

Modular Standardized Electrical and Control Solutions for Fast Track Projects



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Supporting fast track projects

ABB is the leading supplier of electrical and control equipment for power plants. The company offers a comprehensive range of products and services to cope with the needs of all spheres of operation and plant management. The portfolio comprises optimized solutions in process control and automation and the full range of electrical equipment.

In order to comply with the demands of present-day fast track power plant construction, many turnkey suppliers have developed a modular concept for the easy construction of power plants such as:

- concise plant engineering
- short construction times
- possibility for an easy expansion of the power plant
- consideration of site-specific conditions
- cost-effective erection
- economic operation

ABB with its long-standing experience of engineering and delivering electrical and control systems for power plants fits perfectly into this concept.

ABB supports fast track power plant projects by integrating major parts of the electrical and automation equipment in module containers. The equipment will be pre-assembled and pre-tested and thus after delivery of the modules to site, commissioning time can be significantly reduced while insuring high quality. ABB being a single-source supplier, provides all engineering, assembly, installation and commissioning services for the supply of the modules.



Pre-testing electrical and control equipment in the factory

Shipped in containers

Two main factors prompted the ABB engineers to turn to a modular structure for the electrical plant and control equipment in power generation plants.

- short schedules from contract award to handing over to the customer
- fully factory-tested assemblies, enabling plants to be erected and commissioned within a minimum of time and cost with high quality standards

The most common fast track projects in power generation are

- gas turbine and combined cycle power plants
- diesel power plants

A small number of containers is required for power generation plants. ABB is confident that the degree of flexibility achieved will enable the majority of customer wishes to be satisfied.

The containers are delivered separately to site where they are integrated into an electrical and control building module.



Fast shipping of pre-tested containerized electrical and control solutions

If a customer wants to install the modules in the power plant building, the containers stand on their bases in the building with container walls and ceiling removed. The bases are also used for cable laying.

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Inside a container with electrical equipment

Order handling

Time schedule for execution of power plant projects always is a critical issue. To meet this market requirement ABB offers:

- a high degree of advanced pre-engineering
- highly efficient production and testing and the associated project documentation
- a highly flexible adaptation of standard modules on stock to customer needs
- efficient project quality assurance, because all modules are completely factory tested.

Electrical and control solutions for gas turbine and combined cycle power plants

The requirements which have to be fulfilled by the electrical plant and the control system include the provision of equipment for starting up, operation, monitoring and protection of the turbo-alternator set, such as

- start-up and power transmission equipment
- excitation system and switchgear
- batteries, rectifiers and inverters for a dependable auxiliary supply.
- air-conditioning and ventilation systems
- fully automatic measuring and control equipment for startup, shutdown and operation and also operator control and supervision facilities
- protection equipment for the safety of personnel and plant
- factory-tested electrical plant and prefabricated control system modules to achieve short assembly and commissioning times on site

Plug and operate

ABB's containerized solution allows the full integration test of the electrical and control equipment at the factory instead of on site testing.

This includes:

- cabling
- electrical and control functionalities
- optimizing of turbine control systems using turbine simulators

As a result the containers just have to be connected to prepared interfaces on site thus reducing precious assembly and commissioning time.

Design of a typical installation

A typical design feature of many installations is the installation of a generator circuit breaker between the generator and the step-up power transformer and unit auxiliary transformer connected to the generator bus duct.

The generator is started under the control of the start-up system with the generator breaker open. The power for the start-up system and other auxiliary loads is drawn from the HV substation via the step-up transformer and the unit auxiliary transformer. As soon as the generator is running at rated voltage and frequency, it is synchronized and connected to the grid system. The auxiliary supply system provides power for auxiliary loads during start-up and shutdown, when on load, during system faults and at standstill. The auxiliary transformer is powered directly from the generator bus duct.

In order to ensure availability of power to certain essential loads associated with the protection of personnel and plant, a DC battery supply and an uninterruptible AC supply are also provided. The standardized electrical plant and control equipment are of modular design and accommodated in containers, complete with the associated air conditioning and ventilation systems.

