DISTRIBUTION SOLUTIONS

ConVac
Medium voltage vacuum contactor
ConVac vacuum contactors are the best solution for controlling motors and switching apparatus requiring a great many hourly operating sequences. ConVac contactors use vacuum interrupters. Thanks to this breaking technique, they provide excellent performance and can operate in extremely harsh environmental conditions. They are suitable for switching motors, transformers, capacitor banks, switching and power factor correction systems and can be used for a variety of applications in industries, utility, service-providing and shipbuilding sectors, etc. When equipped with fuses, they can be used for circuits with up to 50 kA fault levels.
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ConVac:
its strengths, your benefits

Productivity

Efficiency
Productivity
Maximize your results

Easy to install
- All electrical connections are plug-and-socket with integrated terminal box. This method saves up to 40% of wiring time
Efficiency
Optimize your investments

Affordable range
• Panel design optimization thanks to common and flexible installation position between ConVac 7 and ConVac 12

Optimized logistics
• One single product conforming to IEC, UL and CSA standards at 7,2kV and for both 7,2kV and 12kV common and interchangeable plug in accessories to reduce the customization time up to 80% and plug in accessories, common for all contactor versions, reduce the customization time by 80%
Description

The medium voltage ConVac contactor operates in alternating current and is normally used to control devices requiring a high number of hourly operating sequences.

The ConVac contactor has a linear electromagnetic actuator that moves in line with the moving contact of the vacuum interrupters to guarantee the best performance and long, reliable mechanical life.

Convac has separate poles instead of a single monobloc, which improves both dielectric performance and mechanical behavior.

The ConVac contactor is available in the electrically or mechanically latched version on request.

Applications

ConVac contactors are suitable for controlling electrical apparatus in industries, in service-providing and shipbuilding sectors, etc. Thanks to vacuum breaking technology, they can operate in particularly difficult environments. They are ideal for controlling motors, transformers, capacitor banks, switching systems, etc.

Fitted with fuses, they can be used in circuits with up to 50 kA fault levels.
Compliance with the Standards
- All versions are provided with certification according to IEC 62271-106, Convac 7 is also certified according UL 347 6th edition (UR recognized), also covering CSA C22.2 standards
- The operating characteristics conform to IEC 60721-3-3
- The operating temperature conforms to IEC 60068 and IEEE C37-09: -30 °C … +55 °C
- Altitude: < 1000 m a.s.l.
For other conditions, please contact ABB.

Main technical characteristics
- Chopping current value: < 0.7 A
- Maintenance-free
- Suitable for installation in medium voltage MCC switchgears, MV soft starters and MECB switchgears
- High number of operating sequences
- Direct monitoring of contact wear
- Long electrical and mechanical life
- Remote control
- Multi-voltage feeder

Interruption principle
The main contacts operate inside the vacuum interrupters.
Rapid separation of the fixed and moving contacts in each contactor interrupter occurs on opening.
Contact overheating, generated when the contacts separate, leads to the formation of metallic vapors that can sustain the electric arc up to the first current zero crossing.
When the current crosses zero, cooling of the metallic vapors restores a high dielectric strength able to withstand high recovery voltage values.

Schematic cross-section of the vacuum interrupter.

- 1 Ceramic enclosure
- 2 Seal diaphragm
- 3 Metal screen
- 4 Moving contact
- 5 Fixed contact

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Description

The ABB range of medium voltage contactor proposals now includes a linear electromagnetic actuator. This actuator is able to perform an axial movement in relation to the moving contact of the vacuum interrupter. This reduces mechanical stress and optimizes the mechanical behavior with positive effects on reliability.

Versions available

**Electrical latching:**
Closing takes place by supplying auxiliary power to the multi-voltage feeder. On the other hand, opening occurs when the auxiliary power is interrupted either intentionally (by means of a command) or unintentionally (due to lack of auxiliary power in the installation).

**Mechanical latching:**
The contactor closes as in the electrical latching version but when the apparatus reaches the closed position, this is maintained by a mechanical device. Opening takes place when the opening coil is supplied. This releases the mechanical lock and allows the opening springs to operate.

