



SACE low voltage air circuit-breakers
Sometimes evolution takes a leap.

Origins and evolution of low voltage air circuit-breakers

Air circuit-breakers are circuit-breakers of significant dimensions, characterized by rated currents, short-time currents and high breaking capacities, which are used primarily in industrial applications. They can be utilized both as circuit-breakers for general protection of installations and as circuit-breakers for protection of electric machines (generators, motors, transformers and capacitors).



Although used primarily for industrial applications, they can also be used for low-voltage primary and secondary distribution in all high-power installations: civil, industrial and tertiary sector, and on board ships, in mines and power stations.

The modern versions of the first air circuit-breakers have their origins in the period of post-war reconstruction when deionization chambers were invented.

The history of SACE air circuit-breakers began at the end of the forties – in 1949 to be precise – with the designing of the DM series.

The introduction of deionization chambers is fundamental because these devices, which facilitated the extinguishing of the electric arc, resolved one of the most important problems concerning the interruption of high current values.

When the contacts of a circuit-breaker under load are opened, the surrounding air – which is normally insulating – heats up and ionizes, becoming a conductor. This phenomenon prevents interruption of the current and causes the formation of an electric arc with the development of thermal energy in a quantity proportional to the value of current to be interrupted.

By using a suitable contact shape, it is possible to ensure that the arc, which is subjected to electromagnetic forces determined by the let-through current, is deformed until it enters the deionization chambers where it “breaks” and where the flow of fresh air, favoured by the particular shape of the chambers, cools and deionizes the air, facilitating the extinguishing of the arc.

The use of air circuit-breakers became more widespread with industrial development and the simultaneous ever increasing use of electrical energy in all applications where the value of the currents in play makes the use of more economic and less bulky moulded-case circuit-breakers impossible.

The heat and electromagnetic power generated by the passage of current in short-circuit conditions and during opening under load – caused by high currents – are such that they cannot be contained within the confined space of a moulded-case circuit-breaker, nor can they be withstood mechanically by the relatively fragile materials with which it is made.

Therefore, suitable dimensions and metallic structures are needed to contain the live parts, adapted power springs and operating and opening mechanisms. The air circuit-breakers, in fact, have a support structure made of printed sheet metal and the live parts are held by supports made of printed insulating material, which is particularly robust and resistant to thermal and dynamic stresses and humidity.

Air circuit-breakers can be normal, current-limiting, selective and selective current-limiting.

Current-limiting circuit-breakers are those that, in the event of a short circuit, are able to limit the let-through current to a value that is lower than the prospective value. This characteristic enables important economic savings to be made when constructing both circuit-breakers and the busbars and conductors that they protect.

Selective circuit-breakers are circuit-breakers that are able to withstand high let-through currents for longer times than those normally needed to open a circuit-breaker, thereby enabling downstream circuit-breakers to trip. The tripping of the protection circuit-breaker that is electrically nearer to the fault guarantees the continuity of service in the rest of the installation.

Selective, current-limiting circuit-breakers combine the characteristics of the two families. These circuit-breakers, by exploiting the current-limiting capacity, cause an increase in their resistance to the specific let-through energy, making them therefore able to withstand the fault current for the time needed to guarantee selectivity of the installation.

The figure on page 2 shows a prototype of this type of circuit-breaker, built at the end of the 1950s by SACE of Bergamo.

This is a three-pole air circuit-breaker for rated current of 2000A, 500V, complete with front hand control, electrical control and electromagnetic relay.

This category of circuit-breakers soon became the ideal solution for very high rated currents and breaking capacities, reaching, in versions with two poles and double arc-extinguishing chambers, rated currents of up to 6000A and symmetrical breaking capacities of over 50kA.

Thanks to their solidity, and to the quality and robustness of the components used, as well as the significant dimensions and particular construction process (as an example we can mention the conducting parts with large cross-section and the high pressures on the contacts in the closed position), these circuit-breakers are particularly suited for withstanding the dynamic and thermal stresses of short circuits, with closed contacts, even for long periods.

They therefore satisfy the requirements needed from general circuit-breakers positioned upstream of a distribution system with chronometric selectivity. The name “selective circuit-breakers”, by which they are widely known, developed precisely from this ability to guarantee selectivity.

SACE Timeline

Low-voltage air circuit-breakers

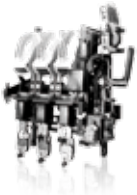
ABB SACE has its origins firmly rooted in over 75 years of history. The company, which has always had very close ties to the area in which it operates and has always been a leader in the electromechanical sector, boasts a “business history” that is both unique and logical at the same time. Innovation and a propensity for improvement have, since the very beginning, been characteristic features

of SACE, which was officially founded as Società Anonima Costruzioni Elettromeccaniche on 7 July 1934. The history of the company can be understood through the evolution of its main products. The history of air circuit-breakers officially begins in 1949 with the designing of the DM series. In 1956 a phase of renewal of low voltage devices and also in the field

of air circuit-breakers begins, and new devices are developed. From 1960, the year in which production officially starts of Otomax, the first air circuit-breaker in SACE history completely designed and built in Italy, SACE begins following a path marked by the launch on the market of increasingly technologically advanced ranges.

