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Distributed Control Systems
for Industrial Automation

ABB



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PROCONTROL P

Analog and Binary Control, Boiler Protection,
Turbine Control, Engineering, Diagnosis



ABB

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PROCONTROL P – forward looking, innovative

PROCONTROL P is a digital process control system which combines innovation and broad functionality with established operational reliability.

Development of the PROCONTROL P power plant control system is ongoing with the aim of further improving

- Cost-effectiveness
- Functionality
- Quality

PROCONTROL P's renowned flexibility makes it suitable for all applications from the smallest local control to a comprehensive system for a large generation unit. Examples for the many successful types of application are heating power plants, refuse incineration plants, industrial power plants, flue-gas scrubbing plants and water treatment plants.

PROCONTROL P is intended as a total system solution which is open for the integration of existing systems. It is thus especially suited for retrofitting and refurbishing existing plants.

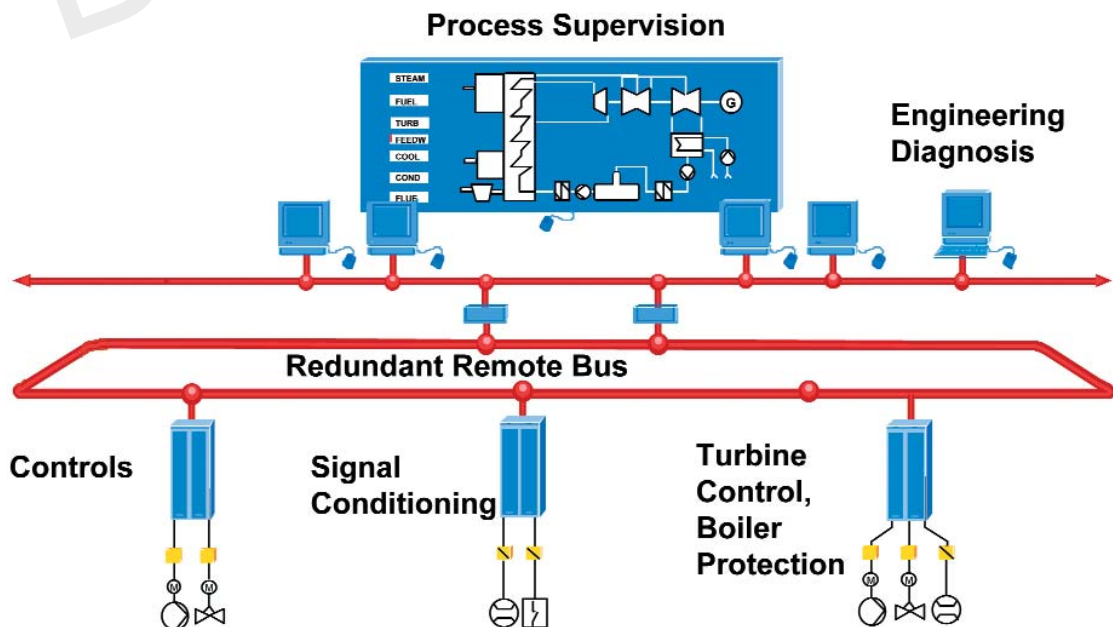
The system solution PROCONTROL P includes:

- I&C system
- Engineering System
- Erection, commissioning service and training tools
- Computer-based documentation

The exchange of data between the various components of the control and communication system takes place via a powerful fibre remote bus conforming to the FDDI standard.

The advantages of PROCONTROL P for the users are:

- Uniform overall system for all control functions
- Simple straightforward structure and function which is easy to handle and operate
- Fully adaptable to the safety, availability and commercial requirements of the process
- Uncomplicated access to all data
- System modification and expansion without interaction with existing modules
- Computer based documentation generation and management
- Maximized availability due to self-monitoring and diagnostic functions
- Forward-looking innovative system



System configuration

I&C Components

Stations:

All-rounder or specialist

A station accommodates the instrumentation and control modules (I&C) and the coupling modules for man/ machine interface (MMI) and external systems (e.g. programmable logic controllers, process control systems etc.). The station bus coupler connects the station to the remote bus. The connection to the remote bus is optional and the station can operate in a stand-alone mode.



