Indoor vacuum circuit breaker for railway applications - GSR II

Single-phase indoor vacuum breaker with magnetic actuator
27.5 kV - 200 kV BIL - 2500 A - 25.0 kA - 50/60 Hz
# Indoor circuit breaker for railway-traction-power-supply

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Product description

The vacuum circuit breaker GSR type is part of the GSx family designed to cover a wide single-phase application range:

- Rated frequency: 16 \(\frac{2}{3}\) Hz or 50/60 Hz
- Nominal voltage from 17.5 kV up to 27.5 kV
- Lightning impulse voltage from 125 kV up to 250 kV
- Rated nominal current from 1250A up to 2500A
- Rated short circuit current from 25 kA up to 31.5 kA
- Fix mounted, truck or cassette mounted

This is obtained by changing only few components, mainly vacuum interrupter and insulators.

In addition, the GSx pole may be operated through either a conventional spring-charged mechanism or a magnetic actuator.

This brochure describes a magnetic driven circuit breaker.

The high-voltage pole

The vacuum interrupter of the GSx pole (1) is placed between the upper and lower terminal, supported by two lateral insulating plates.

One insulated driving rod (3) transmits the motion from the drive cabinet (2) to the upper part of the pole.

The pole is fixed on the drive cabinet with two cast-resin insulators (4).

The upper terminal (5) and the lower terminal (6) contact can be fitted with contacts for fixed or withdrawable assembly.
The magnetic driven operating mechanism

The magnetic actuator is an ultra-modern concept for operating mechanism construction; storing and monitoring its energy electrically. The result is a completely maintenance-free drive system, which can confidently be expected to have even longer life times than its mechanical predecessors.

Careful selection of all components and reliable design guarantee maximum reliability – even under EMC load.

The magnetic actuator technology has been successfully introduced for medium voltage circuit breakers in the three-phase market.

Considering the number of ABB magnetic-driven breakers in operation, the return of experience has already demonstrated the same reliability as spring-charge mechanisms.

The Gsx II is the world’s first commercially produced indoor breaker for railway power-supply, which uses the actuation technology.

The benefits of this technology are:

- Reduced maintenance duties
- Increased reliability of operation thanks to reduced number of components and related settings
- Interfaces through digital inputs with reduced power demand
- Fast simple exchange of any main component.

The actuator is a bi-stable magnet system, in which switchover of the armature to the relevant limit position is effected by the magnetic field of two electrically excited coils.

The armature is held magnetically in the limit positions by the fields of two permanent magnets. Switching operations are released by excitation of one of the coils until the retaining force of the permanent magnets is exceeded.

The vacuum interrupter can be opened manually with a crank, part of maintenance tools.
The control board

The control board consists of two main elements:

- The power supply
- The control unit

Power Supply

All necessary application-specific input and output signals are independent of the type of auxiliary voltage in accordance with the rest of the system, and are integrated by plug-in technology.

The selection of a suitable internal power supply with feed via a UC-DC converter makes the breaker independent of the type and also almost of the level of auxiliary voltage.

The power supply has a galvanic insulation to protect the circuit breaker from external disturbances.

Control Unit

The Control Unit consists in principal of input channels, processing unit, power outputs and message outputs.

Processing unit

The main tasks of the processing unit are:

- To accept an incoming operation command, from local push-buttons or from a remote control system
- To check the status of the other inputs, the capacitor voltage and the position information,
- To switch the capacitor voltage on the relevant coil
- To disconnect the coil from the capacitor once the main contact reached its final position

The logic of the processing unit takes account of priority of OFF commands and integrates anti-pumping and self-monitoring features.

Inputs and outputs

Several digital inputs control the circuit breaker. Two “Off-switching” inputs are available as well as one “Closing lock-out” input.

The inputs are fitted with low-pass filters, to damp out line disturbances. Thanks to a bridge-rectifier, 50 Hz signals can supply the inputs without any additional interface.

Several digital outputs report the status of the circuit breaker. “Circuit breaker opened” and “Circuit breaker closed” outputs are available as well as one “Ready” output and one “Not Ready” output.

Local control

Local control of the interrupter is possible with On/ Off push buttons.

A Led indicates the “Ready” for operation status.
The capacitor bank

The capacitor stores the electrical energy needed for a complete autoreclosing cycle but also ensures power supply to the electronics. The energy content is sufficient for a buffer time of 200 s on failure of the auxiliary power.

After an autoreclosing cycle, the charging of the capacitor bank requires less than 100 W (average value over the charging cycle) for only a few seconds.

The external power consumption is less than few watts when the breaker is in the “On” or “Off” position.

End position sensors

The concept of a breaker control system without any auxiliary switches makes use of sensors to detect the position of the lever shaft. The inductive proximity sensors employed have proven their worth for these functions in practice, and are of course also included in the self-monitoring system.

In addition a mechanical indication (“flag”) of the position of the vacuum interrupter is provided.