1918 - 1947

SACE DM



1956 - 1971

Otomax



1979 - 1989

Novomax



History

1918 The «first» SACE company is created in Bergamo from the ashes of Officina Fantini: little more than a craft workshop, but already able to become the supplier of “Royal Naval Dockyards and State Railways”.

1934 On 7 July, SACE, after several entrepreneurial stages, is officially founded as Società Anonima Costruzioni Elettromeccaniche by four shareholders: Leopoldo Ferrè, Lino Salghetti Drioli, Federico Mazzola and Agostino Eschini

1947 The handover between the old and new SACE takes place: the company, having survived the complex historical era marked by two World Wars, begins to assert itself on the market, becoming a point of reference in the Italian electromechanical industry.

1956 This year is marked by a phase of renewal of low voltage products and the designing of new devices: even in the field of air circuit-breakers, SACE begins to intensify research that leads to the development of the first Otomax prototype.

1960 Otomax, the first air circuit-breaker to officially enter production in SACE history: it was designed to guarantee selective protection and suitable for protecting generators, large engines and outgoing feeders.

1971 Novomax G30 makes its appearance on the market and is presented as the most compact air circuit-breaker of the era, becoming distinguished for its robustness and reliability.

1979 Novomax is presented, the new air circuit-breaker developed by focussing on compactness and optimization of performance. The path begun with the Novomax G30 series progresses, ensuring continuity and, at the same time, innovation.

1988 ABB is founded as a major international electrotechnical group, and SACE, following the merger between the Swedish company Asea and the Swiss company Brown Boveri, becomes ABB SACE.

1989 Launched a year after the establishment of ABB, Megamax is the first air circuit-breaker released onto the market with the ABB SACE brand. In parallel with this range, the concept of retrofitting kit is born.

The history of Società Anonima Costruzioni Elettromeccaniche, from 1934 to the new millennium, is marked by the evolution of its logo on the way from SACE to ABB.



SACE

ABB SACE

ABB

1991 - 2004

Megamax



2006 - 2009

Emax



2010 -2012

Emax



1991 Megamax wins the “Compasso d’Oro” Prize, awarded by the Association for Industrial Design, confirming that the new range not only features significant technological innovation but also responds to the aesthetic and design principles now considered fundamental.

1996 Emax is launched, which is distinguished for its reliability and high performance: the protection functions are, for the first time, fully electronic. Emax is, furthermore, the first series of ABB SACE air circuit-breakers with the UL mark.

2004 The New Emax is launched on the market: an evolution of the previous Emax. This new series of air circuit-breakers is characterized by an increase in electrotechnical

performance and an increase in the level of connectivity: the dialogue between man and machine becomes easier and communication is possible, even by remote means.

2006 Emax X1 is launched. It is presented to the market as the small great air circuit-breaker of the Emax family. It guarantees the performance of an air circuit-breaker with the dimensions of a moulded-case circuit-breaker.

2009 The Emax DC for direct current applications, in compliance with the IEC60947-2 standard, is presented, which enhances the SACE Emax air circuit-breaker offer.

2010 The Emax VF, specifically designed for applications in the wind, mini-hydroelectric, wave and traction power sectors, is launched. It is an innovative solution for protecting variable frequency installations.

2012 The Emax LTT (Low Temperature Technology) is introduced to the market to complete the offer for variable frequency applications. It is presented as the ideal solution for installations in extreme environmental conditions: the Emax LTT air circuit-breaker range is, in fact, able to operate in temperatures ranging from -40°C to +70°C.

2013 To be continued...

SACE air circuit-breakers Otomax (1960)

Otomax is launched in 1960 and is the first air circuit-breaker to officially enter production in SACE history.

It was designed to guarantee selective protection and is suitable for protecting generators, large motors and outgoing feeders. With 2 frame sizes (P2C and P3C), covering models from 1000A to 5000A, it guarantees high performance both in alternating current (up to 660Vac) and in direct current (up to 500Vdc). The range is distinguished by the architecture of the contacts, which are divided into main and arc-breaking; it includes a plug-in version and manual or motorized spring operating mechanisms. It includes the K series of thermal relays, which are suitable for protecting motors. It also introduces the first electronic opening relays: the S series.

Otomax MM

Otomax MM subsequently expands the Otomax air circuit-breaker range and features a new structure that is particularly resistant to impact (up to 70g).



