

The Siemens logo is displayed in a teal, sans-serif font within a white rectangular box in the top left corner of the image. The background of the entire page is a photograph of a high-voltage electrical substation with multiple circuit breakers and insulators under a clear blue sky.

SIEMENS

From 72.5 kV up to 800 kV

# High-Voltage Circuit Breakers

[www.siemens.com/energy](http://www.siemens.com/energy)





Customized products with the shortest delivery times from our global circuit breaker production network

① Germany

② Russia

③ India

④ China

⑤ USA

⑥ Mexico

⑦ Brazil

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3AP1 FG 145 kV



3AP4 FI 800 kV pole

Live tank circuit breakers

Compact circuit breakers



3AP1 DTC 145 kV



3AP1 DTC 245 kV

## Circuit breakers from Siemens

The availability of electric energy is vital for economic development and for quality of life. One of the necessary conditions for a reliable electric power supply is a well functioning transmission system. We are the only company worldwide that supports customers along the entire chain of energy conversion, with an efficient range of products, solutions and know-how for the transmission and distribution of electrical energy from one source. Circuit breakers are the central part of air-insulated (AIS) and gas-insulated (GIS) switchgear. High-voltage circuit breakers are mechanical switching devices which connect and break current circuits (operating currents and fault currents) and carry the nominal current in closed position.

As a world market leader, Siemens takes the responsibility to provide circuit breakers which meet the environmental, technological and economic conditions in the various countries worldwide. More than 90,000 circuit breakers delivered to more than 140 countries prove this.

In this brochure, we are pleased to inform you about our well established product portfolio in the high-voltage range starting from 72.5 kV up to 800 kV and a brand-new prototype for 1200 kV. It comprises live tank and dead tank circuit breakers as well as hybrid solutions combining different functions in a compact design, such as our Dead Tank Compact (DTC) and our Disconnecting Circuit Breaker (DCB).

All our products are manufactured based on our proven modular design encompassing identical interrupter units, operating mechanisms and control elements for all circuit breaker types, whether for GIS or for AIS applications. They are available with porcelain or composite insulators.

Furthermore, you will find out about our quality management over the product lifecycle from development through to operation at our customers' locations. This quality management covers, among other things, service and customer training.

As an outlook for our future ambitions we are also glad to present you a prototype of the next generation in high-voltage switchgear technology. This new generation of circuit breakers performs completely without SF<sub>6</sub> but with a vacuum interrupter based on 40 years of experience in medium power networks up to 52 kV.

In line with our vision as worldwide trendsetter, Siemens engineers have now advanced this vacuum technology for applications above 52 kV to keep pace with our customers' economical as well as ecological requirements. Siemens has introduced the world's first SF<sub>6</sub>-free circuit breaker with vacuum technology for 72.5 kV. Our daily work is to continue this new trend.

We are looking forward to your feedback, questions and remarks. Please do not hesitate to contact us at [circuit-breaker@siemens.com](mailto:circuit-breaker@siemens.com) or at one of our 1,640 Siemens locations worldwide.



3AP1 DT 145 kV



3AP2 DT 550 kV pole

Dead tank circuit breakers

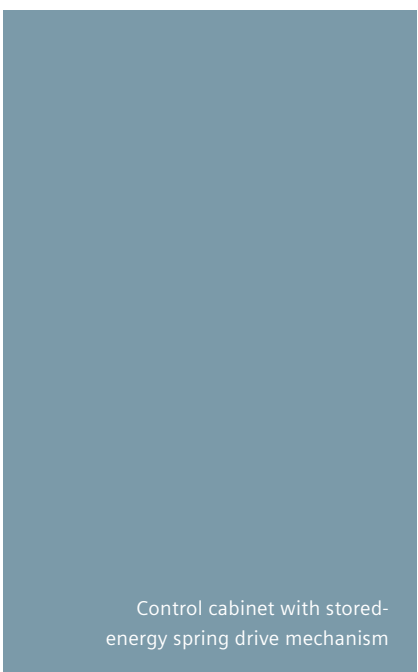
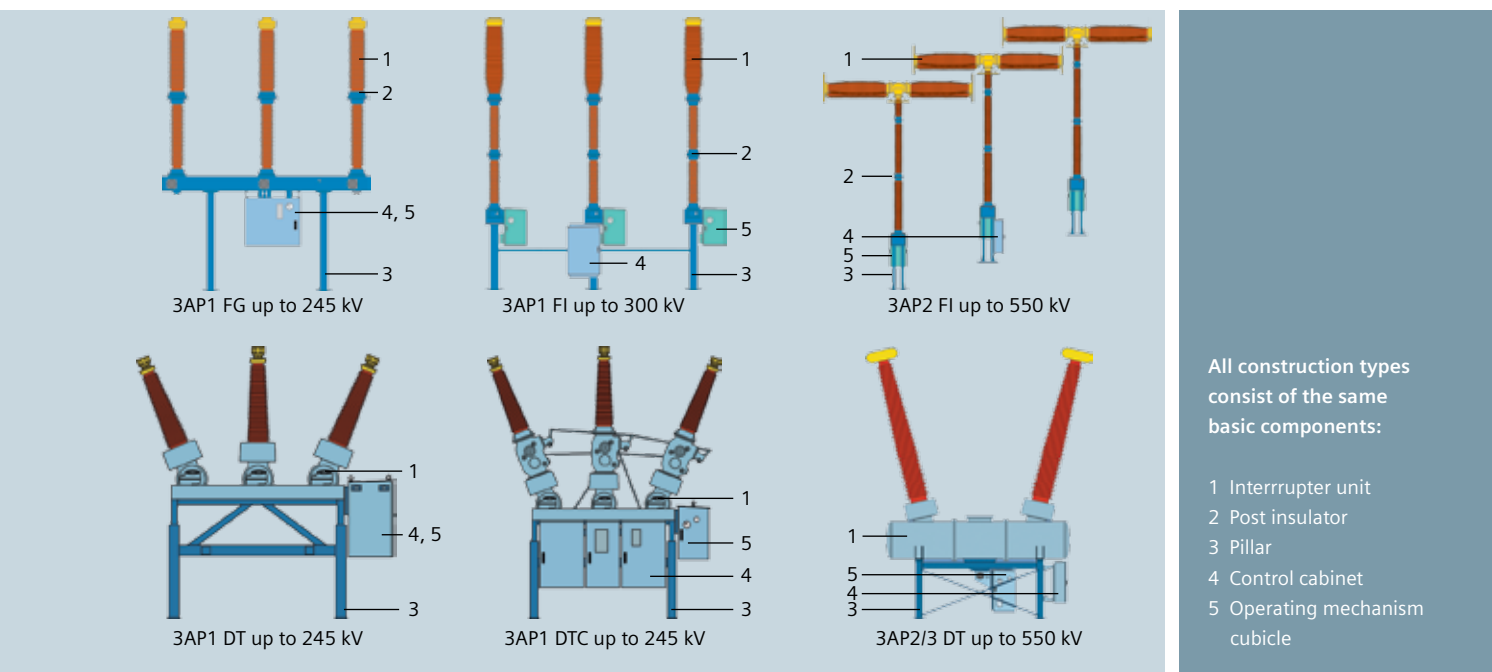
Disconnecting circuit breakers



3AP1 DCB 145 kV



3AP2 DCB 420 kV pole



# Modular design

## Few basic components leading to a high diversity of types

Siemens high-voltage circuit breakers, regardless of type or voltage range, are designed in a well proven modular platform concept. This leads to a high diversity of circuit breaker types and to high flexibility with regard to various applications according to our customers' requirements.

The main components, such as

- operating mechanism
- control system
- base frame
- kinematic chain and
- insulator designs

are identical and based on decades of manufacturing and operating experience. Our GIS switchgear range also includes the same interrupter units, operating mechanisms and control elements. By applying this proven modular design not only at our lead factory in Germany, but also within our global manufacturing network, we are able to fulfill the highest expectations regarding availability and reliability at eminently competitive prices.

This modular principle can also be found in the type definition of our high voltage circuit breakers.

3AP1 FG	Three-pole outdoor circuit breaker
3AP1 FG	Name of circuit breaker series (P, Q, T, V)
3AP1 FG	Interrupter units per pole
3AP1 FG	Spring (F) / hydraulic (E) operated mechanism
3AP1 FG	G: 1 mechanism + 1 common base E: 3 mechanisms + 1 common base I: 3 mechanisms + 3 separate bases
3AP1 DT	DT: Dead Tank DTC: Dead Tank Compact DCB: Disconnecting Circuit Breaker

# Control

The control system includes the secondary technical components required for operating the circuit breaker, which are mainly arranged in the control cabinet. The current transformer connections are also located in the control cabinet. The control, tripping, motor and heating power supplies can be selected by the customer. Two standard control variants are available depending on your requirements.