Racks within a station

The main features of a station: Modular structure with little basic equipment making the system scalable, from the smallest control task to control systems for large-sized plants.

- The control modules process the information independently (multiprocessor system). Heart of the latest developments like the module 83SR52 is a 32bit MC68340 processor.
- Central units are not required to perform control system tasks.
- I/O modules have their own microprocessors which makes signal acquisition and conditioning more efficient.
- Unrestricted availability of all measured process variables in real-time.
- All data transferred within a station are also available on the remote bus for other units in real-time. Conversely, every station has access to all the data on the remote bus. This principle of all data being universally available ensures absolute flexibility with regard to modifications and system expansion. System maintenance is also simpler.
- The independent features of all units and modules permit that they can be distributed between different stations to suit the requirements and possibilities on site.

Perfectly simple: In duplicate

PROCONTROL P needs basically only two types of modules to perform all the signal conditioning and binary and analog control tasks - the universal input module and the binary and analog control module. These two modules alone cover 80% of all power plant control functions. The result is a control system with a clear structure, lower costs for stocking spares and simpler maintenance.

The programmable universal input module includes many features which were simply not available before. All types of transmitters used in power plants can be connected to it. These include for example analog transmitters with an impressed current in the range of 4-20 mA and binary transmitters with integrated NAMUR initiators (DIN 19234).

The input module diagnoses the status of each transmitter, e.g. to detect loss of voltage, short circuit to ground, or wire breaks in process and transmitter wiring. The results of the diagnosis are transferred together with the value of the measured variable.

For each measured variable, the input module can monitor up to four limit values. The permissible limits of a variable are therefore monitored where they should be, as part of the signal conditioning and preprocessing function.

The input module accurately linearizes signals from non-linear transmitters such as thermocouples. The values of the measured variables and the type of transmitter can be freely programmed on-line for every input signal.



PROCONTROL P input module

The programmable universal controller is used for all binary and analog control functions. The programming determines whether the controller has to control a drive, a function group, a discrete regulation task or a complex processing function.

**Standard interfaces:
Milestones on the road
to open communication**

Interfaces are available for connecting to other control systems and automation devices.

Interfaces are needed wherever different system processes such as programmable logic controllers (PLCs), process control systems, coupling PCs and modems using different interfaces and communication protocols are installed in a power plant.

As a consequence of having to couple many third-party systems to the PROCONTROL P bus over the years, a whole range of interfaces covering a wide range of requirements is available.

Data Transfer

The data transfer system: Open to all suggestions

Stations are connected to the remote bus with no reactive effects. The station bus and the remote bus form a single homogeneous communication system and all process signal changes are available in real-time on the station bus for every station. This unique feature of the system enables related functions such as signal acquisition, signal conditioning and binary and analog control to be either located together in one station (stand-alone system) or distributed between different stations (according to control functions). Therefore there are no restrictions on the location of modules and any free slot can be used. This makes PROCONTROL P, amongst other things, especially suitable for refurbishing existing power plants.

Subsequent expansion of existing control systems can be achieved simply without having to shut the system down and without encountering problems with interaction between modules.

Remote bus

The high-speed remote bus is based on the FDDI (Fiber Distributed Data Interface) token ring system according to ISO 9314. It is connected to the station buses via remote bus coupling modules. Optical fiber cables are used for the actual connections. These are firstly insensitive to electromagnetic interference and secondly are suitable for maximum distances of 2000 m between stations, at a data transfer rate of 100 Mbits/s. Maximum network sizes of up to 100 km can thus be achieved.

The FDDI network is in the form of a double ring. The remote bus does not require any common central components and is therefore capable of restructuring the system and maintaining communication in the event of a fault such as the interruption of one of the cables. In this way it fulfils the highest demands with respect to availability.

Station bus

The station bus is confined to a station and links the I/O and processing modules to the system. It comprises backplane p.c.b.s on all the racks, which are connected together.

