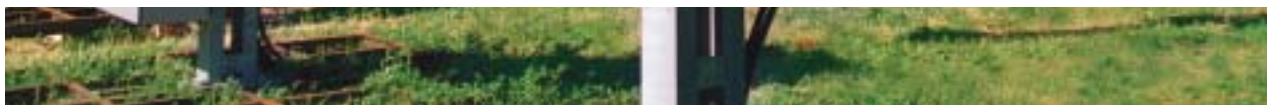




High-Voltage Circuit-Breakers 3AP1/2 72.5 kV up to 550 kV

Power Transmission and Distribution

SIEMENS



The 3AP1/2 High-Voltage Circuit-Breakers Now Applicable for 550 kV

Decades of our experience in high-voltage switching technology go into the design and production of the 3AP1/2 circuit-breakers which set an international trend. We are a powerful partner for our customers and a competent supplier of attractive products and solutions at competitive prices with the high standard of quality that Siemens is known for. We comply with our customers' demands for reliability, safety and cost-effectiveness and serve them throughout the world. No matter what your application is, the 3AP1/2 circuit-breakers provide the best solution for your requirements every time.

Our standard is reliability and safety at all times

The 3AP1/2 circuit-breaker family is available for rated voltages from 72.5 kV up to 550 kV. The latest development of our well established circuit-breakers completes our 3AP product range for rated voltages up to 550 kV. For the application of 362 kV up to 550 kV the circuit-breakers can be equipped with optional closing resistors. It features approved technology and ensures efficient operation. Based on our well proven modular design, we manufacture all of the core components ourselves, which include the stored-energy spring mechanism and the arc-assisted interrupter unit.

More than **50,000 3AP-circuit-breakers** have been **delivered to over 120 countries** around the world in all climatic areas, proving on a daily basis the value and the reliability of the 3AP high-voltage switchgear. The 3AP1/2 high-voltage circuit-breaker operates safely and is capable of withstanding high mechanical loads. Particularly strong porcelain insulators and a circuit-breaker design optimized by using the latest mathematical techniques, give it very high seismic stability whilst in operation enabling it to perform to its full potential during its entire service life.



3AP2 FI 420 kV
Live-tank circuit-breaker
in operation at a major
power transmission and
distribution company



With High-Voltage Circuit-Breakers from Siemens **you** are always on the Economically Safe Side



3AP1 FG 145 kV Live-tank circuit-breaker

Great demands for highest quality

Our quality management system, certified in accordance with DIN EN ISO 9001, confirms that our quality always remains at the same high level. We carry out regular management reviews, internal audits in every department and the continuous development and maintenance of documentation for all processes. Most modern manufacturing technologies and investments in our worldwide production sites, assure reliable and **long-lasting products and process quality** according to Siemens' well-proven high standards.

The high quality, as well as excellent operating experience, is inherited by the 3AP series. The result is very high SF₆ tightness of our switchgear: **The SF₆ leakage rate is less than 0.5% per year.** This not only increases reliability and decreases operating costs as a result of long maintenance intervals, but also has a positive impact on the environment; an important indication of our responsibility. Our switchgear will fulfill your demands for low life-cycle-costs with highest availability and economical and continuous operation. Because we use strong materials under low mechanical loads in the construction of individual switchgear components, **maintenance is not needed for 25 years or 10,000 operating cycles.** By standardizing our internal processes and systematically implementing module strategies for our 3AP product series, we can offer minimal **delivery times.**

The result is low service and investment costs which provide our customers competitive advantages worldwide, which equates to greater success for their own businesses.

The Structure



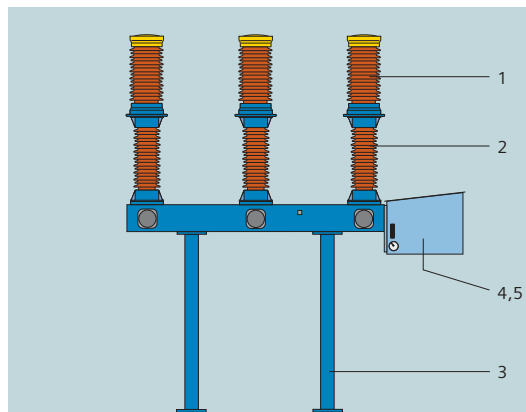
The self compression arc-quenching principle is applied in our 3AP circuit-breakers.

