3

Contactors

CT1215/04, CT1230/04
CT1215/08, CT1230/08

Double pole power contactors for AC and DC

Catalogue C21.en
Double pole CT Series contactors comprise a number of various design versions catering to a wide range of uses, such as:

- **Main contactor for**
  - Traction converters and inverters for auxiliary equipment

- **Contactor for**
  - Field circuits of motors, conventional resistor based traction units (retro-fit), starter and compressor motors, and heating circuits

### Ordering code

<table>
<thead>
<tr>
<th>Series</th>
<th>Main contacts: Nominal voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT11</td>
<td>15 U_n = 1,500 V</td>
</tr>
<tr>
<td>CT12</td>
<td>15 U_n = 3,000 V</td>
</tr>
<tr>
<td>CT13</td>
<td>30 U_n = 3,000 V</td>
</tr>
</tbody>
</table>

- **Main contacts: Conventional thermal current**
  - 04 I_{th} = 400 A
  - 06 I_{th} = 600 A
  - 08 I_{th} = 800 A
  - 11 I_{th} = 1,100 A
  - 15 I_{th} = 1,500 A

- **Mounting position**
  - H horizontal (lock bar yellow)
  - V vertical (lock bar red)

- **Coil voltage**
  - 24 / 36 / 48 / 72 / 110 V DC

- **Auxiliary contacts**

<table>
<thead>
<tr>
<th>Coil tolerance</th>
<th>Surge suppression/type of coil</th>
<th>Suppressor diode / standard coil</th>
<th>Double coil controller (DCC) / double coil</th>
</tr>
</thead>
<tbody>
<tr>
<td>-30 % … +25 %</td>
<td>T CM</td>
<td>T</td>
<td>C</td>
</tr>
</tbody>
</table>

- **Example:**
  - CT1230/04 H 110ET-00

### Features

- Compact, rugged innovative design
- Rated operating voltage 1,500 V or 3,000 V
- Double-break contacts, (normally open)
- 1, 2*1, and 3*2 pole versions
- Easy inspection and replacement of main contact tips as well as arc chute
- Drive system with coil tolerance according to railway standards
- Functional insulation for main circuit
- Basic insulation between main circuit and protective earth
- Reinforced insulation between main circuit and control circuit / auxiliary circuit

### Applications

- Double pole CT Series contactors are designed for a wide range of uses, including:
  - **Main contactor for**
    - Traction converters and inverters for auxiliary equipment
  - **Contactor for**
    - Field circuits of motors, conventional resistor based traction units (retro-fit), starter and compressor motors, and heating circuits

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**Note:**

Presented in this catalogue are only stock items which can be supplied in short delivery time.

For some variants minimum quantities apply. Please do not hesitate to ask for the conditions.

**Special variant:**

If you need a special variant of the contactor, please do not hesitate to contact us. Maybe the type of contactor you are looking for is among our many special designs. If not, we can also supply customized designs. In this case, however, minimum order quantities apply.

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*1* See catalogue C20
*2* Special design, upon request
*3* Series in development
*4.1* Suppressor diode / standard coil
*4.2* Double coil controller (DCC), integrated / double coil
*4.3* For main contacts I_{th} = 400 A
*4.4* For main contacts I_{th} > 400 A
*5* Single pole version. 2x main contacts I_{th} = 800 A, parallel connected
*6.1* Aux. contact, blowout version
*6.2* Aux. contact snap-action switch S826, see also catalogue C06
*6.3* Aux. contact snap-action switch S870, see also catalogue D07
## Specifications

