SIEMENS

Industrial Controls

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

Reference Manual

Edition 06/2013

Answers for industry.

SIEMENS

NEC Article 409 and UL 508A

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

Reference Manual

06/2013

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Legal information

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This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

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indicates that death or severe personal injury **may** result if proper precautions are not taken.

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indicates that minor personal injury can result if proper precautions are not taken.

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Introduction

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Article 409 on Industrial Control Panels was added to the NEC (National Electrical Code) 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 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 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)

Overview of NEC Article 409

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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 consisting of one of the following:

1. Power circuit components only, such as motor controllers, overload relays, fused disconnect switches, and circuit breakers
2. Control circuit components only, such as pushbuttons, pilot lights, selector switches, timers, switches, control relays
3. A combination of power and control circuit components"

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: Marking of the short-circuit current rating

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

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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 defines the SCCR of the entire panel. Paragraph SB4.2.1 and Table SB4.1 list the following components as part of the power circuit:

Disconnect switches	Supplementary protectors
Branch circuit protective devices	Busbars
Fuseholders	Current meters
Load controllers	Current shunts
Motor overload relays	Switch units
Receptacles	Terminal blocks or power distribution blocks

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.

Basic steps for calculating the SCCR of a control panel

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

The short-circuit strength of individual power circuit components can be calculated 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 according to 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 on the nameplate.

Example of marking on a 3RT contactor

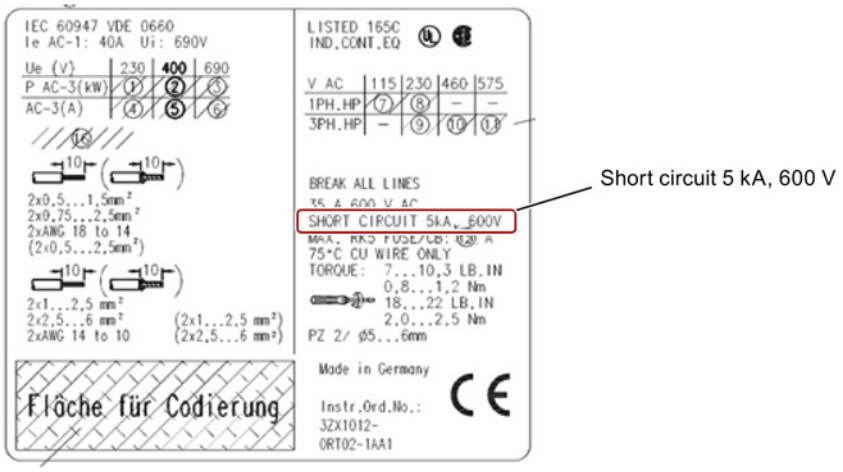


Figure 4-1 Nameplate

Exception

The short-circuit current rating of Siemens frequency converters is stated in the operating instructions or the relevant catalogs. This 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 according to 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

For unmarked components, the assumed maximum short-circuit current rating in accordance with Table SB4.1 (see extract) can be used for calculating the short-circuit current rating.

Table SB4.1
Assumed maximum short circuit current rating for unmarked components
Table SB4.1 revised, effective date to be determined

Component	Short circuit current rating, kA
Bus bars	10
Circuit breaker (including GFCI type)	5
Current meters	a
Current shunt	10
Fuseholder	10
Industrial control equipment:	
a. Auxiliary devices (overload relay)	5

Figure 4-2 Table SB4.1: Assumed maximum short-circuit current rating for unmarked components (extract)

4.1.3 Basic: Tested combination of devices according to 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 short-circuit current rating 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.

High Capacity Short Circuit Ratings:

			Circuit Breaker					
Type No.	Fuse Class J	Comb. Mtr. Ctlr. 3RV2.1 or 3RV2.2	Bkr TM 3RV1742	Bkr TM 3RV1721, 3RV1821	Bkr TM 3RV2711, 3RV2811	Bkr I	Short Circuit	Voltage
3RT2015	25 A					-	100 kA	600 V
			10 A			-	42 kA	480 V
				22 A		-	50 kA	480 V
		16 A			15 A	-	65 kA	480 V
				8 A	3.2 A	-	10 kA	600 V
		12.5 A				-	30 kA	600 V

Figure 4-3 Extract from the UL test report

Download: certificates of compliance

Certificates of Compliance (http://www.siemens.com/sirius/support) for switching devices can be downloaded on the Internet. These contain the contents of the UL test reports that are relevant for configuration.

