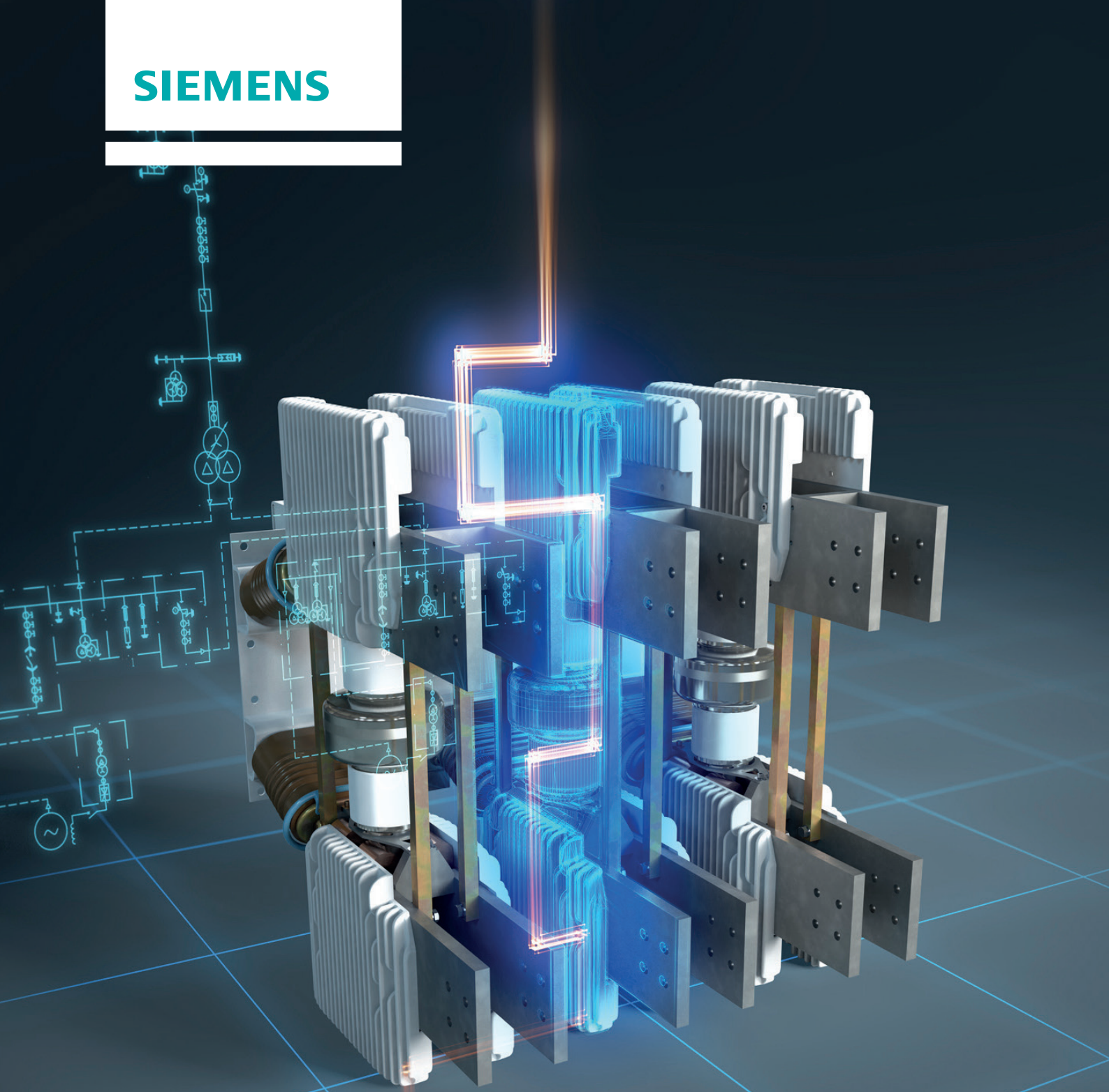
SIEMENS



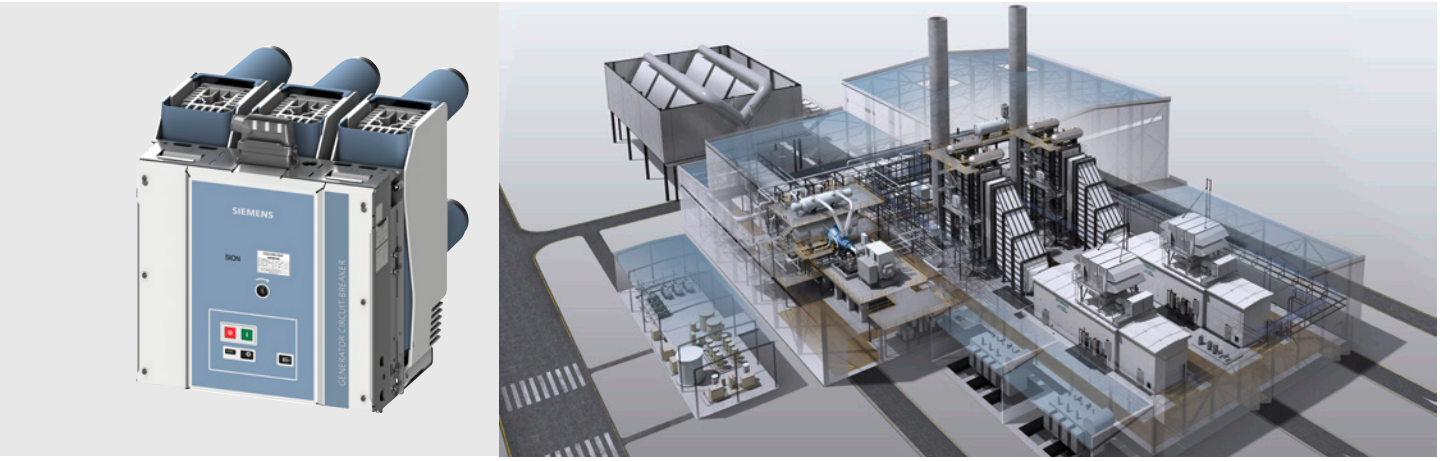
Vacuum circuit breakers

for generator switching applications

siemens.com/generatorswitchgear

Convincing all along the line

Switchgear and switching devices from Siemens



The new generator vacuum circuit breaker in SION design is ideal for the integration of small generators in a compact switch panel group.