The contactor can be ordered in the standard version (fig. 1) or without the front cover, as required by the customer.

**Environmental Management System**
Conforms to ISO 14001 Standards, certified by an independent external organization.

**Health and Safety Management System**
Conforms to OHSAS 18001 Standards, certified by an independent external organization.
<table>
<thead>
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<th>IEC62271-106 (10-2012)</th>
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</thead>
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<tr>
<td>Rated voltages</td>
<td>Ref. std</td>
<td>Value</td>
</tr>
<tr>
<td>Rated voltage [U]</td>
<td>[kV]</td>
<td>4.1</td>
</tr>
<tr>
<td>Rated insulation level [Ud] @50/60Hz</td>
<td>(1 min) [kV]</td>
<td>4.2</td>
</tr>
<tr>
<td>Rated insulation level (Up), impulse</td>
<td>[kVp]</td>
<td>4.2</td>
</tr>
<tr>
<td>Rated frequency [fr]</td>
<td>[Hz]</td>
<td>4.3</td>
</tr>
<tr>
<td>Rated current</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Rated operational current (Ie)</td>
<td>[A]</td>
<td>4.101</td>
</tr>
<tr>
<td>Thermal current (Itth)</td>
<td>[A]</td>
<td>4.4.101</td>
</tr>
<tr>
<td>Short circuit and overload performance</td>
<td>-</td>
<td></td>
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<tr>
<td>Short-time withstand current (Ik) + rated duration [k] or rated momentary current</td>
<td>[A]</td>
<td>4.5</td>
</tr>
<tr>
<td>Rated peak current</td>
<td>[kA peak]</td>
<td>4.6</td>
</tr>
<tr>
<td>Short-time withstand current for 30 s</td>
<td>[A]</td>
<td>6.6</td>
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<tr>
<td>Short circuit breaking current (isc)-combined with fuses</td>
<td>[kA rms]</td>
<td>4.107</td>
</tr>
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<td>Damage classification</td>
<td>-</td>
<td>4.107</td>
</tr>
<tr>
<td>Short-circuit breaking capacity at 7.2kV</td>
<td>[kA]</td>
<td>4.107</td>
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<td>Short circuit making capacity</td>
<td>[kA]</td>
<td>4.107</td>
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<td>-</td>
<td>6.104</td>
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<td>Category</td>
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<tr>
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<td>[kA]</td>
<td>-</td>
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<td>Capacitive switching capabilities (62271-106 / IEEE C37.09a)</td>
<td>4.112</td>
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<tr>
<td>Configuration</td>
<td>-</td>
<td>back to back</td>
</tr>
<tr>
<td>Restrike performance</td>
<td>Class</td>
<td>class C2</td>
</tr>
<tr>
<td>Rated current</td>
<td>[A]</td>
<td>250</td>
</tr>
<tr>
<td>Inrush peak</td>
<td>[kA peak]</td>
<td>8</td>
</tr>
<tr>
<td>Inrush current frequency</td>
<td>[Hz]</td>
<td>2500</td>
</tr>
<tr>
<td>Mechanical life</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Rated duty</td>
<td>[Cycles/hour]</td>
<td>4.102.2</td>
</tr>
<tr>
<td>Life</td>
<td>[Cycles]</td>
<td>6.101</td>
</tr>
<tr>
<td>Mechanical latching</td>
<td>[Cycles]</td>
<td>6.101</td>
</tr>
<tr>
<td>Rated supply voltage of switching devices, and of auxiliary and control circuits (Ua)</td>
<td>4.8, 4.9</td>
<td>-</td>
</tr>
<tr>
<td>Feeder type 1 (Drive unit and closing coil)</td>
<td>[Vdc - Vac 50-60Hz]</td>
<td>-</td>
</tr>
<tr>
<td>Feeder type 2 (Drive unit and closing coil)</td>
<td>[Vdc - Vac 50-60Hz]</td>
<td>-</td>
</tr>
<tr>
<td>Pick-up voltage</td>
<td>[Vdc - Vac 50-60Hz]</td>
<td>-</td>
</tr>
<tr>
<td>Drop-out voltage</td>
<td>[Vdc - Vac 50-60Hz]</td>
<td>-</td>
</tr>
<tr>
<td>Opening coil-Kit RiMe (only for latched contactors)</td>
<td>[Vdc - Vac 50-60Hz]</td>
<td>-</td>
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<tr>
<td>Operating time</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Operating time - Electrically latched</td>
<td>[ms]</td>
<td>-</td>
</tr>
<tr>
<td>Operating time - Mechanically latched (kit RiMe)</td>
<td>[ms]</td>
<td>-</td>
</tr>
<tr>
<td>Closing time</td>
<td>[ms]</td>
<td>-</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>[°C]</td>
<td>IEC 60068</td>
</tr>
<tr>
<td>Weight</td>
<td>15-20 [kg]/33-44 [lbs]</td>
<td>15-20 [kg]/33-44 [lbs]</td>
</tr>
<tr>
<td>Overall dimensions</td>
<td>-</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Width</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Depth</td>
</tr>
</tbody>
</table>