## Basic variant

The basic variant includes all control and monitoring elements that are needed for operation of the circuit-breaker, including the following:

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

## Compact variant

In addition to the basic variant, this compact 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

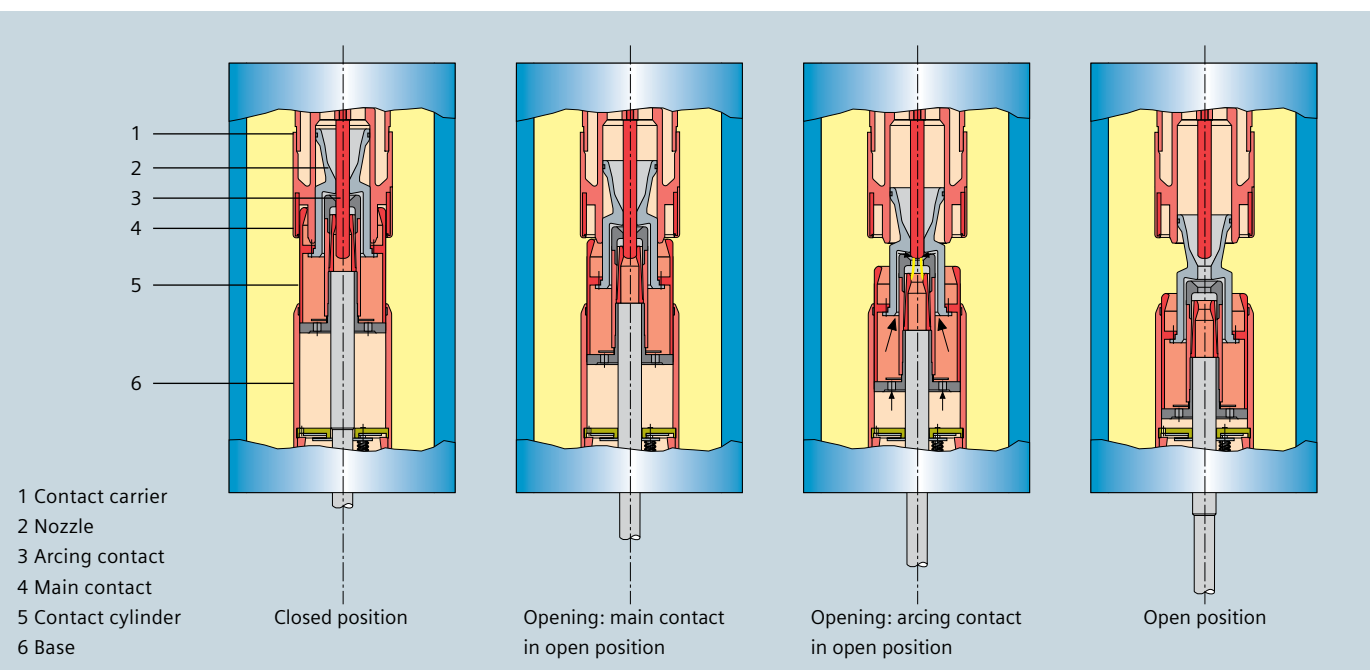
- Overvoltage attenuation
- Motor circuit breaker
- Heating circuit breaker

## Special features

Above and beyond these two standard variants, a large 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. They are completely located in a weatherproof cubicle (IP 55 degree of protection), they are resistant to switching vibrations, and they meet the requirements for electromagnetic compatibility (EMC). The circuit breaker's documentation contains the wiring diagram of the control configuration. This diagram consists of the following documents:

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

Whether our customers prefer the basic variant or the compact variant, we are able to mount them on any circuit breaker of our portfolio. And if a customized control cabinet is needed, we are able to modify the control cabinet according to the customers' wishes.



## Quenching principles

Our complete 3AP family up to 800 kV and above relies on our arc-quenching principles, either the self-compression or the dynamic self-compression principle using the thermal energy of the arc. Siemens patented this method for arc quenching in 1973 and has continued to develop the technology of the self-compression interrupter unit. In short-circuit breaking operations the actuating energy required is reduced to the energy needed for mechanical contact movement.

### Self-compression principle

For applications up to 245 kV, our 3AP circuit breakers with self-compression principle ensure optimum switching performance under every operating condition.

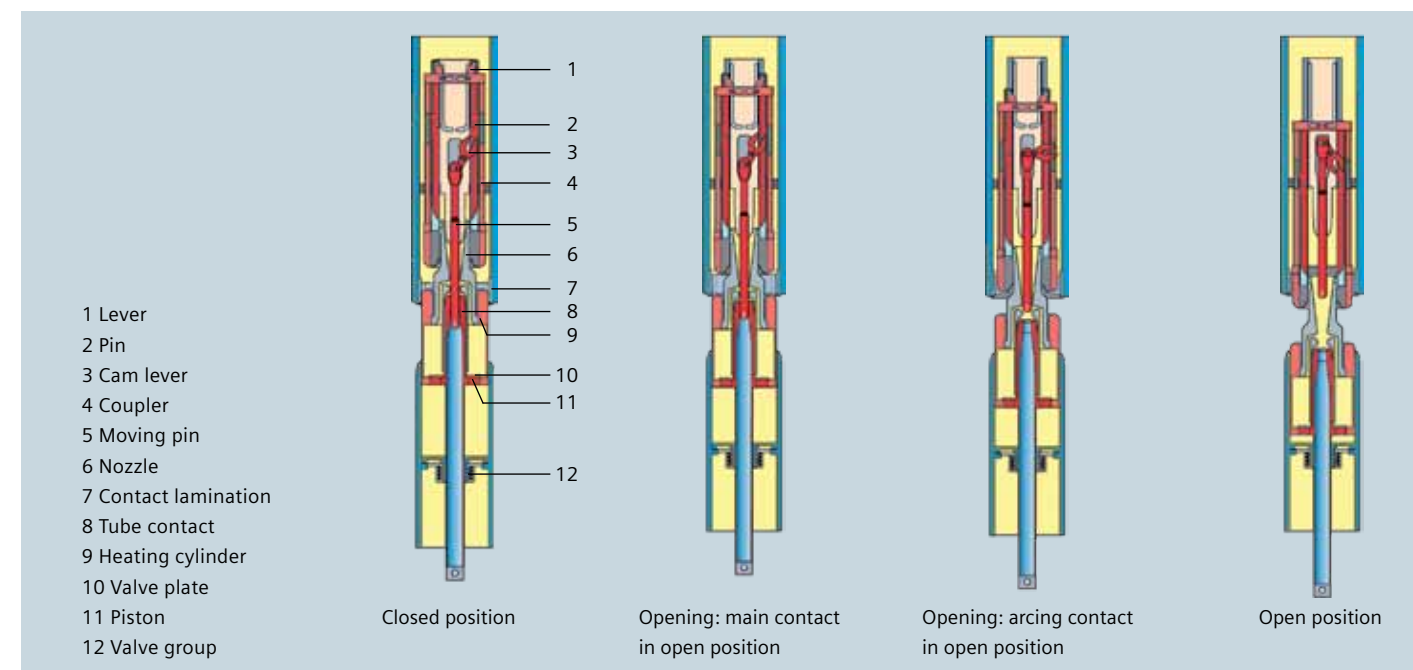
#### Mode of operation

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 (4) and the contact cylinder (5).

During the opening operation, the main contact (4) opens first, and the current commutates to the still closed arcing contact. During the further course of opening, the arcing contact (3) opens up and an arc is drawn between the contacts.

At the same time, the contact cylinder (5) moves into the base (6) and compresses the  $\text{SF}_6$  gas located there. This gas compression creates a gas flow through the contact cylinder (5) and the nozzle (2) to the arcing contact, extinguishing the arc.

When it comes to interrupting a high short-circuit breaking current, the  $\text{SF}_6$  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 (2), extinguishing the arc. In this case, the arc energy is used to interrupt the fault circuit breaking current. This energy does not have to be provided by the operating mechanism.



### Dynamic self-compression principle

From 245 kV onwards, the dynamic self-compression principle with two-way moving contacts is utilized in our 3AP type circuit breakers.

