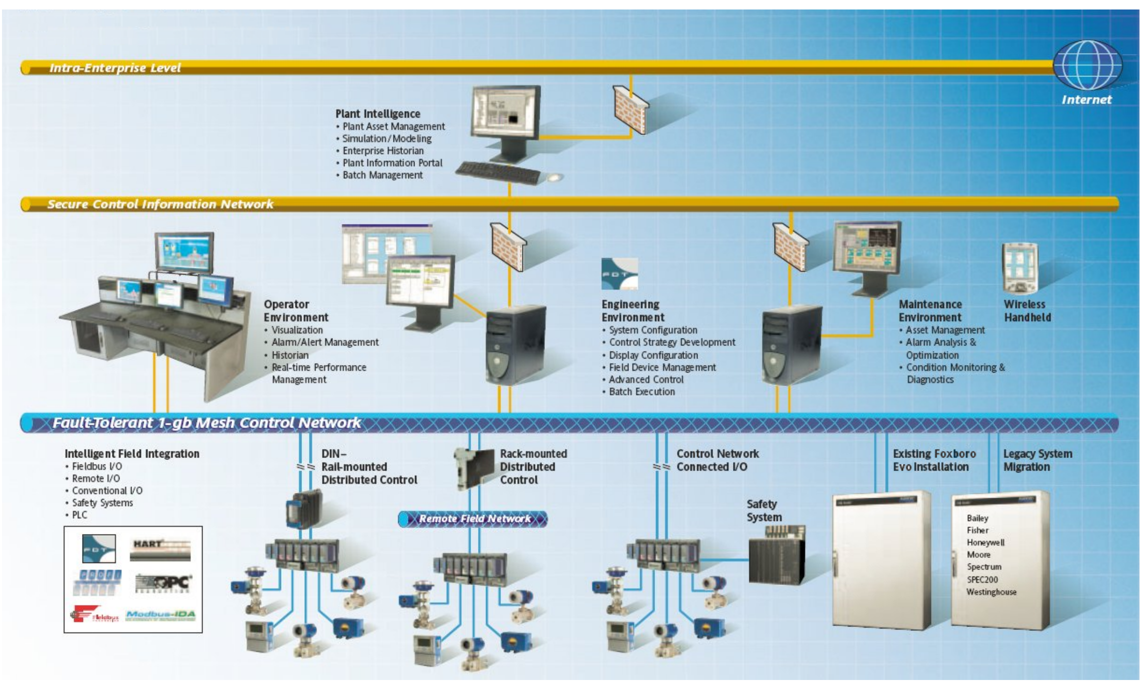
Foxboro™ DCS

Control Software with Foundation™ Fieldbus

PSS 41S-10FF

Product Specification

July 2019



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Legal Information

Features

The Control Software fieldbus solution delivers superior asset reliability and operational cost savings through features such as:

- An innovative device commissioning and downloading process that dramatically reduces the time it takes to get devices running at site. Thousands of device databases can be downloaded in a few hours instead of weeks.
- Superior device maintenance dashboards using an innovative combination of enhanced device descriptions (EDD) and EcoStruxure™ Foxboro™ DCS Field Device Tool (FDT) Device Type Managers to improve the capability to diagnose and troubleshoot poorly performing field devices.
- Full support for mixtures of function blocks in the field devices (Control in the Field) and function blocks in the host (Control in the Host). The Foxboro DCS function blocks in the host can provide the powerful features and connectivity for sophisticated control strategies while the function blocks in the field devices can be used for flow and pressure PID control where latency must be kept to a minimum.
- Excellent uptime whether PID control is placed in the host or in the field devices, through a highly available and robust Control Processor and EcoStruxure™ Foxboro Fieldbus Modules (FBM) subsystem
- A unique data caching mechanism which provides faster completion of operator views and setpoint changes to fieldbus function blocks

And with the Foxboro Fieldbus solution, you have dramatically lower capital expenditures through:

- Reducing the cost of field wiring
- Reducing or eliminating marshalling cabinets
- Minimizing installation costs through a smaller system footprint.