* For UL Class E2 Interrupting capability with R/C Mersen fuse A072BLDAR0-18R
** For higher temperature please contact ABB
*** Highest prospective peak current. Highest cut-off current of the SCPD intended is 45kA
Selection and ordering

1. Feeder/Control Module
ConVac contactors are equipped with a multi-voltage electronic feeder able to cover a wide variety of auxiliary voltages.

The available auxiliary voltages are:
• Feeder 1: 110-125V DC / AC (50/60HZ)
• Feeder 2: 220-240V DC / AC (50/60HZ)

Feeders are plug in and the auxiliary voltage can be switched from feeder 1 to feeder 2 and vice versa by simply replacing the electronic device.

See table 1 for the power required to operate the contactor:

<table>
<thead>
<tr>
<th>Supply Voltage</th>
<th>In-rush power</th>
<th>Holding force</th>
</tr>
</thead>
<tbody>
<tr>
<td>110/125 Vdc-ac 50/60Hz</td>
<td>7A / 10.5A x 200ms</td>
<td>50 W</td>
</tr>
<tr>
<td>220/230Vac 50-60Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>220/240Vdc</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Pulse counter
On request, the contactor can be equipped with an electric pulse counter which provides a visual indication of the number of operations performed by the contactor.
3. Auxiliary contacts
The contactor is equipped with positively driven, class 1 (according IEC 62271-1) auxiliary contacts. Three options are available:
1. Two normally open plus two normally closed (3a)
2. Four normally open plus four normally closed (3b)
3. Six normally open plus six normally closed (3c)

Electrical characteristics:

<table>
<thead>
<tr>
<th>IEC</th>
<th>Class (according to current IEC 62271-1)</th>
<th>Rated DC</th>
<th>Rated short-time withstand current</th>
<th>Breaking capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC</td>
<td>1</td>
<td>10A</td>
<td>100A/30ms</td>
<td>110 V ≤ Ua ≤ 250 V</td>
</tr>
<tr>
<td>UL</td>
<td>B300 – AC-15 : 240V 1.5A / 120V 3A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Q300 – DC-13 : 250V 0.27A / 125V 0.55A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The auxiliary contacts are housed in a plug-in terminal box that can be easily replaced by the customer by switching from one option to the other without any other adjustments required.

4. Open/Close indicator
Indicates the state of the contactor:
- Green: contactor open
- Red: contactor closed

5. Terminals
To ensure maximum flexibility of installation, the electrical devices are equipped with a plug connector with integrated terminal box. It is therefore possible to:
- Unplug the connector
- Prepare the panel wiring separately
- Plug in the connector when the contactor is installed in the panel
Selection and ordering

6-7. Terminals
Installation is extremely flexible since connection to the medium voltage upper terminals of the contactor can be made on both the rear and front sides (7).
The lower phases (6) are connected from the back only.

8. Mechanical latching
The RiMe device for upgrading the electrically latched contactor to a mechanically latched one can be ordered on request.
The device is the plug in type and can be ordered separately from the contactor. It does not need any adjustments or settings.
Assembly only requires two screws (A).
The device is also equipped with a mechanical pull rod to allow emergency opening in the manual mode (B).

