interface module (SB311) in the FCS.

The FCS performs a time synchronization with an external master clock using an IRIG-B time code format through an RS-422 signal.

The acquired SOE data can be displayed and output for any purpose in accordance with the event message display function, trip detail display function, and trip report function supported by the SOE viewer. In addition, The SOE data can be output to an external OPC client, such as the Exaquantum historian. This feature allows the integrated management of SOE data by the Plant Information Management System (PIMS).

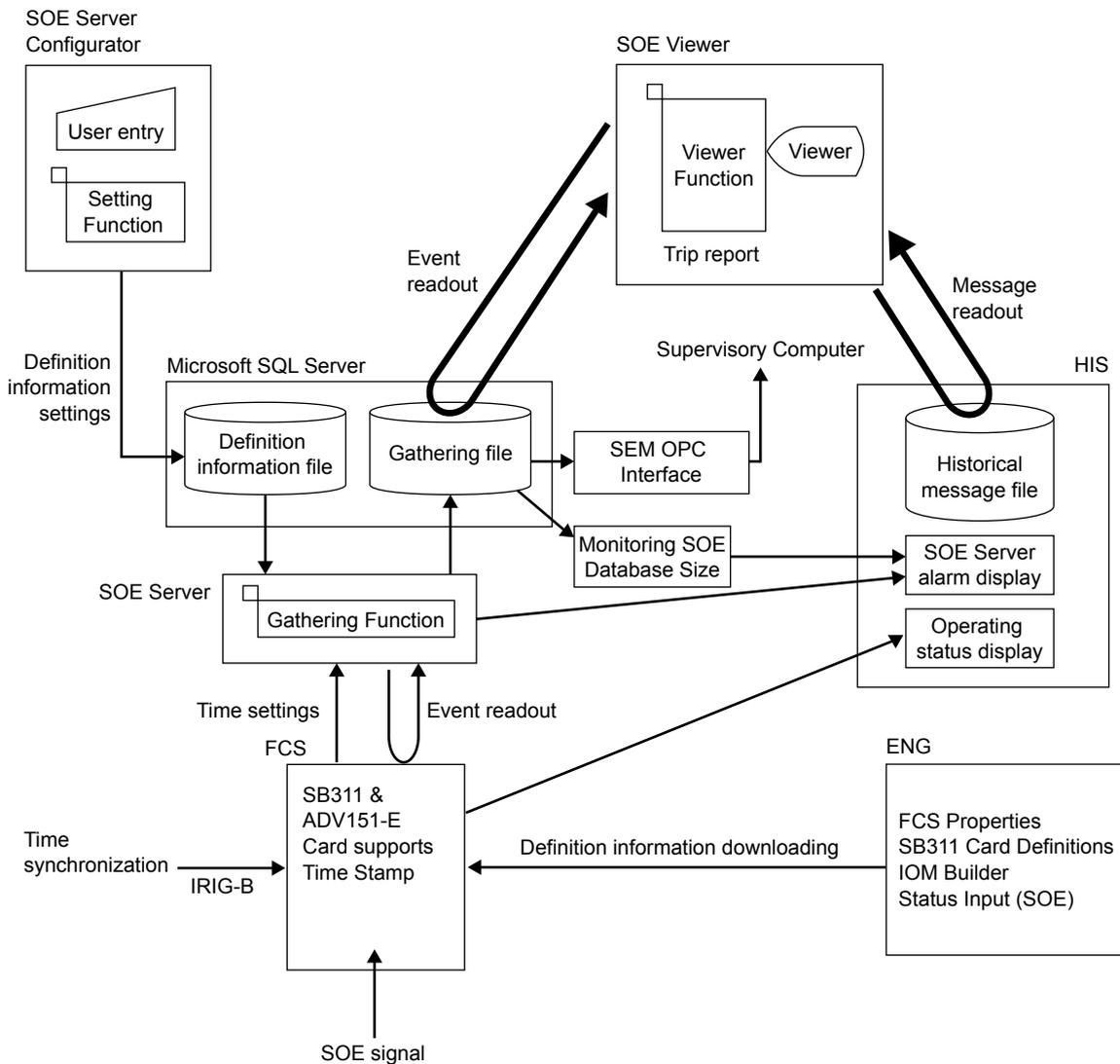


Figure Functional configuration of the sequence of events manager (SEM)

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13.3 Basic SEM Configuration Equipment and Software Packages

The SEM is comprised of the following basic equipment and software packages.

SOE Server

The SOE server acquires and stores time-stamped SOE data from FCSs, and has a server function that transfers the stored SOE data to multiple SOE viewers upon request. The SOE server runs on Microsoft Windows 2000 Server or Windows Server 2003. The SOE server operates when an SOE server package (LPC6900) is installed in an SQL server PC on which Microsoft SQL Server 2000 is running.

The SOE server uses two independent Ethernet networks: one for SOE data acquisition from FCSs, and the other for SOE data transmission to SOE viewers. Up to 2000 SOE inputs can be acquired by one SOE server. The number of SOE viewer clients that can be connected to one SOE server is determined by the number of Windows and SQL server client licenses. Configure the system with the number of client licenses needed for SOE viewers.

SOE Viewer

The SOE viewers display SOE data stored by the SOE server in chronological order according to preset retrieval conditions. The SOE viewers operate when the SOE Viewer Package (LPC6920) is installed on a PC running Windows 2000 or Windows XP, connected to the SOE server via Ethernet.