System Architecture for Foundation™ Fieldbus

Foundation™ Fieldbus provides significant reductions in installation effort and cost. Formerly, this advantage was offset by the complexity of configuring and managing Foundation™ Fieldbus enabled field devices. The EcoStruxure™ Foxboro™ DCS Control Software reduces this complexity and makes installation very simple.

The core hardware elements of the system include the Control Processors (CP270s or later processors), the 200 Series FBM I/O subsystems, and the EcoStruxure™ Foxboro DCS Control Network for control communications. Different types of FBMs allow customers to mix and match the interfaces used to connect sensors, actuators, and field subsystems to the CP270 or later processor. Many customers combine Foundation Fieldbus, HART, PROFIBUS and 4-20mA instrumentation on the same system. FBM228 hardware is used to connect Foundation Fieldbus H1 segments. The FBM228 has four H1 ports, each capable of supporting a maximum of 16 devices. All components are offered in dual redundant configurations to tolerate hardware faults.

The EcoStruxure™ Foxboro DCS Control Editors and Field Device Expert for Foundation Fieldbus provide engineering and management tools to configure, tag, download, diagnose and replace fieldbus instrumentation.

The System Manager monitors the health of the entire system and the field devices attached to it. You use the System Manager to perform various service operations, issuing commands to system or device components. For example, you can take a component off-line, enable and disable alarming, request firmware image updates and initiate a reboot. The System Manager is the high-level health monitor and alert mechanism for instrumentation and fieldbus devices. Should a serious problem occur in a device, the System Manager generates a visual and audible alarm. After you silence the alarm, you can check the overall status of the device in a System Manager display. If the device warrants maintenance, Field Device Expert enables the maintenance person to comprehensively test and examine the device to determine best maintenance action. During startup and device replacement, the System Manager is used to perform service operations such as commanding devices to go off control before replacement and to go on control after device commissioning.

There are many other Control Software components that can be part of a EcoStruxure™ Foxboro™ DCS system fieldbus solution, whether for automation, optimization, planning, or enterprise integration. These include:

- Avantis.Pro™ software for asset reliability and performance management
- Active Factory™ software for analysis and reporting
- Information Server to aggregate and present production and performance data over the web
- EcoStruxure™ Foxboro DCS Control HMI or EcoStruxure™ Foxboro™ DCS FoxView software for operator graphics
- The Control Software Collaboration Walls for a large shared viewing surface
- IntellaTrac® software as a mobile workforce system
- ROMeo® modeling for online optimization

Foundation Fieldbus Cost Benefits

Fieldbus technology provides several key installed cost benefits compared to conventional 4-20 mA technology.

Wiring Savings

Fieldbus uses a multi-drop wiring architecture. Each instrument drops off a nearby device coupler via a spur cable. One or more device couplers connect via a trunk cable back to the FBM228 fieldbus interface card. One shared trunk cable is used compared to many individual cables necessary in a 4-20 mA system, reducing cable purchased cost. And with far fewer connections to make, installation and labor costs are also reduced. The more devices sharing a common trunk cable, the greater the wiring savings.

Cabinet and Space Savings

A 4-20 mA system requires considerable cabinet space to accommodate the many instrument cables. Marshalling cabinets are frequently used to mate the cables run from the field to the correct connectors on the I/O subsystem.

Fieldbus requires far less space in the cabinets for routing and attaching the shared fieldbus trunk cables. And in most applications fieldbus signals do not require marshalling cabinets.

Reductions in Maintenance

Studies show that about 60% of the maintenance effort expended on conventional instrumentation is wasted. Too often operations claims an instrument is faulty, but when it is checked out, nothing is wrong. Time is wasted in calibrating 4-20 mA instruments that drift. And time is wasted running scheduled periodic inspections.

With fieldbus, predictive maintenance practices may be used instead. An instrument will proactively indicate that it has a performance issue or serious fault, or that it has exceeded service warning limits.

