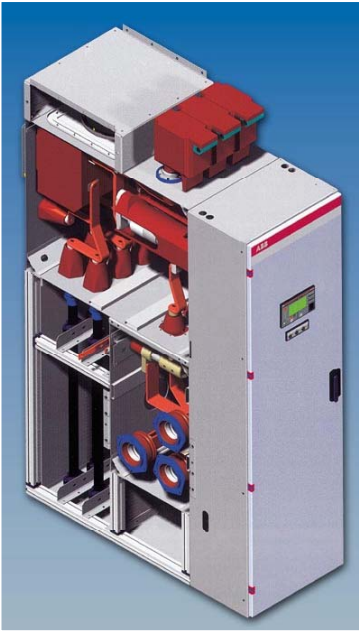


# New gas-insulated switchgear for all medium voltage applications

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**The new ZX1 medium voltage switchgear based on the predecessor product of the same name is a further addition to the ZX system family and fulfils further client needs.**

**In this market segment, those needs include a high level of flexibility in system configuration, segregated single busbars and the optional use of digital bay control and protection systems with sensors or conventional protection devices and instrument transformers.**



**Picture 1:** Panel 1250 A with a block CT and a connectable VT

## Introduction

The ZX family of gas-insulated medium voltage switchgear [1] has been upgraded in the field of segregated single busbar applications and brought even more closely in line with the needs of customers.

The new ZX1 covers a broad market segment: rated voltages from 12 kV to 40.5 kV, rated short-circuit breaking currents up to 31.5 kA and rated currents up to 2500 A.

The modular system is notable for its compact design and high performance parameters. It combines futuristic solutions with both progressive and tried and tested concepts and technologies, such as gas-tight system enclosures with alternative protection and insulating gases, vacuum switching technology, digital bay control and protection, sensors and plug-in technology.

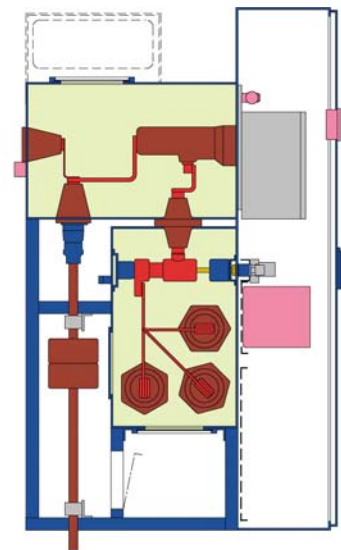
The factory-assembled switchgear installation, type tested on the primary and secondary sides, contains all the maintenance-free live components such as switching devices and measuring systems in a gas-tight stainless steel enclosure under inert gas, reliably protected from aging and the effects of the environment. The gas-tight modules can be combined as required, depending on the client's requirements and the panel type, and the panel to panel connections are effected by plug and socket units. Work involving gas outside the manufacturing location is completely avoided.

## Modular concept with high flexibility

The panels of the ZX1 series are structured in a modular system which permits a maximum of flexibility. Compact modules in a variety of combinations provide a solution to almost all the requirements specified on the world market. This is made possible above all by the positioning of the circuit-breaker compartment above the busbar. As the circuit-breaker compartment has the largest number of variants, it is advantageous that it can be configured to meet the specific needs almost independently of the adjacent panels (e.g. with voltage transformers, current transformers or sensors which determine the volume required for the enclosure). As a result, every individual panel in the system can be optimally structured to suit the client's requirements.

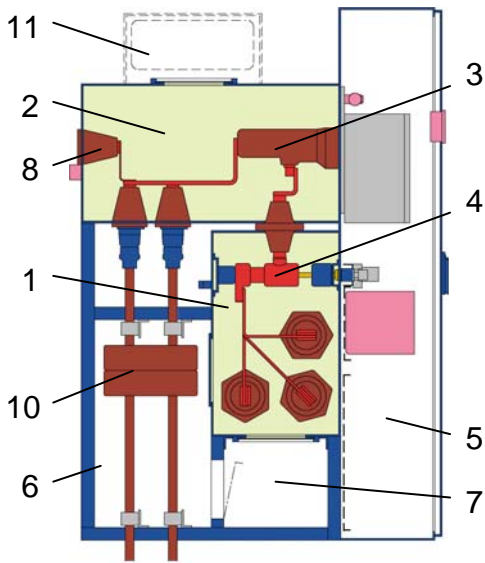
The various modules available also make it possible to integrate both future-oriented sensor systems to detect current and voltage signals and for switch position indication in combination with digital bay control and protection units, and conventional measuring and protection equipment with auxiliary switches.