The arc-assisted interrupter unit of the 3AP circuit-breaker utilises the energy of the arc during opening for an optimal arc quenching, allowing to reduce the operating energy to a minimum. Our circuit-breakers for the voltage range 72.5 kV up to 300 kV have one interrupter unit per pole and up to 245 kV the circuit-breakers are available with a common or a single-pole operating mechanism. 3AP high-voltage circuit-breakers from 362 kV up to 550 kV are equipped with two interrupter units per pole. For special technical requirements, e.g. increased TRV values,

the breakers are available with four interrupter units.

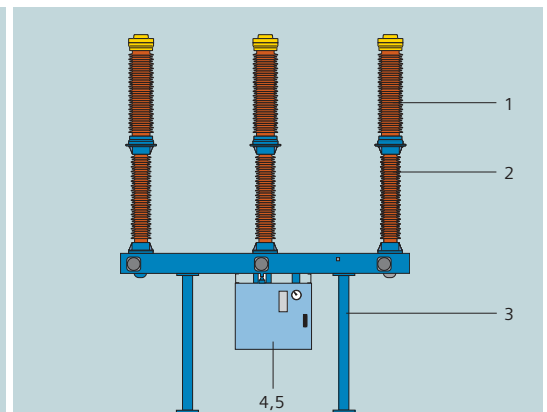
The stored-energy spring mechanism

The compact design of this operating mechanism allows to place the stored-energy spring mechanism within the control cubicle. The main components such as the interrupter unit and the operating mechanism of our 3AP1/2 high-voltage circuit-breakers, are identical to the ones in our 3AP deadtank circuit-breaker family. By applying this proven modular design we can fulfill the highest expectation with regard to availability, reliability, as well as economical performance. This results in continuously high customer satisfaction.



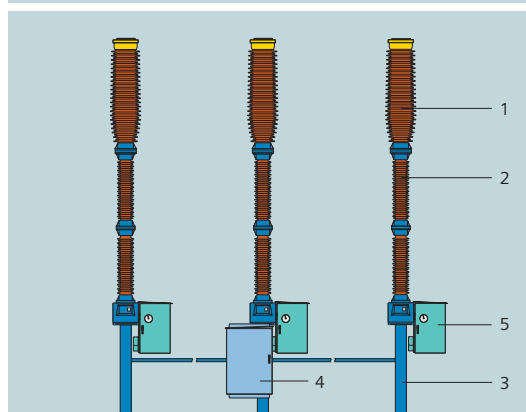
3AP1 FG up to 72.5 kV
One interrupter unit per pole.

Laterally stored-energy spring mechanism, circuit-breaker with common breaker base for three-pole operation



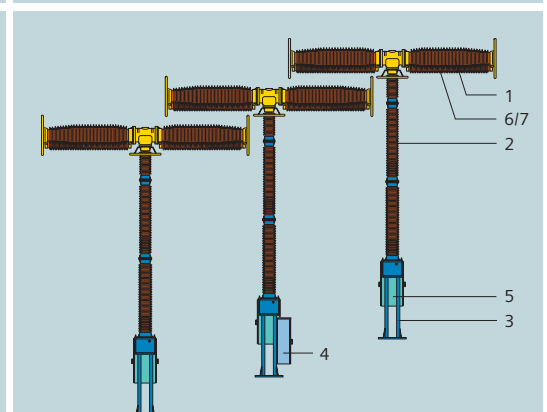
3AP1 FG up to 245 kV
One interrupter unit per pole.

Stored-energy spring mechanism, circuit-breaker with common breaker base for three-pole operation



3AP1 FI up to 300 kV
One interrupter unit per pole.

Stored-energy spring mechanism, three-pole breaker with separate breaker base, for one or three-pole operation



3AP2 FI up to 550 kV
Two respectively interrupter units per pole.

Stored-energy spring mechanism, circuit-breaker with separate breaker base for one or three-pole operation

3AP circuit-breakers are available in different designs

- 1 Interrupter unit
- 2 Post insulator
- 3 Pillar
- 4 Control cabinet
- 5 Operating mechanism cubicle
- 6 Grading capacitor
- 7 Closing Resistor (optional)

The Quenching Principle

The conducting path

The current conducting path of the interrupter unit consists of the contact carrier (1), the base (6) and the moveable contact cylinder (5). In the closed position, the current flows via the main contact (2) and the contact cylinder (5).