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2



3



4

- 1 Otomax
- 2 H series thermal relay
- 3 K series thermal relays
- 4 S series electronic relays

SACE air circuit-breakers

Novomax G30 (1971)

Novomax (1979)

Novomax G30 (1971)

Novomax G30 makes its appearance on the market in 1971 and is presented as the most compact air circuit-breaker of the era. Solid and reliable, it covers frame sizes from 800A to 1600A. It is introduced ahead of the Novomax series, which arrives eight years later and is its natural evolution.

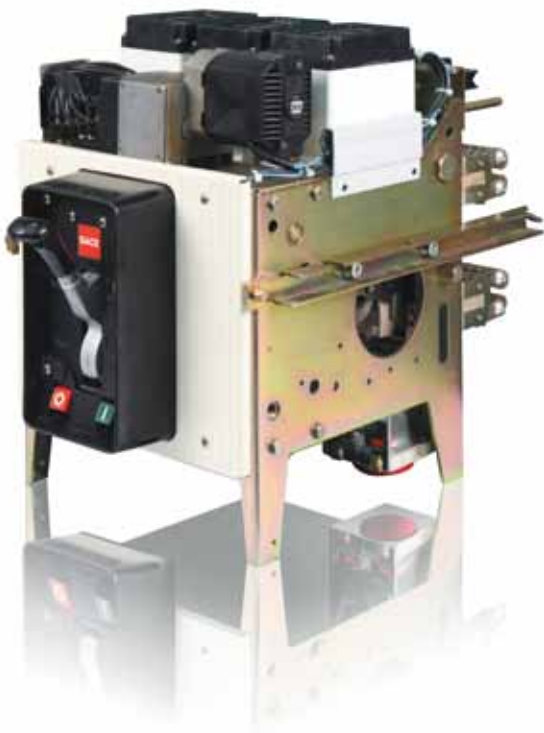
Novomax (1979)

The evolution of SACE air circuit-breakers continues with a focus on compactness and optimization of performance.

Novomax, continuing the path begun with the Novomax G30 series, ensures continuity and, at the same time, innovation.

The advantages of the new family, launched in 1979, are its compact dimensions and high performance. Novomax, thanks to the availability of a range consisting of 5 frame sizes (G2-G3-G4-G5-G6), covering up to 6300A models, guarantees performance of up to 100kA at 660Vac. It is provided with sliding contacts for auxiliary circuits, safety shutters on the fixed part and enables a mechanical interlock to be constructed between the two circuit-breakers. The range includes T series thermal relays.

It is equipped with S1 and S2 series electronic relays. G protection for earth faults and logic output signals (S2 series) are introduced and electromagnetic compatibility (S2/MM series) is implemented.



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2



3

- 1 Novomax G30
- 2 T series thermal relays
- 3 S2 series electronic relays

SACE air circuit-breakers

SACE Megamax (1989)

Megamax is the first air circuit-breaker released onto the market with the ABB SACE brand.

The new series is launched in 1989, a year after the establishment of ABB as a major international electrotechnical Group. In 1988 SACE, in fact, following the merger of the Swedish company Asea with the Swiss Brown Boveri, becomes ABB SACE.

Megamax, with 6 frame sizes available (F1-F2-F3-F4-F5-F6), covering from 1250A to 6300A, succeeds in interrupting up to 130kA at 415Vac and offers high performance of up to 690Vac and 1000Vac/dc (with the special series /E).

The new range, in addition to boasting significant technological innovation, also responds to aesthetic principles that were initially considered secondary. The systematic study of design becomes an integral part of the design process behind the development of new air circuit-breakers. The efforts made regarding design and the standardization of fixed parts and accessories on all frame sizes are recognized publicly, and Megamax is awarded the "Compasso d'Oro" prize in 1991 by the Association of Industrial Design.

In parallel with the launch of this range, the concept of the retrofitting kit is born: the replacement of obsolete equipment with newly designed devices or the introduction of new equipment into the installation can, from this moment, be carried out by using these new kits, specially developed by ABB SACE.

Megamax is equipped with electronic relay: PR1 series (with display), AR1 series (analogue) for alternating current and EG series for direct current. The relay increases the possibilities for interaction and dialogue, enabling, for the first time, the wear of contacts, the number of operations and the electrical quantities to be monitored.



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- 1 Megamax
- 2 PR1 electronic relay
- 3 AR1 electronic relay

SACE air circuit-breakers

SACE Emax (1996)

Emax is launched in 1996 and is distinguished by its reliability and high performance, guaranteed by poles realized in a moulded case.



The new series is able to interrupt currents up to 150kA at 440Vac, 100kA at 690Vac and 65kA at 1150Vac.

From a constructive architecture point of view, although it retains the concept of a metallic support structure, the design is developed using concepts of modularity.