Grow with your requirements

No question: The worldwide energy demand will continue to increase rapidly, placing higher performance requirements on energy suppliers and industrial facilities.

To offer them a decisive advantage, for decades Siemens has been developing and improving high-current and generator circuit-breakers, which can comply with ever-increasing requirements. In addition to ever higher rated currents required in central power plants, there is increasing demand from distributed power plants in the lower performance range, which with more frequent switching operations defines a new dimension of requirements. In this, reliability and low maintenance remain the top priority over the entire life cycle. With comprehensive simulations, preliminary studies, state-of-the-art development technologies, and modern manufacturing processes, Siemens sustainably maintains its leading position in the field of vacuum circuit-breakers.

With Siemens products, the performance, reliability and economic efficiency of the entire switchgear assembly grows, and life-cycle costs are reduced.

Over 45 years of experience in vacuum switching technology

In particular, Siemens has perfected its vacuum circuit-breakers for generator switching applications, where they are subjected to high thermal and mechanical stress:

- Special contact material for minimum contact wear
- Specifically developed contact system
- Optimized design for efficient cooling
- Post insulator construction for highest mechanical stability
- Safe breaking operations by controlling long arcing times even in case of missing zero crossings
- Transient recovery voltages with high rates-of-rise, typical for generator networks, are controlled without additional capacitors.

Application of the proven vacuum switching technology is thus possible for higher short-circuit currents, which formerly had to be implemented with SF_6 switching technology.

Vacuum switching technology established on the market

The exceptional economic and technological aspects of the vacuum quenching principle have made the vacuum circuit-breaker the device that is mostly used worldwide for voltage ratings from 1 kV to 52 kV.

In the last years, the application of the vacuum switching technology has expanded and it is largely accepted even in the field of generator switching duties.

Siemens offers a wide range of vacuum circuit-breakers for generator switching protection.

Our Features – your benefits

Constant dielectric

- The hermetically sealed vacuum interrupters are are not influenced by external environmental conditions
- Switching processes in the vacuum do not produce any decomposition products as this is the case with SF_6 circuit-breakers

Constant contact resistance

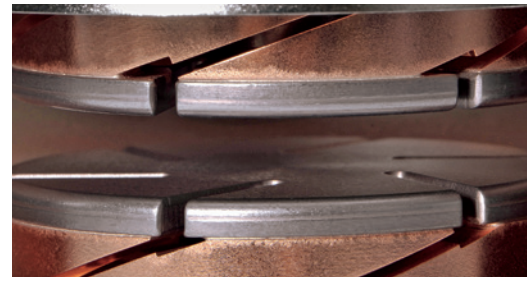
- As there is no oxidation in the vacuum, the contact surfaces remain metallically pure
- This ensures constant contact resistance through out the entire service life
- Separate main and arcing contacts, such as required for SF_6 circuit-breakers, are not necessary

Minimum use of plastic material in vacuum circuit-breakers

- Air is the main insulator
- Avoidance of creepage paths and partial discharges

Safety first

- In the extremely unlikely case of loss of vacuum, only an arc develops, which will be contained within the interrupter and does not result in any explosion



Lower arc energy

Vacuum circuit-breakers have in general very low arc energy due to their low arc voltages resulting from small contact strokes and lack of any insulating gases. This leads to high switching cycles of the interrupter contacts. On the other hand the lower arc voltage is also sufficient enough to reduce the arcing times of faults with high DC time constants.

IMPROVED PERFORMANCE

- Your maintenance expenditure will be drastically reduced thanks to our trend-setting performance with respect to both electrical and mechanical durability, guaranteeing up to 10,000 operating cycles at rated current without maintenance.

MAKE LIFE EASY

- You simplify the plant operating manual by excluding additional processes related to the handling, storage and recycling of hazardous materials.

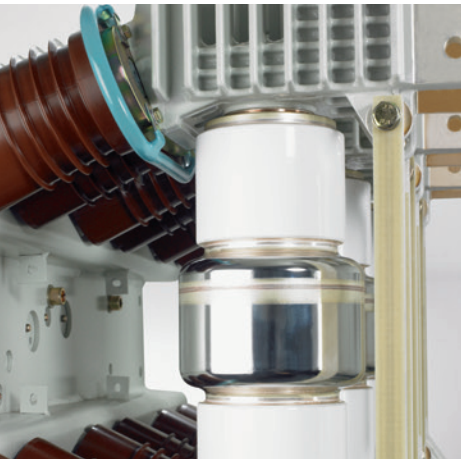
PEACE OF MIND

- The "sealed for life" technology of our vacuum interrupters enables our customers to benefit from a mean time to failure of over 71,400 years.

INNOVATION FOR A BETTER FUTURE

- The Vacuum interruption technology does not use any green house gases like SF_6 offering a clean solution for power plants.