Breaking operating currents

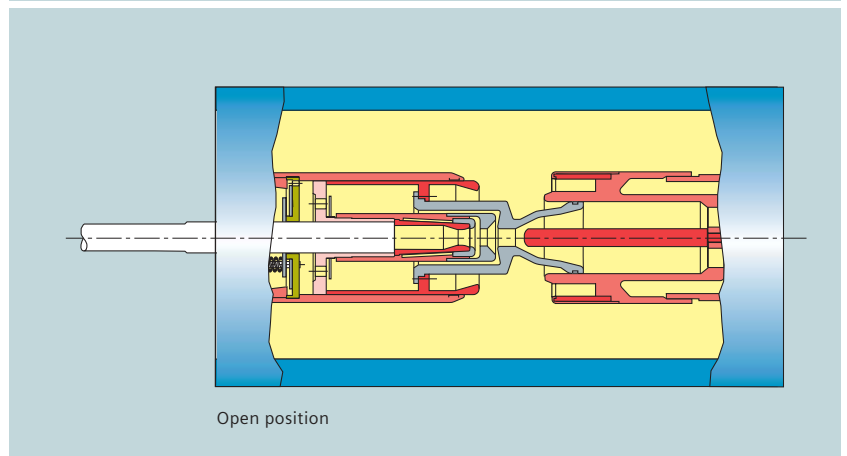
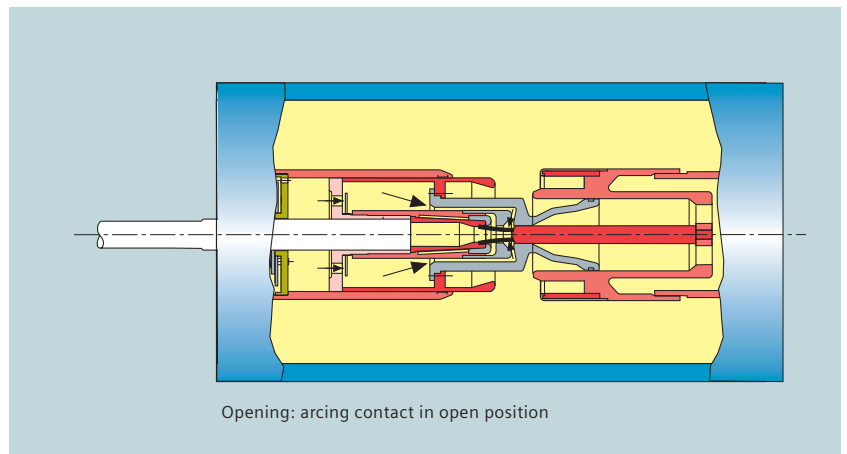
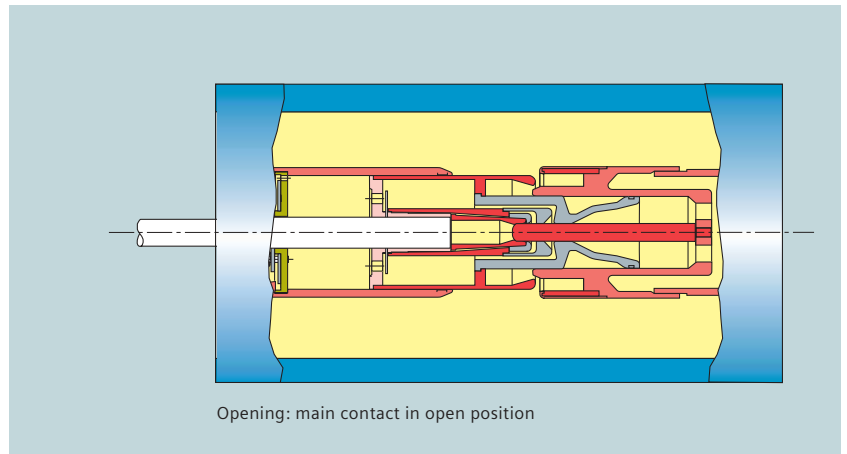
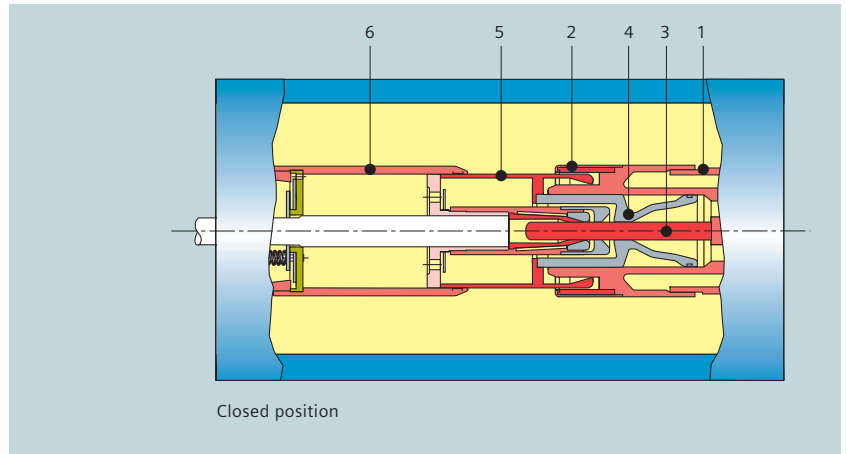
During the opening operation, the main contact (2) opens first, and the current commutates to the still closed arcing contact. During the further course of opening the arcing contact (3) opens and an arc is drawn between the contacts. At the same time, the contact cylinder (5) moves into the base (6) and compresses the SF₆ gas located there. This gas compression creates a gas flow through the contact cylinder (5) and the nozzle (4) to the arcing contact extinguishing the arc.

