NEC Article 409 and UL 508A

Short-circuit current rating (SCCR) of industrial control panels

Reference Manual
Legal information

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| WARNING | indicates that death or severe personal injury may result if proper precautions are not taken. |
| CAUTION | indicates that minor personal injury can result if proper precautions are not taken. |
| NOTICE | indicates that property damage can result if proper precautions are not taken. |

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Introduction

Article 409 on Industrial Control Panels was added to the NEC in its 2005 edition. This Article requires all Industrial Control Panels to be marked with a short-circuit current rating. The short-circuit current rating (SCCR) requirements for UL 508A came into force in April 2006. These changes impact control panel builders, OEMs and end users in a number of different ways:

- The correct choice of power circuit components of a control panel
- Specification of preferred device manufacturers
- Design and marking of panels
- Correct installation and modification of control panels

Siemens is committed to supplying best-in-class products and services to our customers. Siemens provides extensive product documentation to enable its customers to comply with NEC Article 409 and the changes in the UL 508A standard.

Guide

This document includes the following information:

- Overview of NEC Article 409
- Overview of Supplement SB of the UL 508A standard with relevant examples
- Process flow charts
  - Calculating the SCCR value of a component
  - Calculating the SCCR with current-limiting feeder components
  - Calculation of the SCCR value of a control panel

Further information about UL/NFPA

Underwriters Laboratories UL (http://www.ul.com)
UL online certifications directory (http://www.ul.com/database)
National Fire Protection Association NFPA (http://www.nfpa.org)
The NFPA 70: National Electrical Code includes Article 409 on the Construction of Industrial Control Panels operating at 600 volts or less.

**Section 409.2: definition of industrial control panels**

Section 409.2 defines an industrial control panel as:

An assembly of two or more components

- In the power circuit, such as motor controllers, overload relays, fused disconnect switches, and circuit breakers
- In the control circuit, such as pushbuttons, signal lamps, selector switches, time-delay switches/relays, switches, control relays
- Or in a combination of the two circuits

These components are mounted in an enclosure or panel with the associated wiring and terminals.

The industrial control panel does not include the controlled equipment.

**Section 409.110**

Section 409.110 requires a short-circuit current rating (SCCR) to be marked on all industrial control panels. This rating must be based on the rating of a listed and labeled assembly or on another approved method for determining the rating. It also includes a fine print note (FPN) reference to UL 508A Supplement SB as an example of an approved method for determining the SCCR that may be marked on the panel.
Overview of Supplement SB from the UL 508A standard

Components in the power circuit

UL508A is the safety standard for industrial control panels. NEC Article 409 references UL508A Supplement SB as an approved method for determining the SCCR of an industrial control panel. The specific method is outlined in Section SB4.

The SCCR of the control panel is based on the SCCR of each component in the power circuit. The component with the lowest SCCR limits the SCCR of the entire panel. Paragraph SB4.2.1 and Table SB4.1 list the following components as part of the power circuit:

<table>
<thead>
<tr>
<th>Disconnect switches</th>
<th>Supplementary protectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branch circuit protective devices</td>
<td>Busbars</td>
</tr>
<tr>
<td>Fuseholders</td>
<td>Current meters</td>
</tr>
<tr>
<td>Load controllers</td>
<td>Current shunts</td>
</tr>
<tr>
<td>Motor overload relays</td>
<td>Switch units</td>
</tr>
<tr>
<td>Receptacles</td>
<td>Terminals or power distribution blocks</td>
</tr>
</tbody>
</table>

Paragraph SB3.2.1 states that the primary short-circuit protective device for the control circuit is also included in the calculation for the SCCR for the power circuit. Therefore, the SCCR of the overcurrent protective devices (except for supplementary protectors recognized according to UL1077 or sets of supplemental fuses recognized according to UL248-13) are included in calculation of the SCCR of the control panel. Control circuit components on the load side of these devices are not included in calculation of the SCCR.
4.1 SB4.2 – Determining the short-circuit current ratings (SCCR) of individual power circuit components

SB4.2: Determining the short circuit current ratings (SCCR) of individual power circuit components using three possible methods.

- Based on device markings or component instruction sheets
- Based on assumed short-circuit current rating
- Based on tested combinations of devices per UL508

4.1.1 Basic: Device markings or component instruction sheets

Most Siemens power control and circuit protection components include a standard short circuit rating on the front or side label.