Proven quality from Siemens



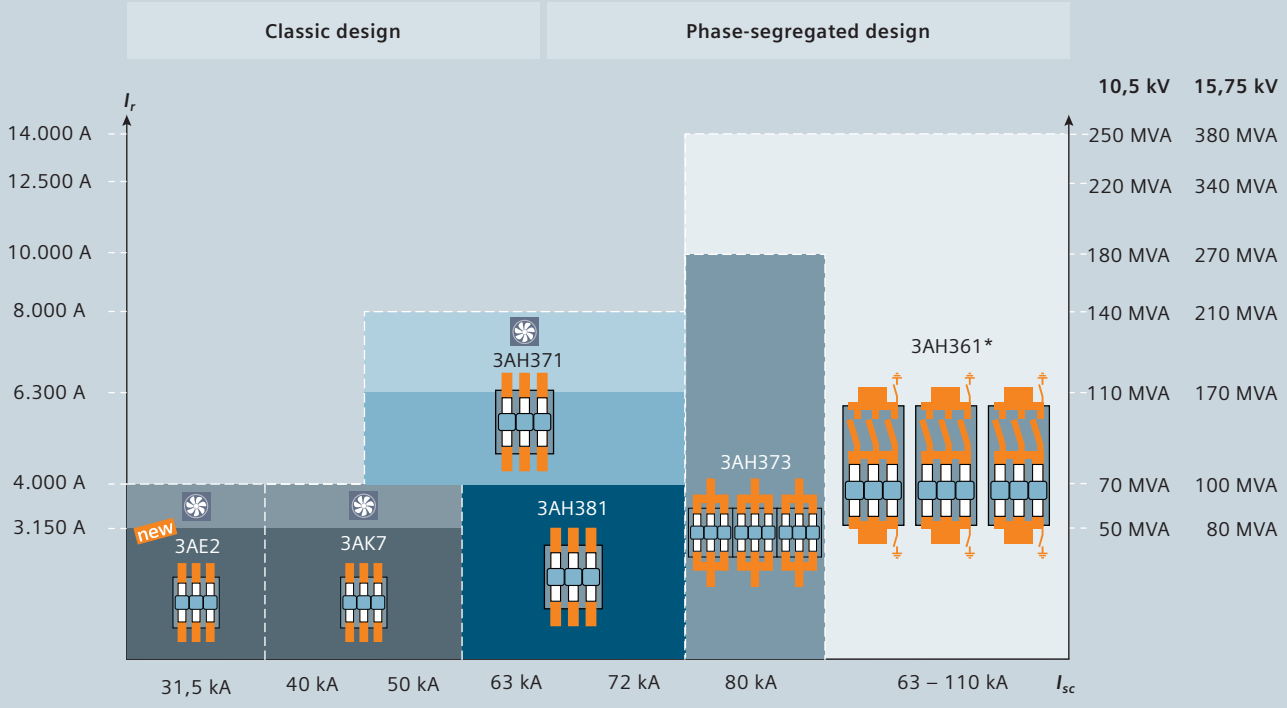
Type-tested according to all relevant standards

Type tests as specified in IEC 62271-100 are performed as a rule for all Siemens circuit-breakers. Generator circuit-breakers are additionally tested in accordance with IEEE C37.013 or IEC / IEEE 62271-37-013. This Standard is the only worldwide standard to take into account the increased requirements to which the devices are subjected when switching generators. As a result the standard has been enhanced to a Dual Logo IEEE/IEC leading standard.

Standard IEEE C37.013 or IEC / IEEE 62271-37-013 includes in particular:

- For generator-side faults: High DC components and the resulting missing zero crossings
- For system-side faults: Higher TRV rates-of-rise
- Higher test voltage levels

Vacuum circuit-breakers for generator switching applications up to 17.5 kV



*Complete module for each phase with integrated main disconnector, earthing switches and starting switch