The SOE viewers provide the functions listed below:

- Event mode display: Lists data source parameters set by the SOE viewer property and all messages matched with the date and time.
- Trip trigger mode display: Lists trip trigger events in the range of dates set by the SOE viewer property.
- Trip detail display: Displays all trip detail records relating to trigger events selected on the trip trigger mode display screen.
- Automatic trip report mode display: Automatically acquires newly generated trip triggers.
- Trip report output: Outputs the trip reports acquired by trip triggers to a csv type file and/or a printer.

| Timestamp | Quality | Type | ID | Resource | Reference | Message |
|-----------------------|---------|-------|---------|----------|-----------|--------------------------------|
| 07/10/03 14:47:47.798 | | SOE-H | SOE_RTN | SOECARD | SOEDI0026 | Plant DI0026 SOE Input Recover |
| 07/10/03 14:47:47.798 | | SOE | SOE_RTN | SOECARD | SOEDI0027 | Plant DI0027 SOE Input Recover |
| 07/10/03 14:47:47.798 | | SOE-H | SOE_RTN | SOECARD | SOEDI0028 | Plant DI0028 SOE Input Recover |
| 07/10/03 14:47:47.798 | | SOE | SOE_RTN | SOECARD | SOEDI0029 | Plant DI0029 SOE Input Recover |
| 07/10/03 14:47:47.798 | | SOE-H | SOE_RTN | SOECARD | SOEDI0030 | Plant DI0030 SOE Input Recover |
| 07/10/03 14:47:47.798 | | SOE | SOE_RTN | SOECARD | SOEDI0031 | Plant DI0031 SOE Input Recover |
| 07/10/03 14:47:47.798 | | SOE-H | SOE_RTN | SOECARD | SOEDI0032 | Plant DI0032 SOE Input Recover |
| 07/10/03 14:47:48.799 | | SOE | SOE_ALM | SOECARD | SOEDI0001 | Plant DI0001 SOE Input |
| 07/10/03 14:47:48.799 | | SOE-H | SOE_ALM | SOECARD | SOEDI0002 | Plant DI0002 SOE Input |
| 07/10/03 14:47:48.799 | | SOE | SOE_ALM | SOECARD | SOEDI0003 | Plant DI0003 SOE Input |
| 07/10/03 14:47:48.799 | | SOE-H | SOE_ALM | SOECARD | SOEDI0004 | Plant DI0004 SOE Input |
| 07/10/03 14:47:48.799 | | SOE | SOE_ALM | SOECARD | SOEDI0005 | Plant DI0005 SOE Input |
| 07/10/03 14:47:48.799 | | SOE-H | SOE_ALM | SOECARD | SOEDI0006 | Plant DI0006 SOE Input |
| 07/10/03 14:47:48.799 | | SOE | SOE_ALM | SOECARD | SOEDI0007 | Plant DI0007 SOE Input |
| 07/10/03 14:47:48.799 | | SOE-H | SOE_ALM | SOECARD | SOEDI0008 | Plant DI0008 SOE Input |

F130301.ai

Figure Trip detail display

The SOE viewer displays SOE data stored by the SOE server and can also access HIS message databases and Unified Operator Interface (UOI) servers to allow an integrated data display of SOE and other message data. Up to eight message data sources can be assigned.

Field Control Station (FCS) with SOE Interface Module

The SEM provides the following four FCS models. These models incorporate two SOE interface modules (SB311) and one IRIG-B branch unit per FCS.

- Models AFS30D-HE and AFG30D-HE 19-inch Rack Mountable, Duplexed Field Control Units for FIO and 19-inch rack mountable
- Models AFS40D-HE and AFG40D-HE Duplexed Field Control Units for FIO with Cabinet

The SB311 module is installed in a dual-redundant configuration consisting of ESB-bus modules with an Ethernet port (for SOE server) and an RS-422 port (for time synchronization). An Ethernet port is connected to the SOE server via an Ethernet hub. An RS-422 port is connected to an external master clock via an IRIG-B branch unit inside the FCS. RS-422 cables are cascade-connected to the IRIG-B branch units in each FCS, and an YCB128 RIO bus terminator is attached at the end of the FCS.

Up to 16 FCS's can be connected to an SOE server. The SOE viewer can display data sources for up to eight SOE servers. If 16 or more FCS's are used, or 2000 or more SOE data items are used, use multiple SOE servers.

SOE Digital Input Module (ADV151-E)

The SOE signals are connected to the SOE Digital Input Module (ADV151-E) installed on a local node in the FCS. Up to 32-point SOE signals can be applied to one ADV151-E module. For each input terminal, the SOE signal input specifications can be set. The status of SOE signal can be used as FCS control and monitoring signals. The ADV151-E module specifications are the same as those of the ADV151-P module except for the SOE-specific functions.

SOE Server Configurator

The SOE Server Configurator is a builder for the SOE server to define the configuration required for acquiring SOE data from the FCS. The SOE Server Configurator (LPC6910) operates when installed on a PC running Windows 2000 or Windows XP connected to the SOE server via Ethernet.

SEM OPC Interface

The SEM provides an OPC interface function for transferring SOE data stored in the SOE server, to an OPC client, such as Exaquantum, connected via Ethernet as an OPC alarm and events (A&E) server. The SEM OPC interface function works when installing the SEM OPC Interface Package (LPC6930) on a PC running as an SOE server.

