



Greater flexibility in substation design

Module based design of substations reduces project lead times and gives greater flexibility to meet customer demands

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Substations, like most things in life, are affected by the passing of time. Changing markets, an environmentally aware population and new technology mean that old and new substations have some challenging times ahead. Completely new substations have to meet tough requirements in terms of footprint, the environment and availability. Substation extensions require high flexibility to cope with already existing control systems, lack of available space and limited downtime.

For many decades ABB engineers have been designing, constructing and executing substation projects of different sizes and technologies. Hundreds of ABB man-years of experience have been used to continuously improve the design processes, and one of the company's latest achievements is a module based substation design approach. Though new to substation design, module based concepts are well known in the automotive industry. Using this approach, all customer requirements can be quickly fulfilled based on a set of substation modules. The modules are comprised of the most up-to-date technologies, such as Plug and Switch System modules (PASS) and the ZX family of gas insulated switchgears. The first applications of the module based substation design philosophy have been successfully demonstrated, and it is clear that this approach is going to be a cornerstone for other turnkey product lines from ABB.

ABB has been delivering substation solutions, based on customers' specifications, for many years. During this time, the company has accumulated hundreds of man-years of experience, and this has been used to continuously improve design processes. These gradual improvements have resulted in flexible and cost effective designs, low lead times and premium quality both in the turnkey substation business and ABB's underlying product portfolio.

One very notable achievement in this area has been the recent development of ABB's module based substation design approach (patent pending) **1**. A module is a pre-engineered package of substation components and their interconnections. In this context, it is referred to as the smallest subsystem on which a substation is built. This approach has been chosen based on a broad turnkey experience and best practice benchmarking with other system integration industry segments. The module based substation design approach is aimed at:

- Lowering project lead times in tender generation and project execution.
- Optimizing the use of ABB's underlying product portfolio.
- Avoiding design errors in engineering.
- Providing premium quality documentation.

To achieve these aims, the most important key factors are:

- Pre-engineered and quality assured design packages (modules).

- Continuous re-use of already proven design components and entire systems.
- Process integration with sub-suppliers.

Productization vs. Modularization

It has become clear to suppliers that a fully standardized substation does not reflect the needs of the majority of customers. Customers want to have maximum design flexibility, and this is possible using the module based substation design approach. In addition, this method also eliminates many repetitive process steps. To appreciate the benefits of using this approach, it is important to be aware of the fundamental differences between this type of substation and a productized one.

With productization a substation is completely pre-engineered on the station level, ie, a certain number of layouts are predefined and changes to them are not possible. On top of this, the substation can only be configured from a number of pre-defined alternatives.

The logistics and engineering, normally needed within substation projects is also pre-defined. These factors result in limited flexibility in meeting customer demands, which in turn means, that in today's market, productized substations only serve a niche market. That is why

the main focus is now on the supply of modularized substations.

Modularization means the substation is subdivided into modules on the bay level. Modules can therefore be bays (eg, incoming line feeders and outgoing feeders), control and protection packages and civil works. These modules can be customized to meet a particular specification.

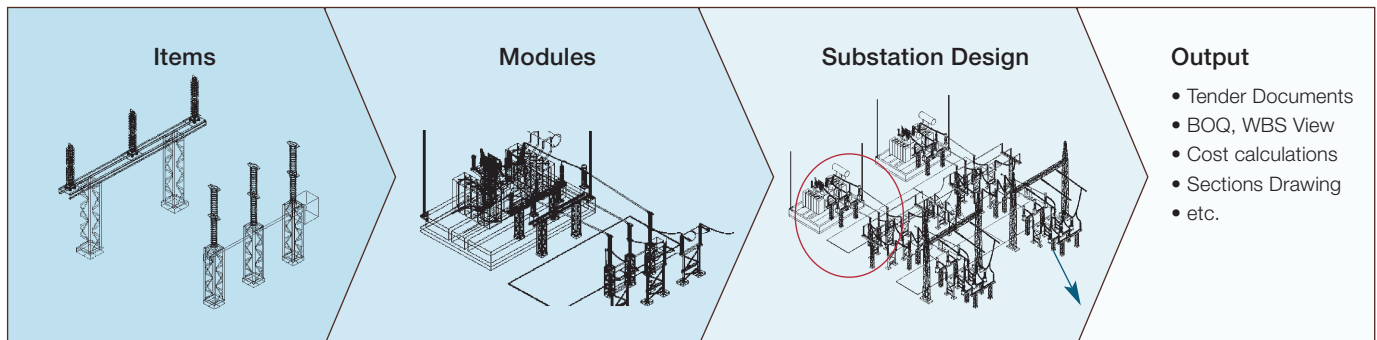
The module based substation design process begins with the initial discussions with customers right through to the offer and execution phases. By using the modules as building blocks, engineers can progressively test the design from a very early stage in a project. The advantage of doing this is that possible and alternative designs can be quickly generated and evaluated. This allows