Then the maintenance staff has at its disposal many computer-based tools to diagnose symptoms and determine the best corrective maintenance action or repair.

Commissioning

Loop checks on 4-20 mA instrumentation require multi-person teams, split between field and control room locations, to make sure the correct instrument is properly functioning and connected to the right wires.

Fieldbus reduces both time and the number of people necessary to commission a field device. The wiring check is simpler. The instrument identifies itself when attached so a complex ring-out of the wiring is not required. It is easier to make sure the right instrument is in the right place as the device provides a device identification number, tag, and manufacturer and model number.

Robust Hardware, Superior Uptime

Whether control is executed in the host or the field device, it is important to have a system that is durable and runs non-stop.

Like other 200 Series FBMs, the FBM228 Foundation Fieldbus interface module is ruggedly packaged. Anodized aluminum housings provide heat sinking so modules need no ventilation holes, operate over a wide temperature range (-20° C to 70° C (-4°

F to 158° F)) and can be mounted either vertically or horizontally. The FBM228 may mount in Zone 2 and Division 2 hazardous areas. As the FBM does not require vented enclosures, cabinets may be mounted in harsh G3 environments where high humidity and corrosive contaminants are present.

The FBM228 is often installed in a redundant configuration in which the module pair manages redundant operation through a dedicated high-speed interlink. The coupled pair responds as a unit to the control processor, so redundancy carries no performance penalty. Switchover upon module failure is fast and highly transparent since state information is shared rapidly over the dedicated high-speed interlink.

Schneider Electric offers a wide selection of rugged connectivity solutions between the FBM228 and the field devices, based on experience working with all major suppliers of fieldbus power supplies, device couplers, field barriers, and physical layer diagnostic modules. Increased reliability of the physical connections between the FBM and power supplies is offered both by solutions that mount the FBM and power supplies on a common carrier, or ones using a prefabricated cable between the FBM and power supplies. Increased reliability of the H1 segments is available through a solution offering a redundancy adapter for FBM connection to a redundant H1 cable system with a ring topology.

High Performance Fieldbus Interface

Maximizing the number of field devices per H1 segment is one way to realize dramatic reductions in installed cost. So Foxboro designed the FBM228 with numerous high-capacity features. The FBM was designed with high capacity for fieldbus communications. Each segment may use up to 96 resource, transducer, or function blocks distributed among the field devices. The function blocks can utilize up to 64 publisher/subscriber VCRs. If desired multiple point input blocks, for example on temperature multiplexers, can be configured to read all eight points more efficiently with a single client/server view, in lieu of eight individual publisher/subscriber VCRs. In addition to providing the client/server support for all of the above, the FBM228 provides up to 32 other client/server connections dedicated to a read/write interface to DCI blocks for such purposes as reading diagnostic parameters from transducer blocks and making that data available to asset management packages, operator displays, historians, and other users of Object Manager data.

Redundant FBM228s insure that each H1 segment is always under the supervision of a link active scheduler (LAS). When a redundant pair of FBMs is used, one module provides the first LAS, and the second module of the pair provides a backup LAS. The FM228 also supports designation of several field devices as link masters, so they can take over the LAS role for their respective segments in the unlikely event both FBM modules fail. As soon as a device is connected to a segment, the FBM automatically insures it matches its configured class of operation, whether basic or link master. For example, if you have configured the system to use the device in basic class but it arrives as link master, the FBM automatically sets the class and reboots the device to activate the class change.

Fieldbus makes a wealth of information available from each device, so it is important the system is responsive to both operational and maintenance users. The FBM reads the full dynamic view from each block that is being used within the device at a user-configured interval, which is defaulted to every 10 seconds. The system is smart enough that if the block is not used, the information is not scanned. Should the static configuration data of a block be changed, the FBM reads the entire static view of the block. You can configure additional diagnostic information to be scanned periodically from the device. For example, you scan valve positioner diagnostic warning conditions bits such as when a valve has exceeded warning limits for distance traveled and the number of valve reversals of lower air supply warning limit. Maintenance practices can become proactive to early warning signs of degrading health, rather than being reactive to catastrophic failure.