#### Mode of operation

In an opening operation, the main contact located between the contact lamination (7) and the heating cylinder (9) is opened. The arcing contact, consisting of the moving pin (5) and the tube contact (8) remains closed, with the result that the current commutates onto the arcing contact.

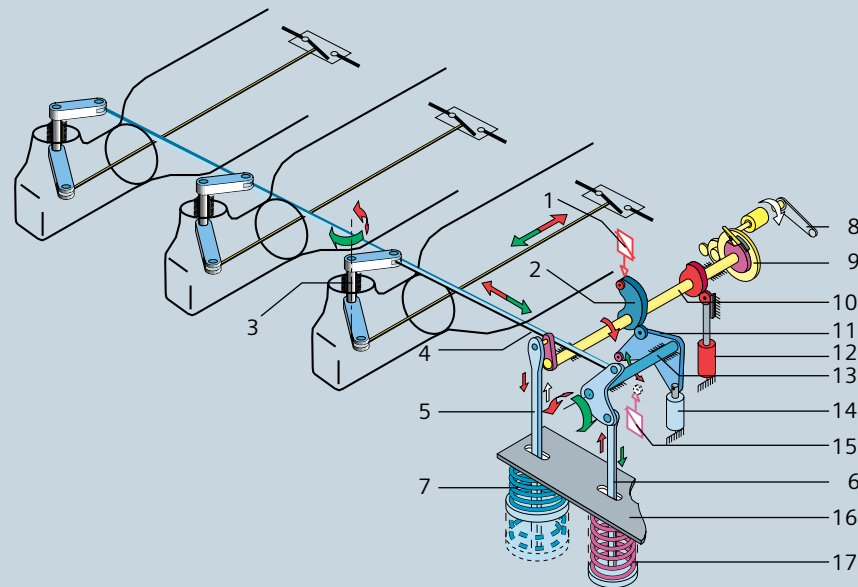
The moving pin (5) is moved against the direction of movement of the tube contact (8) by the connected components of heating cylinder (9), nozzle (6), connecting rod (4), pin (2), control lever (3) (circuit breaker opening movement).

The moved electrode is also pushed in the direction of the heating cylinder (9). During the continued course of the opening operation, the arcing contact opens, creating an arc. At the same time, the heating cylinder (9) moves to the left and compresses the quenching gas between piston (11) and valve group (12).

This causes the quenching gas to be forced in the direction opposite to the movement of the moving contact components through the non-return valve, consisting of piston (11) and valve plate (10), into the heating cylinder and through the gap between the tube contact (8) and the arc quenching nozzle, thus quenching the arc.

With large short-circuit currents, the quenching gas surrounding moving pin (5) in the arcing chamber is heated by the arc's energy and driven into the heating cylinder (9) at high pressure. When the current passes through zero, the gas flows back from the heating cylinder into the nozzle and quenches the arc. When this happens, the valve plate (10) in the heating cylinder (9) prevents the high pressure from entering the compression chamber between piston (11) and the valve group (12).

- 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



## Drive systems

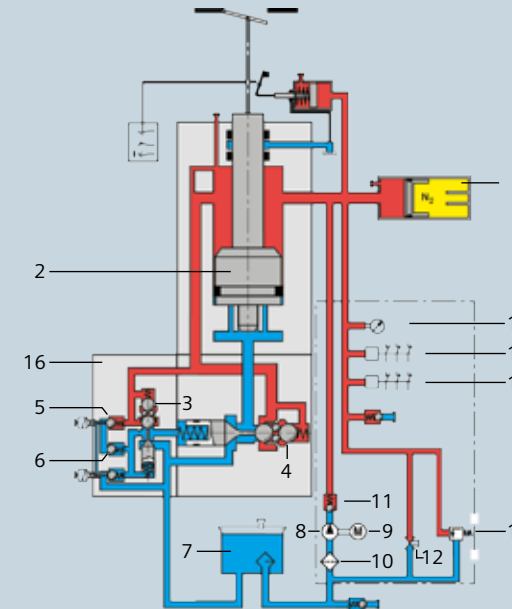
### Stored-energy spring mechanism

The operating mechanism is a central part of high-voltage circuit breakers. The drive concept of the 3AP circuit breaker family is based on the patented stored-energy spring principle and is identical on all types. The use of such an operating mechanism for voltage ranges of up to 800 kV became appropriate as a result of the development of a self-compression interrupter unit that requires minimal actuating energy. The compact design of this operating mechanism makes it possible to place the stored-energy spring mechanism within the control cubicle in a compact housing.

The mechanism types differ in terms of the number, size and arrangement of the opening and closing springs. Both the closing and opening springs are located inside the operating mechanism, thereby achieving a simple and sturdy device. This design minimizes the number of required moving parts. The use of roller bearings and of the maintenance-free charging mechanism is a prerequisite for reliable operation over decades. Proven design principles such as vibration-isolated latches and load-free isolation of the charging mechanism were retained.

#### Advantages of the stored-energy spring mechanism:

- Same principle for rated voltages from 72.5 kV up to 800 kV
- High reliability thanks to low operating energy (10,000 operating cycles guaranteed)
- Fail-safe, economical and persistent due to uncomplicated and robust construction with few moving parts
- Controllable switching state at all times
- Easy access to springs as they are not integrated in SF<sub>6</sub> compartments
- Maintenance-free for 25 years or 6,000 operation cycles
- Low environmental impact compared to former drive systems



- 1 Hydraulic storage cylinder
- 2 Operating piston
- 3 Pilot valve
- 4 Main valve
- 5 Closing solenoid
- 6 Opening solenoid
- 7 Oil tank
- 8 Oil pump
- 9 Motor
- 10 Filter
- 11 Non-return valve
- 12 Pressure compensating valve
- 13 Safety valve
- 14 Pressure gauge
- 15 Pressure monitor
- 16 Compact hydraulic operating mechanism

### Electrohydraulic operating mechanism

The electrohydraulic operating mechanism has been used in 3AT and 3AQ circuit breakers for more than 20 years. Even the highest switching voltages are safely brought under control in the shortest possible time and also the most difficult switching tasks can be mastered.

#### Closing

The main valve (4) is opened electromagnetically. This causes the pressure from the hydraulic storage cylinder (1) to be applied equally to both surfaces of the differential operating piston (2). The force on the side with the larger piston surface is greater and closes the breaker via the connecting rod and operating rod. The operating mechanism is designed such that, in the event of a drop in pressure, the contact position will be maintained.

#### Opening

The main valve (4) is closed electromagnetically. This releases the pressure on the larger of the two piston surfaces and the operating piston (2) moves into the open position due to the pressure differential on the respective piston sides. The circuit breaker is always ready for opening. Two electrically isolated tripping circuits are available, as an option, for reversing the movement of the main valve (4) towards the open position.

#### Advantages of the electrohydraulic operating mechanism:

- High operating energy for the highest switching performance in the shortest possible time
- Contact positions are reliably maintained even if the auxiliary power supply fails
- Multiple reclosure possible without the need for recharging
- Constant self-monitoring
- Checking of energy reserves at any time
- Low-maintenance, economical and long service life
- Meets stringent environmental safety requirements





## Quality right from the start

### Development

The foundation of quality for Siemens high-voltage circuit breakers begins right in the development of a new product. Switching performance, high voltage stability and performance under normal mechanical loads (wind and short circuits) as well as seismic conditions are simulated and optimized in the outline design phase using computer-aided calculations. The use of parts and assembly units in a large number of breaker types such as live tank, dead tank, as well as GIS leads to a high volume standardization of the main components. Steady and regular amounts of produced units form a continuous production process and ensure the highest standards. Statistical quality control is based on large numbers produced, and hence, a higher validity is achieved.

All 3AP circuit breakers are earthquake-proof up to 0.5 g.

All our circuit breakers are completely type-tested in accordance with latest IEC and ANSI standards before their market launch. In our Berlin factory, we have one of the most modern testing laboratories available which are accredited to EN 45001 and part of the European network of the independent testing organization, PEHLA.

All required facilities are available:

- Physics laboratory
- High voltage testing laboratory
- High-power testing laboratory
- Mechanical testing laboratory
- Temperature rise testing laboratory

Other testing laboratories that we work together with are KEMA, CESI, IPH and FGH, which are also part of the European network of independent testing organizations.

### Routine testing

Important components are subjected to complete pre-acceptance testing before assembly. The routine test is performed on the assembled circuit breaker. The specification requirements are automatically imported into the computer-aided routine test plan during order processing. This makes sure that fulfillment of every customer requirement is checked before delivery.