Diagnosis

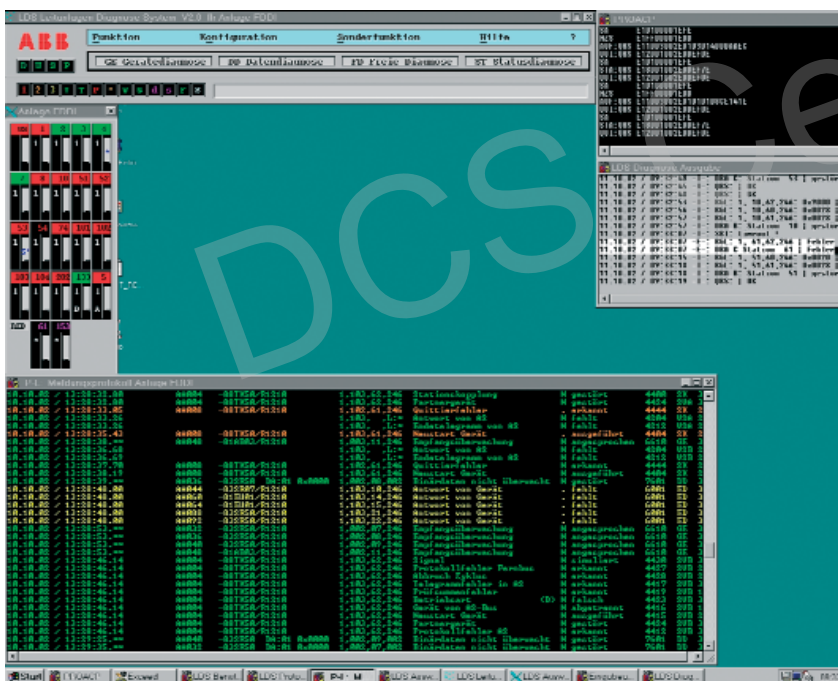
Control system diagnosis: Down to the smallest detail

The control diagnostic system (CDS) makes use of the special PROCONTROL P features, for example, every I/O modules has its own microprocessor and is therefore independent and able to monitor and diagnose itself. These functions are active as soon as a module is inserted into its rack. Also all process data are available via the bus to all other system modules. Thus without having to be configured, CDS is able to recognize all the modules in the system and display them graphically together with their current statuses.

Every I/O module communicates its status data, type and location. From this information, CDS generates the control system graphically on the screen and shows all the cabinets. Cabinets can be individually identified and their states seen from their colors.

Clicking on a cabinet "opens" its door and shows the modules in their racks as in reality. Clicking a second time displays the current contents of the register in a module. As soon as a failure occurs CDS guides the user by highlighting the cabinet, module and register concerned and by displaying a description of the cause. CDS also provides an on-line recommendation for corrective action. CDS includes a report function for analyzing control system and process disturbance such as the crossing of a limit value. Recorded data can be filtered for a period of time, components and type disturbances.

CDS' clear graphic displays enable a comprehensive diagnosis down to the transmitter level without having to be specially configured. It is thus a valuable instrument for efficiently diagnosing and correcting disturbances.



Diagnosis Screen of CDS

Engineering, Documentation and Service for Power Plants

Many tasks - one system:

Engineering, documentation and service

PROCONTROL EDS is the engineering, documentation and service system for the PROCONTROL P power plant control system. It improves the engineering, commissioning and maintenance efficiency.