Breaking fault currents

In the event of interrupting high short-circuit breaking current, the SF₆ gas is heated up considerably at the arcing contact due to the energy of the arc. This leads to a pressure increase in the contact cylinder. During the further course of opening this increased pressure initiates a gas flow through the nozzle (4) extinguishing the arc. In this case, the arc energy is used to interrupt the fault circuit breaking current. This energy needs not to be provided by the operating mechanism.

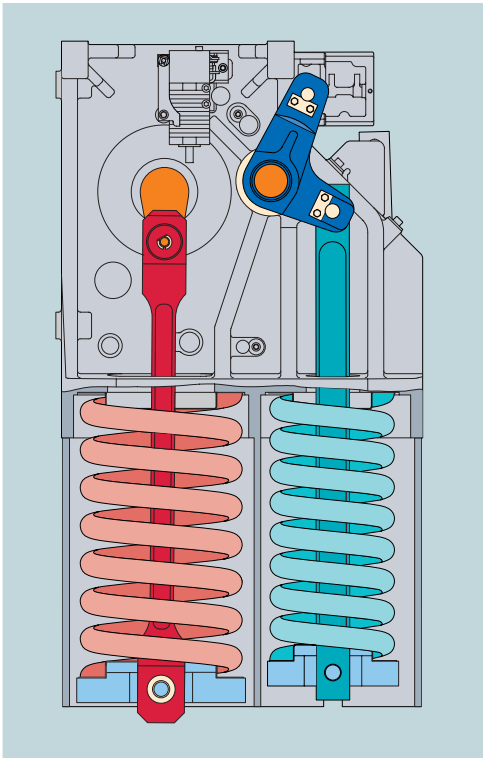
The interrupter unit of the 3AP circuit-breaker is very efficient

A fixed arcing contact is used for rated voltages up to 145 kV. This results in a reduced number of mechanical parts in the interrupter unit.



- 1 Contact carrier
- 2 Main contact
- 3 Arcing contact
- 4 Nozzle
- 5 Contact cylinder
- 6 Base

The Stored-energy Spring Mechanism



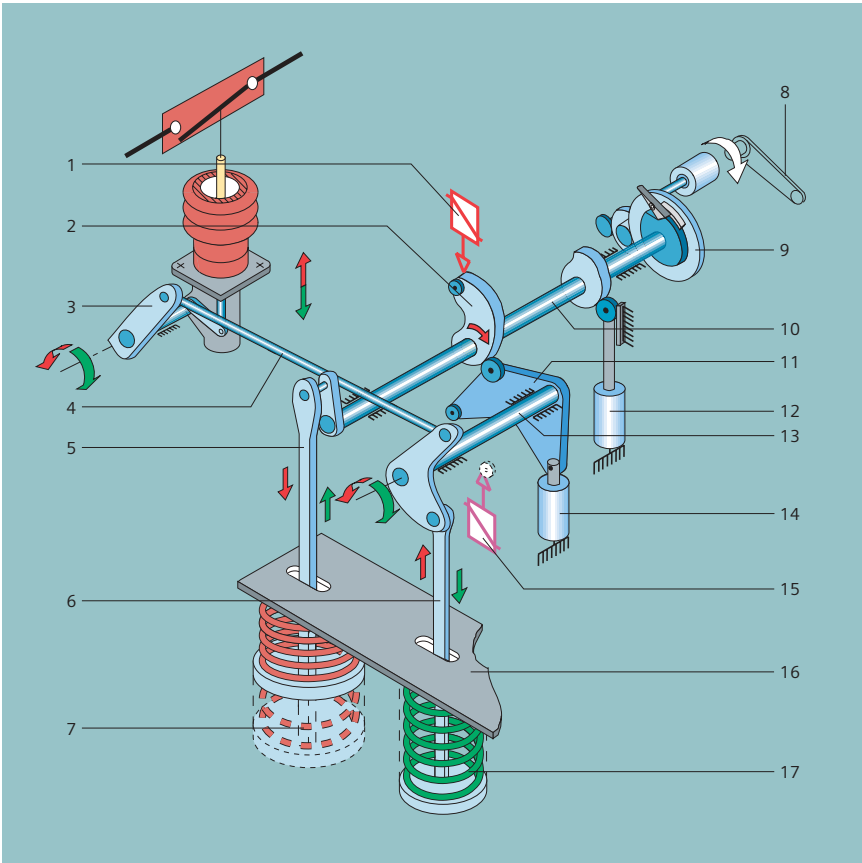
The advantages of the stored-energy spring mechanism:

- Same principle for rated voltages from 72.5 up to 550 kV
- High reliability thanks to low operating energy
- Simple principle of operation
- Controllable switching state at all times
- Low maintenance, economical and long lifetime
- Low environmental impact

There are a number of advantages to our stored-energy spring mechanism

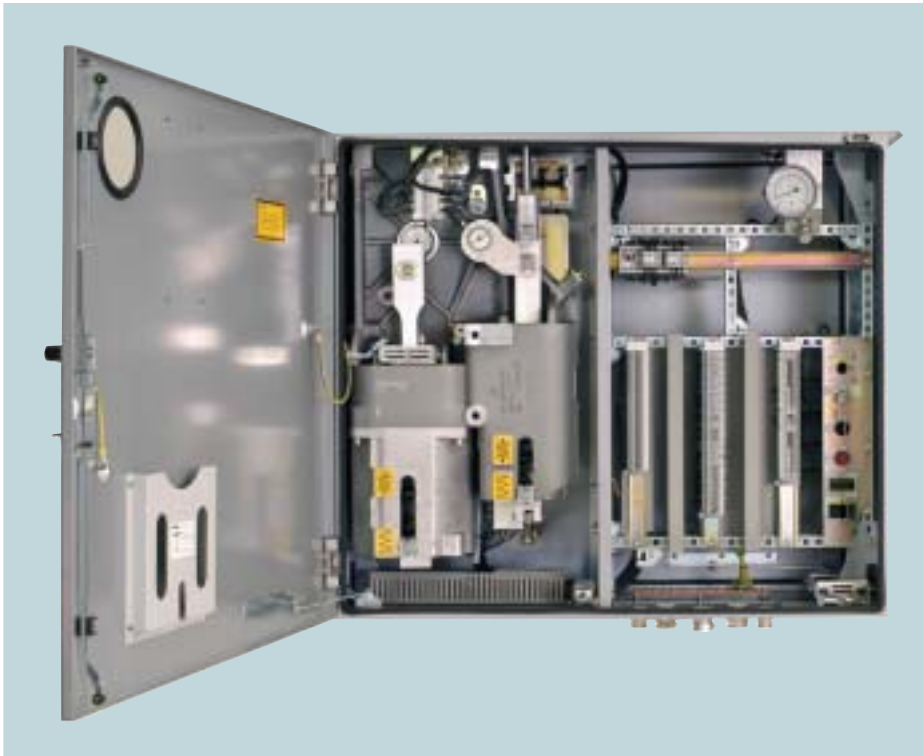
Compact housing can be utilized by applying the most modern production techniques. Since the closing and opening springs are housed in the operating mechanism, a compact and sturdy structure is achieved.

This design results in a small number of moving parts. The use of roller bearings and the maintenance-free spring mechanism are a prerequisite for decades of reliable operation. Proven design principles such as vibration-isolated latches and load-free isolation of the charging mechanism are retained.



- 1 Trip coil CLOSE
- 2 Cam plate
- 3 Corner gear
- 4 Connecting rod
- 5 Connecting rod for closing spring
- 6 Connecting rod for opening spring
- 7 Closing spring
- 8 Emergency hand crank
- 9 Charging gear
- 10 Charging shaft
- 11 Roller lever
- 12 Damper (for closing)
- 13 Operating shaft
- 14 Damper (for opening)
- 15 Trip coil OPEN
- 16 Drive mechanism housing
- 17 Opening spring

The Control



Control cabinet with the stored-energy spring mechanism

The control system includes all the secondary components required for operating the circuit-breaker, most of them are located in the control cabinet. The control, tripping, motor and heating power supplies are, to a great extent, selectable. Depending on customers requirements requirements, two standard control variants are available.