Routine testing is performed in accordance with IEC or ANSI and encompasses the following points at least:

- 100 mechanical operations
- Closing and opening times
- 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 testing
- 2 kV testing of auxiliary circuits

IEC specifies an annual maximum SF<sub>6</sub> leakage rate of 0.5 % or 1 %. Experience from several high and low temperature tests and decades of operational experience show that the leakage rate of Siemens circuit breakers is below even 0.1 % per year.



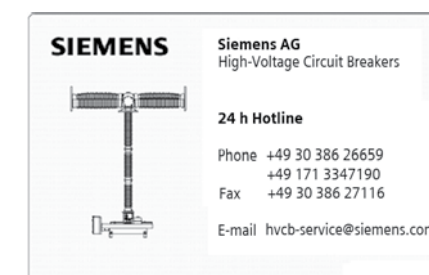
## Easy installation and commissioning

Our circuit breakers for voltage ratings from 72.5 kV to 300 kV can be transported fully pre-assembled and routine-tested. All higher ratings are dismantled into compact, clear and space saving subassemblies for transportation purposes. Transportation costs are minimized by packing several circuit breakers together in one shipment. The subassemblies can quickly be installed into a complete circuit breaker at the switching station. A single supervisor can install one circuit breaker within one and a half days.

Due to the fact that the circuit breaker is already routine-tested in the factory, commissioning can be reduced to a minimum and there is no need for special tools or equipment.

### Lifelong Service for the circuit breaker

We provide installation, commissioning and maintenance on request. And once installed, Siemens high-voltage circuit breakers will operate safely and reliably for years. But in the unlikely event of a fault, you can rely on our worldwide customer support.



We offer service attendance throughout the entire operating life of the circuit breaker. Inspection, maintenance, repair and a round-the-clock fault service give you the necessary backup.

The first inspection of the circuit breaker is necessary after 12 years or 3,000 operation cycles, and the first maintenance is recommended after 25 years or 6,000 operation cycles.

Spare parts and maintenance kits are available for a minimum of 25 years after delivery.



Depending on customer requests, we can offer installation, commissioning and maintenance training in our training center or on site during the regular installation services.





3AP1 FG 145 kV



3AP2 FI 420 kV

# 3AP live tank circuit breaker - the bestseller

## For applications from 72.5 kV up to 800 kV

In contrast to dead tank circuit breakers, the interrupter unit in live tank breakers is not grounded during operation; it is exposed to high-voltage potential and therefore these circuit breakers are called live tanks. The 3AP circuit breaker family is available for rated voltages from 72.5 kV up to 800 kV. 3AP1 circuit breakers up to 300 kV are equipped with one interrupter unit per pole and 3AP2 circuit breakers up to 550 kV include two interrupter units. For applications from 362 kV to 550 kV, the circuit breakers can be equipped with optional closing resistors (3AP3). The 3AP4 includes 4 interrupter units per pole and can also be delivered with closing resistors on request (3AP5). Moreover, our high-voltage live tank circuit breakers are available for three-pole operation with a common base (FG), for single pole operation also with a common base (FE) or for one pole operation with separate bases (FI). In accordance with our modular design, all Siemens 3AP live tank breakers are provided with our stored-energy spring drive mechanism and our self-compression interrupter units.

### Safety and availability at any time

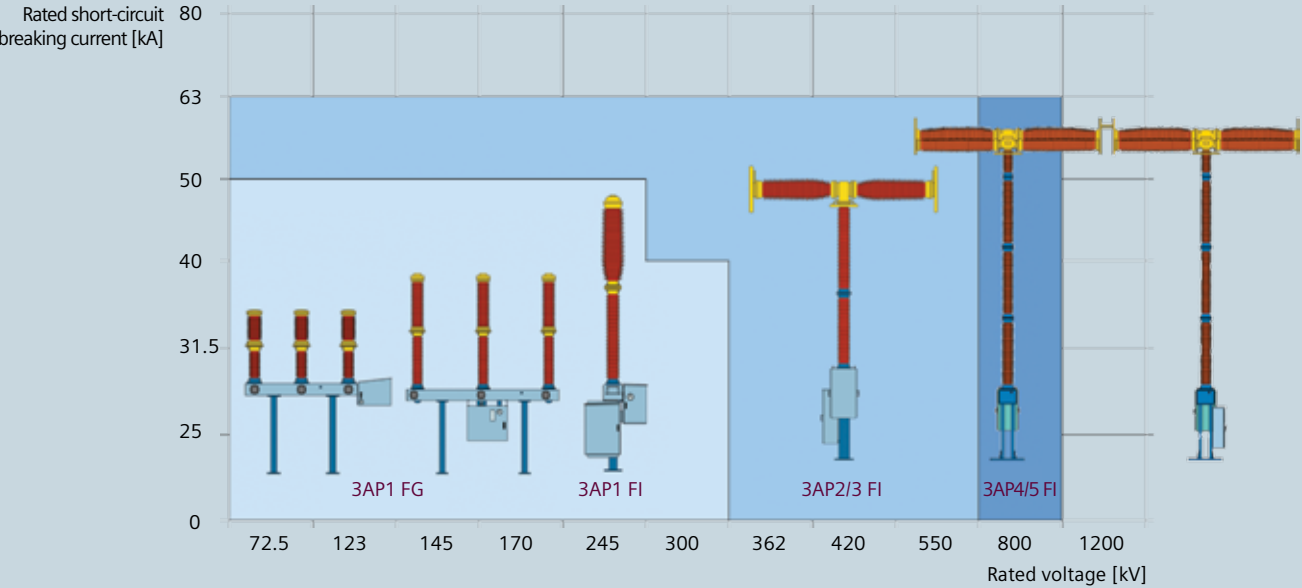
The 3AP high-voltage circuit breakers operate safely and are capable of withstanding high mechanical loads. Particularly strong porcelain insulators and a circuit breaker design optimized by using the latest mathematical techniques give it very high seismic stability whilst in operation, enabling it to perform to its full potential during its entire service life.



3AP4 FI 800 kV pole

Almost 100 years of our experience in high-voltage switching technology go into the design and production of 3AP circuit breakers which define an international trend for attractive products 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, 3AP circuit breakers provide the best solution for your requirements at any time.

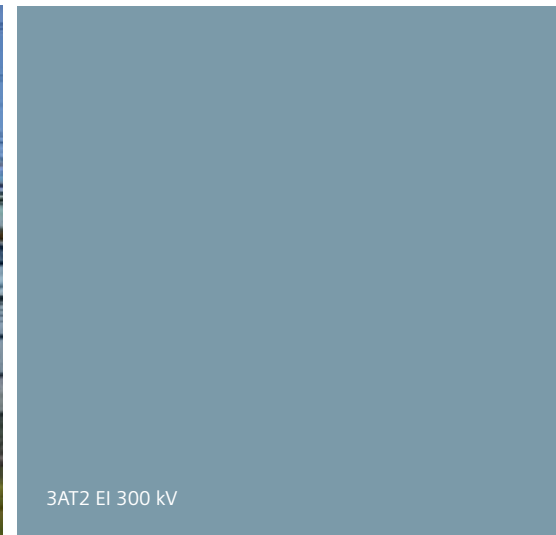
## Technical Data



Type		3AP1						3AP2/3		3AP4/5
Rated voltage	kV	72.5	123	145	170	245	300	420	550	800
Number of interrupter units per pole		1						2		4
Rated power-frequency withstand voltage/min	kV	140	230	275	325	460	460	610	800	830
Rated lightning impulse withstand voltage/min	kV	325	550	650	750	1050	1050	1425	1550	2100
Rated switching impulse withstand voltage	kV	–					850	1050	1175	1425
Rated normal current, up to	A	2500	4000	4000	4000	4000	4000	5000	5000	5000
Rated short-time withstand current (1s-3s), up to	kA <sub>(rms)</sub>	31.5	40	40	40	50	40	63	63	63
Rated short-circuit breaking current, up to	kA	31.5	40	40	40	50	40	63	63	63
Temperature range	°C	-55 up to +55								
Rated operating sequence		O-0.3 s-CO-3 min-CO or CO- 15 s-CO								
Rated break time		3 cycles						2 cycles		
Rated frequency	Hz	50 or 60								
Maintenance after		25 years								

All values in accordance with IEC; other values on request





# 3AT live tank circuit breaker - the power pack

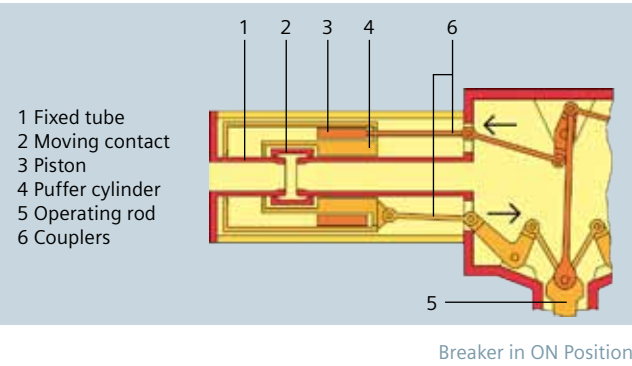
## Electrohydraulically operating circuit breaker for applications from 245 kV up to 800 kV

In contrast to our 3AP series, 3AT circuit breakers are equipped with a hydraulic operating mechanism. Just like all of our circuit breaker types, it provides a high operating energy which safely controls even the highest switching voltages. It can master the most difficult switching duties such as breaking short-circuit currents in the shortest possible time. Its switching performance and the design of its interrupter unit make it eminently suited for generator applications.