External Master Clock

The FCS, to assure 1-ms SOE data resolution and time, performs time synchronization by a pulse-width modulated IRIG-B code signal using an external master clock that incorporates GPS and through an RS422-interface. In addition, time synchronization by the SOE server is executed periodically with an FCS via Ethernet for SOE data acquisition.

Time synchronization for SOE viewers, human interface stations (HIS's), and network equipment, such as an engineering PC, depends on the system configuration. So, use a network time protocol (NTP) to separately set the SOE server.

13.4 System Monitoring and Maintenance Functions

The SEM provides the following functions for system monitoring and maintenance.

- Monitor the SOE server
- Display operating status of the SB311 and ADV151-E
- Monitor free disk space capacity of the SOE server
- Backup and restore the SOE server database

14. Event Viewer Package

Event Viewer Package can search and analyze by filtering historical message from various viewpoints. This package enables plant analysis for the purpose of improving operation efficiency by achieving upgraded controllability and further automation as well as reduce operator's workload.

Event Viewer Package allows visual analysis of historical messages with an event viewer window collaborating with the Standard Operation and Monitoring Function on HIS. The HIS includes a historical message report window, which provides an overview display of various historical messages as alarm message records, operator work records, and the like. Main objectives of the historical message report window are to display, find and print process alarms, operation records, and system and process related events. In addition, Event Viewer Package provides graphs as below.

- Message Summary Window (lower left)
Display all messages of daily (0:00 to 23:59) historical messages
- Event Balance Trend (EBT) graph window (left top)
Display the rate of event occurrences per minute. There are number of events that action required to operator (on the positive axis) and action by operator (on the negative axis).
- Category Sort Window (right top)
Display sorted events with various conditions. (Alarm occur/recover, Event type, etc.)
- Point ID Window (lower right)
Display event IDs such as tag names with sorted by frequency, tag name order, etc.

These windows are allowing an intuitive and quantitative analysis of historical messages through mouse operations.

Upon the occurrence of the most recent event, the data storage period is the past seven days, inclusive of the date upon which the event occurred. However, days when no events occur are not included in this period.

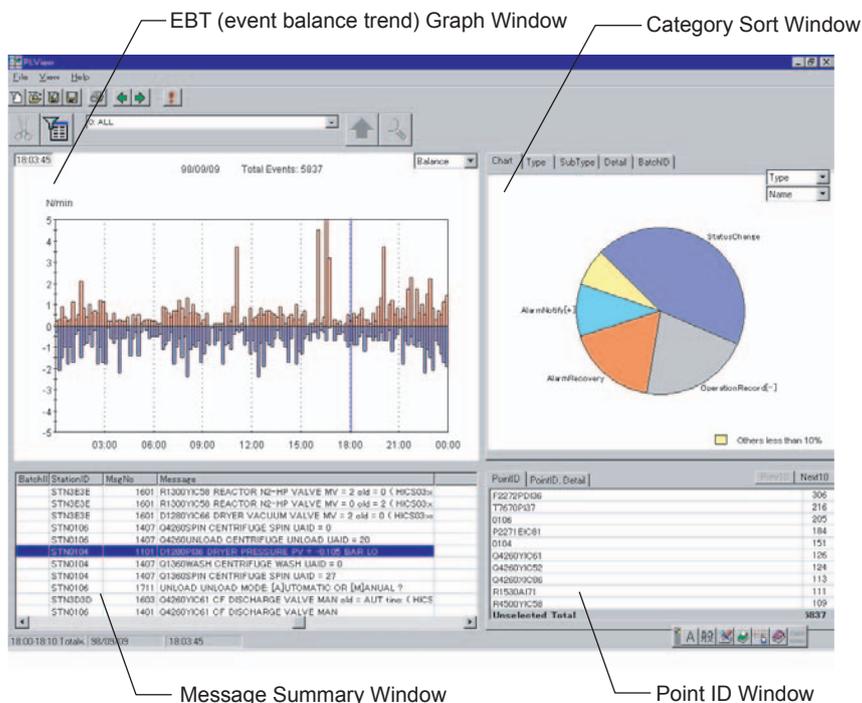


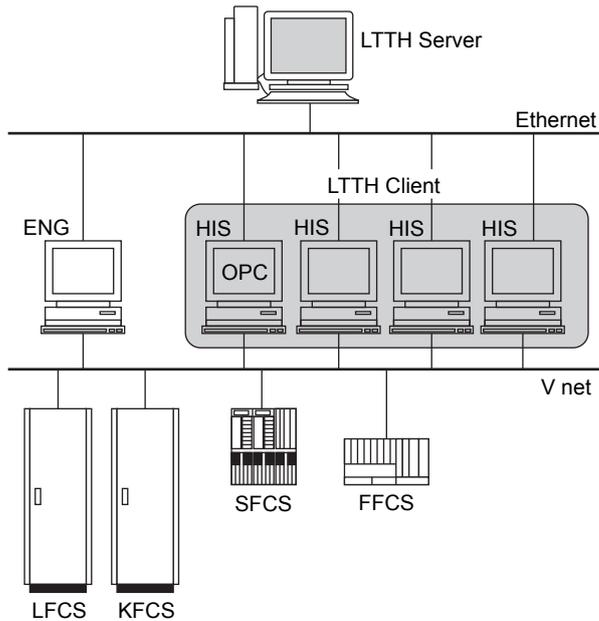
Figure Event Viewer Window

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15. Long-term Trend Historian Package (LTTH)

Long Term Trend Historian (LTTH) acquires process data and alarm messages, stores them over a long term, and displays them with a specific viewer function, providing plant analysis features.