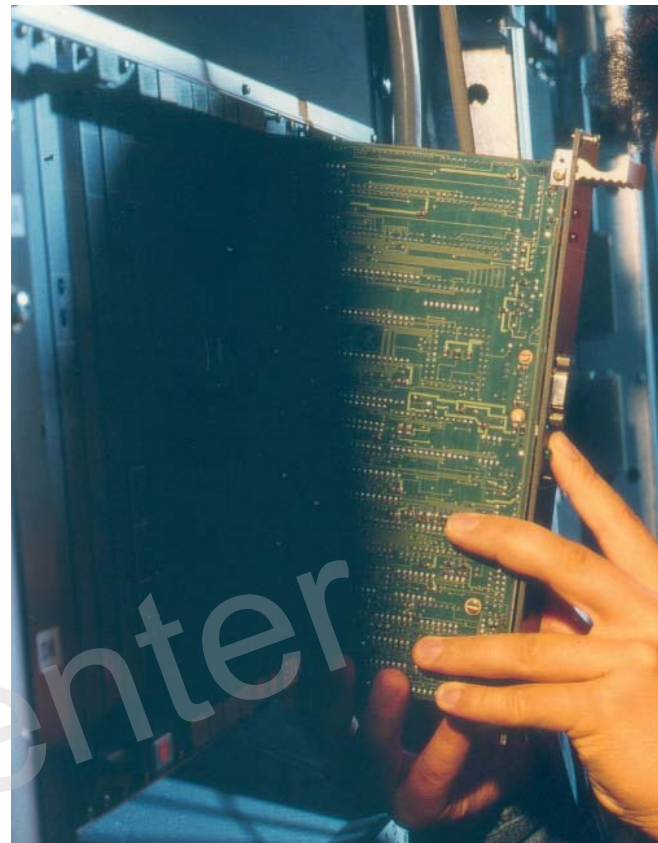
PROCONTROL EDS:

More than just function block programming

The engineering, documentation and service system PROCONTROL EDS is a tool for both internal and peripheral control components. It supports the engineering, commissioning and optimization of control system functions. Since it is directly connected to the PROCONTROL P bus, EDS has access to all the modules of the inner control system throughout the plant. A network links EDS to the process operator station.



Computer generated documentation



Exchange of PROCONTROL P modules during operation

The main tasks performed by EDS are:

- Data entry for the input and maintenance of measurement and drive data
- Generating and editing function charts for I&C functions
- Allocation of hardware (assignment of functions) and downloading of programs
- Debugging of function programs
- Printing of function charts as necessary

EDS provides function-oriented as well as implementation views. The power plant designation system e.g. the German KKS (tag name) is used to identify engineering items; any addresses or other specific control system data are not required. A function is selected by its designation and displayed graphically as a function chart on the screen. The user executes any changes directly in the function chart.



The function editor knows all the PROCONTROL P function blocks and the rules for connecting them. When generating a function using EDS, the user selects a function block and connects it to other function blocks by clicking on them with the mouse!

The computer then automatically arranges function blocks and their interconnections in the chart in relation to the syntax rules.

The data used by the function generator are also needed to program the control modules and to configure the communication systems. This principle ensures absolute consistency between the actual programming of the control system, the configuration of the communication systems and the associated documentation.

EDS automatically updates any other function charts and the connections to them which may be concerned. All cross-references are therefore always up-to-date and it is possible to navigate horizontally through the function charts by clicking on inputs and outputs.

The same applies when making modifications, i.e. EDS automatically updates the other function charts. Wrong connections are detected and rejected immediately an attempt is made to enter them.

On-line testing in function charts: Service made easy

Functions are commissioned with the aid of the debugger. The desired function is called by its tag name (e.g. KKS) upon which it appears on the screen as a function chart. It can be selected from the implementation-oriented view (cabinet, rack, modules) or from the function-oriented view showing the functions in their hierarchical relationship.

If the user wishes to observe the dynamic behavior of a signal, he simply clicks on it in the function chart. Because of the direct connection to the PROCONTROL P bus, EDS displays the values of the signals on-line in the function chart. It is not necessary to specify measuring points.

The following supplementary data can be displayed in the function charts:

- Logical "0" or "1" for binary signals
- Percentages for analog variables
- Physical units for measurements
- Signal error

Provision is also made for overwriting signals with values to be simulated for test purposes. All settings, limits and controller parameters in a function chart can be selected and changed if necessary.

Turbine Automation

Turbine control system: One of the families

The turbine control system comprises PROCONTROL P programmable logic components and includes functions for:

- Signal conditioning
- Protection
- Binary control
- Analog control
- Monitoring

Each of these functions has a clearly defined task while running up or shutting down the turbine and while operating in the load control mode.