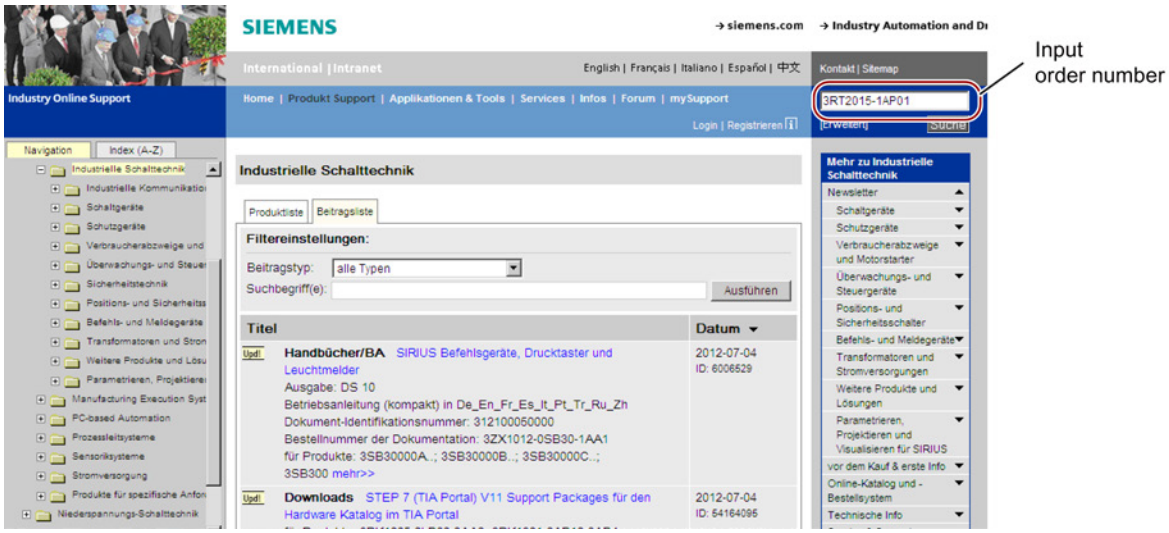


Figure 4-4 Support: certificate download 1

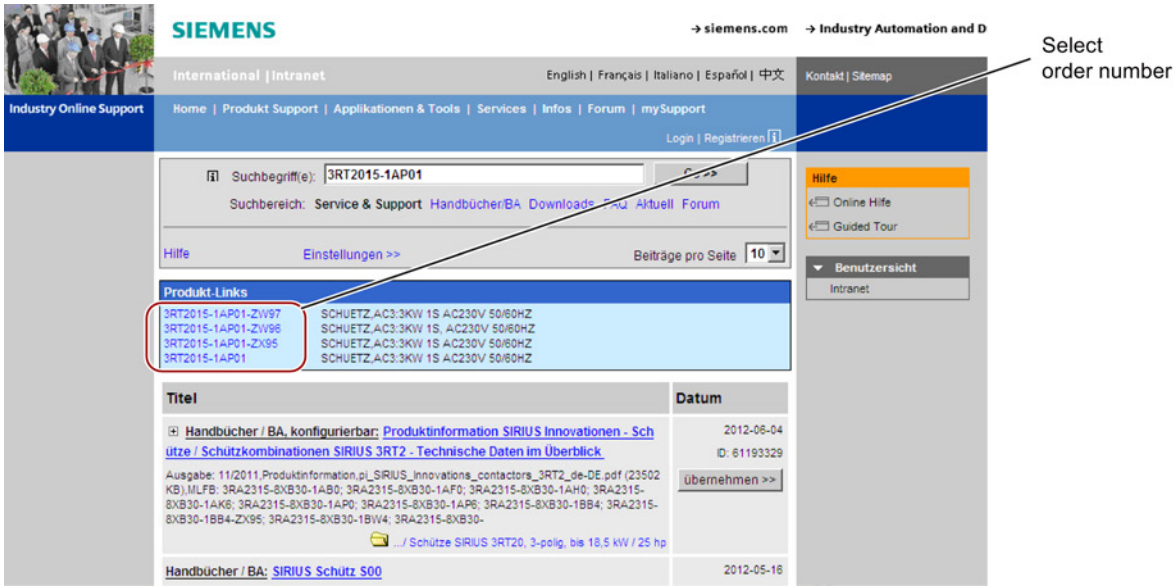


Figure 4-5 Support: certificate download 2

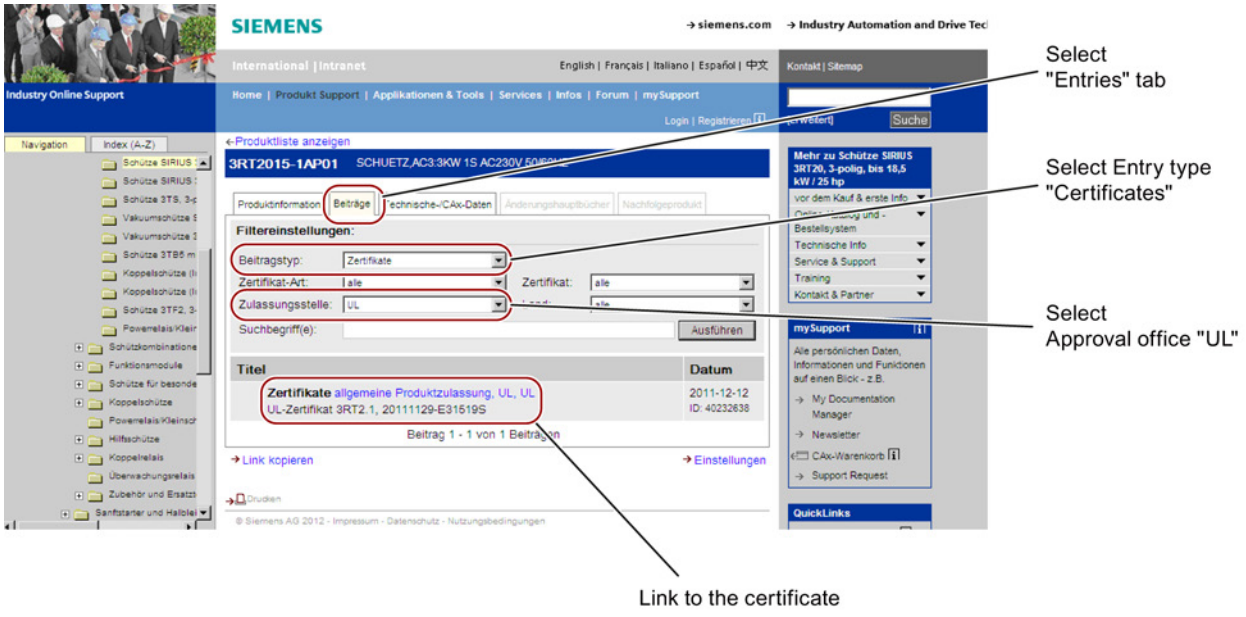


Figure 4-6 Support: certificate download 3

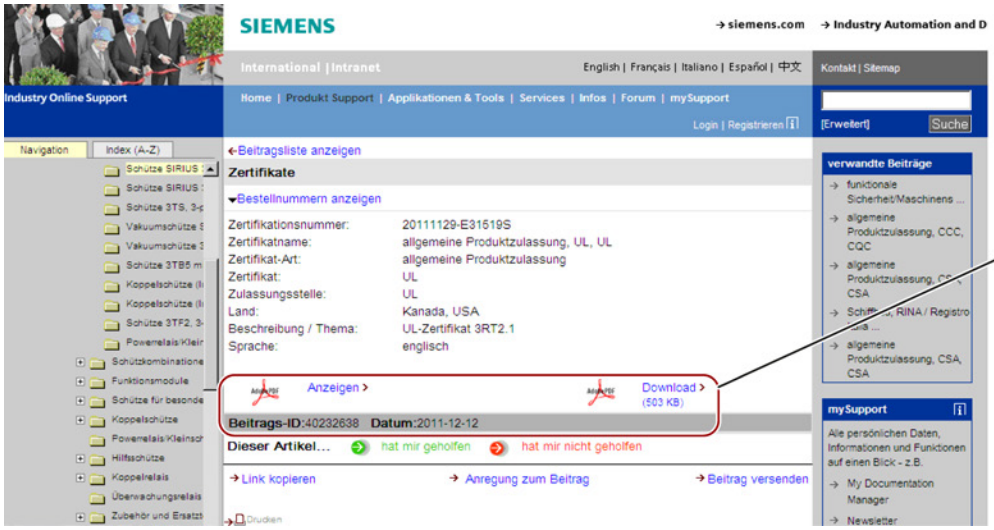


Figure 4-7 Support: certificate download 4

General information and relevant product documentation (including configuration manuals) relating to North America are also available on the Internet (www.siemens.com/applicationconsulting/ul).