The busbar and power cable plug connections, already familiar throughout the ZX range, allow these panels to be supplied factory-assembled as enclosed system units, tested on both the primary and



**Picture 2:** A cut-through of the panel for 800 A with ring type CT

secondary sides. This ensures consistently high product quality, and reproducible test results. The individual modules were developed using the latest design principles and techniques (complete development in 3D CAD with integrated calculation systems for assessment of enclosure strength).



**Picture 3:** A cut-through a panel 1250 A with ring core CT

The panel consists of two core modules filled with insulating gas (with colored background) – the busbar compartment below (1) and the circuit-breaker compartment above (2). The familiar vacuum circuit-breakers (3) are used as switching devices in the ZX series. [2]. With currents up to 1250 A, one or two cables per phase can be connected to the circuit-breaker compartment via inner cone plugs of size 2 or 3. Up to four parallel cables can be fitted in incoming feeders up to 2500 A. Metal oxide surge arresters and plug-in voltage transformers can also be fitted. The simple design of the three position switches (4) in the busbar compartment with a minimal number of individual parts in the gas-filled area also contributes to maintenance-free operation. The two gas compartments are each monitored by a density sensor, and therefore the necessary quantity of gas is ensured irrespective of the temperature and site altitude. In front of the core modules, there is the low voltage bay (5) with sufficient space to accommodate even a relatively extensive amount of secondary equipment. The base frame (6) is designed to ensure that the panel remains stable in its precise location. It also integrates the pressure relief duct (7) for the busbar compartment.

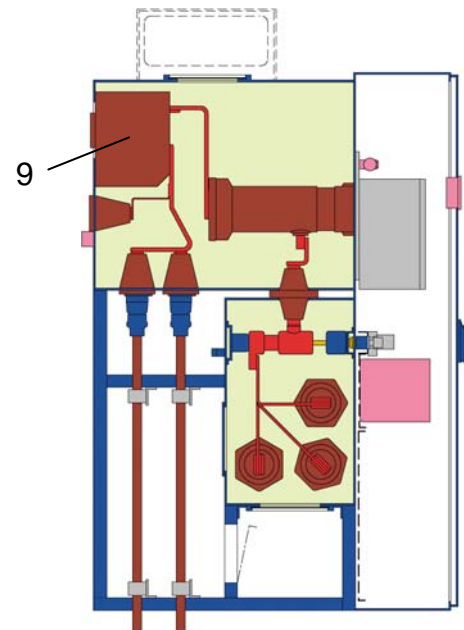
The arrangement of the circuit-breaker compartment facilitates convenient installation of the cables at a cable termination height of 1250 mm. At the rear, the test socket (8) is within easy reach. The secondary output wiring from the instrument transformers is easily accessible both with internal block transformers (9) or sensors, and with toroidal core transformers (10). A pressure relief duct (11) can be fitted above the circuit-breaker compartment, functioning in conjunction with the duct from the busbar compartments to ensure a maximum of operator safety.

The system ratings in the final stage of development extend up to rated voltages of 36 kV (40.5 kV for special markets), rated short-circuit breaking currents of up to 31.5 kA, and rated currents of up to 2500 A.

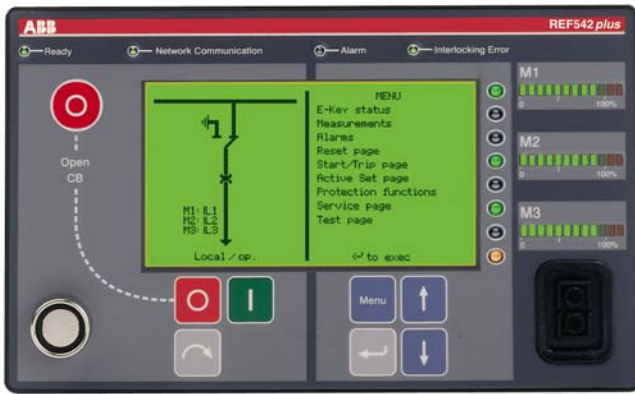
The modules for sectionalizer panels, riser panels and metering panels have also been optimized in terms of both function and space required, and tailored to suit clients' requirements in specific variants (e.g. fitting of one or two sets of instrument transformers, or integrated busbar metering).