Self monitoring

A watchdog monitors if the programmable logic array is working. Additional internal conditions are monitored:

- Availability of the internal voltage
- Position of the end position sensors (XOR logic)
- Voltage level of the capacitor

If these four conditions are fulfilled, the READY LED is shining, the output contact READY is closed and the output contact NOT READY is open.
The control box

A high-resistance welded-steel housing integrates the different parts of the mechanism.

The operation counter, the indication of the position of the main contact, etc.. can be checked through small inspection windows.

Close and Open push buttons are accessible from the front of the drive cabinet. The breaker can be mechanically tripped with a crank also from the front.

The picture below shows the details of the control box, once the front cover removed.

Installation

The breaker may be fix-mounted, truck-mounted or cassette-mounted.

On request, the circuit breaker may be delivered truck-mounted.

The breaker’s truck is typically a rigid steel construction including:

- Two 2,5-mm thickness steel columns rigidly braced
- Four wheels
- Space and fixing holes for current transformer
- Fixed earthing terminals
- Handle to push-in and pull-out the truck

The final arrangement is manufactured according to end-user’s requirements (auxiliary contacts, interlocks, etc.)
Technical data

Type designation  

GSR 5954

**Ratings**

Rated voltage 27.5 kV  
Rated continuous current 2'500 A  
Rated frequency 50/60 Hz  

Rated short-circuit breaking current 25 kA  
Rated short circuit making current 63 kA  
Rated short time withstand current 25 kA, 3 s  

1) 31.5 kA/ 80 kA available on request  

Rated power frequency withstand voltage (50 Hz, 1 min)  
Phase to earth 95 kV  
Across open contacts 105 kV  

Rated impulse withstand voltage (1.2/ 50 μs)  
Phase to earth 200 kV  
Across open contacts 250 kV  

Rated operating sequence O - 0.3 s - CO - 180 s - CO  
Rated opening time ≤ 45 ms  
Rated closing time ≤ 60 ms  

Standard applied  
EN 51052-1 – IEC 694

**Vacuum interrupter**

Storage life > 20 years  
Vacuum degree < 10^{-4} Pa  

Electrical endurance  
- At rated current 20'000  
- Qt rated short circuit breaking current 50  

1) According to vacuum interrupter datasheet, VE1 25 kA

**Magnetic actuator**

Mechanical endurance 100'000
# Characteristics of the control board

## Power supply voltage range

| Service operating voltage, low voltage range | 20 ... 60 V<sub>AC/DC</sub> |
| Service operating voltage, high voltage range | 80 ... 264 V<sub>AC/DC</sub> |

## Consumption

| In operation, device idle | ≤ 4 W |
| During a charging process | approx. 100 W |

## Recharging time

| Capacitor recharging time at minimum voltage | ≤ 3 s<sup>1)</sup> |
| Capacitor recharging time at maximum voltage | ≤ 2 s<sup>1)</sup> |

<sup>1)</sup> Charging time for a 0.1 F capacitor bank

## Binary inputs

| Electrical isolation from the electronics | 2 kV<sub>AC</sub> |
| Electrical isolation between the inputs | 2 kV<sub>AC</sub> |
| Maximum input voltage | 260 V<sub>AC/DC</sub> |
| Response range | 48 to 250 V<sub>AC/DC</sub> |
| Current consumption | ≤ 2 mA at 250V<sub>AC/DC</sub> |
| Protection against voltage surges | Yes |

## Binary outputs

| Electrical isolation from the electronics | 2 kV<sub>AC</sub> |
| Electrical isolation between the inputs | 2 kV<sub>AC</sub> |
| Maximum switching voltage | 400 V<sub>DC</sub>/280 V<sub>AC</sub> |
| Maximum switching current, static outputs | 0.5 A<sub>AC/DC</sub> |

## Accessories

| 5–digit operation counter | 1 |
| Electrical opening and closing push button | 1 + 1 |
| Mechanical indicator “Close”/“Open” | 1 |
| Electrical indicator “Ready” | 1 |

## Service conditions

| Operating temperature range | - 5 / +40 °C |
| Altitude above sea level | ≤ 1000 m |
Type tests reports

Copies of following type tests reports are available on request:

- Insulation voltage
- Short-circuit breaking and making current
- Short-circuit withstand current and peak withstand current
- Capacitive current
- Temperature rise
- Measurement of the main circuit resistance
- Mechanical tests (including mechanical operation test and mechanical life test)

Only routine tests are performed for delivery of the equipment.

Routine tests

The following routine tests are carried out in the seller’s factory:

- Construction inspection
- Mechanical operation and mechanical data test
- Measurement of the main circuit resistance
- Power frequency withstand voltage of the main, auxiliary and control circuit

Markings on the name plate

Following information are mentioned on the adhesive name plate:

- Manufacturer’s name and trade mark
- Type designation name
- Date of manufacture and serial number
- Rated voltage
- Rated lightning impulse withstand voltage
- Rated current
- Rated short circuit breaking current
- Rated operating sequence
- Rated frequency
- Name and type of the operating mechanism;

Technical documentation

For each order, the following technical documentation (in English) will be provided in 2 copies:

- Operation and maintenance manual
- Outline drawing for the breaker
- Outline drawing of the truck (when part of delivery)
- Wiring diagram
- Routine test reports