Example

The following example shows a circuit breaker according to UL489 in a feeder circuit and a tested combination according to 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.

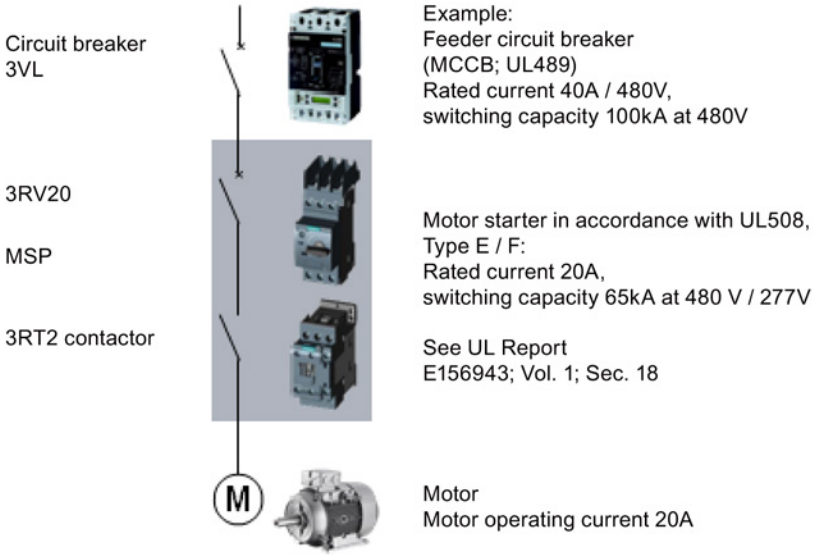


Figure 4-8 Example combination

4.2 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 short-circuit current rating 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