Electrical characteristic:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>peak</th>
<th>time</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>40</td>
<td>100ms</td>
</tr>
<tr>
<td>48..60</td>
<td>25</td>
<td>100ms</td>
</tr>
<tr>
<td>110..125Vac/dc</td>
<td>10A</td>
<td>100ms</td>
</tr>
<tr>
<td>220..240Vac/dc</td>
<td>7A</td>
<td>100ms</td>
</tr>
</tbody>
</table>

9. Mechanical and electrical interlock between two contactors
This is a link that interconnects two contactors, one of which is on the upper level of the bearing plate (1) and the other on the opposite side of the same plate (2).
The device does not need to be adjusted and prevents the contactors from being both in the closed position at the same time. Please contact ABB for this application.

10. Interface with external devices
Two holes on a small shaft (accessory to be required at order stage) for the customer use are provided on both sides of the apparatus. The purpose is to provide an interface from the contactor towards the outside environment. Please refer to the instruction manual for more details.
Specific product characteristics

Electromagnetic compatibility

ConVac vacuum contactors ensure operation without unwarranted trips when interference caused by electronic apparatus, atmospheric disturbance or electrical discharge occurs. Moreover they do not produce interference with electronic apparatus installed close to the contactor.

The above conforms to IEC 62271-1, 62271-106, 61000-6-2, 61000-6-4 Standards and to European Directive 89/336 EEC regarding electromagnetic compatibility (EMC).

Altitude

It is well-known that the insulating properties of air decrease as the altitude increases. This phenomenon must always be taken into account when the insulating parts of equipment is to be installed over 1000 m above sea level are designed. In this case, standards IEC 62271-2 or C37.20.2 are applicable.

Thanks to the higher dielectric capability, available as an optional (32kV), stepping down the power frequency withstand voltage up to 3800 m (1550 ft) can be avoided, as specified by IEC standards. Regarding fuses, please consult the fuse manufacturer for an assessment.

Tropicalization

The metal parts in ConVac vacuum contactors are treated against class C corrosive factors, as specified by UNI 3564-65 and ANSI/IEEE C37.20.2 Standards.

Galvanization is performed in compliance with UNI ISO 2081 Standards, classification code Fe/Zn 12, i.e. thickness 12x10^-3 m, protected by a conversion layer formed mainly by chromates in accordance with UNI ISO 4520.
Graph for determining the Ka correction factor on the basis of altitude, Example (IEC):

- Installation altitude: 2000 m
- Service at a rated voltage of 7 kV
- Power frequency withstand voltage 20 kV rms
- Impulse withstand voltage 60 kVp
- Ka Factor = 1.28 (see graph)

Taking the above parameters into consideration, the apparatus must have the following withstand values (test performed at zero altitude i.e. at sea level):

- Power frequency withstand voltage equal to: 
  \[ 20 \times 1.28 = 25.6 \text{kVrms} \]
- Impulse withstand voltage equal to: 
  \[ 60 \times 1.28 = 76.8 \text{kVp} \]

In view of the above, it is evident that installations at an altitude of 2000 m above sea level with 12 kV service voltage require apparatus with 17 kV rated voltage characterized by 38 kV rms power frequency insulation levels and 95 kVp impulse withstand voltage. ConVac 7 ensures 32 kV power frequency withstand voltage and can therefore be used in this case, with the application of surge arresters to limit impulse withstand voltage to 60kVp.

Installation

Contactor performance remains unaltered in the indicated installation positions:
A) Floor-mounted with moving contacts at the bottom
B) Wall-mounted with horizontal moving contacts and terminals at the bottom
C) Wall-mounted with horizontal moving contacts and terminals at the top
D) Wall-mounted with horizontal moving contacts, interrupters on the front (or rear) and vertical terminals
E) Ceiling-mounted with moving contacts at the top
Specific product characteristics

Use of fuses according to load

Motor control and protection
The motors are supplied at low voltage, generally up to a power of 630 kW. Beyond this power, medium voltage supply is preferable (from 3 to 12 kV) so as to reduce costs and the dimensions of the apparatus forming the circuit. ConVac contactors can be used for voltages from 2.2 kV to 7.2 kV and for motors with up to 3000 kW power ratings.