**Double pole power contactors for AC and DC**

**Series CT, 2 pole**

<table>
<thead>
<tr>
<th>Series</th>
<th>CT1215/04</th>
<th>CT1220/04</th>
<th>CT1215/08</th>
<th>CT1220/08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of voltage</td>
<td>DC (bidirectional), AC (f &lt; 60 Hz)</td>
<td>DC (bidirectional), AC (f &lt; 60 Hz)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main contacts, number of, configuration</td>
<td>2x NO</td>
<td>2x NO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nominal voltage $U_n$</td>
<td>1,500 V</td>
<td>3,000 V</td>
<td>1,500 V</td>
<td>3,000 V</td>
</tr>
<tr>
<td>Rated operating voltage $U_{op}$</td>
<td>1,800 V</td>
<td>3,600 V</td>
<td>1,800 V</td>
<td>3,600 V</td>
</tr>
<tr>
<td>Rated insulation voltage $U_{ins}$</td>
<td>3,000 V</td>
<td>4,800 V</td>
<td>3,000 V</td>
<td>4,800 V</td>
</tr>
<tr>
<td>Rated impulse withstand voltage $U_{im}$</td>
<td>15 kV</td>
<td>25 kV</td>
<td>15 kV</td>
<td>25 kV</td>
</tr>
<tr>
<td>Switching surge overvoltage</td>
<td>$U_s = 1.800 V$</td>
<td>$&lt; 9 kV$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$U_s = 3.600 V$</td>
<td>$&lt; 15 kV$</td>
<td></td>
</tr>
<tr>
<td>Conventional thermal current $I_{th}$</td>
<td>400 A $a)$</td>
<td>400 A $a)$</td>
<td>800 A</td>
<td>800 A</td>
</tr>
<tr>
<td>Component category (IEC 60077-2)</td>
<td>A2</td>
<td>A2</td>
<td>A2</td>
<td>A2</td>
</tr>
<tr>
<td>Short-circuit making capacity</td>
<td>2.5 kA (new contacts) / 5 kA (used contacts)</td>
<td>3.5 kA (new contacts) / 8 kA (used contacts)$b)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated operating current $I_o$ (2 poles connected in series, at operational frequency C2)</td>
<td>450 A</td>
<td>800 A</td>
<td>800 A</td>
<td>800 A</td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.200 V$ (T2 = 15 ms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.800 V$ (T2 = 15 ms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated operating current $I_o$ (per pole, at operational frequency C2)</td>
<td>300 A</td>
<td>450 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.200 V$ (T2 = 15 ms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.800 V$ (T2 = 15 ms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breaking capacity (2 poles connected in series, T2 = 15 ms)</td>
<td>1,400 A</td>
<td>2,000 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.200 V$</td>
<td>800 A</td>
<td>1,200 A</td>
<td>2,000 A</td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.800 V$</td>
<td>600 A</td>
<td>750 A</td>
<td></td>
</tr>
<tr>
<td>Breaking capacity (2 poles connected in series, T2 = 1 ms)</td>
<td>2,600 A</td>
<td></td>
<td></td>
<td>2,300 A $c)$</td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.200 V$</td>
<td>1,800 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.800 V$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breaking capacity (per pole, $c_2$ = 0.8)</td>
<td>1,000 A / 700 A</td>
<td>1,900 A / 1,400 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.200 V$ (f = 16.7 / 50 Hz)</td>
<td>800 A / 500 A</td>
<td>1,500 A / 1,000 A</td>
<td>2,300 A / 1,500 A</td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.800 V$ (f = 16.7 / 50 Hz)</td>
<td></td>
<td>900 A / 500 A</td>
<td></td>
</tr>
<tr>
<td>Breaking capacity (per pole, $c_2$ = 1)</td>
<td>1,300 A / 1,000 A</td>
<td>2,200 A / 1,600 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.200 V$ (f = 16.7 / 50 Hz)</td>
<td>1,000 A / 700 A</td>
<td>1,900 A / 1,200 A</td>
<td>2,900 A / 1,300 A</td>
</tr>
<tr>
<td></td>
<td>$U_o = 1.800 V$ (f = 16.7 / 50 Hz)</td>
<td></td>
<td>1,300 A / 800 A</td>
<td></td>
</tr>
<tr>
<td>Rated short-time withstand current $I_{sw}$ (T &lt; 100 ms)</td>
<td>5 kA</td>
<td>5 kA</td>
<td>8 kA $d)$</td>
<td>8 kA $d)$</td>
</tr>
<tr>