4.2.2 Current-limiting circuit breakers (according to UL489)

To be able to use a circuit breaker in accordance with UL489 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

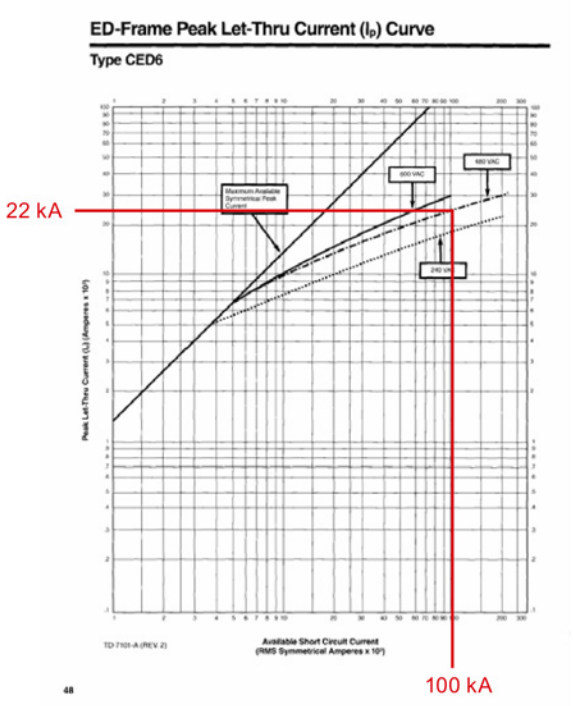
The SCCR of the assembly is the breaking capacity of the circuit breaker in the feeder circuit under the following conditions:

- The SCCR of all individual components in the branch 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 or combination motor controller connected on the load side of the circuit breaker in the feeder circuit if this is smaller than the breaking capacity of the circuit breaker in the feeder circuit.

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

4.2 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



The selected circuit breaker lets 22 kA through at a short-circuit of 100 kA.

⇒ In other words, all components in the branch circuit must be designed for at least 22 kA. The control panel is suitable for a maximum let-through value of 100 kA.

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 peak let-through currents (see column I_p x 10^3).

Table SB4.2
Peak let through currents, I_p, and clearing, I^2t, for fuses
Table SB4.2 revised, effective date to be determined

Fuse types	Fuse rating amperes	Between threshold and 50 kA		100 kA	
		$I^2t \times 10^3$	$I_p \times 10^3$	$I^2t \times 10^3$	$I_p \times 10^3$
Class CC	15	2	3	2	3
	20	2	3	3	4
	30	7	6	7	7.5
Class G	15	–	–	3.8	4
	20	–	–	5	5
	30	–	–	7	7
	60	–	–	25	10.5
300 volt Class T[b]	1	–	–	0.4	0.8
	3	–	–	0.6	1.3
	6	–	–	1	2
	10	–	–	1.5	3

Figure 4-9 Table SB4.2

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 branch 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.

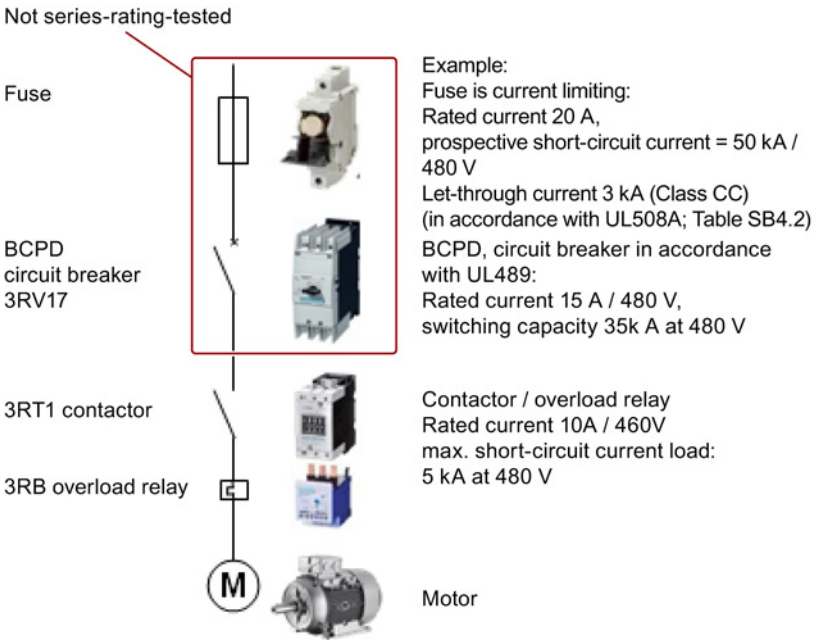
⇒ The SCCR of the assembly is the lowest breaking capacity of a branch circuit protective device or combination motor controller connected on the load side of the fuse in the feeder circuit if this is smaller than the breaking capacity of the fuse in the feeder circuit.