### Constant availability assured

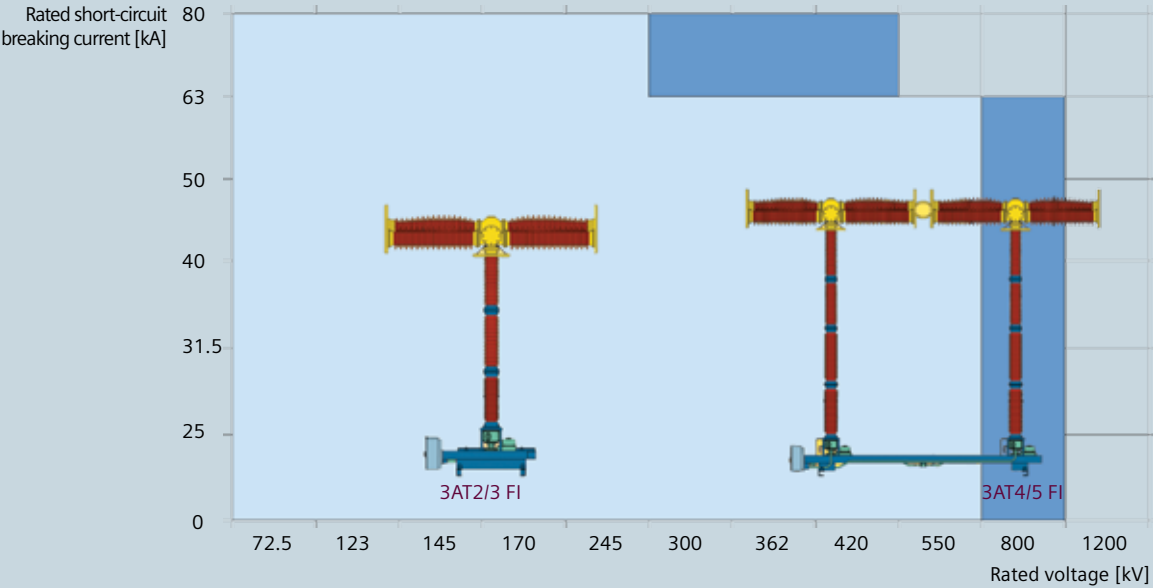
Further significant advantages are the reliability and the extremely rugged design of 3AT high-voltage circuit breakers. Solid porcelain for the insulators and breaker bases optimized by means of the most up-to-date computing techniques provide this circuit breaker with an excellent seismic loading capacity. With additional earthquake damping equipment from Siemens, it is unshakable in almost any location.

The switching mechanism in the interrupter unit is operated via the hydraulic operating mechanism. Also, the current interruption differs from 3AP circuit breakers. The 3AT interrupter unit uses the tried-and-tested double-nozzle quenching system. A contact system with graphite double nozzles ensures a constant quenching response and likewise constant electric strength. The high-performance double nozzles are resistant to erosion and have a long service life.



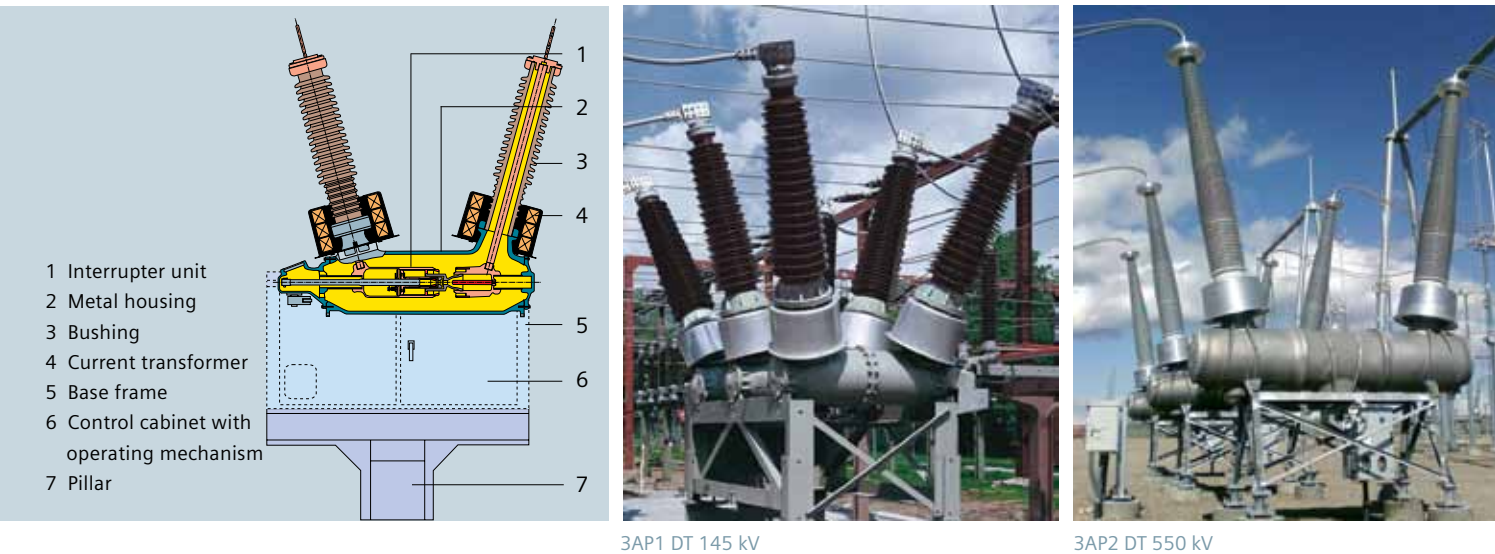
Further advantages of this quenching technique include the minimal pressure rise during the quenching process and the minimal conductivity of the arc plasma. The double-nozzle system is even suitable for special applications such as restrike-free interruption of low inductive and capacitive currents as well as interruption of all types of short-circuits.

## Technical Data



Type		3AT2/3					3AT4/5			
Rated voltage	kV	245	300	362	420	550	362	420	550	800
Number of interrupter units per pole		2					4			
Rated power-frequency withstand voltage/min	kV	460	460	520	610	800	450	520	620	830
Rated lightning impulse withstand voltage/min	kV	1050	1050	1175	1425	1550	1175	1425	1550	2100
Rated switching impulse withstand voltage	kV	–	850	950	1050	1175	950	1050	1175	1425
Rated normal current, up to	A	4000								
Rated short-time withstand current (1s-3s), up to	kA <sub>(rms)</sub>	80	63	63	63	63	80	80	63	63
Rated short-circuit breaking current, up to	kA	80	63	63	63	63	80	80	63	63
Temperature range	°C	-25 up to +50								
Rated operating sequence		O-0.3 s-CO-3 min-CO or CO- 15 s-CO								
Rated break time		2 cycles								
Rated frequency	Hz	50 or 60								
Maintenance after		25 years								

All values in accordance with IEC; other values on request



# 3AP dead tank circuit breaker - the well grounded

## For applications from 72.5 kV up to 550 kV

In contrast to live tank circuit breakers, dead tanks have a metal-enclosed interrupter unit, and the housing is always grounded. Therefore they are called dead tank circuit breakers. For certain substation designs, dead tank circuit breakers might be required instead of the standard live tank breakers. The dead tank breaker offers particular advantages if the protection design requires the use of several current transformers per pole assembly.