<td>Critical current range</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Main contacts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact material</td>
<td>AgSnO$_2$</td>
<td>AgSnO$_2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminals</td>
<td>M10</td>
<td>M12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque</td>
<td>20 Nm max.</td>
<td>30 Nm max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auxiliary contacts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number and type</td>
<td>1x S870 (a1), 1x S870 (b0), 2x S826 or 4x S826</td>
<td>1x S870 (a1), 1x S870 (b0), 2x S826 or 4x S826</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact material</td>
<td>Silver</td>
<td>Silver</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SB28 switching capacity (T = 5 ms)</td>
<td>16 A at 24 V DC, 13.5 A at 80 V DC, 7 A at 110 V DC</td>
<td>16 A at 24 V DC, 13.5 A at 80 V DC, 7 A at 110 V DC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Terminals</td>
<td>Screws M3 / Flat tabs 6.3 x 0.8 mm</td>
<td>Screws M3 / Flat tabs 6.3 x 0.8 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnetic drive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pollution degree / overvoltage category</td>
<td>PD3 / OV2</td>
<td>PD3 / OV2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coil voltage $U_c$</td>
<td>24 / 36 / 48 / 72 / 110 V DC</td>
<td>24 / 36 / 48 / 72 / 110 V DC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coil tolerance</td>
<td>$-30 % \ldots +25 %$</td>
<td>$-30 % \ldots +25 %$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cold coil: 70 W</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pull-in current, typical at $T_2$ = 20 °C</td>
<td>$0.6 \times U_c$</td>
<td>$0.6 \times U_c$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drop-off voltage, typical at $T_2$ = 20 °C</td>
<td>0.1 U</td>
<td>0.1 U</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drop-off time, typical at $T_2$ = 20 °C</td>
<td>50 ms</td>
<td>50 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switching frequency at $T_2$ = 20 °C and 1.25 $U_c$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of coil</td>
<td>Standard coil</td>
<td>Standard coil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surge suppression</td>
<td>Suppressor diode</td>
<td>Suppressor diode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coil terminal</td>
<td>Cage clamp</td>
<td>Cage clamp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingress protection rating (IP code)</td>
<td>IP00</td>
<td>IP00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical endurance</td>
<td>&gt; 2 million operating cycles</td>
<td>&gt; 2 million operating cycles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration / Shock (EN 61373)</td>
<td>Category 1, Class B</td>
<td>Category 1, Class B</td>
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<td></td>
</tr>
<tr>
<td>Mounting position</td>
<td>horizontal / vertical</td>
<td>horizontal / vertical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature / storage temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altitude</td>
<td>-40 °C ... +70 °C / -40 °C ... +85 °C</td>
<td>-40 °C ... +70 °C / -40 °C ... +85 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humidity (EN 50125-1)</td>
<td>&lt; 2,000 m above sea level</td>
<td>&lt; 2,000 m above sea level</td>
<td></td>
<td></td>
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<tr>
<td>Weight</td>
<td>18 kg</td>
<td>30 kg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a) With frequent switching under load the conv. thermal current $I_{th}$ must be limited to 350 A.
*b) Preliminary values
*c) $c_1$ and $c_2$ according to IEC 60077
*d) $a_1$ and $b_0$ according to IEC 60077
*e) For frequent load switching use contactors for vertical mounting (red lock bars).