LTTH consists of an LTTH server and LTTH clients. An Exaopc OPC Interface Package (for HIS) is required to acquire process data and alarm messages.



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LTTH Server Function

- Acquires tag items defined by the CENTUM CS 3000 trend acquisition pen assignment builder and event messages and stores them over a long term.
- Runs on a PC separate from a human interface station (HIS) and acquires data via an OPC interface package incorporated in the HIS.

LTTH Client Function

- Runs on the HIS and displays trend data and event messages saved on an LTTH server.
- Allows a simple analysis of alarms and event messages that occur during a specified period.

The following screens are provided:

Trend and alarm analysis screens

Trend data, alarms and event messages, and screen displaying tag names that most frequent of alarm occurrences within a specified period are displayed together; these data, alarms and messages can linked to each other screens for display.

Trend compare screen

Two trend graphs are displayed side-by-side to compare current trend data with former trend data.

Data to Be Saved

| Data Type | Amount of Data Saved | Data Save Period |
|------------|------------------------------|------------------|
| Trend data | On a per-acquired-data basis | For one year |
| Message | All messages at a time | For one year |

Data Acquisition Period

Data to be acquired are specified by Trend Acquisition Pen Assignment on the HIS. The LTTH data acquisition period is automatically determined in accordance with the data acquisition period specified by the HIS as given below:

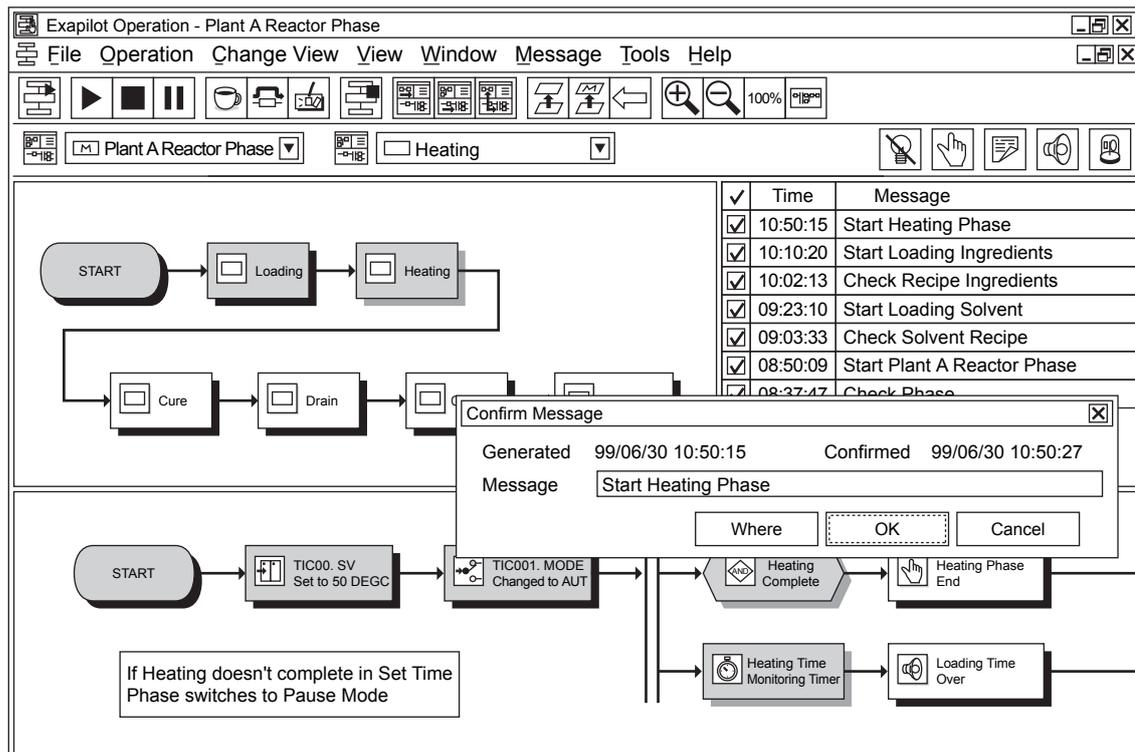
| Data acquisition period specified on HIS | LTTH data acquisition period |
|--|------------------------------|
| One second | Ten seconds |
| Ten seconds | One minute |
| One minute | One minute |
| Two minutes | Two minutes |
| Five minutes | Five minutes |
| Ten minutes | Ten minutes |

16. CENTUM CS 3000 Related Software Packages

Yokogawa’s Exa-series software packages eliminate the information gap between business and control domains and allow Manufacturing Execution System (MES) technology to be applied to increasing plant safety and plant efficiency, reducing manpower, and increasing product quality.