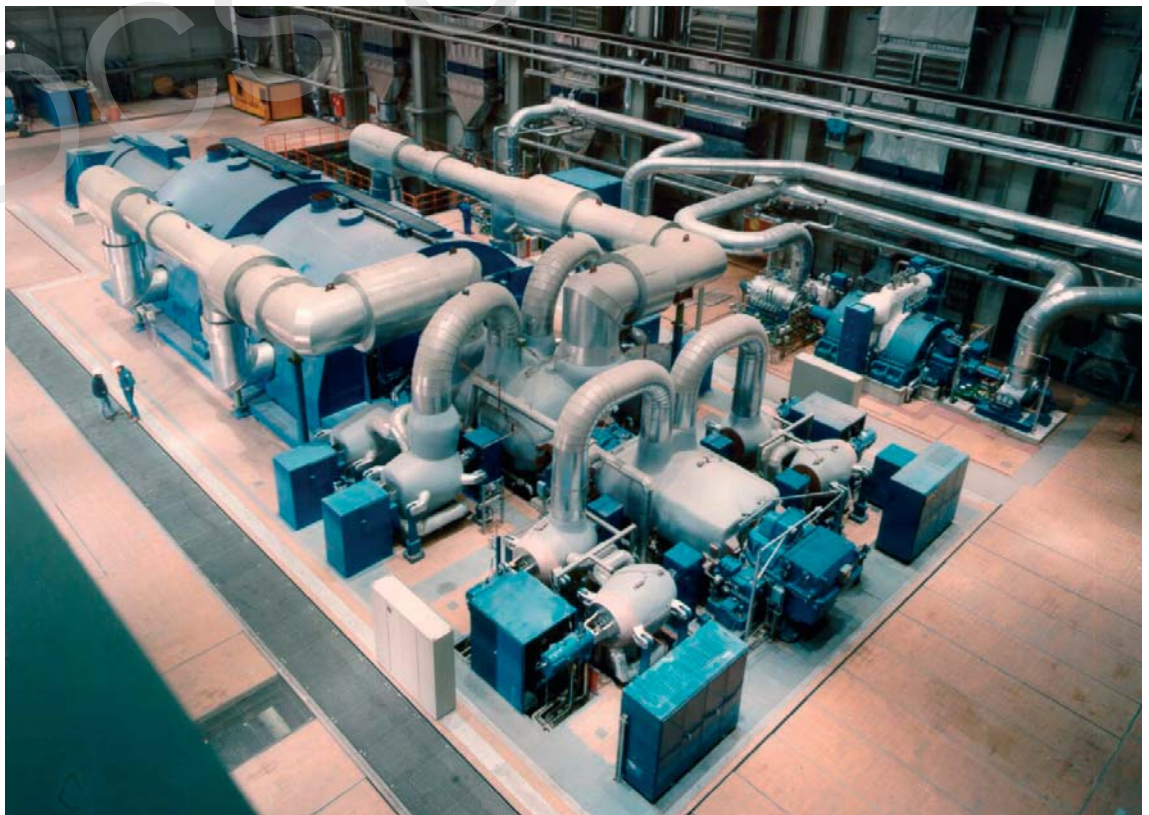
The measured variables are preprocessed in the electronic input circuits of the binary and analog control modules. PROCONTROL P components have also proved reliable for turbine protection.

As in the case with the other parts of the power plant control system, the turbine control system has a hierarchical structure and a functionally distributed layout. Control of the turbine is fully automatic.

The turbine regulator part of the steam turbine control system is designed to control small to medium-sized turbines mainly for industrial applications (TURBOTURN) as well as the large reheater turbines used by power utilities (TURBOTROL).