Electronics play a crucial role thanks to the innovative PR111-PR112-PR113 series of trip units with liquid crystal displays: the protection functions are, for the first time, fully electronic. The electronics also permit harmonic analysis of the currents.

To complete the offer, a new series of current-limiting, non-selective circuit-breakers (L range) are introduced. Emax is the first series of ABB SACE air circuit-breakers with the UL mark.

The new Emax family is further enhanced with a ATS010 (Transfer Switch) control unit, which, by controlling two circuit-breakers, ally manages network-group switching for installations equipped with generator unit for supplying power in the event of a network power failure.

SACE Emax MM

Emax MM enhances the Emax range of air circuit-breakers and is presented as the ideal solution for naval and military applications thanks to its particular impact-resistance qualities (up to 20g).



2



3

- 1 SACE Emax
- 2 PR112 electronic trip unit
- 3 PR113 electronic trip unit

SACE air circuit-breakers

SACE New Emax (2004)

SACE New Emax X1 (2006)

SACE New Emax DC (2009)

New Emax, launched on the market in 2004, is an evolution of the previous Emax.

It is characterized by an increase in electrotechnical performance, with an increase in maximum interrupting voltage to 1.150Vac, thanks to the presence of a new range of electronic trip units (PR121-PR122-PR123 series) and innovative current sensors.

Communication functions are implemented in this new family of circuit-breakers by utilizing both fieldbuses (Modbus or Fieldbus protocol) and wireless communication systems (Bluetooth). The new trip units are characterized by a setting for the various protection functions available (long delay, short delay, instantaneous and earth protection), which is determined by an interchangeable module (rating-plug) with which the rated current In of the trip unit and a series of DIP switches for setting currents and trip times are chosen.

SACE Emax X1 (2006)

Emax X1 is launched in 2006 and is presented to the market as the small great air circuit-breaker of the Emax family. With models from 630A to 1,600A, it guarantees the performance of an air circuit-breaker but with the dimensions of a moulded-case circuit-breaker.

In spite of the compact size, the new “small air” circuit-breaker from ABB SACE guarantees high performance. Emax X1 cleverly covers the gap that traditionally separates moulded-case circuit-breakers from the air circuit-breakers and represents, together with the Tmax T7 moulded-case circuit-breakers, the link between the two large families.

Emax X1 facilitates installation and wiring, enabling installations to be optimized. Extremely flexible, it is equipped with latest generation PR33x trip units that offer all the protection functions required by the market.

SACE Emax DC

Emax DC, for applications in direct current complying with the IEC60947-2 and UL standards, enhances the SACE Emax air circuit-breaker offer. Thanks to the exclusive technology applied to the new SACE PR123/DC and PR122/DC trip units, developed specifically for this range, SACE Emax DC covers any installation and protection requirement up to 1000V DC/ 5000A.

These are high performance electronic trip units that are able to perform an extensive array of protection functions and carry out a complete series of measurements, signalling, data storage and control functions in the circuit-breaker. Information consultation and programming are particularly easy and intuitive thanks to the liquid crystal graphic display.

By developing this range, ABB SACE has confirmed its ability to anticipate trends and offer significant technological innovation. For the first time worldwide, it has constructed an electronic trip unit integrated in the circuit-breaker with advanced protection and fundamental measurement and communication functions.



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SACE air circuit-breakers

SACE Emax VF(2010)

SACE Emax LTT (2012)

SACE Emax VF

Emax VF is launched on the market in 2010 and, together with the Tmax VF range of moulded-case circuit-breakers, is an innovative solution for protecting variable frequency installations.

With the Emax VF range of air circuit-breakers, ABB SACE has demonstrated, once again, that its focus is directed towards energy generation from renewable sources, and it has built, before all other manufacturers, a device that has been developed from the ABB's experience in design and its continuous collaboration with the major wind turbine manufacturers.

The Emax VF range has been specifically designed for applications in the wind, mini-hydroelectric, wave and traction power sectors. It is able to operate in a frequency range between 1Hz and 200Hz and, in detail, includes models E2/VF and E3/VF for low frequencies and E2/VF, E3/VF, E4/VF and E6/VF for high frequencies. SACE VFT (Variable Frequency Technology) has also enabled the protection trip units to be improved and current sensors and arc-extinguishing chambers to be optimized.

SACE Emax LTT

In 2012 the Emax LTT (Low Temperature Technology) circuit-breaker is introduced to the market to complete the offer for applications at variable frequency, typically wind applications. The circuit-breaker is presented as the ideal solution for installations in extreme environmental conditions.

The Emax LTT air circuit-breaker range is, in fact, able to operate in temperatures ranging from -40°C to +70°C thanks to a new generation of lubricants and selected electronic and mechanical components.

SACE Emax 2 (2013)

To be continued...



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