To ensure protection against short-circuits, the contactors must be used in conjunction with current limiting fuses. This solution allows the cost of the apparatus on the load side (cables, current transformers, busbar and cable anchoring devices, etc.) to be reduced still further on the basis of the fuse melting time and current.

More cost-effective devices can be used for withstanding lower short circuit voltages. This solution also allows the user to become practically independent of any subsequent enlargements and resulting increases in network power.

Motor protection fuses

How to choose motor protection fuses for ConVac contactors.
Only use fuses with medium dimensions and striker conforming to Standards DIN 43625 and BS 2692 (1975).

The electrical characteristics must comply with Standard:
- IEC 60282-1 (1974) for IEC market
- R-type for ANSI/UL market

The customer is responsible for choosing a brand of fuse that conforms to the specifications above and for selecting the actual fuse. The choice must be made on the basis of the trip curves provided by the manufacturer and according to the characteristics of the contactor.
To choose the correct ABB fuses, reference can be made to the following instructions.

**DIN fuses**

ABB CMF fuses are used for motor protection. To select the correct fuses, first assess the service conditions by considering the following parameters:

- Supply voltage
- Inrush current
- Inrush time
- Number of starts/hour
- Motor full load current
- Short circuit current of installation

One of the criteria to bear in mind when choosing the fuse is trip coordination with the other protection, such as relays. This will ensure that the contactor, the motor, and all other equipment on the load side of the circuit (which could be damaged by prolonged overloads or by specific let through energy ($i^2t$) that exceeds the withstand rating), are adequately protected. Short-circuit protection is provided by fuses. The rated current of the fuses must always be higher than that of the motor to prevent them from tripping on start-up. However, this method of selection does not allow them to be used as protection against repeated overloads. In any case, they do not provide this protection, especially with the current values up to the end of the initial asymptotic extension of the characteristic curve.

For this reason, always install an inverse time delay trip or definite time delay relay for protection against overloads.

This protection must be coordinated with that of the fuse. The characteristics of the relay and fuse curves must intersect in a point that allows:

1. Motor protection against overcurrents due to overloads, single-phase operation, blocked rotor and repeated starts. Protection is provided by an indirect inverse time delay trip or definite time delay relay which acts on the contactor.
Specific product characteristics

2. Protection of the circuit against fault currents of low value between phases and towards earth is provided by an inverse time delay trip or definite time delay release, which must only trip for short-circuits that can be interrupted by the contactor.

3. Protection of the circuit against fault currents that are higher than the breaking capacity of the contactor up to the maximum internal arc withstand current. Protection is provided by the fuse.

Proceed as follows to verify the service conditions.

- **Rated voltage Un:**
  - This should be the same as the service voltage of the installation or higher.
  - Check that the insulation level of the network is higher than the switching overvoltage value generated by the fuses. In the fuses manufactured by ABB, this value is well below the limit established by standard IEC 282-1.

- **Rated current In:**
  - This must be selected by consulting the diagrams in fig. A. They refer to motors starting at regular time intervals except for the first two starts of each hourly cycle, which can take place in immediate succession.
  - Each diagram refers to a different starting time: 6 s - 15 s - 60 s, respectively. If there are two starts close together, check that the starting current does not exceed the value of \( I_f \times K \)
  - \( I_f \) is the fuse melting current in correspondence to the starting time of the motor, while \( K \) is a minor factor of the unit which depends on the \( I_n \) of the fuse. The table in fig B. gives \( K \) factor in relation to the rated current of the fuse.

- **Full-load current:**
  - The rated current of the fuse must be 1.33 times the full load rated current of the motor or higher. This condition is always obtained for motors started at full voltage for which the procedure described for selecting the rated current of the fuse necessarily imposes values which are always higher than 1.33 \( I_n \).
With reference to the curve with 6 s starting time in fig. A, plot a vertical line on a level with starting current value 650 A which intersects the 16 hourly starts line in the 250 A fuse field.

Note in the melting time curve that the 250 A fuse melts in 6 s (starting time) when 1800 A current passes through it.