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Integration of ABB and third party systems

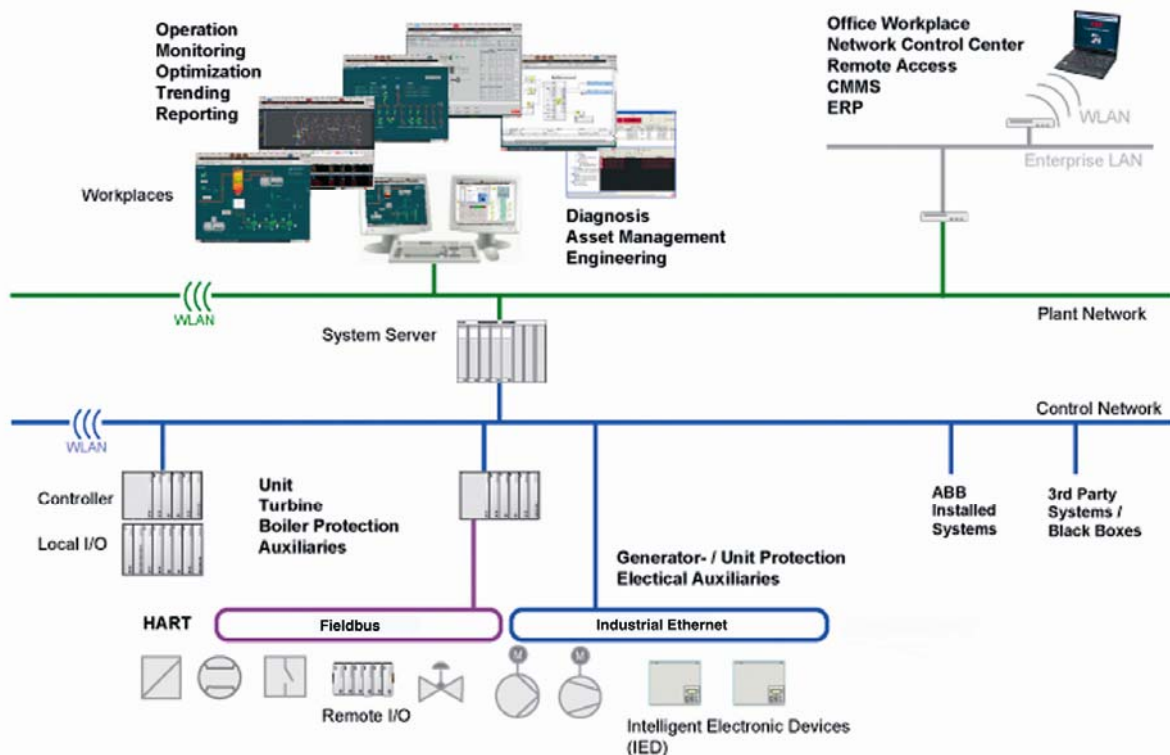
ABB is able to cover the complete range of electrical and control system. As system integrator ABB provides always systems consisting of fit-for-purpose products. Very often these products are from ABB's genuine product portfolio but also third party products will be used whenever required.

Integration engineering

Instrumentation, control and electrical projects for power plants are characterized by engineering processes that concern many technical disciplines such as field instrumentation, cabling, control engineering and electrical components. The parties involved, e.g.

general contractors, consortium partners and suppliers, though with different functions, are working on the same project at the same time, usually at different distributed locations. The engineering process for such a project can be a major challenge, since distributed and simultaneous procedures need to be accurately coordinated and target oriented. The engineering tools must be suitable for handling a series of complex interfaces for exchanging data and documents, while assuring a steady revision process and a high degree of consistency and completeness of the documentation.

With its Engineering Integration Platform EIP ABB applies a consistent solution for the entire engineering process, ranging from input management for the process data needed for detail engineering, installation and commissioning to the compilation of a consistent project- or plant-specific documentation.



Composite solution with System 800xA

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System analysis and single line diagrams

We analyze generation and transmission systems and provide solutions to achieve required power stability and reliability

Short circuit and load calculations

In order to achieve the correct design, layout and selection of electrical systems, it is essential to know the expected short-circuit currents and loads in an installation. ABB has developed a planning tool that can analyze as well as optimize all voltage levels of electrical networks. Our short-circuit current and load calculations help to solve the following tasks:

- dimensioning of electrical equipment
- designing the network protection system
- compensation and grounding
- interference problems

Component sizing

From the short circuit and load calculations, ABB's planning tool can outline the single line diagram for the power plant or transmission network required, indicating the ratings of the foreseen equipment and systems, such as power rating of the circuit breakers, thermal design of the equipment, and protective relays and their settings.

Cable sizing calculations

Cross-sections of cables between the switchgear and their connected loads are an important calculation that take into consideration the operating conditions and cable length involved. Other factors such as permitted loads, ambient temperature, laying methods, thermal short-circuit strength, and permitted voltage drop all influence the cross-section of cables.

Grounding and lightning calculation

The purpose of grounding systems is to protect life and property in the event of short-circuits, ground faults, lightning strikes and switching operation. Although lightning strikes cannot be completely prevented, the probability of a direct strike can be greatly reduced with the aid of model simulations, measurements, and observations.