Example of marking on a 3RT contactor

![Rating plate](image)

Figure 4-1 Rating plate

Exception

The short-circuit current rating of Siemens frequency converters is stated in the operating instructions or the relevant catalogs. The complies with the requirements of NEC Article 409 and is therefore entered in the relevant UL test reports.
Moreover, in the case of frequency converters that are protected with fuses, circuit breakers per UL489 or self-protected combination motor controllers per UL508 type E, the short-circuit current rating of the drive in conjunction with the line-side protective device is stated.

4.1.2 Basic: Assumed short-circuit current rating

Based on the assumed short-circuit current rating per Table SB4.1 (see excerpt)

![Table SB4.1 Assumed maximum short circuit current rating for unmarked components](image)

Figure 4-2 Table SB4.1 Assumed maximum short circuit current rating for unmarked components (excerpt)
4.1.3 Basic: Tested combination of devices per UL508

To increase the short-circuit current rating of a device, an appropriate protective device must be connected on the line side of it. Which protective device is suitable is stated in the relevant UL test report of the device whose SCCR is to be increased.

UL test report

Example: A 3RT2015 contactor has a default value of 5 kA according to its rating plate. The UL test report states the protective devices with which the short-circuit current rating can be increased. Excerpt from the UL test report:

<table>
<thead>
<tr>
<th>Type No</th>
<th>Fuse Class J</th>
<th>Comb. Mtr. Ctrl. 3RV2.1 or 3RV2.2</th>
<th>Bkr TM 3RV1742</th>
<th>Bkr TM 3RV1721, 3RV1821</th>
<th>Bkr TM 3RV2711, 3RV2811</th>
<th>Bkr I</th>
<th>Short Circuit</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>3RT2015</td>
<td>25 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 kA</td>
<td>600 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 A</td>
<td></td>
<td></td>
<td></td>
<td>42 kA</td>
<td>480 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>22 A</td>
<td></td>
<td></td>
<td></td>
<td>50 kA</td>
<td>480 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16 A</td>
<td>15 A</td>
<td></td>
<td></td>
<td>63 kA</td>
<td>480 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 A</td>
<td>3.2 A</td>
<td>-</td>
<td></td>
<td>10 kA</td>
<td>600 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12.5 A</td>
<td>-</td>
<td>-</td>
<td></td>
<td>30 kA</td>
<td>600 V</td>
</tr>
</tbody>
</table>

Figure 4-3 UL test report excerpt
Basic steps for calculating the SCCR of a control panel

4.1 SB4.2 – Determining the short-circuit current ratings (SCCR) of individual power circuit components

Download: certificates of compliance

For switching devices, so-called certificates of compliance can be downloaded from the following link. This contains the contents of the UL test reports that are relevant for configuration. http://www.siemens.de/sirius/support

Figure 4-4 Support: certificate download 1

Figure 4-5 Support: certificate download 2
Basic steps for calculating the SCCR of a control panel

4.1 SB4.2 – Determining the short-circuit current ratings (SCCR) of individual power circuit components

General information and relevant product documentation (including configuration manuals) relating to North America can be downloaded from the following link: www.siemens.de/ul-europa
Example

The following examples shows a circuit breaker per UL489 in a feeder circuit and a tested combination per UL508 Type F. The circuit breaker has been tested and approved for 100 kA and the self-protected combination motor controller per UL 508 Type E has also been tested and approved for 65 kA.

⇒ The combination shown below complies with 65 kA according to the UL rules.

Example:
Feeder circuit breaker
(MCCB; UL489)
rated current 40A / 480V,
break capacity 100kA at 480V

Motor starter per UL508, type E / F;
rated current 20A,
break current 85kA at 480V / 277V

See UL Report
E156943; Vol. 1; Sec. 18

Motor
motor operating current 20A
4.2 SB4.3 - Use of current-limiting components

SB4.3 – Adaptation of the available short-circuit current rating based on the peak let-through currents when using current-limiting devices in the feeder circuit.

When short-circuit-current-limiting components are used in the feeder circuit, all components in the branch circuit must be rated for the peak let-through current of the short-circuit-current-limiting components used in the feeder circuit.

4.2.1 Current-limiting transformers

For branch circuits powered through a load transformer with an isolated secondary winding, the following applies to the SCCR on the secondary side:

- Transformer < 10 kVA ⇒ max. 5 kA on the secondary side, i.e. all devices on the secondary side must be rated for 5 kA or higher
- Transformer < 5 kVA and max. 120 V ⇒ max. 2 kA on the secondary side, i.e. all devices on the secondary side must be rated for 2 kA or higher
- All other transformers are not current-limiting, i.e. they have the same short-circuit current on the secondary and the primary side
Basic steps for calculating the SCCR of a control panel

4.2 SB4.3 - Use of current-limiting components

4.2.2 Current-limiting circuit breaker (per UL489)

To be able to use a circuit breaker as a current-limiting component in the feeder circuit, it must be marked "current limiting."