No one likes waiting for data to appear when opening a display showing device-resident data. Therefore, the CP270 is designed to cache the view data and diagnostic data described above. That way as soon as the display is opened, the user can see the readings from the last scan.

Control in the Field (CIF) Capability

Figure 1 - Block Diagram Typical CIF Loop

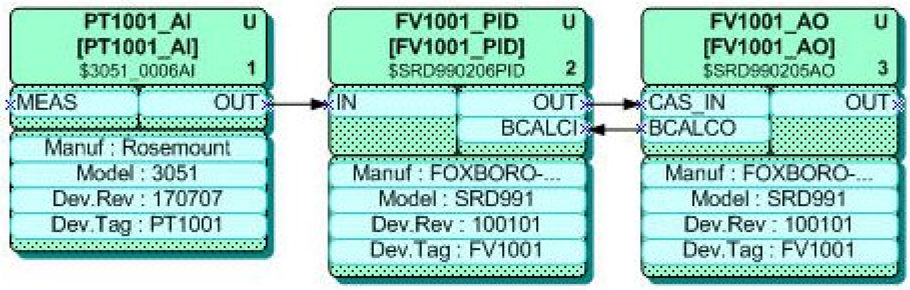
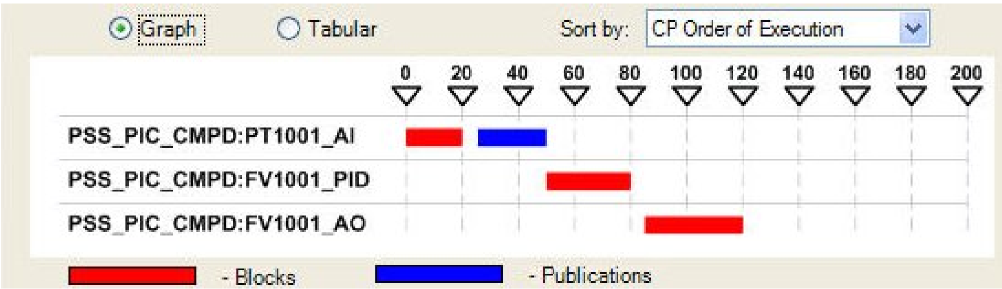


Figure 2 - Schedule for Single CIF Loop



The Foxboro DCS system supports execution of a wide variety of function block types within the field devices. Control-in-the-Field (CIF) loops using fieldbus devices can significantly improve the performance of PID loops used for processes having short time constants, such as pressure and flow loops. It is possible to schedule the AI, PID and AO function blocks to execute adjacent to one another in tight succession. For example, in the schedule diagram in Figure 2, the elapsed time between beginning of execution of the AI block and completion of the AO block execution is only 120 milliseconds.

In contrast, when executing Control-in-the-Host (CIH) through PID and other function blocks within the EcoStruxure™ Foxboro DCS FCP280 or CP270 processor, latency is added moving the measured variable to the control processor PID block, and moving the PID output to the AO block in a field device. Between these two scenarios, CIF offers these advantages over CIH:

- Ability to more aggressively tune the controller
- Less jitter in the control valve
- Less integrated absolute error between the setpoint and process variable over time.

Another advantage of CIF over CIH is that the number of published variables on the fieldbus segment may be reduced, freeing up macrocycle time so you can run loops more quickly or utilize more devices on a segment. When the PID block is placed in the control processor, the Control processor publishes to the setpoint of the AO block and the AO block publishes the true valve position to the system as feedback. With CIF, where both the PID and AO blocks may be placed in the same field device, the system defaults to not publish the PID output to the AO block externally on the segment. However, there is an option to publish these intra-device connections. Although doing so increases bus loading, it improves the update frequency to the system and makes PID manual adjustment more responsive to the operator.