### Control and protection systems

With the modular system described, it is possible to implement a large variety of protection systems. An optimum solution is provided by the bay control and protection unit REF542 *plus*, which is tailored to suit the needs of modern switchgear installations. In combination with current and voltage sensors and further sensors for switch position signaling, the unit performs all the necessary functions for protection, control, interlocking, measurement, communication and monitoring. The modular concept of the REF542 *plus* provides for separation of the control unit from the central processing unit. This facilitates ergonomic placing of the display and optimum positioning of the central unit from a wiring point of view. The REF542 *plus* is already prepared for many of the technologies of the future:



**Picture 4:** A cut-through of the cubicle 1250 A with block CT.



**Picture 5:** Control unit of the Switchbay protection and control unit REF542 plus

- Embedded web server technology
- Monitoring of the switchgear with different communications interfaces
- Direct time synchronization by GPS clock
- Various communication methods available for connection to an automation system
- Spontaneous alarming of service personnel by e-mail or SMS

For a conventional protection system, the use of current transformers of various types in the gas compartment or as cable type current transformers is possible.

Provision is made for voltage transformers as plug-in units above the circuit-breaker. The concept thus permits the use of a wide variety of customized protection devices and meters (for billing measurements). The two approaches can also be combined

under certain circumstances.

The sensor systems are based on the tried and tested technologies of the Rogowski coil as a saturation-free source of a current signal (displayed as a voltage signal) and the high impedance voltage divider. Detection of the switch positions is effected by inductive proximity sensors – a widespread and recognized technology in mechanical engineering. Monitoring of the insulating gas is performed by a gas density sensor which monitors the gas independently of environmental influences and uses transient pressure surges (caused by internal faults) to effect a rapid shutdown of the incoming feeders. This represents a high level solution for even greater operator and switchgear safety, as the effects of an arc fault are extensively limited by the rapid shutdown (approx. 100 ms).

Irrespective of the above, the active arc protection plays a decisive role in avoiding internal faults and ensuring the reliability of power supplies. The undiminished functionality of the maintenance-free live components under inert gas throughout their service lives makes an essential contribution to this.

### The manufacturing process

The modular system of the ZX1 series facilitates a production sequence which also exhibits that modularity in its workflows. The individual modules can be preassembled and only connected up to form a complete panel at a later date. This allows manufacturing steps to be performed in parallel, resulting in a great reduction in throughput times. Production of the fabricated panel enclosures is of great importance in this regard. They are manufactured in stainless steel and assembled using a laser welding system. Compliance with the tight dimensional tolerances required in such a process is ensured by a laser cutting unit. The two systems are extremely flexible as tools on account of the geometrical versatility of the laser, and permit the manufacture of a large number of variants.

Laser welding technology is notable for high process speeds and clean manufacture which makes reworking superfluous. With the limited heat permeation, welding distortion remains extremely low in comparison with conventional welding techniques, ensuring an accurate fit and gas-tightness of the modules, i.e. process and long-term stability.

The optimization potential described can only be exploited if the individual steps of the manufacturing process are monitored by suitable means. The defect potential of the individual process steps is revealed and evaluated in the course of detailed process observation. Statistical methods are then deployed to evaluate the process as a whole and develop an optimized manufacturing and testing strategy for the individual stages.

### Prospects

The new, optimized gas-insulated switchgear unites progressive and futuristic concepts and techniques. The use of vacuum circuit-breakers ensures unrestricted mechanical and electrical functionality throughout the service life of the system. Both appropriately rated sensors and conventional instrument transformers can be used for the monitoring of current and voltage. In conjunction with the computerized, digital bay control and protection system, operator convenience, safety and system reliability are increased, and project planning, production and commissioning are simplified. The plug-in technology reduces assembly times at site to a minimum.

The implementation of the ZX1 system concept results in unrestricted flexibility with a high degree of standardization, a high level of operator and system safety, reliability of power supply, service-friendliness and economy. These benefits have been confirmed by extensive experience in service. Several thousand panels of the ZX series have been in use reliably and without faults since the end of 1995 [3].

*REMARK: English translation of GERMAN publication in the journal "etz 18/2001 page 20-22"*

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