In the table in fig. B, the K coefficient for the 250 A size is 0.6, therefore:

\[
\text{If } x K = 1800 \times 0.6 = 1080 \text{ A}
\]

As this value is higher than the starting current (650 A), use of a 250 A fuse is also correct in the case of two starts close together.

If one observes the melting curve of the 250 A fuse, one notes that an inverse time delay trip or definite time delay relay are required for protection against overloads.

One should consider that prolonged overheating beyond the temperature limit of the insulating materials will notably compromise the life expectancy of electric machines.

If the contactor is self-supplied by means of a VT or CPT, these latter will not trip if a short-circuit occurs, resulting in an immediate voltage drop in the contactor supply. Auxiliary voltage interruption will open the electrically latched contactor while the fuse melts regardless of the presence of a relay.

In this situation, it is important to check that the let-through current generated by the fuse during the contactor opening time is within the breaking capacity of the contactor.

**Motor starting**

Motor starting poses the problem of high current consumption on inrush.

In most cases, since these are asynchronous motors, the starting current can be:

- asynchronous with simple squirrel cage: 4.5 ... 5.5 In
- asynchronous with double squirrel cage: 5 ... 7 In
- asynchronous with wound motor: low values, depending on the choice of starting resistors

**Example of fuse-inverse time delay trip relay coordination for overload**

Motor data:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pn</td>
<td>1000kW</td>
</tr>
<tr>
<td>Un</td>
<td>6kV</td>
</tr>
<tr>
<td>Istart</td>
<td>~ 5in = 650A</td>
</tr>
<tr>
<td>Tstart</td>
<td>6s</td>
</tr>
<tr>
<td>No. hourly operations</td>
<td>16</td>
</tr>
</tbody>
</table>
Specific product characteristics

This current will not be available if the short-circuit power of the network is not sufficiently high and in any case, can give rise to a voltage drop for the whole duration of starting, which cannot be tolerated by loads derived from the network itself. Normally a voltage drop between 15 and 20 percent is considered acceptable, but this must be assessed in the case of special users. The full voltage start condition can be checked analytically and turns out to be possible in most cases. If the calculations show that the starting power causes a higher voltage drop than that allowed, proceed by starting with reduced voltage and a consequent reduction in the starting current. In this case, starting is generally performed by a stepdown autotransformer. For large motors it may be more convenient to use a transformer dedicated exclusively to the machine, which can be slightly oversized in relation to the power required for the the motor: starting therefore takes place at reduced voltage without the rest of the installation being affected. Any motor starting, control, protection and measurement layout can be created by combining different enclosures, with withdrawable contactors appropriately fitted with accessories. Fig. F shows some typical wiring diagrams.

The graph of the motor described in the example is illustrated in fig. E.

Fig. E - Graph showing coordination between the 250 A ABB CMF fuse and inverse time delay trip release.
Fig. F - Typical diagrams of transformer power supply and motor starting
Specific product characteristics

Transformer protection and fuse selection (*)
When contactors are used for transformer control and protection, they are fitted with a dedicated type of current limiting fuses which ensure selectivity in relation to other protection devices and support the high transformer inrush currents without deteriorating.
Unlike motors, in this case, protection against overcurrents on the medium voltage side of the transformer is not essential as this task is accomplished by the protection on the low voltage side.
Protection on the medium voltage side can therefore be entrusted to this fuse alone. This must be selected by taking the no-load inrush current into account.
For smaller transformers made with grain-oriented laminations this value can reach 10 times the rated current.
Circuit-breaker closing occurs at maximum inrush current, which corresponds to the moment in which the voltage crosses zero.
Another result to be guaranteed is protection against faults in the low voltage winding and in that part of the connection from this to the circuit-breaker on the secondary winding, avoiding the use of fuses with rated current which is too high, so as to be able to ensure tripping within a short time even under these fault conditions.
A rapid check of the short-circuit current on a level with the secondary terminals of the transformer and on the supply side of the circuit-breaker on the secondary winding, if positioned at a significant distance, allows the release time on the fuse tripping curve to be verified.
The table below takes both conditions into account, i.e. rated current sufficiently high to prevent unwarranted fuse blowing during the no-load inrush phase and, in any case, of a value which guarantees protection of the machine against faults on the low voltage side.