When using CIF, it is important that the Link Active Scheduling (LAS) function be backed up via another link master device, as an active LAS is necessary to issue compel data commands to initiate data publication on the segment. Devices must be configured to be a link master if they are to become the LAS. The FBM is always a link master. Most often the system is engineered to use a redundant pair of FBMs, thus providing two devices capable of being the LAS. Additional instruments may be set up as link masters to provide third (and if desired, fourth) backups on their respective segments. The manufacturer and model of any devices used as link masters should be chosen carefully. Some devices may not have adequate memory, and sequence and sub-schedule capabilities to hold the schedule. And some devices may not have the same speed as the FBM228, which enables you to minimize delays between compel data messages and published replies. The Control Software provides an on-demand test feature that may be used during system testing to make sure devices properly fulfill their obligations as a backup LAS. Device configuration is defaulted to be Basic rather than Link Master, as too many Link Masters on a segment is not a benefit. When a device is first attached to the FBM, the FBM automatically sets and reboots the device as necessary to ensure it matches its intended role.

The Control Editors include dedicated built-in block templates for the most often used block types in the field devices:

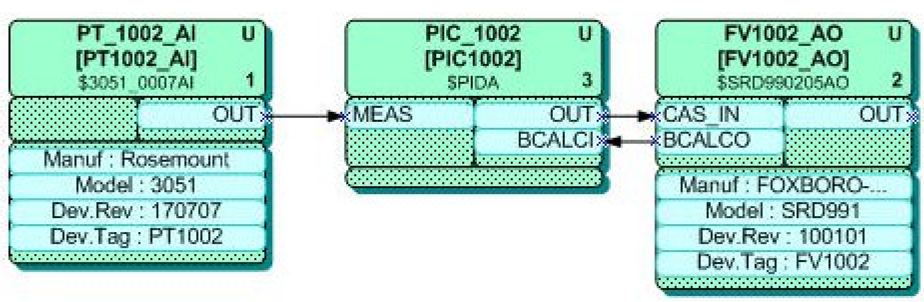
AI	AO	PID
MAI	MAO	DI
DO	MDI	MDO

All other blocks are supported by a universal Foundation Fieldbus block template, named UNIVFF. Block templated with UNIVFF include: Input Selector, Control Selector, Output Splitter, Signal Characterizer, Arithmetic, Lead/lag, Deadtime, Integrator, Set Point Ramp Generator, Timer, Manual Loader, Bias/Gain, and custom function blocks. The Control Software supports templating of any and all blocks described in the DD/CFF file, including instantiable blocks.

When using CIH, data for operational graphics on the control function blocks is communicated directly between the control processor and the operator workstation. When using CIF, however, such data must pass through both the control processor and the FBM. The Foxboro control processor caches all dynamic data read when the FBM reads client/server views of a function block. The user may configure how frequently such views are read, the default being every 10 seconds. The FBM is aware of the block type from the template, so dynamic data specific to standard parameters of that block type is cached. Static data for all standard parameters is cached when the block is configured. With cached data, when an operator graphic or faceplate is opened recent data can be displayed instantly.

Control in the Host (CIH) Capability

Figure 3 - Block Diagram Typical CIH Loop



With fieldbus, the input and output function blocks are always located in the field devices. Engineers have the flexibility to decide whether to locate the control blocks in the field devices, in the control processor, or most commonly combinations of both.

While CIF gives simple pressure and flow loops good performance, CIH may be preferred on many other types of control strategies. Benefits of using control in the host include:

- Ability to create more complex loops
- Consistency of function blocks algorithms
- Easier PID tuning
- More block functionality for batch, sequence and supervisory control.