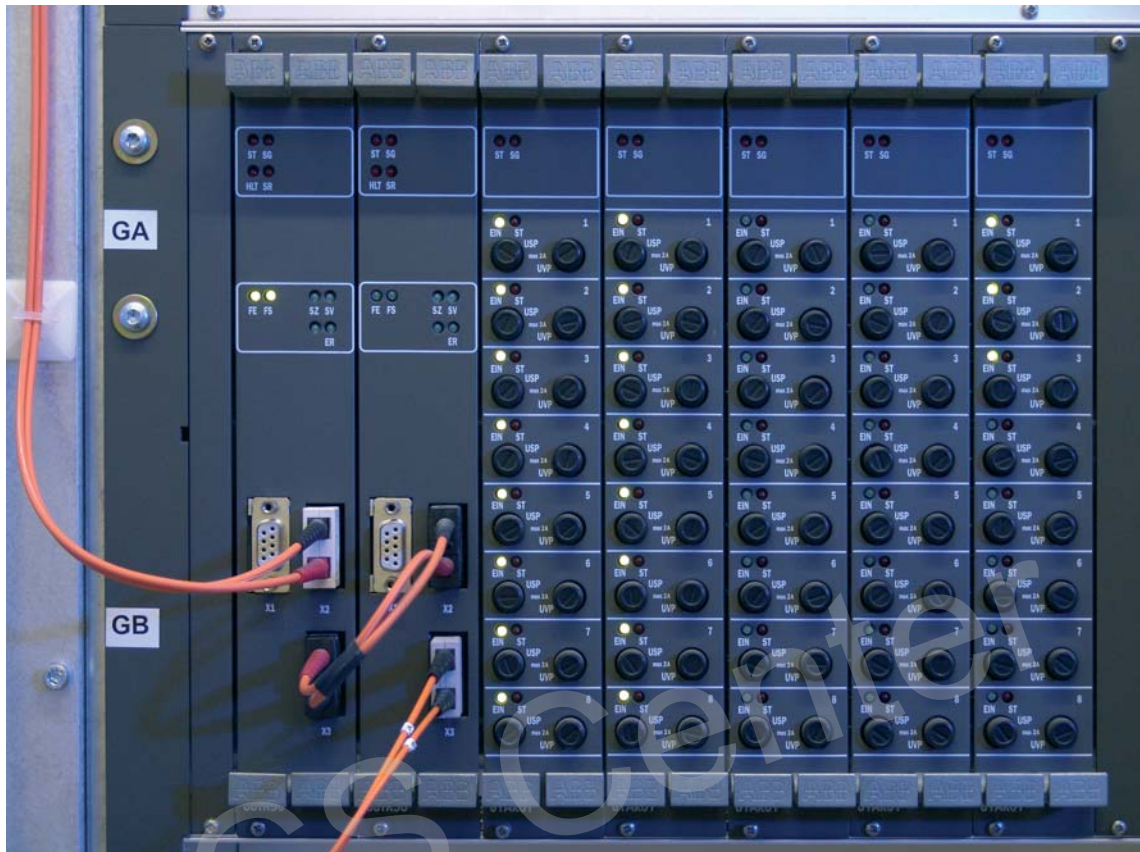
Highly adaptable standard modules enable a wide range of applications to be covered using standard, well-tried configurations. For example to raise the efficiency of power plants, it is becoming frequent practice to tap off a part of the steam between IP and LP turbines for district heating. The associated district heating controller can be implemented using TURBOTURN and as an extension to TURBOTROL.

The TURBOMAX system is for monitoring the thermal status of turbine parts while starting and during load changes ("load reserve computer"). TURBOMAX optimizes turbine control time with a minimum of stress on the module.



Steam turbine

Boiler Protection



PROCONTROL P boiler protection

PROCONTROL PF protection system: Programmed logic safety

The purpose of the protection system is to reliably prevent operating situations which represent a hazard for persons or plant. Safety-oriented control systems have the task of switching the process to a safe state before a potentially dangerous situation can become critical. At the same time safety-oriented control technology ensures a high level of operational availability of the facility in the best interest of the plant user.

PROCONTROL PF is a three-channel stored-program protection system allowing the implementation of safety-oriented applications.

It includes standard test functions for periodically testing all the protection system components such as:

- Input signals
- Input modules
- Output signals
- Tripping circuits

Even during testing, the protection system is in the active state in order to be able to effect emergency trips if need be.

The PROCONTROL FDDI bus provides non-interacting connection of PROCONTROL PF to all the plant control functions. All relevant data for archiving, diagnostics and operation are therefore available throughout the control system at all times. The use of field-proven modules of identical design requires no additional interfacing efforts and facilitates the diagnostic functions and maintenance activities.

Safety-relevant signals and circuits are generated, processed and tested within the protection system. The test routines for channels test the control functions without interfering with the control activities of the system.

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