Basic variant

The basic variant includes all control and monitoring elements that are needed for operation of the circuit-breaker. In addition to the elementary actuation functions, it includes:

- 19 auxiliary switch contacts (9 normally open, 9 normally closed, 1 passing contact)
- Switching operation counter
- Local actuator

Compact variant

In addition to the basic variant, this variant includes:

- Spring monitoring by motor run time monitoring
- Heating monitoring (current measuring relay)
- Light and socket attachment with a common circuit-breaker to facilitate servicing and maintenance work
- Overvoltage attenuation
- Motor circuit-breaker
- Heating circuit-breaker

Special features

Above and beyond these two standard variants, a great number of further components and options are at our customers' disposal. Every control configuration of a circuit-breaker can therefore **be designed individually**. All control components have been type-tested for use on

our circuit-breakers and are all located in a weatherproof cubicle (IP 55 degree of protection). They are resistant to switching vibrations, and meet the requirements for electromagnetic compatibility (EMC).

The circuit-breaker documentation includes the wiring diagram of the control configuration. This diagram comprised the following documents:

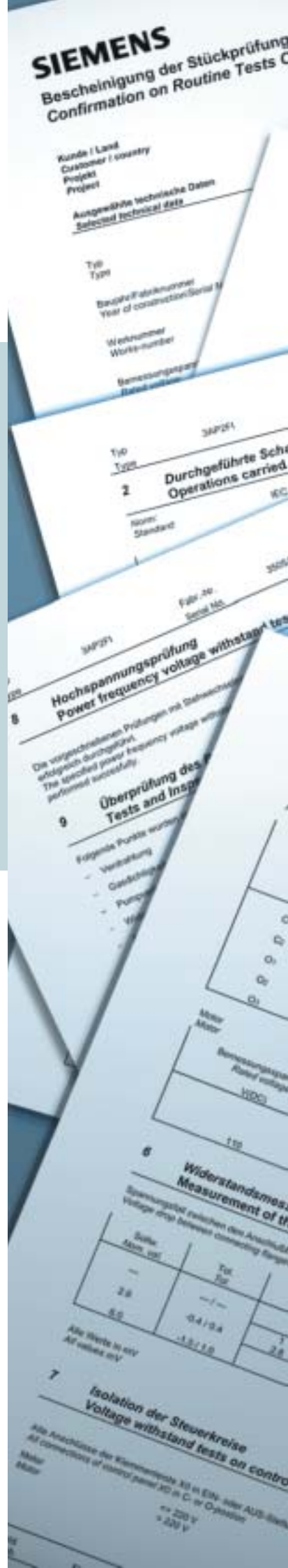
- Location diagram
- Circuit diagram
- Extended equipment diagram along with technical data and equipment parts list
- Connection diagram

The circuit diagram documentation is bilingual in one common customer specific language and in German.

Quality Right from the Start



3AP2 FI 550 kV Live-tank circuit breaker at our high-voltage testing laboratory



Development

The foundations for the quality of Siemens high-voltage circuit-breakers is laid down right from the beginning of the development of a new product. Switching performance, high-voltage stability and performance under mechanical loads (wind and short circuits) and during an earthquake are simulated and optimized in the outline design phase using computer-aided calculations.

The use of common parts and assembled units in a large number of breaker types such as live-tank, dead-tank, as well as in the GIS means the production of a large number of the same type of main components. Steady and regular quantities of produced units allow a continuous production process and ensure the highest quality standards. Statistic quality control is based on large quantities. This results in a higher achieved validity.

All 3AP1/2 circuit-breakers can be used in earthquake areas up to 0.5 g without additional fittings.

Testing laboratories

In our Berlin circuit-breaker plant, there are most modern testing laboratories, in which all required facilities are available:

- Physics laboratory
- High-voltage testing laboratory
- Switching performance testing laboratory
- Mechanical testing laboratory
- Temperature rise testing laboratory

The testing laboratories are certified by the German accreditation body Technik e.V. in accordance with DIN 45001. With the society for electrical high-power tests (PEHLA), the testing laboratories are part of the European network of independent testing organizations (STL). The 3AP1/2 circuit-breakers are fully typetested in accordance with the new IEC 62271-100 and ANSI-Standard.



Routine testing

The main components of the circuit-breakers are subjected to complete pre-acceptance testing before assembly. Based on this quality level, it is possible to confirm a leakage rate of less than 0.5% per year for the circuit-breaker. Each circuit-breaker is completely assembled in the test bay. The product specific inputs for computer-assisted routine testing are imported automatically from the order processing tools. This ensures that in addition to the standard test procedure the fulfillment of every customer requirement is checked before delivery.