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*SCHALTBAU
CT1215/04 Dimension diagram double pole NO contactor for 1,500 V / 400 A (standard version) Series CT, 2 pole

- Release slider to unlock arc chute
- Lock bar with indicator (arc chute open/locked)
  - yellow: mounting pos. H
  - red: mounting pos. V
- Arc chute
- Latching lever
- Main terminal screw M10
- Aux. contact block (incl. cover)
- Coil terminal WAGO 264 (incl. cover)

* Minimum clearance:
Interrupting at maximum capacity could require larger clearance!
Feel free to contact us, we will be happy to assist you with dimensioning.

Dimensions in mm

CT1215/08 Dimension diagram double pole NO contactor for 1,500 V / 800 A (standard version) Series CT, 2 pole

- Release slider to unlock arc chute
- Lock bar with indicator (arc chute open/locked)
  - yellow: mounting pos. H
  - red: mounting pos. V
- Arc chute
- Latching lever
- Main terminal screw M12
- Aux. contact block (incl. cover)
- Coil terminal WAGO 264 (incl. cover)

* Minimum clearance:
Interrupting at maximum capacity could require larger clearance!
Feel free to contact us, we will be happy to assist you with dimensioning.

Dimensions in mm
**CT1230/04** Dimension diagram double pole NO contactor for 3,000 V / 400 A (standard version)

Series CT, 2 pole

**CT1230/08** Dimension diagram double pole NO contactor for 3,000 V / 800 A (standard version)

Series CT, 2 pole

*Minimum clearance:
Interrupting at maximum capacity could require larger clearance! Feel free to contact us, we will be happy to assist you with dimensioning.*
Mounting instructions

**Start up**
Before initial start up make sure that:
- the arc chute is mounted properly and the lock bars are locked in position
- the protective covers are mounted properly
- the contactor is earthed (PE terminal on mounting plate)

**Removal of arc chute**
1. Push both release sliders in the direction indicated by the arrow and hold them in this position.
2. Move all four levers for unlocking the arc chute in the direction indicated by the arrow.
3. The arc chute incorporating the stationary main contacts can now be lifted from the contactor.

**Mounting the arc chute**
1. Mount the arc chute onto the magnetic drive. Note: The arc chute has keys on one side to fit into slots on the corresponding side of the contactor. So you cannot mount it the wrong way round.
2. Move all four levers for unlocking the arc chute into the original position.
3. Check: The arc chute is locked properly, if all four lock bars click into place and cannot be opened without pushing the release slider.

**Removal of protective covers**
- Protective cover auxiliary switches: Dismount arc chute first, then loosen knurled head screws and remove protective cover.
- Protective cover coil terminals: Unscrew cover and take it off.

**Mounting of protective covers**
- Protective cover auxiliary switches: Position protective cover and screw in both knurled head screws. Then mount arc chute.
- Protective cover coil terminals: Introduce protective cover into the groove of the coil drive and locate in position. Then tighten screws.

**Dimensioning instructions**
- Do you need some help? For selecting the contactor that suits your application best do not hesitate to ask our advice.
- For dimensioning CT12xx/xx Series contactors please observe the following instructions:
  1. For connection of the main contacts Schaltbau recommends the use of busbars with the following dimensioning:
     - Conv. thermal current \( I_{th} = 400 \text{ A} \): 60 x 5 mm
     - Conv. thermal current \( I_{th} = 800 \text{ A} \): 80 x 8 mm
  2. Observe clearance of live parts to arc chute! Refer to dimension drawings on page 4 and 5 for data.
  3. CT1230/08: For frequent load switching use contactors for vertical mounting (red lock bars).
  4. For nominal voltages \( U_{N} \geq 3,000 \text{ V DC} \) ask for our special design CT1230/08 ... 200.

**Surge suppression**
- CT12xx/04 Series with main contacts designed for \( I_{th}=400 \text{ A} \):
  - Surge suppression/coil type »F<sub>c</sub>: Standard coil with suppressor diode.
  - The use of a suppressor diode for limiting transient overvoltages occurring on opening of the coil is optimally attuned to the contactor’s switching behaviour. The existing opening characteristic must not be negatively influenced by parallel connection with an external diode.
- CT12xx/08 Series with main contacts designed for \( I_{th}=800 \text{ A} \):
  - Surge suppression/coil type »C<sub>m</sub>: Double coil with integrated double coil controller (DCC module).
  - Observe correct polarity of coil terminals. Do not add any extra suppressor diodes to the configuration.

**Circuit diagrams**

**Versions to industry standard**
- 2x NO \( I_{th} = 400 \text{ A} \), Standard coil, Aux. contacts 4 x S826
- 2x NO \( I_{th} = 800 \text{ A} \), Double coil with double coil controller, Aux. contacts 4 x S826

**Versions to railway standard IEC 60077**
- 2x NO \( I_{th} = 400 \text{ A} \), Standard coil, Aux. contacts (IEC 60077) 2 x S826, 1 x S870<sub>b0</sub>, 1 x S870<sub>a1</sub>
- 2x NO \( I_{th} = 800 \text{ A} \), Double coil with double coil controller, Aux. contacts (IEC 60077) 2 x S826, 1 x S870<sub>b0</sub>, 1 x S870<sub>a1</sub>
Mounting holes