In this case, the let-through currents of the circuit-breaker must be considered. The let-through current can be obtained from the circuit breaker characteristic.

Example

The example shows that this circuit breaker lets through 22 kA during a 100-kA short circuit.

⇒ The SCCR of the assembly is the breaking capacity of the circuit breaker in the feeder circuit under the following conditions:
- The SCCR of all individual components in the circuit is not lower than the peak let-through current of the circuit breaker in the feeder circuit.
- The breaking capacity of all branch circuit protective devices or the SCCR of all "combination motor controllers" is not lower than the breaking capacity of the circuit breaker in the feeder circuit.

⇒ The SCCR of the assembly is the lowest breaking capacity of a branch circuit protective device connected on the load side of the circuit breaker in the feeder circuit or a "combination motor controller" if this is smaller than the breaking capacity of the circuit breaker in the feeder circuit.

⇒ The SCCR value of the assembly is the lowest SCCR value of each branch circuit on the load side of the circuit breaker if the above conditions do not apply.
4.2.3 Current-limiting fuses

Only fuses from UL508A, Tab. SB4.2 may be used as current-limiting fuses. This table shows the relevant let-through currents (see column Ip x 10³).

![Table SB4.2](image)

⇒ The SCCR of the assembly is the breaking capacity of the fuse in the feeder circuit under the following conditions:

- The SCCR of all individual components in the circuit is not lower than the peak let-through current of the fuse in the feeder circuit.
- The breaking capacity of all branch circuit protective devices or the SCCR of all "combination motor controllers" is not lower than the breaking capacity of the fuse in the feeder circuit.

⇒ The SCCR of the assembly is the lowest breaking capacity of a branch circuit protective device connected on the load side of the fuse in the feeder circuit or a "combination motor controller" if this is lower than the breaking capacity of the fuse in the feeder circuit.

⇒ The SCCR of the assembly is the lowest SCCR of each branch circuit on the load side of the fuse if the above conditions do not apply.
## Examples

The following two examples show a fuse as the feeder circuit protective device. The procedure described also applies if a circuit breaker per UL489 is used as the feeder circuit protective device.

### Example 1

⇒ SCCR value 35 kA because the circuit breaker is only suitable for 35 kA. The contactor and overload relay are protected by the fuse in the feeder circuit because 5 kA (SCCR contactor and overload relay) > 3 kA (let-through current of the fuse).

<table>
<thead>
<tr>
<th>Fuse</th>
<th>BCPD circuit breaker 3RV17</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contactor / overload relay rated current 10A / 460V max. short-circuit current ca 5kA@480V</td>
</tr>
<tr>
<td>3RT1 contactor</td>
<td>Motor</td>
</tr>
<tr>
<td>3RB overload relay</td>
<td></td>
</tr>
</tbody>
</table>

### Example 2

⇒ SCCR value 50 kA because the circuit breaker does not have a lower breaking capacity than the fuse. The contactor and overload relay are protected by the fuse in the feeder circuit because 5 kA (SCCR contactor and overload relay) > 3 kA (let-through current of the fuse).

<table>
<thead>
<tr>
<th>Fuse</th>
<th>BCPD circuit breaker 3RV17</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contactor / overload relay rated current 10A / 460V max. short-circuit current ca 5kA@480V</td>
</tr>
<tr>
<td>3RT contactor</td>
<td>Motor</td>
</tr>
<tr>
<td>3RB overload relay</td>
<td></td>
</tr>
</tbody>
</table>
4.3 SB4.4 – SCCR calculation of the industrial control panel

SB4.4 – SCCR calculation of the industrial control panel with limitation to the lowest value of a component or a circuit according to SB4.2 or SB4.3.

Example

The first calculation is based on SB4.2 and looks as the individual SCCR values with which the components are marked or that appear on the list of unmarked components.