16.1 Exapilot: Operation Efficiency Increase Package

For non-steady-state operation – such as startup and shutdown, emergency operation in response to process or device abnormalities, or manual intervention during normal operation – variation in operator skills can cause process irregularities or product quality problems, and affect operational efficiency. With the Exapilot package, an experienced operator can incorporate his skills to automate operation and monitoring, and maintain quality of operation at a consistently high level. Each function of Exapilot is provided based on the operational efficiency improvement cycle, “Plan, Define, Operate, Study, Improve”, so that user can add support for plant changes or new operating methods – and improve operational efficiency – by repeating the Exapilot cycle to create new Exapilot applications. Exapilot applications use Standard Operation Procedures (SOP) to display operation know-how in an intuitive format.



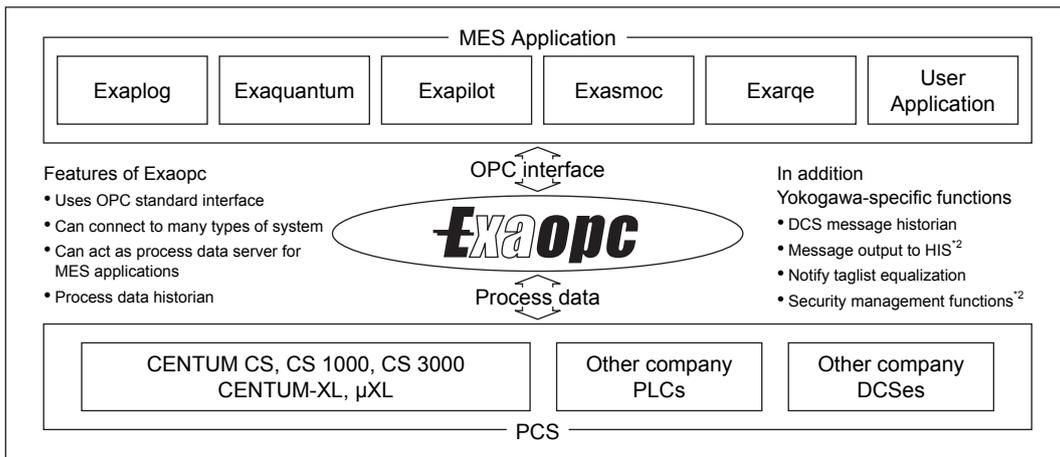
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Figure Exapilot Operation Efficiency Increase Package display example

16.2 Exaopc: OPC Interface Package

Recently there has been progress in sharing data between DCS and Manufacturing Execution System (MES) computer systems; plant information is useful at the top level of the business, and users are demanding information systems which provide timely information to support business activity. In the process industries, data sources range from instruments in the factory to the control room database. Until now, accessing DCS operating data from a supervisory computer has been rather difficult, so MES computer access to operating data was not easy. Yokogawa, with its Exaopc OPC (OLE for Process Control) interface package, offers an OPC Foundation (*1) standard interface which solves these problems. Yokogawa also offers proprietary functions which enhance this interface.

*1: The OPC foundation is a non-profit foundation with over 300 corporate members.



*2: Applies to CENTUM CS 1000/CS 3000 only.

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Figure Exaopc OPC Interface Package

Appendix Correspondence of Abbreviations and Product Models

Table Correspondence of Abbreviations and Product Models

| Category | Abbreviation | Product Name | Product Model |
|--------------------------|--------------|---|------------------|
| Field Control Stations | KFCS | Standard Type Field Control Station for FIO | AFS30□ AFS40□ |
| | KFCS2 | Enhanced Type Field Control Station for FIO | AFG30□ AFG40□ |
| | LFCS | Standard Type Field Control Station for RIO | AFS10□ AFS20□ |
| | LFCS2 | Enhanced Type Field Control Station for RIO | AFG10□ AFG20□ |
| | FFCS | Compact Field Control Station for FIO | AFF50□ |
| | SFCS | Compact Field Control Station for RIO | PFC□-H |
| Safety Control Station | SCS | Safety Control Units (Rack Mountable Type) | SSC10□ SSC50□ |
| Human Interface Stations | HIS | Enclosed Display Style Console Type HIS | LPCKIT |
| | | Open Display Style Console Type HIS | YPCKIT |
| | | Desktop Type HIS | Common PC |
| Bus Converter | BCV | Bus Converter | ABC11□-□ |
| Communication Gateway | CGW | Communication Gateway | ACG10S |

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CENTUM CS 3000

Production Control System

System Overview

TI 33Q01B10-01E 12th Edition

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Revision Information

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- 2.3 Console-type added
- 2.4.2 AMM12C, ACF11 added
- 2.6 Fieldbus added
- 3.9 Graphic Web Display Function added
- 4.1.4 Logic Chart Blocks added
- 6. Batch Management Functions added