the value of potential investments to be estimated with a high degree of accuracy, without any need for extensive detailed design studies.

This approach has been chosen based on a broad turnkey experience and best practice benchmarking.

Results can be obtained in days or even hours instead of the months needed with conventional design approaches. In addition, the ability to generate several alternative designs makes ABB's entire product and system portfolio accessible for any given specification.

1 ABB's module based substation design process.



A typical substation may be comprised of approximately 10 to 30 different pre-engineered modules, meaning the engineering of a substation becomes more or less an assembly exercise. With pre-engineered modules, the overall result is a substation design process that guarantees faster response to customer specifications in parallel with optimized system costs and high quality.

Global competence locally available

With the introduction of a module based substation design approach, know-how from decades of substation design experience from around the globe is consolidated at one single point. This unique source of technology and system design competence for turnkey substation projects is available to all local ABB commercial establishments. In other words, the module based substation design approach serves as a technology platform for all substation projects worldwide.

Automated supporting functions like tender generation, and standard outputs, for example, a bill of materials, result in a unique and streamlined process for turnkey substation projects. Premium quality documentation can be provided according to customer needs. The local reuse of complete project information and structures avoids double design efforts and improves the overall design quality.

Impact on Product Portfolio

With the module based substation design approach, the type of modules used and the level of customization for particular projects can be monitored at any point in time. This information is also used by ABB to plan and optimize the products from its portfolio. Consequently, the company can better im-

2	ABB's new look Plug and Switch System (PASS) M00
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prove product functionality as well as the design of various product lines used for turnkey substations.

The Plug and Switch System (PASS) modules

sent two examples of recently developed technologies which form part of the module concept.

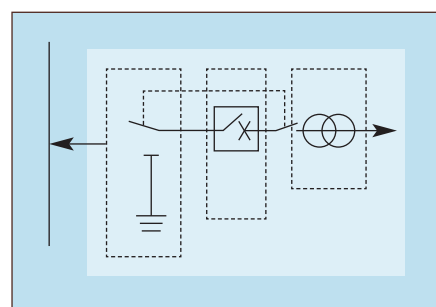
Finding the optimum application of modules and pre-fabricated products in substation design is a very important factor in a module based design system. Modularization offers flexibility and maximum design freedom, and pre-fabrication means that the equipment leaving the factory has been fully tested and customers are guaranteed a high standard of quality.

In order to fully leverage its modular design concept, ABB has introduced new technologies and products like, for example, its hybrid switchgear module series known as PASS. In this case, a hybrid switchgear is one that combines the components of traditional air-insulated switchgear (AIS) and advanced SF₆ gas-insulated switchgear (GIS) technologies. The PASS series is characterized by its compact

and modular design, which encompasses several functions in one module, leading to a reduction in primary connections within a bay and between bays. The design is very flexible in that any substation layout can be met and installed faster and with less manpower.

The Plug and Switch System (PASS) module and the ZX-family of medium voltage gas insulated switchgears repre-

3	Single line diagram of PASS M00.
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The youngest member of ABB's PASS family is the PASS M00 hybrid switchgear module designed for a voltage range of between 72 kV and 100 kV, and a breaking current of up to 31.5 kA. PASS M00 is a combination of well-proven standard components, ie, circuit breaker, a spring operating mechanism, current transformer and an innovative new concept for the combined disconnecting and earthing function. The five-position disconnecter, which is integrated in the main chamber, enables the following functions:

- Line disconnection
- Busbar disconnection
- Earthing of the line through the circuit breaker
- Earthing of the busbar through the chamber

This multifunctional module is available for single and double Busbar configurations, has a single and triple pole operating mechanism option and is ideally suited as a standard product in the design of new modular substations or for retrofit applications.