⇒ 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

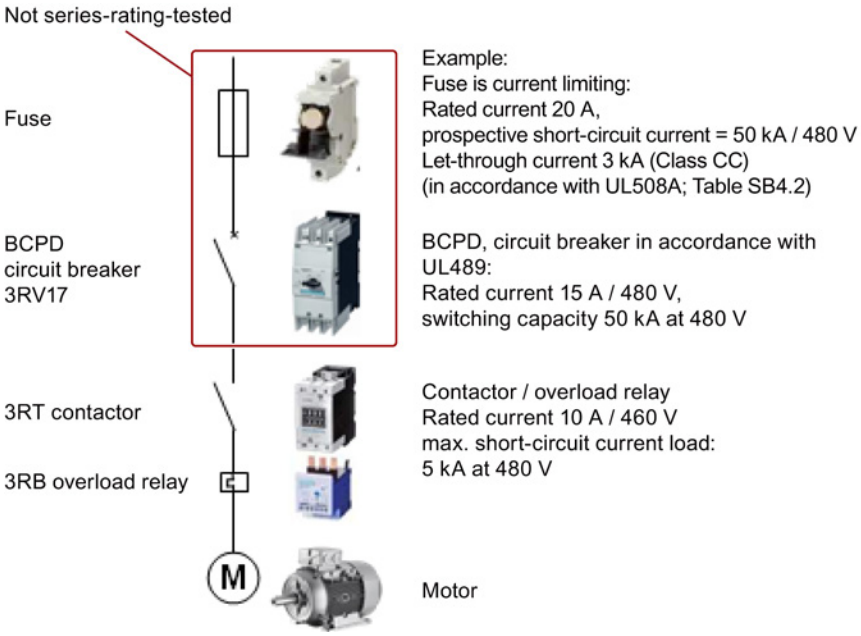
The following two examples show a fuse as the feeder circuit protective device. The procedure described also applies if a circuit breaker according to UL489 is used as the feeder circuit protective device.

Example 1



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

Example 2



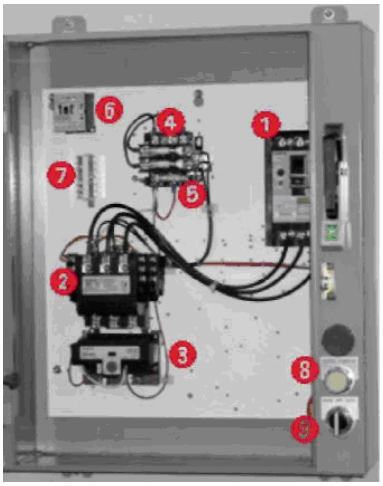
⇒ SCCR 50 kA since the breaking capacity of the circuit breaker is not lower than that of the fuse.
The contactor and overload relays are protected by the fuse in the feeder circuit since 5 kA (SCCR of contactor and overload relays) is > 3 kA (let-through value of the fuse).

4.3 SB4.4 – SCCR calculation of the industrial control panel

The SCCR of the industrial control panel is calculated 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.

Industrial control panel	Components	
	**No.**	**Power circuit**
	①	Circuit breaker
	②	Contactor
	③	Overload relays
	④	Fuses on the primary side of the control transformer
	No.	**Control circuit**
	⑤	Control transformer
	⑥	Control relay
	⑦	Terminal blocks
	⑧	Display lamp
	⑨	HAND-OFF-AUTO selector switch

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:

No.	Power circuit	SCCR at 480 V
①	Circuit breaker	25 kA
②	Contactor	5 kA
③	Overload relays	5 kA
④	Fuses on the primary side of the control transformer	200 kA

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.