Most important characteristics of a dead tank breaker:

- Toroidal-core current transformers on bushings (compact construction)
- High short-circuit breaking currents possible (up to 63 kA with one interrupter unit)
- No creepage path across interrupter unit
- Low impulse load of the bases
- Low center of gravity of the bases (higher seismic withstand capability)
- Heating system available for low temperature applications
- Gas-insulated components ensure highest availability at minimum maintenance effort
- Metal-enclosed interrupter unit (grounded housing)

### Current Transformers

The dead tank circuit breakers can be equipped with bushing current transformers for measurement or protection purposes, fulfilling the requirements according to international standards such as IEC, ANSI, etc.

The current transformers are mounted in weatherproof housings on both sides of each breaker pole and are located at the base of the bushings. The current transformer leads terminate in the control cubicle at short-circuiting type terminal blocks. Our standard housing provides space for up to three current transformers per bushing.

### Another of its strengths

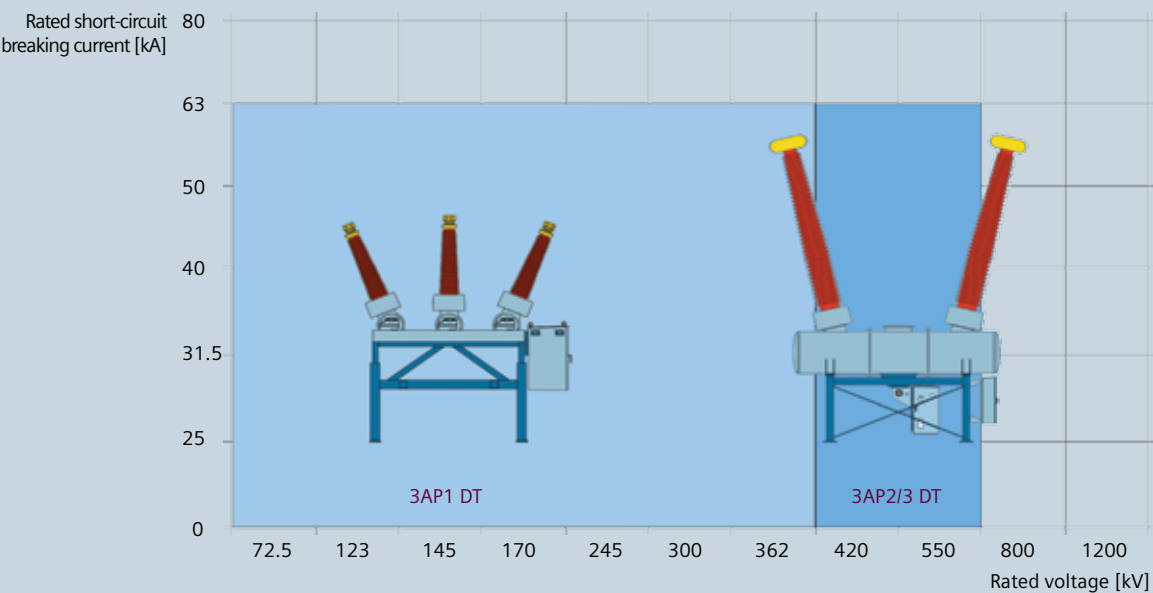
The 3AP DT high-voltage circuit breaker operates safely and is capable of bearing high loads. Extra-strong porcelain bushings and an optimized circuit breaker design give it a very high seismic stability while in operation. The circuit breaker covers the whole temperature range from -55 °C up to 50 °C with pure SF<sub>6</sub>, which makes it applicable for all climate zones.

Like the other circuit breakers, our dead tanks are based on our proven modular design using a patented self-compression arc-quenching system and the stored-energy spring drive mechanism. They assure consistent quenching performance with rated and short-circuit currents – even after many switching operations.

### Coming soon

The upcoming new member of our dead tank breaker family will be usable in ultra high-voltage applications up to 1200 kV. End of 2011, a prototype of this brand-new 3AP5 DT has been delivered to India in the course of expanding the nationwide grids.

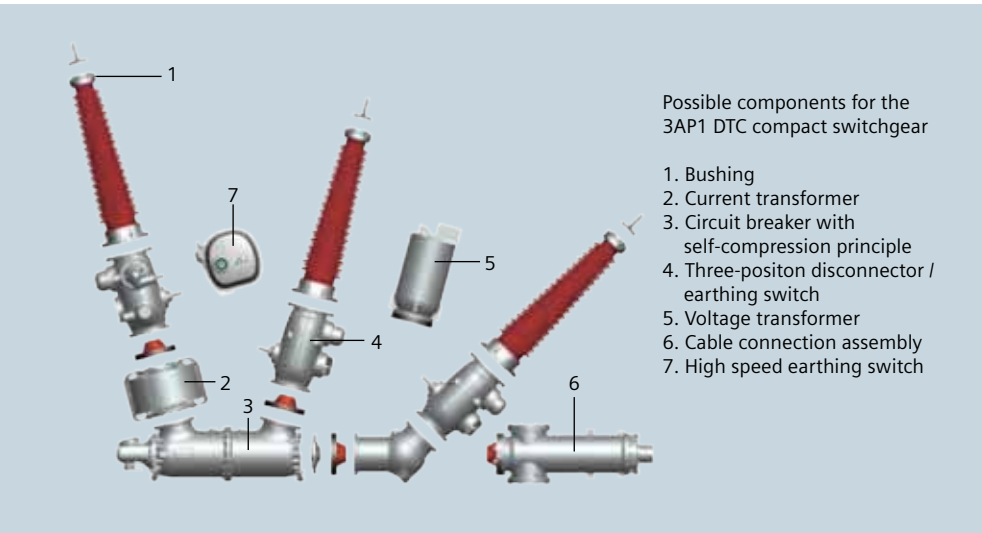
## Technical Data



Type		3AP1					3AP2/3
Rated voltage	kV	72.5	123	145	245	362	550
Number of interrupter units per pole		1					2
Rated power-frequency withstand voltage/min	kV	140	230	275	460	520	800
Rated lightning impulse withstand voltage/min	kV	325	550	650	1050	1380	1865
Rated switching impulse withstand voltage	kV	–				1095	1350
Rated normal current, up to	A	3150	3150	3150	3150	4000	4000
Rated short-time withstand current (1s-3s), up to	kA <sub>(rms)</sub>	40	40	63	63	63	63
Rated short-circuit breaking current, up to	kA	40	40	63	63	63	63
Temperature range	°C	-55 up to +55					
Rated operating sequence		O-0.3 s-CO-3 min-CO or CO- 15 s-CO					
Rated break time		3 cycles			2 cycles		
Rated frequency	Hz	50 or 60					
Maintenance after		25 years					

All values in accordance with IEC; other values on request





- Flexible solutions according to your substation configurations**
- Circuit breaker with one or three-pole operating mechanism
  - Disconnector, earthing switch, high-speed earthing switch
  - Current transformer, voltage transformer and voltage detection system
  - Cable connections possible at various positions
  - Bushings available as porcelain or composite insulators
  - Additional separations of gas compartment, with SF<sub>6</sub> density monitor on request
  - Double breaker modules for ultra compact substation designs
  - Possibility of stand-alone components, e.g. disconnector module with voltage transformer

# 3AP Dead Tank Compact - the versatile

## For 145 kV and 245 kV applications

The hybrid concept on which the 3AP1 Dead Tank Compact (DTC) is based combines SF<sub>6</sub>-encapsulated components and air-insulated devices. The application of gas insulated components increases availability of the switchgear. According to CIGRE analyses, gas-insulated components are four times more reliable than air insulated components. Furthermore, safety can be enhanced by separating gas compartments, e.g. between the circuit breaker and disconnector.

The DTC circuit breaker is a compact arrangement of several functions needed in a substation. The elements of this Siemens compact switchgear is a dead tank circuit breaker, fitted with one or two current transformers, one or more disconnectors, earthing switches and bushings as applicable for connection to the bus bar system. And of course, based on our modular design, the core components are adopted from our high-voltage circuit breakers, disconnectors and GIS product family. Due to the compact design and the flexible use of predefined modules, different layouts can be realized with a minimum of engineering effort.

The level of encapsulation and the design of the DTC module can be defined in accordance with the requirements of the individual substation layout and the system operator's project budget. This leads to optimized investments and greater success for our customers' businesses.