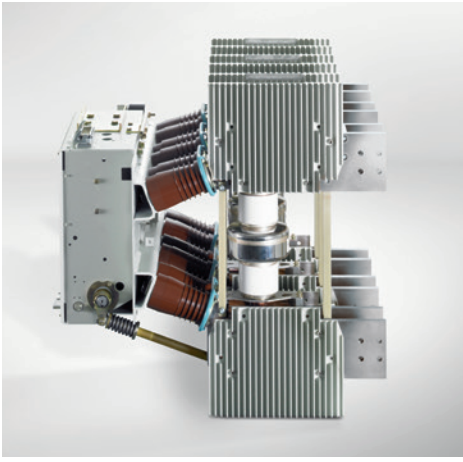
with forced cooling

3AH36, 3AH37 and 3AH38

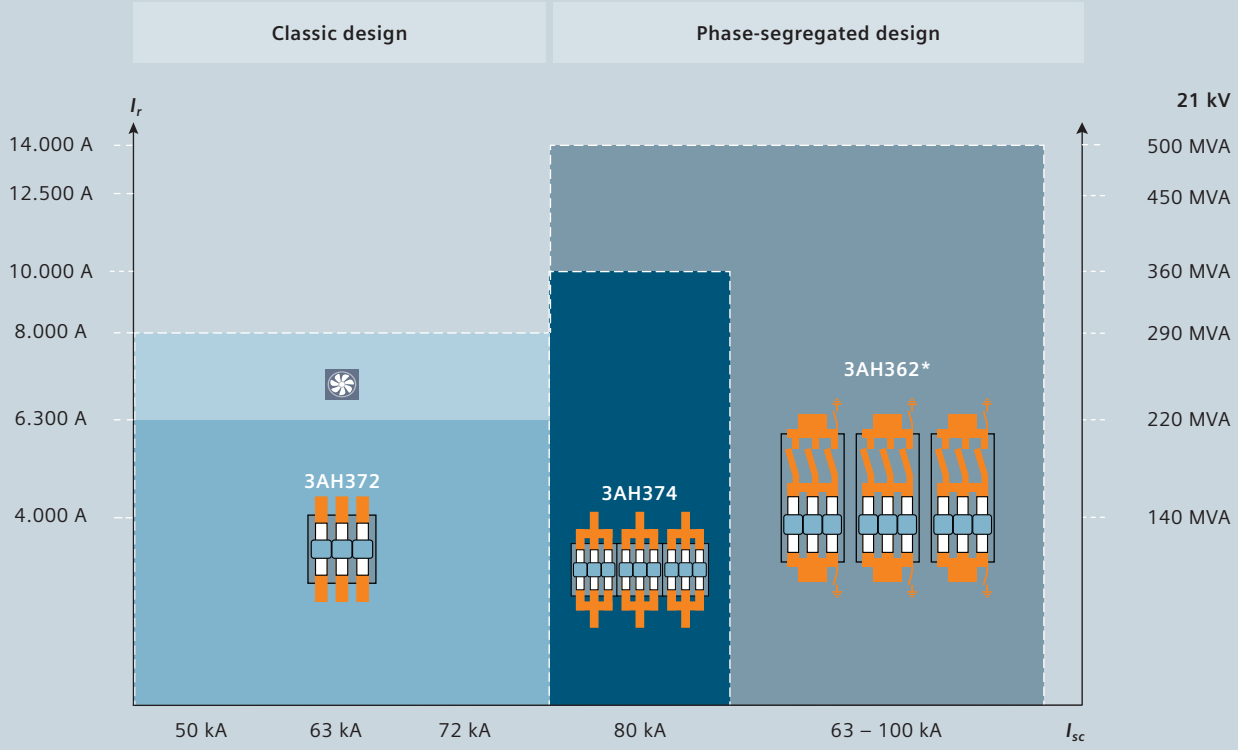
Today, in numerous power supply companies worldwide, the high-current and generator circuit-breaker 3AH38 is standard for breaking normal currents up to 4,000 A. It was the first vacuum circuit-breaker with 63 kA and 72 kA to be type-tested according to the criteria of generator circuit-breaker standard IEEE C37.013.

Its counterpart for higher generator ratings is 3AH37, the first vacuum circuit-breaker worldwide which can carry a normal current of 6,300 A on a sustained basis up to 24 kV without forced cooling. Moreover, at a voltage level of 24 kV it controls short-circuit currents up to 72 kA – with forced cooling, the 3AH37 can be operated with normal currents up to 8,000 A.

The 3AH36 generator switching module was developed especially for phase-segregated enclosed generator switchgear and applicable up to 450 MVA power range.



Vacuum circuit-breakers for generator switching applications up to 24 kV

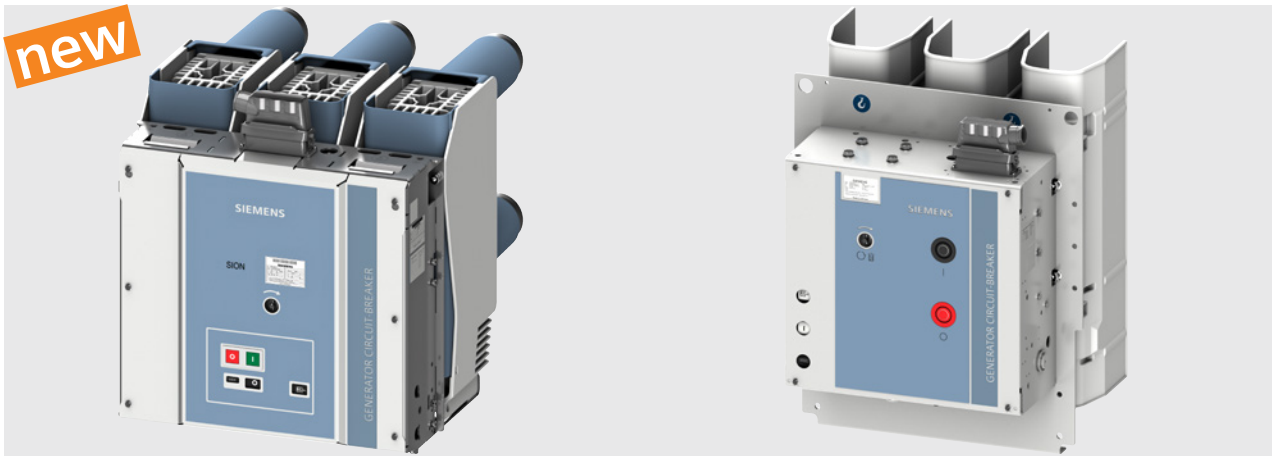


*Complete module for each phase with integrated main disconnector, earthing switches and starting switch

with forced cooling

3AE2 / 3AK7

The compact vacuum circuit-breakers for generator switching applications



The 3AE2 and the 3AK7, for example, are used in the Siemens NXAIR switchboard for switching generators.

The recipe for success of the 3AK7 has now also been applied to the SION: Along with the SION 3AE5 31.5 kA and new 40 kA IEC standard circuit-breaker, there is a virtually identical version as a type-tested IEC/ IEEE 62271-37-013 generator circuit-breaker for 31.5 kA. This offers panelbuilders the lucrative opportunity to cover even smaller generator switching applications alongside the IEC high-voltage market. The SION 3AE2 is available not only with contact arms and contact systems but also as a withdrawable version.

Compact design – high perfomance

The pole shell design enables the slender width and at the same time provides for high currents of up to 3,150 A, and 4,000 A with forced cooling. Depending on the version, the vacuum circuit-breakers are dimensioned to 10,000/ 30,000 operating cycles.