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- 1.3 Revised "1.2 Overview of Function" to "1.3 Solutions Incorporating CENTUM CS 3000"
- 1.3.4 Added "CENTUM V and CENTUM-XL Migration to CENTUM CS 3000"
- 1.4 Added CENTUM CS 3000 Related Software Packages
- 2. Revised System Configuration Diagram
- 2.1 Added Engineering PC (ENG), Fieldbus, Unified Operation/Monitoring Station (UHMS), Business Information PCs and Supervisory Computers, FCS-XL and FCS-V Control Station for Migration to CENTUM CS 3000, and Prosafe "Safety Instrumented System"
- 2.4.3 Revised description of Communications Gateway Unit (CGW)
- 2.4.3 Separated "I/O Module Nests and I/O Modules" from item 2.4.2
- 2.4.3 Added AMN52 to I/O Module Nests, and AAM11B, AAM21J, AMM22C, AMM22TJ, AMM25C, AMM32C, AMM32TJ, AMM32CJ, ACM71 and ACP71 to I/O Modules
- 2.5.1 Revised description of V net cable and length
- 2.8 Added process I/O operation at CPU failure
- 2.9 Added C-Tick Mark description
- 3.1 Revised figure showing Configuration of Operation and Monitoring Functions
- 3.2 Revised order and contents of Common Operation and Monitoring Functions
- 3.2.3 Revised figure showing System Message Window
- 3.2.5 Revised Window Hierarchy explanation
- 3.2.10 Added explanation of Alarm Processing Functions
- 3.2.10 Added notes to figures explaining "Opening Process Alarm Window to Acknowledge Alarm" and "Opening System Alarm Window to Acknowledge Alarm"
- 3.2.11 Added Hard Copy Functions
- 3.3.1 Added examples of Instrument Faceplates
- 3.3.7 Added Message Monitoring Window
- 3.4.5 Added Connecting ITV Camera
- 3.4.6 Added CENTUM Desktop Environment Customization
- 3.5.4 Revised HIS Setting Window
- 3.5.4 Added External Recorder Tab Sheet and ITV Tab Sheet on HIS Setting Tab Sheet Items
- 3.5.6 Added Help Dialog
- 3.6.3 Added Logic Chart Window
- 3.6.4 SEBOL Window: Changed item no. due to addition of 3.6.3 Logic Chart Window
- 3.6.5 SFC Window: Changed item no. due to addition of 3.6.3 Logic Chart Window
- 3.7.5 Added External Recorder Output Functions
- 3.9 Added FCS Data Setting/Acquisition function (PICOT)
- 4.1.4 Revised Logic Chart Block Diagram
- 4.1.7 Added Generic Name
- 4.1.8 Added YS Instrument Blocks (SLCD, SLPC, SLMC, SMST-111, SMST-121, SMRT, SBSB, SLCC, SLBC, STLD) to Table of Regulatory Control Blocks
- 4.1.8 In Table of Unit Instruments and Operations, added OPSFC1, OPSFC2, OPSFC3, OPSFC4, OPSFC5
- 4.2.1 Added ACM71 Ethernet Communication Module, YS Communication Package (for ACM12), MELSEC-A Communication Package (for ACM71)
- 4.2.1 Revised description associated with Communicating with Other Subsystems, and figure showing "Communications I/O Data Flow"

-
- 5.2 Revised "Multiple-project Configuration" to "Multiple Project Connection Functions", and description of the functions
 - 5.3 Added description of Engineering Procedure
 - 5.4.2 In Table of "List of Builder Programs", added Multiple project connection, Plant hierarchy, Engineering unit symbol, Switch position label, State transition matrix, Alarm processing table, Alarm priority level, User-defined status character string, Status change command character string, BCV constants, CGW constants, and Train in batch functions
 - 5.5 Added Expanded Test Functions
 - 5.7 Revised "5.4 Online Maintenance Functions" to "5.7 Online Maintenance Functions," and description of the functions
 - 5.8 Added description of Remote Maintenance Functions
- Feb. 2001/4th Edition**
- For all sections, Windows NT is changed to Windows 2000
 KFCS and APCS are added, so that some chapter, section and item numbers of 3rd Edition are revised.
- 1.3.4 Added "Management Cost Reduction"
 - 1.4.1 Revised description of Exaplog
 - 1.4.2 Revised description of Exapilot
 - 1.4.3 Revised description of Exaopc and figure showing Exaopc OPC Interface Package
 - 2. Added console type HIS, KFCS and APCS to figure showing CENTUM CS 3000 System Configuration (Basic)
 Added console type HIS, KFCS and APCS, deleted CENTUM V and revised UHMIS to Exaopc in figure showing CENTUM CS 3000 System Configuration
 - 2.1 Added console type HIS, KFCS and APCS, deleted Nodes and RIO Bus revised UHMIS to Exaopc
 - 2.2 Added KFCS and CENTUM-XL system to figure showing Example of Large System Configuration
 - 2.3.1 Added this item, revised description of Console-type HIS
 Added open style console type HIS
 - 2.4 Added KFCS
 - 2.4.1 Added KFCS
 - 2.4.2 Revised standard FCS (LFCS) of 3rd Edition to standard FCS for RIO (LFCS)
 - 2.5.1 Added KFCS I/O modules
 - 2.5.2 Added description of I/O modules for LFCS and SFCS
 - 2.6.2 Added "acquiring trend data for other stations" to description of Ethernet
 - 2.7 Added KFCS system configuration with Fieldbus
 - 2.8.1 Added description of KFCS, ESB bus and FIO Node
 - 3. Deleted redundant description of "Easy Hardware Upgrades"
 Added Console Type HIS and Multi-monitor Functions
 - 3.1 Added voice messaging functions, multi-monitor functions and expert trend viewer function to figure showing Configuration of Operation and Monitoring Functions
 - 3.4.3 Added Security on Per-Window Basis
 - 3.4.5 Revised description of Connecting ITV Camera
 - 3.4.7 Added Voice Messaging Functions
 - 3.4.8 Added Multi-monitor Functions
 - 3.5.4 Revised figure showing HIS Setting Window
 Added OPC, Report, Multi-monitor and Process Management Tab Sheet to table showing HIS Setting Tab Sheet Items
 - 3.7.4 Revised table of Typical Figures for Disk Capacity
 - 3.7.6 Added Expert Trend Viewer Function (Option)
 - 3.8 Revised description of this section, added CENTUM Data Access Library and deleted DDE (Dynamic Data Exchange)
 - 3.10 Revised Graphic Web Display Function to Web Monitoring Functions
 Added trend window monitoring to Web Monitoring Functions
 - 4.1.2 Deleted description of Increasing Engineering Productivity - Components and Models
 - 4.1.8 Added new sequence table blocks to table "List of Sequence Blocks"
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- 4.2.1 Added ALR111 and ALR112 communication modules
Added FA-M3 Communication Package (for ALR111, ALR112 and ACM71), Modbus Communication Package (for ALR111 and ALR112) and MELSEC Communication Package (for ALR111 and ALR112)
 - 5. Added Advanced Control Functions
 - 6.2 Deleted Exchanging Data with Windows Application (item 5.2.2 of 3rd Edition) and Reusable Engineering Data (item 5.2.3 of 3rd Edition)
 - 6.4.2 Added system-specific status character string viewer, global switch, trend record, trend display pen assignment and unit common block to List of Builder Program
 - 6.5 Added Snapshot Functions
 - 6.6 Revised figure showing Self-Documentation for Function Block Detail Definitions
 - 7.1 Added ISA S88.01 requirement to description of Support for Multiple Product
 - 7.2 Added note 1 regarding master recipe creation to figure showing Flow of CS Batch 3000
Revised description of (4) Batch results acquisition of Process Management Functions
 - 8.2 Added Search Functions and Favorites
 - 9. Added Plant Resource Manager (PRM)