<table>
<thead>
<tr>
<th>Industrial control panel</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
</tr>
<tr>
<td></td>
<td>①</td>
</tr>
<tr>
<td></td>
<td>②</td>
</tr>
<tr>
<td></td>
<td>③</td>
</tr>
<tr>
<td></td>
<td>④</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control circuit</th>
<th>Catalog no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>⑤ Control transformer</td>
<td>MT0050A</td>
</tr>
<tr>
<td>⑥ Control relay</td>
<td>3RH1122-1AK61</td>
</tr>
<tr>
<td>⑦ Terminal blocks</td>
<td>8WA1011-0DF21</td>
</tr>
<tr>
<td>⑧ Display lamp</td>
<td>52PC4E2</td>
</tr>
<tr>
<td>⑨ HAND-OFF-AUTO selector switch</td>
<td>52SA2CABA2</td>
</tr>
</tbody>
</table>

The components listed under control circuit do not have to be included in the SCCR calculation for the industrial control panel.

The individual SCCR values of the individual power circuit components are as follows:

<table>
<thead>
<tr>
<th>No.</th>
<th>Power circuit</th>
<th>Catalog no.</th>
<th>SCCR at 480 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>Circuit breaker</td>
<td>ED63B050</td>
<td>25 kA</td>
</tr>
<tr>
<td>②</td>
<td>Contactor</td>
<td>40FP32AA</td>
<td>5 kA</td>
</tr>
<tr>
<td>③</td>
<td>Overload relays</td>
<td>48BSH3M10</td>
<td>5 kA</td>
</tr>
<tr>
<td>④</td>
<td>Fuses on the primary side of the control transformer</td>
<td>CC fuses</td>
<td>200 kA</td>
</tr>
</tbody>
</table>

Both the contactor and the overload relay have an SCCR of 5 kA at 480 V. If no further information is available, this industrial control panel would be marked with an SCCR of 5 kA at 480 V AC.
Basic steps for calculating the SCCR of a control panel

4.3 SB4.4 – SCCR calculation of the industrial control panel
Flow chart for calculating the SCCR of a component

5.1 Calculating the SCCR value of a component

Figure 5-1 SB4.2

Short-circuit current rating (SCCR) of industrial control panels
Reference Manual, 02/2013, A5E31896849002A/RS-AA/001
5.2 Calculating the SCCR with current-limiting feeder components

Flow chart for calculating the SCCR of a component

Figure 5-2  SB4.3 (1)
Flow chart for calculating the SCCR of a component

5.2 Calculating the SCCR with current-limiting feeder components

1. Are any of the branch circuits powered through a CC, G, J, L, RK1, RK5, or T class fuse in the feeder circuit?
   - Yes
   - No

2. Do all components in the branch circuit have a SCCR that is greater than or equal to the peak let-through current of the fuse stated in Table SB4.2?
   - Yes
   - No

3. Is the SCCR of all branch circuit protective devices, combination motor controllers, or branch circuits on the load side of the feeder fuse greater than or equal to the breaking capacity of the feeder fuse?
   - Yes
   - No

4. Use the breaking capacity of the feeder fuse

Figure 5-3 SB4.3 (2)
5.3 Calculating the SCCR of an industrial control panel

Flow chart for calculating the SCCR of a component

Determine the short-circuit current rating of an industrial control panel per UL 508A, Supplement SB 4.4

Have the SCCR values of the individual power circuit components been calculated per SB 4.2 or according to the flow chart on the previous page

Yes

No

Does the industrial control panel include only one branch circuit?

No

Yes

Is any of the branch circuits powered through a power transformer with an isolated secondary winding?

No

Yes

Are any of the branch circuits powered through a listed circuit breaker marked “current limiting” in the feeder circuit?

No

Yes

Are any of the branch circuits powered through a CC, G, J, L, RK1, RK5, or T class fuse in the feeder circuit?

No

Yes

Use the smallest SCCR of all branch circuits, power distribution components, control circuit overcurrent protective devices or use of a modified SCCR for each branch circuit powered through an associated feeder component (SB4.3.1 - SB4.3.3).

See SB4.3.1. Use the flow chart on the preceding page to determine whether the SCCR of the branch circuit can be changed

See SB4.3.2. Use the flow chart on the preceding page to calculate whether the SCCR of the branch circuit can be changed

See SB4.3.3. Use the flow chart on the preceding page to determine whether the SCCR of the branch circuit can be changed

Use the lowest SCCR of all power circuit components and of the control circuit overcurrent protection

Compare the lowest SCCR of all power circuit components on the load side of the branch circuit protective device and the control circuit overcurrent protective device with the SCCR of the branch circuit protective device; use the lower of the two SCCR values

Figure 5-4 SB4.4