Power for Complex Loops

CIH features enable construction of more complex and sophisticated control loops than CIF. For performance reasons, it is practical to publish only a small number of parameters on an H1 segment. The number of connections between function blocks in different devices must be minimized, or it will become necessary to slow down the macrocycle or reduce the number of devices per segment. So the fieldbus block specifications were created in a fashion where many parameters in the fieldbus blocks are contained, that is, they cannot be connected to other blocks. The standard fieldbus PID block for example has only six connectable inputs and two connectable outputs.

In contrast, the Foxboro control processor control blocks have a wide variety of connectable parameters. The PIDA block, for example, has 51 connectable inputs and 27 connectable outputs. The user can create thousands of connections between function blocks within the domain of a control processor without any impact on performance or speed.

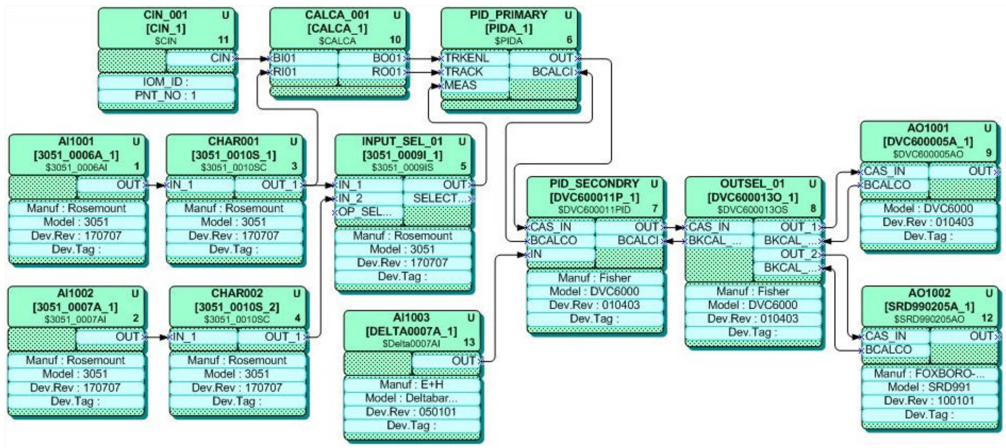
Another difference is in the scope of the loops. It is best if CIF loops are limited to the blocks and I/O points within a single segment. In comparison, the scope of a CIH loop can readily include any block or I/O point within the domain of a control processor.

With flexibility to decide where to put control function blocks, the approach taken by many users is to divide cascade loops, placing the primary loops in the host and the secondary loop where the speed is needed in the field devices.

Consistency of Algorithms

The typical project purchases field devices from many vendors. Although fieldbus specifies the profile of a block and its standard parameters, there can be considerable differences in algorithm features, behavior, and use of custom parameters among the blocks provided by device manufacturers. Control in the host will give a consistent full featured set of algorithms expressly designed to work with one another.

Figure 4 - Typical Mixed CIH and CIF loop



Easier PID Tuning

Control in the host offers easier tuning of control loops for three reasons:

1. All PID blocks in the host will use the same algorithm and tune in similar fashion. With CIF there can be a marked difference in the form of the PID algorithms from different device manufacturers. And the different forms will tune differently. Although there is no universal consensus, the names of the forms are often called ideal, parallel, and serial. The parallel and serial forms are sometimes called non-interacting and interacting respectively. Derivative and Integral interact with one another on serial form algorithms.
   While the fieldbus specifications identify that tuning terms should be expressed as gain, reset, and rate, device manufacturers are inconsistent in the implementation. One device may have reset as repeats per minute and another as repeats per second, or a third vendor may actually use the inverse as minutes per repeat.

2. Tuning the algorithms in the control processor is easier because there is almost no propagation delay from the entry of changes to the tuning constant changes. And trends can be created with very fast updates of the process variable, setpoint, and output to more accurately observe the loop response. With CIF delays in manipulating the tuning constants and observing the results on the trends can make tuning difficult.

3. With CIH, self-tuning capabilities are available. The Foxboro control processor self-tuning capabilities include a feedback block that can be attached to a PID permanently to run adaptively, or a single block can be moved from PID to PID to tune each loop and then be removed. A feedforward tuning block is also available. With CIF self-tuning capabilities are either not available or of limited consistency.