Selection table for fuses for transformers

<table>
<thead>
<tr>
<th>Rated voltage of the transformer [kV]</th>
<th>Rated power of transformer [kVA]</th>
<th>Rated voltage of the fuse [kV]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25 50 75 100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>16 25 25 40 40 50 63 80 100 125 160 200 250 315 2x250 (*)</td>
<td>3.6/7.2</td>
</tr>
<tr>
<td>5</td>
<td>10 16 25 25 40 40 50 63 80 100 125 160 200 250 315 2x250 (<em>) 2x315 (</em>)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6 16 25 25 40 40 50 63 80 100 125 160 200 250 315 2x250 (*)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>6 10 16 16 16 20 20 25 31.5 40 50 63 80 100 125 160 200 2x160 (*)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>6 6 10 16 16 16 20 20 25 40 40 50 63 80 100 125 160 200</td>
<td></td>
</tr>
</tbody>
</table>

Use CMF fuses.
(*) External fuse carrier required.

Capacitor switching
When it comes to switching capacitor banks, the choice of a contactor and fuses suitable for switching-in/out the bank while guaranteeing protection in the case of overloads or short-circuits requires particular care.
The presence of current transients when a capacitor bank is switched in requires accurate calculation procedures.
The capacitor switching application can normally be of two types:

1. Single bank installation (single three-phase capacitor bank)
   In installations of this sort there is only one type of switching-in transient, called switching-in transient of a single capacitor bank to the network.
   An example of a typical current transient is illustrated in fig. A.

2. Back-to-back installation (several three-phase capacitor banks in parallel, which can be switched-in separately).
   In installations of this sort there are two types of switching-in transients:
   a. when the first capacitor bank is switched-in a switching-in transient of a capacitor bank to the network occurs
   b. when the other banks are switched-in a switching-in transient of a capacitor bank to the network with other banks already supplied in parallel occurs. In this case, the current transient is the type shown in fig. B

---

**Fig. A - Example of a current transient when a single capacitor bank is switched-in.**

- a = Switching-in transient current: first peak at 600 A peak and 920 Hz frequency.
- b = 400 kVAR transient voltage at the bank terminals.
- c = Power supply phase voltage $10/\sqrt{3} = 5.8$ kV.
- d = Rated current of bank at 50 Hz: 23.1 A.

---

**Fig. B - Example of a current transient when a capacitor bank is switched-in with another already supplied.**

- a = Switching-in transient current: 1800 A peak and 4280 Hz frequency.
- b = 400 kVAR transient voltage at the bank terminals.
- c = Power supply phase voltage $10/\sqrt{3} = 5.8$ kV.
- d = Component at 4280 Hz frequency of the inrush transient current.
- e = Component at 1260 Hz frequency of the inrush transient current.
Specific product characteristics

Choice of contactors for switching-in capacitor banks
Standards CEI 33-7 and IEC 871-1/2 specify that capacitor banks: “... must be able to operate correctly under overload conditions with up to 1.3 In rms value of the line current, without considering the transients”. Thus the switching, protection and connection devices must be designed to continuously withstand a current 1.3 times higher than the current there would be at rated sine wave voltage and frequency.

On the basis of the rms value of the capacitance, the tolerance of which can be +10 percent of the rated value, a device must be chosen for a maximum current value of 1.3 x 1.10 = 1.43 times the rated current of the bank.

ConVac contactors fully fulfil the requirements of IEC 62271-106 and ANSI C37.09a (within limits in table on page 11) Standards, and are certified class C2 (ConVac 7) and Class C1 (ConVac 12) for back-to-back capacitor bank switching.

Single bank
The parameters of the current transient, peak values and own frequency, which are present when the bank is switched into the network, are usually of a considerably smaller size than those in the case of multiple banks.

Two or more banks (back-to-back)
When there are several capacitor banks, calculations regarding the installation must be made, considering the case of a single bank being switched-in with the other capacitor banks already switched in.

Under these conditions, check that:
• maximum inrush current does not exceed the value given below (see table);
• inrush current frequency does not exceed the value given below (see table).