Flow chart for calculating the SCCR of a component

5

5.1 Calculation of the short-circuit current rating of an individual power circuit component according to UL 508A SB4.2

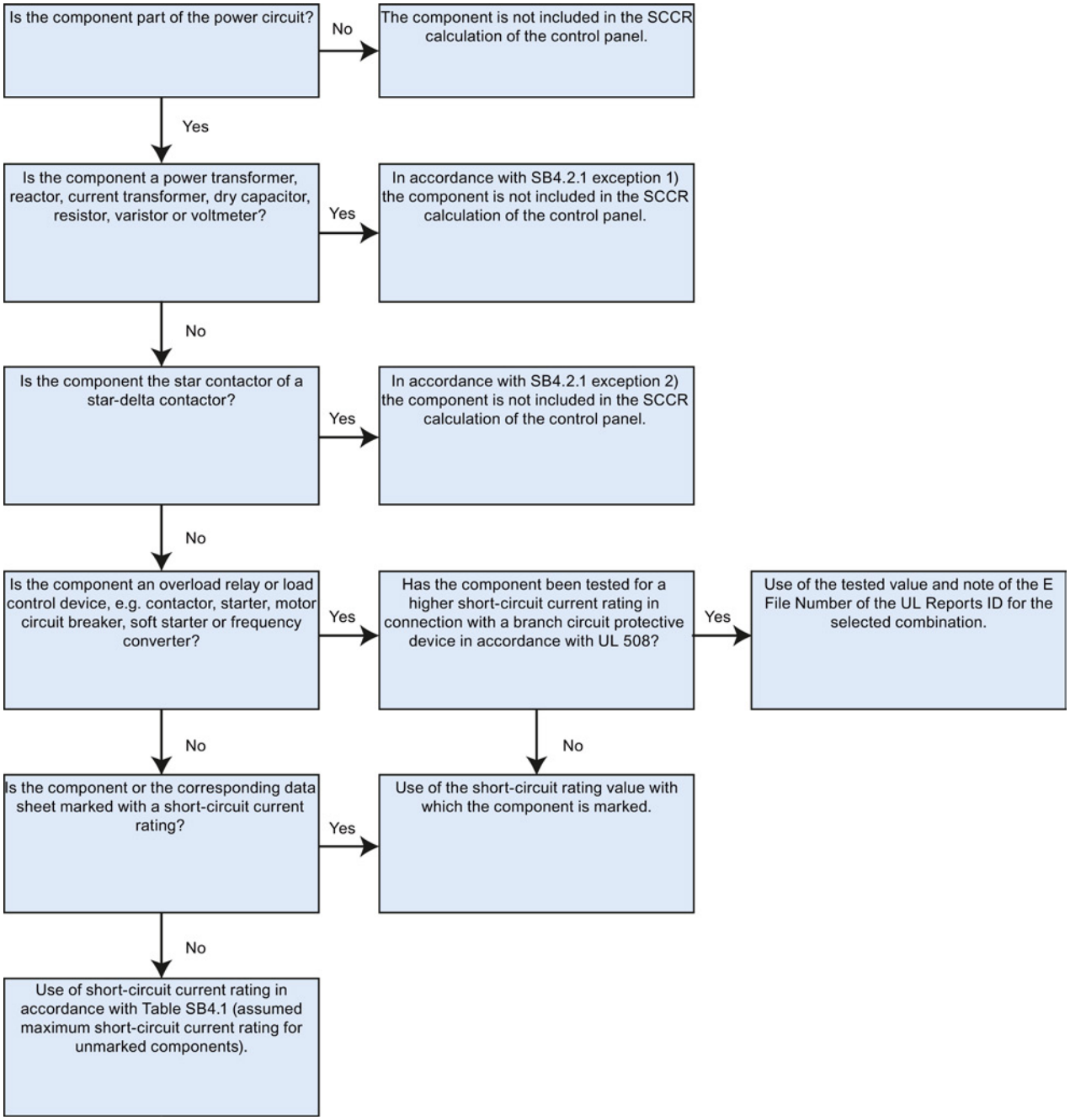


Figure 5-1 SB4.2

5.2 Calculation of the short-circuit current rating of current-limiting feeder components

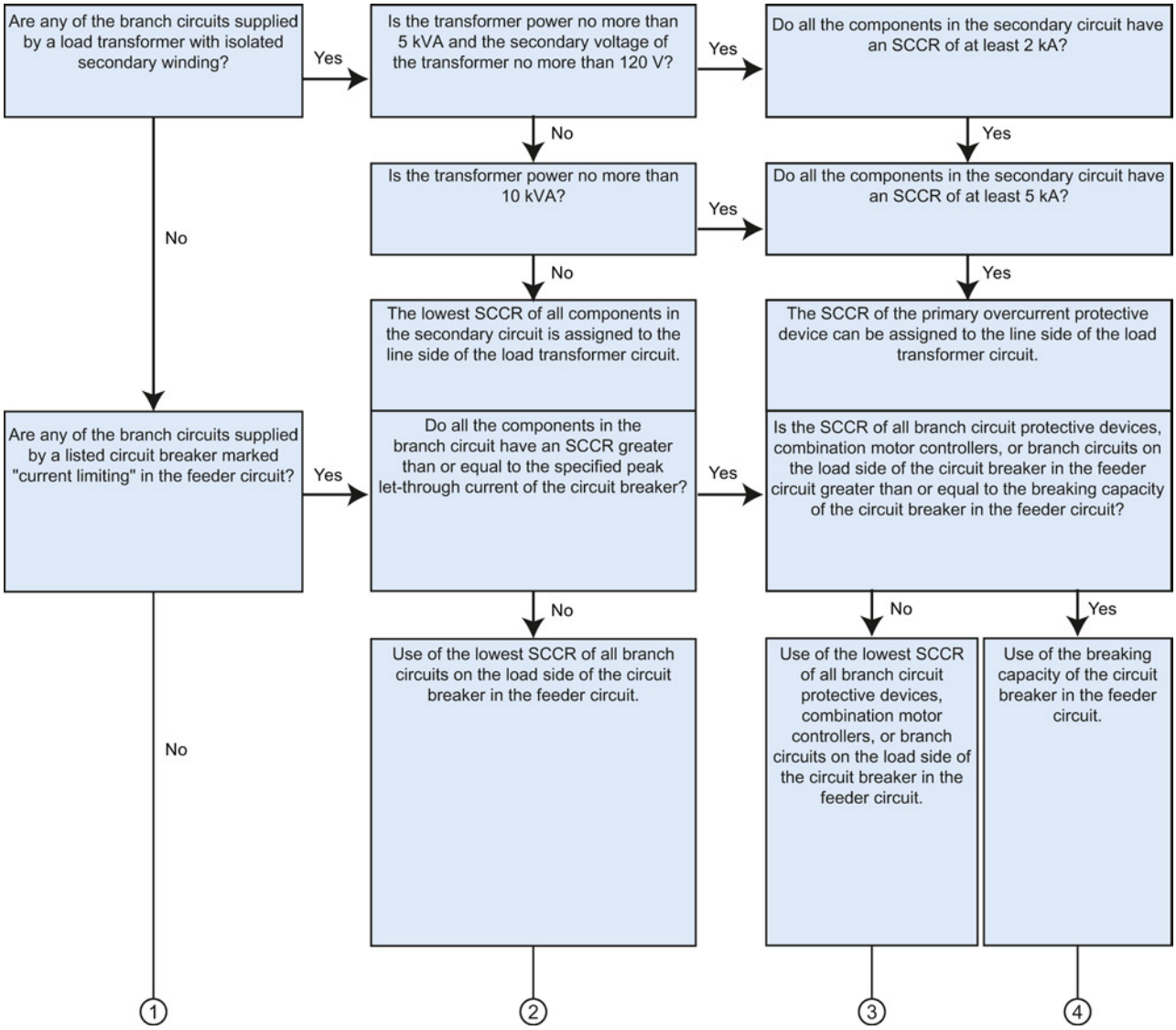


Figure 5-2 SB4.3 (1)