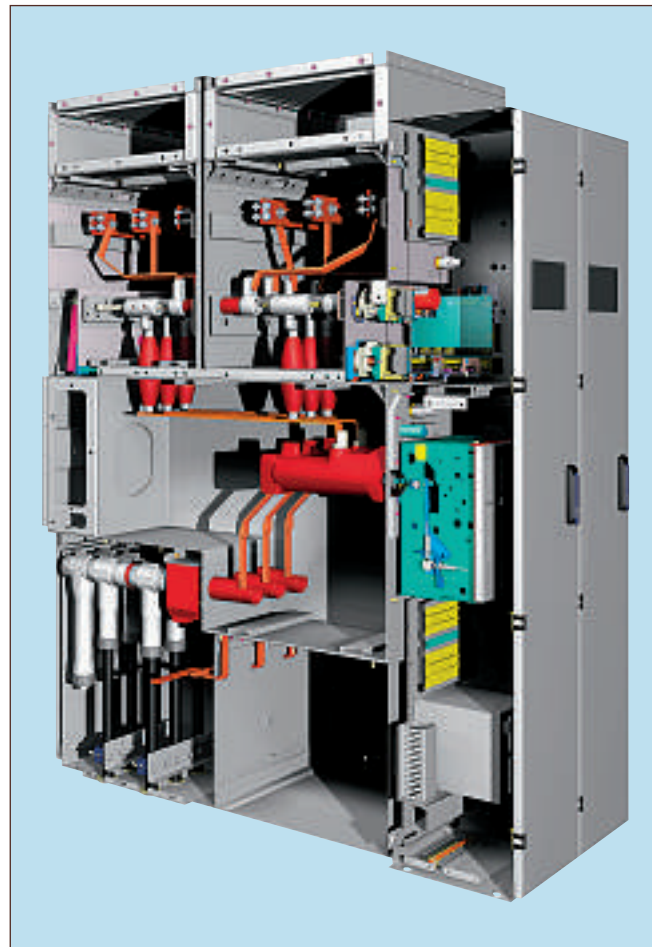
The ZX-family of high performance gas-insulated switchgears

These highly flexible metal clad switchgears are mainly used in medium voltage single (type ZX1.2) and double (type ZX2) busbar applications 4. With rated voltages from 12 kV to 40.5 kV, rated short circuit currents up to 31.5 kA (40 kA for the ZX2) and rated currents up to 2500 A, they cover a wide market segment. The compact modular structure of this family of products combines future oriented designs with progressive and reliable concepts and technologies. Performance is guaranteed because of the wealth of experience accumulated through years of know-how, research and development.

The primary and secondary type switchgears assembled and tested in the factory contain maintenance free active components, such as switching and measuring devices. These components are contained in a gas insulated stainless steel enclosure to protect against ageing and environmental influences.

The different switchgear modules in this family allow the addition of optional future oriented technologies, eg, Rogowski coils and proximity switches, or conventional technologies for meter-

4 ZX2-bay with a double busbar.



ing, control and protection as well as for position indication.

For special requirements, modules are available that serve as a double breaker feeder panel for capacitive switching at 40.5 kV, up to 800 A with the highest security class C2. For limited space requirements (ie, up to 24 kV), a double feeder panel with two 630 A outgoing feeder panels share one common busbar compartment. The total width of this double feeder panel is 800 mm. ZX panels consist of two or more gas filled main units – the busbar compartments and the circuit breaker compartments. The vacuum circuit-breaker can be used as a switching device, and power cables are connected to the circuit breaker compartment using, ie, the inner cone cable plug system with size 2 or 3.

The motor operated rod-type three-position disconnecter in the busbar compartment ensures maintenance-free operation. Density switches monitor each gas compartment so that the necessary amount of gas, independent of temperature and assembling height, is secured. The low voltage compartment is located in front of the core modules and is available, depending on customer requirements, in different depths.

The future of substation design

ABB's module based design process (patent pending) results in reduced lead times and extremely high flexibility. It supports the customer's requirements from early project development right through to tendering and execution. This in combination with innovative switchgear solutions from ABB has led to speedier and easier installations.

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