<table>
<thead>
<tr>
<th>Peak current</th>
<th>Maximum inrush current</th>
<th>Ip (kA) x f (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8kAp</td>
<td>2.500 Hz</td>
<td>20000</td>
</tr>
</tbody>
</table>

For maximum inrush current values below 8kA, the inrush frequency can be increased so that the product of current by frequency results as less than

\[ Ip (kA) \times f (Hz) = 8 \times 2.500 = 20,000 \]

for instance:

\[ Ip (kA) = 5kA \text{ the maximum admissible inrush frequency becomes } f (Hz) = 20,000 / 5 = 4,000Hz \]

This rule can be applied to inrush currents below 8kAp, corresponding to the maximum value, which must not be exceeded even when the frequency is lower than 2500Hz.

Refer to ANSI C37.012 or IEC 62271-100 Annex H to calculate the inrush current and frequency. If the calculations result in inrush current and frequency values which are higher than the maximum allowed, then air reactors of a suitable value must be installed in the circuit, while the cables connected must also be considered. Use of reactors is also recommended when there are frequent operating sequences with high inrush frequencies.

Environmental protection program
ConVac contactors are manufactured in compliance with ISO 14000 Standards (Environmental Management Directives). The production processes comply with the Standards for environmental protection in terms of:
• Reduced energy consumption
• Raw materials
• Production of waste.

All this is achieved thanks to the environmental management system adopted in the production facility, as certified by the Certification Authority. Careful selection of materials, processes and packing during the design stage minimizes environmental impact during the life cycle of the product (LCA - Life Cycle Assessment).

The products are easy to dismantle and the components can be easily separated for recycling at the end of the useful life of the apparatus. For this purpose, all the insulating components are marked according to ISO 11469 (2nd ed. 15.05.2000) standards.
Overall dimensions

ConVac 7

Electrically latched version

Mechanically latched version
Overall dimensions

ConVac 12

Electrically latched version

Mechanically latched version
Electric circuit diagram

Graphical symbols for circuit diagrams (60617 IEC and 60617 CEI EN Standards)
Electric circuit diagram
Electric circuit diagram
The contactor circuits are illustrated in the diagrams below by way of example. In any case, in view of product development and for specific applications, it is always useful to refer to the electric circuit diagram provided with each piece of apparatus.

**Operating state shown**
The diagram illustrates the following conditions:
- contactor open
- circuits de-energized
- “-BGS1: NC contact but shown in the state of contactor open and circuits de-energized”.

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**Key**
- Reference number of the diagram figure
- See note indicated by the letter
- KFA = Auxiliary control relay or contactor (use ABB contactor type B7 or BC7 or equivalent)
- QAC = Contactor
- MBC = Closing coil
- BGF1 = Position contact of medium voltage fuse
- BGB1 to BGB6 = Contactor auxiliary contacts
- SFC = Push-button or contact for contactor closing
- SFO = Push-button or contact for contactor opening
- RD = Diode
- XDB = Connectors for the contactor circuits
- PGC = Electric operation counter
- RLM = Mechanical interlock
- - - - = At customer’s charge. Use the diagram given or equivalent diagrams.

**Description of diagram figures**
- Fig. 1 = Control circuits of contactor
- Fig. 2 = Control circuits of contactor with mechanical latching (RIMe)
- Fig. 3 = Auxiliary contacts. Version with 4 contacts
- Fig. 4 = Auxiliary contacts. Version with 8 contacts
- Fig. 5 = Auxiliary contacts. Version with 12 contacts
- Fig. 11 = Electric operation counter

**Incompatibility**
The circuits indicated in the following figures cannot be supplied at the same time on the same contactor:

<table>
<thead>
<tr>
<th>1-2</th>
<th>3-4</th>
<th>3-5</th>
<th>4-5</th>
</tr>
</thead>
</table>

**Notes**
- A) The contactor is delivered complete with the sole applications specified in the ABB order confirmation. Consult the catalog of the apparatus when making out the order.
- B) Control command duration (-SFO and -SFC) at rated voltage Ua
  - Fig. 1 and Fig. 2: -SFC minimum 300ms, -SFO minimum 300ms.
  - Shorter command duration on request.