- 2 pole standard contactor, CT1215/04, CT1230/04 Series

- 2 pole standard contactor CT1215/08, CT1230/08 Series

Spare parts

<table>
<thead>
<tr>
<th>Items</th>
<th>Spare part, description</th>
<th>CT1215/04</th>
<th>CT1230/04</th>
<th>CT1215/08</th>
<th>CT1230/08</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Set of two stationary contacts</td>
<td>MC CT1015/04</td>
<td>MC CT1030/04</td>
<td>MC CT1015/08</td>
<td>MC CT1030/08</td>
</tr>
<tr>
<td>1</td>
<td>Contact bridge with mounted contact holder, mounting position »H« horizontal</td>
<td>CBH CT1215/04</td>
<td>CBH CT1230/04</td>
<td>CBH CT1215/08</td>
<td>CBH CT1230/08</td>
</tr>
<tr>
<td>1</td>
<td>Contact bridge with mounted contact holder, mounting position »V« vertical</td>
<td>CBV CT1215/04</td>
<td>CBV CT1230/04</td>
<td>CBV CT1215/08</td>
<td>CBV CT1230/08</td>
</tr>
<tr>
<td>1</td>
<td>Protective cover coil terminals</td>
<td>CC CT1030/04</td>
<td>CC CT1030/08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Protective cover aux. switches</td>
<td>CA CT1030/04</td>
<td>CA CT1030/08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Snap-action switch (SPDT)</td>
<td>S826 a L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Contact block of 2x S870 (momentary switches a1, b0)</td>
<td>AS S870</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Maintenance instructions

- CT12xx/xx Series contactors are maintenance free with normal use.
- Make regular inspections once or twice a year. So when installing the contactor, make sure that there is enough space to remove and replace the arc chute with ease and that the main contacts become accessible for inspection.
- Frequent switching or switching under high load may lead to increased wear of the main contacts. In this case replacement of the main contacts may become necessary. The design of the CT contactor series allows for easy replacement of the main contacts. For detailed information please refer to our manuals C21/04-M.en and C21/08-M.en respectively.

Safety instructions

- The switching device meets the requirements of basic insulation. Make sure the plate onto which the drive of the contactor is mounted is earthed in a vibration resistant way.
- Do not use contactor without properly mounted arc chute.
- The contactor has unprotected live parts and carries a label that warns of the hazard. This caution must be observed and the label must not be removed in any way.
- The required clearance of live parts to ground and other parts of the contactor is to be observed as well as the safety regulations of the applicable standards.
- Switching at maximum breaking capacity might require larger clearance! Do not hesitate to ask our advice for dimensioning.
- Do not use contactor without protective covers (for coil terminals and auxiliary switches).
- Coil suppression for reducing surges when the coil is switched off is optimally attuned to the contactor’s switching behaviour. The existing opening characteristic must not be negatively influenced by parallel connection with an external diode.
- Improper handling of the contactor, e.g. when hitting the floor with some impact, can result in breakage, visible cracks and deformation.

Dimensions in mm

Standards

- IEC 60077: Railway applications – Electric equipment for rolling stock
- EN 50124-1: Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment
- IEC 61373: Railway applications - Rolling stock equipment - Shock and vibration tests

Defective parts must be replaced immediately!
Schaltbau GmbH
For detailed information on our products and services visit our website – or give us a call!

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Electrical Components and Systems for Railway Engineering and Industrial Applications

Connectors
- Connectors manufactured to industry standards
- Connectors to suit the special requirements of communications engineering (MIL connectors)
- Charging connectors for battery-powered machines and systems
- Connectors for railway engineering, including UIC connectors
- Special connectors to suit customer requirements

Snap-action switches
- Snap-action switches with positive opening operation
- Snap-action switches with self-cleaning contacts
- Enabling switches
- Special switches to suit customer requirements

Contactors
- Single and multi-pole DC contactors
- High-voltage AC/DC contactors
- Contactors for battery powered vehicles and power supplies
- Contactors for railway applications
- Terminal bolts and fuse holders
- DC emergency disconnect switches
- Special contactors to suit customer requirements

Electrics for rolling stock
- Equipment for driver’s cab
- Equipment for passenger use
- High-voltage switchgear
- High-voltage heaters
- High-voltage roof equipment
- Equipment for electric brakes
- Design and engineering of train electrics to customer requirements

We reserve the right to make technical alterations without prior notice.
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