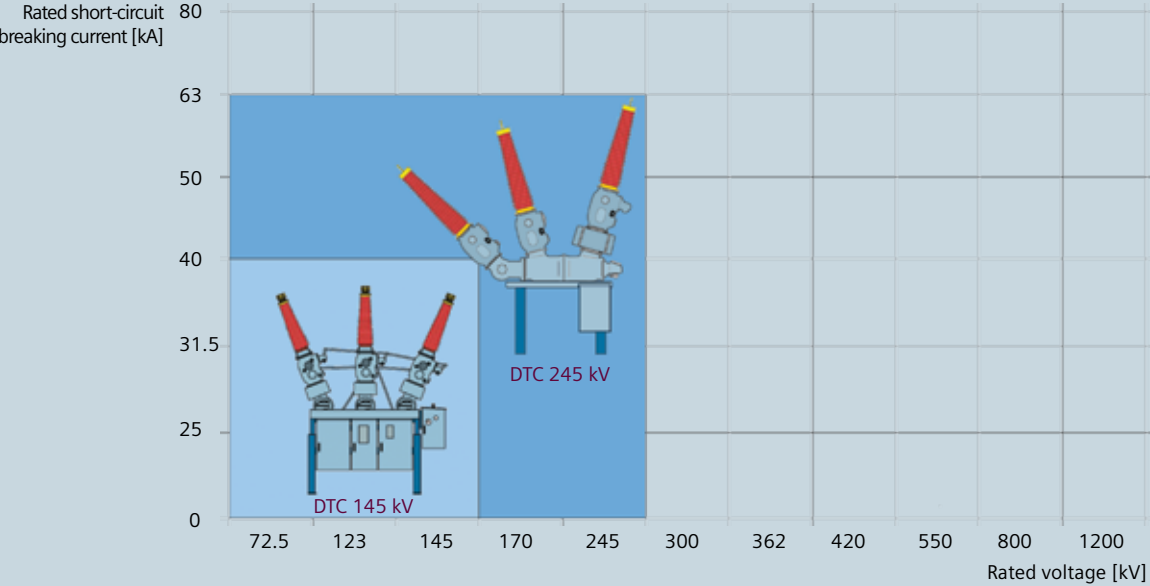


3AP1 DTC 245 kV

- The 3AP1 DTC offers you:**
- Proven SF<sub>6</sub>- and air-insulated components that can be combined in new and different ways
  - Optimized investments according to the requirements of your individual substation layout
  - Gas insulated components ensure the highest availability at minimum maintenance effort
  - Flexibility in confined spaces and extreme environmental conditions, e.g. low temperature applications

Benefit from the hybrid idea!

# Technical Data



Type	3AP1 DTC	
Rated voltage	kV	145 245
Number of interrupter units per pole		1
Rated power-frequency withstand voltage/min	kV	275 460
Rated lightning impulse withstand voltage/min	kV	650 1050
Rated switching impulse withstand voltage	kV	—
Rated normal current, up to	A	3150 4000
Rated short-time withstand current (1s-3s), up to	kA <sub>(rms)</sub>	40 63
Rated short-circuit breaking current, up to	kA	40 63
Temperature range	°C	-55 up to +55
Rated operating sequence		O-0.3 s-CO-3 min-CO or CO- 15 s-CO
Rated break time		3 cycles
Rated frequency	Hz	50 or 60
Maintenance after		25 years

All values in accordance with IEC; other values on request



3AP1 DCB 145 kV



3AP2 DCB 420 kV

- Your advantages:**
- Highest reliability by applying well-proven and established components from Siemens circuit breakers and Ruhrtal earthing switches
  - Highest availability due to reduced maintenance interruptions
  - Costs and space saving solution by combining the circuit breaker and disconnector in one device
  - Minimized costs for transportation, maintenance, installation and commissioning as well as civil engineering (foundation, steel, cable ducts etc.)
  - Compact and intelligent interlocking and position indicating device
  - Optionally available with earthing switch (145 kV)
  - From one source (documentation and technical support, assembly and installation, customer training, 24-hour-service)

# 3AP DCB Disconnecting Circuit Breaker – the combined

## For 145 kV and 420 kV applications

In switchgear, isolating distances in air combined with circuit breakers are used to protect the circuit state in the grid. Siemens has developed a device in which the isolating distance has been integrated in the SF<sub>6</sub> gas compartment in order to reduce external environmental influences. The DCB (Disconnecting Circuit Breaker) is used as a circuit breaker and additionally as a disconnector – two functions combined in one device.

The DCB was developed on the basis of a higher-rated standard 3AP circuit breaker to provide the higher dielectric properties required. Due to the SF<sub>6</sub>-insulated disconnector function there is no visible opening distance anymore. The proper function of the kinematic chain has been most thoroughly verified. The closest attention was paid to developing a mechanical interlock which guarantees that the circuit breaker remains in the open position when used as a disconnector.

When this mechanical interlock is activated, it is impossible to close the breaker. The current status of the DCB can also be monitored electrically and is shown by clearly visible position indicators.

Up to voltages of 145 kV, an additional air-insulated earthing switch could be mounted onto the supporting structure. Its earthing function has been implemented by a



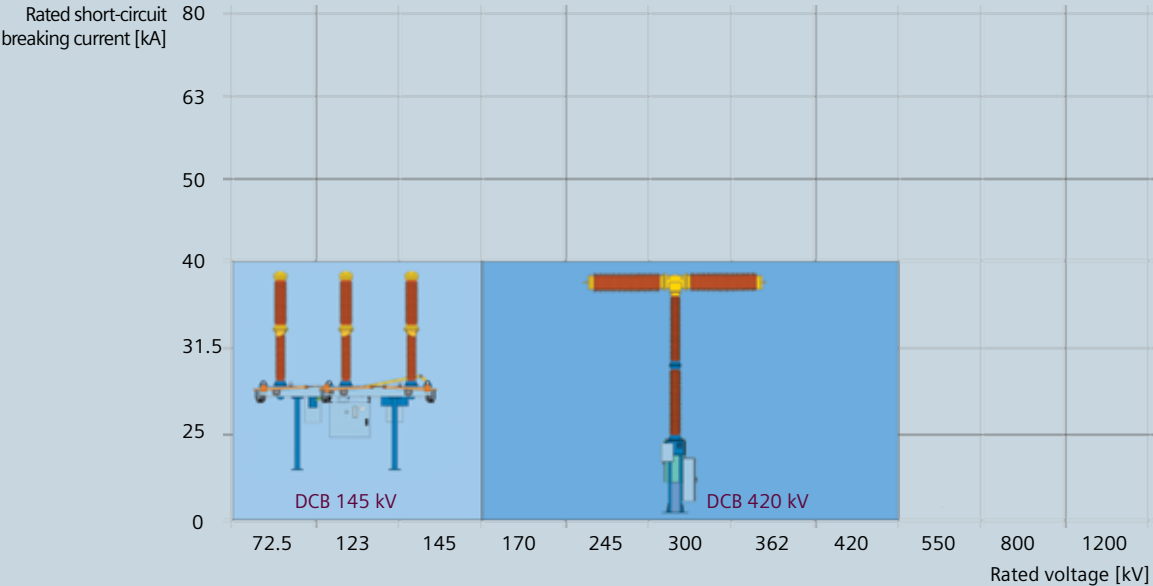
3AP2 DCB interlock indicator

well-established earthing switch with a Ruhrtal designed maintenance-free contact system. The disconnecting circuit breakers are type-tested according to class M2 and C2 of IEC 62271-108, a specific standard for combined switching devices.

By combining the strengths of our well proven product portfolio, we can provide a new type of device which fulfills customers’ needs for the highest reliability and safety, while saving space and costs at the same time.