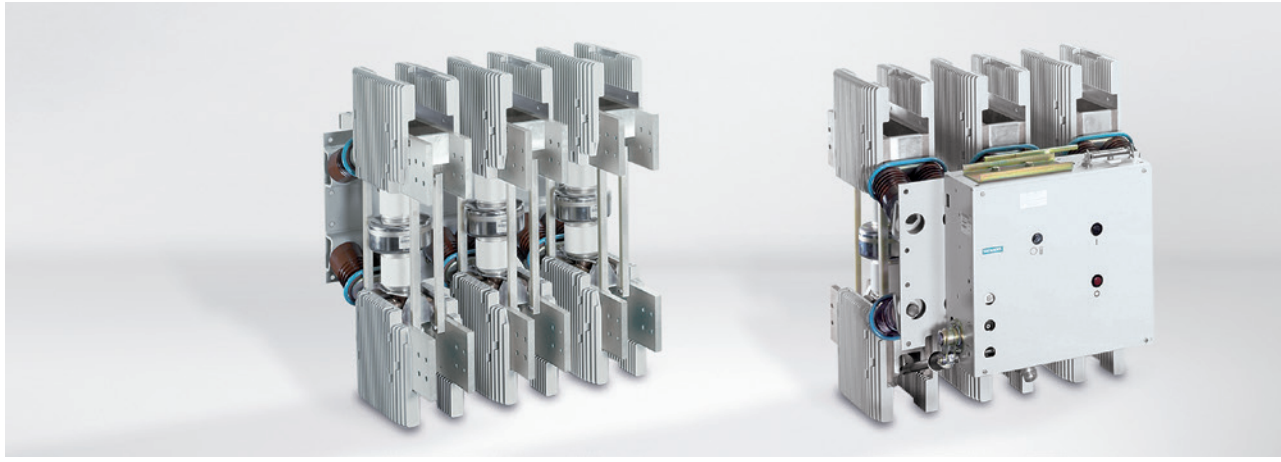
Rated short-circuit breaking current I_{SC} (3 s)	**[kA]**	**31,5**		**40**	**50**	
DC component of rated short-circuit breaking current	[%]	65		70	75	
Asymmetrical breaking current	[kA]	43		56	73	
Rated short-circuit making current	[kA]	87		110	137	
Generator short-circuit breaking current I_{SCG}	**[kA]**	**25** [1)]	**18,5** [2)]	**20**	**25** [1)]	**25** [2)]
DC component of short-circuit breaking current	[%]	110	130	120	110	130
Asymmetrical breaking current	[kA]	46	39	39	46	52
Rated currents	**[A]**	**1.250; 2.000; 2.500; 3.150; 4.000 (with forced cooling)**				
Rated voltage 12 kV 50/60 Hz; U_p = 75 kV; U_d = 28 kV (optional 42 kV)		**3AE2185**		**3AK753**	**3AK755**	
Rated voltage 15 kV / 17,5 kV* 50/60 Hz; U_p = 95 kV; U_d = 38 kV (optional 42 kV)		**3AE2285**		**3AK763**	**3AK765**	
Rated operating sequence						
– For short-circuit breaking current		CO – 30 min – CO, up to 30 short-circuit breaking operations Further operating sequences possible: O – 3 min – CO – 3 min – CO, ...				
– For operating current		CO – 3 min – CO, up to 10,000 / 30,000 operating cycles				

* U_d and U_p fulfill the specifications for rated voltage 15 kV in accordance with IEC /IEEE 62271-37-013 and for 17.5 kV in accordance with IEC 62271-100

[1/ 2)] Class G1/ Class G2 – Classification IEC/IEEE 62271-37-013

3AH37 and 3AH38

The classic vacuum circuit-breakers for generator switching applications



3AH37 and 3AH38 are installed, for example, in the Siemens switchgear type VB1-D.

Modular design – maximum flexibility

The modular design enables to use ideal materials for main current path, cooling and for mechanical forces. Thus, the 3AH37 combines low resistance of the main circuit with high mechanical stability and ideal cooling performance.

Moreover, the modular construction enables even horizontal installation of the circuit-breaker, if required. To do this, cooling elements can be installed that are especially provided for this mounting position. Thus, the 3AH37 can be operated continuously in every position without additional fans, reliably excluding any overheating.

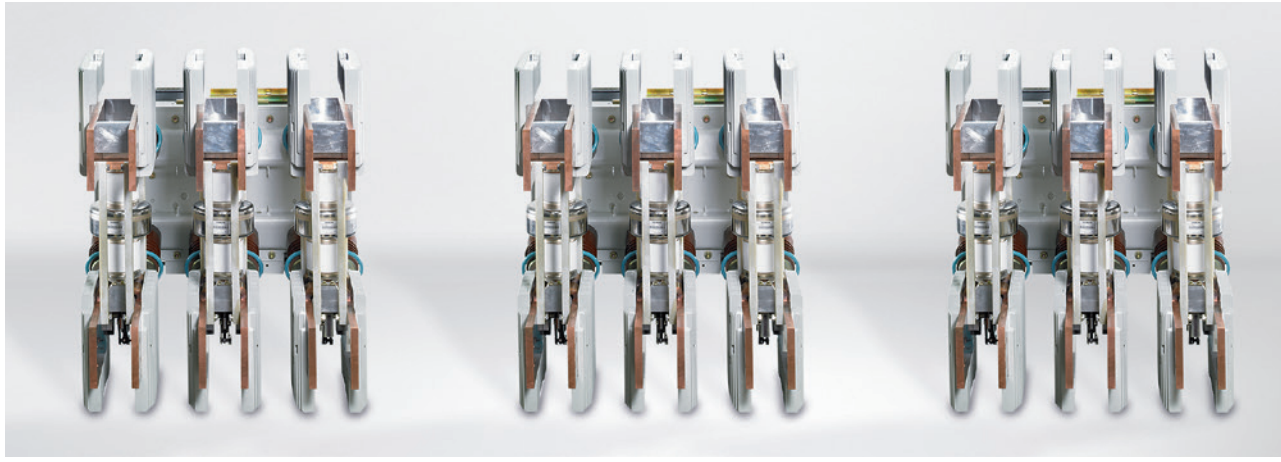
Rated short-circuit breaking current I_{SC} (3 s)	**[kA]**	**50**		**63**		**72**	
DC component of rated short-circuit breaking current	[%]	75		70		70	
Asymmetrical breaking current	[kA]	73		89		101	
Rated short-circuit making current	[kA]	137		173		197	
Generator short-circuit breaking current $I_{SC\ gen}$	**[kA]**	**25** [1)]	**25** [2)]	**31,5** [1)]	**25** [2)]	**36** [1)]	**25** [2)]
DC component of short-circuit breaking current	[%]	110	130	120	130	110	130
Asymmetrical breaking current	[kA]	46	52	62	52	67	52
Rated currents	**[A]**	**3.150; 4.000; 5.000; 6.300; 8.000 (with forced cooling)**					
Rated voltag 17,5 kV 50/60 Hz; U_p = 110 kV; U_d = 50 kV		≤4.000 A: **3AH3817** >4.000 A: **3AH3712**		≤4.000 A: **3AH3818** >4.000 A: **3AH3713**		≤4.000 A: **3AH3819** >4.000 A: **3AH3714**	
Rated voltage 24 kV 50/60 Hz; U_p = 125 kV; U_d = 60 kV		**3AH3722**		**3AH3723**		**3AH3724**	
Bemessungs-Schaltfolge							
– For short-circuit breaking current		CO – 30 min – CO, up to 30 short-circuit breaking operations Further operating sequences possible: O – 3 min – CO – 3 min – CO, ...					
– For operating current		CO – 3 min – CO, up to 10,000 operating cycles					