Fieldbus Made Easy

The Foxboro system is designed to increase productivity and make fieldbus easy to use throughout the plant lifecycle. Extensive tools for engineering, device commissioning, diagnostics and device repair/replacement are found within the combined Control Editors and Field Device Expert for Foundation Fieldbus toolset.

Built-In Fieldbus Expertise

The know-how of Foxboro DCS fieldbus experts built into the software includes the following:

- To have a successful fieldbus project, it is important that someone understands the unique features and functions in each model of field device used. Since not all users have such expertise, Field Device Expert captures the knowledge of the expert in a template. Then, other users without such expertise can simply use the template to automatically and properly configure most all block settings within the device. Templates are user-customizable by the expert on each project.
- Field Device Expert behaves like an expert in building the detailed schedule of block execution and data publishing on the H1 bus. The user simply configures a loop diagram with function blocks in proper execution sequence. Field Device Expert takes care of the rest.
- Configuring a device to be a Link Master is simple. A lead engineer picks which models of devices can be used as link masters. On those models a radio button allows setting a device as link master. The FBM then automatically takes care of setting the boot operational class of each device and rebooting each device as necessary as soon as the device is connected to the segment.

Fast Downloads

On any system the speed in deploying the configured parameter settings of the blocks from the host to the field device is naturally constrained by the fieldbus protocol and 31.25k bps speed of the H1 segment. But most systems require considerable human interaction in a procedure that is typically performed instrument by instrument. Just the act of downloading the configuration settings into the instruments can therefore require teams of persons, and total time on site can take weeks.

To compensate for this inherent limitation in fieldbus speed, Schneider Electric has taken a unique approach that uses an automated and massively parallel technique so configuration download activities can be occurring on all FBMs and all segments simultaneously without requiring instrument-by-instrument human supervision. Configuration data for all blocks used in the device is held in the control processor and FBM. Even custom configuration data is held, as the templates contain a list of custom parameters the user wishes to include in the download. The System Manager provides the ability to quickly enable control on multiple devices or single devices to place them into service. The FBM automatically downloads configuration information into the device when the tag and model type are correct and control is enabled.

Simulation Capability

An important consideration when using fieldbus is function block simulation capability prior to having instruments. Simulation occurs:

- For control engineers while developing and verifying control strategy design
- During factory acceptance testing of the system, when field devices are typically not present.

The Foxboro solution offers two function block simulation capabilities. For computer-based control strategy simulation, the FSIM Plus™ product allows control strategies engineered through the Control Editors and captured in save all format to be executed via PC-based simulation. Run/freeze and step capabilities enhance the engineer's ability to troubleshoot and spot issues. A tie-back process modeling facility enables closing the control loop.

The execution of fieldbus function blocks can also be simulated through execution of blocks in the control processor with a simulation option in each block.

Simulation capabilities are supported for the following fieldbus function blocks:

AI	AO	PID
MAI	MAO	DI
DO	MDI	MDO

System Upgrade Capabilities

The features described in this Product Specification Sheet can be added to older systems having CP270s and FBM228s through software and firmware upgrades. No new hardware is required.

Redundant FBM228 modules offer online image update capability between similar revisions. The newest CIF capabilities described here, however, change the software type of the FBM, and therefore an off-line upgrade is used for customers having older systems without CIF capabilities.

With fault-tolerant CP270s you can elect to perform either an online or offline upgrade. The online upgrade updates one module at a time, leaving the other module on control. The switchover results in only about a 1.5 second control interruption. The upgrade process takes about 1 to 5 minutes per module.

Device Replacement Capability

The Foxboro Fieldbus solution makes it extremely simple for a technician, even one without any fieldbus experience, to replace a failing or failed fieldbus instrument. The technician starts by halting control action with a simple command in the System Manager. The technician then opens the Device Preparation Wizard from the desired device tag in the Control Editors and tags the replacement device. The FBM then sets the device per the database as either a basic or link master device and writes all standard parameters to the blocks of the device plus custom parameters in the download list, exactly matching the database for the removed device. The technician then restores control action for the device through a menu selection in the System Manager.