Nov. 2001/5th Edition

For all sections Corresponded to R3.02.

- 2. Added Enhanced FCS.
- 2.2 Added description that tags can be monitored up to 1,000,000.
- 2.5 Added AAP149 Pulse Input Module for Compatible PM1 and ALE111 Ethernet Communication Module.
- 3.3.5 Added display buttons for each alarm priority level.
- 3.4.9 Added Advanced alarm Filter Function.
- 4.2 Added subsystems supported by Ethernet communication; FA-M3, PLC-5, SLC 500 and MELSEC.
- 9. Revised description of Plant Resource Management.
- 10. Added FDA: 21 CFR Part 11 Compliant Function.

Sep. 2002/6th Edition

All sections Revised in line with system version upgrade to R3.03.

Descriptions for Windows XP support added.

Introduction "CRT" deleted.

Trademark acknowledgments revised.

- 1.4.3 Number of OPC Foundation participants revised to 200.
"Windows NT-version" deleted from "Exapilot Windows NT-version" in the figure of Exaopc.
- 2.2 "V net" in the figure of a large system configuration changed to "HF-bus."
- 2.3.1 "18-inch LCD/" added to the figure of an enclosed display style console.
- 2.4 KFCS2 and LFCS2 added.
- 2.4.1 Description for the maximum number of node units per KFCS2 added.
- 2.5.1 AI143 and AAI543 field-to-system isolated, point-to-point non-isolated modules added.
AST143, ASR133, ASD143, ASD533 modules with built-in barriers added.
- 2.5.2 "RTS" changed to "RTD" (resistance temperature detector).
- 2.10 Description for compliance to US standards deleted.
- 3 "LCD/" added to "CRT" for an enclosed display style console.
- 3.1 "Remote Desktop Function," "Configured Information Reference Function," and "Consolidated Historical Message Viewer" added to the figure of configuration of operation and monitoring functions. "Advanced Alarm Filter Functions" moved to a different position.
- 3.2 "Alarm handling" changed to "Alarm processing."
- 3.2.10 "Alarm handling" changed to "Alarm processing."
- 3.3.1 Instrument faceplate of a timer block changed.
Figure of the graphic window showing overview objects changed.
- 3.4 Voice messaging functions, advanced alarm filter functions, and remote desktop function added to operation and monitoring support functions.
- 3.4.10 Page for the remote desktop function added.
- 3.5.4 Figure of the HIS setting window revised.
- 3.11 Page for the configured information reference function added.
- 3.12 Page for Consolidated Historical Message Viewer added.
- 4.1.8 A list of enhanced motor control and switch instrument blocks added.
- 8.3 "Helper package" changed to "PLUG-IN application."