U_p = Rated lightning impulse withstand voltage U_d = Rated short-duration power-frequency withstand voltage

[1/ 2)] Class G1/ Class G2 – Classification IEC/IEEE 62271-37-013

3AH37 up to 80 kA – phase-segregated

The three circuit-breaker solution for phase-segregated design



In the case of generator switching applications with phase-segregated designs, the requirements for pole synchronism have been implemented in accordance with IEC 62271-100, and tested with short-circuit currents up to 80 kA and operating currents up to 12,000 A.

Example of a retrofit installation of the 3AH37 90 kA circuit-breaker

Rated short-circuit breaking current I_{SC} (3 s)	**[kA]**	**50**		**63**		**72**		**80**	
DC component of rated short-circuit breaking current	[%]	75		70		70		70	
Asymmetrical breaking current	[kA]	73		89		101		113	
Rated short-circuit making current	[kA]	137		173		197		219	
Generator short-circuit breaking current $I_{SC\ gen}$	**[kA]**	**25** [1)]	**25** [2)]	**31.5** [1)]	**25** [2)]	**36** [1)]	**25** [2)]	**40** [1)]	**40** [2)]
DC component of short-circuit breaking current	[%]	110	130	120	130	110	130	110	130
Asymmetrical breaking current	[kA]	46	52	62	52	67	52	74	84
Rated currents	**[A]**	**4,000; 5,000; 6,300; 8,000; 10,000; 12,000**							
Rated voltage 17.5 kV 50/60 Hz; U_p = 110 kV; U_d = 50 kV		**3AH3732**		**3AH3733**		**3AH3734**		**3AH3735**	
Rated voltage 24 kV 50/60 Hz; U_p = 125 kV; U_d = 60 kV		**3AH3742**		**3AH3743**		**3AH3744**		**3AH3745**	
Rated operating sequence									
– For short-circuit breaking current		CO – 30 min – CO, up to 30 short-circuit breaking operations Further operating sequences possible: O – 3 min – CO – 3 min – CO, ...							
– For operating current		CO – 3 min – CO, up to 10,000 operating cycles							

U_p = Rated lightning impulse withstand voltage U_d = Rated short-duration power-frequency withstand voltage *Higher ratings on request

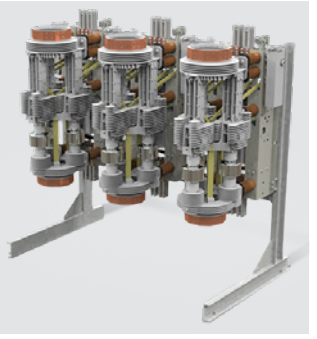
[1/ 2)] Class G1/ Class G2 – Classification IEC/IEEE 62271-37-013

3AH36 110 kA – phase-segregated

The circuit-breaker module solution for phase-segregated design

The 110 kA generator circuit-breaker module was developed especially for straight-line current carrying, such as is required in compact generator switchgear. The following options have been integrated:

- Main disconnector
- Transformer-side earthing switch
- Generator-side earthing switch
- Starting switch



3AH36 generator circuit-breaker module

Installation of the 3AH36 generator circuit-breaker module solution on a common frame as a HB3-C retrofit solution

3AH36 generator circuit-breaker module solution is also used single-pole enclosed in the Siemens HB3 switchboard.

Rated short-circuit breaking current I_{SC} (3 s)	**[kA]**	**63**	**80**	100	**110**
DC component of rated short-circuit breaking current	[%]	70	70	75	60
Asymmetrical breaking current	[kA]	89	113	146	144
Rated short-circuit making current	[kA]	173	219	274	302
Generator short-circuit breaking current $I_{SC\ gen}$	**[kA]**	**31,5**[2)]	40[2)]	63[2)]	75[2)]
DC component of short-circuit breaking current	[%]	130	130	130	130
Asymmetrical breaking current	[kA]	66	84	132	157
Rated currents	**[A]**	**8,000; 10,000; 12,500; 14,000**			
Rated voltage 17.5 kV 50/60 Hz; U_p = 110 kV; U_d = 50 kV		**3AH3613**	**3AH3615**	**3AH3617**	**3AH3618**
Rated voltage 24 kV 50/60 Hz; U_p = 125 kV; U_d = 60 kV		**3AH3623**	**3AH3625**	**3AH3627**	**–**
Rated operating sequence					
– For short-circuit breaking current		CO – 30 min – CO, up to 30 short-circuit breaking operations Further operating sequences possible: O – 3 min – CO – 3 min – CO, ...			
– For operating current		CO – 3 min – CO, up to 10,000 operating cycles			