Setting and sensitivity calculation

From the short circuit and load calculations, we determine the lower limit value of the fault currents. This is used to design the protection

system and select the protection relays and their settings. By doing so, faults are detected and isolated selectively and swiftly from the network.

The excitation system

The main tasks of the excitation system are:

- feeding the generator field winding with a reliable DC current under all possible operating conditions
- enabling the stable operation of the generator with the power system and with other machines in the same plant
- keeping the generator running within its permissible operating range
- supporting network stability

The gas turbine static start-up system

Gas turbines often have to be started quickly at short notice. Start-up systems are an integral part of gas turbine plants, because the turbines develop self-sufficient torque to accelerate only above a certain speed. The start-up system accelerates the turbine "gently" and economically above the ignition speed using the generator as motor with variable frequency.

The advantages of this start-up procedure are:

- smooth starting of the gas turbine
- significant reduction of the current surge due to the starting load in the power system
- fast acceleration from standstill to the self-sustaining speed.

With the aid of isolators, the solid-state start-up system can also be used to start up other turbine units (cross-connected start)

Generator bus duct

The generator bus duct transmits power from the generator to the step-up transformer and to the unit auxiliary transformer.

The phases of the generator bus duct are individually metal clad. The metal cladding is arranged concentrically around each of the phase conductors and the conductors themselves are aluminum tubes.

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Generator circuit breaker

The three-phase SF6 generator circuit breaker performs the following tasks:

- point of separation between the generator and its services transformer with the advantage that services transformer can be supplied from the step-up transformer during starting and in the event of a generator fault
- synchronization
- tripping of faults



Generator bus duct with generator circuit breaker

Step-up power transformer

The step-up transformer transmits the generator's electrical energy to the HV power system and supplies the unit auxiliary transformer with energy from the power system when the generator breaker is open. On-load tap changers are provided for adjustment of the HV and the reactive power.



Combined cycle power plant with step up transformers

Unit auxiliary transformer

A three-phase oil-filled transformer supplies the power required by the auxiliaries of the gas turbine unit or combined cycle unit.

LV switchgear

The 0.4 kV LV switchgear supplies almost all the plants auxiliary loads.

MV switchgear

ABB proposes medium voltage metal-clad, arc proof, air insulated switchgear.

Fast power switch-over

A high-speed transfer device guarantees an optimum safeguarding of critical load through automatic transferring from the main feeder to a stand-by feeder in the shortest possible time to protect important processes from expensive outages.

Electrical measurements, meters and recorders

The following measurements are carried out for the purposes of monitoring, metering and recording the operating statuses of the electrical plant and auxiliaries:

- current and voltage
- frequency and power factor
- power

Batteries, chargers and inverters

To ensure a continuous supply of power to essential loads in the event of a power systems fault or the failure of the auxiliary supplies, 220V and 24 V station batteries equipped with chargers, inverters and the associated switchgear are provided.



Containerized batteries for 24 Volt and 220V uninterruptible power supply

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Synchronization equipment

Dual-channel synchronization equipment guarantees safe and reliable synchronization of the generator with the network.

Variable speed drives

Variable speed drives increase plant availability and flexibility through improved process control. They are being considered more and more often as an alternative to fixed speed motors, or controls by throttling valve or liquid coupling in:

- feed-water pumps,
- cooling water pumps, fire fighting pumps
- fuel gas booster compressors



Containerized variable speed drives

Unit protection

A digital microprocessor-based protection system is provided for protecting the generator, the turbine, transformers and other plant items in the generator zone. The generator protection schemes detect external and internal faults and faults in the excitation system and an emergency stopping of the turbine in addition to the electrical trips.

Process control

The control system comprises sequence and drive control in the open-loop controller, and control of analog process variables in the closed-loop controller plus the turbine protection system.

The application software is built using standard software module libraries. This reduces the possibility of errors and increases the overall reliability and availability of the system.



Containerized control room of a combined cycle power plant

Automatic start-up

Operation of the power plant can be fully automated; the various auxiliaries are automatically controlled in a sequential manner. No operator intervention is required, except for selecting the fuel and setting the load.

Protection

Highest priority is given to the protection system. The control system contains a SIL 3 certified over-speed protection system according to IEC 61508. The protection is built as a fault tolerant 2 out of 3 system, with each protection channel implemented in a separate controller.

Further Equipment

ABB delivers additional standardized solutions for fast track projects:

- instrumentation
- grounding and lightning protection
- lighting and power sockets
- telephone and communication systems
- security & alarm systems
- clock systems, fire detection, CCTV



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