Device Upgrade Capabilities

Device manufacturers frequently make changes to capabilities files, device description files, and device firmware. And when major device changes are made, the manufacturers often introduce new device revisions or models. The most common change is a correction or extension made to the capabilities and description files without a device revision. The updated description files can be added into the Schneider Electric system simply by a reinstall, overwriting the older files. The new description files are automatically linked to the lowest level template for that device model. Neither the device instances nor control strategies already configured are impacted.

Faultstate Handling

When control is placed in the host, the Foxboro DCS system provides control processor and FBM failsafe functionality to complement the faultstate functionality in the field devices. A failsafe timer in the FBM monitors communications from the control processor. If this timer expires because the FBM is not receiving new setpoints to send to the device, the FBM initiates the faultstate in the cascade connection to the device. The output block in the device retains its last output until its faultstate timer expires, and then the output changes to the configured faultstate value.

Lowering Operational Costs

As previously mentioned, fieldbus technology reduces capital expenditures through wiring savings, cabinet space savings, and elimination of marshalling cabinets. But the more significant cost benefit is that it can reduce operational expenditures and improve profitability year after year during system operation.

Fieldbus is able to provide more information about the process, in realtime. Multiple transducer capabilities are built into fieldbus so several process variables can be measured and transmitted by a single device. More realtime data delivered to plant personnel can lead to more informed decision making.

The largest operational savings in fieldbus have proven to be improving asset reliability and performance. Instead of maintenance being reactive after complete device failure has occurred, it is possible to proactively spot early degradation in device performance. When a proactive maintenance technique prevents loss of production, the economic payback can be enormous. A side benefit is that when degradation is detected early, maintenance can be conducted at lower cost at more opportune times.

The Foxboro DCS system goes beyond just providing more realtime measurement data. Devices also have a wealth of diagnostic data. Realtime collection of desired diagnostic data may be configured into the control processor. For example, it is possible to deliver all the following information from a valve positioner transducer block with regular realtime updates:

- Actual valve position
- Air supply pressure
- Number of valve reversals
- Valve travel distance

The diagnostic variables are accessed in the background via client/server updates at rates that are individually selectable for those diagnostic variables.

The early warning system for proactive maintenance is provided either by the built-in Needs Maintenance Soon alarm in the System Manager or by alarming on customized diagnostic data collection within the control processor.

The Field Device Expert then plays an important runtime role. It starts by allowing user customization of watch, trend, and diagnostic screens to optimize the presentation of relevant realtime data and diagnostic information. All that’s needed is a device description with basic functionality. The system automatically converts the description each time a view is opened to an FDT device type manager (DTM) format allowing Field Device Expert to render the user screen customization. Hyperlinks form a home page for the device provides access to an electronic notepad, manuals, specification sheets, repair procedures and other documentation useful in managing the device.

In addition, if the device manufacturer has put enhanced features into the device description (such as menus to display trend charts or gauges) those online displays are made available through the Enhanced EDD tab, presenting an online view of the device, designed by the device manufacturer.

Third, when the user selects the Vendor DTM tab, Field Device Expert opens the DTM created by the device manufacturer. DTMs are an open standard technology that allows device manufacturers to provide feature-rich and user-friendly PC human interfaces to diagnose and maintain their devices. For example, on valve positioners it is possible to view and exercise valve step and stroke tests or consolidate performance variables into powerful graphic representations.

Related Product Specification Sheets

For further details on Field Device Expert, refer to *Field Device Expert for Foundation Fieldbus* (PSS 41S-10FDMFF).

For detailed information about the FBM228, refer to *FBM228 FOUNDATION Fieldbus Redundant Interface Module for Control In the Field Applications* (PSS 31H-2Z28).

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