Oct. 2003/7th Edition

For all sections Corresponded to R3.04

- 1.4 Moved to Chapter 15
- 1.4.1 Descriptions on Exaplog deleted
- 2 Figure CENTUM CS 3000 System Configuration (Basic) and Figure CENTUM CS 3000 System Configuration revised
- 2.1 Compact FCS for FIO added
Generic Subsystem Gateway Package added
- 2.2 Figure Example of Large System Configuration revised
- 2.3.1 Descriptions on Enclosed Display Style Console Type HIS with 21-inch CRT and Open Display Style Console Type HIS with 15-inch LCD deleted
- 2.4 Compact FCS for FIO added
- 2.4.1 FCU Configuration in FFCS added
Mounting of FFCS added
- 2.5.1 AAV144, AAV544, and ALP111 added
- 2.6.1 Descriptions on V net revised
- 2.7 Notes on Fieldbus Connection (FCS for FIO) added
- 2.8.2 Redundancy and Reliability of the Compact FCS for FIO added
- 2.8.3 Moved from 2.8.2
- 2.9 Descriptions on CPU Failure revised
- 2.11 Time Management added
- 3.2.1 Figure Operation Keyboard revised
- 3.5.4 Figure HIS Setting Window revised
- 4.1 Figure Configuration of FCS Control Functions revised
- 4.1.8 Valve Pattern Monitors added
- 4.1.9 Offsite Block Functions added
- 4.1.10 Moved from 4.1.8
Function outline of List of Function Blocks added
- 4.1.11 Process Input/Output and Software Input/Output added
- 5 4.2 Subsystem Communication Functions revised and moved to Chapter 5
Generic Subsystem Gateway Package (GSGW) added
- 6.5 Descriptions on Receiving Communications from Other Stations revised
- 7 Moved from Chapter 5
- 8 Moved from Chapter 7
- 10 Table Optional Packages and Responses in Individual Group Functions added
Figure Example of a System Configuration revised
- 10.2 Table Clauses Regarding Data Integrity and Solution in CENTUM CS 3000 revised
- 11 Moved from Chapter 8
- 12 Sequence of Events Manager (SEM) Function added
- 13 Event Viewer Package added
- 14 Long-term Trend Historian Package (LTTH) added

Oct. 2004/8th Edition

For all sections Corresponded to R3.05

- 2.3.1 Console Type HIS with 18-inch LCD changed to LCD
- 2.5.1 AAP849 Analog Input/Output Module added
- 2.11.2 Accuracy of VEHICLE clock corrected
- 2.11.3 Time adjustment of a PC with ENG function deleted
- 3.1 Remote Operation and Monitoring Server Function added to configuration of Operation and Monitoring Functions
- 3.4.10 Benefits of Remote Desktop Function is Corrected
- 3.10 Remote Operation and Monitoring Server Function description added
- 4.1.10 Fieldbus simplified universal block added to faceplate blocks
- 6.8 Yokogawa Engineering Service replaced with our service section

March.2005/9th Edition

For all sections Corresponded to R3.06

- i Trademark added
- 2 "ProSafe" changed to "ProSafe-RS" in description of Safety instrumented system.
- 2.2.3 Description on Migration from CENTUM CS 1000 to CS 3000
- 2.4 PFC□-S/-E added to compact FCS for RIO
- 2.4.3 Compact FCS changed to compact FCS for RIO and PFC□-S/-E added
- 3.1 System Integration OPC Station added
- 3.1.4 Description on System Integration OPC Station added

- 6.9 Description on Coordination with SmartPlant Instrumentation added
- 6.10 Description on Device Panel Functions added

June 2006/10th Edition

General "Safety Instrumented System (ProSafe-RS)" was added in Chapter 7.

Cover Page The logo of ProSafe-RS was added under the logo of CS 3000 R3 in the upper right corner.

Introduction Descriptions of ProSafe-RS and safety instrumented system were added.

- 1.3 Description of a safety instrument system was added.
- 1.3.6 Section 1.3.6, "Improved Security and Safety for Plants" was newly added.
- 2.1 The position of ProSafe-RS was unified.
- 2.10 Description of functional safety was added.
- 3.2.10 Description of the process alarm window of the alarm processing function was revised.
- 3.3.5 Description of the process alarm window was revised.
- 3.5.1 SCS and SENG were added to the system status list display window.
- 3.5.2 Description of the system alarm window was revised.
- 3.5.4 Description of the SCS status display window was added.
- 7 "Safety Instrumented System (ProSafe-RS)" was added in Chapter 7 and subsequent chapter numbers were changed.

December 2006/11th Edition

Descriptions for ProSafe-RS R1.02 support was revised.

For all sections corresponded to R3.08

- 1.3.6 "Improved Security and Safety for Plants" was revised.
Description of "ProSafe-RS" was revised.
- 2.10 Description of functional safety was added.
- 3.15 "Versatile Terminal Service Application Portal(VTSPortal)" was newly added
- 3.16 "Consolidated Alarm Management Software for Human Interface Station (CAMS for HIS)" was newly added.
- 7 "Safety Instrumented System (ProSafe-RS)"
Model was added or changed.
- 7.2.3 Hardware Configuration of SCS.
Figure "Hardware Configuration of SCS" was revised.
ESB bys (SNB10D) was added.
- 7.3.3 Security Levels
The explanation of "Security Levels" was added.
- 7.6 Comparison of HIS Operation and Monitoring
Table "Mapping Blocks and Elements" was revised.

Dec. 2007/12th Edition

General for ProSafe-RS R1.03

- 2.10 Marine Standards added to various standards
Error in Standards for Hazardous Location Equipment corrected
- 3.5.4 SCS Status Display Window
Link Trans Lock added to the Figure in
- 3.16 SCS added and corrected in System Configuration of Consolidated Alarm Management
- 7.2.1 System Overview
SCS Link Transmission added
Description in Products Related to Input/Output Modules revised
AKB651 added to Dedicated Cable
SED2D description added to Terminal Boards
Relay Boards description revised
Figure in Wiring Check Adapters changed
- 7.2.3 States and Operations of SCS
Forcing and Override
Grouping Override added to Table Differences between Forcing and Override
- 7.6 Comparison of HIS Operation and Monitoring
Table Mapping Blocks and Elements
Data Grouping Override added to Override from HIS
Table Software Input and Output That Can Be Used with SCS
Global switch supported by SCS

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