ONE device – TWO functions

## Technical Data



Type		3AP1 DCB	3AP2 DCB
Rated voltage	kV	145	420
Number of interrupter units per pole		1	2
Rated power-frequency withstand voltage/min	kV	275 or 315	520 or 610
Rated lightning impulse withstand voltage/min	kV	650 or 750	1425 or 1665
Rated switching impulse withstand voltage	kV	—	1050 or 1245
Rated normal current, up to	A	3150	4000
Rated short-time withstand current (1s-3s), up to	kA <sub>(rms)</sub>	31.5	40
Rated short-circuit breaking current, up to	kA	31.5	40
Temperature range	°C	-40 up to +40	
Rated operating sequence		O-0.3 s-CO-3 min-CO or CO- 15 s-CO	
Rated break time		3 cycles	
Rated frequency	Hz	50	
Maintenance after		25 years	
Insulating medium		SF <sub>6</sub>	

All values in accordance with IEC; other values on request





3AV1FG 72.5 kV prototype

- Reliable**
- More than 40 years of experience in vacuum switching technology
  - Suitable for low temperature applications
- Efficient**
- Maintenance and service-free even with frequent breaking operations
- Performance**
- 2-cycle current interruption
  - Feasible up to 145 kV
  - High number of short-circuit interruptions
- Ecological**
- Vacuum interrupting medium
  - Nitrogen insulating medium

# 3AV vacuum circuit breaker – the trendsetter

## 3AV1FG 72.5 kV prototype

**The next generation of high-voltage circuit breakers**  
The outstanding technical performance and low lifecycle costs of vacuum circuit breakers make this solution the preferred technology in power networks up to 52 kV. Based on 40 years of experience producing medium-voltage vacuum interrupters and with more than 3 million units delivered, Siemens is now introducing this proven technology to high-voltage power networks above 52 kV. The upcoming new member of our circuit breaker family meets the same high quality standards as our SF<sub>6</sub> portfolio and is also designed according to our well proven modular platform concept. The new 3AV1 vacuum circuit breaker has concrete technical advantages: It features reliable switching capacity, requires no maintenance even when subjected to frequent breaking operations, and is also environmentally friendly – thanks to switching operations performed in a vacuum, with nitrogen as the insulating medium. These circuit breakers will be the right choice for future projects and a wide range of applications.

**Field experience**  
Prototypes of the new Siemens high-voltage vacuum circuit breakers have already been installed in European power networks. A number of Energy customers are operating the 3AV1 prototypes in their systems and are sharing operating and field experience with us.

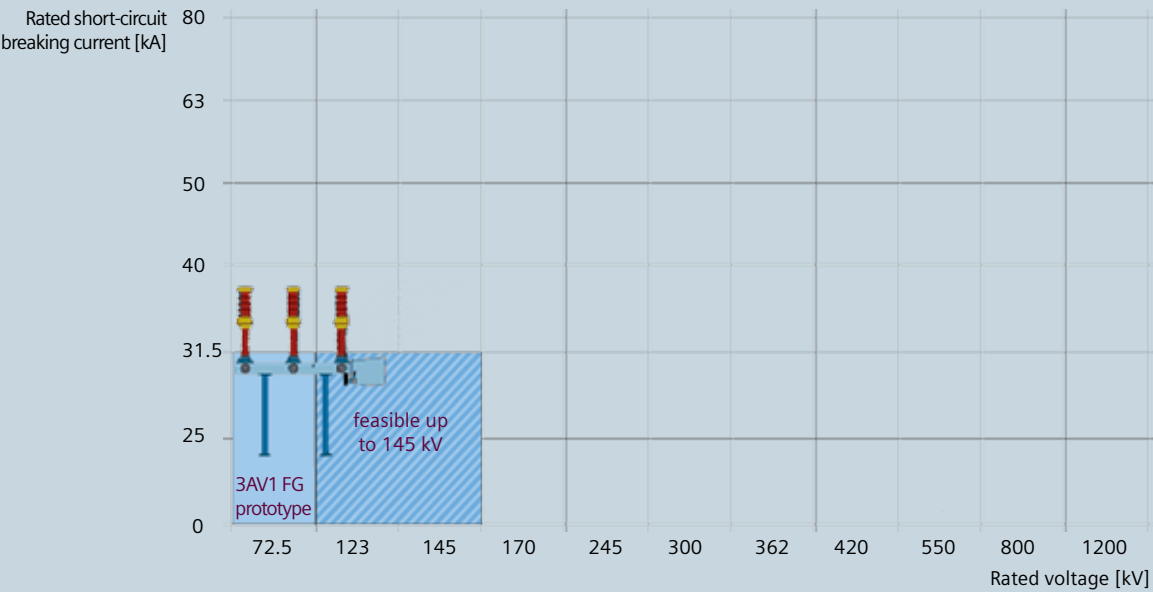
In fact, several thousand switching operations have already been performed successfully in the field, and documented. Market launch will follow the completion of studies. Siemens ensures the highest quality standards and offers customers the highest degree of security for their energy supplies. A complete set of type tests in accordance with the latest edition of IEC 62271-100 has proven the suitability of the 72.5 kV live tank vacuum circuit breaker prototype.



Vacuum interrupters for 72.5 kV and 145 kV

High-voltage goes vacuum

## Technical Data



Type		3AV1
Rated voltage	kV	72.5
Number of interrupter units per pole		1
Rated power-frequency withstand voltage/min	kV	140
Rated lightning impulse withstand voltage/min	kV	325
Rated switching impulse withstand voltage	kV	—
Rated normal current, up to	A	2500
Rated short-time withstand current (1s-3s), up to	kA <sub>(rms)</sub>	31.5
Rated short-circuit breaking current, up to	kA	31.5
Temperature range	°C	-55 up to +40
Rated operating sequence	O-0.3 s-CO-3 min-CO or CO- 15 s-CO	
Rated break time	2 cycles	
Rated frequency	Hz	50
Maintenance after	25 years	
Insulating medium	N <sub>2</sub>	

All values in accordance with IEC; other values on request

# Full control with circuit breaker accessories

## Controlled switching with PSD02/03



Energizing and re-energizing during an autoreclosing operation of shunt compensated transmission lines cause switching overvoltages on the transmission lines. These overvoltages can be minimized by the introduction of controlled switching, which can be provided by the standard PSD02 control unit from Siemens or the specialized PSD03 version. Conventional methods to reduce overvoltages and protect the electrical equipment involve circuit breakers equipped with closing resistors or the installation of surge arresters. Using PSD can replace these additional devices and helps to save costs. The design is based on more than 10 years of experiences with controlled switching. This includes applications such as capacitor bank and reactor switching, energizing of transformers and uncompensated transmission lines up to 800 kV.

### At a glance:

- Switching of transmission lines without closing resistors
- Single and three phase auto-reclosing
- One device for all switching tasks
- Unrestricted parameter-definable software
- Standard CLOSE- and OPEN-trigger circuits
- Two switching procedures can be specified at the same time
- Linear and vectorial compensation
- Secure current measurement with "ring-type transducers"
- Software operation protected by user hierarchy
- Evaluation using graphic user interface
- Switching history can be transferred
- Cyclic history, alarms, measurement values



## Controlled contacts with SICEA01



The SiCEA01 contact erosion analyzer is used to determine the extent of wear to the circuit breaker contacts. The breaking currents of the circuit breaker are used to determine the contact wear. Switching operations with currents below the rated normal current are evaluated with the rated normal current. The contact burn off is calculated using the integral of the circuit breaker breaking currents. The result is compared with the configured reference values. If the result of this comparison exceeds the warning or alarm value, the corresponding signal contact is activated, and the signal light on the contact wear analysis device shows the status. With this warning or alarm, SiCEA01 shows whether the circuit breaker contact system has already been worn down to a specific level, which allows servicing work to be scheduled in good time.

### At a glance:

- Device for determination of contact-wear
- 2 limits (warning and alarm), adjustable in % of the maximum permissible contact-wear
- Digital relays and LEDs for warning and alarm
- Calculation of the integrated current during open operation for three poles
- Ambient temperature from -40 up to +85°C
- Input:
  - 3 x analog signal of protection current-transformer input  $\pm 100$  mA signal conditioning with external AC-transformer 100A/100 mA; 3 x reference contact; auxiliary contacts
- Output:
  - 3 relay output (warning, alarm, system OK); 3 LEDs
- Communication via Ethernet



## Controlled monitoring with SOLM01



The Siemens SOLM01 on-line monitoring system supervises the status of the circuit breaker by means of sensor technology. SOLM01 records events, measures momentary values as well as other external parameters and compares them with given reference values. It is able to inform the servicing team automatically about divergences or signs of wear, and calculates trends for the further operational behavior. It optimizes servicing work with regard to corrective and preventive maintenance measures. The measured data is continuously obtained by the data collector and stored in a database on the Oracle server. The data can be accessed via a web browser on the Intranet/Internet by an unlimited number of authorized users with different rights. Alarm messages can also be sent directly to the SCADA system via relay outputs.

### At a glance:

- Complex monitoring for determining its condition
- Measurement of momentary values
- Determination of external parameters
- Cumulative or integral monitoring of the operating stress of the breaker
- Estimation of tendencies of the operating behaviour
- Assessing the further reliability
- SOLM01 does not influence circuit-breaker control
- Data acquisition with distributed front-end pre-processing
- Premature detection of possible malfunctions
- Supports the future field bus communication protocol IEC 61850





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