U_p = Rated lightning impulse withstand voltage U_d = Rated short-duration power-frequency withstand voltage

[2)] Class G2 – Classification IEC/EEE 62271-37-013

More than a good technology

The Siemens performance portfolio – from consultancy to a reliable switchgear

Sectional view of a vacuum interrupter

Correct selection of the generator circuit-breaker

Selection criteria are:

- Rated voltage
- Rated current
- Response to System-side short circuit
- Response to Generator-side short circuit

Design for normal operation

In the vicinity of generators, special conditions arise. Thus, every application is specifically adapted to the customer's requirements.

Basis for the solutions is the application guide in IEC / IEEE 62271-37-013.

Design for the case of fault

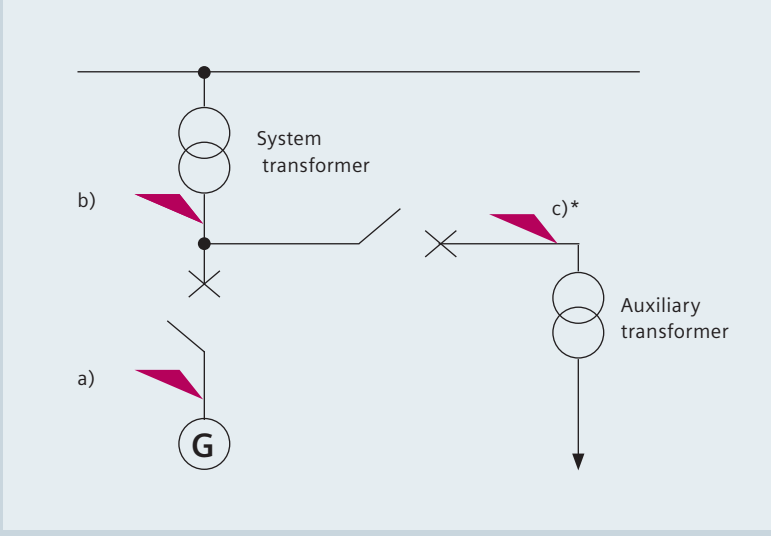
In general, the symmetrical system-side short-circuit current (case of fault a) is higher than the generator-side short-circuit current (case of fault b), and therefore determines the required breaking capacity of the generator circuit-breaker.

The DC component of the generator-side short-circuit current is higher, which must also be taken into account for assessment of the breaking capacity.

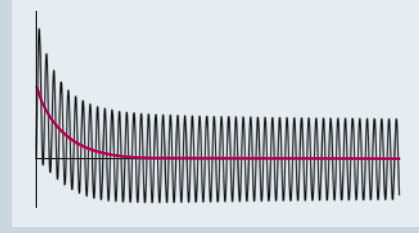
Overvoltage protection measures

From the view of the vacuum switching principle, no overvoltage protection measures are necessary for switching generators, unless the short-circuit current of the generator is smaller than 600 A. However, surge arresters are usually equipped for this switching application in order to protect the expensive equipment from all other overvoltages.

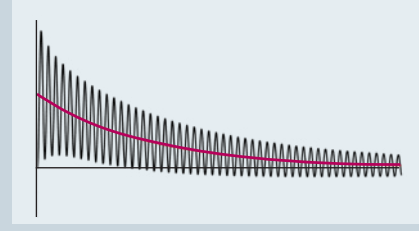
In the case of fault, two different fault current components overlap.
The short-circuit current component to be interrupted is supplied by
a) High-voltage system or
b) Generator or
c) High-voltage system and generatorr



* The fault currents are superimposed in fault location c).



Fault location a: System source shortcircuit with continuous AC component



Fault location b: Generator-Generator source short-circuit with zero missing

You know your application and we know the behaviour and features of our switching devices.

Together we work out the perfect solution for your application.

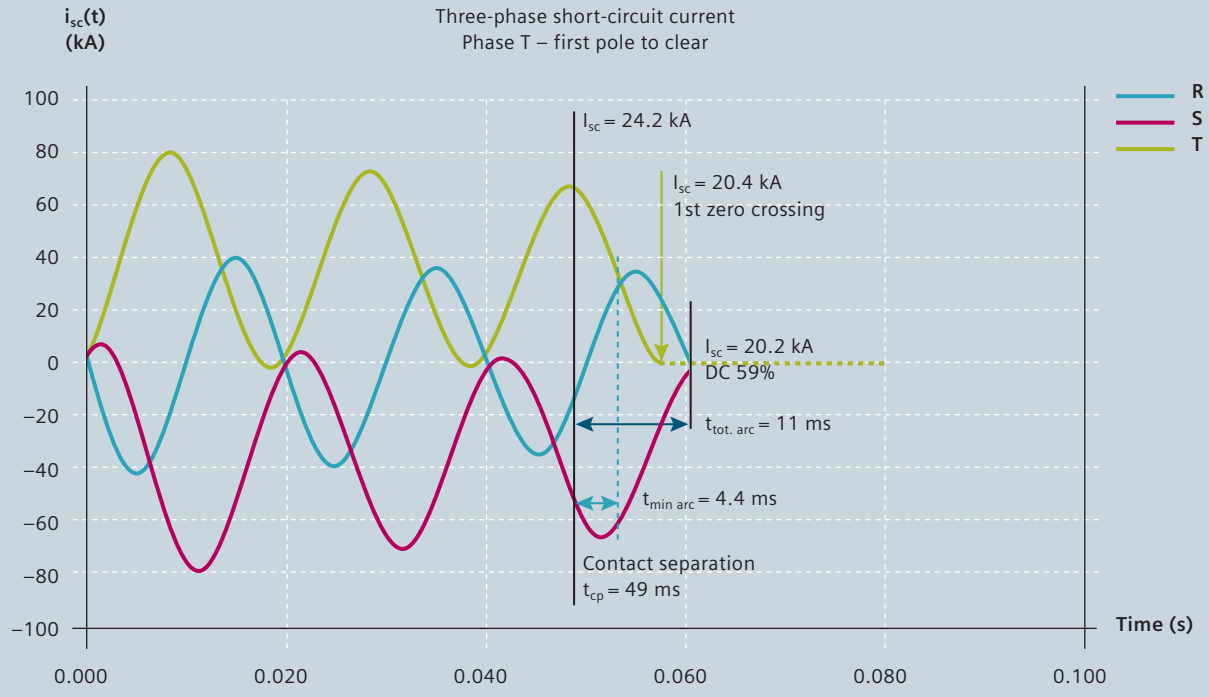
For this purpose, we kindly ask you to submit the following data:

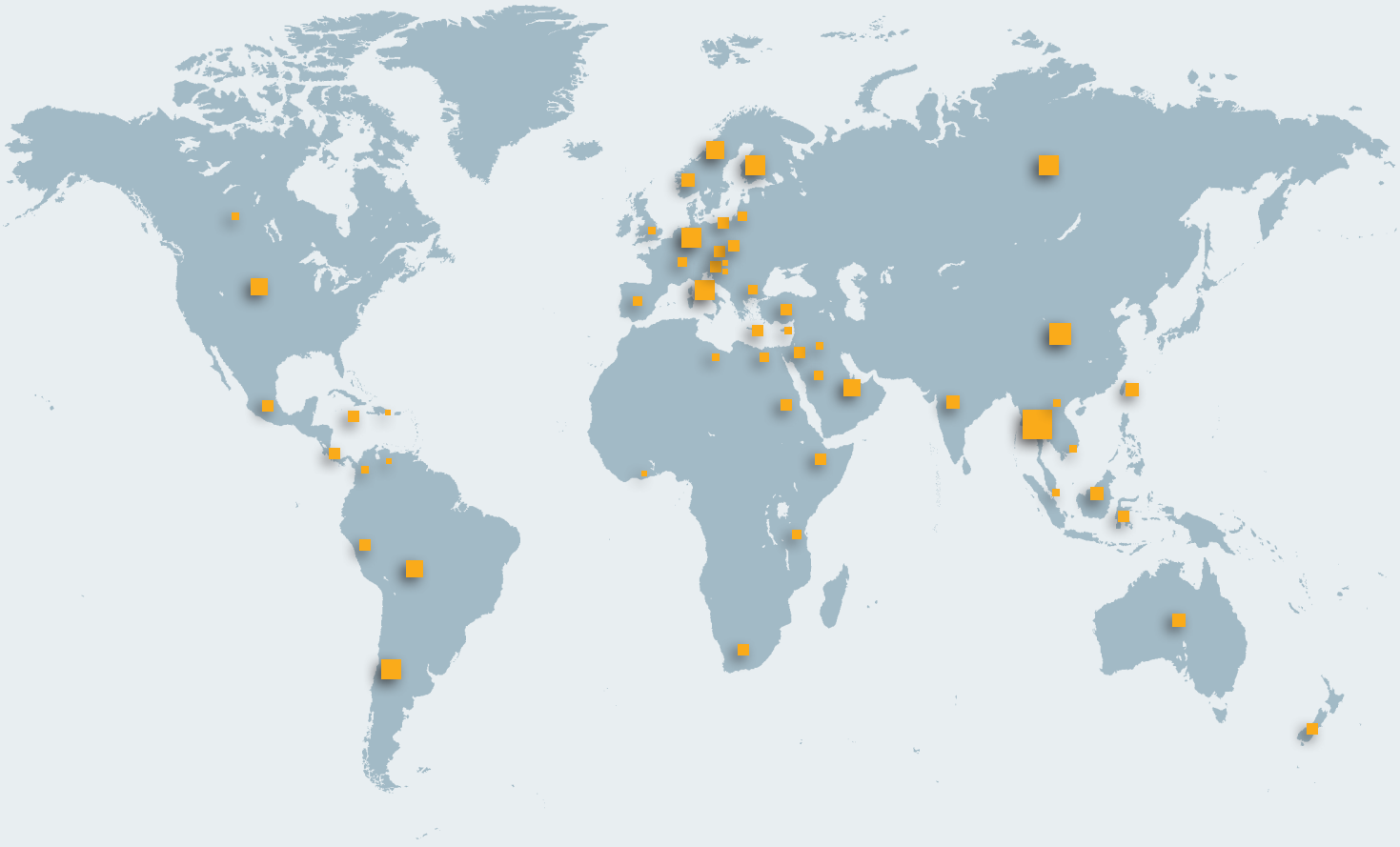
- Data sheets of:
  - Generator
  - Transformer
  - Auxiliary transformer & motors, if applicable
- Single-line diagram
- Information on equipment operation, e.g. interconnected circuits

Based on the information concerning your application, our experts select a circuit-breaker which is suitable for all service conditions, including protection in case of fault.

Among other things, the result of the calculations contains a graphical representation of the current characteristics, as shown below:

Basic representation of the analysis for the case of fault





More than
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years of
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More than
3,650
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in 57 countries

1st
company to introduce
110 kA generator
vacuum circuit-breaker

Securing more than
80 GW
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production

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Printed in Germany
TH 260-120542 WS 04130.5

Article No. EMLP-B10161-00-7600