Routine testing is performed in accordance with the IEC- or ANSI-standards and it includes at least the following operations and measurements:

- Series of 100 mechanical switching cycles
- Switching time determination
- Release and motor currents
- Gas monitoring
- Testing of control circuits in accordance with the circuit diagram
- Voltage drop of the main conducting path
- High voltage tests

Installation – Simply Easy



Installation and commissioning

The circuit-breaker is dismantled into few subassemblies for transportation. Transportation costs are minimized by using a very compact transport unit and by packing several circuit breakers together into one transportation unit.

The subassemblies can be quickly assembled into a complete circuit-breaker on site.

The 3AP circuit breakers can be installed by a single installation fitter:

- 3AP1
one working day
- 3AP2
two working days

No special tools are required

Service by the manufacturer is available to the operator

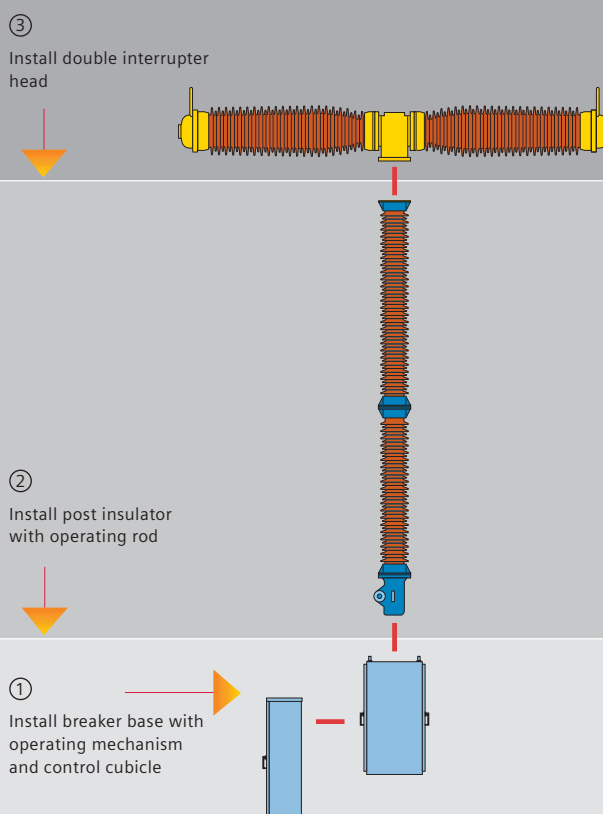
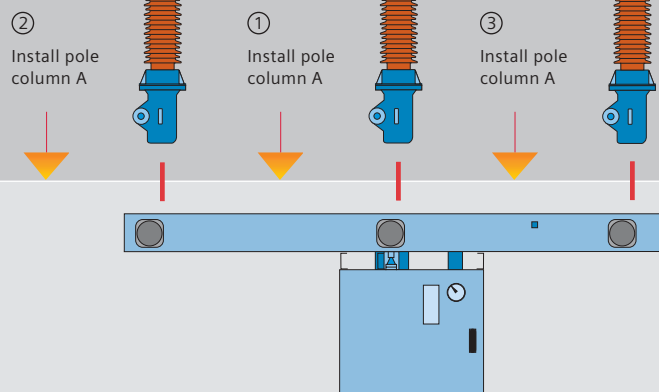
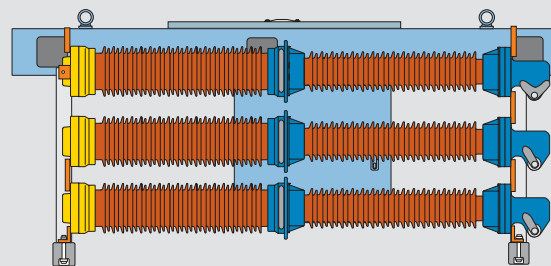
Throughout the entire service life of the circuit-breaker we provide installation and commissioning and any other services on request.

The first visual inspection of the circuit-breaker is not necessary until after 12 years, and the first **maintenance** is recommended **after 25 years**.