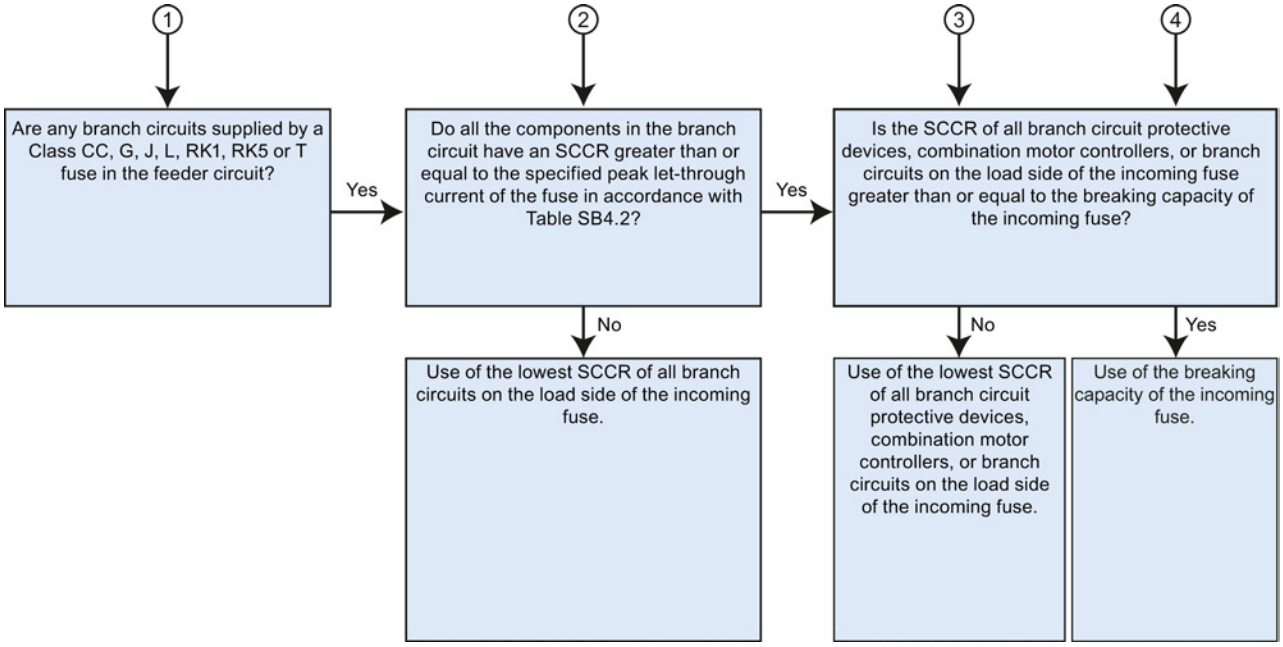


Figure 5-3 SB4.3 (2)

5.3 Calculation of the short-circuit current rating of a control panel in accordance with UL 508A Supplement SB 4.4

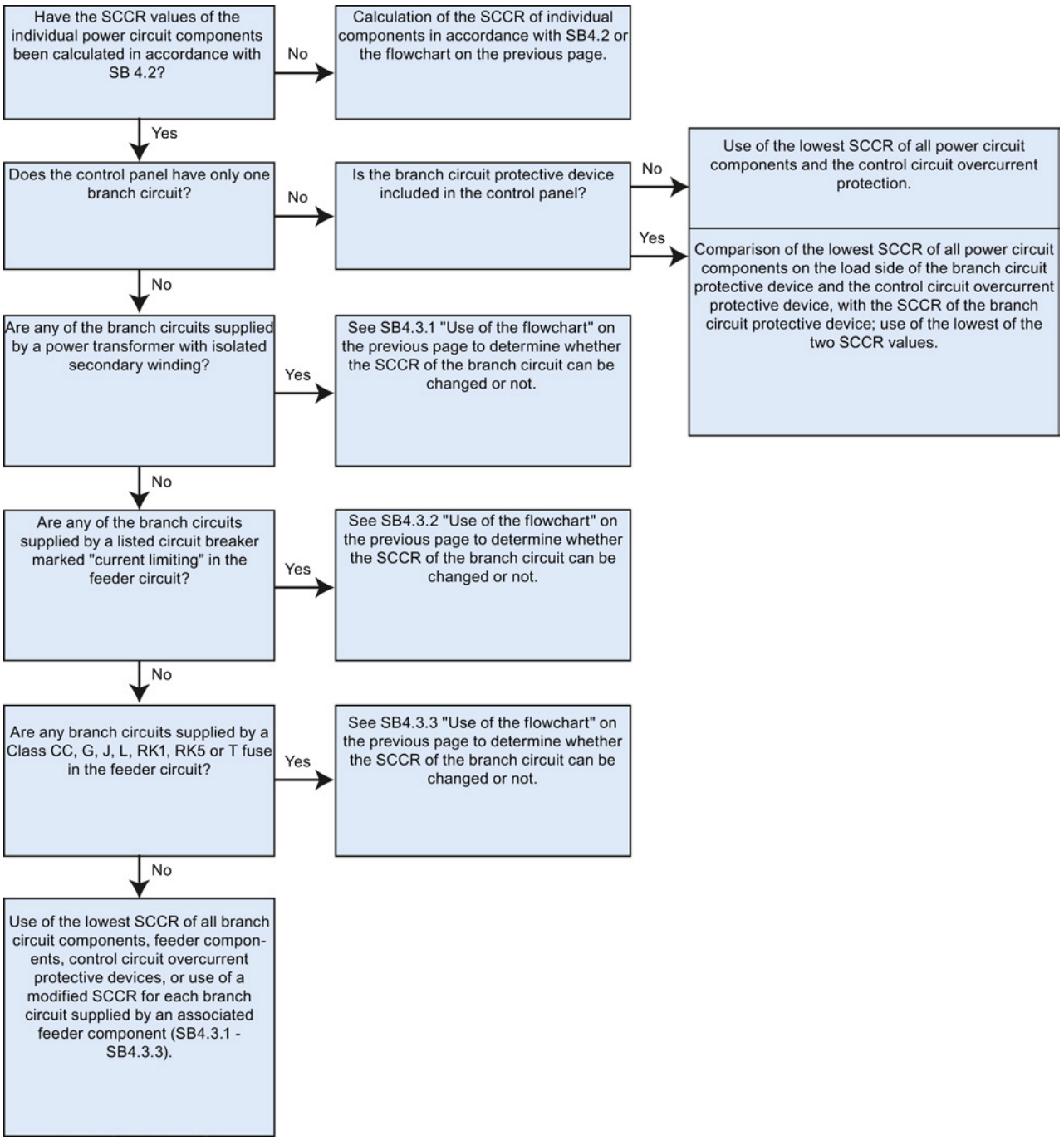


Figure 5-4 SB4.4

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