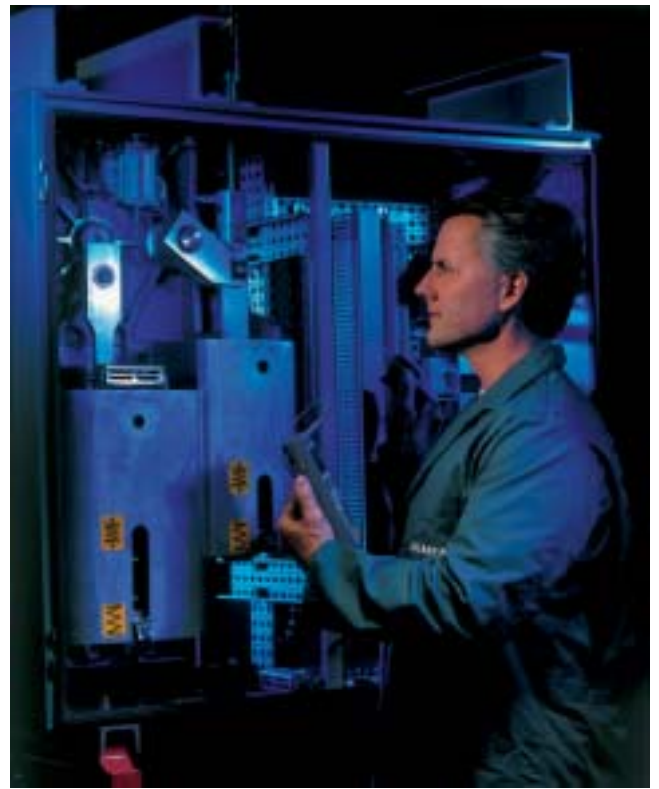
Depending on customer requests, different diagnostic tools can be offered.

A worldwide **24 hours service** is available, which immediately sends out service personnel and/or delivers spare parts as needed.

Transport unit of a
3AP1 FG 145 kV
Live-tank circuit-breaker



Technical Data



Type		3AP1						3AP2			
Rated voltage	kV	72.5	123	145	170	245	300	362	420	550	
Number of interrupter units per pole		1						2			
Rated power frequency withstand voltage/min	kV	140	230	275	325	460	460	520	610	800	
Rated lightning impulse withstand voltage/min	kV	325	550	650	750	1050	1050	1175	1425	1550	
Rated switching impulse withstand voltage	kV	850						950	1050	1175	
Rated normal current, up to	A	4000	4000	4000	4000	4000	4000	5000	5000	5000	
Rated short-time withstand current (1 s - 3 s), up to	kA _(rms)	40	40	40	40	50	40	50	50	63	
Rated peak withstand current, up to	kA _(peak)	108	108	108	108	135	108	170	170	170	
Rated short-circuit breaking current, up to	kA _(rms)	40	40	40	40	50	40	63	63	63	
Rated short-circuit making current, up to	kA _(peak)	108	108	108	108	135	108	170	170	170	
Temperature range	°C	-30 or -40 ... +40 or +50									
Rated operating sequence		0-0.3 s-CO-3 min-CO or CO-15 s-CO									
Rated break time		3 cycles						2 cycles			
Rated frequency	Hz	50/60									
Type of drive mechanism		Stored-energy spring mechanism									
Control voltage	V _{DC}	48...250									
Motor voltage	V _{DC}	48/60/110/125/220/250 or									
	V _{AC}	120...240, 50 Hz; 120...280, 60 Hz									
Flashover distance	phase/earth	mm	700	1250	1250	1500	1900	2200	3400	3400	3800
	across open breaker	mm	1200	1200	1200	1400	1900	2200	3200	3200	3800
Min. creepage distance	phase/earth	mm	2248	3625	3625	4250	6125	7626	10375	10375	13750
	across open breaker	mm	3625	3625	3625	4250	6125	8575	10500	10500	13750
Dimensions	height	mm	3810	4360	4360	4810	6050	6870	6200	6200	7350
	width	mm	3180	3880	3880	4180	6640	8235	8847	9847	13050
	depth	mm	660	660	660	660	880	880	4380	4380	5050
Phase spacing (min.)	mm	1350	1700	1700	1850	2800	3600	4000	4500	6000	
Circuit-breaker weight	kg	1350	1500	1500	1680	2940	3340	5370	5370	7160	
Maintenance after		25 years									

Values in accordance with IEC, other values available on request

For further Information

Please fax this page
to the following number:
Fax **+49 30/386-25867**
or send us an e-mail:
circuit-breaker@siemens.com

Name

Position

Company

Street

Postcode/City/Country

Phone/Fax

Please send me more information on the following topics:

- High-voltage circuit-breakers for outdoor installation
- Live-tank and dead-tank high-voltage circuit-breakers technology
- High-voltage compact switchgear 3AP1 DTC for 145 kV
- Eliminate stress: Controlled switching of high-voltage circuit-breakers
- SF₆ in power engineering – acting responsibly
- Ruhrtal – Disconnectors and Earthing Switches
- Further copies of this brochure

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www.siemens.com/ptd

The information in this document contains general descriptions of the technical options available, which do not always have to be present in individual cases. The required features should therefore be specified in each individual case at the time of closing the contract.

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